Report on the National Survey of Grevy's Zebra in Kenya

24-29 November 2008

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On behalf of the Grevy's Zebra Technical Committee

Contents

Acknowledgements

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Executive Summary

This report presents the results of the Kenyan national survey for Grevy's zebra, carried out in November 2008 in collaboration with the Monitoring of the Illegal Killing of Elephants (MIKE) survey, the Kenya Wildlife Service and the Grevy's Zebra Technical Committee. The report begins with a description of the conservation status of Grevy's zebra and past efforts to survey them. The aerial survey methods used in this survey are presented alongside a detailed description of the survey area. Results are divided into three distinct sections. In the first, Grevy's zebra numbers are presented in terms of management zone and land use type. In the second, aerial survey results are compared to ground survey data collected simultaneously. In the third, the distribution of Grevy's zebra is compared to a range of human and environmental variables. Finally, recommendations are made for future surveys.

The goals of the survey were to: determine the distribution and provide a minimum count of Grevy's zebra across Kenya; identify locations where populations have declined and those where populations have increased based on survey results; and, to institutionalize a periodic count of Grevy's zebra in Kenya. The survey used a standardised minimum count methodology to count Grevy's zebra within a 46,391 km^2 survey area.

The total number of Grevy's zebra counted was 2,407. Results showed that the highest concentrations of Grevy's zebra were found in the centre of the Laikipia and Wamba management zones. In Wamba, Grevy's zebra were found chiefly in community conservancies. More than 60% of Grevy's zebra sightings occur on community land, demonstrating that pastoralist communities in northern Kenya are critical to the survival of this species. Communities of particular importance are Meibae, West Gate and Kalama Conservancies in the Wamba management zone, and Koija and Kirimon in the Laikipia management zone. In Laikipia, Grevy's zebra were found mainly within private ranches. Both the Lewa Wildlife Conservancy and Ol Jogi remain important refuges for the species. Eleven percent of all Grevy's zebra sighted were found outside conservancies within community trust land, indicating that healthy sub-populations of the species exist even where there is no formal protection in place.

The precision and/or accuracy of a minimum count such as this cannot be determined without some form of multiple sampling, or a measure of detectability. Carrying out simultaneous ground counts in nine blocks has enabled comparisons between methods. Ground and aerial counts were found to coincide for most areas except Kirimon and Meibae, where external factors indicated that ground counts were off the mark. This result is encouraging because it suggests that aerial surveys are a potentially useful method to estimate zebra populations.

Grevy's zebra distributions were closely aligned with those of plains zebra, especially in the Laikipia and southern Wamba management zones. North of this plains zebra were not present. Cattle and Grevy's zebra also exhibited extensive overlap of range, especially in Laikipia and Wamba, but also in Laisamis and El Barta.

The Grevy's Zebra Technical Committee recommends modification of the management zones to include Grevy's zebra that were counted in areas outside the current zone boundaries. Assessment of population health is also possible by determining age structure during an aerial survey and should be undertaken during the next count in light of the threats to Grevy's zebra recruitment that have been identified by previous research. We also recommend improving the survey method including using a 1km transect interval across all areas in order to avoid missing Grevy's zebra, determining a detection factor for Grevy's zebra in each survey block and correcting results for this, and investigating the option of sample surveys. In future surveys a more systematic ground survey should be employed in parallel with the aerial survey to more fully explore the accuracy of this method. Finally, we recommend that local experts be used as spotters to improve the accuracy of counts and promote local involvement in the survey.

Background

Grevy's zebra (*Equus grevyi*) are in crisis. Numbers have declined rapidly in recent times (Nelson, 2003; Rowen & Ginsberg, 1992) from estimates of 15,000 in the late 1970s (Grunblatt *et al*, 1989) to current estimates of between 1,700 and 2,100 animals (Nelson, 2003; Williams *et al*, 2003). This represents a maximum decline of 85% over the last 27 years. The range of Grevy's zebra has also dramatically reduced in size. This species once ranged over large tracts of south western Somalia and northern Kenya, as well as large areas of Ethiopia through to northern Djibouti and southern Eritrea. Today it remains only in northern Kenya and southern Ethiopia, with 93% of the population occurring within Kenya.

The last comprehensive survey of Grevy's zebra in Kenya was undertaken in the year 2000 (Nelson & Williams 2003), resulting in an estimated national population of 2,571 (± 136). In 2004, information contributed by various stakeholders in a workshop suggested that Grevy's zebra numbers may have further decreased to between 1,567 and 1,976 (Williams & Low 2004), which represents a decline of a third in just four years.

In response to this sharp decline, conservation efforts for this species have been intensified over the last five years, particularly in communal lands. A second stakeholder workshop in 2007 suggested that the number of Grevy's zebra in Kenya was between 1,838 and 2,319 (Mwasi & Mwangi, 2007). This result suggests a marginal increase in Grevy's zebra numbers from the previous estimate of 2004.

However both the 2004 and 2007 numbers were based on estimates of local stakeholders and conservation experts. Without effective accounting of Grevy's zebra numbers, we cannot know whether these conservation efforts are successful. Further, we cannot effectively plan future conservation action without knowing the current status of Grevy's zebra in Kenya.

For evaluating current conservation and planning future action, the recent *Conservation and Management Strategy for Grevy's Zebra in Kenya* (KWS, 2008) considers population monitoring imperative. Monitoring will provide baseline data on the distribution and numbers of Grevy's zebra within Kenya. Such data will enable the assessment and prioritization of appropriate actions for Grevy's zebra conservation and will be used to update their IUCN conservation status. Furthermore, the national strategy emphasizes the importance of developing standardized methods for surveying Grevy's zebra throughout their range and at regular intervals in the future.

In 2008 the Kenya Wildlife Service (KWS) and the Monitoring of Illegal Killing of Elephants (MIKE) planned a survey of elephants within Laikipia and Samburu Districts. This survey is usually undertaken every four years and provides a minimum count of elephants for this region of northern Kenya. The MIKE elephant survey area overlaps significantly with the core area of Grevy's zebra range (Figure 1). For this reason, we chose to combine forces and carry out a joint survey for Grevy's zebra and elephants. It is anticipated that the collaboration with MIKE will institutionalize the national survey for Grevy's zebra and will ensure it is repeated at four year intervals. By working together with MIKE, we shared equipment and personnel thus saving costs. The survey was carried out in November 2008 using standard aerial survey methods. The exercise was coordinated by KWS in collaboration with MIKE and the Grevy's Zebra Working Group.

The Grevy's Zebra Working Group is a collaboration of seven organizations including: African Wildlife Foundation, Denver Zoo, Princeton University, Grevy's Zebra Trust, Kenya Wildlife Service, Lewa Wildlife Conservancy, Marwell Wildlife and Northern Rangelands Trust. These organisations are committed to conserving Grevy's zebra. The Working Group

has since evolved into the Grevy's Zebra Technical Committee (GZTC) in line with the coordinating framework defined in the Conservation and Management Strategy for Grevy's zebra (KWS, 2008). The GZTC's mission is to deliver pragmatic, management oriented initiatives to strengthen Grevy's zebra conservation action within Kenya. The GZTC coordinates and implements conservation, research, education, and management activities in line with the objectives of Conservation and Management Strategy.

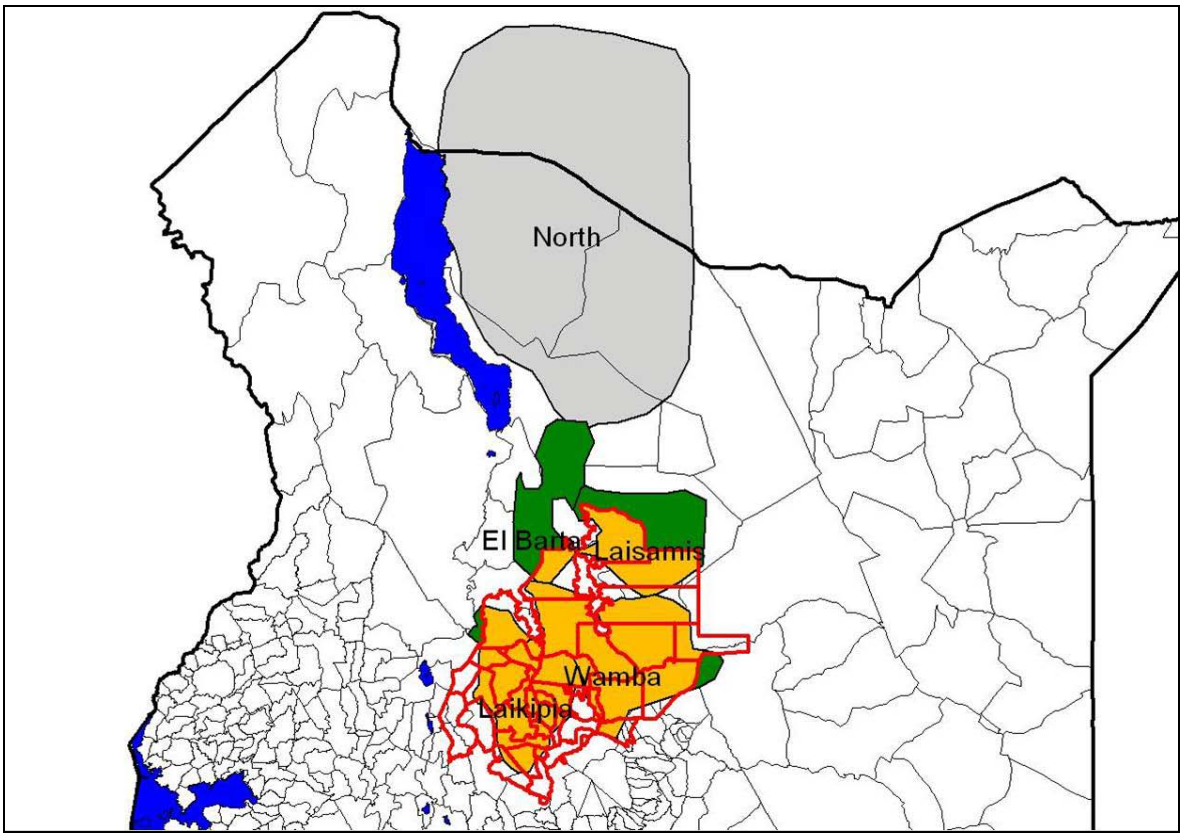

Figure 1: The MIKE survey zones (red outline) and their overlap with the Grevy's zebra survey zones (yellow). Extensions required for Grevy's zebra are displayed as green. The excluded North zone is shown in grey.

