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Population Status and Trend of the Maasai Giraffe in the Mid Kenya-Tanzania Borderland

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Abstract

Among the nine sub-species of giraffes, the Maasai giraffe is the most widespread and common in Northern and Southern Kenya. Although it's considered by the IUCN to be a species of no conservation concern, they have been reported to have declined in some of their range areas mostly due to bush meat activities, habitat fragmentation and loss. There are also concerns recent climatic changes especially prevalence of droughts is increasingly becoming another threat to their survival. In this regard, this study examined the status and trend of the Maasai giraffe in the Kenya-Tanzania border after the 2007 to 2009 drought. Amboseli had the highest giraffe number (averaging 2, 062.5 ± 534.7 giraffes), followed by a distant Lake Natron area (725.8 ± 129.4 giraffes), Magadi/Namanga (669.5 ± 198.0 giraffes), and lastly West Kilimanjaro area (236.5 ± 47.8 giraffes). Further, the proportion of giraffes were highest in Amboseli (55.09% ± 5.65%) followed by Lake Natron area (20.98% ± 3.42%), Magadi/Namanga area (16.35% ± 3.83%), and lastly West Kilimanjaro (7.58% ± 2.12%). But in terms of population growth after droughts, giraffe had positive growth in all locations in the borderland, with Magadi leading (+339.82 ± 329.99) followed Lake Natron area (+37.62 ± 83.27), Amboseli area (+38.11 ± 7.09), and lastly West Kilimanjaro (+3.21 ± 57.95.27). Their wet season population and density was much higher than that of the dry season. However, though the species was widely spread in the borderland, they seemed to avoid the region between Lake Magadi and Amboseli which is traversed by the Nairobi-Namanga highway both in wet and dry season. There is a need to develop a collaborative management framework for cross-border

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conservation to enhance their protection, conservation and genetic linkage.

Keywords

Drought Effects, Kenya-Tanzania Borderland, Maasai Giraffe, Status and Distribution

1. Introduction

In Africa, giraffes are found widespread south of the Sahara Desert particularly in eastern, southern and central parts of the continent [1] [2]. Their habitat is mainly savanna landscapes where they exploit browse forage resources found in vegetation communities with trees and shrubs. Approximately 10,000 years ago, giraffes roamed all over the continent but they became extinct in North Africa due to climatic changes and subsequent creation of the Sahara desert [1] [3]. For instance, in Egypt, they vanished more than 4000 years ago and in Morocco nearly 1400 years ago. Populations in Central and West Africa are reported to be quite small, fragmented and on the decline, those in southern and East Africa are relatively widespread and found in most countries where suitable habitats still exist [3] [4].

Giraffes are exclusive browsers, mainly focusing on nutritious young and new tree and shrub shoots, but Acacia trees are their favorite source of forage [2] [3] [5]. Although they live in landscapes with scanty water, they are ecological adapted to go without drinking for several days during which they depend whole on preformed water contained in the browse forage. They are social, non-territorial and tend to live in small groups but intermittently form large coalitions or aggregations of about 12 to 15 individuals comprising of familiar females and their calves [2] [3]. However, these coalitions are rather fluid and only last for a short duration.

There are nine different sub-species of giraffes living in various parts of Africa ([6] [7], and two of them are considered to be threatened, Rothschild's Giraffe (*Giraffa camelopardalis rothschildi*) and Nubian Giraffe (*Giraffa camelopardalis camelopardalis*). Within the continent, Kenya is the only country with three subspecies while other countries have either one or two, making it the epicenter for giraffe speciation [2] [3]. In the last decade or so, the number of giraffes in African have declined by nearly 30% due to a combination of threats like severe poaching for bush meat, human-wildlife conflicts, habitat fragmentation and loss due to increase in human population and associated land use changes [4]. The estimated number was approximately 46,045 giraffes in the continent within protected areas, and 140,700 [4] in the entire continent both in and outside protected areas (excluding populations in Sudan). However, the Rothschild's giraffe is the second most endangered subspecies, and it's estimated that <670 individuals are left in the wild with 60% of them found in Kenya. Historically, the sub-species was wide-spread and was found in Uganda, southern Sudan and across western Kenya but has almost be exterminated in most of its former range, with only a few small and fragmented populations in Uganda and Kenya [3] [4].

The Maasai Giraffe (*Giraffa camelopardalis tippelskirchi*) which is the focus of this article was formerly widespread in the arid and drier regions of the Southern and Northern Savanna of Africa [2]. However, it has been largely fragmented into isolated populations in most of landscapes in West Africa, and is locally extinct in southern Kalahari, but there are populations still surviving in other parts of its former range [2]. For African giraffe numbers, they were estimated in 1998 in protected areas to be >24,000 individuals and a total of approximately 60,000 individuals in the entire continent [4]. In East Africa, the species is found in Southern Kenya (*i.e.* Tsavo, Maasai-Mara and Amboseli ecosystems) and throughout Tanzania, in Savanna landscapes endowed with woodlands and bushes. Ecologically, the Maasai Giraffe is well adapted to living in such regions with their height giving them an advantage to exploit food resources which are mostly out of reach to other herbivorous mammalian species [2]. Together with other giraffe sub-species, the species is thought to have shaped the biology of browse woody plant species, including the evolution of galls, thorns and growth structure of branches [3]. Thus, the flat top of Acacia species like the umbrella acacia (*Acacia tortilis*) may have evolved as a growth form in response to the herbivory effects of giraffes. They also influence the shape, browse forage production, flowering, thorn density and length of numerous species of shrubs [3].

Although the population of the Maasai Giraffe is considered by the IUCN (International Union for Conservation of Nature) to be stable compared to other sub-species, they have been eliminated in most of their former range in the last century [9]. In Kenya and Tanzania specifically, their population trend vary from region to region. For instance, there was a 70% decline in Maasai Giraffe in the Maasai-Mara ecosystem of Kenya in a span of 20 years [8], and this was attributed to; land and vegetation changes, increase in livestock, poaching and reduction in migration opportunities. In another study in Northern Tanzania, there was an increase in the population of Maasai Giraffe [9] after reduction in elephant numbers (*Loxodonta africana*). Throughout Kenya and Tanzania, the Maasai Giraffe population is faced by numerous threats mainly bush meat poaching and poaching for products like their tail hair and hide for use in bracelets and trinkets [4] [10] [11]. Other threats are fragmentation and destruction and loss of habitat of their prime habitats and landscapes due to increase in human population and associated anthropogenic activities [12] [13]. Another emerging threat to the Maasai Giraffe is prevalence of droughts, which then compounds the numerous threats currently facing this sub-species.

Thus, this research focused on the population status and distribution of the Maasai Giraffe in Northern Tanzania and Southern Kenya borderland as a result of the 2007 to 2009 drought. Although, the sub-species occupies a niche which gives it an ecological advantage over other browsers, drought conditions can compromise their food resource base making them vulnerable to physiological challenges associated with food and even water shortages [1]. Further, in the last couple of decades, tremendous human induced changes have occurred in these borderlands creating a landscape whose environmental conditions may not sustain high populations of Maasai Giraffes. Therefore aerial counts in the Kenya-Tanzania borderland need to be assessed frequently to monitor their status and distribution.

