Journal of Arid Environments 135 (2016) 64–74

Contents lists available at ScienceDirect

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv

Population density of elephants and other key large herbivores in the Amboseli ecosystem of Kenya in relation to droughts

Moses Makonjio Okello [a, *], Lekishon Kenana [b], Hanori Maliti [c], John Warui Kiringe [d], Erastus Kanga [b], Fiesta Warinwa [d], Samwel Bakari [c], Stephen Ndambuki [b], Edeus Massawe [c], Noah Sitati [e], David Kimutai [c], Machoke Mwita [c], Nathan Gichohi [e], Daniel Muteti [b], Benard Ngoru [b], Peter Mwangi [b]

[a] Department of Tourism, Nairobi Campus, Moi University, P.O. Box 63056 - 00200, Nairobi, Kenya
[b] Kenya Wildlife Service, P.O. Box 209949 - 003948, Nairobi, Kenya
[c] Tanzania Wildlife Research Institute, P.O. Box 489357, Arusha, Tanzania
[d] SFS Centre for Wildlife Management Studies, P.O. Box 27743 - 00506, Nairobi, Kenya
[e] African Wildlife Foundation, P.O. Box 838484 - 3949, Nairobi, Kenya

ARTICLE INFO

Article history:
Received 26 November 2014
Received in revised form
15 August 2016
Accepted 20 August 2016

Keywords:
Amboseli ecosystem
Distribution
Drought
Mortality
Population trends

ABSTRACT

Kenya/Tanzania borderland is a critical area for conservation of biodiversity. This study was done to establish the effects of 2007 and 2009 droughts through aerial counts. Findings indicate that large mammal population collapsed, but some species crashed more than others. Total large mammal density declined over three times (−207.43%), recovering modestly (+41.59%) between 2010 and 2013. Over that time, the most abundant species was zebra (10,466.3 ± 2860.5 animals), followed by wildebeest (8921.0 ± 4897.9), Grant's gazelle (3447.0 ± 303.7), Maasai giraffe (1381.3 ± 132.7), African elephant (990.67 ± 12.60), eland (544.0 ± 311.4), Thomson's gazelle (495.3 ± 232.3), buffalo (331.3 ± 128.8) and impala (354.3 ± 61.0). The species affected most by drought was lesser kudu, followed by African buffalo, Maasai giraffe, kongoni, common eland, common wildebeest, common zebra, Grant's gazelle, gerenuk, impala, African elephant, Thomson's gazelle and fringe - eared Oryx respectively. Further, large mammal species numbers were dependent on location ($\chi 2 = 13{,}647.35$, df = 15, $p < 0.001$), with numbers being higher near protected areas. Animals with low numbers, specific diets, water - dependent and limited range were most affected by the drought. This provides a baseline for future comparisons and also future effects of droughts.

1. Introduction

Wildlife conservation in Kenya began during the British colonial rule and continued after independence in 1963. This has seen nearly 8% of the country set aside for biodiversity conservation purposes, and plans are underway to have additional landscapes designated as wildlife conservation areas. This is in recognition of the key role played by tourism in foreign revenue generation. Although numerous strategies and financial resources have been used to enhance wildlife conservation, there is rampant population decline of numerous species throughout the country such as the African elephant (*Loxodonta africana*), black rhino (*Diceros bicornis*), gravy zebra (*Equus grevyi*), and large carnivores especially lion (*Panthera leo*) and cheetah (*Acynonix jubatus*), various species of monkeys, hilora antelope among others (Western et al., 2009a).

Numerous studies have examined the causes of decline of wildlife populations in different parts of Kenya (e.g. Ottichilo et al., 2000, 2001; Okello and Kiringe, 2004; Western et al., 2009a; b; Primack, 1998). Collectively, these studies reveal that a myriad of anthropogenic factors such as; human-wildlife conflicts, illegal wildlife poaching, bush meat activities, increase in human population, alienation or inadequate involvement of locals in conservation initiatives and programs, proliferation of inappropriate land uses like agriculture which compromise wildlife survival and its conservation are responsible for the decline of wildlife. However, the contribution of drought to wildlife decline has not been fully evaluated yet its effects on populations can be devastating just like

* Corresponding author.
E-mail addresses: mokello33@mu.ac.ke, mokello33@gmail.com (M.M. Okello).

http://dx.doi.org/10.1016/j.jaridenv.2016.08.012
0140-1963/

human related impacts. This article therefore focusses on the impact of the 2007 to 2009 drought on elephants and other key large mammalian wildlife species in the Amboseli Ecosystem of Kenya.

In the last century, most parts of Kenya more so the high potential and heavily human populated have seen tremendous decline and loss of large mammalian wildlife species. However, the Amboseli Ecosystem, a semi-arid region, which until recently was characterized by relatively low and sparse human population (although now increasing because of immigrants and high birth rates) is still endowed with diverse free ranging wildlife species. Two major factors have interactively contributed to preservation of wildlife in the ecosystem, elephants included; a semi-arid environment which acts as an ecological limitation to land use especially proliferation of rain-fed agriculture, lifestyle, culture and traditions of the Maasai people who are the main inhabitants. The foundation of the Maasai lifestyle is pastoralism which thrives in relatively dry areas and allows livestock and wildlife to co-exist which makes it compatible with wildlife conservation (Berger, 1993; Ntiati, 2002). Further, overtime, various taboos and traditional beliefs which abhors eating and indiscriminate killing of wildlife among the Maasai has equally contributed to wildlife preservation over the years (Seno and Shaw, 2002; Kangwana, 2011).

