AERIAL TOTAL COUNT OF ELEPHANTS, BUFFALO, GIRAFFE AND GREVY'S ZEBRA IN LAIKIPIA-SAMBURU-MERU-MARSABIT ECOSYSTEM* (NOVEMBER 2017)

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** Laikipia-Samburi-Meru-Marsabit Ecosystem Hereafter: LSMME*

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EXECUTIVE SUMMARY

In Kenya, wildlife population trends are monitored after every three to five years. One of the methods; the total aerial count of elephants and other large mammals in Kenya has been carried out since the 1960's. In Laikipia-Samburu ecosystem it was first undertaken in 2002, where about 5,447 elephants were recorded. Other surveys were subsequently conducted in 2008 and 2012. The 2017 count focused on four large mammal species namely elephants, Grevy's zebra, giraffe and buffalo. An additional seven marks of human activities were also recorded. In 2017, the aerial census area was extended to 65,516 km^2 from 55,000km^2 of 2012 to cover parts of Meru Conservation Area.

The main objective of the survey was to sustain the long term aerial monitoring of wildlife populations in Laikipia, Samburu, Marsabit and Meru ecosystems. The specific objectives for the aerial survey were to: 1) Determine the present status and trends of elephant, buffalo, giraffe and Grevy's zebra population; 2) Establish elephant poaching levels through observation of carcasses within the ecosystem and 3) Document estimated numbers and distribution of human activities in the Laikipia-Samburu-Marsabit-Meru ecosystem.

In order to enhance the accuracy of the count and minimize inter- observer variability the entire census crew were taken through a rigorous training and simulation sessions where pilots were tested on how to navigate through straight line transects whereas FSOs and RSOs were trained on data capture using various equipment and counting with confidence. Eleven aircrafts were used to fly the observers who captured data using GPS and digital voice recorders. The aircrafts comprising of 4 and 2 seater planes, were flown along pre-determined transects at altitudes between 300 - 400ft above ground across the ecosystem with a North - South or East – West orientation whichever was appropriate. The observers recorded the numbers and positions of all observations made according to the survey protocol.

The aerial census search effort for Laikipia-Samburu, Marsabit and Meru were 178.79 km^2/hr, 119.36 km^2/hr and 177.05 km^2/hr respectively. The census results indicate that, a total of 8,021 elephants were counted in the Laikipia-Samburu-Meru-Marsabit ecosystem. The Laikipia-Samburu ecosystem alone had 7,166 elephants; Marsabit Conservation area had 181 while Meru Conservation Area had 674 elephants. The population increased by about 12%, which represents an annual increase of 2.4% over the period. A total of 76 elephant carcasses were recorded in Laikipia-Samburu-Marsabit ecosystem while Meru Conservation Area (MCA), recorded 19 elephant carcasses. Buffalo numbers stood at 7210 in the entire survey area. This comprised 4450 buffalo in Laikipia-Samburu ecosystem, 2711 buffalo in Meru Conservation Area and 49 buffalo in Marsabit ecosystem. This translates to a growth rate of 2% per annum. A total of 5237 reticulated giraffes were counted in the LSMM ecosystems. Laikipia-Samburu ecosystem had the highest number of giraffes (n=4019 giraffe), followed by Meru (n=876 giraffe), while Marsabit had the lowest number (n=342 giraffe. The population showed an increase with a 7.8% population growth rate per year. Grevy's Zebra abundance which stood at 1627 showed a reduction compared to year 2012 (1,897) and year 2008 (2400). The results suggests a slowing rate of decline since the year 2008 and 2012 (5.4% to 2% per annum). Laikipia–Samburu had an increase in livestock numbers whereas Marsabit and Meru ecosystems recorded a decline. Generally, the population of elephant, buffalo and giraffe showed a remarkable increase and this

was attributed to establishment of private and community conservancies and security enforcement which boosted the government's effort in protection of wildlife leading to reduction of elephant poaching. The decline of Grevy's zebra population was attributed to drought conditions between 2016 and 2017 which took an unknown toll on the population.

We conclude that efforts put in place to curb elephant poaching in Kenya and within the ecosystem have been fruitful and should be sustained to further sustain future elephant population growth. Habitat fragmentation by human activities and mostly livestock herding was evident leaving vulnerable elephant populations which were restricted to parts of the core area (PA and conservancies) and contributing to the declining Grevys' zebra population. We recommend for continued anti-poaching and covert operations to sustain the reduction of elephant poaching in the ecosystem, improve management of Marsabit National Rerseve which is an immediate wildlife dispersal area from Marsabit forest and revival of the Protected Areas of Bisanadi National Reserve, Kora National Park, Rahole National Reserve and Mwingi National Reserve in Meru Conservation Area.

LIST OF ACRONYMS

AGL	Above Ground Level
AWF	African Wildlife Foundation
CR	Critically Endangered
DEM	Digital Elevation Model
DRSRS	Department of Resource Survey and Remote Sensing
ESRI	Environmental Systems Research Institute
FSO	Front Seat Observer
GIS	Geographical Information System
GPS	Global Positioning System
HAG	Height Above Ground
IUCN	International Union for Conservation of Nature
LSMM	Laikipia Samburu Marsabit Meru Ecosystem
KFS	Kenya Forest Service
KM	Kilometers
KWS	Kenya Wildlife Service
MCA	Meru Conservation Area
MIKE	Monitoring Illegal Killing of Elephants
MM	Millimeters
MFR	Marsabit Forest Reserve
MNR	Marsabit National Reserve
NGA	Northern Grazing Area
NP	National Park
NR	National Reserve
NT	Near Threatened
PA	Protected Area
RSO	Rear Seat Observer
SPP	Species
TAWIRI	Tanzania Wildlife Research Institute
UTM	Universal Traverse Mercator
VU	Vulnerable

1.0 INTRODUCTION

The most comprehensive approach to aid the understanding of trends in wildlife population is to undertake long-term monitoring of the wildlife numbers. In Kenya, such surveys are carried out after every three to five years. The censuses follow international standards recommended for Monitoring Illegal Killing of Elephants (MIKE) as setup under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In Kenya, such surveys have been carried out over the years and have resulted to accumulation of massive data (Thouless *et al.*, 2016; Chase *et al.*, 2015).

Aerial count of elephants and other large mammals in Kenya have been carried out since the 1960's (Thouless *et al.*, 2008). Since 1970s, the Department of Resource Surveys and Remote Sensing (formerly known as Kenya Rangelands Management Unit) has been undertaking sample aerial surveys of wildlife in the Kenya (Thouless *et al.*, 2008). Aerial total surveys focusing on specific ecosystems have been carried out since 1994 (Thouless *et al.*, 2002). The first total count of elephants and other large mammals in Laikipia-Samburu ecosystem was undertaken in 2002, where about 5,447 elephants were recorded within the Laikipia-Samburu ecosystem (Thouless *et al.*, 2002). Consecutive surveys recorded 7415 elephants in 2008 and 6365 elephants in 2012. In addition, 2400 and 1897 Grevy's Zebra were recorded in 2008 and 2012 respectively (Litoroh *et al*., 2008; Ngene *et al.*, 2013). In the Laikipia-Samburu-Marsabit ecosystem, a total of 5331 buffalo were counted in 2008 compared to 4069 buffalo in 2012. A total of 2557 and 2839 giraffes were counted in 2008 and 2012 respectively (Ngene *et al.*, 2013).

The 2017 count focused on four large mammal species, and an additional seven marks of human activity including livestock. That was a shorter list of targets than previous years' which included approximately 40 species or objects were counted. The effect of reducing the number of targets is to increase the observer's accuracy by reducing their work load and hence their vulnerability to fatigue. This allows them to stay focussed on the targets of importance and make more accurate observations. The census therefore focused on Elephants, buffalo, giraffes and Grevy's Zebra. Since 2012, Grevy's zebra have been specifically targeted when undertaking national aerial census within their known range in Kenya.

Counting Grevy's zebra from the air is a difficult task. Their stripe pattern and physical characteristics, while distinct, provide a remarkable degree of concealment against the backdrop of dry open rangeland, scrub and bush that they inhabit. From a distance of a few hundred meters in a moving aircraft they most often appear grey and indistinct. Furthermore, the population is often mixed with other wildlife, plains zebra particularly, and livestock over much of their range, making the task of detecting harder. Other factors influencing the variability of observer accuracy in detecting and assessing numbers of animals from the air for the Samburu, Laikipia and Marsabit census are assumed to be relatively consistent over time. As such the 2017 count likely represents a consistent estimate of Grevy's zebra numbers using this method and provides a useful trend over the past 9 years.

In the Meru Conservation Area (MCA), total aerial surveys of elephants, buffalo, giraffe and Grevy's have been carried out since 2005. The number of elephants counted in conservation area between 2005 and 2015 was: 2005 (n = 703 elephants), 2006 (n = 504 elephants), 2007 (n = 747

elephants, 2011 (450 elephants), 2014 (n = 414 elephants) and 2015 (n = 659 elephants) respectively (Chase *et al.*, 2015; Ouna *et al.*, 2014). The conservation area's population status and trend of the other species (buffalo, giraffe and Grevy's zebra) for the period 2006, 2007, 2011 and 2014 are provided by Ouna *et al.* (2014).

In 2008 the Laikipia Samburu Marsabit aerial census covered a total of 46,391km^2, in 2012 a larger area of 55,000km^2 was included and in 2017 the area was further extended to cover 65,516 km^2. Aerial counts have provided vital information to policy makers and park managers to facilitating sound management of elephants in the ecosystem. Habitat loss and compression of the elephant population emanating from sedentary settlements around major migratory corridors and former elephant range is a key elephant conservation and management issue in the ecosystem. Human-elephant conflict is currently the greatest problem, besides the loss of elephant range as a result of land use change and increasing settlements in formerly unsettled areas. Regardless of these challenges being faced by the Laikipia-Samburu-Meru-Marsabit (LSMM) ecosystem, it remains an important elephant range in Kenya; it hosts the second largest population of elephants after Tsavo East and West National Parks which are formally protected. In principle, The Laikipia Samburu population is Kenya's largest population outside protected areas. In addition, it has the largest population of Grevy's zebra in Kenya and the world; over 90% of the remaining *in-situ* population of Grevy's zebra world. Therefore, it is important to continue to monitor the population of elephants and Grevy's Zebra as well as buffalo and giraffe in the ecosystem to provide continuous long term data for sound management.

As a long term monitoring process, the survey data and information is valuable for the effective management of the entire LSMM ecosystem as it continues to experience pressures from human population growth and consequent changes in land use, and land tenure systems. The Laikipia-Samburu ecosystem experienced livestock incursions in 2016 and part of 2017 with armed herdsmen destroying property and fences in the ecosystem. It will therefore be important to establish the impact of such an incursion on the wildlife.

The goal of the 2017 aerial survey was to sustain the long term aerial monitoring of elephants, buffalo, giraffe and Grevy's Zebra in Laikipia, Samburu, Meru and Marsabit ecosystems. The specific objectives for the aerial survey were to:

1. Determine the present status and trends of elephant, buffalo, giraffe and Grevy's zebra population;
2. Establish elephant poaching levels through observation of carcasses within the ecosystem;
3. Document estimated numbers and distribution of human activities in the Laikipia-Samburu-Meru-Marsabit ecosystem.

2.0 STUDY AREA

2.1 Laikipia-Samburu Ecosystem

Detailed description of the study area has been done by other authors (Omondi, Bitok and Mayienda, 2002; Thouless *et al.*, 2002; Ihwagi, 2007; Thouless *et al.*, 2008; Kahindi *et al.*, 2009;

Lororoh *et al.*, 2010; Ngene *et al.*, 2013; Ouna *et al.*, 2014; Thouless *et al.*, 2016;). The survey area covered about 61,816 km^2 and was divided into three parts: Laikipia-Samburu ecosystem (37,936.7,km^2), Marsabit ecosystem (8,482.4 km^2) and Meru Conservation Area (15, 396.9km^2). Figure 1 below shows the spatial extent of the study area during the November 2017 survey.

The climate within this area is typically dry savanna, hot and dry for most of the year with highly variable and erratic bimodal rainfall, 90% of which falls in April and November. The climate gets drier as you move northwards of the study area, rainfall drops to less than 500mm per year except in the mountains where variations may reach high of 1250mm per year. Consequently, humans and permanent agriculture are concentrated in the south and livestock ranching and wildlife are concentrated in the north. Laikipia lies on the leeward side of Mount Kenya and the weather is thus affected by the rain shadow of the mountain (Kahindi *et al.*, 2009). It has a high diversity of habitats ranging from the lowland, xeric scrub bush lands comprising *Acacia* and *Commiphora* species to the highland, mesic cedar and camphor forests (Barkham and Rainy 1976). EwasoNg'iro River and its tributaries is the lifeline for wildlife providing dry season food resources in the dry season.

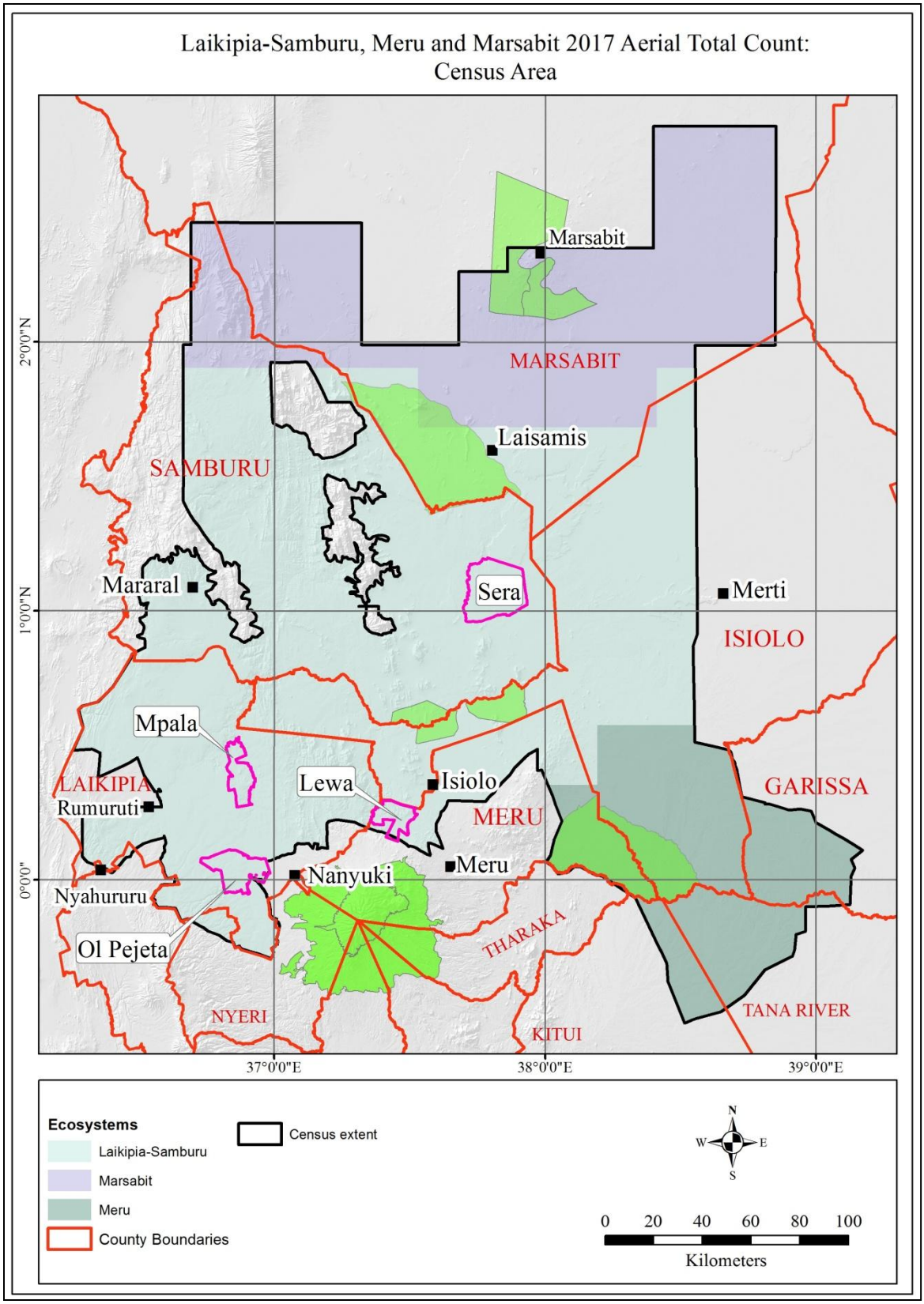

Figure 1: Laikipia-Samburu-Meru-Marsabit 2017 aerial survey area

Three main vegetation types characterize the Laikipia-Samburu ecosystem; woodland dominated by whistling-thorn acacia (*Acacia drepanalobium*), which is the most common vegetation type (Young *et al.*, 1997); savanna dominated by perennial grasses with widely spaced trees and shrubs; and bushland with a discontinuous layer of perennial grasses and >30% canopy cover dominated by wait-a-bit thorn (*Acacia mellifera*), mgunga (*Acacia etbaica*), prickly thorn (*Acacia brevispica*), and white cross berry (*Grewia tenae*) (Augustine and McNaughton 2004).

The ecosystem also hosts the second highest densities of wildlife in Kenya, after the Maasai Mara, including the country's second largest population of elephants (Omondi, Bitok and Mayienda, 2002; Georgiadis *et al.*, 2007). Tourism based on this wildlife resource plays an increasing role in the local economy.

Major land uses include national reserves, community conservation areas, undeveloped government-owned trust land, forest reserves, private ranches, sanctuaries and agricultural settlements. While most of Laikipia consists of the private ranches, Samburu is mainly a low lying pastoral grazing land with forested ranges (Kirisia/Leroghi/Mathews). Various reserves and community conservation areas are found within Samburu County, they include Buffalo Springs and Shaba National Reserves. Several Community Wildlife Conservancies namely Namunyak, Kalama, Meibae and Il Ngwesi.

The population densities within the ecosystem are relatively low, Laikipia County covering about 8,600km^2 has a population of about 400,000 persons, Samburu county on the other hand has an area of 20,000km^2 and a population of over 220,000 persons, while Isiolo is 25,000km^2 and with a population of 143,000 persons. Within majority of the ecosystem, wildlife exists with other contiguous land uses that mainly revolve around pastoralism and subsistence agriculture.

The private ranches in Laikipia host a lot of resident wildlife populations that are either confined by fencing or are free ranging. The fencing influences movement patterns of wildlife. Subdivision of some of the ranches and the subsequent settlement in the western and southern parts of the County has led to intense human-wildlife conflicts as the migratory corridors have been blocked. Notable conservancies hosting rhinos include OlPajeta, OlJogi, Lewa and Solio Conservancies.

2.2 Marsabit Ecosystem

The census covered the whole of Marsabit Forest Reserve (MNR), Southern Marsabit National Reserve, and extended to areas all around Losai National Reserve and the adjacent community land, guided by previously known distribution of elephants. Protected areas include Losai National Reserve which is not actively managed, Marsabit National Reserve under KWS but insufficient management and KWS/KFS managed Marsabit Forest Reserve plus four community land conservancies namely Melako, Shurr, Jaldessa and Songa which overlap with the National Reserves.

The climate of Marsabit ecosystem is hot, arid tropical climate, with two short, April and November sub humid peak seasons. The mean monthly daytime temperature is 26-20°C in the plains, in contrast to 17-19°C in the mountains. The rainfall regime consists of bimodal rainfall

pattern with peak seasons in April and November. Annual rainfall ranges from 50 to 250 mm in the lowlands and 800 to 1000 mm in the forest.

The Marsabit elephant range comprises evergreen montane forest, owing to humidity received from mist condensation and the frequent cloud formation in the peak areas of Mount Marsabit, semi-deciduous bush-land, deciduous shrub-land and perennial grassland. Marsabit forest is the main source of water for human, livestock and wildlife. The surrounding areas suffer water scarcity due to limited availability of groundwater sources which the local communities depend on. Wetlands such as Bongole, elephant pools, Lake Paradise have been affected by droughts and livestock incursion.

