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HABITAT STRUCTURE DETERMINES THE ABUNDANCE OF THE ENDANGERED SHARPE'S LONGCLAW *MACRONYX SHARPEI* (AVES: PASSERIFORMES: MOTACILLIDAE) AT TIMAU MONTANE GRASSLANDS IN CENTRAL KENYA

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COMMUNICATION

Habitat structure determines the abundance of the Endangered Sharpe's Longclaw *Macronyx sharpei* (Aves: Passeriformes: Motacillidae) at Timau montane grasslands in central Kenya

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Abstract: Understanding the habitat selection and structure of a species is critical for developing evidence-centered conservation actions. Sharpe's Longclaw *Macronyx sharpei*, a passerine bird endemic to Kenya, is threatened by reductions in habitat size and quality that have left it inhabiting a small and highly fragmented range. From January to June 2016 we investigated the abundance and density of Sharpe's Longclaw in Marania farm located in Meru county in the northern sector of Mt. Kenya, where no previous study had been done. Population abundance and density were determined using the flush and count method. We observed that these birds were exclusively found in grasslands, being most abundant in habitats of short grass with tussocks, and less so in areas with tall grass. This habitat specificity indicates a key requirement for survival of Sharpe's Longclaw populations in this area. We recommend surveys in and around Marania farm to determine the distribution of suitable habitats for this species, and that the farm be designated an Important Bird Area. Further studies should also focus on determining the intensity of grazing that is compatible with conservation of Sharpe's Longclaw populations.

Keywords: Conservation, density, endemic, grasslands, passerine bird, population.

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For **Author details** & **Author contribution** see end of this article.

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INTRODUCTION

Abundance of bird species is largely influenced by the spatial and temporal distribution of key resources (McCain 2009). Elevation and slope affect vegetation structure, site productivity, distribution, composition, and secondary biotic interactions (Girma et al. 2017). The conservation of Sharpe's Longclaw (Image 1) requires a detailed understanding of population sizes and distribution, and habitat quality and availability. This endemic and endangered species is restricted to grasslands at 1,800–3,500 m altitude (BirdLife International 2018). It has been reported at higher elevations, but this has not been confirmed (Borghesio et al. 2013). Much of past research has been concentrated in the Kinangop grasslands in the southern parts of Nyandarua County (Muchai 1998; Muchai et al. 2002; Ndang'ang'a et al. 2002; Mwangi et al. 2012; Borghesio et al. 2013). The species occurs at low densities throughout its range (BirdLife International 2015). In Kinangop grasslands, Ndang'ang'a et al. (2002) recorded a density of 1.2 individuals/ha while Muchai et al. (2002) and Mwangi et al. (2012) found an overall mean density of 0.85±0.21 individuals/ha and 1.24 ± 0.15 individuals/ha, respectively. At Lake Ol' Bolossat, Wamiti et al. (2008) recorded a density of (0.004–0.06 individuals/ha). There are few precise breeding records (Keith et al. 1992). The highland grasslands that are strongholds for Sharpe's Longclaw (Muchai 1998; Muchai et al. 2002; Ndang'ang'a et al. 2002; Borghesio et al. 2013) also provide nesting, feeding, and breeding habitats for the eastern African endemic and near-threatened Jackson's Widowbird *Euplectes jacksoni*, the regionally threatened Long-tailed Widowbird *E. progne*, and the Afro-tropical highland biome-restricted species Hunter's Cisticola *Cisticola hunteri* (Bennun & Njoroge 1999).

The Timau high altitude grasslands in Kenya have recently undergone significant reduction, primarily due to habitat conversion to crop lands (Kimani et al. 2015). The alarming decline of local grassland habitat is linked to land sub-division within family units and sale of land parcels, resulting in native grassland loss and fragmentation. The local people living in the Kenyan highlands whose livelihood mainly revolves around small-scale farming play a large role in habitat fragmentation (Muchai 1998; Ndang'ang'a et al. 2002; Kimani et al. 2015). The main threat to native grassland habitat is conversion, especially through cultivation and establishment of woodlots of exotic species (Muchai 1998; Muchai et al. 2002; Borghesio et al. 2013). These factors have exacerbated the pressure on highland grassland biodiversity, and the establishment of large-scale farming for commercial crops that are more profitable than livestock has also contributed to reduction of native grassland habitats.

