Analyzing the effect of armed conflict, agriculture and fire on the movement and migratory behaviour of White eared kob and Roan antelope in the Boma-Gambella landscape of Ethiopia and South Sudan

By: Kassahun Abera and Afework Bekele (Prof.).

1. Introduction

1.1. Background

Wildlife migrations are indicators for functionality and connectivity of land or seascapes; hence the disruption of this phenomena indicates a socio-political and environmental crisis. Wildlife ecologists are nowadays, equipped with technological tools that allow them to obtain data about the dynamics of animal's movements and behaviours (Silke et al., 2011). The concept of home range is a multi-dimensional space in a landscape or a cognitive map of the species about its environment, which is indeed behavioural response, and not only delineations of species habitat zones (Roger and Michael, 2012). The behavioural components of movement ecology, like decision-making in navigation and orientation, habitat selection and dispersal are associated with features and the state of landscape ecology (Bolen and Robinson, 2003; Miller et al., 2015). White eard kobs (*Kobus kob leucotis*) are among the migratory species of the Boma-Bandingilo-Jongeli-Gambella landscape. Roan antelopes (*Hippotragus equines*) represent resident species. The landscape entertains (among others) conflicting land use types and armed conflict (Michael et al., 2001; Angela, 2017).

In this paper, I present the impact of these threats on movement and migration pattern of these two target species based on telemetry and aerial survey data.

1.2. Research objective

General Objective

- To investigate the impacts of armed conflict, agricultural investments, fire, livestock and settlements on the movement pattern and migratory behaviour of White eared kob and Roan antelope in the Boma-Gambella landscape.

Specific Objectives

- To map the seasonal population abundance and distribution trends; movement patterns and routes, home ranges against the extent of existing Protected Areas in the landscape focusing on White eared kob and Roan antelope
- To detect the impact of armed conflict, livestock encroachments and agricultural investments on the biodiversity of the Boma-Gambella landscape,
- To detect behavioural responses of White eared kob and Roan antelope to the threats mentioned above.
- To make recommendations on the potential transboundary conservation area networks between Ethiopia and the Republic of South Sudan.

2. Methodology

2.1. The study area

The Boma-Gambella landscape is a transboundary landscape between Ethiopia and the Republic of South Sudan. It encompasses the Boma and Bandingilo National Parks of South Sudan and the Gambella National Park of Ethiopia. For this study, the geographic scope is restricted to the Boma-Bandingilo and Gambella landscapes using 95% Kernel density range of the migratory white eared s a reference (Fig. 1).

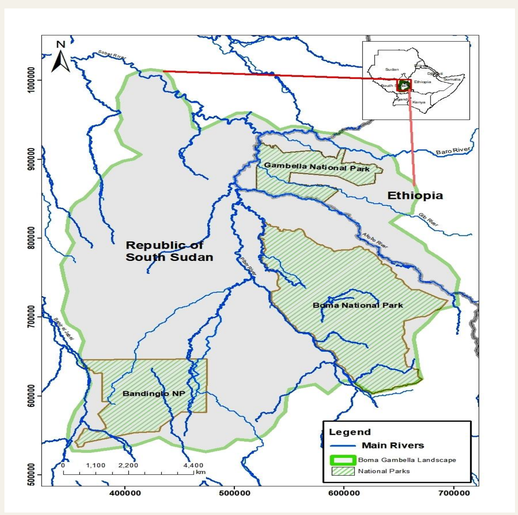

Figure 1. Boma-Gambella landscape

2.2. Methodology

The Systematic Reconnaissance Flights (SRF) survey methods as explained by Norton-Griffiths (1978) and Frederick et al., (2010) were strictly followed. One wet season (May – October) and four dry season (November – April) surveys were undertaken.

The home ranges for the two-target species were computed using the adhabitatHR package for analysis of animal movement data - a package fitted to the open source statistical software R version 3.3.2 and run on RStudio version 1.0.36 environment based on Clement (2016) methods.

The orientation of movement, trajectories and distances travelled and unusual displacements were interpolated using path segmentation analysis based on Fuller et al., (2005), Patel et al., (2015), and Edelhoff et al., (2016).

3. Results

3.1. Trends in the abundance and distribution patterns

a. White eared kob

Table 1. Population estimates of White eared kob

Survey Zone/Year	2010	2013	2015
Core	203,181	292,688	399,299
South	51,962	58,479	29,169
Combined	255,143	351,167	428,468

The most widely distributed species with a considerable population outside of the current protected area system (Fig.2).