The forest and adjacent community land cover have over 10 years period experienced more than 50% forest/shrubland/grassland conversion to agriculture/settlements or bare land as a result of land use change from nomadic to sedentary mixed farming and modern commercial developments examples highways, urban. This has resulted to increased land fragmentation and sedentary areas. Nevertheless the main economic activity of the wider Marsabit county residents is still nomadic pastoralism.

Elephant movement study in Marsabit forest ecosystem using telemetry indicates that migrations to and from the lower Laikipia–Samburu rangelands to Marsabit forest ecosystem are still active (Ngene, 2010). Three (3) elephant corridors or dispersal areas in the ecosystem have been documented as Southern and South Western corridors, these are: Chachane–Bule Marmar corridor which passes through cultivated areas, Karare-Bongole–Karare-Kamboy-Logologo–Malgis–Samburu–Ewaso and Chop–Gudes–Seralaparawa-Samburu-Ewaso dispersal areas (Ngene 2010). Once out of the MFR/NR, the animals find their way into the Mathews Range and the Buffalo springs-Shaba-Samburu conservation complex. Parts of former wildlife dispersal areas on the mountain are no longer existent or just fragmented due to displacement by livestock and human settlement. The area further eastward to the southwest of the forest is densely populated and is under cultivation. To date about 60 per cent of the National Reserve is unavailable for wildlife dispersal all year round. Competition for resources between humans and wildlife causes negative changes to habitats, affects wildlife feeding and migratory behaviours, which further escalates human-wildlife conflicts.

2.3 Meru Conservation Area

The Meru Conservation Area (MCA) is located in five Administrative Counties, which are Meru, Garissa, Tana River, Isiolo and Kitui. Meru County is densely populated with an area of about 7,000 km^2 and a population of about 1.4 million people. The MCA covers an area of approximately 8482.4km^2 which is a significant proportion of the county and parts of Kitui, Garissa and Isiolo counties. The conservation area is the second largest protected area in Kenya after the Tsavo Conservation Area. It comprises Meru (870km^2) and Kora (1787km^2) National Parks, Mwingi, and Bisanadi National Reserves and the Northern Grazing Area (NGA). The national parks are managed by Kenya Wildlife Service (KWS) whereas the National Reserves are managed by the County Governments of Kitui (Mwingi National Reserve; 745km^2), Garissa

(Rahole National Reserve; 1270km^2) and Isiolo (Bisanadi National Reserve; 606km^2). The NGA is a community grazing area to the north of Meru National Park.

The conservation area is largely found in the lowlands and in the leeward side of the Nyambene Hills. The conservation area is classified as Agro-Ecological Zone (AEZ) VI, which isarid to semi-arid. Rainfall is quite low ranging between 380-1000mm annually. The Rainfall Pattern is bi-modal with the long rains running from mid-March to mid-May while the short rains are experienced from October to December. Meru National Park has an annual average rainfall of between 600-800mm per annum. Kora National Park has an annual average 500mm being higher in the west and declining towards the East. The average rainfall in MCA ranges between 380mm-1000mm.

The vegetation types in the count area can be characterized into four communities: Acacia wooded grassland, *Combretum* Wooded grassland, *Acacia-Commiphora* bushland and unique riverine vegetation consisting mainly of stands of Hyphaene and Raphia palms, and a network of Ficus trees (Ament, 1975). The later type of vegetation is found along rivers in all the vegetation types. These vegetation communities closely correspond to park geological divisions. , *Acacia/Commiphora* bushland is dominant where the basement rock is exposed in the south of the park where as Combretum wooded grassland is dominant on the western boundary of the park where there is slightly acidic volcanic soils. Acacia on alkaline volcanic alluvial soil dominates the north and northeastern parts of the park. In this later section, there are extensive swamps with a distinct plant community. Different rivers and streams rising in the Nyambene hills flowing across it to join the Tana River in the south-eastern corner dissect the entire park. In the swamps and along rivers, there is a dense riverine forest or stands of doum palms (*Hyphaene sp*) and Raffia palms (*Raphia* sp), especially *Raphia farinifera*, *Hyphaene coriacea* and *Phoenix reclinata*. On the Tana River, Tana River poplar *Populus ilicifolia* and a number of *Ficus* sp. are dominant. Other riverine trees include *Ficus sycomorus, Newtonia hildebrandtii*, *Acacia elatior* and *Acacia robusta*. The red-flowered Parasitic *Loranthus* grows on the branches of *Acacia reficiens* trees along the rivers. There are numerous riverine swamps with sedges *Cyprus* sp. and grasses *Echinochloa haplacelada* and *Pennisetum mezianum*.

The MCA is traversed by 14 permanent rivers that flow in parallel streams along the slopes of Mt. Kenya and drain into Tana River. The soil type varies from the dark rich volcanic soils on the hilly North-western side to the grey-brown alluvial soils towards the flat eastern parts.

The MCA is surrounded by a variety of different peoples, with varied cultures, traditions and land use practices. The Borana pastoralists are found to the northern and eastern areas of Meru National Park and Bisanadi National Reserve; The Tharaka and Kambas who are sedentary and practice agriculture occupy areas to the south of MCA; and to the west of the area the Ameru agriculturalists predominate. The Orma who are pastoralists occupy the remaining areas to the north and east of Kora National Park, with increasing numbers of Somali pastoralists migrating into the area in recently.

MCA management is taking steps to help improve the compatibility of cultural practices and land-uses surrounding the MCA with the areas conservation, and to ensure that MCA-adjacent communities are directly benefiting from the area's natural resources. This is being carried out

through management actions under the community Programme, which involve enhancing or developing community institutions, and the promotion of community tourism initiatives and potential attractions outside the protected area.

The MCA is a protected area with wildlife conservation as a major economic activity. Owing to marginal potential for rain fed agriculture, the adjoining community land has traditionally been under agro and pure pastoralism. The influx of more sedentary communities into the area is putting the wetter margins under exclusive crop cultivation. Commonly cultivated crops include legumes, millet, sorghum, maize. Commonly kept livestock include cattle on the western boundary of Meru National Park; cattle goats and donkeys in southern Tharaka; and cattle sheep, goats and camels in the Northern Pastoral lands.

3.0 MATERIALS AND METHODS

3.1 Training

In order to enhance the accuracy of the count and minimize inter- observer variability, the actual census was preceded by three days of training of new crew and refresher training for experienced crew. The entire census crew were taken through a rigorous training and simulation sessions where pilots were tested on how to navigate through straight line transects whereas FSOs and RSOs were trained on data capture using various equipment, counting with confidence and how to differentiate "look-alike" animals (e.g., donkey, Grevy's and burchell's zebra). The objectives of the training were to:

i. Ensure that all crews were familiar with the survey protocol.
ii. Ensure that the process of data collection was well practiced and that all participants had a clear idea of the pattern of data recording using the survey tools.
iii. Evaluate survey crew performance and capability before the count was initiated.
iv. Train observers on appropriate GPS and camera setup, handheld camera shooting and ground photo processing.

The training and evaluation was characterized by a series of ground and airborne sessions as described by KWS, TAWIRI and AWF, 2015, and delivered using formal presentations and exercises. A survey manual is available for all crew as a reference tool for future similar surveys (KWS, TAWIRI and AWF, 2015).

Besides the training for the Pilots, FSOs and RSOs the data team were taken through various sessions and simulations of data capture to ensure that data capture is standardized. The training for the data team involved understanding the species codes and transcribing the information from the dictaphones to the datasheets.

The Rear Seat Observers (RSO's) were each calibrated to count using an aircraft tailored to their sitting height eye level to enable the estimation of observable strip width (500m) given the height of the aircraft from the ground (300ft) and viewing angle (12^0). The calibrated streamers were

then mounted on either side of the aircraft's wing struts. The viewing angles for each observer were measured using clinometers to position streamers.

For each calibration made, test flights were conducted using markers placed at 500m along and perpendicular to the 1.5km long airstrip. This was to align the streamers to the markers and to enable the census crew gauge and confirm the width span. To minimize inter observer variability in estimation and enhance species identification, all observers were independently subjected to test flights where they counted a portion of the same block twice.

3.2 Survey design

The census methodology adopted during the 2017 aerial census was a continuation of total count approach for wildlife and livestock among other human activities as described by Norton-Griffiths (1978), Douglas-Hamilton *et al.* (1994, Douglas-Hamilton (1997) and KWS, TAWIRI & AWF 2015. These standards were put in place to maximize the accuracy of the count while improving search effort for the target species and use of current technology.

The survey covered an area of approximately 61,816km^2 and was divided into 115 counting blocks ranging in size from 200-600km^2 (Figure 2) The blocks were designed to be an achievable target for one aircraft in a single day (based on previous surveys experience and the calculation of available flying time).The shape of the blocks also took into consideration the geographical features like hilly areas that could not be crossed by aircrafts and the avoidance of rivers being used as block boundaries. Finally, the blocks were designed so that they do not cut across areas of high wildlife densities.

The survey block maps with Northing and Easting (in UTM) were printed and used by the pilots and FSOs, to aid in navigation (Figure 3). Only experienced well trained observers were used as flight crews. A complete cover approach was implemented in which the aircrafts flew adjacent flight lines spaced at one/two kilometres depending on the elephant density, visibility and terrain. The one kilometre transects spacing covered areas of known high density of elephants in Laikipia-Samburu ecosystem, Meru-Bisanadi ecosystem and parts of Marsabit National Park/Reserve (Figure 4). The wider spacing (2km transect spacing) of flight lines was predominantly towards the northern part of the census area as well as the area outside Meru and Bisanadi protected areas (Figure 4).

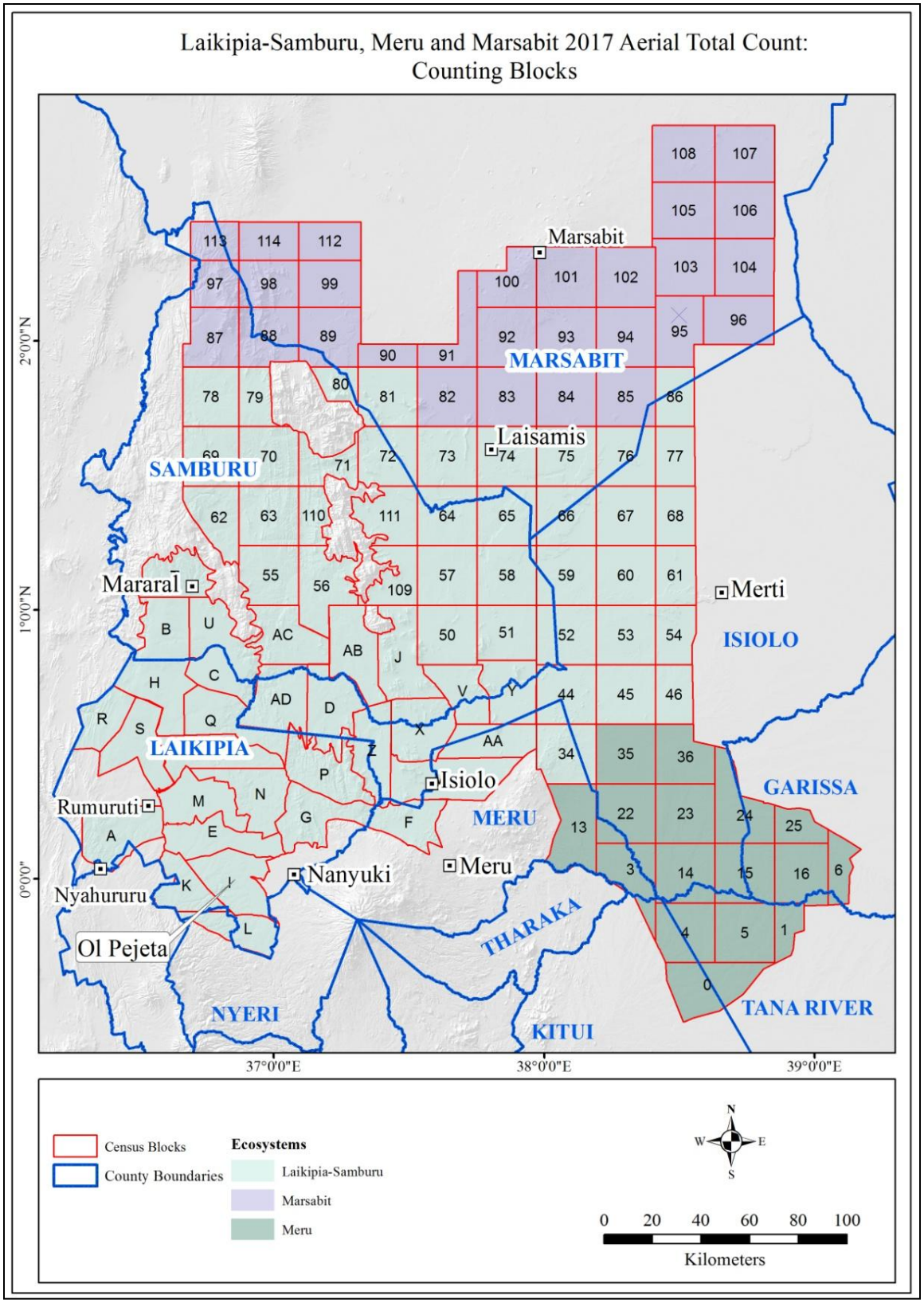

Figure 2: The aerial survey blocks used during the November 2017 aerial survey

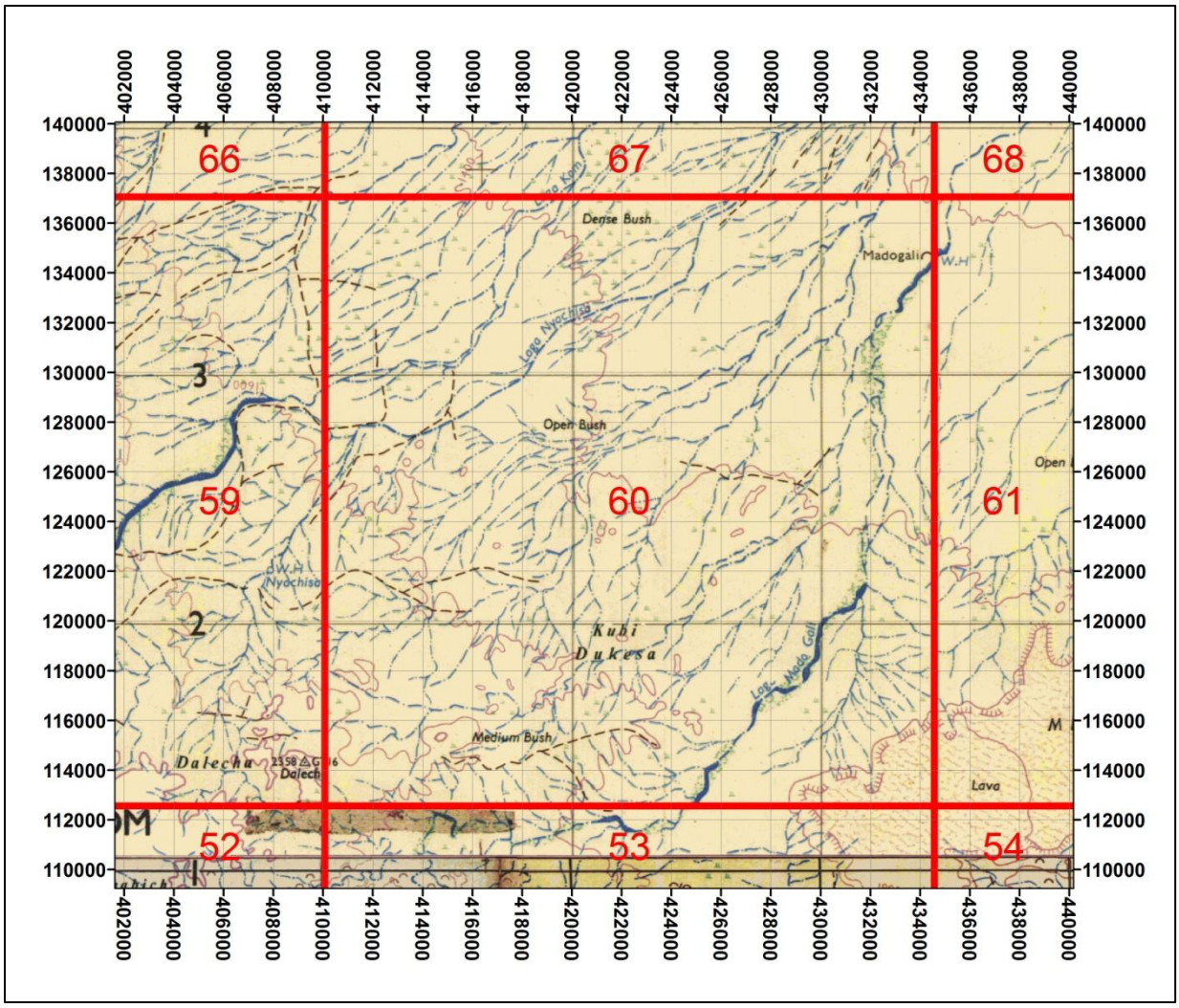

Figure 3: A block map with northings and eastings as used by census crew

Observers counted the target species within 500 m strip-width on either side of the aircraft. To reduce the potential for double counting arising from animal movement, information on elephant movement patterns in the survey area was used to aid in block designs and allocation of day to day counting blocks in addition to flight orientation (north-south or east-west). All elephant herds with more than 10 individuals were circled and photographed for purposes of recounting and obtaining a more accurate estimate as recommended by Hamilton (1997) and KWS, TAWIRI & AWF 2015. During the survey, elephants and elephant carcasses, Grevy's zebra, buffalo and giraffes were counted. Various aspects of human activities including settlements, livestock, agricultural cultivations and charcoal production were recorded.