2. Objectives

The overall objective of this research was to establish the current status of the giraffe population and its recovery after the severe 2007 and 2009 droughts in the Kenya-Tanzania borderland. The specific objectives were to:

Specifically, this study examined the following objectives:

1) Evaluate the population status and distribution of the Maasai giraffe;
2) Examine the effects of 2007 to 2009 droughts on its population and recovery;
3) Assess seasonal changes in Maasai giraffe density and distribution;
4) Elaborate implications for giraffe conservation in the Kenya-Tanzania borderland.

3. Study Area and Methodology

3.1. Study Area

The Amboseli-West Kilimanjaro and Magadi-Natron cross-border landscape, as comprises of various ecologically linked areas of Kenya and Tanzania, and is characterized by a high endowment of diverse wildlife species (**Figure 1**). It lies between 10˚37'S and 30˚13'S, South and 350˚49'E and 380˚00'E, East, and on the Tanzanian side, it covers Natron and West Kilimanjaro areas. In Kenyan, it includes; the Amboseli National Park, adjoining Maasai group ranches, private land in the Oloitokitok area along the Kenya-Tanzania border, and the southern part of Kajiado county from Namanga to Magadi and Nguruman The census data reported in this paper were conducted in a landscape covering 25,623 Km^2 which included; 9214 Km^2 of the Amboseli Ecosystem, 6348 Km^2 of the Namanga-Magadi areas in South-Western Kenya, 3013 Km^2 of the West Kilimanjaro and 7047 Km^2 of the Natron areas in NorthTanzania.

3.1.1. Amboseli Area

Amboseli region lies in the Southern part of Kenya, along the international border with Tanzania, and occupies an area of nearly 8797 Km^2 (**Figure 1**) covering Amboseli National Park, communal Maasai group ranches, private lands on slopes the of Mt. Kilimanjaro [14] [15]. The geology of the area is linked to the formation of Mt. Kilimanjaro, and thus quaternary volcanic soils dominate the northeastern part of Kilimanjaro, and basement rock soils are common on the southeast section [16]. Overall, the region is characterized by an arid to semi-arid environment, with most of it lying in ecological zone VI, making unsuitable for crop farming unless under irrigation [16]. The annual rainfall varies between 400 to 1000 mm [17], and has a bimodal pattern but is largely variable in space and time and unreliable. The short rains usually occur between end of October and mid-December, and the long rains between March and May [14] [18]. Most of the landscape is devoid of permanent wa-

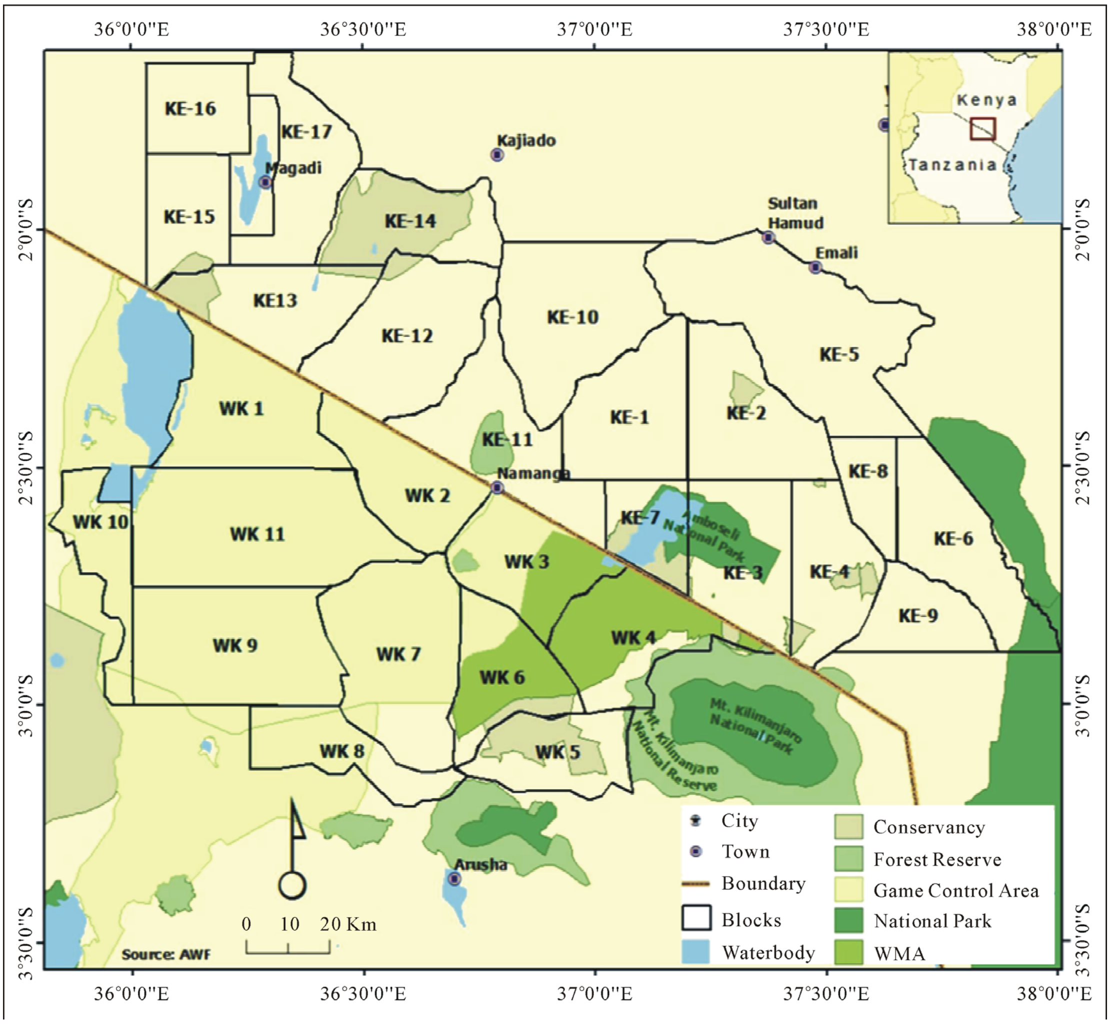

Figure 1. The Amboseli-West Kilimanjaro and Magadi-Natron landscapes along the Kenya-Tanzania borderland. Source: Kenya Wildlife Service and Tanzania Wildlife Research Institute 2013.

ter resources, with a few scattered rivers, springs and swamps whose water is supplied through underground hydrological system associated with Mt. Kilimanjaro [14].

Historically, the Amboseli area was predominantly occupied by the Maasai people who depended on pastoralism to meet their livelihood needs [19] [20]. However, in the last century, other Kenya ethnic groups especially the Kikuyu and Kamba have moved into the area, and have introduced farming [14] [18] [21]. Due to due to political, socio-economic and lifestyle changes coupled by decline in pastoralism, most of the Maasai have ventured into crop production, making agro-pastoralism the main land use [14] [17] [18]. This is especially common long the slopes of Mt. Kilimanjaro where soils and rainfall are suitable and in the rangeland where irrigation is possible using water from springs, rivers and swamps. At the same, tremendous changes have occurred in terms of human population, through immigration and a rapidly birth rate among the Maasai people [17].

Typical vegetation in the region is influenced by the ecological conditions which are arid to semi-arid [16]. Some of the key vegetation types include; Acacia dominated bushland southward to the forest belt of Mt. Kilimanjaro, and open grasslands found to in the north and northeast section up to the Chyulu Hills, near Tsavo West National Park.

