

# Effects of human activities on birds and their habitats as reported by forest user groups in and around North Nandi Forest, Kenya

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## Summary

Species-rich tropical forests are becoming increasingly fragmented, degraded and are declining due to human activities, threatening the survival of avian species that depend on them. We assessed the detrimental effects of human activities on birds and their habitats in and around North Nandi Forest. A semi-structured questionnaire survey was used to collect data on human activities affecting birds and their habitats among forest users and forest protectors in North Nandi Forest. Habitat destruction (70%) was the main detrimental human activity on avifaunal habitats, while hunting of birds for subsistence use (10%) only affected certain bird species. The age group between 20 and 40 years used the forest most frequently and most activities were undertaken in indigenous forest habitat. Significantly, men undertook timber extraction and livestock grazing, while women undertook collection of firewood and medicinal herbs. Illegal forest exploitation should be curbed in order to ensure future survival of avifaunal diversity in North Nandi Forest.

## Introduction

Forest cover has been estimated to exceed 4 billion hectares or 31% of the global land surface (FAO 2010). Forest cover is largely lost through human activities such as land conversion, timber extraction and minimally through natural events such as fire and drought. Even though afforestation, reforestation and natural regeneration have reduced the net loss of forest cover (FAO 2011), ecosystem services and the conservation value of remnant forests continues to decline, at least in the short term (FAO 2010).

Habitat fragmentation is a paradigm of three main effects: degradation of habitat quality and extent; separation of habitat fragments by anthropogenic matrix (e. g. pasture lands and settlements) and increased intensity of edge effects (Saunders *et al.* 1991, Forman 1995). Habitat changes particularly affect less abundant and range-restricted birds, rainforest specialists, and altitudinal migrants (Bett *et al.* 2016, Brooks *et al.* 1999, Raman 2001). The main effect of habitat fragmentation and degradation is a reduction of avian population size and increased vulnerability to extinction (Simberloff 1994). This exposes risks to many tropical avian species, as they are narrowly distributed and do not tolerate conditions outside of the forest (Turner 1996).

The majority of forest reserves in Kenya are jointly managed by government parastatals in conjunction with local communities (Musila 2011). North Nandi Forest Reserve and its surrounding modified habitats are facing an imminent threat from

encroachment and human activities: uncontrolled logging, charcoal burning and firewood collection, while intense pressure from cattle-grazing is affecting the structure and regeneration of this forest (Ng'weno *et al.* 2005; Musila, *et al.* 2004; Bennun & Njoroge 1999). With the accelerating population growth rate around this forest reserve, human activities are likely to significantly reduce or locally exterminate populations of avian species that are highly sensitive to habitat disturbance. This study assessed potential threats facing avifauna and their habitats in indigenous forest (undisturbed), forest edge (disturbed), exotic tree plantations and small scale farmlands adjacent to the North Nandi Forest Reserve. Understanding the effects of humans on birds and their habitat will help in devising strategies to ameliorate these detrimental activities.

### Materials and methods

North Nandi Forest is in Nandi County (34°51'E, 0°33'N; 1700–2130 m) and receives annual precipitation between 1200 and 2000 mm. Precipitation is bimodal, with a main wet season between March and June, and an auxiliary wet period in September–October (KFS 2010).

The forest was first gazetted in 1936 as a Trust Forest covering 11 850 ha. Since gazettement, a total of 1343 ha have been excised. An additional 410 ha have been converted to tea plantations under Nyayo Tea Zone. Out of the present gazetted forest area (10 500 ha), approximately 8000 ha is indigenous closed-canopy forest, while the remainder consists of scrub, grassland, exotic monoculture tree plantations, cropland and tea (Blackett 1994).