Goals

The goals of the Grevy's zebra survey were to:

1. Determine the distribution and provide a minimum count of Grevy's zebra across Kenya
2. Provide baseline data from which to identify future locations where populations have declined and those where populations have increased
3. Institutionalize a periodic count of Grevy's zebra in Kenya

Specific outputs

- To produce a minimum count of Grevy's zebra by area for the country. This represents the first comprehensive count of Grevy's zebra in Kenya since 2000.
- To produce a map with detailed information on the distribution of Grevy's zebra across Kenya. This will enable the prioritisation of conservation resources and provide information to assess conservation initiatives such as the newly established community conservancies.

- To provide a baseline for future comparisons to be made so that populations that are increasing and those that are declining can be easily identified. This allows us to assess where conservation efforts have been successful and where further intervention is required.
- To provide the count data to IUCN authorities so that the global conservation status of Grevy's zebra may be updated.

Survey Methods

Sample surveys carried out by the Department of Resource Surveys and Remote Sensing (DRSRS) have provided data on Grevy's zebra across its range in Kenya since 1977 (Grunblatt *et al*, 1996). However, the regularity of the DRSRS surveys has been inconsistent due to lack of resources. In addition, because Grevy's zebra occur in relatively low densities and are grouped in herds, results from these sample surveys have significantly high standard errors (Grunblatt *et al*., 1996; Muchoki, 2000; Williams, 2002).

The 2000 ground survey in Kenya carried out by Nelson used capture-mark-recapture methods (Nelson & Williams, 2003). Whilst this method is low cost and is considered to be more accurate for estimating a low density and widely dispersed species such as Grevy's zebra, the investment of labour and time required to undertake the analysis significantly delays the delivery of results. Because timely results are needed for assessing conservation progress, it was felt that this method would not be appropriate for current management needs.

Minimum counts for Grevy's zebra have been successfully conducted on Lewa Wildlife Conservancy in Kenya since 1977 (Williams, 2002). They were also carried out in Ethiopia (Thouless, 1995a; Thouless 1995b) and the most recent count for Ethiopia combined aerial and ground surveys to estimate their national population (Williams *et al*, 2003). We recognise that one limitation of this method is that there is no accounting for accuracy or precision and this is further explored in the Discussion section.

The MIKE elephant survey uses a standardised minimum count methodology (Craig, 2004). The survey area is divided into survey blocks and surveyed using transects flown at approximately 1 km intervals, except in areas where elephants and Grevy's zebra are known to occur at low densities and therefore transects are flown at 2 km intervals. Given the high visibility within the majority of Grevy's zebra range, this transect interval enables total coverage of the survey area. Aircraft speed is held constant at approximately 130 kph and mean height at which the aircraft flies above the ground is 200-400ft. Each aircraft contains a pilot, a front seat observer who navigates and records data, and two rear seat observers. The observers count all Grevy's zebra seen on either side of the aircraft (500 m for 1 km transect spacing and 1,000 m for 2 km transect spacing), noting the number of animals and their location with a GPS.

Survey Zones

The Grevy's zebra range in northern Kenya has been divided into five distinct zones for the purposes of management and the survey area was based on these divisions (Figure 1). The zones are: Laikipia, Wamba, El Barta, Laisamis and North and they represent the majority of Grevy's zebra range. The Laikipia and Wamba zones are considered to be high density, with relatively large populations of Grevy's zebra. El Barta and Laisamis are considered to be lower density, with smaller but significant populations of Grevy's zebra. The North zone is considered to be extremely low density, with only small scattered herds occurring.

For the purpose of the Grevy's zebra national survey, we focused efforts on the four core zones of Laikipia, Wamba, El Barta and Laisamis. The North zone was excluded from the national survey on account of the very low densities of Grevy's zebra spread over a large

area making an aerial survey for that zone economically unfeasible. A combined ground and aerial survey is planned to cover the North zone later in 2009.

The MIKE survey boundaries excluded several key areas of the Grevy's zebra range, so additional areas that required coverage were incorporated into the survey. These were: the north-western edge of the Laikipia zone, the eastern portion of the Wamba zone, the north eastern half of the Laisamis zone and the northern three quarters of the El Barta zone (shown in green on Figure 1). The area of the extensions is displayed below in Table 1.

Table 1: Area of required extensions for each survey zone

Survey Zone	**Extra coverage (km^2)**
Wamba	430
Laikipia	228
El Barta	4,435
Laisamis	3,359
Total	**8,452**

After merging the two layers, a final survey area map was drawn up to accommodate both Grevy's zebra and elephant core ranges in northern Kenya (Figure 2).

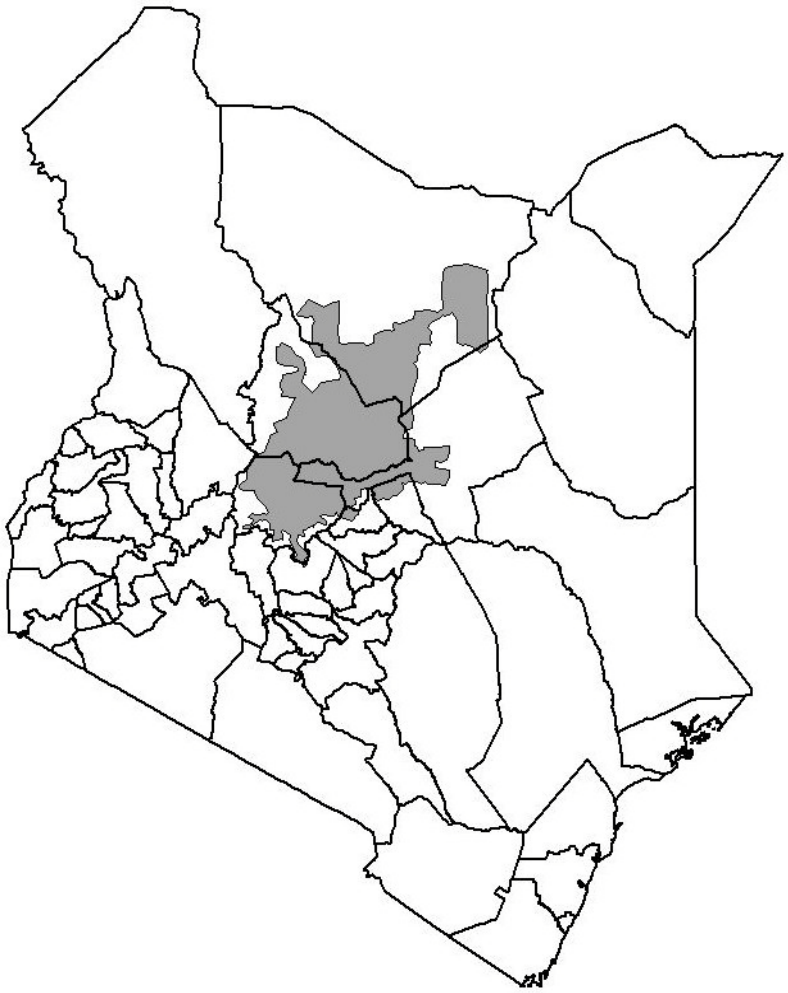

Figure 2: Map of Kenya showing the survey area in grey and district boundaries

Results

Minimum Count and Distribution of Grevy's Zebra

The total number of Grevy's zebra counted during the survey was 2,407 (Table 2 and Appendix 1). The area covered was 46,391 km^2 and the survey was conducted by 10 aircraft. The Wamba and Laikipia zones accounted for about 93 % of all the individuals counted. Two percent of the individuals counted were in areas which had not been included in any of the management zones.

Table 2: Grevy's zebra sightings per management zone

Management zone	No of sightings	Number	Percentage of total
Wamba	126	1,310	54.4%
Laikipia	104	916	38.1%
Laisamis	12	102	4.2%
Outside management zones	9	49	2.0%
El Barta	6	30	1.2%
Total		**2,407**	**100%**

A land use map was created from several sources, including the Ewaso Land Use Map, NRT's Conservancy boundaries and the ILRI Kenya Protected Areas map. Each land use was coded according to its conservation status (Figure 3). The survey results were then overlaid on a map of land use, and the number of Grevy's zebra per land use was calculated (see Appendix 2 for description of land use and Appendix 3 for results per individual land unit).

The number of Grevy's zebra falling into each broad category of land use is displayed in Table 3 and Figures 3 and 4. The largest number of Grevy's zebra was found within Community Conservancies, with the second largest number being found on Community Land. In combination, these two community land categories harboured 60% of all the Grevy's zebra observed. Private ranches displayed 23%. Seven percent of Grevy's zebra were found on Government land, 3% on land classified as settlement 2% on agricultural land and 1% within National Reserves. Community conservancies which had high concentrations of Grevy's zebra included Meibae, West Gate, Koija, Kalama and Lekurruki. Lewa Wildlife Conservancy and Ol Jogi were the private ranches in which high numbers of Grevy's zebra were reported.