Image 1. Sharpe's Longclaw *Macronyx sharpei*

Lack of appropriate information on the population status of Sharpe's Longclaw prevents efficient management of the habitats necessary to guide conservation efforts. Collection of such information on population size, abundance, and density are important when deciding where to allocate resources in conservation and research activities, and to provide empirical data to evaluate existing management strategies. These data are essential for the IUCN Red List of Threatened Species assessments. The overall objective of this study was to investigate population abundance and density of Sharpe's Longclaw in different habitat types in Marania farm, following reports that the species was present there. A detailed understanding of population size, spatial distribution and demographic trends will inform future management decisions and conservation interventions.

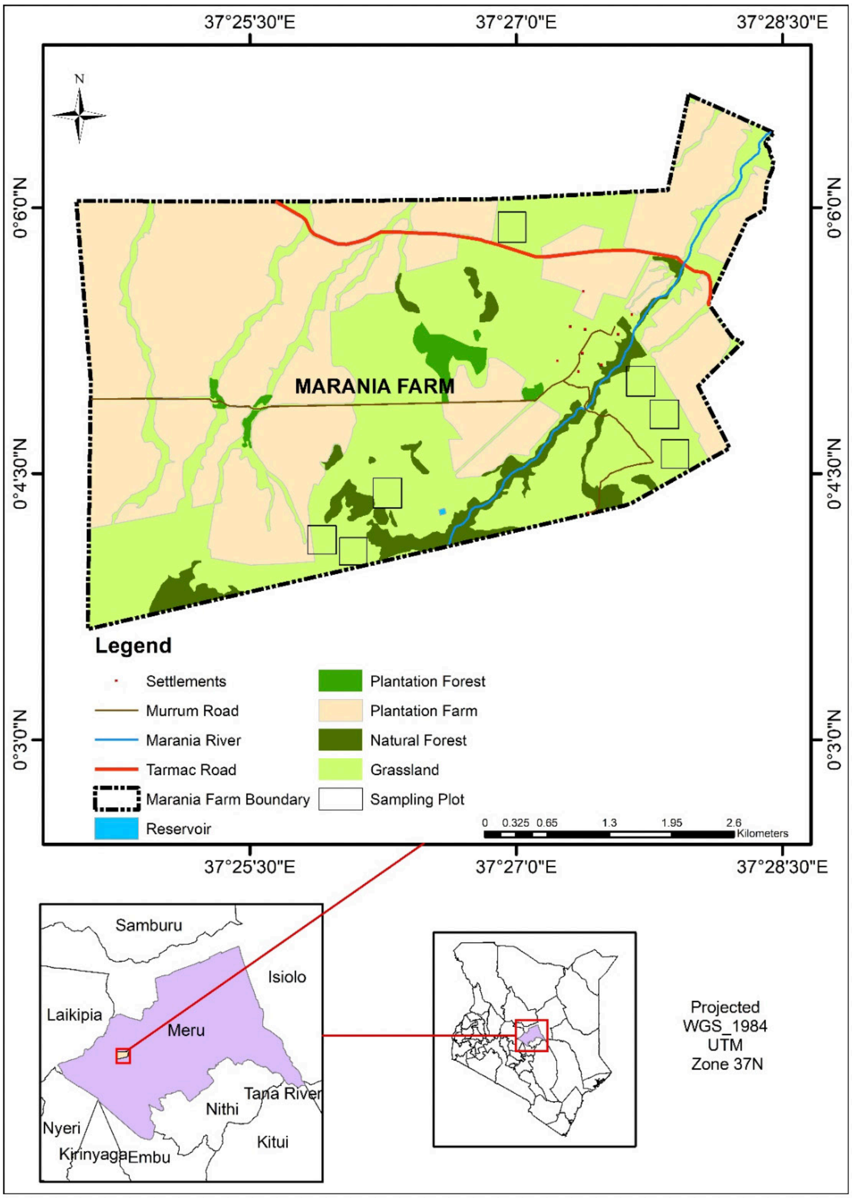

Figure 1. The location of Marania farm, Meru County, Kenya.