3.1.2. Namanga-Magadi Area

This landscape comprises of Meto, Torosei, Mbuko, Elangata Wuas, Olkiramatian, Lorngosua and Shompole ranches, which collectively cover about 5513 Km^2 (**Figure 1**). For most parts, the topography of the area is a combination of gently undulating plains and outstanding hilly landscape and the rift valley. The soil is "black clayey" (grumosolic soils) and consist of a range of "black cotton" soils including the calcareous and non-calcareous variants.

Ewaso Ngiro is the only permanent river though there are several other seasonal rivers like the Namanga and Esokota which originate from Namanga and Meto hills. The other main seasonal river is the Ol Kejuado that originates from Ilemelepo hills to the north west of Ibisil town and drains into river Kiboko.

The diverse physical features have led to spatial-temporal variation vegetation communities, but generally, the dominant woody species include a variety of *Acacia* spp., *Commiphora* spp. and *Balanites* spp. Key grasses include *Chloris roxburgiana*, *Pennisetum stramenium*, *Pennisetum mezianum*, *Digitaria* sp., *Cynodon dactylon* and *Eragrostis* sp. Rainfall is low, bimodal and highly variable, ranging between 400 - 600 mm, making pastoralism by the Maasai the most common land use [18]. However, limited irrigated and rain fed agriculture is practiced in a few areas, mostly along the Maili-Tisa-Namanga road, the main rivers and Ewaso Ngiro.

3.1.3. West Kilimanjaro Area

The West Kilimanjaro covers an of nearly 3014 Km^2 within the Longido District of Arusha, Tanzania, and the northern extent of the area is the Tanzania-Kenya border from Namanga southeastward to Irkaswa (**Figure 1**). Its eastern border is defined by the boundary of Kilimanjaro National Park extending southward close to the community of Sanya Juu. The southern part extends west from Sanya Juu to the northeast corner of Arusha National Park, continuing along the northern park border to the Arusha-Nairobi Road that also defines the western extent of the area.

The area comprises of a complex mosaic of diverse communities, extensive grazing lands, and large agricultural fields at lower elevations on Mt. Kilimanjaro. There are traditional, agro-pastoral Maasai communities that graze livestock and raise subsistence crops. The area has several Protected Areas (PAs) in its neighborhoods, mainly; Kilimanjaro N. P (755 Km^2) on the eastern boundary, Arusha N. P (137 Km^2) to the south, and Amboseli N. P (392 Km^2) in southern Kenya, 20 km north of the Tanzania-Kenya border. Other PAs in the West Kilimanjaro include Longido Game Controlled Area (GCA) (1700 Km^2), and Ngasurai Open Area (544 Km^2) which provide important habitats for wildlife. Additionally, there are two private conservation areas, West Kilimanjaro Ranch (303 Km^2) and Endarakwai Ranch (44 Km^2).

Although the area varies in elevation (1230 to 1600 m), the predominant ecological zone is semi-arid savannah interspersed with woodlands. There are extensive agricultural fields along the lower, western flank of Mt. Kilimanjaro, and lowland forests within the boundary of Kilimanjaro NP. Rainfall is unpredictable, especially at lower elevations, and highly variable from year to year. The average annual rainfall in the semi-arid lower elevations is 341 mm/year [19] [22] and 890 mm/year in agricultural areas at lower elevations on Mt. Kilimanjaro also at Mt. Meru and Monduli in the southern part.

3.1.4. Natron Area

This landscape covers an area of about 7047 Km^2, and lies west of the West Kilimanjaro area with its northern extent defined by the Tanzania-Kenya border (**Figure 1**). Its western part is found along the eastern side of Lake Natron to Ngorongoro Conservation Area. The southern boundary extends from the southeast corner of Ngorongoro Conservation Area eastward to the northwest corner of Arusha National Park. The area comprises of a mosaic of diverse vegetation communities and extensive grazing lands. There is a unique Maasai grazing area extending westward from the Kiserian-Mriata Ridge (on the eastern side of the region) extending westward encompassing the grasslands adjacent to Gelai (2942 m ASL) and Ketumbeine (2858 m ASL) mountains. This area is characterized by well-drained savannah grasslands and woodlands where Maasai graze their cattle during the dry season and no permanent human settlements are allowed. It's largely a semiarid savannah interspersed with open acacia woodlands (*Acacia* spp. and *Commiphora* spp.). Like west Kilimanjaro area, rainfall is unpredictable and highly variable from year to year (less than 350 mm). Hunting blocks of Lake Natron GCA and the northern portion of the Monduli GCA are also found within the area.

3.2. Methods and Materials

For a many years since its creation, the Kenya Wildlife Service (KWS) has been undertaking total aerial counts of large herbivores using developed methods [23] [24]. This approach has generated substantial set of total count data from which trends and dynamics of wildlife populations in the country have been understood. Consequently, wet and dry season total elephant counts were carried out in 2010 and 2013 using similar techniques, and systematically covered the entire area of the defined census zone and recorded every individual elephant and herds, including the location on the ground using GPS coordinates.

To improve the quality of data collected on the elephant population, both crew and planes were calibrated to aid in estimation of distance for subsequent calculation of observable strip width. Streamers were mounted on either side of the aircraft wings to create two strip categories, the inner and outer (**Figure 2**). Inner category was defined as the region from the farthest one could see from the belly of the plane to the lower streamer. Likewise the outer category was defined as the region between the lower and the upper streamer (within the streamers). Calibration for observers entailed adjusting the angle of view of the streamers to correspond to 500 M and 250 M on the ground for a set altitude of 300 Ft AGL for the upper and lower streamer respectively. This was done by use of clinometers. The Rear Seat Observers (RSO's) were each calibrated and observer specific and plane specific metrics for each calibration recorded according to an individual's physique. The metrics comprised measurements from various reference points on the air craft such as low and high eye mark on the aircraft window, upper and lower streamer mark on wing strut and plane fuselage. In addition, Front Seat Observers (FSO's) and pilots were also calibrated for the purpose of assisting the RSO's to determine whether or not the counted animals are within the strip width.

For each calibration made, test flights were conducted at the set altitude for streamers (300 Ft AGL) to determine how well the streamers fitted to the desired strip width on the ground. This was achieved by creating a flight line at 500 M and 250 M from a very straight and long (5 KMs) section of a road. When the aircrafts flew on this line, the road was either 500 M or 250 M from the plane and this allowed for evaluation of the streamers. To asses inter observer variability in estimation and enhance species identification, all observers were independently subjected to count a portion of the same block with different species of known numbers in mock flights.