Table 3: Summary of Grevy's zebra sightings by land use type

Land Use Type	No of sightings	Number	Percentage of total
Community Conservancy	92	1,193	49.6%
Community Land	43	258	10.7%
Government Land	6	166	6.9%
National Reserve	13	24	1.0%
Private Ranch	80	556	23.1%
Settlement	9	67	2.8%
Agriculture	6	40	1.7%
Unclassified	7	103	4.3%
Total		**2,407**	**100%**

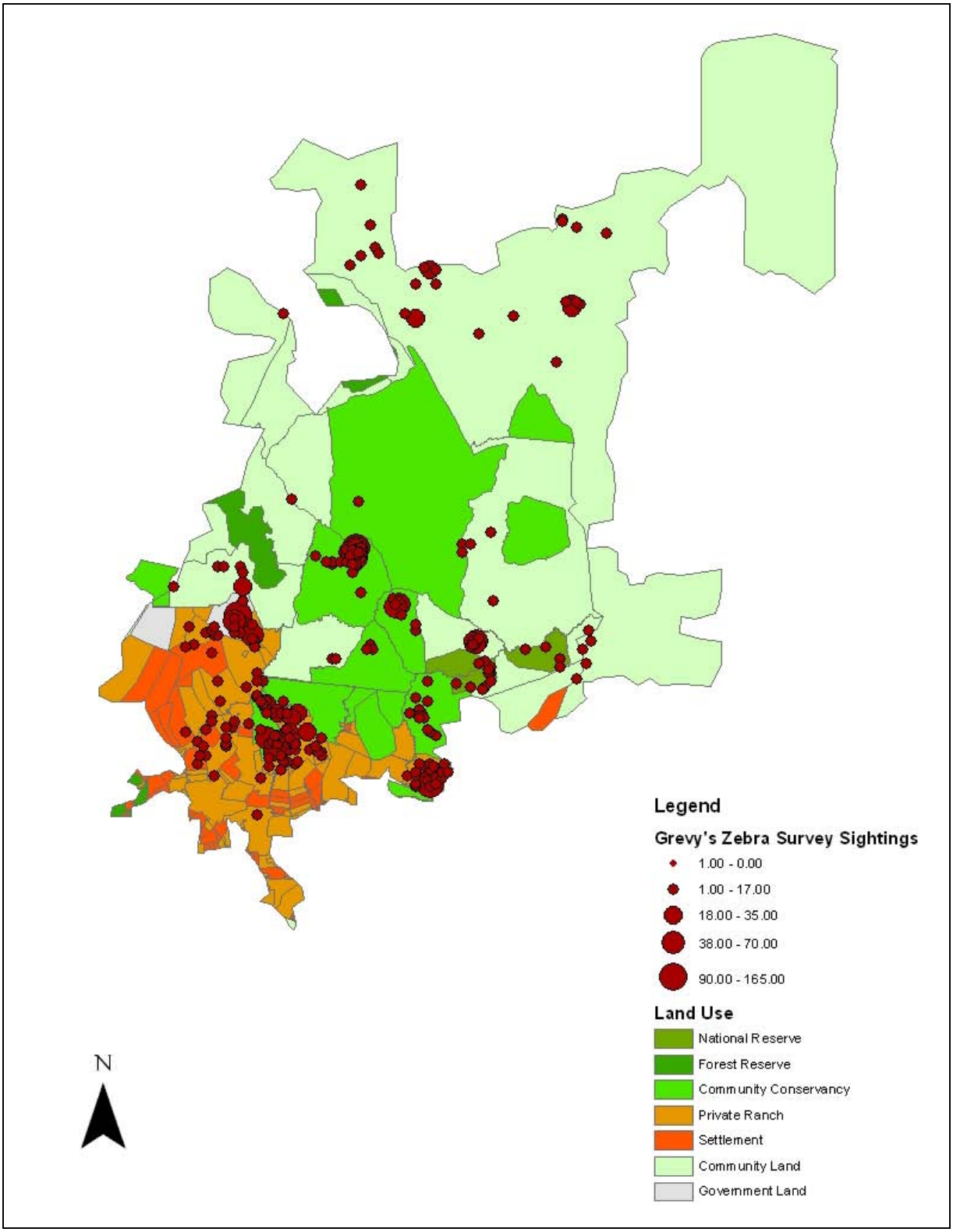

Figure 3: Map showing Grevy's zebra numbers and distribution across different land use types

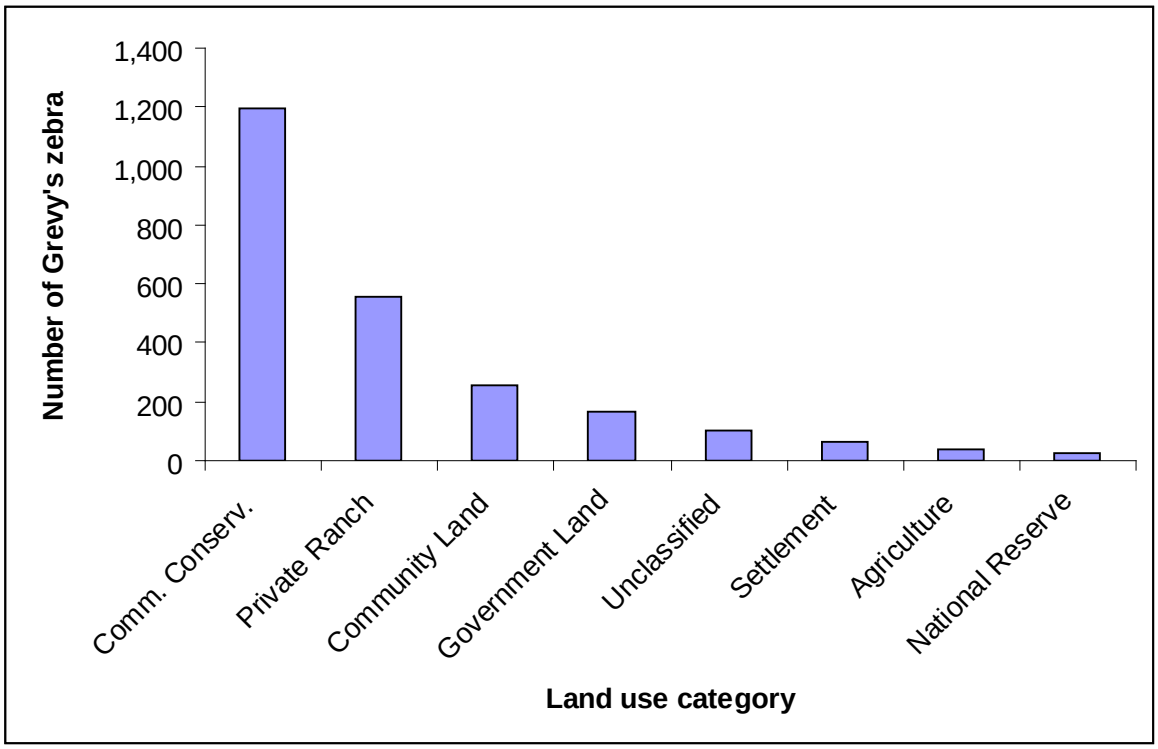

Figure 4: Grevy's zebra and land use

The results of the survey further endorse the critical role played by community conservancies in Grevy's zebra conservation. One striking example is Kalama Conservancy, where 110 Grevy's zebra were counted which, before it established its core conservation area with water dedicated to wildlife, had few resident Grevy's zebra. Over the last five years, Kalama has become an extremely important area for Grevy's zebra breeding because of its water availability for lactating females. This type of conservation management has significant implications for the future of Grevy's zebra and shows the importance of supporting the growth of community-led conservation.

These results are also close to the guess-estimates for Grevy's zebra numbers made by stakeholders during the 2007 workshop to draft the conservation and management strategy for Grevy's zebra (Mwasi & Mwangi, 2007) and reflect the value of local knowledge on the ground.

Comparing Ground and Aerial Counts

Introduction

Aerial counts have been extensively used in wildlife management. However, there is need to establish the accuracy of the resulting data (Jachmann, 2002). The wide use of this technique is attractive because it enables rapid coverage of extensive and sometimes inaccessible areas (Salvig *et al*., 1997; Caughley, 1977). For example, in the present study, it was possible to cover nearly the whole of Kenyan Grevy's zebra range in five days. In this section we compare aerial counts in nine conservancies and reserves to ground counts collected over the same time period.

Methods

The aerial survey of Grevy's zebra in the Laikipia/Samburu ecosystem was conducted as described in Section 1. During the aerial surveys, ground teams familiar with Grevy's zebra distribution conducted counts of Grevy's zebra in West Gate conservancy and also in Samburu and Buffalo Springs National Reserves. Similar ground surveys were conducted by community scouts in Kalama, Sera, and Meibae conservancies, Namunyak Wildlife Conservation Trust and El Barta (Figure 5). In response to high numbers of Grevy's zebra counted during the aerial survey in Kirimon area, a team was deployed to conduct a ground survey in the area four days after the aerial survey.

Data Analysis

Ground and aerial survey data were only compared for the nine conservation areas (see Table 4). We used ArcGIS 9.2 to extract numbers of Grevy's zebra occurring in each conservation area during the aerial survey. We assumed that ground survey teams accurately counted all Grevy's zebras in each area they surveyed but the aerial survey team missed some individuals. This can occur because small groups are harder to see from the air or some individuals could have been concealed by habitat or terrain obstructions (Jachmann, 2002). We therefore used ground count data to calibrate aerial survey data (Salvig, *et al*, 1997, Williams, Nichols and Conroy, 2002). To calibrate the aerial survey data, we assumed that ground counts were proportional to the aerial counts. We therefore calculated a proportionality constant (r) by dividing the total number of animals sighted by ground count teams by the number of animals sighted in the same areas by the aerial survey teams. An r value of close to one indicated that ground and aerial counts were similar.

