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A bird community structure of a tropical forest, twenty years after logging, in Ghana

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Abstract

The avifaunal composition of a tropical forest, Kakum Conservation Area under natural regeneration, 20 years after a selective logging operation was studied. The study area was divided into approximately eight equal blocks and four transects each 1km long each was laid in every block. One hundred and thirty-five (135) bird species were recorded from all the forest blocks. Pycnonotidae (15 species) and Sylviidae (eight species) families dominated the entire avian assemblage all the eight blocks. Estimated richness using second order jackknife estimator was 137.14 (SD=1.06) and Shannon-Wienner diversity index at 95% confident limit was 4.63. There was a high similarity index and high species overlap ranging from 0.79-0.91 among the various forest blocks. Twelve feeding guilds were identified; five of the guilds accounted for over 60% of the total avian abundance. The potential of selectively logged forests to protect many species of forest birds after several years of logging can however not be underestimated. Long term avian monitoring program must be incorporated into the park management system.

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Introduction

Tropical forests with their unique structure harbor and support diverse avifauna populations; despite this uniqueness, tropical forests are lost at an annual rate of 0.8% mainly to agriculture (Sahas, 2009) and recently timber extraction. These have remained a threat to biodiversity conservation through habitat loss in the light of destruction of several million hectares of forests in the tropics since 1900 (Barlow *et al*., 2007; Koh, 2007). The corresponding effect has been extinctions, reduction in species richness and the concentration of the most valuable species remaining, 'hotspots', in small pockets spread across the earth (Brooks *et al*., 2002). Until the past two decades, the impacts of habitat fragmentation and logging disturbance on tropical forest avifauna have not gained much attention from conservation biologists around the world (Holbech, 2005). The interest however, has resulted in a number of published long- and short-term intensive studies from South America, South-East Asia and East Africa.

Unfortunately, few data originate from Central and Western African bio-geographic areas. Of the studies done, the general consensus is that selective logging has a detrimental impact on vegetation structure and consequently on overall diversity and rarities, except for a few studies (Whitman *et al*. 1998; Aleixo 1999; Owiunji and Plumptre 1998; Owiunji, 2000). Amongst the few exceptions in contradiction to the general consensus of the impact of selective logging on avian diversity, were studies by Akom, (2004) and Holbech, (2005) in Ghana which have also showed that selective logging in Ghana had moderate and rather short-term reversible effects on vegetation structure and avifauna diversity. The relationships between the intensity of logging and impacts on biodiversity are however, poorly understood due to the low level of research carried out in this direction.
So far, in Ghana, most of the studies on selective logging and birds' diversity have been conducted in timber production forest reserves. The Kakum Conservation Area however has metamorphosed from different management types since inception until its present status. It therefore offers a unique forest system where a comparative study on logging practices that target biodiversity conservation can be done. This is even more urgent since there is a global objective of developing sustainable tropical forestry management practices. The main goal of the study was to assess the avian diversity, composition and assemblages 20 year after selective logging in the KCA.

Materials and methods

Study area

Location and legal setting of kakum conservation area (kca):

The KCA (1º 51'-1º 30' W; 5º 20'-5º40'N) made up of Kakum National Park and Assin Attandansu Resource Reserve is located in the Twifu Hemang Lower Denkyira and Assin Districts of the Central Region of Ghana (Fig. 1). The conservation area forms about 366km² of contiguous forest. Timber exploitation started in the two reserves in 1936 with mahogany (*Khaya ivorensis*) being the principal species logged until 1989, when the Wildlife Division took over its management from the Forestry Department (Hawthorn & Musah, 1993; Kpelle, 1993). As a result of initial faunal survey the Kakum forest reserve was designated as a national park and Assin Attandansu forest Reserve as a resource reserve in 1991 under Wildlife reserves regulations 1971, LI 710 as amended by Wildlife reserves regulations 1991, LI 1525 (Wildlife Department, 1996). It has been identified that 105 species of vascular plants and about 266 bird species occur in the KCA (Wildlife Department 1996).