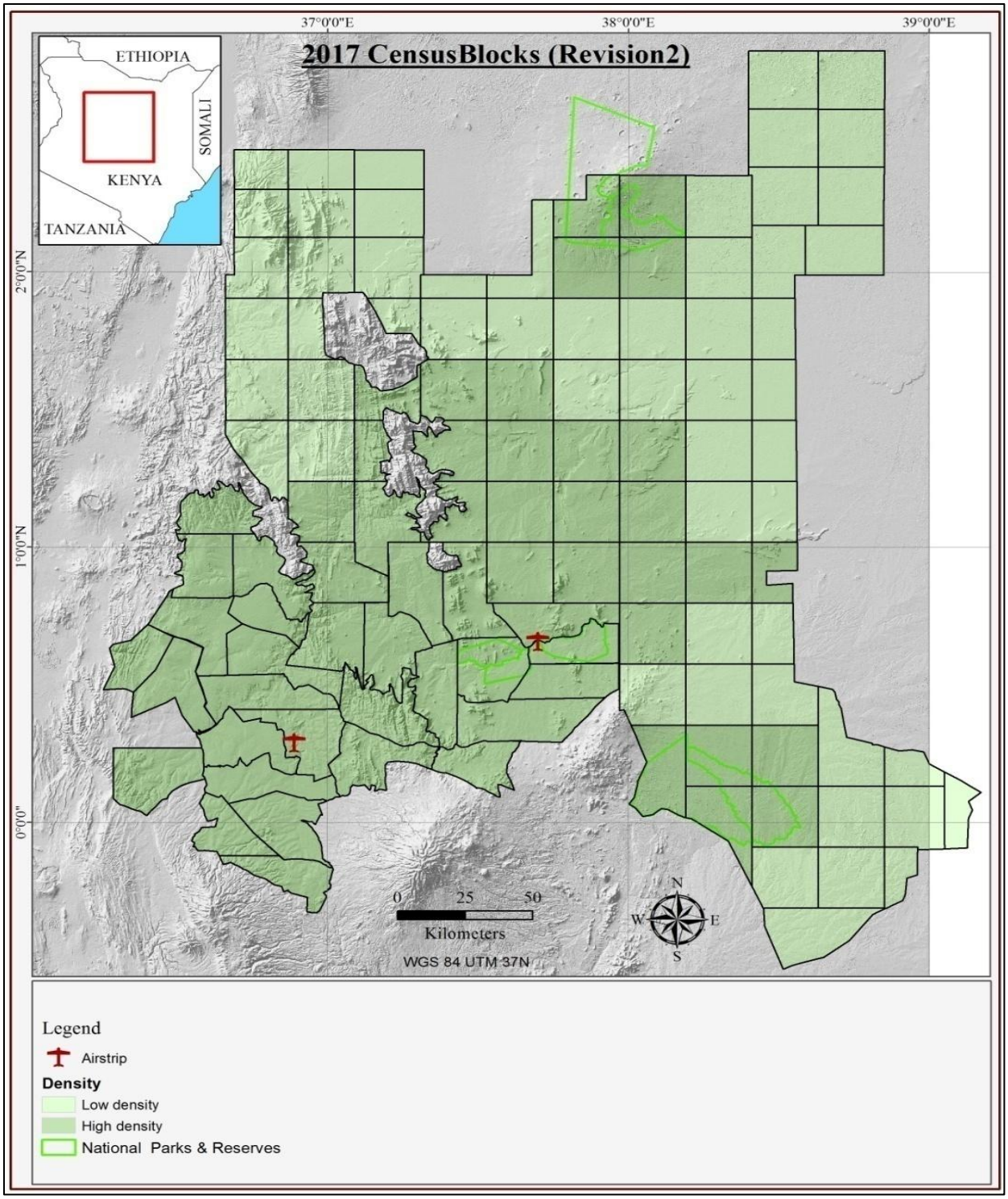

Figure 4: The map of the study area showing the blocks used during the aerial survey. Blocks marked high and low density were counted using 1km and 2km transect spacing respectively

3.3 Data recording

A total of 11 aircrafts were used during the aerial census. The flight crew included a pilot, a Front Seat Observer (FSO) and two Rear Seat Observers (RSO) for four seater aircrafts and one FSO who doubled up as an RSO in the two seater planes. Each FSO navigated through the predetermined transects and marked observation positions using a GPS device. The RSOs used dictaphones and cameras to document observations and tied them to the GPS position marked by the FSO. Wherever a sighting was made, the RSOs recorded on the dictaphone; the species name, estimated numbers of target observation, side of the aircraft, and the GPS waypoint, for example "Elephant, 36, Left, GPS 002". When the estimate was uncertain or more than 10 elephants, the aircraft circled the observation to reconfirm. For such elephant groups the pilot made one final circle to allow observers capture photograph(s) of the group. A GPS enabled digital camera was provided to each observer to capture geo-located photographs of large or partially obscured groups of elephants and Grevy's zebras. The date, individual flight crew members, aircraft registration number and flight times (take off, start of counting, stop of counting and landing time) were recorded in the Dictaphone and logged in the database as well.

The exercise started every morning at 0730 hrs and ended at 1800 hrs. Breaks were taken during aircrafts refuelling and at lunch time. Fuelling sites were well distributed in the survey area (e.g., Mpala Research Centre, Sarova Shaba Lodge, Laisamis and Meru National Park) to cut down on transit time and maximize on search effort. The specified flight parameters adhered to during the survey were; height; 300-350ft Above Ground Level (AGL), maximum speed of 180 km/hr, a known heading; flight duration of 3 hours maximum before a rest period and no counting between 1100 and 1500 hours. These were done so as to reduce fatigue and inter-crew variability and provide optimal conditions for counting from the air given the prevailing environmental conditions.

Elephant carcasses were counted alongside live elephants. Four categories of carcasses by age were recorded; fresh, recent, old and very old (Hamilton and Hillman 1981; Olindo *et al.*, 1988). These were:

(i) Fresh', in which carcasses have fresh skin giving the rounded appearance, scavengers probably present. These are carcasses estimated to be less than three weeks old.
(ii) 'Recent', in which carcasses less than one year and may be distinguished by a rot patch around the body which has killed vegetation.
(iii) 'Old', in which carcasses have usually decomposed to a skeleton and vegetation is beginning to grow. This applies to dead elephants that have died more than a year ago.
(iv) 'Very old', in which the bones have began to turn grey. These no longer stand out and are hard to distinguish from air.

3.4 Post flight procedures

After landing and reporting to operation base station, the FSOs handed over the GPS, Cameras and Dictaphones to the GIS team and data loggers for downloading and transcribing the audio data into the aerial census database.

The GPS data was downloaded into ArcGIS program (ESRI, 2011). Spatial joins between the way points and field data were created and the batch converted into a shape-file. Another team of GIS personnel checked through the records especially zone boundaries where pilots overlapped for possible double counts. These double counts were cross checked with FSOs and RSOs then rectified as need was. Repeat counts along block boundaries were corrected before data analysis. The crew computed the time spent in counting for each session and the time spent on transit after landing. Data processing and full details of this process are available in the survey manual (KWS, TAWIRI and AWF, 2015).

3.5 Data auditing and analysis

All the data was audited by an independent team drawn from Save the Elephant, Marwell Wildlife Space for Giants and Kenya wildlife Service. The data audit took place from 6-8 December 2017. The audit involved listening to all dictaphones and counterchecking whether what was recorded on the datasheets tallied with what was in the voice records. Any disparities were noted and corrected on the raw datasheets and database.

The audited data were tabulated and cleaned in the KWS animals' census database. The Excel Pivot tools were used to analyse and describe population sizes, densities and distribution data. The 2017 census covered a larger area than in 2012 as a result of expansion of the Marsabit and Meru count areas hence comparisons are only made for common blocks in the two censuses.

The current elephant, buffalo, giraffe and Grevy's zebra population sizes, density and distribution was calculated for the entire LSMM and comparisons done on LSMM ecosystems with past survey data. Simple percentages were calculated to aid interpretation of population changes and trends as described by Zar (1996). (The species, livestock and other human activities distribution maps were prepared using ArcGis 10.3 following procedures described by ESRI (2014).

Elephant carcass ratio was calculated as "dead / (dead + live elephants)" as outlined by Douglas-Hamilton and Burrill (1991). The study area falls under the designated Laikipia-Samburu-Meru MIKE site, where detailed records of systematic monitoring of mortality are available. Therefore, carcass ratios were further calculated using the ground carcass records to aid the discussion on the true picture of elephant mortality

4.0 RESULTS

4.1 Census effort and survey parameters

4.1.1 Search effort

The search for targeted species was done using eleven aircrafts; two caravans, two Cessna planes (182 and 206), three huskies, three super cubs and one Aeroprakt-A22 alter light aircrafts. The aircrafts overflew the entire survey area measuring about 61,816km^2 for a period of ten days and took a total of 469.38 flight hours. The actual data collection took 70% of the total flight time which was spent on searching and enumerating the observations while 30% was used to commute from the operation bases and refuelling stations to the counting blocks (Table 1). Marsabit blocks consumed half of the time on transit even after having a fuelling station at Laisamis.

Table 1: Total count time and search effort in the three ecosystems

Ecosystem	Area (km^2)	Total Count time (hrs)	Total Transit time (hrs)	Search effort (km^2/hr	No. of elephants	Elephant density
Laikipia Samburu	37,936.7	212.18	56.53	178.79	7,166	0.19
Marsabit	15,396.9	67.13	66.1	229.36	181	0.01
Meru	8,482.4	47.91	19.52	177.05	674	0.08
Total		**327.23**	**142.15**		**8,021**	

4.1.2 Flight speed

The caravan planes flew at an average ground speed of 192 km/hr (a range of of 175 km/hr to 218 km/hr). The Cessna 206 and 185 planes flew at an average speed of 212 km/hr and 149 km/h respectively. Super-cub and the huskies flew at an average ground speed of 135.54 km/hr and 158.64 km/hr respectively (Table 2).

Table 2: Planes' average ground speed during the aerial survey

No.	Planes	Aircraft type	Count time (hrs)	Transit time (hrs)	Average speed (km/hr)
1	5Y DRS	Caravan	24.15	11.45	198
2	5Y GOK	Caravan	21.85	10.42	187
3	5Y BCD	Cessna	44.40	15.93	212
4	5Y STE	Cessna	34.90	15.08	149
5	5Y KWC	Husky	50.17	20.85	142
6	5Y KWG	Husky	48.57	16.70	164
7	5Y KWL	Husky	36.05	14.52	169
8	5Y BHL	Super cub	22.07	11.53	135
9	5Y BSH	Super cub	17.82	10.00	131

No.	Planes	Aircraft type	Count time (hrs)	Transit time (hrs)	Average speed (km/hr)
10	5Y BAU	Super cub	17.50	9.15	138
11	5Y BWX	Aerokrapt	9.77	6.52	137
	Grand Total		**327.23**	**142.15**	**160 (Average)**

4.1.3 Flight transects and height above ground

Transects were flown on both north-south and east-west orientations depending on topography and hydrology of a particular block. Hilly areas were covered with spiral manoeuvres that ensured safety of the crew, without compromising the objectives of the survey. These areas were covered not in regular transect but patrolled to ensure they were well covered (Figure 5). In the north-eastern part of the survey area mostly Marsabit areas, the survey transects were spaced at 2 km because the landscape is open and hence visibility was good enough for crews to spot and count animals upto one kilometre away.

For effective and successful sighting of observations by the RSOs, the pilots flew the aircrafts at an average height of 300-350 feet above ground. The lowest recorded flight height was 160 feet and highest flight height was 713 feet above ground.

4.2 Population size and distribution of elephants and elephant carcasses

A total of 8021 elephants were counted in the Laikipia-Samburu-Meru-Marsabit ecosystem. For Laikipia-Samburu-Marsabit ecosystem, a total of 7347 elephants were counted. The Laikipia-Samburu ecosystem alone had 7166 elephants while the Marsabit Conservation area had 181 elephants. The Meru Conservation Area recorded a total of 674 elephants. An allocation of the numbers into the administrative units shows that Laikipia County had the highest number of elephants (n=3407 elephants) followed by Samburu County (n=2349 elephants) and Meru County (n=1145 elephants). Marsabit and Isiolo Counties had the low numbers of elephants; 198 and 922 respectively (Figure 6). Theses should however be interpreted with caution because the sizes and other characteristics of landscape in each country vary a lot.

In Laikipia, most of the elephants were found mainly within a cluster of private ranches and conservancies in the central part of the county. Traditionally, Laikipia hosts approximately 42% of the population, despite being only a third of the ecosystem (Ihwagi *et al.* 2015). Key elephant concentration areas within Laikipia include Borana, Il-Ngwesi Conservancy, Loisaba Conservancy, Suyian and Mpala ranch. In Samburu County, most of the elephants were found in the south eastern parts of the County, at the fringes of Mathew ranges. Samburu National Reserve, Kalama, Namunyak and Sera Community Conservancies in particular had large numbers. In Meru ecosystem, the elephants occurred on the north-western tip of Meru National Park. Most of the elephants in Marsabit ecosystem were found to the south of Marsabit National Reserve although a group was located at Bule Marmar, about 90km north-east of Marsabit Forest.

A total of 76 elephant carcasses were recorded in Laikipia-Samburu-Marsabit ecosystem during the survey. The 'very old' elephant carcasses, i.e., those estimated to have died about a year ago, comprised 75% (n=57) of the total carcasses. The 'old' carcasses, i.e., those that were several years old were 25% (n=19). Most of the carcasses were recorded in the southern and eastern parts of Samburu County (i.e., Sera, Namunyak, Kalama Community Conservancies), and central parts of Laikipia County (i.e., Laikipia Nature Conservancy, Mugie Ranch).

In Meru Conservation Area (MCA), we counted 19 elephant carcasses (14 old and 5 very old). Most of the carcasses in MCA were recorded to the north of Bisanadi National Reserve. Other carcasses were recorded in Meru National Park (Figure 6). There were no fresh and recent carcasses recorded in both the Laikipia-Samburu-Marsabit ecosystem and Meru Conservation Area.

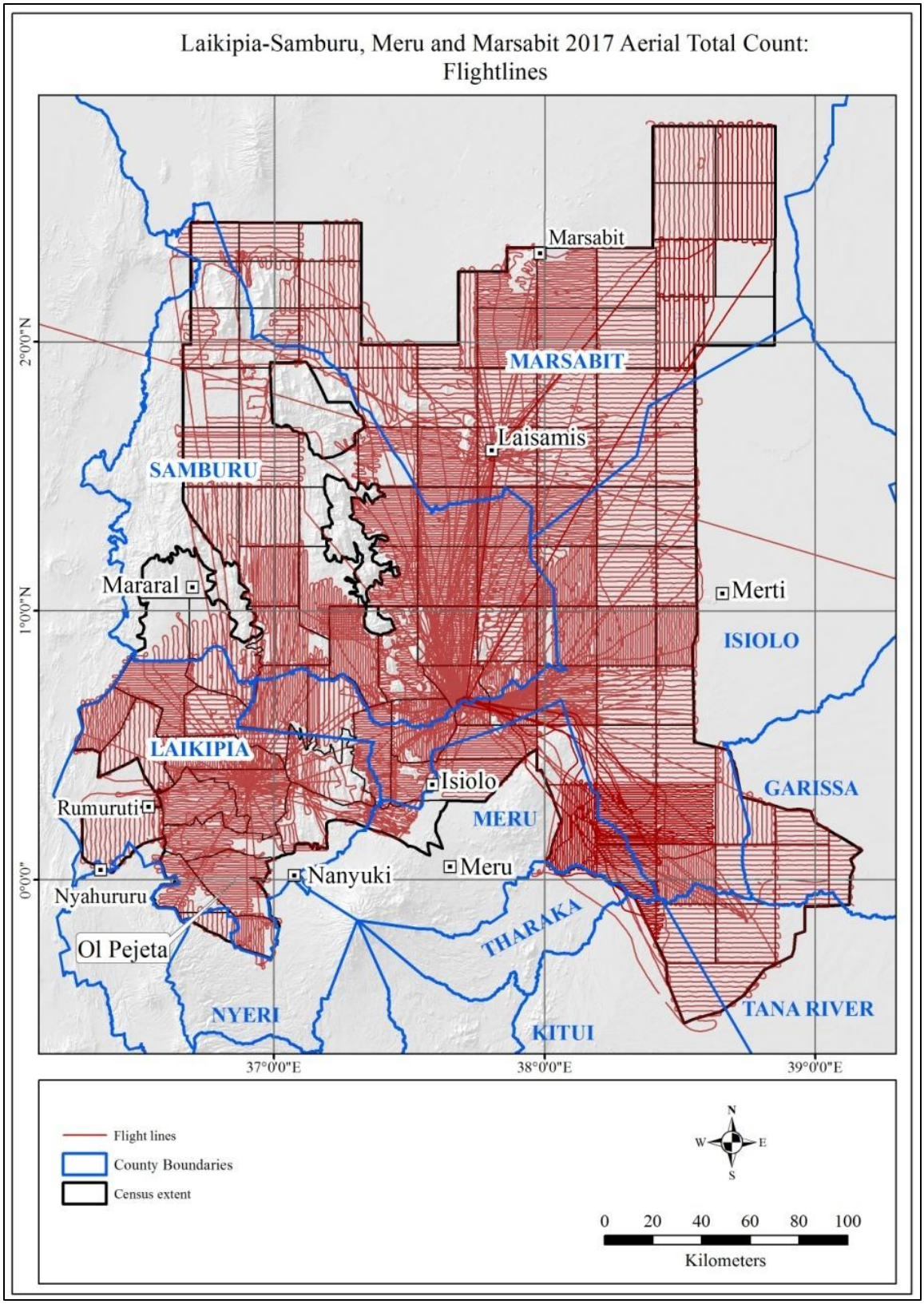

Figure 5: The survey flight tracks

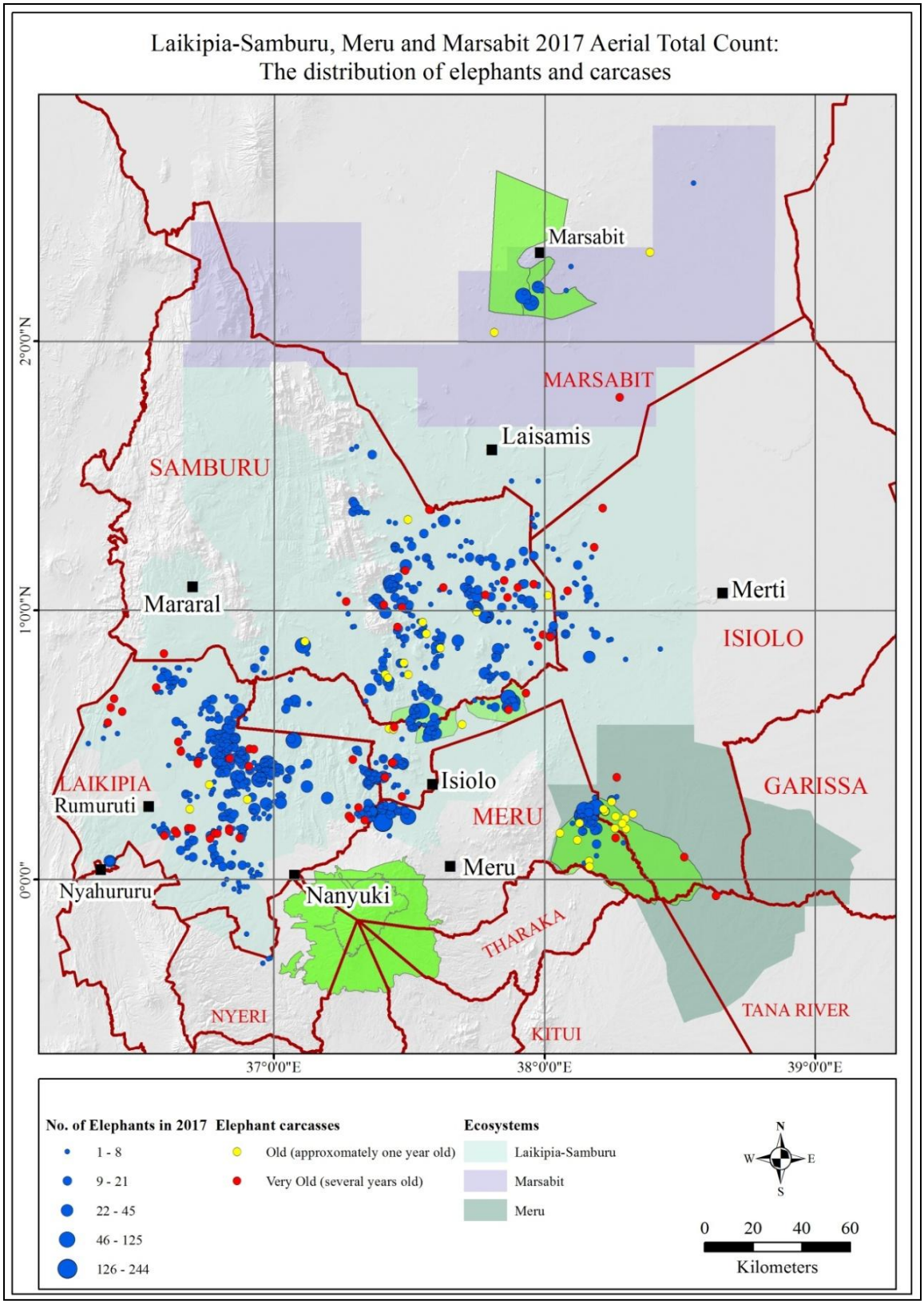

Figure 6: The distribution of elephants and elephant carcasses. No recent and fresh carcasses were recorded

4.4 Buffalo population and distribution

A total of 7210 Buffalo were counted in the survey area in 2017 (Table 3). This comprised 4450 buffalo in Laikipia-Samburu ecosystem, 2711 buffalo in Meru Conservation Area and 49 buffalo in Marsabit ecosystems. There was a 5 years increase of 11% (n=430 buffalo) in Laikipia-Samburu-Marsabit ecosystem from 4069 buffalo in 2012 to 4499 buffalo in 2017. This translates to an increase of about 86 buffalo per annum or a growth rate of 2% per annum. In Meru Conservation Area, the population of buffalo showed an increasing trend of 31% in 5 years (Table 3). Figure 7 below shows the trend of buffalo population in the survey areas over a 10 years period. After a decrease between 2008 and 2012, the buffalo population in Laikipia-Samburu-Marsabit ecosystem started to increase again after 2012 (Figure 7). In Meru Conservation Area, the buffalo population shows an increasing trend (Figure 7).

