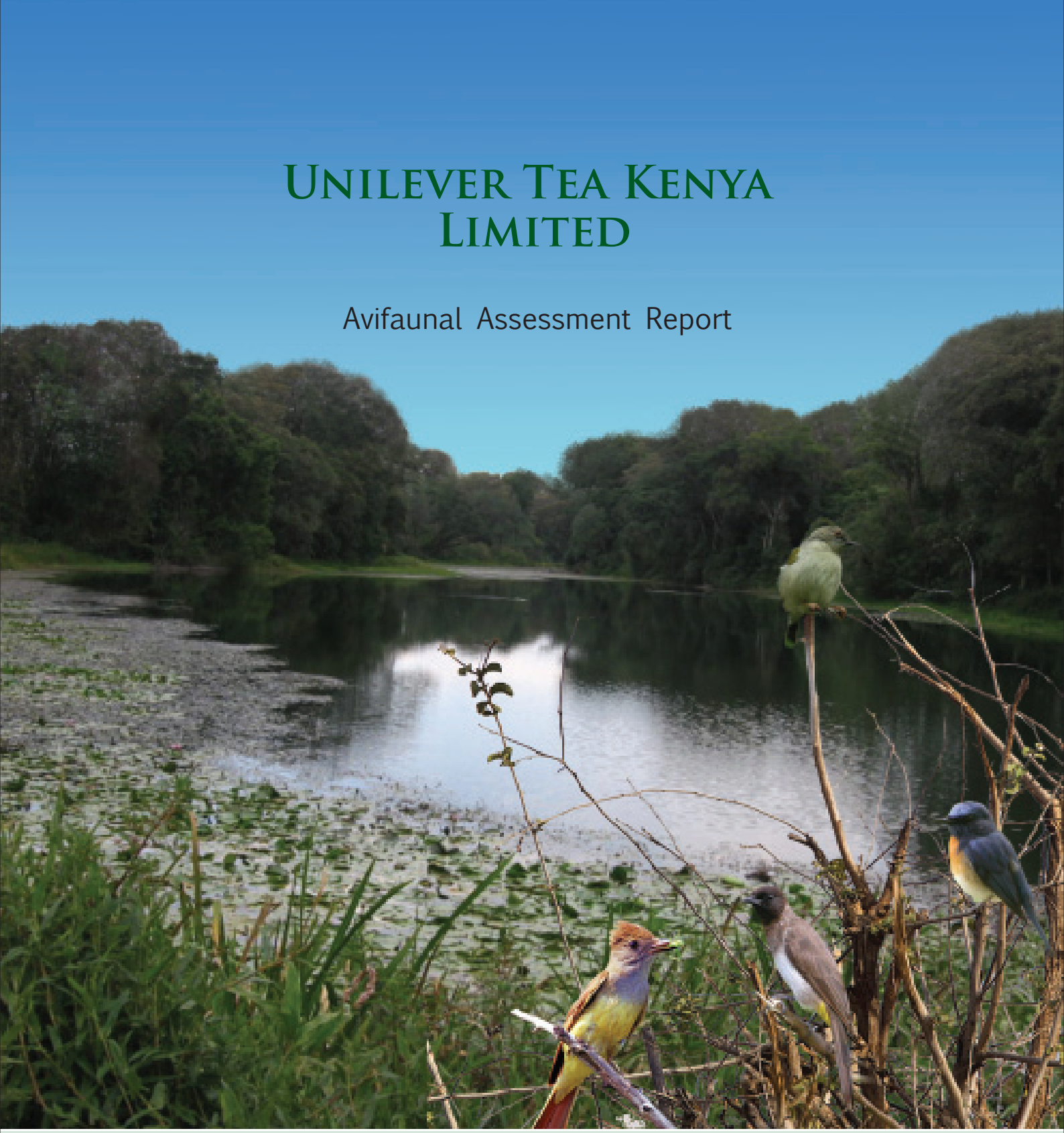
Unilever Tea Kenya Limited

Avifaunal Assessment Report



Technical Report May 2009

Unilever

NATIONAL MUSEUMS OF KENYA

WHERE HERITAGE LIVES ON

This book is dedicated to the life and work of the late Kimbo Beakbane. Our first company 'birder' who passionately believed that business and the environment should live in harmony.

