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Human Population Growth and Wildlife Extinction in Ugalla Ecosystem, Western Tanzania

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Abstract. Incessant human population growth is a major cause of wildlife loss worldwide. Wildlife species, which offer a number of human needs, decline or disappear as human populations clear wildlife habitats for anthropogenic activities. The objectives of this paper are to synthesize the available information concerning human and wildlife populations and to develop a spatial GIS model for the Ugalla Ecosystem to estimate the future impacts of increasing human populations on wildlife populations using a combination of fine-resolution human population data for the years 2002, 2012, and 2050. A survey was conducted to supplement data and support the model on the relationships between human and wildlife population densities. Results indicate that by 2050, many of the presently abundant types of wildlife species will begin to disappear as the number of people in contact with wildlife increases. The paper therefore suggests that burgeoining human population around protected areas must be curtailed to enhance both consumptive and non consumptive forms of tourism in future.

Key words: Ugalla ecosystem, wildlife, GIS, human population growth, population projection

1. INTRODUCTION

The human population around most protected areas in Tanzania has, over the years, been changing in terms of its size, density and livelihood strategies. Since the 1970s Tanzania's protected areas have come under increasing threat from a combination of human activities. There is also a growing realisation that the population dynamics of the surrounding settlements have had adverse impacts on protected areas. The major population issue is migration, which has more dramatic short-term impacts on the environment.

Wild animals are extensively utilised for food and commercial purposes (Festa-Bianchet, 2003; Davies & Brown, 2007; Smith, 2008). Human beings continue to exploit wildlife both for current benefit and because they have had a historical relationship with wild animals as a valuable natural resource (Mills, 2007). Wildlife exploitation has been widely reported to have an undesirable influence on wildlife populations (Taylor & Dunstone, 1996; Fa *et al.*, 2006; Setsaas *et al.*, 2007; Caro, 2008). However, not all species are affected in the same manner; some are affected more than others, while some are only affected indirectly (Mills, 2007). Contemporary wildlife conservation science has been paying much attention to how, why, and to what extent populations of different wildlife species are affected by human exploitation (Weber, 2000; Festa-Bianchet, 2003; Ryena-Hurtado & Turner, 2007; Caro *et al.*, 2009).

It is unfortunate that all types of protected areas are vulnerable to wildlife poaching (Newmark, 2008). The magnitude of poaching differs depending on the effectiveness of the anti poaching measures (Hilborn *et al.*, 2006). Areas adjacent to strictly protected areas, which are also used for tourist hunting, are the most heavily poached (Wittemyer *et al.*, 2008) because of the poor law enforcement (Holmern *et al.*, 2007) and human population pressures. Caro *et al.* (2007) argued that the combined impact of trophy hunting and poaching on wildlife populations is considerably larger than the perceived impact of a single form of hunting). In Tanzania, notwithstanding its internationally recognised and highly valued protected areas, wildlife poaching is increasingly becoming a controversial issue (Carpaneto and Fusari, 2000; Baldus, 2002; Holmern et al., 2004; Rustagi, 2005; Caro, 2008).

Wildlife areas surrounding Ugalla Game Reserve (wildlife management areas, game controlled areas and open areas) face severe human pressure since their conservation status and level of protection are lower than the reserve. As a result, populations of different species in the reserve are closed in terms of immigration and emigration (UGR, 2006).

This paper reports the results of testing an old hypothesis that human population growth will cause the decline and extinction of the wildlife across Africa and Tanzania in particular. The overall objective of this paper is to synthesize the available information concerning human and wildlife populations and to develop a spatial GIS model to estimate the future impact of human populations on wildlife populations. Specific objectives of this study are to estimate current population size and distribution of selected wildlife species, to assess the trends and projected selected wildlife resources based on recent population levels and to assess consumptive forms of tourism in future for the purposes of developing sound management priorities.

This study was guided by a conceptual framework that posits that the Human Wildlife Conflict is considered inevitable in all communities where human and wildlife coexist. Studies indicate that relatively high densities of wildlife and people can co-exist if wild animals are not subjected to high levels of deliberate human disturbance.

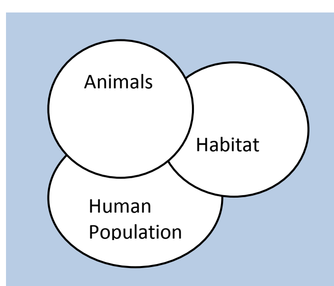

Fig. 1. People and wildlife co-existence: a difficult equation

2. LITERATURE REVIEW

The population of the African continent, which has the world's largest reserves of wildlife, is expected to double from 0.8 billion to 1.8 billion people in the next 40 years (ILRI, 2009). Africans will not only be packed more tightly into cities, they and their crops will also increasingly impinge upon territories populated by wildlife. It is the consequence of this effect that populations of many wildlife species have declined substantially inside and outside protected areas in Africa (Ogutu & Owen-Smith, 2003; Owen-Smith & Mills, 2006; Stoner et al., 2006, 2007; Caro & Scholte, 2007; Bolger et al., 2008; Harris et al., 2009; Ogutu et al., 2009; Western, Russell & Cuthill, 2009).