Forest blocks selection and transect distribution

To equalize sampling intensity, the conservation area was divided into eight blocks each occupying approximate area of 45km². The forest blocks were identified with the nearest protection camp as follows: Aboabo, Abrafo, Adiembra, Afiaso, Antwikwaa, Briscoe II, Homaho, and Kruwa (Fig. 1).

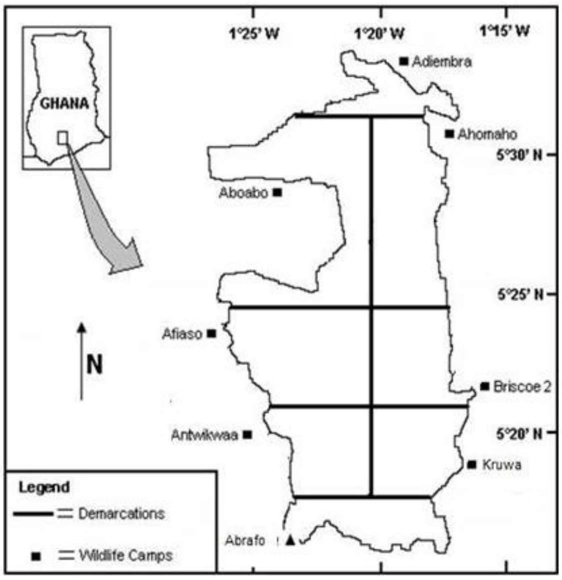

Fig. 1. The map of Kakum Conservation Area showing the stratification.

In each forest block four transects of approximately one km length each were laid at random with the intersection of one minute squared grid lines forming the beginning of each transect in a north direction after Danquah *et al* (2007).This totals to thirty-two transects (32), each of one kilometer. The transect method was chosen since majority of songs, especially calls were known and this method also allows for recording as many bird species as possible in a tropical ecosystem Holbech (1996). Mist-netting was not done in this studies due to logistical constrains hence secretive and silent species might have been missed out.

Data collection

The fieldwork was conducted in April/May 2009. Bird counts were conducted between the hours of 0600 and 1000 GMT through direct observations and the use of songs or play-back procedure of songs to detect territorial and non-territorial species.Two experts participated in the survey: one person identified and counted birds another recorded the vocalized species.

All birds encountered along transects were recorded. For each bird species encountered, the following were recorded: mode of detection (visual or vocal); position within the forest block; the number of birds and activity at the instant of encounter. Occurrence of guilds in each block was also noted. These were different species of birds observed to have been feeding together. Thus guild categories were based on diet and foraging behaviour. These guilds were adopted from the one used by Clement (2000) and have been altered for the purpose of this study so that direct comparisons could be made between the different block.

Overflying species were excluded from the recordings because their particular locations were difficult to determine. Only species encountered during the survey period were considered. Transects did not have any fixed width because while estimates of distances to visually observed birds may be easier, estimation of distances to calls is more difficult and not reliable. To avoid double counting on an individual bird on each transect, transects were at least 0.5km away from one another. Hence, in counts where visual observations and vocal records are combined transect width is not taken into account Pomeroy (1992). Overflying and nocturnal species were excluded. Nomenclature of bird was after Borrow and Demey (2004).

Data analysis

Bird species abundance data recorded during the transect counts were reported as species and individual bird encounter rates per km. That is the total number of individuals and/or species recorded in the area over the total distance walked. Bird community diversity for all the forest blocks was calculated using the Shannon-Wiener and Simpson index of diversity. The analysis was conducted with the PAST ecological software at a significance level of 5%. The quantitative modified version of Morrista-Horn Index (Maguran, 1991) was used to evaluate the degree of species overlap between the various forest blocks using EstimateSWin800 Version 8.0.0 Colwell (2006).