Table 3: Trend of buffalo numbers in Laikipia-Samburu-Marsabit ecosystem

Ecosystem	Year of census									
				5YRS				10YRS		
	2017	2014	2012	%change	2011	2008	2007	%change	2006	2005
Laikipia-Samburu-Marsabit	4499	-	4069	11%	-	5331	-	-16%	-	-
Meru	2711	-	-		3030		1832	48	948	2288
Total	7210									

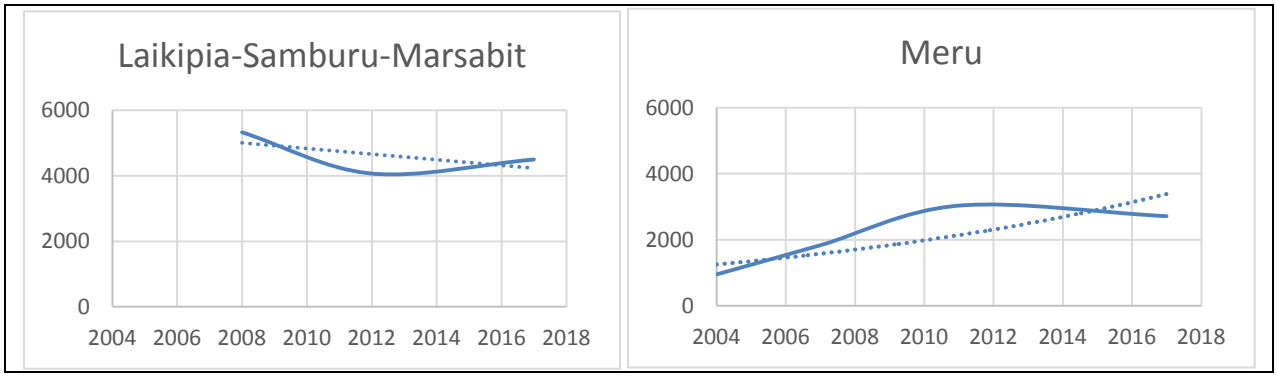

Figure 7: Trend of buffalo over a 10 years period in Laikipia-Samburu-Marsabit ecosystem and Meru Conservation Area

Meru ecosystem had the higher density of 0.32 buffalo/km^2 than Laikipia-Samburu-Marsabit (LSM; Table 4). Within LSM there were less and more widely distributed Buffalo in 2012 (n=4069, 0.072 buffalo/km^2) than in 2017 (n=4499, 0.080 buffalo/km^2; Table 5). Further the current LSM population is still lower than it was in 2008.

Table 4: Population density in the census area

Ecosystem	No. of Buffalo	Area (km^2)	Density
Laikipia-Samburu	4450	37937	0.117
Meru	2711	8482	0.320
Marsabit	49	15397	0.003

Table 5: Density trend of buffalo Laikipia-Samburu-Marsabit ecosystems

Year	2008	2012	2017
No. of counted Buffalo	5331	4069	4499
Area Covered (Km2)	46391	56300	56300
Popn' density Size (No./km^2)	0.115	0.072	0.080

Spatial distribution of buffalo appears to vary positively with presence of actively managed wildlife protected areas (Figure 8). In Meru Conservation Area, the buffalo occur on the northern tip of Meru National Park (Figure 8).

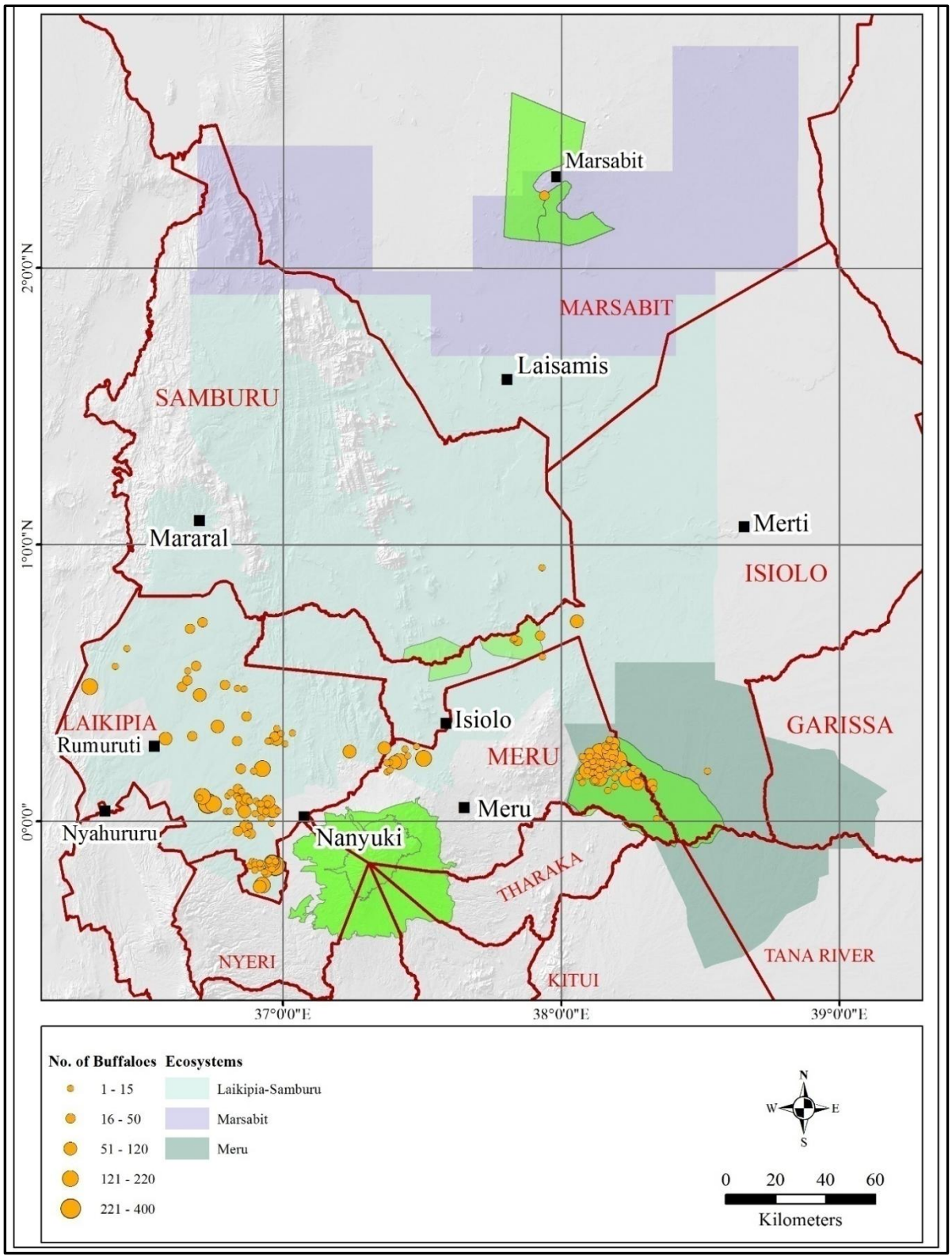

Figure 8: The distribution of Buffalo in Laikipia-Samburu-Meru-Marsabit Landscape in 2017

4.5 Giraffe population and distribution

A total of 5237 reticulated giraffes were counted in the LSMM ecosystems. Laikipia-Samburu ecosystem had the highest number of giraffes (n=4019 giraffe), followed by Meru (n=876 giraffe), while Marsabit had the lowest number (n=342 giraffe; Table 6; Figure 9). Overall, the density of giraffes was 0.085 giraffe/km^2, whereas the density in Laikipia-Samburu ecosystem was the highest at 0.474 giraffe/km^2 (Table 6). Most giraffes were concentrated in central of Laikipia, South East Samburu and Bisanadi-Meru areas (Figure 10).

Table 6: Numbers and density of giraffes in the surveyed ecosystems

Ecosystem	Area (km^2)	No. of Giraffe	Percentage	Density(Giraffe/km^2)
Laikipia-Samburu	8482.4	4019	76.7	0.474
Meru	37936.7	876	16.7	0.023
Marsabit	15396.9	342	6.5	0.022
Total	61816	5237	100	0.085

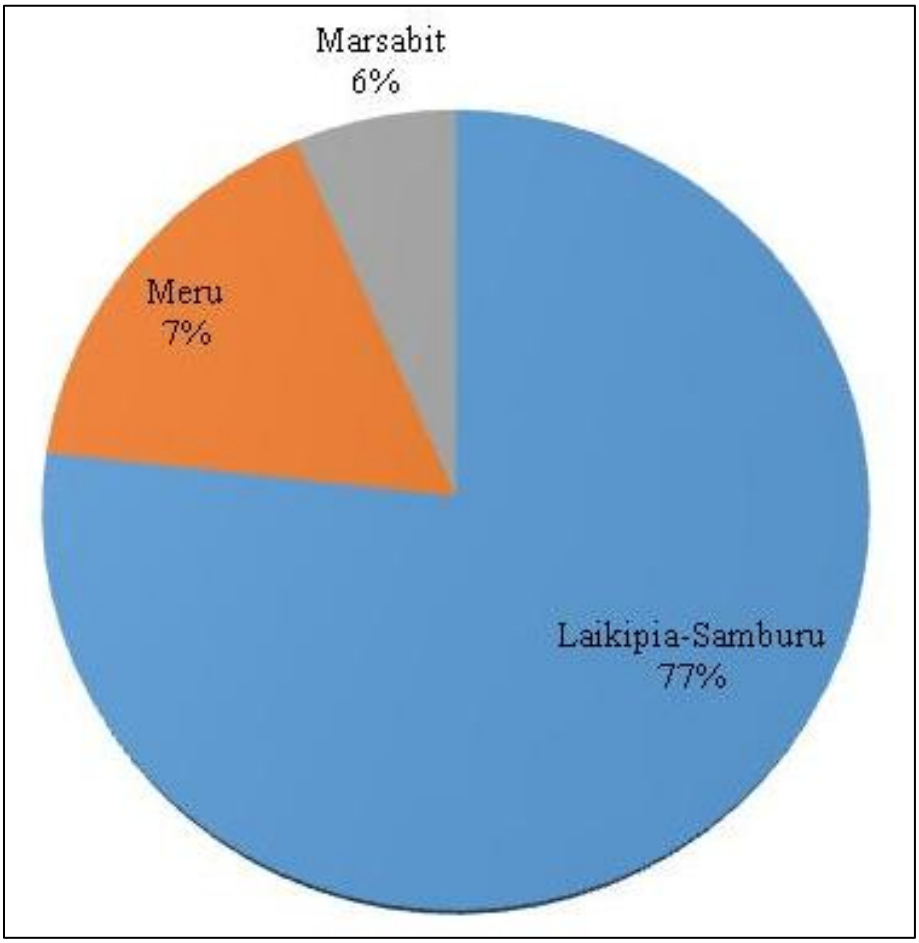

Figure 9: Proportion of giraffe's distribution in the surveyed ecosystems

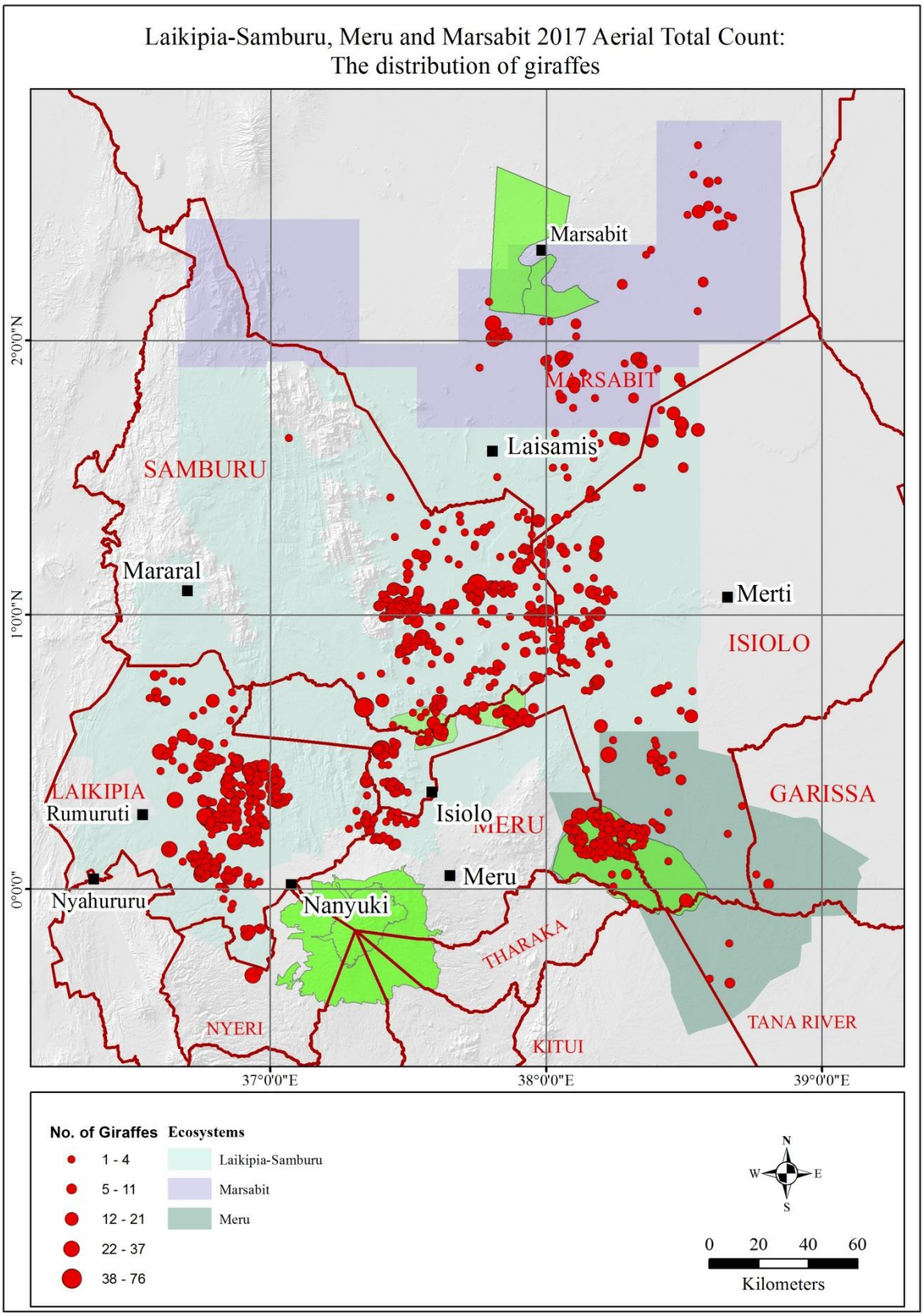

Figure 10: The distribution of giraffes in Laikipia Samburu-MarsabitMeru Ecosystems 2017

4.6 Grevy's zebra population and distribution

During the survey, a total of 1627 Grevy's Zebra were counted, a reduction compared to yr 2012, 1897 (14.2% more) and yr 2008, 2400 (a further 20.9%). From the past three surveys a standardised trend has been developed to provide comparable numbers over a similar area. Raw count data for the entire area covered by each survey suggest a decreasing population size trend (Figure 11). The standardised number reflecting animals found in a similar sized area provide a decrease of 32.8% over this period.

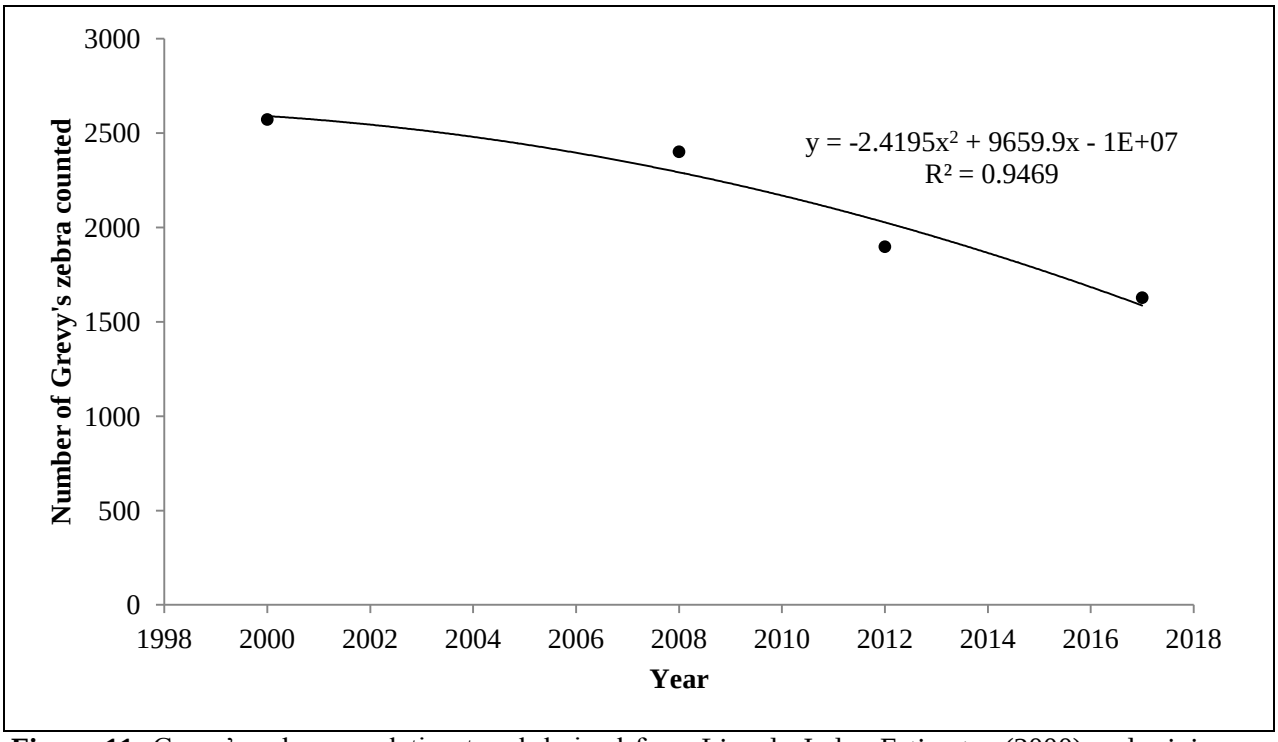

Figure 11: Grevy's zebra population trend derived from Lincoln Index Estimator (2000) and minimum total aerial count (2008, 2012 and 2017)

Grevy's zebra proportional population distribution showed a trend shifting from community areas and unprotected landscapes to protected and privately managed land. In 2008 approximately 80% of the population was distributed over community areas. By 2012 proportions in more protected landscapes had started to increase and only 57% were found in community areas. In 2017 we have seen an almost matched reversal of the 2008 distribution with over 80% of the Grevy's zebra detected in protected areas, private conservancies and ranches (Table 7). Of some concern is that more than 30% of the population can be found in just two locations within the remaining species range (Table 8). Distribution across the region as evidenced by the numbers detected per management zone show the greatest proportional increase in the Wamba management zone (Table 8). The Wamba zone also had the most Grevy's zebra within it, followed by Laikipia, Laisamis and Elbarta (Table 9; Table 10). Grevy's zebra detected outside these zones accounted for 58 individuals in small and widely distributed groups (Table 10). These animals do not present a concentrated population that can be used as a focus for conservation efforts (Figure 12).

Table 7: Grevy's zebra distribution by land use category

Land Use Category	Population Estimate	Percentage (%)	Protected area split
Community conservation Area (CCA)	311	19	
National Park	9	1	
National Reserve	368	23	81%
Private Ranch	387	24	
Private Wildlife Sanctuary	251	15	
Settlements	78	5	19%
Trust Land	223	14	
Total	1627		

Table 8: Grevy's zebra distribution by conservation management zone

Management Zone	No Counted in 2017	Percentage (%)		
		2008	2012	2017
Elbarta	28	2	1	2
Laikipia	488	38	34	30
Laisamis	70	4	8	4
Wamba	983	54	55	60
Outside Zones	58	2	2	4
Grand Total	1627			

Table 9: Grevy's Zebra Distribution by location and each locations proportional contribution to the population size. *note that this figure is made up cumulatively of small groups distributed throughout the survey area.

