CENSURING ELEPHANT POPULATIONS IN ABERDARES FOREST USING DUNG DECAY STUDIES

Introduction

The Aberdare mountain range lies in the central highlands of Kenya (Latitude 01^o 07' – 00^o 01' South and Longitude 36^{o}28' – 36^{o}55' East) running in a NNW-SSE direction. Altitude varies from 1850 m in the lower parts to 4001 m at the highest point. The Aberdare Conservation Area (ACA) is about 1779 Km2 comprising the Aberdare National Park (765.8 Km2) and part of the surrounding Forest Reserves (1013 Km2). It is located in four counties, namely Nyeri, Nyandarua, Kiambu and Muranga.

The Aberdares are vital to Kenya as four out of seven of Kenya's largest rivers, flowing north, west, east and south, rise in the Aberdare Range. These rivers flow through semi-arid to arid areas, providing vital resources to dry ecosystems in such areas as Samburu and the Tana River basin. They also provide power to the national grid and water to seven major towns – including almost the entire population of Kenya's capital city, Nairobi.

The ACA is an important area for conservation and economic development. On the foothills and high slopes of the Aberdare, 30 percent of Kenya's tea and 70 percent of its coffee are produced. On its lower slopes, four million farmers depend on its rich soils and rainfall. The National Park attracts about 25,000-60,000 tourists annually, especially to the famous Treetops and the Ark as well as trout fishing lodges (Economic Survey, 2009).

The Aberdares host a large population of elephant. Elephant densities from the last 'sample' survey conducted in 2005 (Bitok and Kones, 2005) suggest that the ACA houses the densest elephant population in Kenya, with 2.4 elephants/Km^2 in the Aberdares National Park and 2.56/km^2 in the areas surveyed outside the park. The blockage of migration routes for decades, together with natural population growths, would assume densities over 3 elephants/km^2 by 2017.

Dung decay study

The rate of elephant dung decay is one of two parameters needed to convert dung counts to elephant density and slight variations have considerable effect on the results (i.e. Hedges et al., 2012; Vanleeuwe and Probert, 2014). It is therefore very important that a site-adapted dung decay study is completed prior to each survey. To account for seasonality (elephants tend to occupy the environment differently in different seasons) elephant dung surveys are best completed at the end of a particular season, to ensure that all dungs encountered during the survey were deposited during the same (elapsed) season. Site-adapted dung decay studies are therefore best started at the onset of the season of interest and continued throughout the season until the survey is complete. The associated dung decay study was therefore started in September 2017 at the onset of the wet season. The study was completed at two different sites in the Aberdares, at two different stations: Treetops (1966m Asl) and The Ark (2286m Asl).Every week fresh dung piles were tagged and coded and they were revisited on a weekly basis to note their state of decay, using an illustrated key of dung decay age classes as described by Barnes and Jensen (1987).

These classes are defined as follows:

Stage A: pile intact, very fresh, moist, with odour;
Stage B: pile intact, fresh but dry, no odour;
Stage C1: more than 50% of the pile is distinguishable, some has disintegrated;
Stage C2: less than 50% of the pile is distinguishable, the rest has disintegrated;
Stage D: pile completely disintegrated, forms a flat mass;
Stage E: decayed to the stage where it would be impossible to detect at 2 meters range in the undergrowth, and it would not be seen unless directly underfoot.

Data Analysis

Since rainfall has an important effect on dung defecation rates (Barnes et al., 1997; Theuerkauf & Gula, 2010) rainfall data for the period leading up to and during the time of the survey, namely 1st April 2017 through 20th Nov 2017 from the stations surrounding ACA.

In Distance, several combinations of key function and adjustment terms and a number of data truncation options and cut-points were tested. Detailed histograms of the data and goodness of fit tests were used to identify violations of assumptions. Akaike's Information Criterion (AIC) was used in model selection (Burnham & Anderson 2002), with particular attention paid to model fit at distances near zero to avoid biased estimates (Buckland et al., 2001).

To improve model fit approximately 7% of these data were right truncated at 3.8m. To deal with some potential heaping at zero and rounding to convenient values the data were analysed as grouped in 5 equal intervals. ArcMap10.4 was used to view recorded GPS tracklines (transects and recces) as well as to develop distribution maps of all human activity signs and poaching sign combined and elephant dung. This was achieved by creating a point file of all transect starting points, linking columns with the sum of signs to each of the points. The point file was converted to a raster map using the IDW (inverse distance weighted) interpolation function in ArcMap 10.4.

Preliminary Results

Dung decay rates and dung production rates

A site- and season-specific decay rate was estimated by retrospectively monitoring 79 fresh dung piles on a weekly basis until each one decayed. The average time to decay $\hat{t}$ was 61.171 days (SE 3.63). To generate a site- and season-specific defecation rate we used a wet season rainfall model (Theuerkauf & Gula) using an average daily rainfall of 1.333mm derived from data of 12 stations in and bordering the ACA, between September 2016 and January 2017 (ANNEXIII). Results suggested a wet season daily defecation rate of 13.1 (SE 0.64). Note that using an estimated decay rate of 18 as often taken from the literature (to be consistent with previous surveys, Bitok and Kones, 2005) would lead to a much lower estimate (see later).

Dung piles classified as decayed (age class E) were removed, leaving 217 dung piles for analysis. Approximately 7% of these data were right truncated at 3.8 m to improve model fit. To deal with some potential heaping at zero and rounding to convenient values the data were analyzed as grouped in 5 equal intervals. The final model that was fit to the pooled data was a uniform key function with cosine adjustment terms (Fig. 4). This gave an estimated detectability probability of 0.39 and an effective strip half-width of 1.48 m. The encounter rate of dung piles per km was 0.0048 (95% CI 0.004 - 0.0059).

Figure 4: The detection function fitted to the pooled elephant dung pile data for the ACA survey.