Wild animals live in home ranges of varying sizes (Knight *et al*., 2009), and majority of the time they are found outside core protected areas (Thirgood *et al*., 2004). Some of the factors determining species home ranges include the quality and quantity of food resources, reproductive characteristics (van Beest *et al*., 2011) and species' migration patterns (Boone *et al*., 2006; Mpanduji & Ngomello, 2007). Since human landuse changes around wildlife areas occur concomitantly with habitat manipulation (Mundia & Murayama, 2009), different species in and outside core protected areas have become increasingly vulnerable.

The level of protection, distance from human settlements and reserve boundaries (Brashares *et al*. 2004), have all been identified as important predictors of hunting pressure in Africa. Elephants, lions and rhinocerous throughout Africa are subject to widespread loss of habitat, prey depletion, and human–animal conflicts that are associated with rapid human population growth (e.g., Ray et al. 2005; Woodroffe & Frank 2005; IUCN 2008).

East Africa has lost more than half of its wildlife in the last 30 years (Stoner et al., 2006; Western et al*.,* 2009). In Tanzania, human population growth has been particularly high along the borders of the wildlife areas and deforestation has accelerated in the past 15 years (Packer et al. 2009) with concomitant declines in herbivore populations (Stoner et al. 2007). Furthermore, wildlife is declining in all major wildlife areas and ecosystems, including national parks and game reserves (TNRF, 2008). Most of this is driven by high human population growth and growing human settlements (Lamprey & Reid, 2004; Norton-Griffiths et al., 2009), in the rural areas, changing economic realities mainly expansion of large-scale cultivation and other land-use changes and policies (Msoffe et al., 2011, Serneels, Said & Lambin, 2001), and illicit hunting (Loibooki et al., 2002) and livestock incursions into protected areas (Ogutu et al., 2009).

Studies conducted in Tabora Region illustrate that almost all forest reserves in the region are encroached (Shishira and Yanda, 1998). The encroachment is in the form of new settlements and clearing of forests for agriculture and livestock grazing. Due to uncontrolled harvesting of fuel wood especially for tobacco curing, deforestation of both the public lands and forest reserves has proceeded at a rapid speed (Newmark, 2008).

A letter dated January 22, 2004 from the Director of Wildlife to the Country Representative of Africare/Tanzania indicates that the Ugalla game reserve in Tabora region reserve is encroached especially in the southern part originating from four villages: Katambike; Urwilla; Ukondamoyo and Kambuzi. Poaching is a serious problem in the Ugalla ecosystem because of poverty and a massive increase in demand for animal protein (Wilfred & MacColl, 2010).

3. MATERIALS AND METHODS

3.1 Study areas

The study was conducted in Sikonge, Kaliua and Urambo Districts, Western Tanzania. These districts contain a substantial part of the Ugalla ecosystem, in which Ugalla Game Reserve is the key component (Figure 2). Ugalla Game Reserve lies between longitude 31°26′ to 32°23′ E and latitude 5°31′ to 6°03′ S, covering an area of approximately 5000 km² in the western part of Tanzania. The reserve constitutes a critical component of the Ugalla ecosystem (UGR, 2006). It borders seven forest reserves (Fig. 3), which are also linked to other forest reserves; for example, Isuangala, Ipembampazi and Itulu. The forest reserves form a buffer zone around Ugalla Game Reserve, and contain partially protected areas. Ugalla Game Reserve is a source of animals for the adjacent partially protected areas and forest reserves (Hazelhurst & Milner, 2007). According to the 2012 population census, Sikonge, Urambo and Kaliua Districts had population sizes of 179883, 192781 and 393358, respectively (NBS, 2012). In general, the human population of Tabora region is among the fastest growing region in Tanzania with a growth rate of 3.6% (NBS, 2012).