Results

Avifauna composition

The sample-based, non-randomized species accumulation curve generated, using data pooled from all 32 transects from the various blocks have reached an asymptote, suggesting that majority of the resident avifauna species had been sampled (Fig. 2).

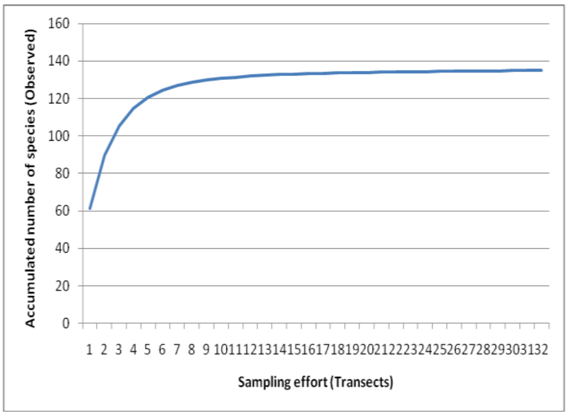

Fig. 2. Sample-based species accumulation curves of the total 3,641 individual birds encountered on 32 transects in KCA.

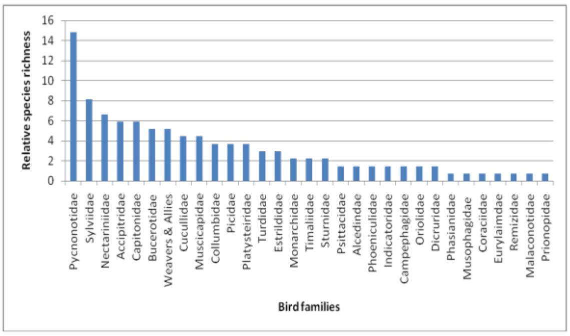

Fig. 3. Relative species richness in terms of bird family contribution arranged in order of highest richness to the lowest.

A total of 3641 individual birds belonging to 31 avian families and 135 species were recorded from 32 transects over 32 km during the entire study period in the area. The most dominant Family in all the blocks was the Pycnonotidae, followed by Sylviidae contributing 15 and eight species respectively. Other common groups were the Nectariniidae, Accipitridae, Capitonidae, Bucerotidae, Cuculidae, Musicapidae, Collumbidae, Picidae, Platysteiridae, and Ploceidae contributing an average of 7 species. Three (3) species were recorded each from the Monarchidea, Timaliidae and Sturnidae families. Figure 4 gives the detail overview of the individual family contributions to the avifauna composition of KCA arranged in order of high contribution to low contribution of species richness or family of importance.

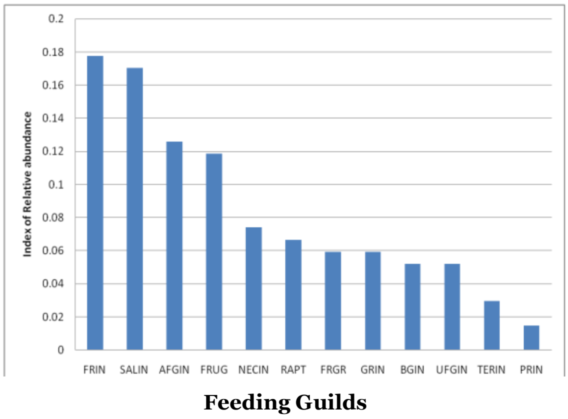

Fig. 4. Relative abundance of guild composition of birds in KCA. RAPT indicates Raptor; GRIN, Granivore insectivore; FRUG, Frugivore; FRGR, Frugivore-Granivore; FRIN, Frugivore-Insectivore; AFGIN, Aerial foraging insectivore, UFGIN, Understorey floliage-gleaning Insectivore, TERIN, Terrestrial Insectivore, SALIN, Sallying Insectivore.