MATERIALS AND METHODS

The population of Sharpe's Longclaw was studied in Marania farm, Meru County (0.080–0.070 ^{0}N and 37.458–37.367 ^{0}E), part of the northern section of Mt. Kenya that offers a previously unstudied fragmented population of the species. Marania farm is an approximately 2,580ha privately owned farm bordering Mt. Kenya National Park on the north-eastern side. The elevation of Marania farm grasslands where this study was carried out ranged from 2400 to 2800 m. In Marania farm, rearing of livestock (sheep and beef cattle) that forage in the native grasslands is controlled by paddocks, although the animals are supplemented with hay during the dry seasons. There is also natural vegetation in the valleys and hill tops.

Grasslands in this farm cover an area of 865ha while the rest is under cultivation and interspersed with natural and planted forests. The farm has crops such as wheat, canola, peas, maize, and a small portion of mixed crops. They also practice animal husbandry. During the study, there were approximately 150 cattle grazing in the study area, over 400 sheep, and about 20 horses. The average annual rainfall in the area ranges 380–2,500 mm with a bimodal rainfall pattern in March–May and October–December (Gakuubi & Wanzala 2012).

Sharpe's Longclaw is a monogamous, sedentary species restricted to high altitude, open, short grasslands. It is territorial and insectivorous, feeding particularly on grasshoppers and beetles. Birds live in permanent groups of two–seven individuals depending on the quality of their habitat (Muchai 1998; Muchai et al. 2002).

Sampling Design and Census

During the first month of the study (20 January–20 February 2016), a survey of Marania farm was done to determine appropriate study plots through purposive sampling. The study area was divided into six grassland plots (Figure 1) measuring an average of 2.25 ± 0.12 (SD) ha (range 2.21–2.45 ha). Three of the plots were characterized as short grass with dense tussocks (SGWDT) and the other three as tall grass (TG) following Muchai et al. (1998). The plots were separated by different matrices with either natural forest, farm cultivation or plantation forests. Grass height at plots was classified as SGWDT and ranged between 10–20 cm while those of TG were 30cm and above, following design employed by Muchai (1998).

The plots were monitored for a period of five months (February–June 2016). Sharpe's Longclaw (SLC) is known to breed during the onset of rains or shortly after rains (Kimani et al. 2015). The study partly coincided with the breeding season but, only for a short period between April and May (Muchai 1998). This was done deliberately to ensure the breeding population was present. Due to the limitation of time, the study lasted only five months, in which February and March were dry while April–June were wet months. Censuses were conducted at each study plot at different times of the day (spread in three 4-hour long observation periods; 06.00–10.00 h, 10.00–14.00 h, 14.00–18.00 h) to give a spread of data on a spatial and temporal spread throughout the day. Each study plot was intensively searched once every week; 20 censuses were undertaken in each of the six study plots. Study plots were intensively searched using a flush-out and count method (Muchai 1998; Muchai et al. 2002) where two people dragged a 50m rope on opposite ends to flush out the birds for easier sighting. Flushed out Sharpe's Longclaws were recorded, and the position they flew to was noted to avoid double counting. The original position of the bird was marked using a hand-held global positioning system unit (Garmin etrex 20).

Statistical analysis

Bird abundance in grasslands was examined in relation to plot size, grass height and presence/absence of tussocks using a generalized linear model via Poisson regression (Table 1). Abundance per plot was calculated as the total number of individuals counted divided by the number of sessions the birds were counted in that plot. Mean density was calculated as the mean abundance divided by the size in hectares of the plot. Generalized linear model via Poisson regression was used to determine which of the independent variables explained population abundance in the grassland habitat.

RESULTS

Mean abundance

The mean ± SE abundance in short grass with dense tussocks (SGWDT) was 4.53 ± 0.30 while in tall grass (TG) it was 2.23 ± 0.29. Figure 2 illustrates a significant difference in mean abundance between SGWDT and TG ($P= 0.01$, $df =40$, $t = -6.95$).