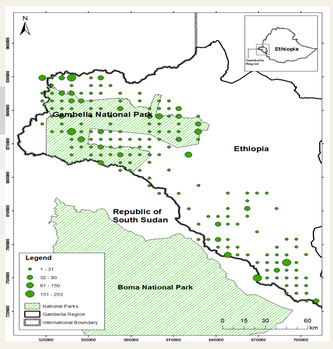

Figure 2. Distribution of White eared kob

b. Roan antelope

Table 2. Population estimates of Roan antelope

Survey Zone/Year	2010	2013	2015
Core	1287	34	542
South	0	0	1864
Combined	1287	34	2406

Roans are distributed in a fragmented population outside of the current protected area system (Fig.3).

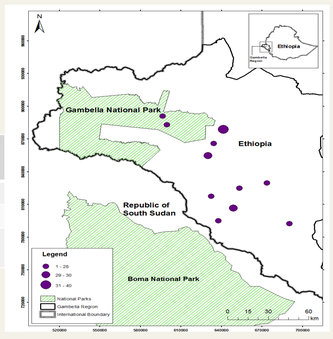

Figure 3. Distribution of Roan antelopes

3.2. Movement ecology and home ranges

a. White eared kob migration routes

Out of the total of 64 (35 females and 29 males) white eared kobs fitted with satellite GPS collars, 43 (67%) and 13 (20%) were found to be migratory and resident, receptively. The kobs have **four** orientation of migration routes (Fig.4).

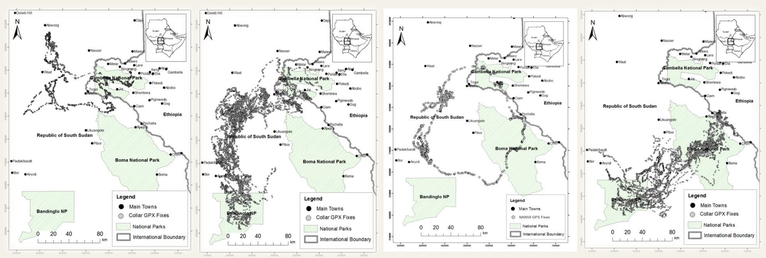

Figure 4. The migration routes of White eared kobs

The longest terrestrial mammal migration route (860 km) in Africa (Fig.5).

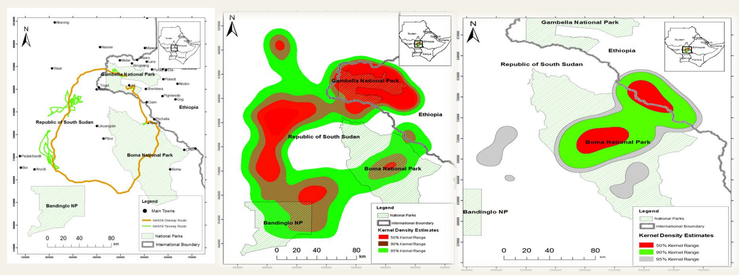

Figure 5. White eared kob longest migration route and home ranges

The total home range of White earek kob was calculated to be 73,891 km²; 76% of which is outside of the existing protected area system (Table. 3).

Table 3. Total home range evaluation of White eared kob in the Boma-Gambella landscape

Home Range Category	Area (km²)	% of Total Range	Remarks
Boma-Gambella Landscape	73891	100%	Using 95% KDE limit
Ethiopia	14019	19%	
Gambelia National Park	4575	6%	
Range Outside of Protected Areas (Ethiopia)	9444	13%	Represents 67% of the range in Ethiopia
South Sudan	59872	81%	
Bandingilo National Park	5867	8%	
Boma National Park	7373	10%	
Range Outside of Protected Areas (South Sudan)	46632	63%	Represents 78% of the range in South Sudan
Total Home Range with in Protected Areas	17815	24%	
Total Home Range outside of Protected Areas	56076	76%	

b. Roan antelopes

All six Roan grouped tagged with GPS collar and tracked for two year were found to be moving a very restricted range in four groups isolated from each other. Based on 95% Kernel density estimate; each roan groups monitored was found to be confined separate ranges each having an average range size of 175 km² (Fig. 6).