Results

Figure 5 shows the distribution of all Grevy's zebra counted by aerial survey teams and in comparison with the sightings by the ground survey teams while Table 4 shows the number of Grevy's zebra counted by the ground and aerial survey teams. In Figure 6 we compare the ideal situation (where both ground and aerial teams detect an equal number of animals) with the actual results. In Samburu and Buffalo Springs reserves, West Gate and Kalama Conservancies and Namunyak Wildlife Conservation Trust, the distribution of sightings was similar. The scouts in Meibae Conservancy lumped their sightings into one GPS location making it impossible to examine distribution of the ground sightings. In Sera conservancy, the aerial survey team did not encounter any Grevy's zebra. The proportionality constant r was 0.637.

Two areas stand out as having large discrepancies between the ground and aerial counts: Meibae and Kirimon. In Kirimon, a poor security situation meant the ground team could not cover the entire area effectively. In Meibae scouts were unable to cover the entire conservancy area. These areas are in contrast to the other seven areas, where effective coverage was achieved. If the results for Meibae and Kirimon are removed and the r value recalculated, a result of 1.225 is returned.

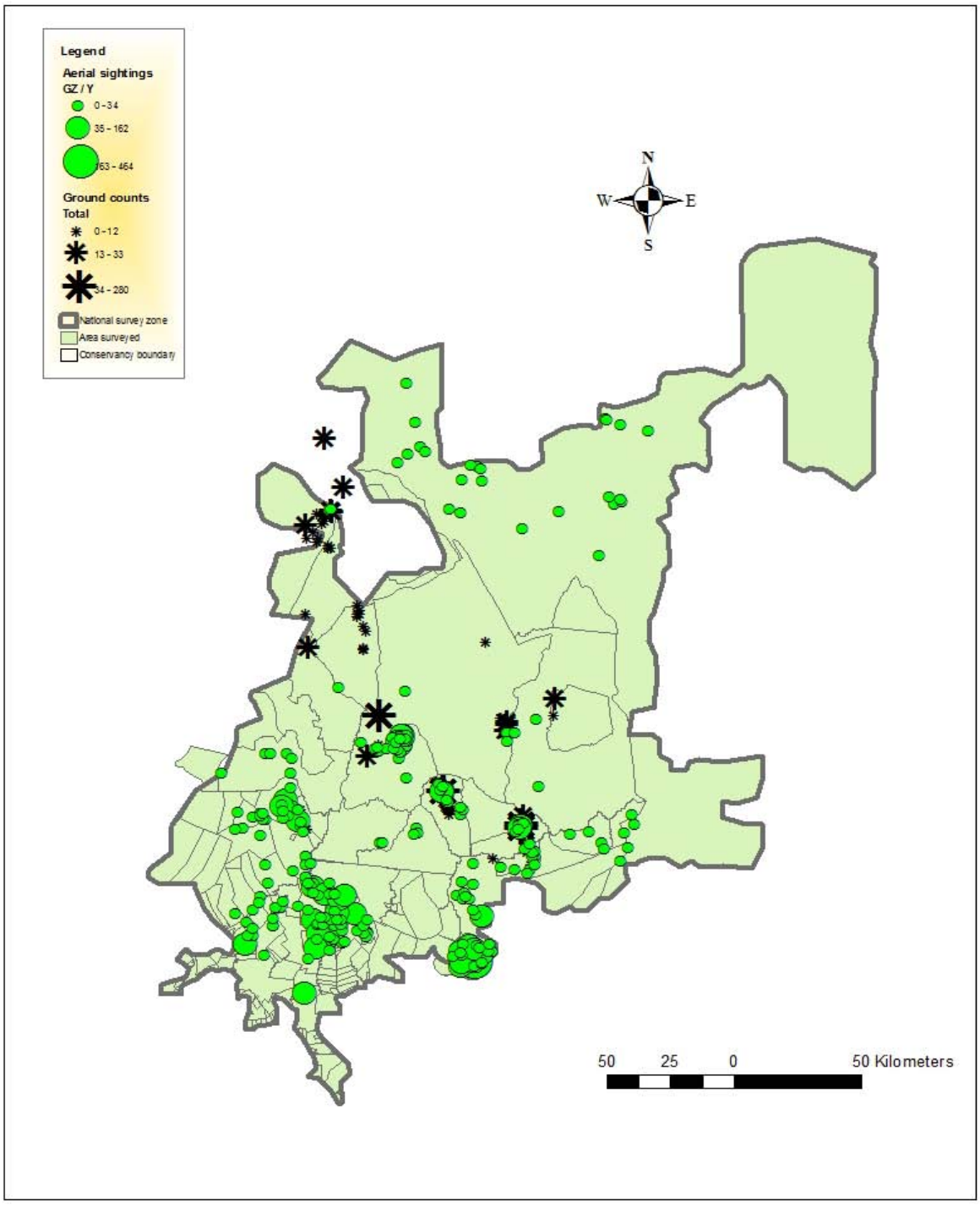

Figure 5: Map showing the distribution of aerial and ground sightings of Grevy's zebra in selected areas

Table 4: Comparison of aerial and ground counts for selected areas

Area name	**Aerial count**		**Ground count**		
	Date	Number	Date	No	Source
Samburu NR	26-Nov-08	2	26-Nov-08	8	AWF
Buffalo Springs NR	26-Nov-08	17	26-Nov-08	25	AWF
Kalama	26-Nov-08	110	25-Nov-08	105	Kalama /NRT
El Barta	27-Nov-08	17	28-Nov-08	21	GZT
West Gate	26-Nov-08	161	27-Nov-08	178	AWF
Meibae	27-Nov-08	646	30-Nov-08	301	NRT
Kirimon	26-Nov-08	269	30-Nov-08	96	GZT
Namunyak and Donyo Wasin	25-Nov-08	9	27-Nov-08	26	NRT/Namunyak Conservation Trust
Sera	25-Nov-08	0	27-Nov-08	18	NRT
Total		1,221		778	

Discussion and Recommendations

The major cause of discrepancy between aerial and ground counts can be attributed to aerial counts for Meibae and Kirimon which were almost twice as large as the ground counts. This was unexpected because aerial surveys are typically expected to undercount compared to ground counts (Jachmann, 2002; Salvig *et al*.,1997). For Kirimon area, the ground team conducted the survey a few days after the aerial survey. Security issues related to cattle rustling prevented the team from covering the entire area. It is likely that many zebras were missed by the ground survey team because they either moved away from the area or occurred in areas inaccessible to ground teams. In Meibae, community scouts conducted ground surveys on foot and it is unlikely that they could cover the whole conservancy on foot. Here again, lack of complete coverage may mean that the ground count did not see many zebra herds. .

In El Barta the figures were low for both aerial and ground surveys due to the lower search intensity. The transects for El Barta were flown at 2 km intervals and the ground team was small so coverage was limited. From ongoing monitoring in the area population estimates are between 100 to 150 Grevy's zebra and the area should continue to be recognized as an important management zone.

These results provide a basis for planning future surveys. Since aerial surveys are expensive, there is need to examine how best to make them as accurate as possible. This can be achieved by examining operational details that can be standardized. For example transect width, height above ground, and habitat stratification (Buckland *et al*., 2001). To calibrate aerial surveys areas that are well known should be selected and ground counts conducted using standardized count protocols. Both aerial and ground counts should be done simultaneously to avoid errors resulting from time lag and animal movements.

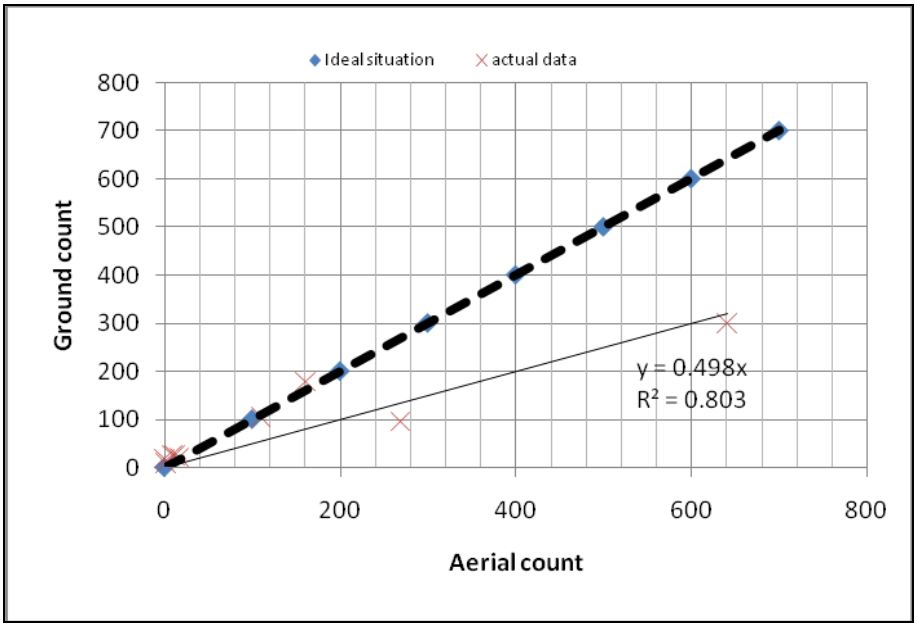

Figure 6: Comparison of aerial and ground counts in 9 conservation areas in Samburu ecosystem. The dotted line represents the ideal situation where both teams counted equal number of Grevy's zebra. The solid line represents the actual situation.

Grevy's Zebra Distribution in Relation to Human and Environmental Variables

Introduction

Understanding how the distribution of endangered species is influenced by human land use, competitors and habitat is important for conservation planning. Knowing the distribution of Grevy's zebra enables us to investigate the influence of variables such as livestock, land use and settlement. In this section we use the aerial survey data to determine the Grevy's zebra distribution as of November 2008 and analyse this distribution in relation to the distribution of human settlements, livestock, cattle (as a sub-set of livestock) and plains zebra. These variables were selected because they are believed to have an influence on the distribution of Grevy's zebra. Humans and livestock represent potentially important competitors to Grevy's zebra. Plains zebra are the most closely related species to Grevy's zebra in the region and have similar ecological needs.