In the context of the Amboseli Ecosystem, the Amboseli National Park which is the ecological lifeline of herbivorous wildlife species is an important dry season concentration area for elephants and other large wildlife species like common wildebeest (*Connochaetes taurinus*), buffalo (*Sycerus caffer*) and common zebra (*Equus burchelli*) (Western, 1975; Western and Maitumo, 2004; Croze and Lindsay, 2011; Kangwana and Browne-Nunez, 2011). These species also tend to spend nearly 80% of their time outside the park and use a landscape about 20 times bigger than the park (Croze and Moss, 2011). Studies have therefore demonstrated that these species move seasonally in and out of the park (Western, 1975; Esikuri, 1998; Kioko, 2005; Croze and Lindsay, 2011), but are currently living in a rapidly evolving human matrix characterized by enormous land use, tenure and increasing human population growth as a result of immigrants overflowing from fertlile arable lands, and increasing local birth rates (Okello and Kioko, 2010; Kangwana and Browne-Nunez, 2011). This poses an immediate and future threat to the survival and conservation of wildlife in the entire ecosystem (Western, 1982; Kangwana and Browne-Nunez, 2011).

The population of elephants in the ecosystem which is currently estimated at nearly 1500 individuals (Croze and Lindsay, 2011) was nearly exterminated in the 1980s due to poaching. Moss (2011) estimated that in the early 1970's, the elephant population in the entire ecosystem was about 600 individuals and due to the relative safety accorded to them, the population rapidly increased, and by the end of 2002, it stood at nearly 1225 individuals. It's one of the best-studied wild elephants in Kenya and the world, as a result of work of Cynthia Moss and her collaborators over the last 30 years. The population once extended from Ol Donyo Orok in the west to the Chyulu Hills in the east, near the town of Emali in the north, and to the slopes of Mt. Kilimanjaro in the south (Western and Lindsay, 1984). During the 1990s and into the last century, the range has begun to expand again. Consequently, considerable efforts have gone into encouraging the Amboseli elephants to disperse more widely outside the park by working towards greater tolerance amongst local communities.

The future and long term conservation of elephants and other wildlife types in the Amboseli region depends not only on maintaining the ecological integrity of Amboseli National Park and adjoining areas but also enlisting the support of the Maasai who live beyond the park boundaries. However, there are concerns that the park's integrity and consequently its ability to support elephants and populations of other large herbivores like zebra and wildebeest has increasingly been compromised by long term vegetation changes. For the last 50 years or so, the yellow acacia woodlands have significantly declined and are nearly absent in most parts of the park, and this has created a lot of concern among conservationists and wildlife management authorities in the country (Western and Maitumo, 2004; Western, 2006).

In their 20 years research work in the park, Western and Maitumo (2004) demonstrated that loss and impaired regeneration of Acacia woodlands in the park was largely attributed to impacts associated with elephants. Subsequent studies (Western, 2006) further revealed tremendous changes in vegetation within the park characterized by decline and loss of woody vegetation communities and expansion of grassland and scrubland. This has in turn put a lot of ecological pressure on the swamps through herbivory and trampling effects of large aggregations of elephants, zebra and wildebeest particularly during the dry season when their dispersal is reduced. Another concern regarding the future of the park is the effects if climate change and rainfall variability (Fig. 1). Thompson et al. (2009) noted that the glaciers and relief rainfall of Mt. Kilimanjaro are the major source of water for the Amboseli swamps, but climate change effects on water sources are affecting the volume of these swamps. This is also being accelerated by the logging and general deforestation on Mt. Kilimanjaro. The short and long term ecological damage associated with environmental change can't be underestimated, and calls for crafting of well thought and sound management strategies that will reduce significant deterioration of the park. Thus, every effort should be made to ensure the landscape adjoining the park is secured and both elephants and other migratory species are able to use them as has been the tradition.

Another concern in the borderland is the emergence of agriculture especially in the Amboseli Ecosystem, which was introduced in the last century by immigrants from other parts of Kenya plus the Chagga people from Tanzania (Esikuri, 1998; Ntiati, 2002; Okello, 2005; Okello and D'Amour, 2008). The ecological ramifications and threats posed by this new land use continues to cause a lot of concern among conservationists and wildlife conservation NGOs working in the region. Seno and Shaw (2002) have described the emergence of a diverse community of farmers, ranchers, and entrepreneurs in areas like the Amboseli as the biggest challenge to the future of wildlife conservation. Further, the push and general clamor for sub-division of the group ranches will have irreversible negative impacts on elephants and other species alike and will negatively affect wildlife survival and conservation efforts, and this

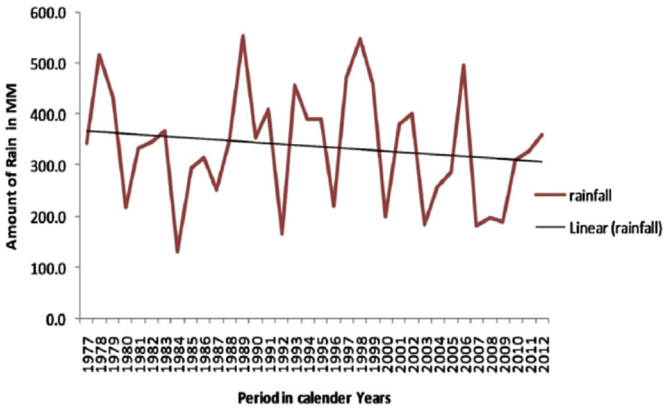

Fig. 1. Rainfall trends in the Amboseli Ecosystem (1977–2012). Source.Kenana et al., 2013