The target landscape was divided into blocks based on visible features from the aircraft like hills, ridges and rivers which helped the pilots to easily navigate during flight (**Figure 3**). To improve counting efficiency, the blocks were delineated into rectangular and square shapes, which also made it easier for the pilots and the Front seat observers (FSOs) to navigate using GPS units. It also gave them ample time to make comprehensive ground observations, and an attempt was made to ensure the blocks were large enough (about 900 Km^2 each on average), and could be covered within a maximum duration of six hours per day. The enhance reliability of the data collected, the counting crew were trained on how to conduct aerial counts using mock test flights. Thus, different crews flew at different times but maintaining the same flight orientation so as to evaluate any inter observer variation in their ability to identify, detect, estimate and count wildlife species. They were also trained on use of

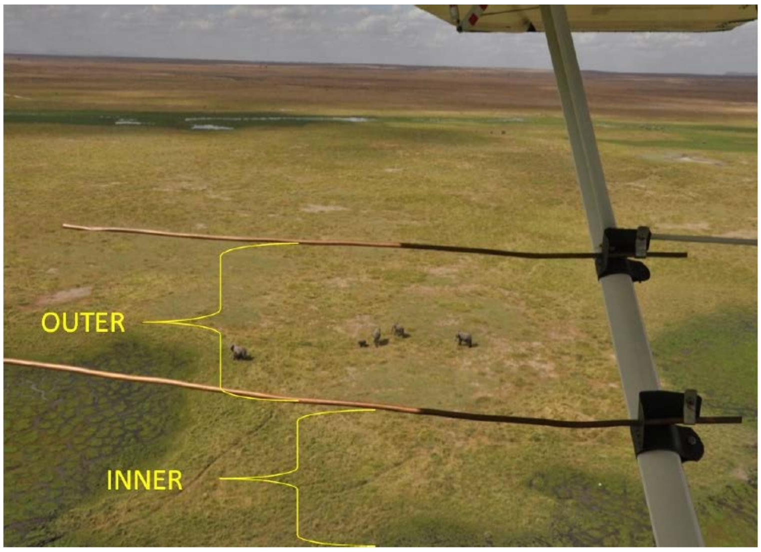

Figure 2. Layout of the census flight paths and flights direction used for the data collection in the study area. Source: Kenya Wildlife Service and Tanzania Wildlife Research Institute 2013.

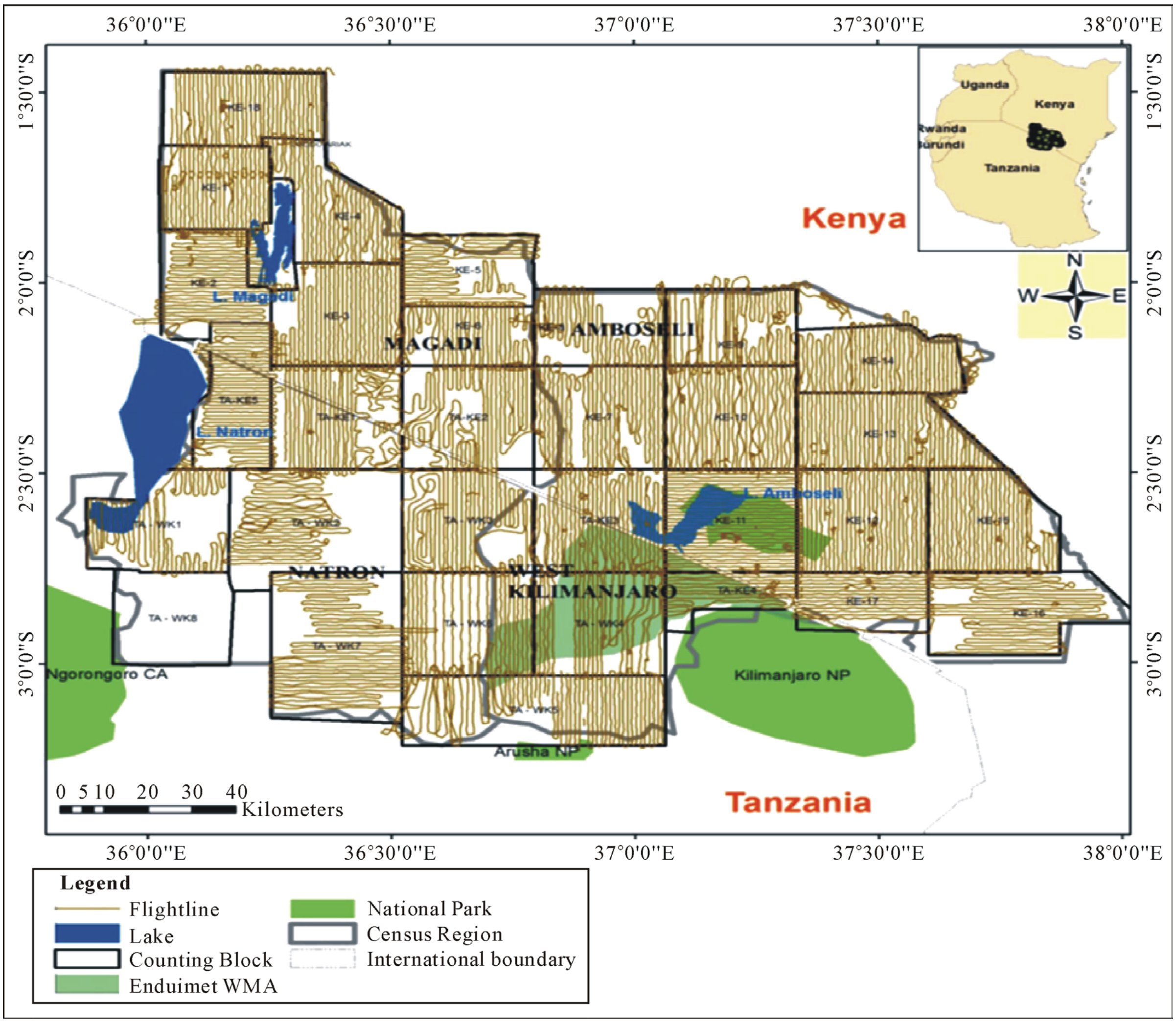

Figure 3. Position of steamers on the wings of an aircraft to help standardize distance of animals from the aircraft during aerial census animal counts. Source: Kenya Wildlife Service and Tanzania Wildlife Research Institute 2013.

voice recorders, GPS units and cameras, wildlife species identification, counting, estimation of herd sizes, data processing and handling. As noted by [23], all this preparation was done in recognition of the fact that the accuracy and reliability of such total aerial counts rely heavily on the experience of the flight crew and the pilot.

Counting of large herbivores was done in each block using a light aircraft which flew along East-West and North-South flight transects of 1 - 2 Km width depending on the visibility on the ground and nature of the terrain (**Figure 2**). On average, each count began approximately 7.30 am and ended in the afternoon, and the end time was dependent on the size of each block. The crew comprised on a pilot, front and rear seat observers, and in each block the observers systematically searched for any large herbivores on the ground and recorded; the number of individuals, their spatial location using GPS coordinates, the number, and herds of more than ten individuals were photographed so that the actual number could be verified later [23]. Data capture was also done using tape recorders, and on landing, the ground crew downloaded records captured in digital voice recorders, and the data recorded in the GPS units using DNR-Garmin/MapSource software. Once downloaded, the voice records were processed digitally to remove background noises to enable the data to be clearly heard. A team of transcribers listened to these records transcribed the data onto data sheets, and where there were discrepancies; these were verified, corrected and reconciled. All data were then entered into a spread sheet. Double counts especially on flight lines that were overlapping or very near each other were visually searched and eliminated using GIS software. Flight path and way point data were processed using ArcGIS 10.1 software to produce spatial elephant distribution maps.

In addition to elephant data, the flight observers noted and recorded human activities mainly vegetation clearing, livestock grazing, human settlements and infrastructure development. These were considered to represent key changes in the landscape which threatened its ecological integrity and elephant conservation.