Determinants of Sharpe's Longclaw abundance

Three variables were the significant determinants: grass height ($\beta =0.021$, $P=0.050$), tussocks presence/absence ($\beta=1.101$, $P=0.001$) and interaction of grass height and tussocks presence /absence ($\beta= -0.059$, $P<0.001$) (Table 1). The equation of the fitted model was:

Abundance = 1.188+0.021 grass height +1.101 tussocks presence/absence -0.059 grass height* tussocks presence/absence.

Table 1. Generalized linear models via Poisson regression examining the relationship between grass height (GLHT), tussock presence/absence (TUPA) and their interaction (TUPA * GLHT) on Sharpe's Longclaw abundance in Marania farm grasslands.

Parameter	Estimate ± SE	95% confidence limits	Wald chi-square	Df	Sig.
Intercept	1.19 ± 0.18	0.83, 1.55	42.43	1	< 0.01
Grass height	0.02± 0.01	-0.00, 0.04	3.84	1	0.05
Tussock presence/absence	1.10± 0.34	0.427, 1.78	10.25	1	0.001
TUPA * GLHT	-.059 ± 0.01	-0.086, -0.03	18.52	1	< 0.001

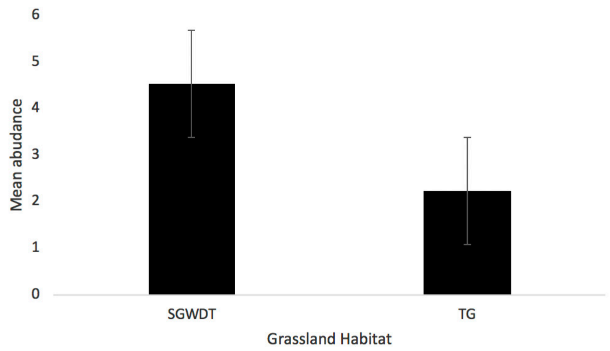

Figure 2. Comparison of mean abundance of Sharpe's Longclaw between short grass with dense tussocks (SGWDT) and tall grass (TG).

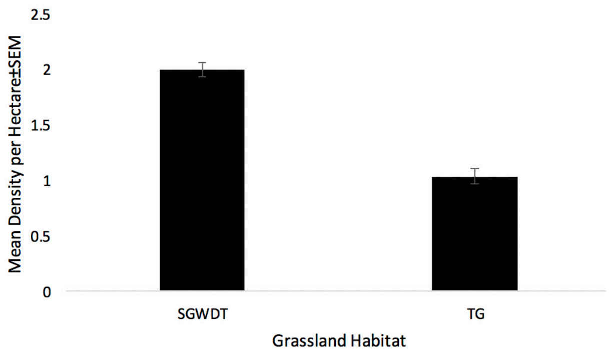

Figure 3. Mean population density of Sharpe's Longclaw in short grass with dense tussocks and tall grass in Marania farm.

Mean density

As birds did not occur in non-grassland habitats, the six grassland plots had a mean density of 0.78±0. 37SD. The mean density was 2.00 ±0.06 and 1.04 ±0.07 Sharpe's Longclaw per ha for SGWDT and TG, respectively (Figure 3). There was a significant difference between mean densities in SGWDT and TG (Mann-Whitney W-test = 89.0, df = 42, P = 0.0001).

DISCUSSION

Sharpe's Longclaw population abundance and densities had a clear association with habitat variables. The birds revealed a strong preference for areas of short grass with dense tussocks. Areas of tall grass were less preferred, and birds occurred there at lower densities. This preference for a specific grassland habitat matches that reported in studies by Muchai et al. (1998, 2002) and Mwangi et al. (2012) in Kinangop grasslands.