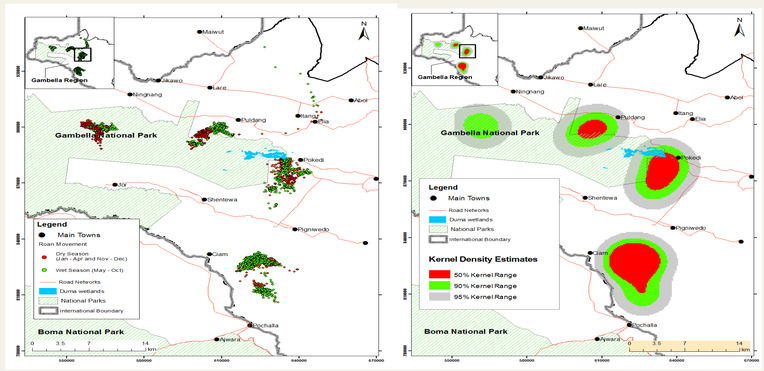

Figure 6. The migration routes of White eared kobs

3.3. Response of wildlife to armed conflict, livestock and agriculture

a. White eared kob

Wildlife migration routes and home ranges were found to be overlapping with armed conflict hotspots and livestock ranges in the landscape.

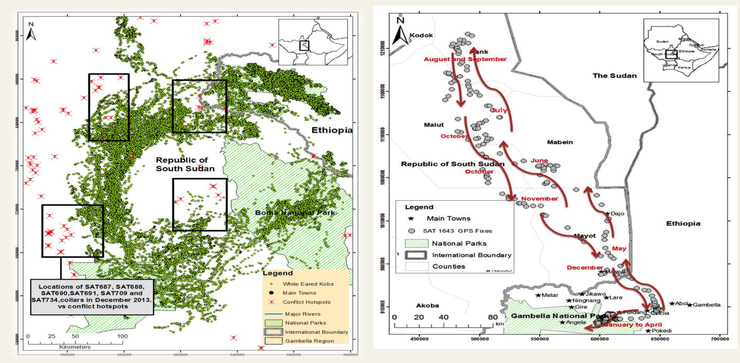

Figure 7. Armed conflict hotspots and livestock movement patterns against White eared kob migration routes

Migratory kobs have responded to impact of armed conflict by showing sudden displacements upto 11km per day during peak conflict weeks.

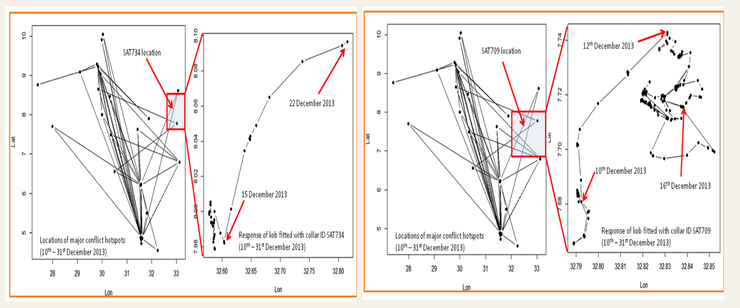

Figure 8. The response of White eared kob to armed conflict

b. Roan antelopes

Almost half of the 90% of Kernel density range falls within a commercial agriculture concessions. There is an overlap between a cropping calendar of the major commercial crops (Soya bean and Rice) and Roan movement. The Roans spend their considerable time in the concession both during the sowing and harvesting seasons (Fig.9)

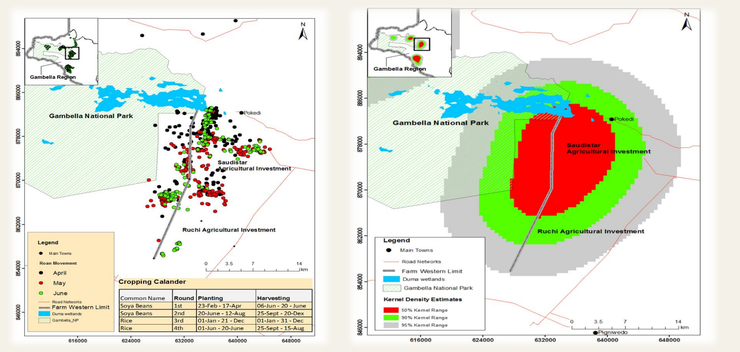

Figure 9. Roan movement and hope range against Soya beans and Rice cropping calendar of commercial agriculture

Conclusion and Recommendation

The landscape is connected by ecosystems, cultures and challenges. It has been shattered by decades' long civil war and ethnic conflicts. Most of wildlife core areas, migration routes and home ranges are outside of the existing protected areas. It could be concluded that, despite all the challenges, the presence of rich biodiversity, mosaic of shared cultural and ecological attributes would bring opportunities to bring about harmonized development, peace and security.

Acknowledgements

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Contact Information

Address

Kassahun.abera@giz.de (corresponding author)
Senior Advisor for Conservation,
GIZ-Biodiversity and Forestry Programme, Addis Ababa, Ethiopia.
and afeworksimegn@gmail.com
Lecturer and researcher at Department of Zoological Sciences,
Addis Ababa University, Ethiopia.