Location	**Number Counted**	**Proportion**
Lewa Conservancy	240	0.15
Buffalo Springs Reserve	236	0.15
Meibae	170	0.10
*Outside designated areas	145	0.09
Ol Jogi	141	0.09
Shaba	128	0.08
Westgate	81	0.05
Mukogodo	73	0.04
Chololo	42	0.03
Oldonyiro	41	0.03
Mpala	40	0.02
Leparua	29	0.02
Ngare Ndare Community	29	0.02
Mathira-1	28	0.02
Meru North	25	0.02
Nasuulu	23	0.01

Location	Number Counted	Proportion
P&D	15	0.01
Loisaba	13	0.01
ADC Mutara	12	0.01
Loroki	12	0.01
Soita Nyiro Farm	12	0.01
Waso	11	0.01
LMD Mar mar	10	0.01
Laikipia National Park	9	0.01
Segera/Mukenya	8	>0.01
Ol Maisor	7	>0.01
Mugie (E)	7	>0.01
Mathira 2	5	>0.01
Sosian Ranch	5	>0.01
Thome-B	5	>0.01
Ol Pejeta	4	>0.01
Samburu National Reserve	4	>0.01
Male	3	>0.01
Elkarama	2	>0.01
Kalama	2	>0.01
Kalama Conservancy	2	>0.01
Naibungas	2	>0.01
Nakuprat	2	>0.01
Baragoi	1	>0.01
Biliqo Bulessa	1	>0.01
Louniek SFT	1	>0.01
Sera	1	>0.01
Grand Total	**1627**	**1.00**

Table 10: Population Group Size Categories indicating average group size per category, total number detected per category and their relative proportional contribution to population size

	Size	No. of Locations	Total	Proportion
201 - 250	238	2	476	0.3
151 - 200	-	1	170	0.1
101 - 150	138	3	414	0.3
51 - 100	77	2	154	0.1
11 - 50	27	15	404	0.2
6 - 10	6.8	6	41	0.0
1 - 5	2.3	12	28	0.0

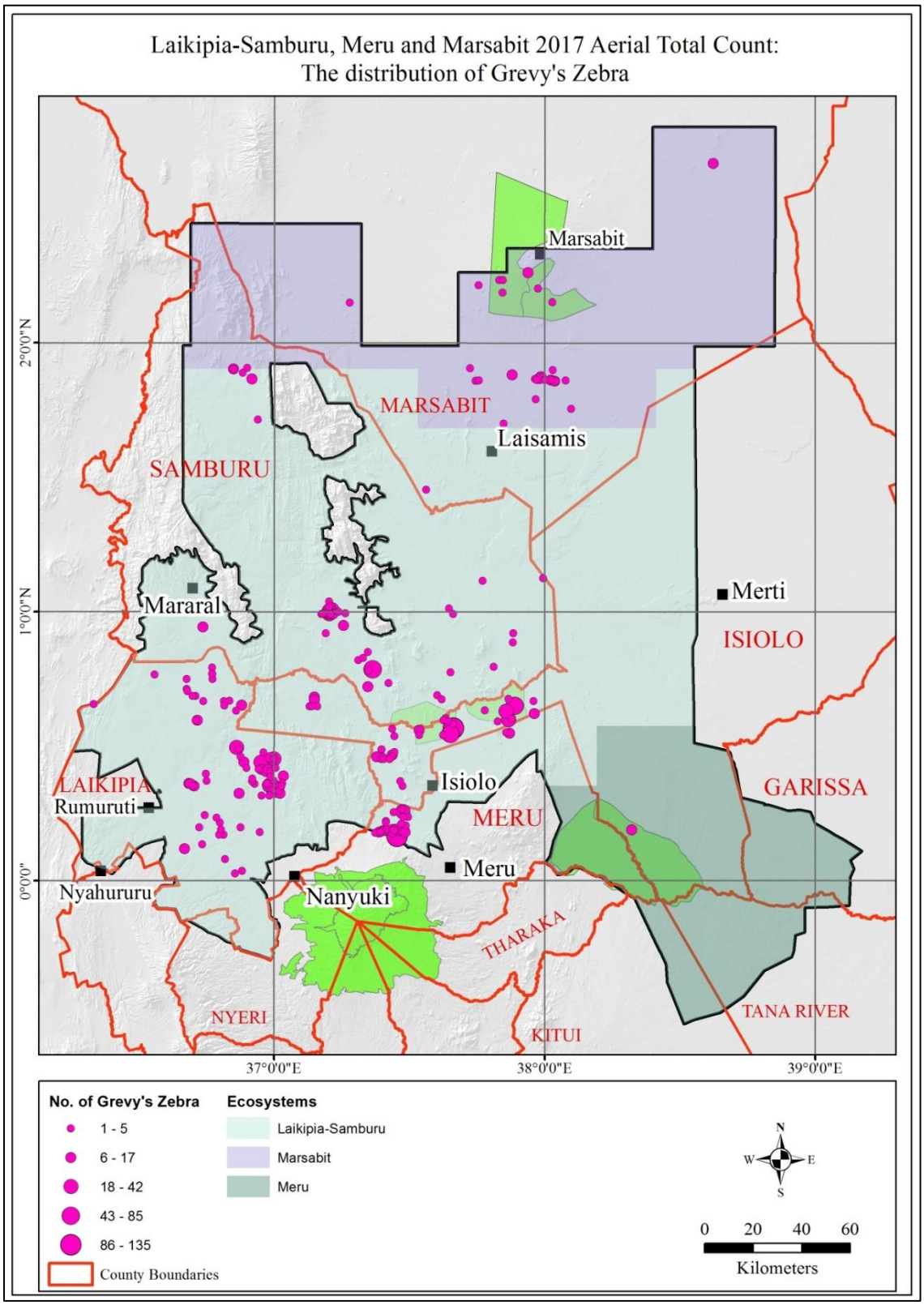

Figure 12: Grevy's zebra distribution and group size representation from the 2017 Samburu, Laikipia and Marsabit aerial total count.

4.7 Livestock numbers and distribution

A total of 1,092,202 herds of livestock were counted during the survey comprising of 82,425 camels, 206,107 cattle, 802,002 shoats (sheep & goats) and 1,688 donkeys (Table 11). Most of the livestock counted were located in Laikipia-Samburu ecosystem (69%), majority being shoats (n=547,830 shoats). On the other hand, Meru Conservation Area had the least number of livestock (13%) with shoats also forming the bulk of it (n=121,421). The overall livestock densities were higher in Laikipia-Samburu ecosystem (19.83 animals/km^2), closely followed by Meru Conservation area (16.53 animals/km^2) and Marsabit ecosystem (13.01 animals/km^2). The highest density of camels was recorded in Marsabit ecosystem (2.32 animals/km^2) while the highest density of cattle was recorded in Laikipia-Samburu ecosystem (4.39 animals/km^2). The shoats' densities were generally high in all areas with Meru Conservation Area and Laikipia-Samburu ecosystem recording the highest of 14.32 and 14.44 animals/km^2 respectively. Donkey densities were low with the highest being in Laikipia-Samburu ecosystem (0.03 animals/km^2).

Table 11: Livestock numbers counted during the survey

Species	Laikipia-Samburu		Meru		Marsabit		Total
	No.	Density	No.	Density	No.	Density	
Camels	32,905	0.87	9,838	1.16	35,703	2.32	78,446
Cattle	166,352	4.39	8,867	1.05	30,888	2.01	206,107
Shoats	547,830	14.44	121,421	14.32	133,331	8.66	802,582
Donkey	1,285	0.03	89	0.01	294	0.02	1,668
Grand Total	752,372 (69%)	19.83	140,215 (13%)	16.53	200,216 (18%)	13.01	1,092,202

Shoats and cattle were widely distributed throughout the census area (Figure 13). Both cattle and shoats followed a similar distribution pattern in the entire survey area although shoats were more widely distributed covering areas where cattle were absent. In the Laikipia-Samburu ecosystem, cattle and shoats were mainly concentrated in the western half of the block and covered almost the entire landscape.

In Marsabit ecosystem, the cattle and shoats clustered from the southern half of the Marsabit forest all the way south to the east of Laisamis area. Shoats were more widely distributed into the eastern and western boundaries of the counting block where few or no cattle were observed. For Meru Conservation Area, most of the cattle were concentrated at the Northern boundary of Meru National Park with some scattered herds found in Bisanadi and North Kitui National Reserves. A small herd of cattle were seen inside the park near the western edge. There was a very high population of shoats stretching from the Northern boundary of Meru National park, through the entire Bisanadi National Reserve up to the Tana River spilling into the southern edge of Meru Park. Shoats also occupied the entire Kora National Park and North Kitui National Reserve.

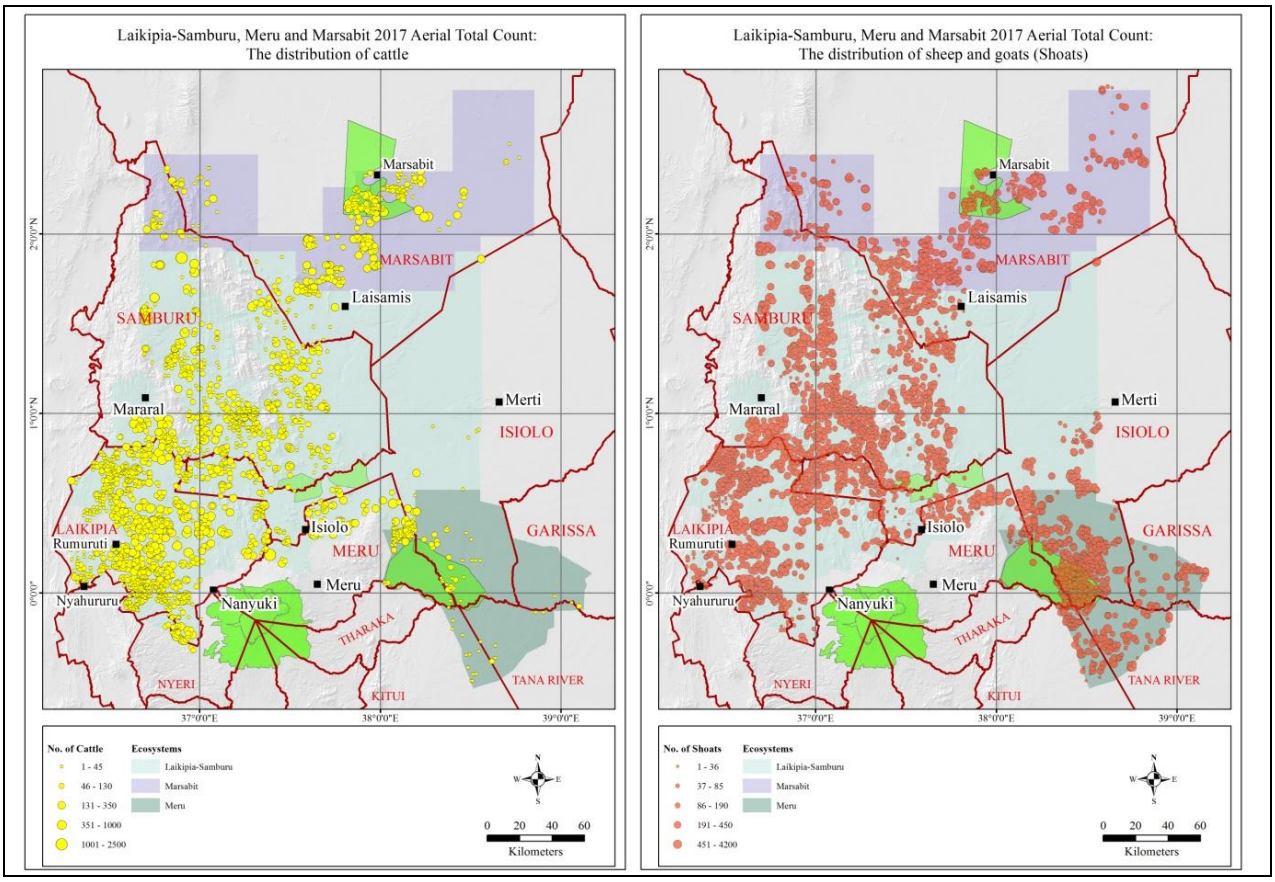

Figure 13: Distribution of cattle and shoats in the survey area

Camels were found in the entire surey area but they were more concentrated on the eastern half (Figure 14). Marsabit had large concentrations distributed in the entire ecosytem. The camels were also present in large numbers in almost the entire area of Meru but were scattered and few in the laikipia-Samburu ecosytem. Donkeys were few in the survey area with the most of the observations being made in the Laikipia-Samburu ecosytem. Very few donkey populations were observed in both Meru and Marsabit areas.

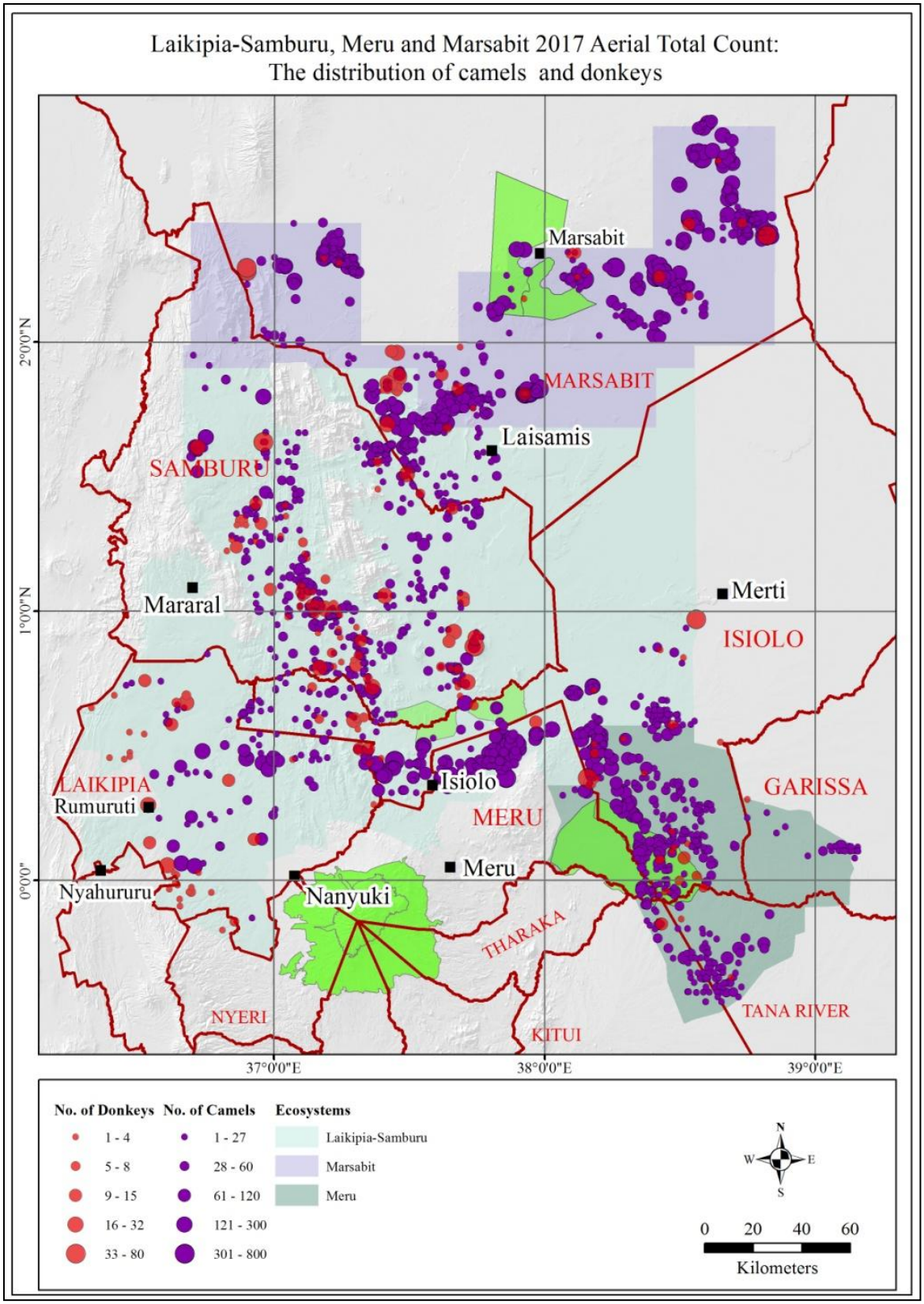

Figure 14: Distribution of camels and donkeys in the survey area

4.8 Other human activities

Besides livestock, various human activities were observed during the LSMM aerial census, they included agriculture at varying scales, charcoal burning and different types of human settlements both permanent and temporary. The human activities recorded included permanent and temporary human settlements, charcoal kilns and wotering points (Table 12). Permanent and temporary human settlement, dominated the human foot print recorded, with a total of 6,723 temporary structures (bomas) and 6,425 semi-permanent structures (Mabati roofs, villages and markets) being recorded. Majority of these settlements were within the Laikipia-Samburu ecosystem where a total of 6,088 permanent structures were recorded and 5,403 temporary ones (bomas) were identified (Figure 15A). Meru ecosystem recorded a total of 220 permanent structures and 463 temporary ones. Majority of settlements in Marsabit ecosystem were temporary bomas with a total of 857 units being recorded against 112 semi-permanent structures.

Charcoal production was the second most dominant activity within the landscape, a total of 1,278 charcoal kilns were recorded within the larger LSMM area. Similarly, majority of the kilns were in the Laikipia-Samburu area (n=972), followed by Meru ecosystem (n=305) while in Marsabit ecosystem only 2 kilns were observed. Charcoal burning in Laikipia is mainly concentrated in central and north western parts of Laikipia and elevated levels of charcoal production were seen in western parts of Samburu (Figure 15B).

The other notable human activity is crop farming within wildlife habitats and dispersal areas. Such type of crop farming activities is mainly concentrated around the forest reserves and community areas that are contiguous to the conservation areas. In Laikipia, farming activities were predominant in the west and south western parts of Laikipia as well as in scattered areas across Samburu County. Other areas were crop farming is common is around Marsabit Mountain especially in Karare, Kituruni, Songa, Badassa, Manyatta Jillo and Gabbra Scheme. It should be noted that the crop farming during this census were categorized as presence absence and not based on individual number of farms or plots therefore it is difficult to use this tally as a measure of extent of farming or for comparison with previous databases of agricultural activities.