Species richness and diversity

The estimated richness of avifauna for the Reserve using second order jackknife estimator was 137.14 (SD=1.06). The result shows that out of the 31 families, Pycnonotidae alone contributed 14.8% of the overall species richness. Families phasianidae, musophagidae, coraciidae, eurlaimdae, bemizidae, malaconotidae and prionopidae recorded 0.74% each to the species richness. The Shannon-Weiner diversity index of bird species surveyed in entire area was 4.63 at 95% confidence limit. The diversity indices for the individual blocks (Table 1) show relatively no variations. Species overlap between the blocks was very high ranging between 0 79-0.91.

Relative abundance of guilds the various blocks

Twelve feeding guilds were identified and classified according to their families with reference to their feeding strategies observed during the field survey. The distribution of individuals among guild categories based on the diet and foraging behaviour of birds showed clear consistencies among all the blocks with five guilds (i.e. Frugivore Insectivores, Sallying Insectivores, Aerial foraging Insectivores, Frugivores, and Nectarivore-Insectivore) showing a clear dominance (Fig. 4) in all the blocks. These five guilds accounted for 17.7%, 17.03%, 12.59%, 11.85% and 7.40% respectively of all observations in the study area. The Predator Insectivore (PRIN) guild comprising of species such as *Dryoscopus sabini* and *Prionops caniceps* recorded the lowest values of 1.48% in the area.

Discussion

Species composition, diversity and richness

The dominating species were from the pycnonotidae family. The species composition of this study did not differ much from the community described for the primary moist semi-deciduous forest of the Bia reserve in Ghana (Taylor & MacDonald, 1978) and Holbech, (1992, 1996) who did not find major differences in species composition between logged and unlogged forest (Holbech, 1992) or between forests of different logging regimes (Holbech, 1996). The generally high similarity and homogenous composition of birds observed in the study area follows the trend observed by Holbech (1992, 1996) where no major differences in species composition between logged and unlogged forest or between forests of different logging regimes were recorded. Allport *et al.* (1989) likewise documented high species similarity (> 80%) between logged and unlogged areas of the Gola forest (Sierra Leone) and found an almost identical species composition 99% in mist-net samples. Only seven species were exclusively listed by Gartshore *et al.* (1995) in primary forest and not in logged areas of the Taï National Park. Dranzoa (1998) did not also report any drastic changes in species composition between logged and unlogged forest in Kibale (Uganda) and in Bossematié in Cote D'Ivoire no difference was also found between logged and unlogged forest areas (Waltert 2000).

Changes in abundance of individual species by feeding guild

The distribution of individuals among guild categories based on the diet and foraging behaviour of birds showed clear consistencies among all the strata with five guilds (i.e. Frugivore Insectivores, Sallying Insectivores, Aerial foraging Insectivores, Frugivores, and Nectarivore-Insectivore) showing a clear dominance in all the blocks. These five guilds accounted for over 60%, of all observations in the study area. The Predator Insectivore recorded the lowest values of 1.48% in area as shown in fig 5. The relatively high abundance of the sallying-insectivore guild in this study contradicts with findings by Johns (1989, 1992) who found lower abundance of many sallying insectivorous species (flycatchers and monarchs) after logging in peninsular Malaysia. This contradiction may be as result of the time lapse between the last logging and time of the study where there might have been some recovery by the birds from the shock of logging.

Conclusions and recommendations

Selective logging has the potential to protect many species of forest birds in comparison with alternative uses of the forest, such as clearing for agriculture. There will always be species that suffer as a consequence of the logging activities. It cannot however be regarded as an alternative to the preservation of areas of tropical rain forest, but can be used as a means to protect certain adaptable species which would otherwise become extinct if a forest landscape were to be totally removed of the trees.

Future research on the effects of logging on birds should aim at starting in advance of the logging event, and ideally continue several decades after the event to enable clear patterns of responses of logging effects to be established.

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