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# Home ranges and survival of Nahan's Francolin *Francolinus nahani* in Budongo Forest, Uganda

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## Abstract

We studied home ranges, habitat use and survival of radio-tagged Nahan's Francolin in Budongo Forest Reserve, Uganda during July 1998–December 1999. We studied Nahan's Francolin in an unlogged nature reserve, in a compartment logged in 1947–1952 and in a compartment logged twice, in 1963–1964 and 1996–1997. Mean home range was  $14.22 \pm 1.35$  ha ( $n = 17$ ). The home range was significantly larger in the nature reserve than in the recently logged compartment. Birds spent more time during the day in areas with high understorey vegetation density but preferred to roost and nest between buttresses of large trees. Understorey vegetation density and canopy openness were significantly greater in the logged forest than in the nature reserve. Annual survival of adult Nahan's Francolins was  $20.09 \pm 7.33\%$  ( $n = 23$ ). Our results suggest that the maintenance of large trees and areas with high understorey vegetation density are both important for Nahan's Francolin.

**Key words:** Budongo Forest, home range, Nahan's Francolin

## Résumé

Nous avons étudié le territoire, l'utilisation de l'habitat et la survie de francolins de Nahan marqués dans la Réserve Forestière de Budongo, en Ouganda, entre juillet 1998 et décembre 1999. Nous avons étudié les francolins de Nahan dans une réserve naturelle non exploitée, dans une parcelle qui avait été exploitée entre 1947 et 1952 et dans une parcelle où des coupes de bois avaient eu lieu deux fois, en 1963–64 et en 1996–97. Le territoire moyen couvrait  $14,22 \pm 1,35$  ha ( $n = 17$ ). Le territoire était significativement plus grand dans la réserve naturelle que dans la

parcelle récemment exploitée. Pendant la journée, les oiseaux passaient plus de temps dans les endroits où la végétation des sous-bois était très dense, mais ils préféraient se percher et nicher protégés par le rempart de grands arbres. La densité de la végétation des sous-bois et l'ouverture de la canopée étaient sensiblement plus grandes dans la forêt exploitée que dans la réserve naturelle. La survie annuelle des francolins adultes était de  $20,09 \pm 7,33\%$  ( $n = 23$ ). Nos résultats suggèrent que le maintien de grands arbres et de zones où la végétation des sous-bois est dense est très important pour le francolin de Nahan.

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## Introduction

### General background

The Nahan's Francolin *Francolinus nahani* is a forest specialist species (Bennun, Dranzoa & Pomeroy, 1996; Carswell *et al.*, 2005) found in forest remnants in eastern Democratic Republic of Congo and western Uganda. It is a globally endangered species because of its small and severely fragmented distribution. It is undergoing a continuing decline in the area of occupancy and in the extent and quality of habitat, as a result of deforestation and forest degradation (BirdLife International, 2000, 2004, 2006).

There is little available information on virtually all aspects of the life history of Nahan's Francolin. Small and fragmented populations combined with secretive behaviour makes the observation of the species difficult in the wild. Several components of animal life history traits are important in developing conservation strategies. We defined home range as the area traversed by the individual in its normal activities of gathering food, looking for mates and caring for young (Burt, 1943; White & Garrott, 1990). Harris *et al.* (1990) gave a detailed description in the studies on the home range using radio telemetry. To date,

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several studies have been carried out to investigate the home range and habitat utilization of game birds using radio tracking. McDonald, Storm & Palmer (1998) studied the home range and habitat utilization of male ruffed grouse (*Bonasa umbellus*) in different forest types. Smith, Ardis & Lees (1998) investigated the home ranges of the Black-breasted Button-quail *Turnix melanogaster* in habitats with different management practices. Jansen, Little & Crowe (2000) investigated habitat utilization and home range of the redwing francolin *Francolinus levaillantii* in highland grasslands. Survival is linked with both home range and habitat and is important in providing basic information on the population dynamics of the species.