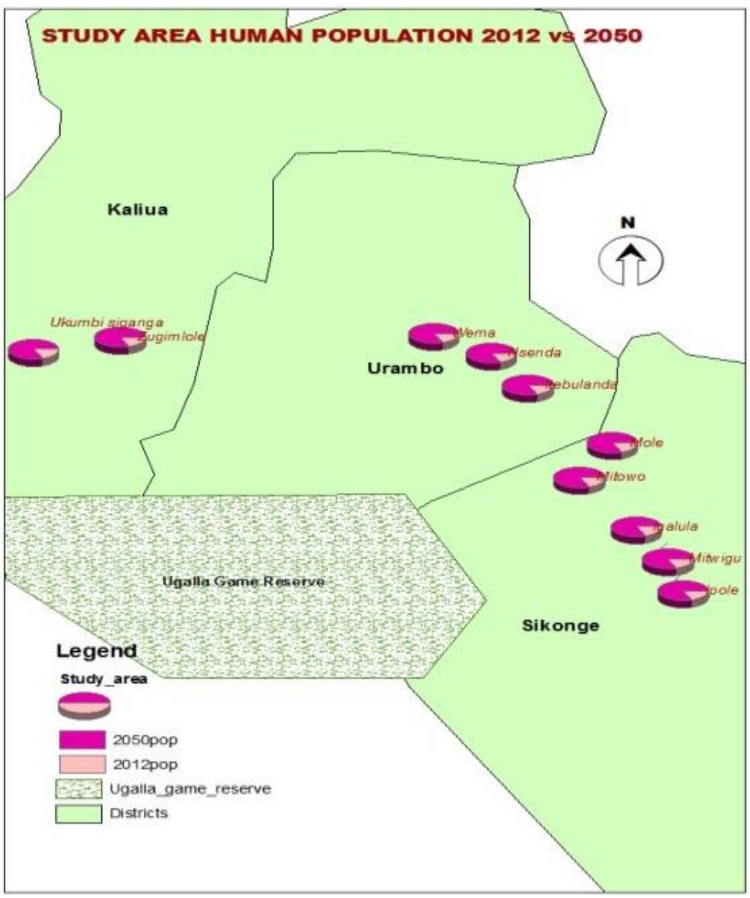

Figure 2. Ugalla ecosystem in Tanzania, including its three fringing districts and study villages and their current populations

Source: Ugalla Population-Wildlife Study 2011-2013.

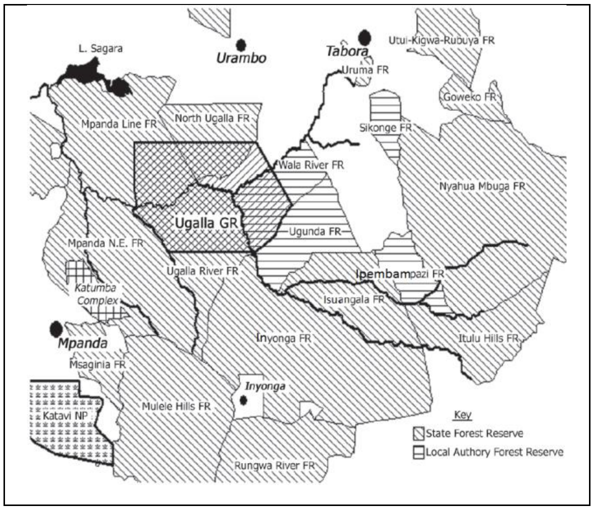

Figure 3. The Forest Reserves around the Ugalla Reserve

Source: The Ugalla Reserve Management Plan 2000

Fig. 4. Ugalla Forest Reserve SignboardGame

3.2 Field Sampling and Measurement

Following the theory for sampling techniques by De Vaus (2002), a sample of 10 study villages was randomly drawn from a total of 122 villages (8.2% sampling intensity) in Sikonge, Urambo and Kaliua Districts. The study villages were, Zugimlole, Ukumbisiganga, Wema, Nsenda, Itebulanda, Mole, Mitowo, Igalula, Mitwigu, and Ipole (Figure 2).

To adequately provide empirical explanations to the specific objectives set for this study, the author developed fine-resolution GIS coverages of future human populations for Tanzania. These coverages were combined with in-depth field observations of the relationship between the densities of people and wildlife to create scenarios of wildlife decline in Ugalla ecosystem. Predictions on the future fate of endangered wildlife were aligned with a survey carried out in selected villages surrounding the reserve ecosystem.

3.2.1 Geographic Distribution of Human Population

The geographic distribution of human population in the three districts was derived from the 2012 national census data. These data were aligned with Landscan™ databases obtained from East View Information Services, USA. Landscan uses spatial data and imagery analysis and a multi-variable dasymetric modeling approach to dis-aggregate census counts within an administrative boundary. The resulting Landscan dataset represents an ambient population which integrates diurnal movements and collective travel habits into a single measure. High-resolution imagery was used for validation to smaller villages and populated places around the Ugalla ecosystem. Landscan was used because of its added qualities. It allows quick and easy assessment, estimation, and visualization of population close to critical areas.

Landscan provides global grids of 30" x 30" latitude/longitude grid approx. 1km^2 where census counts are allocated to grid nodes on the basis of probability coefficients. The probability coefficient is based on slope, proximity to roads, landcover, night time lights, and an urban density factor. The spatial resolution of Landscan is 30 arc seconds (<1 km at the equator), and the population layer is updated on a yearly basis. Landscan 2012 was combined with the Ugalla map to provide estimates of people at critical areas.

3.2.2 Projection of Human Population

To estimate future human populations, extrapolation from 2012 to 2050 population data was performed. The official census population data of 2012 were extrapolated to 2050 by applying an average annual geometric growth rate. The formula employed for calculating the annual growth rate is:

$$r = \frac{LN\ [(P_2/P_1)]}{(t_2 - t_1)}$$

where, LN = the natural log, P1 and P2= population counts for the first and second reference years, t1and t2= time periods 1 and 2.