Table 12*:* Observations of human activities by county within the Laikipia-Samburu-Marsabit-Meru ecosystem in 2017

	Settlement Permanent	**Settlement Temporary**	**Charcoal Kilns**	**Watering Points**
Laikipia-Samburu	6088	5403	972	1279
Meru	220	463	304	124
Marsabit	117	857	2	148
Total	**6425**	**6723**	**1278**	**1551**

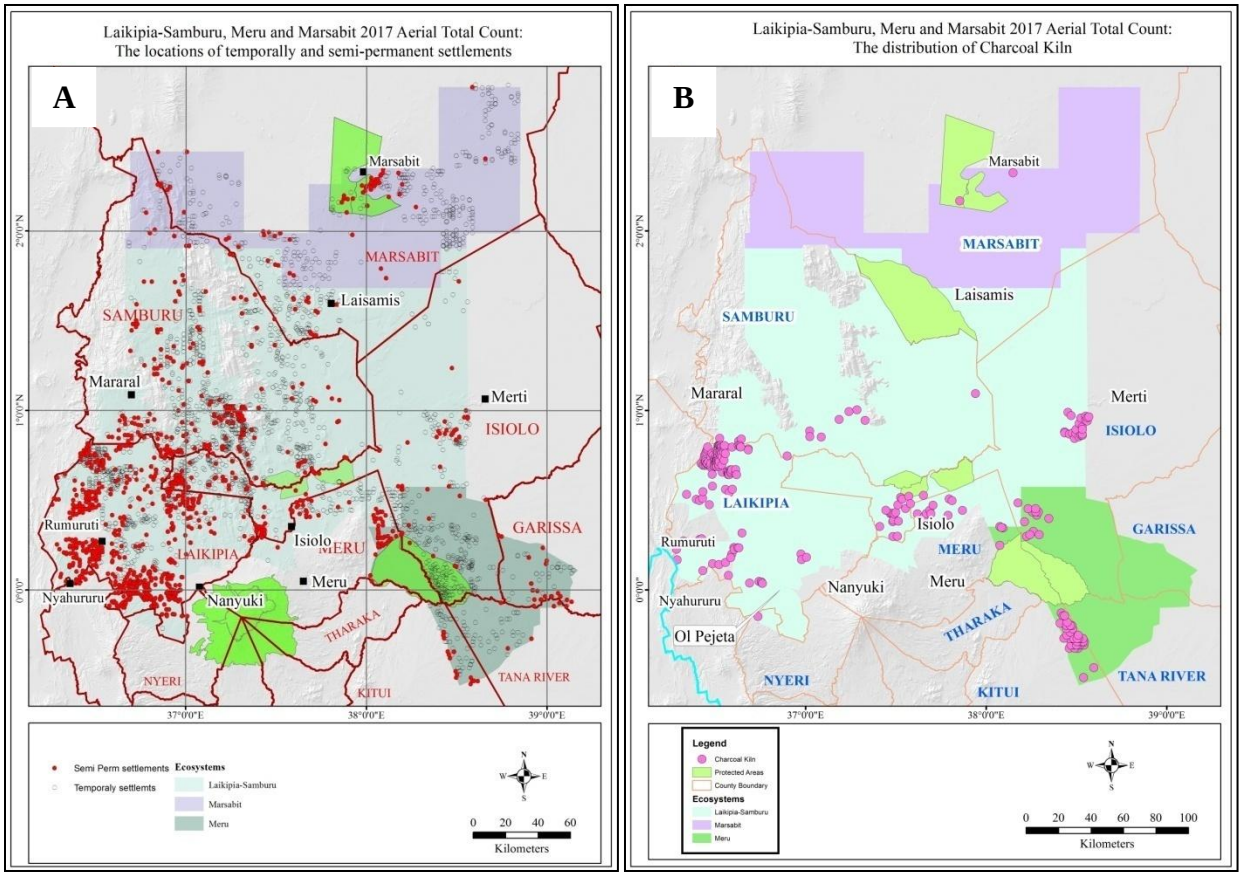

Figure 15: Map showing the distribution of human activities recorded in Laikipia-Samburu-Marsabit-Meru ecosystem in November 2017. **A:** Temporary and semi-permanent settlements; **B:** Charcoal kilns

5.0 DISCUSSION

5.1 Survey search effort

The search effort for this survey was calculated using the planes' actual counting time. The term search effort refers to the area (km^2) covered by the aerial count crew in one hour (Douglas-Hamilton, 1996). Search effort determines the proportion number of large animals counted during a survey exercise. High search effort (relatively small area per time period) generally should result to higher wildlife count because more time is spend spotting and enumerating wildlife while low search effort (relatively large area per time period) would result to lower wildlife numbers. In 2012, the average scanning intensity for all blocks was $209km^2$/hr while in 2017 the search effort was $188.90km^2$/hr (3.15 km^2/min). This was interpreted to mean that the planes spent one hour for every 188.90 square kilometres searching and enumerating wildlife and other attributes found in the survey area. According to (Craig 2012), the search effort should aim at $1.5km^2$ per minute in order to improve on wildlife estimates. This was though not achieved as some blocks were done at 2 km spacing thus taking less search effort compared to 1 km spacing transect interval. Marsabit area recorded the lowest search effort (229 km^2/hr) compared to Meru

and Laikipia-Samburu counting blocks which had a search effort of 177.05 and 178.79km^2/hr respectively. Nevertheless this would not affect the wildlife numbers as such blocks are usually occupied by human settlement and livestock and the transect spacing is as recommended by Doughlas-Hamilton (1996).

The speeds of aircrafts during the survey comply with the recommended speed of 180 km/hr for aerial surveys (KWS, TAWIRI and WWF, 2015). The height was adjusted at high altitude according to terrain, vegetation, and feedback from the crew. The crew (FSO and RSO) would at some point ask the pilot to fly higher or lower when photos are being taken and when making close examination of observations such as elephant carcasses. At some point, a pilot flew over (or around) large hills (Nyambene, Mathews range, Mkokondo & Marsabit Forests and Borana escarpment) up to 700 feet high, when it occurred in the middle of the transect and survey block. In such terrain it was difficult for pilots to maintain the recommended flight height but the pilots went back to the normal survey height after overflying the hilly areas.

5.2 Elephant population and distribution

The population of elephants in Laikipia-Samburu-Marsabit ecosystem and Meru Conservation Area has increased since the last count of 2012. The 2017 survey recorded 7347 elephants in Laikipia-Samburu-Marsabit ecosystem compared to 6454 elephants in 2012. The population increased by about 12%, which represents an annual increase of 2.4% over the period. Out of these 7166 and 181 elephants were counted in Laikipia-Samburu ecosystem and Marsabit ecosystem compared to 6365 and 89 elephants in 2012 respectively.

The Marsabit ecosystem recorded the highest increase of elephants (51%) with 89 elephants being counted in 2012 while in 2017, we counted 181 elephants. For the Laikipia-Samburu ecosystem, the elephant population increased by 11% (2012: n=6365 elephants; 2017: n=7166). This translates to about 2.2% annual increase between 2012 and 2017.

Laikipia Samburu ecosystem is shared by both wildlife and humans, with only 3% of the landscape formally protected as national reserves. Over the last decade, a number of communities have formed conservancies and boosted the government's effort in protection of wildlife. These include anti- poaching efforts. The increase of elephant population in the ecosystems is attributed to the coordinated efforts by the government together with Conservation NGOs and development partners to curb the poaching threat, which had led to substantial decline of numbers as at the time of the 2012 census (Ngene *et. al*., 2013, Ihwagi *et. al*., 2015). These efforts have been going on since 2013 up to present and have resulted to reduction of elephant poaching (CITES, 2017; Wittemyer *et al.*, 2014).

However it is important to note that livestock incursions in the survey area have restricted the range of elephants. For example fewer elephants were recorded at Laikipia Nature Conservancy in 2017 than in 2012 (Figure 16). In addition, livestock has restricted elephants in Meru Conservation Area to the northern tip of Meru National Park (Figure 16). The livestock is accompanied by armed herdsmen who are sometimes used by ivory dealers to poach the elephants.

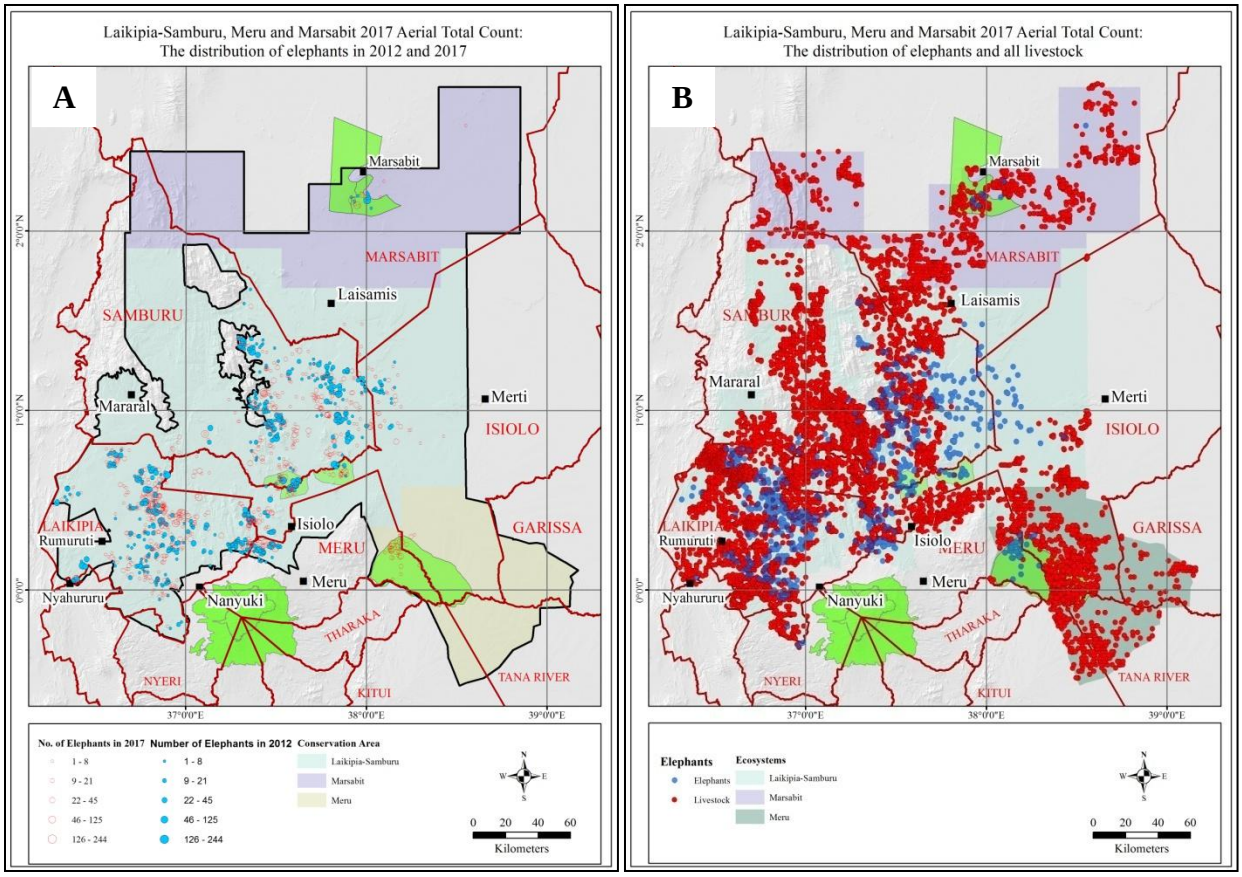

Figure 16: The distribution of elephants and livestock. A: Distribution of elephants in Laikipia-Samburu-Marsabit ecosystem in 2012 and 2017; B: Distribution of elephants and livestock in 2017

The study area falls under the designated Laikipia-Samburu Monitoring Illegal Killing of Elephants (MIKE) site, where detailed records of systematic monitoring of mortality are available. Carcass ratios were calculated using the ground carcass records of the years 2017. The number of dead elephants by September 2017 was 255 individuals. We calculated carcass ratio using the number of elephants from only the Laikipia-Samburu part of the ecosystem, which coincides with the MIKE monitoring area. The number of elephants counted in the region was 7166. A carcass ratio was therefore 0.034 (3.4%). This is a decline from the 2012 census when carcass ratio was 0.04 (4%), which is an indication of decrease of elephant mortality in the survey area.

5.4 Buffalo population and distribution

The population of buffalo in the landscape indicate an increase in growth rate, which can be attributed to favourable climate, suitable forage and shelter, and active habitat management by community and private conservancies. As a result Laikipia-Samburu conservancies and ranches, Meru National Park, Marsabit National Reserve are preferred buffalo range areas. A low 5 years (i.e., 11%) buffalo increase and 2% annual growth rate coupled with small density change from 7 to 8 animals/10 km^2 are likely effects of prolonged drought conditions over the years.

5.5 Giraffe population and distribution

Whereas giraffes are classified as vulnerable due to global declining numbers over the past three decades(IUCN 2017), the number of giraffes counted in Laikipia-Samburu ecosystem was 45.4% higher compared to 2012 census (Table 13 and Figure 17). This was equivalent to 7.8% population growth rate per year since 2012. The increase could be attributed to the fact that female giraffes sexually mature at the age of four to six years and have shorter inter-calving period; and in this case, the census was conducted after 5 years; hence a high proportion of female giraffes counted in the previous census had given birth by year 2017. Search effort was also higher in 2017 compared to the previous census in Laikipia-Samburu ecosystem. There is need to assess the number of predators in the area as low number of predators could lead to higher rate of population growth.

Table 13: Number of giraffes per Ecosystem (2005-2017) (*_ historical data not available)

Area/Year	2005	2006	2007	2008	2011	2012	2014	2017
Laikipia-Samburu	-	-	-	2557	-	2762	-	4019
Marsabit	-	-	-	-	-	368	-	342
Meru	423	636	817	-	892	-	894	876

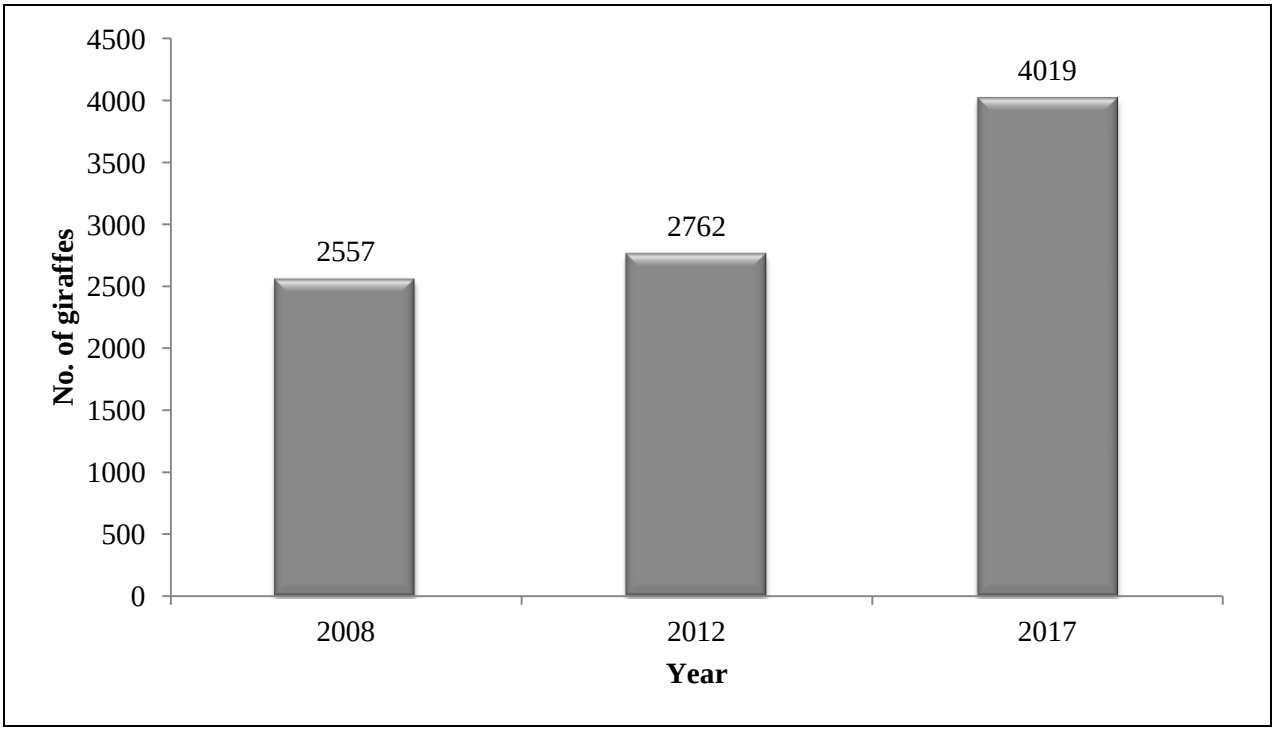

Figure 17: Number of Giraffe in Laikipia-Samburu Ecosystems (2008-2017)

The number of giraffes counted in Meru ecosystem was 2% lower than counted in the previous census in 2014 (Table 13). The decrease could have been because of stress caused by enclosed nature of the ecosystem and high numbers of predators leading to lower birth rates and decline in numbers. However, the number of giraffes in Meru ecosystem had been increasing from 2005 to 2014 and only decreased at an annual rate of -0.4% from 2014 to 2017 (Table 2 and Figure 4).The number of giraffes in Marsabit ecosystem reduced by 7.1% from 2012 to 2017, equivalent to a negative growth rate of -1.5% per year since 2012 (Table 2); despite the increase in the area of coverage in Marsabit ecosystem in 2017 compared to previous census.

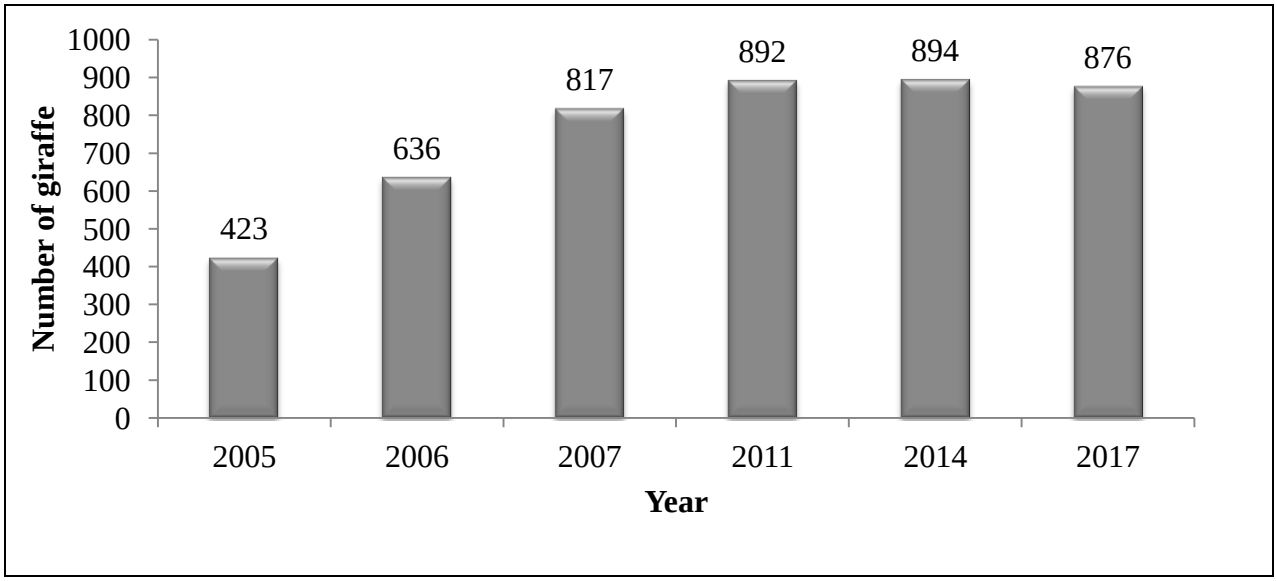

Figure 18: Number of giraffe in Meru ecosystem (2005-2017)

5.6 Grevy's zebra population and distribution

The Grevy's zebra population is slowly recovering; The results suggests a slowing rate of decline since the year 2008 and 2012 (5.4% to 2% per annum). Furthermore, proportional distribution of the population appears to suggest an ongoing redistribution from unprotected areas to private and protected areas. This is despite the apparently similar regional distribution over the landscape (Litoroh 2010; Ngene *et al.,* 2013). This reflects a localised movement between core habitats in community areas and adjacent protected landscapes. The two largest sub-groupings were in Lewa Wildlife Conservancy and Buffalo Springs National Reserve.

The intense drought conditions between 2016 and 2017 have taken an unknown toll on the population. High mortality was recorded in the Wamba and Laisamis management zones (GZT unpublished data, 2017). This alone may account for a large part of the decrease in numbers detected between 2012 and 2017. Additionally variability in observers and aircraft crews surveying the Laikipia landscape may have influenced results over large portions of this area. Numbers for Laikipia should be viewed as conservative. The trend thus suggested by the past three aerial counts, assuming that detectability and variability are similar, is believed to be a

reliable indication of population performance. While population decrease may well be slowing, population size is still decreasing.