3.3. Data Analysis

Only data for the dry period of 2010 and 2013 were used so that comparisons between similar census zones and for wet and dry season could be compared. Tallies, percentages, means and standard errors for the data were calculated using standard mathematical and statistical methods [25]. Population changes were done based on the density of the 2013 and how it varied from 2010 for that particular season.

Chi-square goodness of fit and chi-square cross-tabulations were done to establish differences and the association between ostrich numbers and ecosystem areas; periods after (2010) and post drought (2013); and seasons (wet and dry) using SPSS statistical software. Statistical tests were considered significant if type 1 error (alpha) was less than 5% (0.05) [25].

Since the census areas (for both wet and dry season) for 2010 and 2013 were similar, the total numbers, density and percentages (proportions) of each species of the large mammals seen were reliable measures for comparison.

4. Results

The Maasai giraffe was well represented in all the landscapes and ecosystems (protected areas and dispersal areas) along the Kenya-Tanzania borderland from the end of Tsavo-Mukomazi ecosystem to that of Natron-Magadi areas during the 2010 and 2013 censuses. Amboseli and its surrounding group ranches had the highest number of Maasai giraffe (**Table 1**) in the borderland (averaging 2062.5 ± 534.7 giraffes), followed by a distant Lake Natron area (725.8 ± 129.4 giraffes), Magadi/Namanga (669.5 ± 198.0 giraffes), and lastly West Kilimanjaro area (236.5 ± 47.8 giraffes).

In terms of the proportion of giraffes in each area of the borderland counted (**Figure 4**), Amboseli and surrounding group ranches led (55.095% ± 5.65%) followed by a distant Lake Natron area (20.985% ± 3.42%), Magadi/Namanga area (16.35% ± 3.83%), and lastly West Kilimanjaro (7.585% ± 2.12%). Further, in terms of giraffe density (**Figure 5**), Amboseli and its surrounding group ranches had also the highest elephants density (**Table 1**) in the borderland (averaging 0.23 ± 0.06 giraffes per Km^2), followed by Magadi/Namanga area (0.11 ± 0.03 giraffes per Km^2), Lake Natron area (0.10 ± 0.02 giraffes per Km^2), and West Kilimanjaro area (0.08 ± 0.02 giraffes per Km^2).

Generally the Maasai giraffe populations seemed to be increasing in most locations from 2010 (after the drought of 2007-2007) in the 2013. Further, the wet season numbers and densities seemed to be increasing compared to the dry season within and between the years except for 2013 dry season when numbers in Lake Natron area and West Kilimanjaro were higher in dry season than in wet season (**Table 1**). Considering changes in the density in each of the locations of the borderland between 2010 and 2013, Magadi/Namanga had the most positive average change (increase in giraffes) in density (+339.82 ± 329.99, four fold), compared to other locations in the borderland (**Table 2**).

The positive growth in giraffe density of Magadi was then followed by a distant Lake Natron area (+37.62 ± 83.27), but with high variability in density increase. The high variation in Lake Natron area density was possibly because the area witnessed a density decline between the wet season of 2010 and 2013. The next positive increase in density occurred in Amboseli area (+38.11 ± 7.09), with density increasing in both the wet and dry seasons. West Kilimanjaro had the lowest change (but positive) in giraffe density (+3.21 ± 57.95.27) partly because it had a decline in density between the wet season of 2010 and 2013 (**Table 2**). This wet season decline in giraffe density was therefore seen in Lake Natron area and West Kilimanjaro between 2010 and 2013.

Considering changes in the proportion (%) of all borderland giraffe meta-population in each of the locations of the borderland between 2010 and 2013, similar trends were observed (**Table 2**). Magadi/Namanga area the highest positive growth in the proportion of giraffes in the borderland (+406.46 ± 379.41) followed by Lake Natron area (+57.62 ± 83.28), which also had a decline in proportion of giraffes in wet season. The third location in proportion of giraffes in the borderland was Amboseli area with +44.56 ± 7.43, with all positive increase in proportion in both wet and dry seasons. Lastly, West Kilimanjaro had the lowest increase in the proportion of

Table 1. Maasai giraffe numbers and density in the key population hotspots of the Kenya/Tanzania borderland.

Location	Year	Season	Census Area (Km^2)	Giraffe Numbers	Giraffe Density (per Km^2)	Proportion (%) Giraffe Numbers in the Borderland
Amboseli and Surrounding Group Ranches	2010	Wet	8797.00	2283	0.26	54.83
		Dry	8797.00	1053	0.12	59.02
	2013	Wet	9214.44	3470	0.38	66.69
		Dry	9214.44	1444	0.16	39.82
	Overall (Mean ± SE)		-	2062.5 ± 5.34	0.23 ± 0.06	55.09 ± 5.65
Magadi/Namanga Areas	2010	Wet	5513.00	780	0.14	18.73
		Dry	5513.00	92	0.02	5.16
	2013	Wet	6348.32	991	0.16	19.05
		Dry	63.48.32	815	0.13	22.48
	Overall (Mean ± SE)		-	669.5 ± 198.0	0.11 ± 0.03	16.35 ± 3.83
West Kilimanjaro Area	2010	Wet	3014.00	263	0.09	6.32
		Dry	3014.00	216	0.07	12.11
	2013	Wet	3013.18	119	0.04	2.29
		Dry	3013.18	348	0.12	9.60
	Overall (Mean ± SE)		-	236.5 ± 47.8	0.08 ± 0.02	7.58 ± 2.12
Lake Natron Area	2010	Wet	7047.00	838	0.12	20.12
		Dry	7047.00	423	0.06	23.71
	2013	Wet	7047.26	623	0.09	11.97
		Dry	7047.26	1019	0.14	28.10
	Overall (Mean ± SE)		-	725.8 ± 129.4	0.10 ± 0.02	20.98 ± 3.42

Table 2. Maasai giraffe numbers and density changes in wet and dry seasons between 2010 and 2013.

Location	Season	Giraffe Density (per Km^2) (mean ± SE)	Giraffe % Numbers in Location (mean ± SE)	Change (%) in Giraffe Density over 3 Years	Change (%) in Giraffe Proportion over the 3 Years
Amboseli and Surrounding Group Ranches	Wet	0.32 ± 0.06	60.76 ± 5.93	+45.11	+51.99
	Dry	0.14 ± 0.02	49.42 ± 9.60	+30.92	+37.13
	Overall	0.23 ± 0.06	55.09 ± 5.65	+38.11 ± 7.09	+44.56 ± 7.43
Magadi and Namanga Areas	Wet	0.15 ± 0.01	18.89 ± 0.16	+10.33	+27.05
	Dry	0.07 ± 0.06	13.82 ± 8.66	+669.31	+785.87
	Overall	0.11 ± 0.03	16.35 ± 3.83	+339.82 ± 329.49	+406.46 ± 379.41
West Kilimanjaro Area	Wet	0.06 ± 0.02	4.30 ± 2.01	−54.74	−54.75
	Dry	0.09 ± 0.02	10.85 ± 1.26	+61.15	+61.11
	Overall	0.08 ± 0.02	7.58 ± 2.12	+3.21 ± 57.95	+3.18 ± 57.93
Lake Natron Area	Wet	0.10 ± 0.02	16.05 ± 4.08	−25.66	−25.66
	Dry	0.10 ± 0.04	25.91 ± 2.20	+140.89	+140.90
	Overall	0.10 ± 0.02	20.98 ± 3.42	+57.62 ± 83.27	57.62 ± 83.28