The forward extrapolations were thereby computed with the following formula:

$$P_{2050} = P_1 e^{rt}$$

where, r = the geometric growth rate (as defined above), t = the number of years the initial estimate will be projected forward/backward, P1 = population counts for the first reference year.

3.2.3 Reliability of Data

In order to check for the reliability of the projected human population data, grid-cell-by-grid-cell growth rates between 2002 and 2012 were employed. The rates for this time period rather than earlier decades were used because they best represent the increased migration into unsettled rural areas expected in the future. For the years 2050 and beyond, it was found that the cell-based growth rates resulted in country-level human populations that were higher than the 'medium variant' UN country-level projections for the same years because the growth rates did not account for the expected decline in fertility and the effect of AIDS on African human populations. Therefore, for the 2012-2050 period of time, the projected aggregate population totals for Tanzania were adjusted to match the UN population projection.

3.3 Wildlife Population distribution

During this study, large mammal populations on the reserve were monitored from game vehicles using distance sampling along six 10 km line transects that coincide with the reserve road network. The transect lines in total incorporated different terrain types present on the reserve.

The principal researcher helped by game wardens and research assistants travelled the transect lines and road systems and recorded their encounters with the three studied animals in accordance with accepted protocols. Each time an animal was seen, the species was identified, the number of individuals recorded, the distance along the transect line they were encountered and the Geographical Positioning System (GPS) location of the animal(s). The large mammal species commonly encountered during surveys were wildebeest, zebra, giraffe, impala, warthog, kudu, waterbuck, hartebeest and the earmarked ones such as elephants, black rhinos, and lions whose distribution forms the basis of all subsequent analysis.

3.3.1 Comparing estimates

GPS and terrain data obtained from the transect surveys were combined with existing GIS maps of the reserve to investigate ranging and habitat use of the species encountered. Population estimates were then formulated for each species using DISTANCE© V.6.0, a software programme which estimates density and abundance from transect data. In addition annual game count collected via helicopter was compared against the estimates obtained from the game transects.

3.3.2 Predicting Future Wildlife Populations

3.3.2.1 Species Occupancy Models

To examine the forecasted changes in human population density, the villages' distance-to-Ugalla forest edge and percent forest cover were considered because they affect the future population of wildlife species. The study used single-species occupancy models for the 3 target species, a method described fully in Schwenk and Donovan (2011). Occupancy models predict the probability that a species will occur ψ based on empirical presence-absence data and species' sensitivities to variables like forest amount, forest arrangement, development, and roads (MacKenzie et al. 2006). These models were used to calculate the probability of occupancy ψ within each 30 m pixel in the study area based on animal surveys at 10 sites across the Ugalla ecosystem in 2011 and 2013.

3.3.2.2 Conserved Lands and Species Habitat

The probability of occupancy maps represented species distributions across the Ugalla ecosystem. For each species, calculation was done on the proportion of the total occupancy probability that occurred within boundaries of Ugalla protected land. The study considered this proportion as a quantitative metric of species conservation (e.g., if 30% of the total occupancy probabilities in year *t* occurred within a protected area, 0.30 represents the degree to which protected lands in year *t* support a species distribution).

To estimate the proportion of total occupancy that occurred on protected lands for each species, summation was done on ψ values across each raster cell in the year 2012. Then, summation was done on the total ψ values that occurred on protected lands in the year 2012 and divided the summed amount of occupancy probability protected by the total amount of occupancy probability in the study area. This analysis was conducted for each of the 3 study species in two years, 2012 and 2050.

3.4 Development of Human - Wildlife Scenarios

To develop scenarios, all the available information about the relationship between human and wildlife populations was synthesized. The first step in scenario development was to establish a quantitative relationship between human population density and wildlife populations.

The study attempted to quantify this relationship by differentiating the effects of human population density on the three different groups of wildlife species distinguished by their preferred habitats: *elephants* (loxodonta Africana) prefer open savanna woodlands, *lions* (Panthera leo) prefer dry scrubland vegetation, and *rhinocerous* (diceros bicornis) prefer shrubby habitats (Jordan, 1986). From these, only savanna and shrubby wildlife are affected strongly by human use. Thus in this study, future scenarios for wildlife populations were only developed for savanna and forest, but not riverine wildlife.

Distinguishing three general classes for describing the effect of human populations on wildlife populations led to the establishment of: (1) a lower class where human populations are so low that they have no effect on wildlife populations, (2) a moderate class where human populations are associated with a decline in wildlife populations, and (3) a higher class where human populations are high enough to extinguish wildlife populations. Human population maps for the year 2012 were then grouped into these three classes and then overlaid with the distribution of each of the studied wildlife species to create scenarios of the changes in the status of wildlife populations between 2012 and 2050. Two scenarios, liberal and conservative, were developed. For the liberal scenario (maximal human impact on wildlife), the human population thresholds for no effect and extinction were 16 and 39 people km^2 and for the conservative (minimal human impact) scenario, 30 and 50 people km^2 respectively.