A survey in 2016 using new photographic 'capture – recapture' techniques based on digital stripe identification, estimated a population size of 2250 Grevy's zebra (Berger Wolfe, 2016). However, the initial number of unique individuals detected, reflecting a proxy total count in comparison to the aerial total count presented here and before applying the Lincoln-Petersen estimator, was 1942 uniquely identified individuals. These figures are complimentary and very encouraging. Berger-Wolfe (2016) estimate of the population size, if correct, suggests only moderate overall reduction from the Nelson and Williams (2000) estimate of 2571 Grevy's zebra in the ecosystem. However, this should be scrutinised and verified with repeated similar estimates.

5.7 Livestock numbers and distribution

Compared to 2012 census, the livestock numbers in Laikipia-Samburu ecosystem increased by 230,339 animals but declined in Marsabit by 20,521 (Ngene *et al.*, 2013). This may be attributed to the influx of livestock into Laikipia ranches occasioned by drought in early 2017. The decline in livestock numbers in Marsabit despite the increase in the size of area counted may indicate that the recent drought caused livestock deaths or migrations into other areas.

In Meru, the number of livestock counted during the survey reduced by almost 50% from 277,465 to 140,215 compared to what was counted in the 2014 aerial count (Figure 19).This was contrary to the previous trend where the numbers have been rising from 2006 to 2014. However, a similar drop was witnessed between the year 2005 and 2006. The drop may also be attributed to exodus of livestock from the area and deaths occasioned by drought.

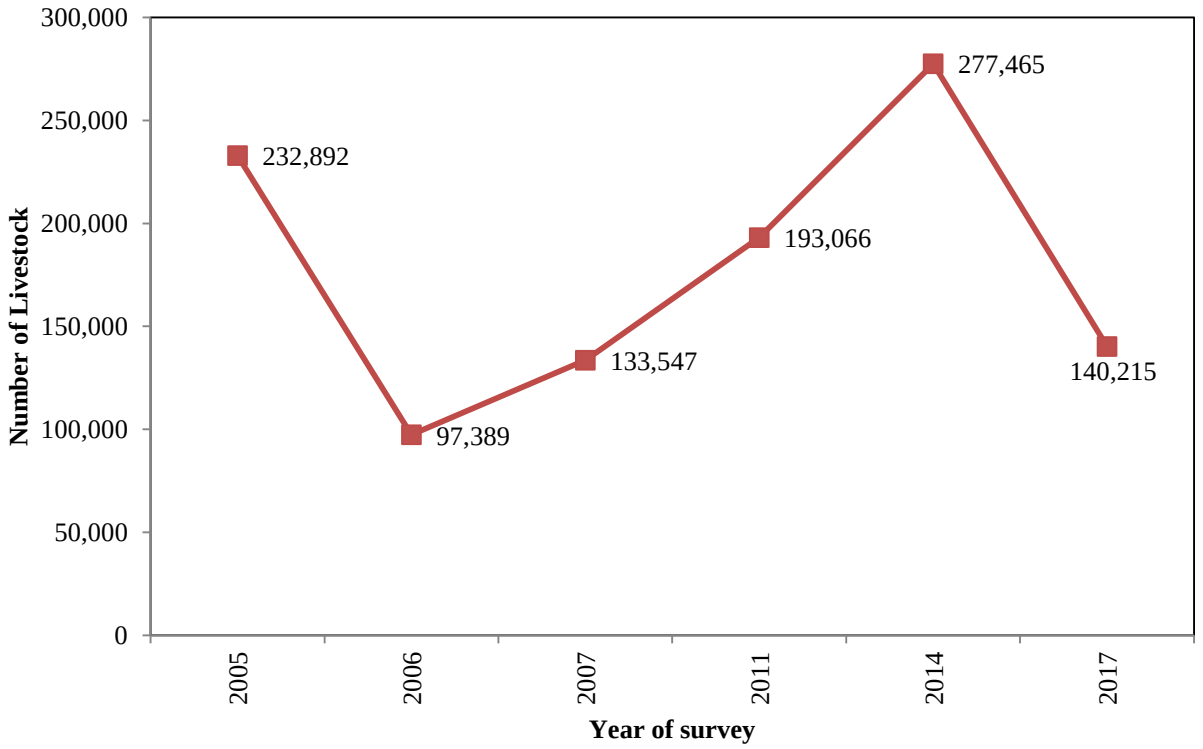

Figure 19: Livestock trends in Meru ecosystem from 2005 to 2017

Livestock were evidently more widely distributed in Laikipia- Samburu ecosystem during the current survey as compared to previous survey done in 2008. The concentration of shoats at the protected areas adjacent to Meru National Park increased significantly when compared to the last count done in 2014.

The distribution data below (Figure 20) shows a clear separation of habitat use among elephants and livestock in the entire survey area. The situation is well pronounced in the Meru ecosystem where elephants have been pushed out of the protected areas surrounding Meru National Park where they previously utilized and were only counted inside the park and some parts of the adjacent Bisanadi National Reserve.

4.8 Other human activities

The Laikipia-Samburu ecosystem is an expansive landscape that harbours various activities, besides the existence of a lot of domestic livestock that are jointly utilizing the habitat with wildlife, there are considerable amounts of other human activities that are bound to affect the both the distribution of wildlife and their overall survival within the landscape. The widespread distribution and occurrence of human activities such as livestock keeping, farming and illegal charcoal production are known to have impacts on the distribution and occurrence of wildlife species. Majority of the settlements that were observed are utilized as temporary or permanent shelters by local communities who either engage in livestock husbandry, or are involved in

subsistent activities like agriculture and Charcoal burning as an income generation activity. If we consider the Laikipia-Samburu and an example, and compare the settlements that were recorded during the previous census (n=8442) against the number that were recorded this year (n= 13148). We observe that there is a considerable increase in human settlements with a substantial amount being the semi-permanent structures. This to a large extent points to an escalation of the threats to wildlife and their habitats due to the competing land uses that are expected to emerge with these settlements. The same story applies for the Meru ecosystem, where there were a total of 498 settlements recorded in 2012 against a total of 974 recorded this year.

The seasonality of the other human activities (charcoal burning and crop farming) makes a direct comparison between the years difficult although we can still observe that there were more charcoal kilns in the Laikipia-Samburu (n=972) this year as compared to the census of 2012 (n=385).

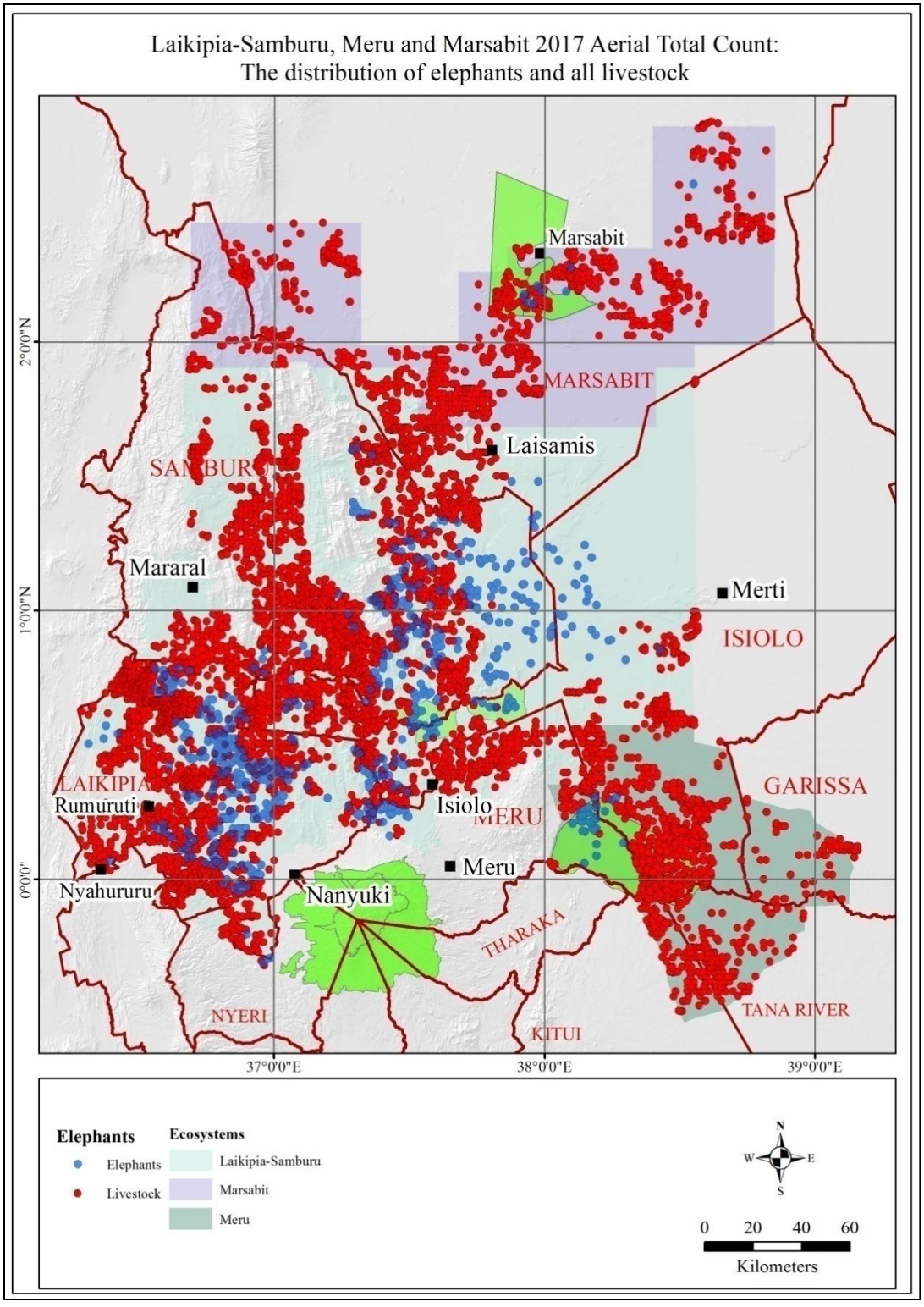

Figure 20: Livestock and elephant distribution patterns in the survey area

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The population of elephants in the survey area increased during the five year period. Efforts put in place to curb elephant poaching in Kenya and within the ecosystem have been fruitful. These efforts should be sustained to further sustain future elephant population growth.

The 2017 aerial count largely agrees with similar figures presented by alternate methods for assessing the Grevy's zebra population status. From these data there does appear to have been a decreasing trend over the past 9 years. This decrease is most noticeable in traditionally low density areas, outside of formally managed conservation landscapes like protected areas, conservancies and private ranches. A combination of increasing environmental variability, severe drought and survey methodology variance are contributing to the general decreasing trend in the population, particularly in communal rangelands where human populations are rapidly increasing.

There has been an influx of livestock into the Laikipia- Samburu ecosystem and this scenario is likely to affect the wildlife species negatively as their habitats are being encroached. The livestock numbers reduced in Marsabit and Meru areas but the pressure on Meru National Park is now higher since most of the livestock have moved into its borders and might soon overran the park if the situation is not addressed urgently.
Also, there is continued pressure of human activities on wildlife and its habitats within the LSMM landscape. It is unlikely that majority of the species would co-exist with livestock or in areas with high density of human settlements. Conflicts like crop raids are bound to occur in new crop farming areas.

Lastly, aerial Survey methodology is expensive and difficult to implement over such large areas. Alternative, new technologies, operating in a more intensely targeted way over a much smaller landscape (25,000km^2), have recently come to the fore. It is likely, given their agreement with historic estimates that these will be more suited to the long term monitoring of the elephants, buffalo, giraffe and Grevy's zebra population in future. However, until newer methods can deliver a calibrated trend for population status monitoring and management uses, the current aerial methodologies are still satisfactory for these purposes.

6.2 Recommendations

The following is recommended:

1. The on-going anti-poaching and covert operations should be continued to sustain the reduction of elephant poaching in the ecosystem. In addition, international pressure at user

2. There is need to improve management of Marsabit National Rerseve which is an immediate wildlife dispersal area from Marsabit forest. There is need to further

investigate the movement of buffalo around Meru Conservation Area ecosystem to understand the interaction of factors that influences their distribution.

3. Livestock drives be conducted immediately in wildlife protected areas so as to free sufficient habitats for wildlife conservation in the region. Specific emphasis should be put on the protected areas in Meru Conservation Area, which has been adversely affected by the livestock incursion problem.

4. The revival of the protected areas (Bisanadi National Reserve, Kora National Park, Rahole National Reserve and Mwingi National Reserve) in Meru Conservation Area is important to ensure adequate control of livestock and win more space for wildlife.

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ANNEXES

Annex 1: Concept on Aerial Count of Elephants, Buffalo, Giraffe and Grevy's Zebra in Laikipia-Samburu-Meru-Marsabit Ecosystem in Kenya

BACKGROUND

Aerial counts of large mammals in various ecosystems in Kenya have been carried out since the 1960's (Thouless *et al.*, 2008). For example 5,447 elephants were counted in the Laikipia and Samburu ecosystem in 2002; 7,415 in 2008; 6365 in 2012 and 2,400 and 1,897 Grevy's Zebra in 2008 and 2012 respectively (Litoroh *et al.*, 2008; Ngene *et al.*, 2013). These counts have provided vital information to policy makers and park managers, facilitating sound management of elephants in the ecosystem. The impact of the 2009 severe drought and recent increase in poaching need to be assessed using this aerial count. Habitat loss due to compression of the elephant population emanating from sedentary settlements around major migratory corridors and former elephant range is a key elephant conservation and management issue in the ecosystem. Human-elephant conflict is currently the greatest problem associated with loss of elephant range as a result of land use change and increasing settlements in formerly unsettled areas. Currently, the area has the second largest elephant population and the largest (~90%) of Grevy's Zebra population *in-situ* of the world in Kenya, and is therefore important to continue to monitor the population of elephants and Grevy's Zebra in the ecosystem to provide continuous long term data for sound management. This concept proposal seeks funding to facilitate the November 2017 aerial count of elephants and Grevy's Zebra in Laikipia Samburu and Marsabit.

GOAL AND OBJECTIVE

The goal of this aerial count is "*to sustain the long term aerial monitoring of elephants, buffalo, giraffe and Grevy's Zebra in Laikipia, Samburu, Meru and Marsabit ecosystems*". The specific objectives for the aerial survey are:

1. Determine the present status of elephant, buffalo, giraffe and Grevy's zebra population
2. Establish elephant poaching levels through observation of carcasses within the ecosystem
3. Detail changes in the elephant, buffalo, giraffe and Grevy's zebra population size and their distribution since the last aerial survey of 2012
4. Document estimated numbers and distribution of human activities in the Laikipia-Samburu-Meru-Marsabit ecosystem

JUSTIFICATION

The following is a summary of justifications for the dry aerial count of elephant, buffalo, giraffe and Grevy's zebra in Laikipia-Samburu-Meru-Marsabit ecosystem.

A. Monitoring of species trends in numbers and distribution is essential in order to; -

i. Assess their Survival prospects
ii. Learn more about their ecology and survival chances in the face of various pressures
iii. Establish human-elephant conflict pressure points

iv. Establish elephant carcass distribution in the survey area as this will help pinpoint areas of high mortalities and cause. This will enable appropriate intervention management strategies to be put in place.

As a long term monitoring process, the survey data and information is valuable for the effective management of the entire Laikipia-Samburu-Meru-Marsabit ecosystem as it continues to experience pressures from human population growth and consequent changes in land use types. The Laikipia-Samburu ecosystem experienced livestock incursions in 2016 and part of 2017 with armed herdsmen destroying property and fences in the ecosystem. It will therefore be important to establish the impact of this livestock incursion to elephants, buffalo, giraffe and Grevy's zebra. . This concept is consistent with Kenyan Elephant, Giraffe and Grevy's Zebra species specific strategic plans.

STUDY AREA

The survey area lies astride the entire Laikipia and Samburu counties and some parts of Isiolo, Meru and Marsabit counties covering over 60,000km² in Kenya. This will include over 100 ranches and conservancies, vast areas of community trust land outside protected area, six reserves (Laikipia NR, Losai NR, Buffalo Springs NR, Samburu NR, Meru NP, Kora NP, Mwingi NR, Bisanadi MR, Shaba NR and Marsabit NR) and one proposed Laikipia National Park. A total of about 119 blocks will be covered in about 11 days using approximately 15 aircrafts (Figure 1).

METHODS

The method to be adopted during the November 2017 total aerial count for wildlife and livestock will be the same as that used in previous census (Douglas-Hamilton *et al.*, 1994; Douglas-Hamilton, 1997; Omondi *et al.*, 2002, 2005, & 2008). The count will therefore employ the Global Positioning System (GPS) technique with ARGIS software being used for plotting species distribution maps. About 15 aircrafts will be used during the aerial count. Each of the aircraft will have a GPS for use in navigation, recording survey path, and waypoints. All observations will be saved in the GPS as way points with the geographical location referenced and will be used to produce species distribution maps. Photographs will be taken and used to count individuals in large herds, unless the view was obstructed by thick vegetation, in order to establish the correct count (Douglas-Hamilton, 1997). Also, the aircrafts will circle around large herds to ensure that a good count is achieved and a better photograph taken. All GPS's will be downloaded onto a computer at the ground operation base each evening. The Front Seat Observers (FSO) will do a summary table of each block. Any double counts in neighboring blocks will be worked out and eliminated during these evening sessions. The exercise will start every morning at 6.30-7.30am and will end late in the evening. Breaks will be taken during refueling of the aircraft and at lunch hour. Fuelling sites will be strategically distributed in survey area to minimize loss of time to refueling sites. Each survey crew will consist of 1 observer and a pilot for 2 seat aircraft and a pilot, 1 FSO and 2 Rear Seat Observers (RSO) for a 4 seat aircraft.

SCOPE OF SURVEY

The survey will primarily gather data on elephants, buffalo, giraffe and Grevy's zebra however information on livestock (cattle, sheep, goats, donkey, and camel) will also be obtained. Other data to be collected will include: locations of human activities (e.g. logging, farming, settlements, and cattle boma) and water points.

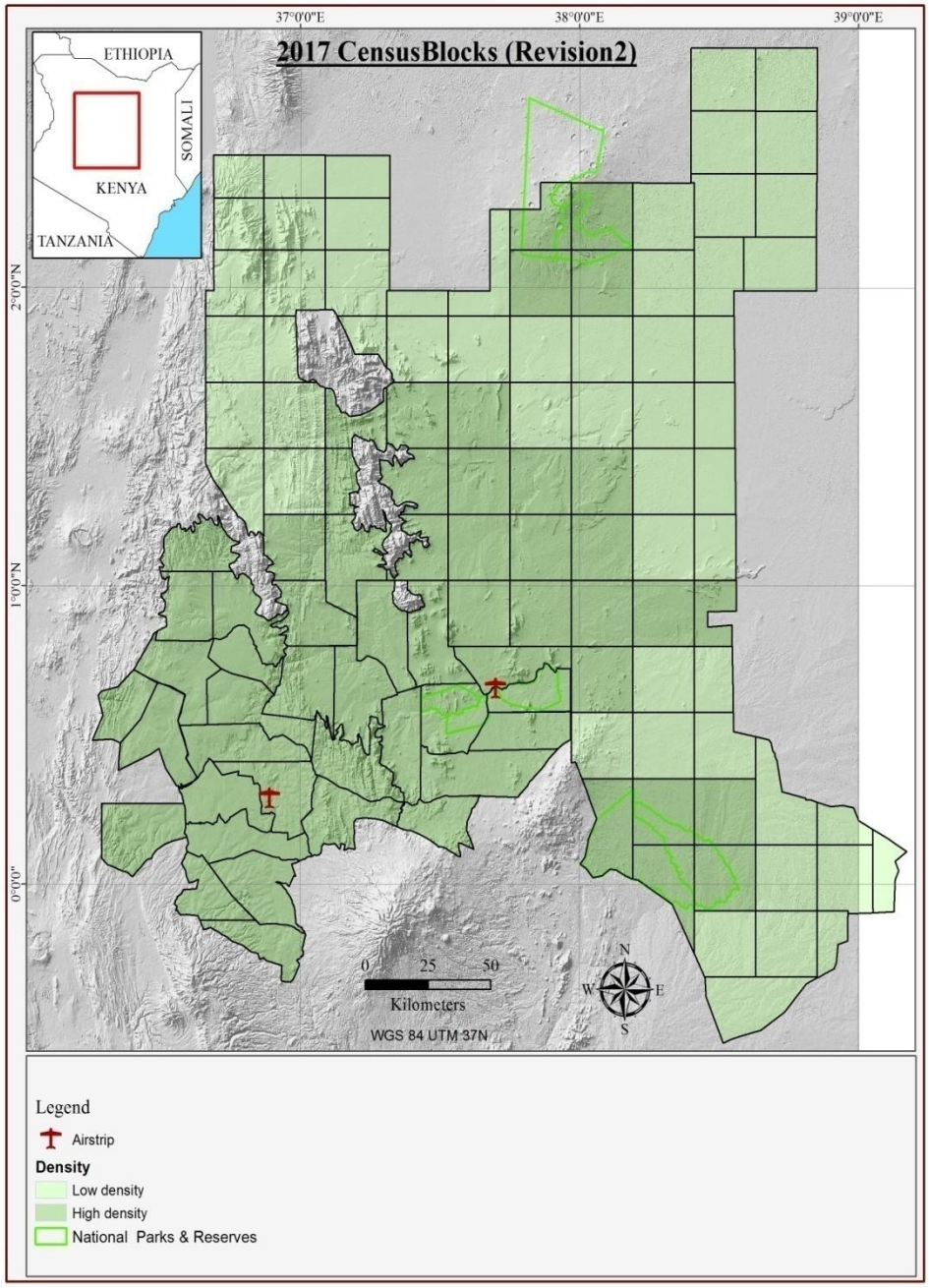

Figure 1: A map showing the counting blocks to be flown during the 19-30 November 2017 aerial survey in Laikipia-Samburu-Meru-Marsabit ecosystem

ANTICIPATED OUTPUTS

The major outputs of the surveys will be one report for the count of large mammals in Laikipia, Samburu and Marsabit with special focus on Elephants, Buffalo, Giraffe and Grevy's Zebra. The report will include properly tabulated and mapped numerical and distributional data for all species counted and showing a clear distinction between inside and outside the protected areas. Flight paths, dates and times flown will also be shown. Report writing will take about 6 working days.