#### Objectives of the study

The aim of the study was to determine the ranging patterns of Nahan's Francolin in Budongo Forest Reserve (BFR) and the specific objectives were to:

1. determine its home range size,
2. compare the home range patterns in the logged and unlogged forest types,

3. determine the habitat use of the species and
4. determine survival of the species.

#### Study area

The study was conducted in Budongo Forest Reserve, Uganda (Fig. 1) in compartments N15, N3 and W21 (Fig. 2) that have different management histories. N15 (777 ha) is an unlogged compartment set aside as a nature reserve. N3 (620 ha) was logged once in 1947–1952 and 80.0 m<sup>3</sup> ha<sup>-1</sup> of timber was removed (Plumptre, 1996). W21 (1116 ha) was logged twice: first in 1963–1964 when 36.1 m<sup>3</sup> ha<sup>-1</sup> of timber was removed and then in 1996–1997 when additional 5.5 m<sup>3</sup> ha<sup>-1</sup> was removed (Plumptre, 1996; Ngabo & Dranzoa, 2001).

#### Methods

Nahan's Francolin being an interior forest specialist species which is highly secretive, we used radio-telemetry techniques. Nahan's Francolins were located by using playback (Sande, 2001; Sande, Dranzoa & Wegge, 2001). These

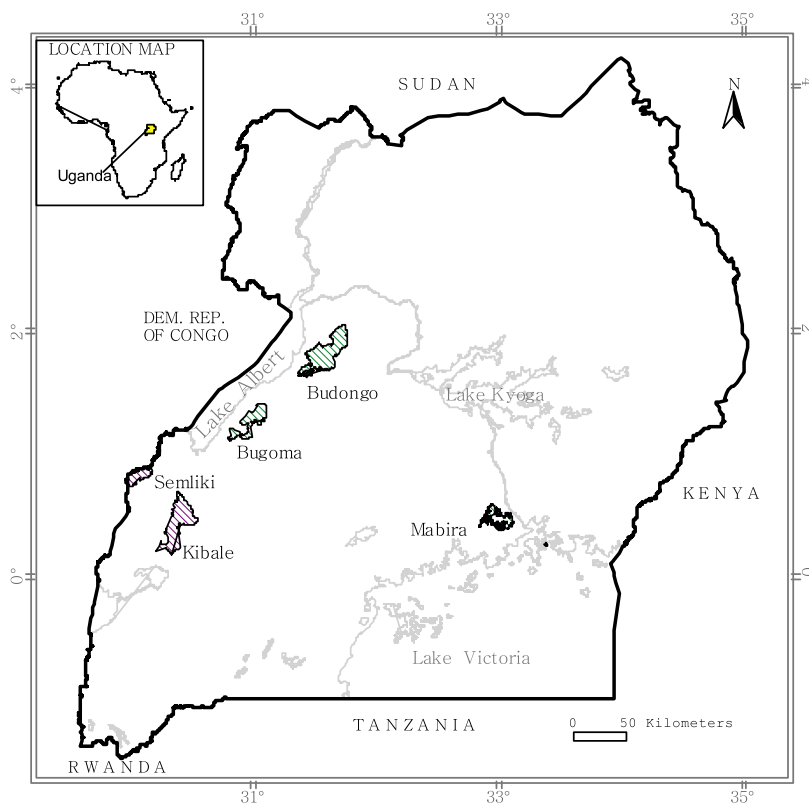
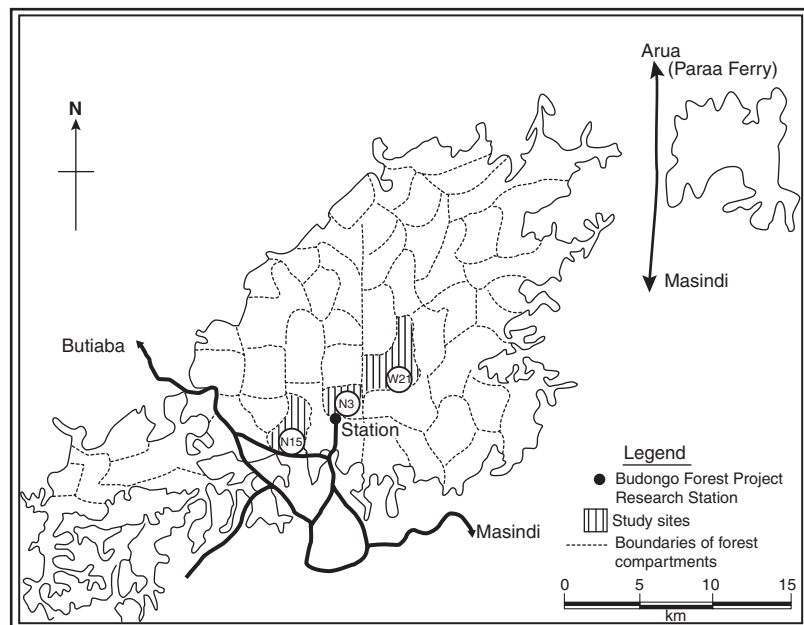