3.5 Assessment of consumptive forms of tourism

Perceptions of illegal hunting (consumptive utilization) were collected from 10 villages occurring in the three districts using semi-structured questionnaires administered through face to face interviews. Perceptions are important because they reflect people's habitual way of life, as well as their shared expectations and experiences with an activity (Uddin & Foisal 2007). The household heads were targeted as the respondents. In case of their absence, another permanently resident adult (=18 years) in the households took part in the interview in his residence. No distinction was made between hunters and non-hunters. This was done to encourage local residents to openly provide illegal hunting information.

Data collected included information on sighting of bushmeat and/or wild animal products being perceptions of illegal hunting trends, hunted animal species, and reasons for hunting. A total of 236 local residents were interviewed.

Data analysis employed Chi-square (χ^2) test for goodness-of-fit to test whether responses on the prevalence of illegal hunting and perceived illegal hunting trends in 2012 were different among the 236 respondents using SPSS version 16 for

Windows (SPSS Inc., Chicago, USA). Response categories were used in the Chi-square tests. Cross-tabulation with gamma (G) test was used to establish the association between responses on prevalence of illegal hunting and perceived illegal hunting trends.

4. RESULTS AND DISCUSION

4.1 Human population- wildlife scenarios

In 2012 population and housing census, 38% of human population was found in the surrounding Ugalla ecosystem in Urambo, Kaliua and Sikonge Districts (766,022 people). By 2050, the human population around Ugalla is predicted to grow by 395,824 extra people, an increase of 18% (see Table 1)

Not all the three groups of wildlife (African elephant, lion and rhinocerous) are affected by human use. A comparison was made between the state of wild animal populations and the existing human populations in different villages surrounding the Ugalla ecosystem. Results of the study indicated that wild animals particularly elephants occur in areas with population densities ranging from 0 to 15 per square kilometre; occasional animals of this species are found in areas of 16 to 39 per square kilometre, but never when the population exceeds 40, to the square kilometre.

Results indicate that populations of rhinocerous decline when human populations rise above 16-39 km^2 and disappear altogether when they reach above 40 people km^2. These ranges were used to create two sets of classes (one liberal, one conservative) that bracket the quantitative data depicting the relationship between human and selected wildlife populations (Table 1). Results of the application of these classes on future scenarios of populations of wildlife show that by the

Table 1: The two sets of classes used to create the liberal and conservative scenarios to estimate future wildlife populations

Human population density (people km^2)	State of elephant, rhino and lion populations	Year
Classes for the liberal scenario		
< 15	High	2012
16-39	Declining	
> 39	Low	
Classes for the conservative scenario		
<30	High	
30-50	Declining	
>50	Low	
Human population density (people km^2	State of elephant, rhino and lion populations	Year
Classes for the liberal scenario		
<25	High	
26-66	Declining	
>66	Low	
		2050
Classes for the conservative scenario		
<50	High	
50-70	Declining	
>70	Low	

Source: Ugalla Population-Wildlife Study 2011-2013.

year 2050, the distribution of wildlife will contract in the Ugalla Ecosystem, but will not disappear (Fig. 5a and b).