TIME PLAN

Time plan for the MCA wildlife aerial survey

Activities	No. of days	Responsibility	Start	End
Purchase and delivery of fuel to MCA	15 days	APO/AFO-MCA; SRS-MCA	01/11/17	15/11/17
Actual count	10 days	H-SC&M, AD-MCA; H-EM, SWs-Laikipia & Samburu; SRS-MCA, SRS-ECA; H-EM	19/11/17	30/11/17
Report writing	5 days	H-SC&M, AD-MCA; H-EM, SWs-Laikipia & Samburu; SRS-MCA, SRS-ECA; H-EM	10/12/17	25/12/17

Key: H-SC&M = Assistant Director-Species Conservation & Management; H-EM = Head-Ecological Monitoring & Bio-prospecting; AD = Assistant Director; MCA = Mountain Conservation Area; ECA = Eastern Conservation Area; SW = Senior Warden; SRS = Senior Research Scientist; APO = Procurement Officer; Procurement Committee; AFO = Area Finance Officer

BUDGET

Item	Description	Units	Unit cost (Ksh)	Source			Total (KES)
				USAID (KES)	KWS (KES)	Other Donors (KES)	
Aircraft fuel (avgas)	Drums	150	40,000	4,000,000	0	2,000,000	6,000,000
Aircraft fuel transportation	Round trip to & fro NBI	3	65,000	0	195,000	0	195,000
Vehicle running				100,000	0	0	100,000
Vehicle maintenance				50,000	0	0	50,000
Local travel & accommodation	65 paxs	11 days	12,000/day	8,580,000	0	0	8,580,000

Item	Description	Units	Unit cost (Ksh)	Source			Total (KES)
				USAID (KES)	KWS (KES)	Other Donors (KES)	
Aircraft maintenance costs	2 aircrafts	50 hours	10,000/hour	0	0	0	1,000,000
Allowances							
Flying allowances (pilot)	8 hrs*15 pax*11 days	1320	1,000	1,320,000	0	0	1,320,000
Rangers allowances	10	10	1,150	0	115,000	0	115,000
Allowances for DRSRS Staff	10 Paxs*11 days			0	831,600	0	831,600
Local travel & accommodation refunds	15pax	2 nights	8,400	252,000	0	0	252,000
Transport refunds	15pax	2 trips	1,000	30,000	0	0	30,000
Local travel & accommodation for logistical staff	4 pax* 2 dys	8	8,400	67,200	0	0	67,200
Report writing							
Local travel & accommodation	6 pax	5 days	8,400	252,000	0	**0**	252,000
Stationery						0	
GPS cells	pairs	120	300	36,000	0		36,000
Printer cartridges	pcs	4	8,000	32,000	0	0	32,000
Printing papers	reams	10	600	6,000	0	0	6,000
Pens & pencils	pkts	5	500	2,500	0	0	2,500
First Aid kit				20,000	0	0	20,000
Clip boards	pcs	10	200	2,000	0	0	2,000
Erasers	Dz	1		300	0	0	300
Sweets	Pkts	12	300	3,600	0	0	3,600
Paper bags	Dz	2	300	600	0	0	600
Sharpeners	Pcs	10	100	1,000	0	0	1,000
Water	65 pax*2pc	4 days	50	26,000	0	0	26,000
Airtime	10pax*1000	10	1,000	0	10,000	0	10,000
Grand total				**14,781,200**	**1,151,600**	**2,000,000**	**18,932,800**

Note: Others Donors are Born Free Foundation (BF) = **Kshs 1,000,000**; and, Giraffe Conservation Foundation (**GCF) = Kshs 1,000,000**

SOURCE OF AIRCRAFTS

A total of 15 aircrafts will be used during the survey. They will be provided by the below organizations and individuals.

No.	Name of Organization	No. of Aircrafts
1.	Kenya Wildlife Service	4
2.	Department of Resource Survey and Remote Sensing	2
3.	Save the Elephant	2
4.	Marwell Wildlife	2
5.	Loisaba Conservancy	1
6.	Private Individuals	2
Total		**13**

REQUEST TO CANINET SECRETARY, MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES

Officially launch the Laikipia-Samburu-Meru-Marsabit aerial survey on 20th November 2017 AT Shaba Sarova Lodge, Isiolo County.

Annex 2: Press release of the great northern Kenya wildlife census, 19-30 November 2017

In line with her mandate to conserve wildlife in the country, Kenya Wildlife Service **(KWS)** will be leading a number of other key conservation partners in an aerial survey of **elephants, buffalo, Grevy's Zebras and Giraffe** in the greater northern landscape of Kenya. The survey, to be undertaken between **November19 and 30' 2017**, will use **14 aircraft**, with **pilots** and **observers** to systematically survey **Laikipia, Samburu, Isiolo, Marsabit and Meru Counties** from the air.

Alongside the four KWS aircrafts assigned to the survey, others organizations donating aircrafts are Save the Elephants (2 aircrafts), Department of Resource Surveys and Remote Sensing (2 aircrafts), Loisaba Conservancy (2 aircrafts), and Marwell Wildlife (2 aircrafts). Two other private operators are also donating their aircrafts and time to participate in the survey.

This year's aerial survey will focus on these four charismatic and endangered species in an effort to **establish their total numbers and distribution**. The data collected will then be compared with that from past aerial surveys to discern the species trends.

Comparing the information helps to evaluate the success of the Kenya's species conservation efforts and provides information on where to concentrate future conservation resources. In addition, data on livestock and human activities (settlements, farms and logging) and water points will also be collected and recorded to help explain the trends in number and distribution of the species over the years.

This year's survey is supported by different conservation organizations of this great landscape. There will be a briefing of the public and media during an **opening ceremony at Sarova Shaba Lodge on November 20, 2017**.

They will be joined by international, national, and county representatives to learn more about the aerial survey, issues and trends in conservation in northern Kenya.

The Great Northern Kenya Wildlife Count includes an area of about **65,000 square kilometers** and it will take **7 full days** to cover using **14 aircraft.** This area is among Kenya's great wildlife conservation areas. Wildlife survives here because of the goodwill of its **residents**, including land use that supports or **tolerates wildlife**.

USAID is providing funding support through a **grant of USD 150,200 (Kshs 15,020,00) to KWS.** The Giraffe Conservation Foundation (Kshs 1,000,000) and Born Free Foundation (Kshs 1,000,000) also providing financial support to this exercise. Many organizations, Conservancies and individuals including Mpala Research Centre, Space for Giants, Northern Rangeland Trust, Lewa Wildlife Conservancy, Mount Kenya Trust, Losaba Conservancy, and Laikipia Wildlife Forum are **volunteering their time and expertise** to make this year's survey a success.

For more information, please contact Dr. Shadrack Ngene at: sngene@kws.go.ke

Annex 3: Program during official opening of aerial census of elephants, bufallo, giraffe and gravy's zebra in Laikipia-Samburu-Meru-Marsabit ecosystem on 20th November, 2017

7:30 a.m. – 8:30 a.m.	Registration
8:30 a.m. – 9:30 a.m.	Exhibitions by Laikipia Wildlife Forum Members and Conservation NGOs
9:30 a.m. – 10:00 a.m.	Introductions
10.00 a.m.	Brief overview of the census By Deputy Director Biodiversity Research and Monitoring
	Welcome remarks by Ag. Director General, KWS
	Remarks by CEO Save the Elephants
	Remarks by Director, USAID
	Remarks by CEO, Laikipia Wildlife Forum
	Remarks by Regional Commissioner/County Commissioners
	Remarks by Governors of County Governments (Laikipia, Samburu, Marsabit, Isiolo and Meru)
	Speech by Principal Secretary, State Department of Natural Resources
	Speech by Cabinet Secretary, Ministry of Environment & Natural Resources
	Group Photograph
	Press Conference and Interviews
	Official flag off by Cabinet Secretary and Principal Secretary at Shaba National Reserve airstrip

Annex 4: Names of security personnel at different bases during the Laikipia-Samburuu-Meru-Marsabit aerial wildlife census (19-30/11/2017)

Shaba National Reserve Base

1. 6999 Sgt Hussein Kule
2. 8852 Rgr Duncan Korir
3. 10206 Rgr Alinoor Aden
4. 10800 Rgr Osman Mohamednasir

Mpala Research Centre Base

1. 8214 Cpl Benson Lepayiale
2. 10534 Rgr Ezekiel Kiyonga
3. 9724 Rgr James Ndungu
4. 10418 Rgr Benard Chebon

Laisamis Airstrip Base

1. 5066 Cpl Barako Ali
2. 6969 Rgr Leguyaya Alex
3. 9918 Rgr Gedion Mbuthia
4. 11050 Rgr Elijah Osuga

Annex 4: The detailed training schedule and actual survey programme

Contacts: Dr. Shadrack Ngene, Kenya Wildlife Service, sngene@kws.go.ke;
Dr. Zeke Davidson; Marwell Wildlife, davidson.zeke@gmail.com
Mr. Frank Pope, Save the Elephant, frank@savetheelephants.org

Mandate

To provide a certified selection of survey flight crews for the accurate collection of aerial survey data. This is based on the following:

1. Any participant in a KWS aerial survey count will need to meet the criteria of the selection process.
2. No Attendance at training will mean crews are not eligible to fly the survey.
3. Crews will be selected on a performance basis with the top 15 crews forming the core survey team. A further three crews will be engaged for standby purposes.
4. Crews not selected for the **Laikipia-Samburu-Meru-Marsabit** survey are still invited to re-test in future selection events.

Aim

1. To Certify and provide refresher training for air crews participating in the November 2017 **Laikipia-Samburu-Meru-Marsabit** aerial survey.
2. To reduce variability among survey crews to acceptable levels – suggested between 5 and 15 percent.

The training

The training will involve the following:

1. Pre test and select 15 potential survey crews and three backup aircrews on the basis of eyesight, species recognition and technical skill.
    a. Requirements:
        i. Eyesight
        ii. Color sensitivity normal
        iii. Perfect recognition of critical large mammals in the survey
2. Flight-test and select rear seat observers for survey work and several backup/replacement RSO's. Each RSO to pass two flight sessions with performance at the specified level. The following sessions will be followed:

    Session 1:

    1. Crew member prepared and ready for flight
    2. Crew member familiar with all aspects of data collection – equipment operation, data collection protocol and procedures.
    3. Crew assembled and ready to fly in a professional fashion.
    4. No airsickness
    5. Stamina and alertness for 2.5 hours of continuous flight
    6. 75% species recognition minimum
    7. Accurate tally of numbers of key wildlife species – to 75% of baseline.
    8. Acceptable estimation of large herds of secondary animals – livestock and noncritical wilife species. To 60% of baseline

Session 2:

1. Review of 1-5 above
2. Spotting and identification of 90% of all species minimum
3. Consistent performance throughout test flight

3. **Basic training for FSO's in 4 seat aircraft:**
    1. Aircraft management – speed and height vigilance and pilot support – Aircraft to be maintained within 50ft of target altitude and 20Mph (32Kmh^{-1}) of target speed.
    2. Spotting ahead of track and reverting to crew
    3. Confirming counts for orbited groups of target species.
    4. Logging sightings on a paper backup as recorded by RSO's on Dictaphone.

Timing

Three days are allocated to training and testing of pilots and crew. Pre-test to be conducted in-situ at the base of operations for the Laikipia-Samburu-Meru-Marsabit Survey, in the days preceding the count (20-22 November 2017).

Pilots and crews to arrive on site by 05:00p.m on the 19th November 2017.

Daily operations

The operational timetable for training days will be executed as close the schedule below as possible, all factors allowing:

Timing	Module	All Trainees	Ground Crew
Day 1			
06:30 – 07:45	Breakfast		
08:00 – 10:00	Orientation to Laikipia-Samburu-Marsabit-Meru ecosystem survey area	1. Review of Laikipia-Samburu-Marsabit-Meru Counts 2. Context for 2017 – a change in emphasis – 3 approaches. 3. Calibrating for Future sample counts. 4. Operational mandates 5. Equipment and procedures to be used by 2017 crews – the total count effort.	1. Refuel all aircraft 2. Fit Streamers for outer Transect markers. (to be aligned in the Pm session)
Tea Break.			
10:30 – 11:00	Introduction to the 2017 Laikipia-Samburu-Marsabit-Meru count system.	1. What is being counted? 2. How will it be done? 3. Why like this?	
11:00 – 11:30	Demonstrating counting skill – discovering what we need to improve on.	Using the software "Wildlife Counts" to demonstrate to the group what their personal variability is likely to be. Each observer gains a personal understanding of their own skill level.	
11:30 – 12:00	Sky Demon	Introducing Sky Demon and the navigation requirement for the survey.	

Timing	**Module**	**All Trainees**	**Ground Crew**
12:00 – 13:00		Static Simulation 1. Breaking into designated crews 2. Setting up a simulated cockpit seating for all crew 3. Using all recording and navigation equipment a demonstrator will stress test each crew in a high volume spotting and recording scenario to prepare work flow and cockpit management for flight testing.	Using observer's "down time" to calibrate streamers.
Lunch			
		Pilot and FSO / **RSO's**	
14:00 – 15:30	Flight Preparations	Set up aircraft for flight / Calibrate remaining streamers	Calibrate remaining streamers
15:30 - 1730	Flight Crew test flight	2 hour monitored test flight for speed and altitude only / Wildlife counting skill development using simulation software: **80% pass required.**	
18:00 – 19:30			

Day 2		**All Crews**	
06:30 – 07:45	Breakfast Briefing starts at 07:00		Refuel all aircraft
08:00 – 10:00	Flight test 2	2 hour On Transect count test – Return to Base (RTB)	
Tea Break.			
1100 – 13:00	Debrief from Day 1	Assess Crew Performance, feedback on issues and learning's.	
13:00 – 15:30	Lunch Break		
15:30 – 17:30	Flight Test 3 – RTB	2 hour On Transect count test – Return to Base (RTB)	
Day 3		**All Crews**	
06:30 – 07:45	Breakfast Briefing starts at 07:00		Refuel all aircraft
08:00 – 10:00	Flight test 4 -RTB	2 hour On Transect count test – Return to Base (RTB)	
	Flight Test 5 – RTB		
12:00 – 13:00	Analysis of the flight data so far		

PM	
	Any crews still needing to fly and polish skills can continue with flight training. Crews achieving standards can rest. i. Review all aircraft and equipment and prepare for start of survey. ii. Time available for repairs if required. iii. Time available for adaptive planning and testing if required
	1. Final Survey Crew is announced. 2. Any Dropped crews can then return to their home bases – better luck next time! Log books endorsed for participation.
	To allow slow and safe pace the time here will be used to pick up any spill over in training the selected crew.
	Any crews still needing to fly and polish skills can continue with flight training. Crews achieving standards can rest.

Survey days scheduling

Flying time during the survey will be restricted to two 2.5 hour flights, and one 2.0 hour flight, broken by a 3 hour lunch stop. Two 30 min rest intervals during each day's operations are mandated. Total hours of activity will be 9 per day. No Crew will operate for more than 6 days consecutively.

The operational timetable for Survey Days will be executed as close the schedule below as possible, all factors allowing:

1) 05:00 Ground Crew to refuel all aircraft.
2) 05:30 Crews muster for a breakfast briefing.
3) 06:30 Crews to make their aircraft and equipment ready for flight
4) 07:00 Take Off – all planes depart
5) 07:45 All aircraft "On transect" and counting – conditions allowing.
6) 10:15 All Aircraft to break for rest, landing where possible. Where landing is impossible or impractical, pilot to ascend to 2000ft AGL and orbit in shallow turns allowing crew to relax and re-focus.
7) 11:15 All Aircraft back on transect.
8) 13:45 – 15:45 – Lunch – Aircraft to land in proximity to their Grid square and take lunch.
9) 15:45 – All aircraft airborne
10) 1600 All aircraft return to transect.
11) 1800 All counting stops – Light conditions prohibit counting beyond 18:00.
12) 18:30 – 19:00 all aircraft land back at Base.
13) 19:30 FSO's return all equipment and data to Ground Data Team and log any issues.
14) 20:00 Pilots and crews to muster for daily debrief over informal dinner
15) 21:00 Crews released for the day
16) 22:00 LIGHTS OUT!

Rest days will be worked in for both Pilots and Crew. Flying time during the survey will be restricted to four 2.5 hour flights, broken by a 3 hour lunch stop and two 30 min rest intervals during each days operations. Total hours of activity will be 9 per day.

Note: All crews selected will be monitored throughout the survey for any decay in accuracy or technical proficiency. Substitutions can be made for crew needing rest or for training to be implemented for correction of errors during the course of the survey.

Training requirements:

1. Reliable Wifi – management of Sky Demon flight plans.
2. Light projector
3. Reliable power source
4. Streamers
5. Inclinometers (Phone App's)
6. Digital navigation Software – Sky Demon.

Annex 5: Meru Ecosystem all data details

(i) Wildlife Species

Species	Meru NP	Bisanadi NR	Kora NP	Mwingi NR	Rahole NR	Outside PA's	Total
Buffalo	2,488	214				9	2,711
Elephants	640	12				22	674
Giraffe	434	278	10		10	148	875
Grevy zebra	6						6

(ii) Elephant carcasses

Item	Meru NP	Bisanadi NR	Kora NP	Mwingi NR	Rahole NR	Outside PA's	Total
Old carcass	6	5				3	14
Very old carcass	1	2	1			1	5

(iii) Human activities

Item	Meru NP	Bisanadi NR	Kora NP	Mwingi NR	Rahole NR	Outside PA's	Total
Camel	280	1,704	1,298	560	305	7,782	11,929
Cattle	165	586	163	169		11,964	13,047
Shoats	6,460	23,380	13,970	10,412	9,163	72,680	136,065
Donkeys		30	10	10		95	145
Cultivation				20		30	55
Village						19	22
Water pan wet		2	11	26	7	51	126
Bomas		104	45	62	65	263	539
Mabati roofs			8	12	62	202	284
Charcoal				278		33	311