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We also single out the efforts of the Research and Development Team led from the front by Gabriel Tuei and with support from Joel Kimetto, Fred Ouko, David Lang'at and Richard Lang'at and others; they assisted us from the planning stages of this work all through to its very successful implementation. They took us around both during reconnaissance and fieldwork providing very crucial insights and information, without which this project would not have turned out to be as successful, or indeed, not nearly as enjoyable. It was largely down to their hard work on the ground and tireless efforts during fieldwork that everything went according to plan. Many thanks—it was a great TEAM EFFORT! Various scientists at Unilever UK—particularly Dr. Christof Walter and Dr. Gail Smith—also provided interesting and useful comments, additions and ideas which greatly improved this report.

Members of previous teams surveying biodiversity at Unilever, particularly Mordecai Ogada and Dorothy Nyingi provided us with interesting and useful information about their experience and project results. For their professionalism we are very thankful. Other important players contributed in various ways to the success of this work including the local community members and other Unilever employees who were not only very hospitable but also showed keen interest in our exercise. We hope that our results will be helpful for them as they safeguard their biodiversity, forest & environment—their heritage.

Bird ringing: Sylvester Karimi (L) and Joel Kimetto (R)
(Inset: Sylverster and David Lang'at)

Executive Summary

In 1999, Unilever Tea Kenya (UTK) initiated the Sustainable Agriculture program at the Kericho Tea Estates. As a result, dispersed throughout the tea monocultures today are patches of forests, small wetland areas and windbreaks consisting of indigenous and exotic trees; riparian forests form an integral part of the landscape making up over 10% of the entire area. This study aimed at assessing the avian diversity in the Unilever sustainable tea growing zones. Because birds are a good indicator for many other forms of biodiversity, presence of forest-dependent bird species across the landscape will help gauge how well the sustainable agriculture is supporting forest-dependent biota in general.

Fieldwork was conducted over a three-week period between 6th and 28th March 2009. Following a reconnaissance survey, sampling points were set progressively from the NE extension (Kapkatunga) down to South to Kaptien and SW to Ngoina covering the continuous forest blocks (Kapkatunga and Sambret), as well as most riparian strips and planted indigenous forests in the various estates; exotic plantations and tea monoculture zones were also sampled. The two main systematic methods used to sample and census birds were timed-species counts (TSC: 85 in total) and point counts (PC: 136 in total) distributed across the different habitats and administrative estates (Divisions). In addition, there was targeted mistnetting in four sites across the entire study site.

Overall, a total of 174 species were identified in this study, which is slightly higher but comparable to the 121 and 132 species recorded in the previous studies in the Maasai Mau Forests. It is likely that the 174 species list was not entirely comprehensive, with the species accumulation models showing the complete species list for the entire UTK-Kericho Estate is likely to be 200-220 species. A number of species of interest were recorded, including two globally Near-threatened species (Pallid Harrier and Semi-collared Flycatcher), regional endemics (Hartlaub's Turaco and Hunter's Cisticola) and several nationally scarce species. Overall, 30 of the 174 species recorded were Afrotropical Highland biome species, while six were Guinea-Congo Forest biome species. There was a sizeable representation of migrants with 24 species being either Afrotropical or Palaearctic Migrants.

Similar to previous studies in the Maasai Mau Forests (Southwest Mau, Transmara and Maasai Mau Forest), about 40% of the species assemblage here was forest dependent, while, based on feeding guilds, the species composition was predominantly insectivorous. This highlights the importance of the retained forest as well as the riparian strips in conserving true forest dependent species. Differences between the current and previous studies (which were done predominantly in forested habitat) can be attributed to either season (presence or absence of migrants) or the fact that the current study included agricultural areas which have different species assemblages from forests.