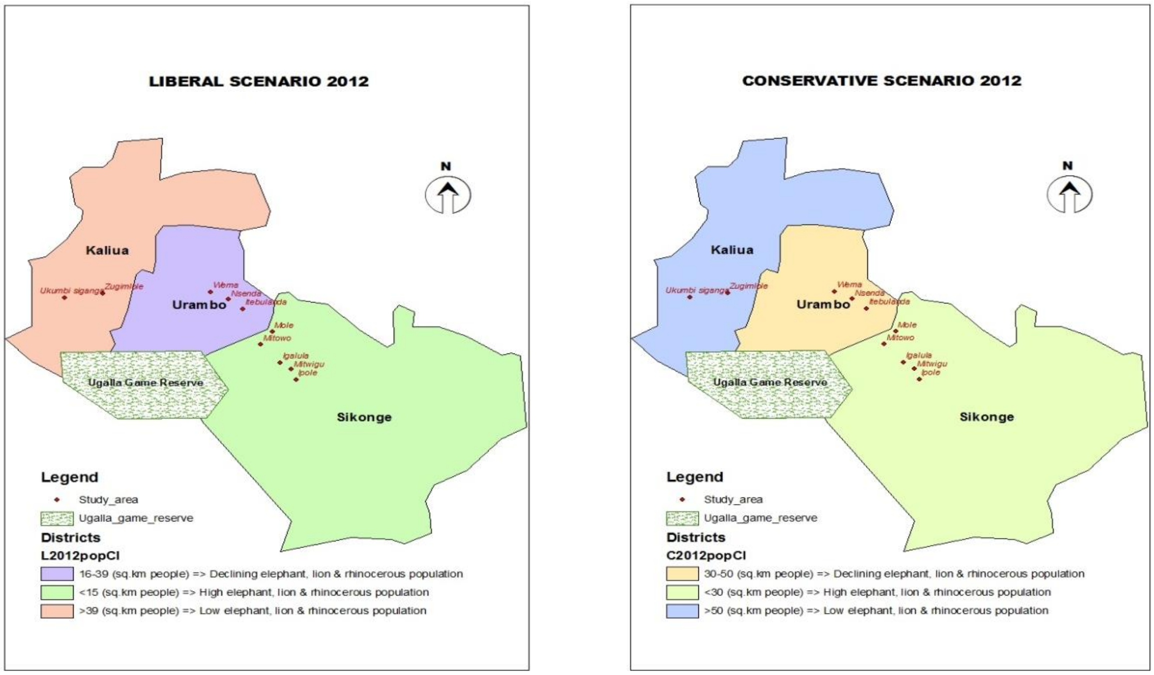

Figure 5a and b. Model estimates of two scenarios of selected wildlife species distribution (2012)

Source: Ugalla Population-Wildlife Study 2011-2013.

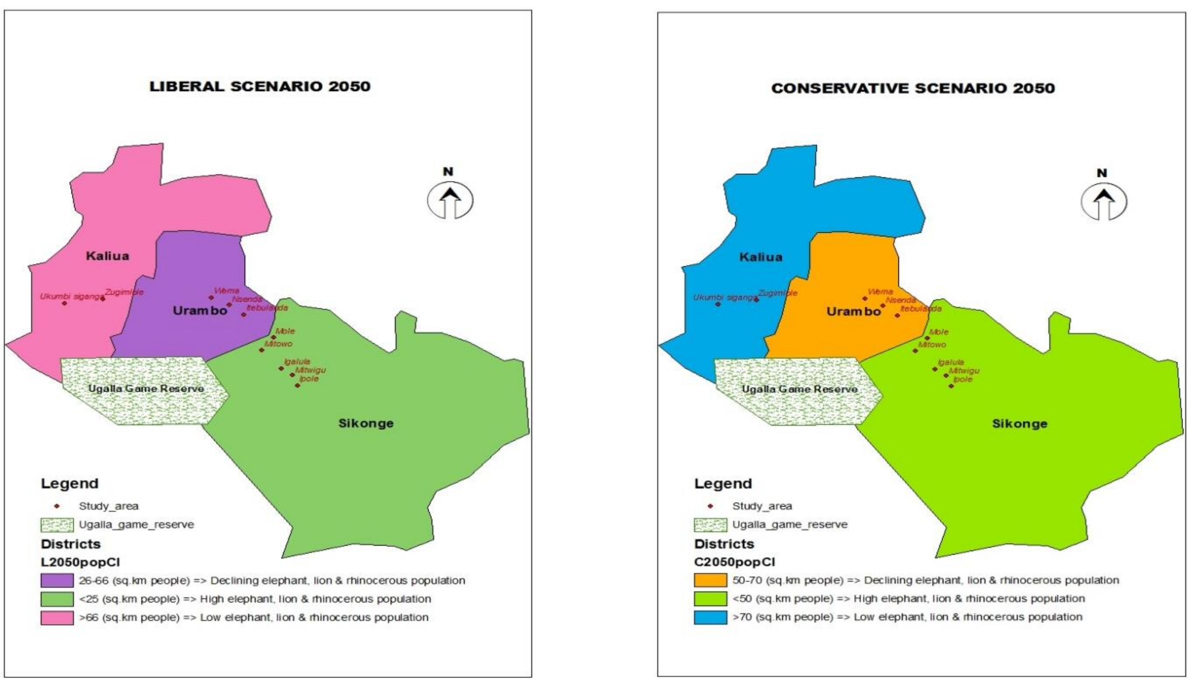

Figure 6a and b. Model predicted changes of two scenarios of selected wildlife species distribution (2050)

Source: Ugalla Population-Wildlife Study 2011-2013.

The greatest decline and contraction in the number of elephants and rhinocerous populations will occur in the Ugalla Game Reserve. However, significant populations of lions will remain in the west and east hunting blocks. These species will disappear from most of forest reserves and remain in relatively small numbers in the Ugalla Game Reserve. The small patches of elephants currently existing in the Ugalla ecosystem may disappear entirely by 2050. The liberal and conservative scenarios principally differ in the speed that elephants, lions and rhinocerous populations decline over time.

Since the percentage of people who will be in contact with the present populations of wildlife will increase substantially in the future (Fig. 6a and b). In 2050, about a third of the rural people who presently live in scattered settlements which are far from the Ugalla forest reserve will have moved closer to the forest reserve.