Fig 1 Showing the location of Budongo Forest Reserve and other forests where Nahan's Francolin has been reported in Uganda

Fig 2 Showing the compartments N15, N3 and W21 where the study was conducted in Budongo Forest Reserve



birds were then trapped using a mist-net. Using the existing and well-maintained trail system in BFR, when the birds responded to the playback, one 18-m mist-net would be set along the trail at a point perpendicular to the direction from where the birds were responding. The cassette would then be played about 10 m from the mist-net in the direction of about  $180^\circ$  from where the birds responded to attract them towards the playback and trap them as they tried to cross the net.

Nahan's Francolins mostly live in groups of two to six individuals (Sande, 2001). One or more members of a group were radio-tagged. Radio transmitters weighing 9 g (about 3% of the bird's body weight), with frequencies ranging from 150.5 to 151.0 MHz were attached to the trapped birds using a harness (backpack) with cords passing round the base of the wings without meeting ventrally (Kenward, 1987). The radio-tagged birds were released from where they were trapped and were followed using a Telonix receiver and a 3-element Yagi antenna.

The forest compartments where the study was carried out have a trail system with grids intersecting each other at 100 m intervals. Points 20 m apart were marked with a flagging tape around the blocks where the trapped birds were ranging. A map of the ranging area for a group, or more than one neighbouring groups, with all the marked 20 m points was drawn on a map on graph paper to a

scale of 1 cm representing 10 m on the ground. X and Y axes were drawn on each map so that all the points on the map could be converted into coordinates. Three bearings were taken at three different marked points nearest to the radio tagged bird. These bearings were plotted on the map to get the coordinates of the bird's location by triangulation (Kenward, 1987).

Continuous radio tracking (fixes taken at very short intervals over a set period of time, Harris *et al.*, 1990) was used where location fixes were taken three times a week for every radio-tagged individual. Discontinuous radio tracking (locating an animal at either discrete or random time intervals throughout the study period, Harris *et al.*, 1990) was used to collect data on the daily home range sizes. Whole day radio-tracking was also carried out where birds were followed and location fixes taken at half an hour intervals from dawn to dusk when they went to roost.

#### Home range analysis

Home range data were analysed using Ranges V Computer Program using the location coordinates from triangulation. Home range was determined using the Minimum Convex Polygon (MCP), which is the smallest polygon that can be drawn around a set of fixes (Kenward & Hodder, 1996). The range boundary of the MCP encompasses all

the fixes including occasional fixes well beyond the main area of activity (Harris *et al.*, 1990). This means that the range size is strongly influenced by peripheral fixes and the range area can include large areas that are never visited. Despite these weaknesses, MCP is the most commonly used home range estimator (Harris *et al.*, 1990; White & Garrott, 1990; Plumptre, Reynolds & Bakuneeta, 1997; McDonald *et al.*, 1998; Smith *et al.*, 1998; Jansen *et al.*, 2000).