It has been observed that many endemic bird species have high densities on grazed pastures due to co-evolution with large grazing mammals, for instance the Chestnut-collared Longspur *Calcarius ornatus* (Kantrud 1981; Knopf & Rupert 1996). Low grazing intensity results in long grass and bush encroachment, while intense grazing destroys grass tussocks (Borghesio et al. 2013). Muchai et al. (2002) found that the persistence of Sharpe's Longclaw in the grasslands depends on intermediate levels of disturbance, resulting from grazing by mammalian herbivores. Our findings are consistent with those of Muchai et al. (2002), in that all the areas where we found Sharpe's Longclaw had grazing, especially by cattle. Although we did not have adequate data to verify a relationship with various grazers, we suggest that the stocking rate might be more important than the species, as shown in Sliwinskia & Koper (2015). Besides domestic animals, wild antelopes (Bushbucks *Tragelaphus scriptus*, Duiker *Neotrragus moschatus*) were regularly observed during the survey period, while Cape Buffaloes *Syncerus caffer* and African Elephant *Loxodonta africana* from the neighboring Mount Kenya National Park sometimes were reported to break fences and graze as well (unpublished data). These wild animals might also influence grassland height (Ogada et al. 2008) and ultimately Sharpe's Longclaw, but the data we had did not allow for testing of their effects on grassland height and structure. Field observations showed that Sharpe's Longclaw used tussocks mainly to rest during the hottest part of the day, which also agrees with observations by Muchai et al. (2002).

The height of grass plays an overriding role in determining habitat segregation and food specialization among bird species (Fisher & Davis 2011). Interspecific competitive exclusion is believed to be the main mechanism explaining occurrence or specialization of birds in grassland vegetation of different heights (McDonald 2017). Therefore, at least within grassland systems, mosaics of short and longer vegetation are likely to hold the maximum benefit for many farmland birds (Benton et al. 2003). Maphisa et al. (2017) argue that a combination of grass height and cover is more essential than just grass height alone or grass cover alone. It would be plausible to argue that Sharpe's Longclaw would probably spend more time being vigilant to detect predators other than carrying out other essential life process in tall grass due to tall grass obscuring their visibility (Muchai et al. 2002).

Although effect of patch size was not investigated in this study, results by Mwangi et al. (2012) showed large patches of grassland that are favoured by Sharpe's Longclaw compared to small ones. Consistent with this finding, Marania farm, being a large grassland under the same management, is a potential Sharpe's Longclaw conservation site if properly managed. A year-long study is recommended to understand the breeding strategies that are exhibited by the Sharpe's Longclaw. In addition, our findings indicated that tall grass was equally good for Jackson's Widowbird *Euplectes jacksoni*, a Near Threatened species. This species had over 40 nests in the tall grasses. Large patches of grassland would be ideal for conservation of various species in different categories of threats.

Conclusion and Recommendations

The findings of this study demonstrate that Timau grasslands still hold suitable and extensive habitat for the endemic and Endangered Sharpe's Longclaw. The study established that the mean population abundance was higher for short grass with dense tussocks compared with tall grass. Mean density was also higher in habitat of short grass with dense tussocks. In comparison to previous studies, it was acknowledged that Marania appeared better than other parts, like Kinangop grassland, previously thought to be the world stronghold of the species.

Sharpe's Longclaw is threatened by a very rapid and continuing reduction in the extent and quality of its habitat (Birdlife 2018). It is, therefore, imperative for conservationists to collaborate with farms such as Marania farm to adopt suitable management practices due to the role they play in conservation of this grassland-dependent bird species. Surveys in neighbouring farms should also be carried out to determine abundance and the extent of population distribution of Sharpe's Longclaw, and to assess the suitability of its habitat. This will be critical in guiding a discussion with the landowners on the merits of designating the farm/grasslands the status of BirdLife International Important Bird Area (IBA). This would be an important task that can be undertaken by the Sharpe's Longclaw Working Group. One way of recognizing the role Marania farm play in conserving Sharpe's Longclaw would be designating the area as an IBA to allow easy marketing of the area as a key tourist attraction site (avi-tourism) for Meru County. Being an endemic species that is becoming rare in its formerly known areas like Kinangop, good marketing would take keen bird watchers to Marania farm where it would be easy to find and perhaps photograph the Sharpe's Longclaw in its natural habitat.

Further research needs to be undertaken for both wet and dry seasons in order to understand if the species is affected by seasonal dynamics. Further research is also needed to shed light on the most appropriate conservation measures. More information is required to determine the best grazing regimes optimal for Sharpe's Longclaw with economic benefits for easier adoption.

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Author contribution: Study design (DK, MM,JK, JM, BW & PN); Data collection (DK, JM, MM, JK, BW, SB & WW); Data analysis (DK, JM, JK & MM); Manuscript write up (DK, JM, MM, JK, BW& PN).

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