4.2 Change in species occupancy

One of the objectives of the study was to predict the change in species occupancy models for 3 wildlife species. In both scenarios, all 3 species occupancy probabilities show a decrease between the years 2012 and 2050. Occupancy probabilities will decrease by as much 38% for elephants and as little as 19% for rhinocerous especially in places where distance-to-edge has decreased. Lions overall occupancy will decline by 1.5% within protected Lands.

Table 2. Total occupancy probabilities ψ across the study area and within protected lands for 3 wildlife species: Elephants (EL), Rhinocerous (RH) , and Lions (LI).

Species	Total ψ 2012	Total ψ 2050	Total percent decline in ψ	Percent decline in ψ within protected areas
EL	1031		4.51	1.89
RH	79		3.83	1.70
LI	280		3.66	1.51

Source: Ugalla Population-Wildlife Study 2011-2013.

4.3 Wildlife current density estimate

The density estimates (individuals±SE km^2) for elephants (19.69±7.39 km$^{2)}$ was higher than lions (9.12±4.68 km^2), and rhinocerous (2.45±0.86 km^2). The variation in density estimates and abundance was partly related to the species encounter rate that tended to decrease from elephants to rhinocerous (Table 3). Elephants and lions were observed in smaller groups. The present estimates for elephants and rhinocerous were lower than 10.96 and 7.44 km^2, respectively. The low density of elephants and rhinocerous was because of pressures from habitat loss to agriculture and hunting.

Table 3 Estimated mean herd size (±standard erros), encounter rate (herds km^2), density of clusters and abundance of wild animals in Ugalla forest ecosystem

Species	Number of herds	Mean herd Size	Density of cluster (in km^2)	Encounter rate (in 1^2)	Abundance estimates (n)
Elephants	1031	13.28±1.11	1.48±0.54	0.89±0.05	1020±1016
Rhinocerous	79	2.20±1.79	0.89±0.43	0.54±0.05	3±7
Lions	280	12.67±2.66	0.34±0.10	0.20±0.02	228±133

Source: Ugalla Population-Wildlife Study 2011-2013.

Owing to the differences in the methods often used, this study used ground Distance Sampling. Nevertheless, this study trusts that ground Distance Sampling is more robust as it allows a more accurate estimate of population size than other methods, and it addresses detectability issues. Moreover, the method has been proved to work well on African savannah mammals. Density estimates done in Ugalla ecosystem by this study point to the fact that illegal hunting, which exacerbates animal off take from the same populations, calls for up-to-date population status of the animals.

4.4 Consumptive Utilization

Responses on perceptions of illegal hunting trends between 2011 and 2012 varied among the 236 respondents ($\chi^2 = 5.991$, df = 2, $p < 0.05$; $\chi^2 = 6.011$, df = 2, $P<0.05$). A higher proportion of the respondents (n = 156, 66%) perceived that illegal hunting activities had increased whereas (n = 42, 18%) of the respondents perceived that illegal hunting activities had decreased and 16% (n = 38) of the respondents perceived that illegal hunting activities had remained the same in the study area between 2011 and 2012. The main reasons for the perceived increase in illegal hunting were reported to include; (i) that poachers were increasing in number due to increased human needs (n = 173, 73%), (ii) unawareness of conservation (n=55, 23%) and (iii) less game wardens to curtail illegal hunting (n=8, 4%)

Similarly, responses on the frequency of sighting illegally hunted animals and being traded in villages between 2011 and 2012 varied among the 236 respondents (χ^2 = 9.31. df = 2, $p < 0.001$). A higher proportion of the respondents 45% (n=107) reported that they had sighted illegal hunted animals or bushmeat being traded at least once over six months whereas 28% (n = 65) and 27% (n = 64) of the respondents reported that they had sighted illegal hunted animals or bushmeat being traded at least once in a month respectively. There was a significant relationship between responses on the frequency of sighting illegally hunted animals and/or bushmeat being traded and the perceived illegal hunting trends (gamma = 0.34, P = 0.002).

A total of 26 wild animal species, including large herbivores and carnivores, were reported as being illegally hunted in Ugalla forest ecosystem between 2011 and 2012, with impala, kudu, buffalo, zebra and rhinocerous together with elephants being the most hunted (Table 2). Respondents highlighted several reasons why local people were involved in illegal hunting, namely, (i) the need for bushmeat for domestic consumption(n = 162, 69%), (ii) local trade in bushmeat in order to raise money (n = 61, 26%), and (iii) as a way of minimising crop damage (n = 13, 5%)

The study has also shown that frequency of illegal hunting declines with distance from human settlements.