Methods

The following analysis was undertaken using data from the 2008 national survey of Grevy's zebra and using landscape maps from a variety of sources. Arc View 3.2 and Arc Info 9.2 were used in the analysis of geographical data and Excel was used for statistical tests. It should be noted that the data used in this analysis was collected over a short time period at the end of 2008 and is therefore a snapshot of the conditions in northern Kenya. As such the results displayed here should be considered indicative rather than conclusive.

Grevy's zebra and habitat

A large scale habitat map with 8 classes of habitat was sourced from Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The map covered the Laisamis and El Barta survey zones entirely, and most of Wamba, excluding the southern-most part, but only covered the north and east of the Laikipia survey zone. Grevy's zebra sightings from the national survey were projected over the habitat map and the number of sightings per habitat type was recorded. It should be noted, due to the partial coverage of the habitat map, only 1,333 Grevy's zebra could be used in this analysis. The area of each habitat type was calculated. The proportion of Grevy's zebra sightings within each habitat, and the proportional area that each habitat type covered, were used to calculate a selection index, which indicated habitats which were preferentially selected by Grevy's zebra.

Distribution maps

Aerial survey data were separated into individual data sets for Grevy's zebra, livestock, cattle, settlements, and plains zebra. Zero values were removed from each data set before being projected in GIS. A distribution map with graduated symbols was created for each data set to show broad coverage in relation to protected areas within the survey area. In addition, a kernel contour map highlighting 95%, 75% and 50% contours was produced to determine the density of sightings for each data set.

Grevy's zebra and other variables

We investigated the relationship between the distribution of Grevy's zebra and the distribution of human settlements, livestock, cattle, and plains zebra. All variables were point data, that is, distinct points where sightings occurred. In order to compare variables directly, we first converted each one to a raster grid. A raster is a grid that covers the entire survey area. Each grid square contains an individual value for the variable in question. Predicted values are used for squares where no point data occurs. The advantage of the raster is that it provides total coverage of the survey area, and thus makes comparisons between variables much more convenient.

Each variable was sampled using 2,000 random points. The 2,000 data points for each variable were then directly compared using Pearson correlation and Logistic regression analysis to determine the direction and strength of any relationships.

Results

Grevy's zebra and habitat

The habitat map did not cover the entire survey area, as previously explained. However, for the area of coverage, grassland was dominant, accounting for 50% of the land area. Bushland covered 30% of the area and shrub grassland covered 15%. Shrubland was relatively minor at 5% coverage, and forest accounted for 1%. There was no woodland within the selected area. A selection index was calculated for each habitat, with values less than 1 indicating avoidance, and values greater than 1 indicating preference.

Table 5: Grevy's zebra sightings and habitat type

Habitat type	Area km2	Propn	No. Grevy's zebra	Propn	Selection index
Bushland	8,974.03	0.30	7.00	0.01	0.03
Shrub grassland	4,439.99	0.15	80.00	0.06	0.40
Forest*	263.93	0.01	-	0.00	-
Grassland	14,969.25	0.50	1,168.00	0.88	1.76
Shrubland	1,485.30	0.05	78.00	0.06	1.2
Woodland*	-	0.00	-	0.00	-

*There was not sufficient data to calculate a selection index for forests or woodland.

Nearly 90% of all Grevy's zebra were seen within grassland habitat. While grassland habitat was dominant, the high selection index value indicates this habitat was selected preferentially by the species (Figure 7). Grevy's zebra exhibited a slight preference for shrubland. Shrub grassland and bushland exhibited low selection index values, indicating these areas were avoided by the species.

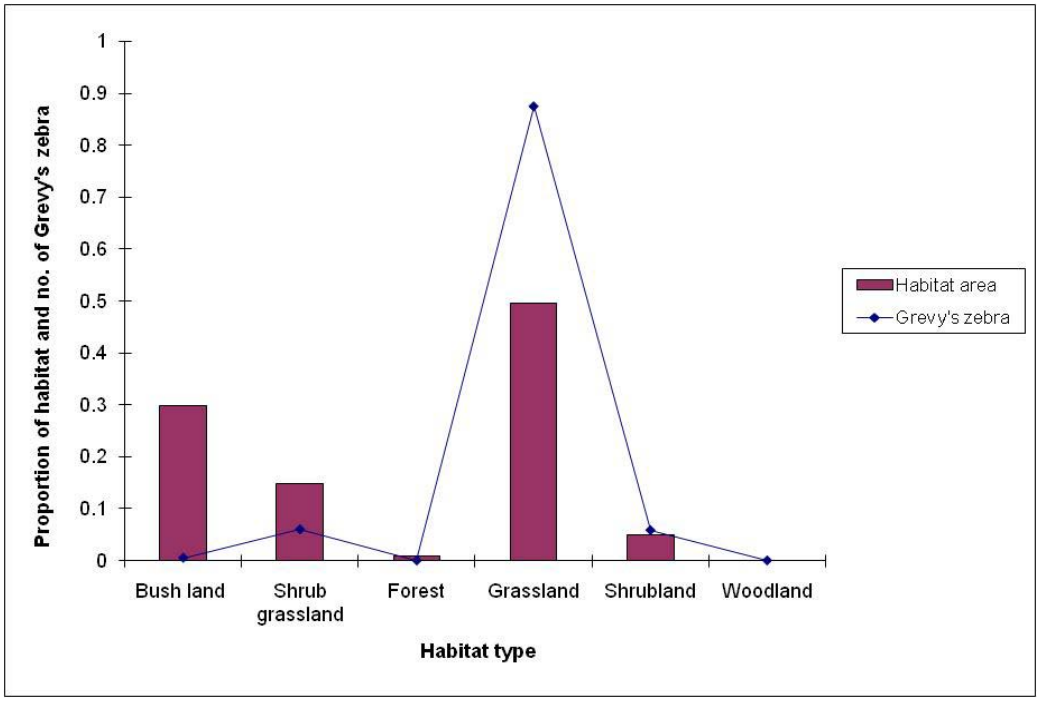

Figure 7: Grevy's zebra sightings and habitat

Grevy's zebra and other variables

The following figures (Figures 9 to 13) display the kernel contours of the survey data for Grevy's zebra, plains zebra, livestock, cattle and settlement as a means of visual comparison. Data are displayed as 50, 75 and 95% kernel contours. Protected areas are displayed as green blocks and the survey area as a grey boundary. In order to put into geographical context the location of the community conservancies and other protected areas, Figure 8 shows how these land units are distributed across the five Grevy's zebra management zones.

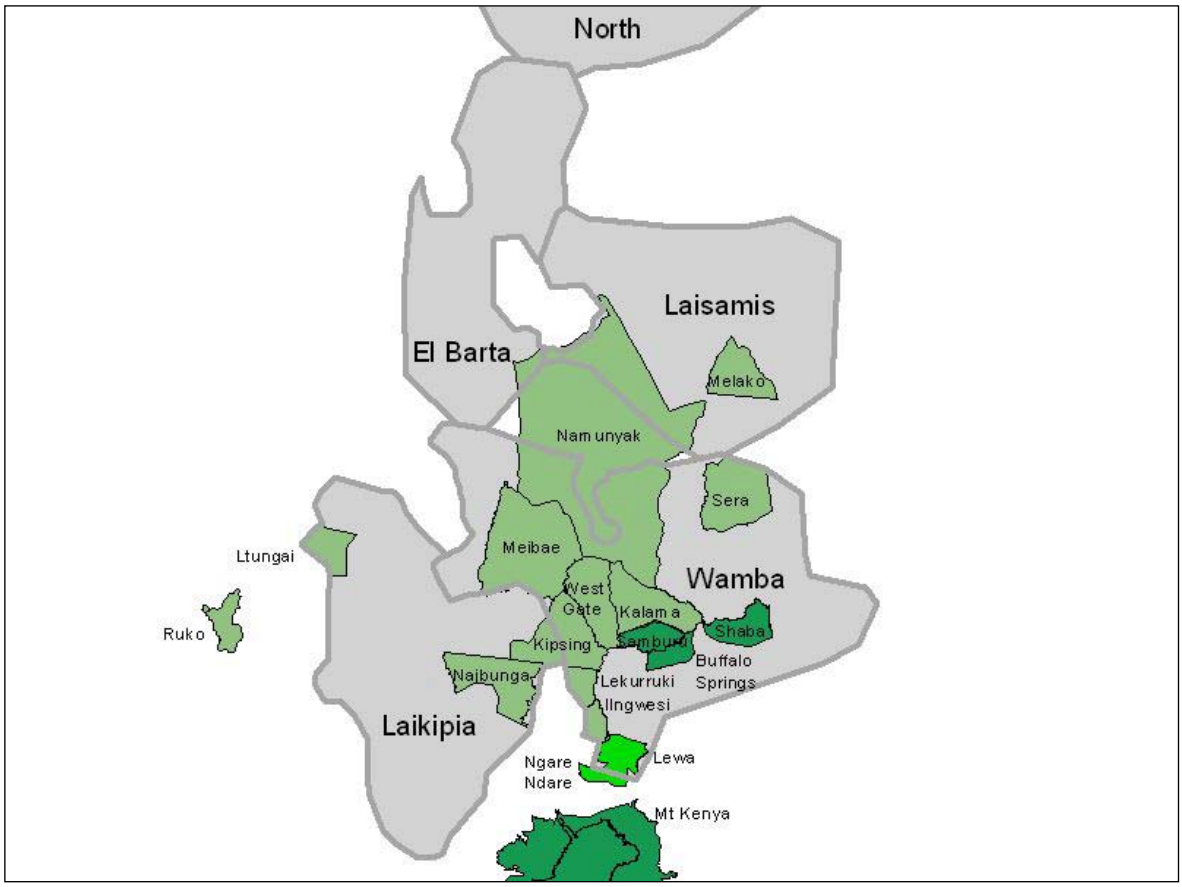

Figure 8: The location of protected areas as they relate to the Grevy's zebra management zones