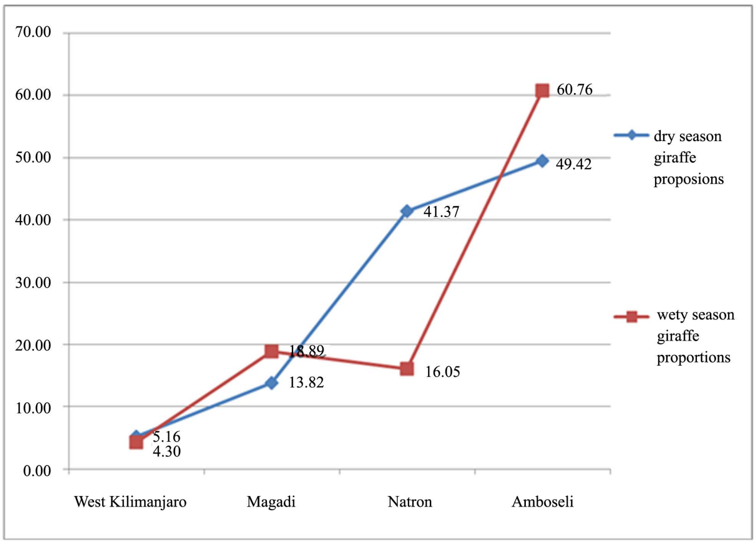

Figure 4. The Maasai giraffe proportions (%) in the wet and dry season in Amboseli, West Kilimanjaro, Magadi and Lake Natron areas of the Kenya/Tanzania borderland.

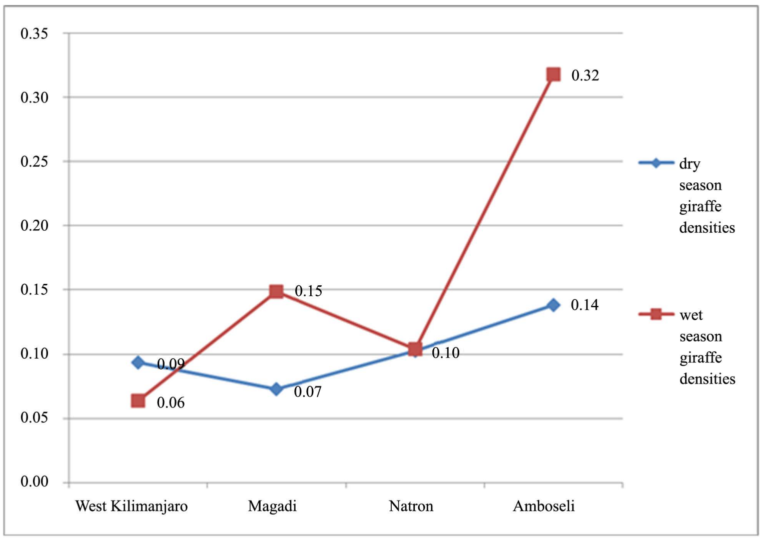

Figure 5. The Maasai giraffe densities (per Km^2) in the wet and dry season in Amboseli, West Kilimanjaro, Magadi and Lake Natron areas of the Kenya/Tanzania borderland.

giraffes in the borderland (+3.18 ± 57.93) since there was a decline in this proportion in the wet season between 2010 and 2013 (**Table 2**).

In terms of wet season and dry season comparison for every year, all the locations in the borderland had significantly different giraffe numbers between wet and dry season for every year; and between pairs of dry seasons and wet seasons of subsequent years (**Table 3**). Amboseli area for 2010, wet season giraffe number was higher than dry season number ($p < 0.001$). Similarly in 2013, wet season giraffe number was also higher ($p < 0.001$) than dry season number in Amboseli area. Further, for each subsequent pair of wet season, and dry season, the giraffe numbers were significantly higher ($p < 0.001$ in all cases) for 2013 than 2010 for Amboseli area (**Table 3**). Similar trend was observed for Magadi/Namanga area, with wet season giraffe number was higher than dry season number ($p < 0.001$) in 2010, and wet season giraffe number was higher ($p < 0.001$), than dry season number in 2013. Further, for each set of wet season, and dry season, the giraffe numbers were higher ($p < 0.001$

Table 3. The differences in Maasai giraffe numbers between seasons and within season in various locations within the Kenya-Tanzania borderland.

Census Location	Year	Season Census Done		Chi-Square Goodness of Fit Value	Conclusion
		Wet Season	Dry Season		
Amboseli	2010	2283	1053	$X^2 = 453.51$, df = 1, $p < 0.001$	For 2010, wet season numbers were higher than dry season number.
	2013	3470	1444	$X^2 = 835.30$, df = 1, $p < 0.001$	For 2013, wet season numbers were higher than dry season number.
	Chi-Square Value	$X^2 = 244.91$, df = 1, $p < 0.001$	$X^2 = 61.23$, df = 1, $p < 0.001$	For each set of wet season, and dry season, the giraffe numbers were significantly higher for 2013 than 2010.	
Magadi	2010	780	192	$X^2 = 355.70$, df = 1, $p < 0.001$	For 2010, wet season numbers were higher than dry season number.
	2013	991	815	$X^2 = 17.15$, df = 1, $p < 0.001$	For 2013, wet season numbers were higher than dry season numbers.
	Chi-Square Value	$X^2 = 25.14$, df = 1, $p < 0.001$	$X^2 = 385.43$, df = 1, $p < 0.001$	For each set of wet season, and dry season, the giraffe numbers were significantly higher for 2013 than 2010.	
West Kilimanjaro	2010	263	216	$X^2 = 4.61$. df = 1, $p = 0.032$	For 2010, wet season numbers was higher than dry season number.
	2013	119	348	$X^2 = 112.29$, df = 1, $p < 0.001$	For 2013, dry season numbers were higher than wet season number.
	Chi-Square Value	$X^2 = 54.28$, df = 1, $p < 0.001$	$X^2 = 30.89$, df = 1, $p < 0.001$	For each set of wet and dry season, the giraffe numbers were different. They were higher in the wet season of 2010, but higher in the dry season of 2013.	
Natron	2010	838	423	$X^2 = 136.58$, df = 1, $p < 0.001$	For 2010, wet season numbers were higher than dry season number.
	2013	623	1019	$X^2 = 95.50$, df = 1, $p < 0.001$	For 2013, dry season numbers were higher than wet season numbers.
	Chi-Square Value	$X^2 = 31.64$, df = 1, $p < 0.001$	$X^2 = 246.34$ df = 1, $p < 0.001$	For each set of wet and dry season, the giraffe numbers were different. They were higher in the wet season of 2010, but higher in the dry season of 2013.	

in all cases) for 2013 than 2010 for Magadi/Namanga area (**Table 3**).