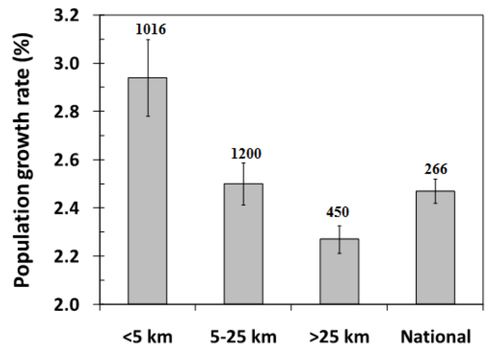

Figure 7. Human population growth and demand for lion, rhinocerous, and elephant trophies in Tanzania. (a) Annual population growth from 2002 to 2012 in wards located each distance from Ugalla game reserve (numbers above bars). Wards <5 km from protected areas grew faster than those 5–25 or >25 km away ($p < 0.001$). Source: Ugalla Population-Wildlife Study 2011-2013.

Similarly, the rate of bushmeat consumption falls with increasing distance of human settlements from wildlife populations, and drops steeply from ~30 km. As a result of these (and other impacts), human encroachment of protected areas typically imparts negative ecological impacts and wildlife populations fare better in parks where human settlement is not permitted.

Results from this study indicate that Ugalla region remains an intact ecosystem, but in recent years, the area has been under greater pressure from human disturbance. The greatest threats outlined in a conservation action plan for the area include agricultural expansion, cattle herding, fire, logging, and poaching. Snare poaching is most common, but large game such as buffalo (*Syncerus caffer*), rhinocerous (diceros bicornis) or elephant (*Loxodonta africana*) are hunted with firearms. Elephant, rhinocerous and lion numbers have declined sharply over the Ugalla ecosystem in just the last five years, along with increased illegal ivory trade (Wasser et al. 2010).

The evidence drawn from this study confirm that the relationship between human population density and populations of wild animals is similar to other African countries which show that lions are not found in areas with more than 50 people km^2. In Nigeria and western Cameroon, these three wildlife species declined strongly as human population density increased in different locations (Brashares, 2004).

At the present rates of extinction, as many as 20% of the Ugalla's species could be gone in the next 30 years. This rate of extinction has been unprecedented since the disappearance of dinosaurs 65 million years ago (WWF, undated).

Results of this study have also demonstrated consistency with Kiringe's results in that increasing human populations are resulting in increased encroachment of wildlife areas and elevated pressure on natural resources (Kiringe et al., 2007). Wildlife is rapidly disappearing from unprotected lands, due to a wide array of threats (Newmark, 2008) and as a result, illegal hunters are increasingly focusing their efforts on protected areas. Within protected areas, illegal hunting is more prevalent in areas close to the borders and near human settlements (Muchaal, et al 1999; Hofer et al., 2000; Wato et al., 2006; Marealle et al., 2010). Greater time spent in protected areas also increases the risk of being apprehended by anti-poaching game scouts (hereafter referred to as 'scouts'). In Serengeti NP during a period of high poaching intensity and low levels of enforcement, there was a positive relationship between distance from the boundary and occurrence of buffalo (Metzger et al., 2010). Similarly, in Sokoke Forest in Kenya, the occurrence of hunters' traps declines with distance from the boundary (Fitzgibbon et al., 1995).

Recent assessments have highlighted that steep declines in wildlife populations are occurring in most African countries (Craigie et al., 2010) and illegal hunting has been implicated as a key contributing factor (Scholte, 2011). In Kenyan parks for example, illegal hunting and the bushmeat trade is considered to be the primary driver for declining wildlife populations (Okello and Kiringe, 2004), and in Zambia, hunting for bushmeat for commercial trade has replaced trophy poaching as the primary threat to wildlife (Barnett, 1998).

5. CONCLUSION

Evidence drawn from results of this study indicates that higher population pressure correlates positively with hunting pressure. This evidence leads to acceptance of the hypothesis set for this particular study. The study further notes that human population growth represents a politically sensitive topic and one that conservation agencies appear reluctant to address. However, frank discussion of the issue of high levels of human population growth fringing protected areas is required, because if current trends continue, other interventions to address illegal hunting and the bushmeat trade are much less likely to succeed. The loss of wildlife as a result of illegal hunting can have severe consequences for ecosystem services.

Given the geometric rise in human population levels, statistics show that, roughly, every day 30 elephants are slaughtered through poaching in Tanzania. Elephant and rhino poaching levels are the worst in a decade, and recorded elephant tusks seizures stand at their highest levels since 1989, according to statistics provided in 2012 by the Convention on International Trade in Endangered Species, CITES. Rhino poaching is rampant in Tanzania, but, most of these animals have disappeared, while few remained in highly-protected parks.

Urgent efforts are required to raise awareness among policy-makers in this country of the severity and urgency of the threat posed by illegal hunting and the bushmeat trade. Failure to address the problem will have dire consequences for biodiversity conservation, will preclude the sustainable use of wildlife as a development option and have long term negative impacts on the tourist hunting and tourism industry in general.

Likewise, there is a need to capitalize on non consumptive tourism which serves dual purposes; protecting the various unique wildlife species, and improving the livelihoods of local communities. Sustainable tourism is inevitable in developing countries like Tanzania since most tourists come for viewing wildlife and wilderness (non-consumptive tourism) rather than for hunting and angling (consumptive tourism).

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