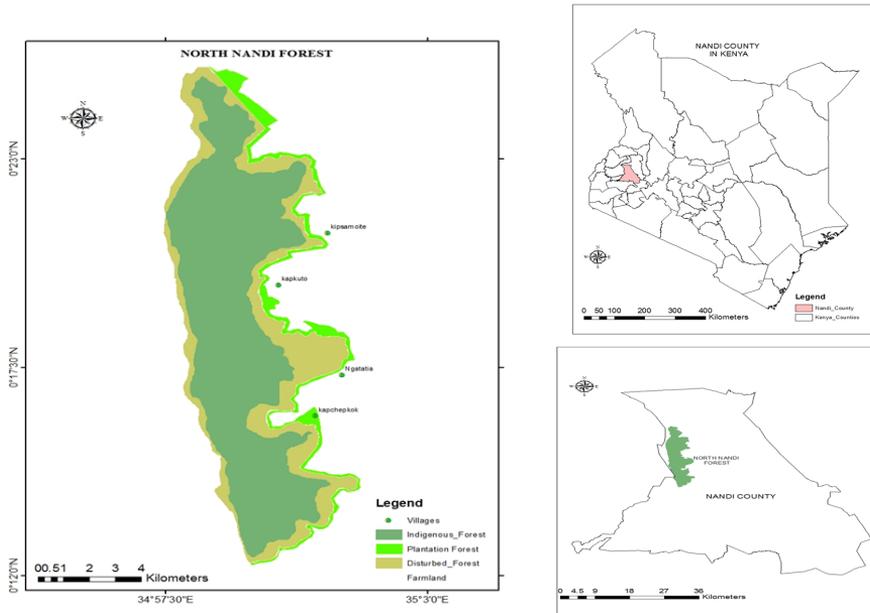
#### *Site selection*

The eastern part of North Nandi Forest Reserve was chosen for this study due to its accessibility and proximity to the local community. Community members who consistently utilized forest resources were targeted along four habitat strata: indigenous forest (*c.* 8000 ha), disturbed forest (*c.* 1500 ha), plantation forest (*c.* 1000 ha) and farmlands (*c.* 500 ha). To evaluate the current threats facing forest habitats, questionnaires were administered to community members from four villages that were 1 km from the tea buffer zone. These four villages, namely, Kapkuto, Ngatatia, Kipsamoite and Kapchepkok, allowed for replication of the data collected (Fig. 1).

#### *Sampling procedure*

Questionnaires targeted two groups, forest users from the local community and forest protectors, who consisted of staff from the Kenya Forest Service (KFS) and Community Forest Associations (CFA).

Data from forest users were collected using semi-structured questionnaires administered to respondents from selected households. A systematic random sampling technique was used to select respondents where every fifth household was selected. A total of 100 households (25 per village) were selected from a total of 507 households in the study area. Questionnaires relating to the use of various forest habitats were used to gather information on anthropogenic activities in the forest and avifaunal decline. Respondents (15 years old and above) who actively used these forest habitats were targeted (Kothari 2004). Respondents were divided into three age structures: 15–20 years, 20–40 years, and >40 years. Age structure was compared with frequencies of forest use (daily, weekly and monthly). Human activities in the forest habitats based on gender were also compared.



**Figure 1.** Map of North Nandi Forest, Kenya showing the various study habitats: indigenous forest, disturbed forest, plantation forest and farmland, and the location of study sites designated as villages.

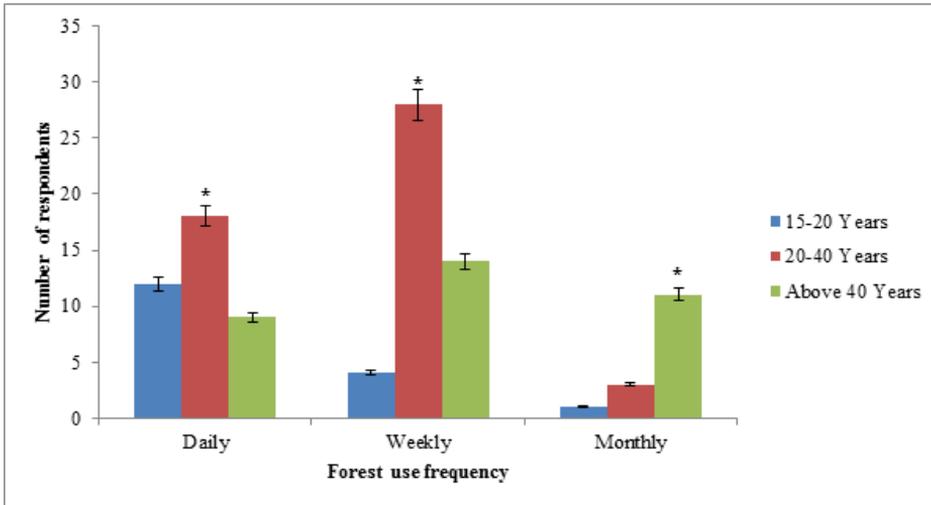
Data were collected from 25 forest protectors, ten KFS officers stationed at three posts within the forest and 15 CFA officials. Respondents answered questions on security patrols in the forest, human activities and bird conservation activities. Analyses were done using Pearson chi-square with a 5% significance level.