In Kilimanjaro area for 2010 (**Table 3**), wet season numbers was higher ($p < 0.001$) than giraffe dry season number in West Kilimanjaro area. But for 2013, wet season numbers were lower ($p < 0.01$) than the dry season. Similar trend was observed for Lake Natron area, with wet season giraffe numbers being higher ($p < 0.001$) than dry season number in 2010. But in 2013, wet season numbers were lower ($p < 0.001$) than dry season numbers. Further, in both West Kilimanjaro and Lake Natron areas, the giraffe numbers in 2013 was lower for the wet season ($p < 0.001$), and also for the dry season ($p < 0.001$) than of 2010 (*i.e.* in both West Kilimanjaro and Lake Natron areas, the giraffe numbers were declining in all seasons with time).

In terms relationships between giraffe numbers in different locations (closer or further away from protected areas), influence of seasons on giraffe numbers varied among the locations in the borderland (**Table 4**). In general, the giraffe abundance in various locations in the borderland was depended on season (chi-square cross tabulations, $p < 0.001$); with giraffe numbers increasing in all locations in the wet season than in the dry season. However, in the wet season, giraffe number was dependent on the year ($p < 0.001$), with the giraffe number increasing over time near protected areas than further away from the protected areas (**Table 4**). In the dry season, giraffes in locations were also dependent on the year ($p < 0.001$), with giraffe numbers increasing with time both near protected areas but more so further away from the protected areas (**Table 4**).

5. Discussions

The Maasai giraffe was found to widely using the Kenyan-Tanzanian borderland than most herbivores, but looking at their distribution they are increasingly being confined to certain areas and not present in some. The distribution showed that Amboseli (and the group ranches) were the core area of giraffe locations, with over half of the giraffe population in the borderland being located in Amboseli area. Therefore, like other species such as

Table 4. The relationship between Maasai giraffe numbers and census location proximity to existing protected areas (Amboseli and West Kilimanjaro) and away (Magadi and Lake Natron area) within the borderland.

Season of the Year	Year	Location of Census Area		Chi-Square cross Tabulation Value	Conclusion
		In or around Protected Areas	Away from Protected Areas		
Wet Season	2010 (After Drought)	2546	1618	$X^2 = 62.85$, df = 1, $p < 0.001$	In the wet season, giraffes numbers in location was dependent on year, with the number increasing over time near protected areas than further away.
	2013 (Post Drought)	3589	1614		
Dry Season	2010 (After Drought)	1269	615	$X^2 = 161.53$ df = 1, $p < 0.001$	In the dry season, giraffes in location was dependent on year, with giraffe numbers increasing with time both near protected areas but more so further away from protected areas.
	2013 (Post Drought)	1792	1834		
Overall Wet Season		6135	3232	$X^2 = 145.29$, df = 1, $p < 0.001$	Generally giraffes numbers in locations were depended on season, with giraffe numbers increasing in all locations, more near than further from protected areas in the wet season.

elephants, Amboseli area still the most important area in the borderland for giraffe conservation, and therefore conservation of the Amboseli Ecosystem must remain a priority especially for Kenya Wildlife Service. So while we must continue to strengthen our giraffe protection and maintain the landscape ranging for giraffes it is emerging that habitat destruction (especially the trees and shrubs on which these specialized browsers feed) could be the main threat. Giraffe numbers have also become a concern in the borderland ecosystems because they have become popular and easy targets for bush meat trade. Poachers use crude weapons like machetes to cut off giraffe meat and pack them in sacks and transport them on donkeys across borders to market places and other demand areas for sale.

Despite Amboseli supporting more than half of the Maasai giraffe in the borderland, the fastest growth in density and numbers of giraffes was in Magadi and Lake Natron. This area (especially if natural connectivity can be maintained) represent a much more promising area for giraffe population growth and source for other sink areas in the ecosystem. The fact that the growth in these two locations is faster than in Amboseli and West Kilimanjaro seem to suggest that there is still great potential for giraffe population to continue to grow in these areas and possibly further from carrying capacity (for which possibly the Amboseli-West Kilimanjaro continuum has been attained). It is therefore important to also focus on this cross-border area with a view of securing not only natural giraffe habitats of continuous trees and shrublands, but also security from poachers. Since giraffes are not very vulnerable to predation by large herbivores (except may be a group of lions) due to both their size and ability to kick with both their front and hind legs, poaching by humans (bush meat), human encroachment and habitat destruction (habitat clearing for agriculture, cutting of tree and shrub resources for various uses, increasing commercial charcoal and firewood kilns to expanding markets and urban areas) represents the common threat to giraffes in the borderland.

It is likely that these giraffe populations may be connected as a Meta-population which is stabilized by each other in the borderland area. It is therefore very important that key corridors and connectivity pathways are maintained across the border between Magadi and Lake Natron on one hand, between Lake Natron and West Kilimanjaro through the expansive Longido rangelands, and between West Kilimanjaro and Amboseli. Natural vegetation with good tree and shrub cover and minimal degradation by human impacts and overgrazing will allow for this critical connectivity between these ecosystems so as to continue to maintain the larger borderland giraffe Meta-Population. There seems to be little hindrances to ostrich movement across various ecosystems on the Kenyan side of the borderland, including ease crossing of the busy Nairobi-Namanga highway. This means that connectivity in the greater ostrich Meta population in the borderland is available and just controlling poaching, habitat and human encroachment will allow ostrich populations to continue to thrive over time. General habitat destruction such as increasing charcoal kilns in the borderland rangeland lends support to concerns about habitat destruction.

Maasai giraffe population is generally increasing in all the areas of the borderland, especially in the wet season after the devastating effects of 2007-2009 droughts in the borderland ecosystems. This is expected because wet season is associated with lush growth in vegetation and plenty of available surface water. Much forage and water will improve not only resources for ostrich growth, viability and reproduction fitness, but will also provide thermal cover and reduced competition with livestock and wild herbivores for plant resources and water. The buildup of insects and other food items including forbs and grass allow for increasing of ostrich ranging and numbers during the wet season. Like other borderland wild herbivores, ostrich also disperse widely during the wet season, but may be confined in the dry season because of thermal load and patchy distribution of water and food sources. Nevertheless, ostrich can also get (preformed) water from eating lush vegetation and insects as such tissues contained water which will often meet metabolic requirements of ostriches, especially in dry season and areas of water scarcity.

Generally, it was expected giraffe populations to be increasing in Amboseli and Magadi/Namanga locations from 2010 through 2013 as a recovery from droughts of 2007 and 2009, and in the wet season when forage is more plentiful. However, this was not the case for West Kilimanjaro and Lake Natron areas, as the dry season numbers in giraffe numbers were higher than the wet season. Two reasons may explain this, first that in some areas, giraffe numbers will concentrate in places where there is more water availability, partly to access free flowing water, but secondly and more importantly because such areas may be associated with lush acacia and other tree and shrub densities that will provide critical forage in the dry season. Since this may be accompanied by reduced landscape ranging and movements as giraffes settle in places where forage availability and distribution will likely support them more in the dry season, these may lead to enhanced concentration of giraffes in such places and hence have a more elevated giraffe numbers in dry season than the wet season when they disperse more and venture in other areas due to a wide availability of forage.