According to Kenward (1987); Harris *et al.* (1990) & Kenward (1992), areas estimated with convex polygons typically reach asymptotes with 25–50 fixes. MCP was used to analyse home ranges because some of the fixes taken for the birds being monitored were less than 50. All the fixes taken for each group monitored were used in MCP home range analysis.

#### *Habitat analysis*

Habitats used by Nahan's Francolin in the home range were referred to as core areas. Core areas are defined as areas with high fix density in a range (Kenward & Hodder, 1996). Habitat preference was assessed using maps from MCP analysis. The core edges at 5% intervals, utilization plots and arithmetic mean described in detail by Kenward & Hodder (1996) were used. This option provides plots, which help to decide which fixes are part of the core and which are not. The analysis produces a result screen, which shows a map of the range edges, a table showing the area and percentage of the total area of each percentage polygon and a graph of utilization distribution (Kenward & Hodder, 1996). The 50–60% isopleth has been found to be suitable to define the core area for several mammal species (Harris *et al.*, 1990). However, in this study, the 50–70% isopleth was taken to define the core areas.

#### *Vegetation analysis*

In each of the home range of every radio tagged group, ten plots each measuring 10 m × 10 m were randomly selected using X and Y coordinates of the map used for triangulation as random numbers. Five plots in the core areas and five outside the core area but within the home range were chosen and understorey vegetation density (UVD) and canopy openness were assessed.

UVD was measured in each plot from four directions (north, east, south and west) using a 1 m × 1 m check board with 20 cm × 20 cm black and white small squares.

UVD was estimated for 20 cm and 1 m above the ground. In each case, the number of quarters of the squares visible in the four directions was counted.

Canopy openness was assessed at the same points where the UVD was estimated using a spherical densiometer, a concave mirror with a grid etched on it. Four readings were also taken from the four directions (north, east, south and west) at each point and averaged.

#### *Survival analysis*

Survival of Nahan's Francolin was studied using the radio-tagged birds. The dates when the birds were tagged were noted and those when individuals were predated or could not be traced with their transmitters were also noted. Survival rate was estimated using the Kaplan–Meier (Pollock *et al.*, 1989).

## **Results**

A total of 30 individuals (22 groups) were radio-tagged and of these, 23 (from 17 groups) were used in home range analysis because there were at least 30 location fixes to undertake MCP analysis.

#### *Home range*

Overall mean home ranges were  $14.22 \pm 1.35$  ha ( $n = 17$ , range, 6.56–28.98 ha) and mean core areas were  $5.10 \pm 0.57$  ha ( $n = 17$ , range = 2.34–9.49 ha). Mean home ranges were significantly larger in the unlogged than in the logged forest ( $t = 2.31$ , 7 df,  $P < 0.05$ ). There was a positive correlation between group size and home range ( $r = 0.844$ , 7 df,  $P < 0.05$ ). Home range was significantly smaller when a female member was incubating than when there was no nesting bird in the group ( $t = 3.19$ , 4 df,  $P < 0.05$ ).

#### *Habitat*

The proportion of the understorey vegetation density (UVD) up to 1 m above the ground was significantly higher in the core areas than outside the core areas within the home range ( $t = 7.02$ , 44 df,  $P < 0.01$ ). UVD for strata 0–0.4 and 0.4–1 m was also higher in the core areas than outside ( $t = 5.69$ , 44 df,  $P < 0.01$  and  $t = 6.00$ , 44 df,  $P < 0.01$ , respectively). The canopy openness in the core areas and outside the core areas within the home range did

not differ ( $t = 1.74$ , 44 df,  $P > 0.05$ ). In the core areas, canopy openness was greater in the logged compartment than in the unlogged ( $t = 2.78$ , 24 df,  $P < 0.01$ ).