## Results

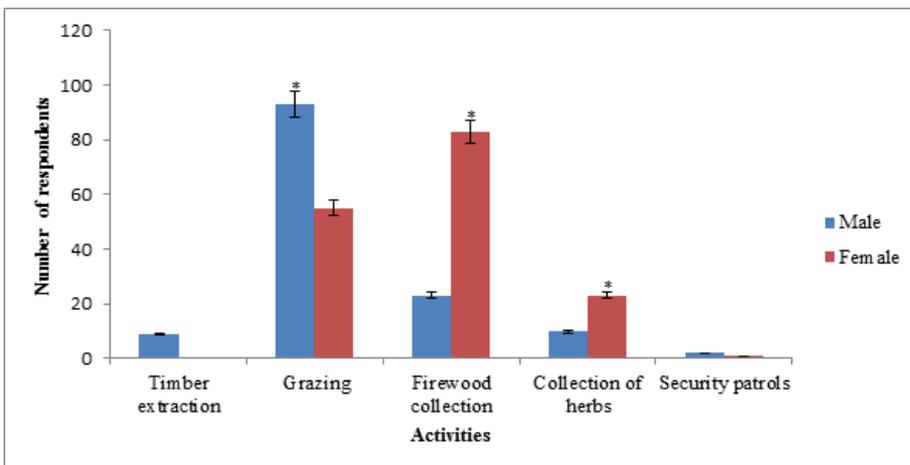
### *Responses of community members to forest exploitation and avifaunal decline*

Habitat destruction consisting of the clearing of wetlands and bushes for farming was reported by 70% of respondents and was the main reason reported for the disappearance of birds in and around North Nandi Forest. The other reasons suggested for bird disappearance were changes in climatic conditions (20%), and hunting of birds for subsistence use (10%).

Respondents aged between 20 and 40 years used the forest most frequently – daily or weekly – while those over 40 years old used the forest on a monthly basis ( $\chi^2 = 19.485$ ,  $df = 4$ ,  $p = 0.0001$ ; Fig. 2). There was no significant difference between a respondent's age and the habitat they used within the forest. Indigenous forest was used the most, while plantation forest was the least used habitat. Almost all age categories participated in similar activities within indigenous forest habitat. However, the collection of medicinal herbs was done mostly by those aged 20 years and above. Livestock grazing and firewood collection were the dominant activities across all age categories. Activities within the forest were gender specific ( $\chi^2 = 57.622$ ,  $df = 5$ ,  $p = 0.0001$ ). Only men participated in timber extraction, and significantly more men participated in livestock grazing as opposed to women. Women collected firewood and medicinal herbs (Fig. 3).



**Figure 2.** Forest use frequency by community members around North Nandi Forest.



**Figure 3.** Gender roles versus activities in North Nandi Forest.

*Responses of Kenya Forest Service rangers and Community Forest Association officials to forest exploitation and avifaunal decline*

KFS rangers reported that they conducted forest patrols as part of their mandate to protect it from exploitation. Of the total respondents, daily patrols were made 60% of the time, weekly patrols 32%, and monthly patrols 8%. There were more patrols conducted in indigenous forest (76%), followed by disturbed forest (16%) and plantation forest (8%).

Human activity that had the greatest negative effect on forested habitats was timber extraction (60%), followed by livestock grazing (20%), firewood collection (15%), and charcoal burning (5%) according to KFS and CFA officials. Indigenous forest (76%) was the most adversely affected habitat, followed by disturbed forest (20%) and finally, plantation forest (4%).

The only activity geared towards bird conservation was the provision of security

for local and international researchers. According to respondents, the main threats affecting forest and bird conservation in and around Nandi North Forest were habitat destruction (64%), lack of initiatives to conserve birds by relevant conservation authorities (24%), and subsistence hunting of birds (12%) – especially gamebirds such as Crested Guineafowl *Guttera pucherani*.

## Discussion

### *Detrimental impacts of human activities on birds and their habitats*

Habitat destruction and subsistence hunting of birds were the main human activities reported that could negatively impact birds and their habitats in and around North Nandi Forest. Human activities with the greatest impact on the forested habitat were timber extraction or illegal logging, firewood collection and charcoal burning. These activities change the vegetation structure of habitats, thus affecting bird diversity (Musila 2011). The most adversely affected habitats were indigenous forest, followed by disturbed forest and lastly plantation forest. Firewood collection has been revealed as the major threat to wildlife habitat in developing countries (Masanja 2014).