From the point counts, Yellow-whiskered Greenbul and Common Bulbul were the commonest and most widespread species, whereas based on the TSCs it was Common Bulbul and Yellow White-eye. From the mistnetting, Yellow-whiskered Greenbul was by far the commonest species. Lastly, the TSC-Index revealed that the commonest bird species was the Common Bulbul, followed by the Yellow White-eye and Yellow-whiskered Greenbul, respectively. In all, the greenbul, bulbul and white-eye were evidently the commonest species across UTK-Kericho Estate.

Albeit with slightly different overall sampling effort, Kapkorech (99 species), Jamji (95) and Kericho (94) Estates had the highest number of species recorded during this study. This could be due to the predominance of indigenous forest habitats especially in Kapkorech but also in Kericho, and the very diverse habitats for Jamji which included Jamji Division (wet) and Ngoina (drier).

Bird-habitat analysis based on mean number of species recorded per TSC (NB: only TSC data were used in order to control for differences in sampling effort amongst habitats) ranked TSCs in the indigenous forest habitats the highest, followed by riparian strips and monoculture plantations. Unsurprisingly, due to specificity in habitat requirements, very few species (6) occurred across all the seven different habitats studies; the majority (55) were restricted to only a single habitat. Most of these habitat-unique species (36) were restricted to indigenous forests (riparian strips and the retained indigenous forest blocks at Kapkatunga and Sambret), with 18 being

Executive Summary *contd.*

forest-dependent species. This highlights the crucial role played by the retained indigenous habitats within the Unilever Estate at Kericho in holding forest species that may otherwise not survive in the landscape.

Conservation issues and recommendations

- *Linkage between Unilever and neighbouring ecosystems:* UTK-Kericho Estate is clearly an important area for conservation of forest birds, which are closely linked to the avifauna of the neighbouring Mau Forest ecosystem. There are several important species for conservation both globally and nationally. Given the occurrence of these birds and the ever-growing levels of threat in the Mau ecosystem, the populations supported at Unilever may play an increasingly important role in the conservation of these species in future and so should be maintained
- *Key floral and landscape features at Unilever:* For the conservation of the forest birds that occur in the Unilever Estate boundaries, it is vital that the Sustainable Agriculture methods are maintained. It is essential to maintain the indigenous forest riparian strips as well as the continuous forest block at Kapkorech and Sambret. While the riparian strips may largely play a connection role linking various habitats and ecosystems, the indigenous forest patch is large enough and close enough to the Mau Forest to sustain breeding populations of forest dependent species which is crucial
- *Threats:* Currently, the main threats here may be external (related to human activities outside), given that the small-scale (subsistence and tea) farmers do not typically apply sustainable agriculture
- *Increasing the management and status of birds at Unilever:* Riparian forest conservation and planting on UTK land provides important habitat for forest-dependent bird species. This key habitat can be enhanced by enrichment tree planting (especially of endemic or threatened species). Besides these strips, the blocks of forest including the continuous block at Kapkorech as well as the scatter of indigenous woodlots in the various arboreta, Monkey Sanctuary and Podocarpus stand will be crucial for providing extra habitat and 'stepping stones' for dispersing species. Further, in addition to habitat provision, the conservation of forest birds in the Estate will be bolstered through protection from hunting or inappropriate exploitation by company rules and education programmes
- *Monitoring:* the long-term monitoring technique to be used for birds is the point counts method. A randomly generated list of GPS locations where point counts were undertaken during this baseline survey and which can be used for monitoring are provided (though may need to be increased in a few Estates such as Chebown (which has only 3 points at the moment)
- *Research recommendations:* First, it would be interesting to repeat this exercise in a different season in order to have a more complete picture. Secondly, further biological and life (natural) history research should be carried out on the forest birds within the UTK-Kericho farm to improving our understanding of how they use these habitats, i.e., whether for feeding, breeding or moving between different ecosystems. Lastly, monitoring should be maintained to check for trends in time and space, in order to understand effects of various practices (such the evolving Sustainable Agriculture) and also especially with the activities related to the neighbouring Mau ecosystem. This will help improve on the agricultural practices themselves for greatest benefit to the forest dependent birds and other fauna.