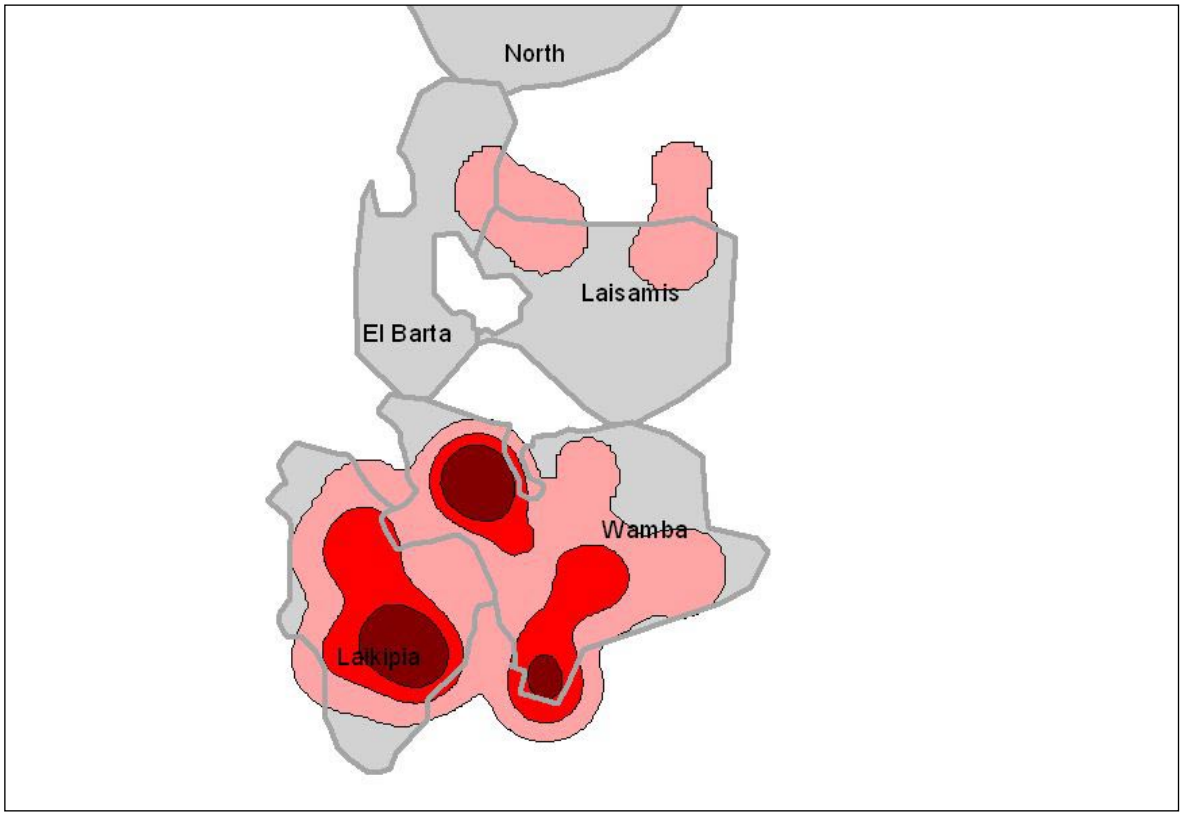

Figure 9: Grevy's zebra distribution

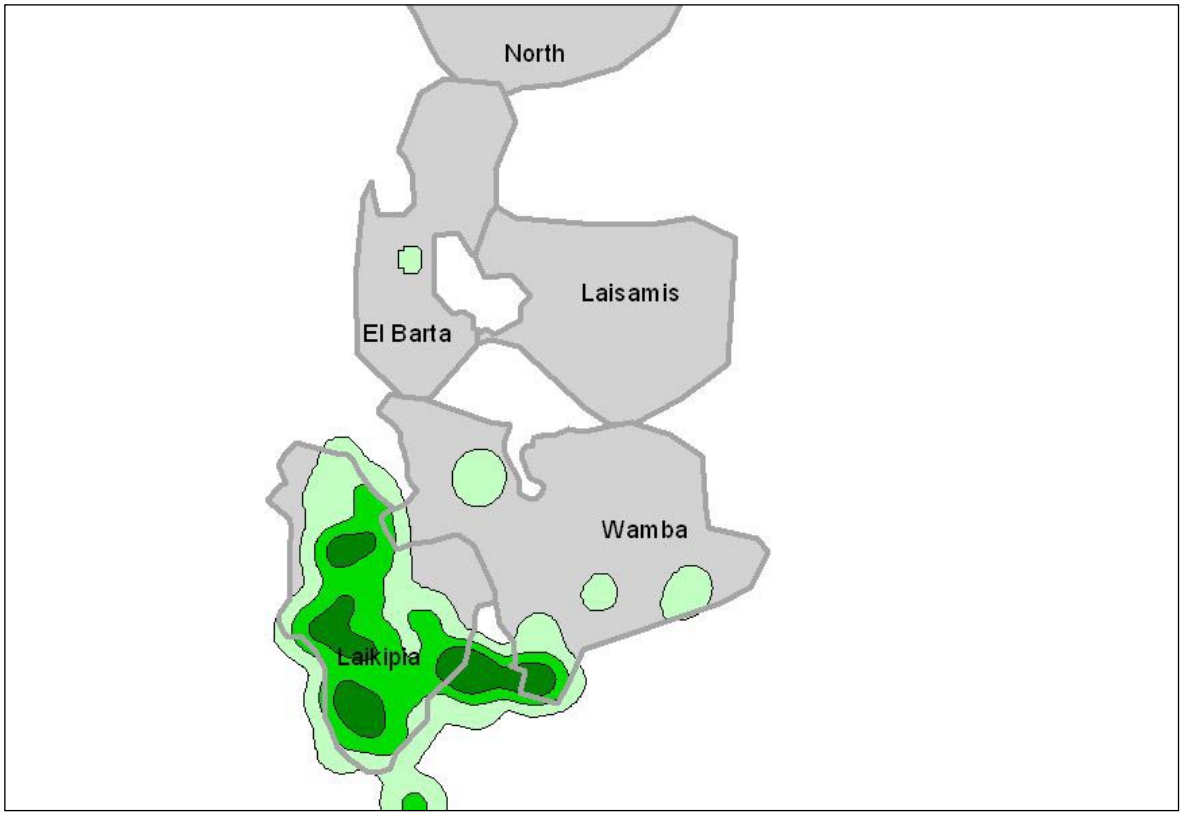

Figure 10: Plains zebra distribution

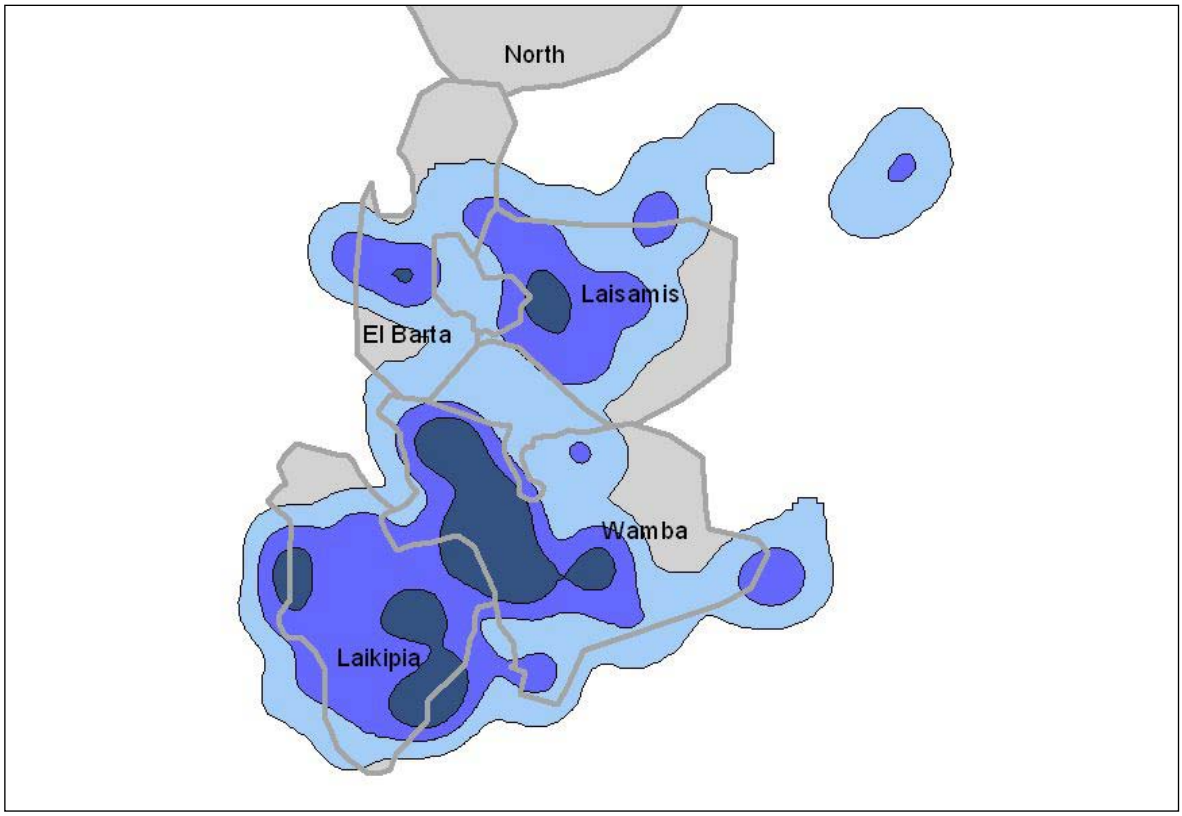

Figure 11: Livestock distribution

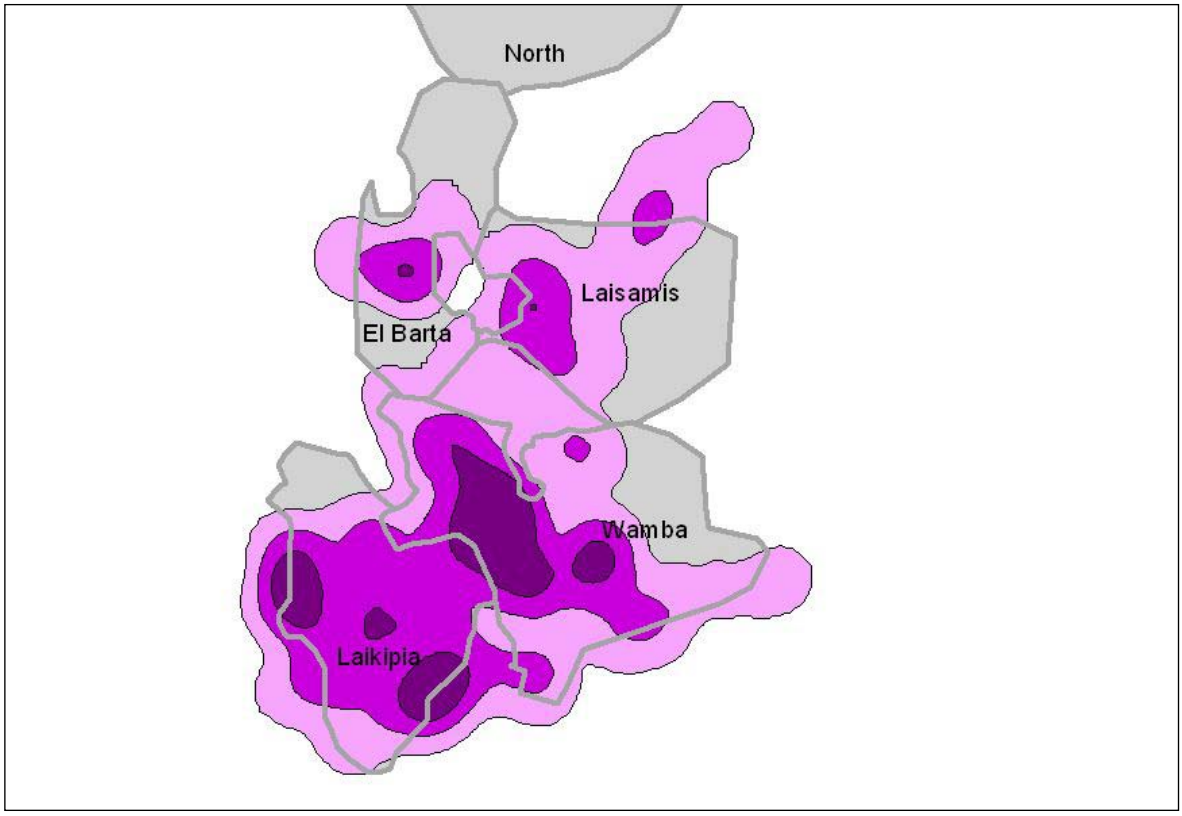

Figure 12: Cattle distribution

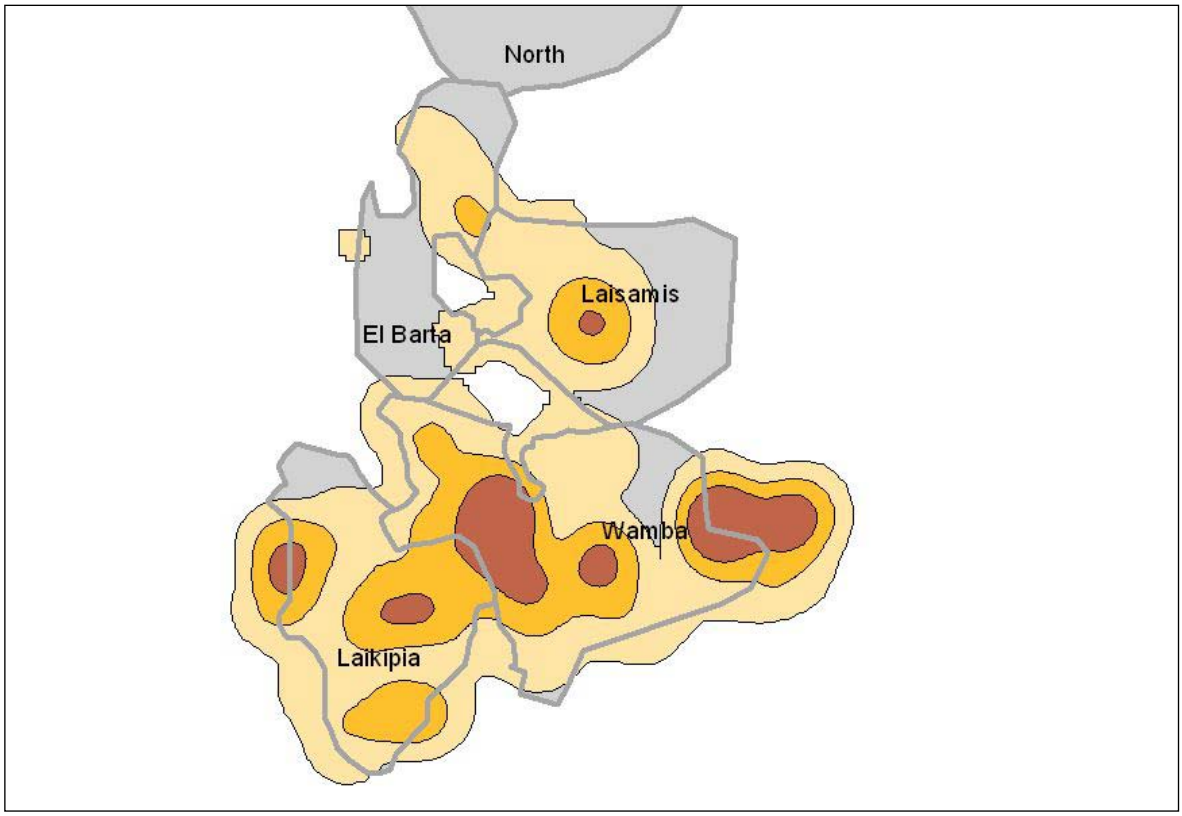

Figure 13: Settlement distribution

The relationship between Grevy's zebra distribution and other variables was investigated using the bivariate Pearson Correlation test. This test produces an r value between 0 and 1, with 0 indicating no relationship and 1 indicating a very strong relationship. Grevy's zebra and plains zebra displayed a strong positive correlation, due to an overlap of distribution in the Laikipia management zone and in Meibae Conservancy in the Wamba management zone.

Grevy's zebra and livestock exhibited a positive correlation, resulting from overlapping distributions in the Laikipia management zone and in Meibae and West Gate conservancies in the Wamba management zone (Table 6). Interestingly, when taken in isolation cattle exhibited a stronger relationship with Grevy's zebra, indicating a greater overlap than with livestock overall. Grevy's zebra and settlement exhibited a weak positive relationship. This indicates Grevy's zebra are neither associated with, nor avoid settlement areas.

Table 6: Pearson correlation

Variables	**r**	**P**
Grevy's Zebra-Livestock	0.195477	<0.01
Grevy's Zebra -Cattle	0.228887	<0.01
Grevy's Zebra -Settlement	0.088981	<0.01
Grevy's Zebra -Plains zebra	0.527943	<0.01

Recommendations

New survey zones for Grevy's zebra

The national survey of 2008 revealed that some Grevy's zebra occurred outside the current distribution map (Figure 14). It is recommended that current management zones for Grevy's zebra be updated using the results of the 2008 survey. A suggested method for updating the zones is displayed below.

All current sightings should be incorporated into the nearest management zone by expanding the boundaries to encompass all sightings. Before this is done, all sightings should be buffered at 10km distance in order to incorporate not only the location where the Grevy's zebra were sighted, but also the habitat immediately surrounding each sighting (Figure 14). We chose 10 km because this accounts for the daily ranging patterns of Grevy's zebra.

The zones should also be adjusted to exclude the Matthews and Ndoto mountains where Grevy's zebra are not likely to occur. New management zone boundaries are displayed in Figure 15. There is currently no data with which to modify the north management zone; however, it is anticipated this area will be surveyed before the end of 2009.