Results indicated that in the wet season, giraffe number increased over time near protected areas than further away from the protected areas. But in the dry season, giraffe numbers increased with time both near protected areas, but more so further away from the protected areas. This is an interesting finding because it underscores the importance of protected areas as core and safe areas of building wildlife populations. They serve as a source for dispersal for wildlife to other locations especially in the dispersal areas associated with these protected areas. The increase in protected areas and away from protected areas in different seasons of the year indicates that while the long term strategy in giraffe conservation must be increasing and at a minimum maintaining its populations over time, we can only achieve this with a holistic landscape approach where both the protected areas and their dispersal areas (other landscape ranges for giraffes away from the network of protected areas) must be considered in the national protection strategy. This calls for the increased involvement and encouragement of the landowners and communities on whose land Maasai giraffe roams outside of protected areas to support the initiative, develop conservation areas of their own and if possible be helped (in terms of capacity and technical support) to benefit from ecotourism ventures associated with giraffes and other large mammals on their land. This strategy will provide for more conservation space outside protected areas, but also encourage connectivity among key populations. The other critical consideration if the forming of partnerships and collaborative management between the communities and national government of Kenya and Tanzania to promote and enhance conservation of biodiversity across the borderland.

6. Conclusions

The status and distribution of the Maasai giraffe is still very good in the mid borderland of Kenya-Tanzania. Most of the giraffes however are found in Amboseli and Lake Natron area, but there is also a good population in Magadi/Namanga area and West Kilimanjaro in Tanzania. The population growth was positive after the droughts, indicating that the giraffe population was revering well in the borderland, with a high recovery seen in Magadi/Namanga area and West Kilimanjaro possibly because of high birthrate and immigration from Amboseli and Lake Natron areas. The population is expected to grow only if there is concerted effort in both Kenya and Tanzania and the borderland communities to avoid habitat destruction, giraffe poaching in bush meat, snaring and harassment of giraffes. Further, joint monitoring between Kenya (KWS) and Tanzania (TAWIRI) will enhance science-based management through population monitoring and trend. The giraffe population status and distribution is good enough to make it not a species of conservation concern unless the poaching and habitat destruction now on the increase becomes a serious threat to its population status.

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References

[1] Skinner, J.D. and Smithers, R.H.N. (1990) The Mammals of the Southern African Sub-Region. University of Pretoria Press, Pretoria, 604-606.

[2] Estes, R.D. (1992) The Behaviour Guide to African Mammals; Including Hoofed Mammals, Carnivores and Primates. The University of California Press, Oakland.

[3] Kingdon, J. (1984) East African Mammals: An Atlas of Evolution of African Large Mammals. University of Chicago Press, Chicago.

[4] East, R. (1998) African Antelope Database. IUCN/SSC Antelope Specialist Group Report, IUCN Nairobi, Kenya, 94-100.

[5] Pellew, R.A. (1984) Giraffe and Okapi. In: Macdonald, D., Ed., *Hoofed Mammals*, Torstar Books Inc., New York.

[6] Ansell, W.F.H. (1968) Artiodactyla (Excluding the Genus *Gazella*). In: Meester, J.A., Ed., *Preliminary Identification Manual for African Mammals*, Smithsonian Institution, Washington DC, 152-160.

[7] Dagg, A.I. and Foster, J.B. (1982) The Giraffe, Its Biology, Behavior and Ecology. Van Nostrand Reinhold Publishers, New York.

[8] Ottichilo, W.K., de Leeuw, J., Skidmore, A.K., Prins, H.H.T. and Said, M.Y. (2000) Population Trends of Large Non-Migratory Wild Herbivores and Livestock in the Maasai Mara Ecosystem, Kenya, between 1977 and 1997. *African Journal of Ecology*, **38**, 202-216. http://dx.doi.org/10.1046/j.1365-2028.2000.00242.x

[9] Van der Deugd, H.P. and Prins, H.H.T. (2000) Movements and Group Structure of Giraffe (*Giraffa camelopardalis*) in Lake Manyara National Park, Tanzania. *Journal of Zoology*, **251**, 15-21. http://dx.doi.org/10.1017/S0952836900005033

[10] Fennesy, J. and Brown, D. (2014) *Giraffa camelopardalis*. IUCN 2008, Red List of Threatened Species. www.iucnredlist.org

[11] Muller, Z. (2010) Sticking Our Necks Out: Developing a National Giraffe Management Strategy for Kenya. *Giraffa*, **4**, 26-27.

[12] Wanjala, M.J. (2005) An Overview of Wildlife and Tourism Management in Kenya. *Proceedings of the Third African Conference on Peace through Tourism*, Lusaka, 6-11 February 2005, 123-131.

[13] Githiru, M., Njeri, T., Muthoni, F.K., Yego, R., Muchane, M., Njoroge, P. and Giani, A. (2007) Wild Herbivores in Bour-Algi Giraffe Sanctuary, Kenya: Abundance, Habitat Use and Interactions with Humans. Zoology Department Research Report, National Museums of Kenya, Nairobi.

[14] Ntiati, P. (2002) Group Ranches Subdivision Study in Loitokitok Division of Kajiado District. Land Use Change Impacts and Dynamics (LUCID) Working Paper 7, International Livestock Research Institute (ILRI), Nairobi.

[15] Western, D., Groom, R. and Worden, J. (2009) The Impact of Subdivision and Sedentarization of Pastoral Lands on Wildlife in an African Savanna Ecosystem. *Biological Conservation*, **142**, 2538-2546. http://dx.doi.org/10.1016/j.biocon.2009.05.025

[16] Pratt, D.J. and Gwynne, M.D. (1977) Rangeland Management and Ecology in East Africa. Hodder and Stoughton, London.

[17] Reid, R., Gachimbi, L., Worden, J., Wangui, E., Mathai, S., Campbell, D., Maitima, J., Butt, B., Gichohi, H. and Ogol, E. (2004) Linkages between Changes in Land Use, Biodiversity and Land Degradation in the Loitokitok Area of Kenya. Land Use Change Impacts and Dynamics (LUCID) Working Paper Series 49, 1-29.

[18] Okello, M.M. and D'Amour, D.E. (2008) Agricultural Expansion within Kimana Electric Fences and Implications for Natural Resource Conservation around Amboseli National Park, Kenya. *Journal of Arid Environments*, **72**, 2179-2192. http://dx.doi.org/10.1016/j.jaridenv.2008.07.008

[19] Western, D. (1982) Amboseli National Park: Enlisting Landowners to Conserve Migratory Wildlife. *Ambio*, **11**, 302-308.

[20] Berger, D. (1993) Wildlife Extension: Participatory Conservation by the Maasai of Kenya. ACTS Environmental Policy Series No. 4, 5-45.

[21] Kiringe, J.W. and Okello, M.M. (2005) Use and Availability of Tree and Shrub Resources on Maasai Communal Rangelands near Amboseli, Kenya. *African Journal of Range and Forage Science*, **22**, 37-46. http://dx.doi.org/10.2989/10220110509485860

[22] Western, D. (1975) Water Availability and Its Influence on the Structure and Dynamics of a Savannah Large Mammal Community. *East African Wildlife Journal*, **13**, 265-285.

[23] Douglas-Hamilton, I., Gachago, S., Litoroh, M. and Mirangi, J. (1994) Tsavo Elephant Count 1994. Kenya Wildlife Service, Nairobi.

[24] Norton-Griffiths (1978) Counting Animals. Handbook 1, 2nd Edition, African Wildlife Foundation, Nairobi.

[25] Zar, J.H. (1999) Biostatistical Analysis. Fourth Edition, Prentice Hall, Inc., Upper Saddle River.