Firewood collection was regulated through the issuance of permits by KFS and the cutting of fallen trees is permitted by KFS rangers. No restrictions are placed on collection of medicinal herbs. Debarking of trees for herbal medicine, especially *Fagaropsis angolensis* and *Tabernaemontana stapfiana*, was rampant, leading to these species dying and being removed for firewood. Continuous removal of dead wood by the surrounding community may affect the density and distribution of cavity-nesting bird species (e.g. woodpeckers) due to the decline in quantity of holes (Veiga *et al.* 2013) and for food (Waiyaki 1995).

Livestock grazing in the indigenous forest has led to the further opening up of undergrowth vegetation and thickets, likely affecting understory and skulking bird species. Uncontrolled livestock grazing in the forest continues as earlier observed by Musila *et al.* (2010), thus it is likely interfering with the rate of forest regeneration. This happens through feeding and trampling on germinating tree seedlings and saplings by grazing animals. Vegetation alteration from grazing-associated activities leads to changes in avian diversity with protected ungrazed sites having higher diversity compared to unprotected grazed sites (Mamo *et al.* 2016).

Subsistence hunting was observed at Kipsamoite where community members had laid several traps on a trail used by Crested Guineafowl. This activity may significantly reduce local populations of this species because it is currently restricted to forest habitat due to severe hunting in farmlands, in a scenario similar to that reported by Perveen & Khan (2010) for cranes in northern Pakistan.

Based on age structure, those aged 20–40 years used forest habitats most frequently, on a daily basis, and this may be a reflection of their high population as opposed to the younger and older age groups. Unemployment in this age group may be a significant factor that drives them to exploit free and easily accessible forest resources such as firewood, timber and pasture for domestic animals. Similarly, unemployment and low education levels have also been shown to negatively influence the degree of awareness of biodiversity conservation held by local communities (Mehta & Heinen 2001).

Based on gender roles, both men and women used forest habitats in relatively equal amounts, but they differed in terms of their activities in these habitats. Timber

extraction for fencing poles and construction was solely done by men, who mainly targeted indigenous forest and disturbed forest. Effects of logging on bird diversity ranges from changes in feeding guild structure, decreases in species richness, and loss of corridors and sink habitats (Bett *et al.* 2016, McCarthy 2012). *Syzygium guineense*, a fruiting canopy tree, was targeted for fencing poles and has been seriously logged to a point that it is only found in the indigenous forest. This tree is important to frugivorous canopy birds such as turacos and Black-and-white Casqued Hornbill *Bycanistes subcylindricus*. Collection of firewood and medicinal herbs was mainly done by women.

#### *Appropriate conservation strategies for birds and their habitats*

Based on this study, the main conservation strategies to mitigate detrimental human activities on birds and their habitats in and around North Nandi Forest were to intensify security patrols in indigenous forest by carrying out more daily patrols. Increased security patrols would allow for regeneration of trees and provide a more suitable habitat for birds as outlined in the North and South Nandi Forests Strategic Ecosystem Management Plan (KFS 2015). This is currently being done by KFS rangers and CFA scouts.

In disturbed forest, reforestation of open patches using indigenous tree seedlings was identified as a key conservation strategy that would create more bird nesting sites and feeding sites. Afforestation in empty plantation forest patches is important in creating sink and dispersal habitats for forest birds. Agro-forestry in farmland creates extended habitats for birds, especially non-forest species. A study by Fahrig *et al.* (2008) in Kakamega Forest demonstrated that plantations with a mixture of indigenous tree species can have high conservation value for avifauna.

Community-based organizations engaged in the planting of both exotic and indigenous tree seedlings may increase forest cover. Farmers should be educated on the need to practice agro-forestry to eliminate overdependence on forest resources and improve their livelihoods thus protecting birds and their habitats (KFS 2015). Illegal forest exploitation should be curbed in order to ensure future survival of avifaunal diversity in North Nandi Forest.

Detrimental human activities may play a major role in the disappearance and local extinction of birds in and around North Nandi Forest. The indigenous forest is fast-changing to a disturbed forest, further worsening the status of forest-dependent bird species. However, some conservation strategies currently in place such as reforestation at the forest edge by KFS and CFA may slowly reverse this trend.

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