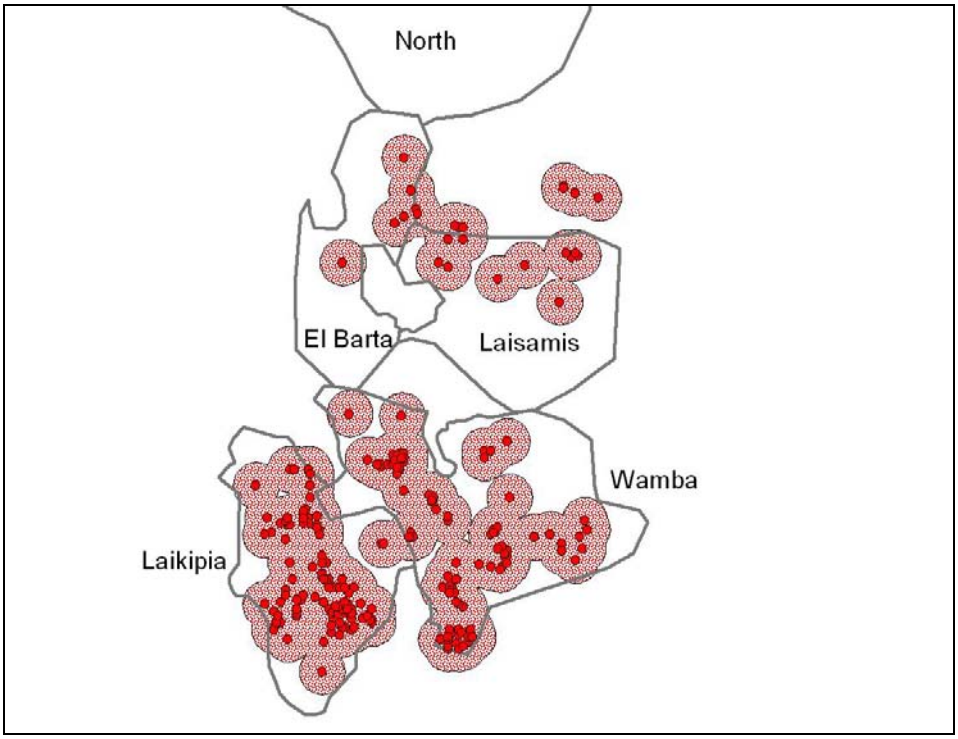

Figure 14: Old survey zones for Grevy's zebra with survey data overlaid

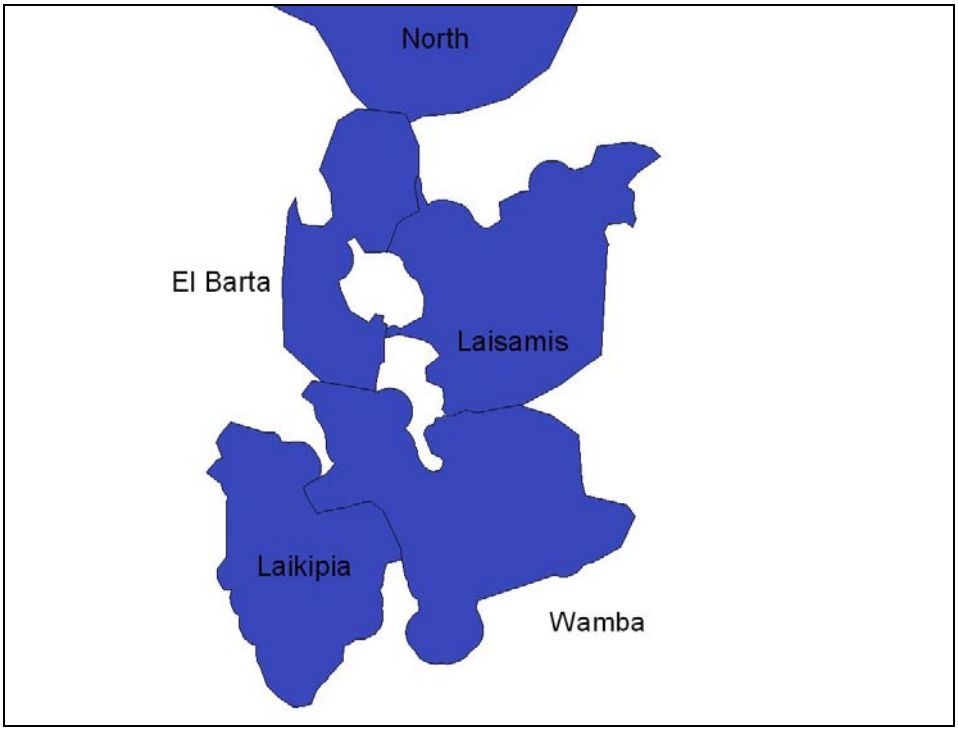

Figure 15: Proposed new survey zones for Grevy's zebra

Determining the age structure of Grevy's zebra populations

The age structure of a population is critical information for management because it indicates population health. By counting the number of Grevy's zebra foals during the next aerial survey it will be possible to identify which populations are breeding and those which have a high proportion of adults. This information can inform further investigation on the ground to determine what the limiting factors are to a healthy breeding population and provide a baseline for future evaluation of conservation efforts focused on increasing foal survival. Differentiating adults and foals from the air is straightforward but it will require further training for the spotters to ensure they are familiar with identifying foals of Grevy's zebra and it is strongly recommended that this component of the count be incorporated into the next survey.

Transects at 1km intervals

For several outlying blocks of the survey area, transects were spaced at 2km distance. This was initially the case for Meibae conservancy, which yielded results that were far lower than expected by local experts. As a result a second survey was scheduled, this time with 1km spacing. This survey presented a much higher number of Grevy's zebra, a figure in closer keeping with the expectations for the conservancy. Unfortunately the ground counts did not cover the entire area and so it was not possible to verify the results of the second survey. However, it is almost certain that the 1km transect results are more accurate, given the assumption that a wider transect width leads to a lower rate of detection. For future Grevy's zebra surveys using a minimum count methodology, it is recommended that all blocks are surveyed with a 1km interval between transects. In addition we must standardize all operational parameters in the survey such as height above ground, transect width, and strip width (Jachmann, 2002).

Detectability

Currently there is no measure of detectability incorporated into the minimum count methods used in this survey. Detectability is an important consideration: essentially it is the measure of how detectable a Grevy's zebra is in different habitats. One would expect it to be more difficult to locate Grevy's zebra in thick bush as opposed to open grassland. Therefore, it is reasonable to assume that in survey blocks with thicker bush, a greater percentage of Grevy's zebra will go undetected, as opposed to a block with open grassland. Where detectability is not accounted for in a survey, there is a greater likelihood of undercounting to occur and it is also difficult to ascertain the accuracy of surveys.

It is possible to calculate the detectability of different survey blocks, and to use the resulting detection factor to correct the number of Grevy's zebra counted. To give a simplified example: if a certain block returned a correction factor of 0.8 this would mean that on average 80% of Grevy's zebra were detected, and 20% were not. The count for this block would be increased by 20% in order to account for the Grevy's zebra that were missed.

Detectability can be calculated for different habitat types across the entire study area if all blocks are counted in the same standardized way. The simplest method would be the 'double observer', the details of which are presented by Cook and Jacobson (1979).

Sample surveys

Sample surveys have been used widely for mammal surveys across Africa. They have two advantages over minimum counts: first, they provide a measure of precision, and second, they are usually much cheaper than minimum counts, because they only cover a sample of the entire survey area. In brief, a sample area selected that is representative of the entire area of interest. The sample area is usually 10-50% of the entire area of interest, but can be modified so that we achieve a targeted level of error in our survey. Increasing the sampled area usually will decrease the confidence limits on our estimate. The sample area is surveyed in detail and simple statistical techniques are then used to extrapolate the entire population size. Sample survey methodology should be considered for future Grevy's zebra surveys, providing the opportunity to reduce flying costs by up to 60%.

The cost savings could be used for wider monitoring such as foal patrols, or to target sampling areas where management interventions have taken place so their success can be evaluated.

Grevy's zebra survey experts

It is recommended that in all future surveys that Grevy's zebra experts are included in all survey crews. This should increase the accuracy of Grevy's zebra counts and reduce the risk of confusion between plains and Grevy's zebra. It also engages those on the ground in being actively involved in the survey.

Ground Counts

In this survey ground counts provided one way to verify the accuracy of the aerial survey methods. However, there were issues with timing and coverage of the ground surveys. This method should be used in all future surveys, but ensuring ground and aerial blocks are matched, and ground survey teams cover the entire area.

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Appendix 1: Grevy's zebra sightings per survey block

Block	Sighting	Number
10	40	627
14	42	408
9	22	294
30	12	267
23	23	206
7	21	124
28	16	89
Korr	9	70
Laisamis	6	65
34	12	50
12	6	40
South Horr	6	23
3	4	21
6	8	20
8	5	20
19	6	20
Ngilai	2	16
29	5	15
25	1	10
5	2	7
Marsabit1	4	7
32	1	4
11	2	2
4	1	1
17	1	1
1	0	0
2	0	0
13	0	0
15	0	0
16	0	0
18	0	0
20	0	0
21	0	0
22	0	0
24	0	0
26	0	0
27	0	0
31	0	0
33	0	0
		2,407

Appendix 2: Land Use Description

Land Use Type	Description
Community Conservancy	Community institution in place to implement conservation and development goals of the community
Community Land	Includes group ranches and land held in trust by County Councils where the main livelihood is livestock keeping
Government Land	Land managed by government
National Reserve	Formally gazetted protected area managed by County Councils
Private Ranch	Privately owned ranch where tourism, wildlife and/or livestock are the main livelihood
Settlement	Heavily settled areas
Agriculture	Agricultural land
Unclassified	-

Appendix 3: Grevy's zebra sightings per individual land use type

Management units	Land use type	Sightings	Number
Meibae	Community Conservancy	42	646
Lewa	Private Ranch	23	206
Trust Land	Community	43	258
NYS Mar Mar	Government Land	6	166
West Gate	Community Conservancy	11	161
Koija	Community Conservancy	14	154
Ol Jogi	Private Ranch	21	136
Kalama	Community Conservancy	4	110
Unclassified	Unclassified	7	103
Lekurruki	Community Conservancy	12	80
Mukogodo	Private Ranch	4	46
Loroki	Agricultural land	6	40
Ngorare Ranch	Private Ranch	9	37
Chololo	Private Ranch	2	32
P&D	Settlement	4	32
Naibunga	Community Conservancy	3	24
Male	Private Ranch	1	20
Buffalo Springs	National Reserve	7	17
Mugie (E)	Private Ranch	4	15
Thorne A	Settlement	2	12
Namunyak	Community Conservancy	3	10
Kihoto	Private Ranch	1	10
Kisima	Private Ranch	2	10
Mathira 2	Settlement	1	10
Narok	Settlement	1	10
Ol Doinyo Lemboro	Private Ranch	2	9
Kipsing	Community Conservancy	3	8
Sosian Ranch	Private Ranch	1	8
Colcheccio	Private Ranch	4	7
Mugie (W)	Private Ranch	1	6
Mohammed	Private Ranch	1	5
Shaba	National Reserve	4	5
Ol Pejeta	Private Ranch	1	4
Segera/Mukenya	Private Ranch	1	3
Mathira 1	Settlement	1	3
Samburu	National Reserve	2	2
El Karama	Private Ranch	1	1
Soita Nyiro Farm	Private Ranch	1	1
			2,407