### Survival

The Kaplan–Meier estimate showed an annual survival rate of  $20.09 \pm 7.33\%$  ( $n = 23$ ). Annual survival was  $33.0 \pm 10.1\%$  in unlogged forest. Estimates for the logged compartment and comparisons between logged and unlogged were not carried out because of small sample sizes in the logged compartments. Of the 23 individuals that were radio tracked for at least 2 weeks, there was evidence from feathers and recovery of radio transmitters that 34.7% of the adults were killed by predators. A Great Sparrow Hawk (*Accipiter melanoleucus*) and a local hunter both responded and moved towards the playback suggesting that both are potential predators of Nahan's Francolins.

## Discussion

### Ranging patterns and habitat preference

The home range of Nahan's Francolin (14.22 ha), a forest francolin, is large and comparable to that of the grassland redwing francolin (8–15 ha, Jansen *et al.*, 2000). Nahan's Francolin preferred to forage in areas with high understorey vegetation density, which was lower in core areas of unlogged forest than in the logged one. Probably this could be because of the hiding of birds from the predators in the thick understorey. Nahan's francolins are able to pick some of their food items such as insects, insect larvae and molluscs (Sande, Dranzoa & Wegge, 2006) from the leaves, and thus it would not be surprising to find them spending most of their time in areas with thick understorey.

The home ranges were significantly reduced during incubation probably because the nonbreeding members of the breeding group foraged near the nest and called the incubating individual in the morning to join the entire group for feeding. This was ascertained by monitoring a radio-tagged incubating individual before leaving the nest. The group members would call from about 30 m from the nest and the incubating individual would walk or fly out of the nest and join the calling birds. It could therefore be argued that probably Nahan's Francolin reduce the home range when nesting to an area the breeding individuals can effectively defend. Home ranges for neighbouring groups were found to overlap (Fig. 3).

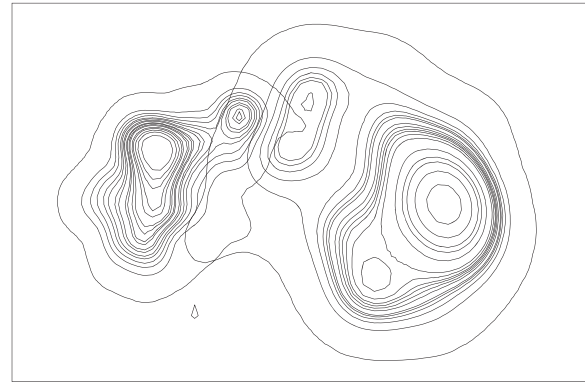


Fig 3 Showing home range overlap of two neighbouring Nahan's Francolin groups

### Survival

Francolins and other game-birds are often subjected to very high harvest and predation rates (Fuller, Carroll & McGowan, 2000), which are probably a contribution to the low survival of Nahan's Francolin. Around BFR, 29% of the residents responding to a survey admitted that they had eaten Nahan's Francolins' meat (Dranzoa, Sande & Kahindo, 2001), which showed that local people hunt this threatened species of conservation concern. The fact that a hunter with a bow and arrow responded and moved towards the playback ready to shoot confirms that local people hunt the francolins. This study also showed that the Great Sparrow Hawk, which responded and moved towards the playback, is one of the potential predators.

## Conclusion

The study has provided previously unknown information on home range patterns, habitat preferences and survival of the Nahan's Francolin. This information is vital for the management and conservation of the forests where the species is found. Budongo Forest Reserve is managed by the National Forestry Authority that licences logging. Legal timber extraction has negative implications on the survival of the species because the logging process removes the large mature trees, which provide roosting and nesting sites (Sande, 2001). It can be argued that logging creates areas with high UVD preferred by Nahan's Francolin, but such areas naturally occur in the unlogged forest in gaps created by natural tree falls. Nahan's Francolin at best requires a mosaic of microhabitats: high UVD for feeding and large buttresses for nesting and roosting. Avoidance of

logging or creation of more nature reserves can help in the conservation of this species.

We suggest that the relationship between food availability with home range, group size and habitat preference be studied in detail. This will indicate how food availability influences the home range during normal nonbreeding conditions and when a member of a group is nesting, whether the large home range with large group size is related to food availability and whether there is comparatively more food in the core areas than in the noncore areas.

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