Overall, the retention of non-tea habitat (especially indigenous riparian strips and forest blocks) under the Sustainable Agriculture Initiative at UTK-Kericho Estate can thus indeed be said to be a key addition to the natural environment, providing important additional habitat for forest-dependent biodiversity. Through this, a wide range of plant and animal species are sustained, which contributes to maintaining the natural balance across this extensive landscape that includes the vast Mau

Introduction

Birds are one of the best-studied classes of organism and almost certainly the best-known group of vertebrates. There have been numerous studies on forest birds of eastern Africa, and most species are readily identifiable using field guides and standard reference works (e.g., Zimmerman et al. 1996). Ecologically, birds also benefit humans by providing important ecosystem services, such as: provisioning services via game meat for food, feathers for garments and guano for fertilizer; regulating services by scavenging carcasses and waste, by controlling populations of invertebrate and vertebrate pests, by pollinating and dispersing the seeds of plants; cultural services, as exemplified by the prominent roles of birds in art and religion and by the billions of dollars spent on bird-watching; and supporting services by cycling nutrients and by contributing to soil formation (Sekercioglu 2006). The African Crowned Eagle, Stephanoaetus coronatus, is an example of a top predator in some forests, and may take prey as large as Colobus Monkeys.

Birds are often considered as a useful indicator group, either for monitoring environmental change or for assessing biodiversity importance (Brooks et al. 2001). Birds as a group have many characteristics that make them good indicators: they are well-studied, taxonomically stable, easily surveyed, widely-distributed across almost all habitats, and include both generalised and specialised species. There are enough bird species (about 1,100 species in Kenya, more than 1,300 in East Africa, and more than 2,170 in Africa) to make meaningful comparisons between sites, but few enough that taxonomic and identification problems are rarely an issue (Davies 2002).

Agriculture expansion into forestland triggers loss of natural habitat, faunal and floral species declines or changes in species composition. For birds, for instance, there could be a loss or interference of nesting and breeding grounds. These negative impacts on biodiversity often translate to a deterioration of the services these biodiversity provide, and that people are dependent upon. As a result, it is very important to regularly take stock of the existing biodiversity and hence establish changes overtime in order to assess the impact of these changes.

Tea estates can contribute to biodiversity through striving to restore and retain the world's indigenous forest cover. Indigenous trees play a critical role in our environment through water retention, stabilisation of soil profiles and as a contributor to biodiversity. Tea estates can take deliberate actions within their own boundaries to support both water catchment conservation and biodiversity. This is the basis and ultimate goal for Unilever's Innovative Sustainable Agriculture Program. This approach to sustainable agriculture is based upon four key principles: Producing crops with high yield and nutritional quality to meet existing and future needs, whilst keeping resource inputs as low as possible; Ensuring that any adverse effects on soil fertility, water and air quality and biodiversity from agricultural activities are minimised and positive contribution will be made where possible; Optimising the use of renewable resources whilst minimising the use of non-renewable resources; Enabling local communities to protect and improve their wellbeing and environments.

Sustainable Agriculture is productive, competitive and efficient while at the same time protecting and improving the natural environment and conditions of the local communities

Excerpt of Unilever's Sustainable Agriculture Mission Statement formally adopted in December 1998

In addition to these four principles, ten indicators were selected to measure progress of the sustainable agriculture practices implemented (see Appendix IV). Of interest here is Indicator 5 which focuses entirely on biodiversity and its interaction with agriculture. It is clear that agriculture has shaped most ecosystems in the world, and biodiversity can be improved or reduced by agricultural practices. Besides, some biodiversity is highly beneficial for agriculture e.g., pollinators and pest control agents. Sustainable agriculture practices endeavour to improve biodiversity, both by 'greening the middle' of fields as well as 'greening the edge'. Some parameters identified for assessing this indicator include: level of biodiversity on site, habitat for natural predator systems, cross boundary effects.

Introduction *contd.*

In 1999, Unilever Tea Kenya (UTK) started its pilot program at the Brooke Bond Tea estates in Kericho to apply the sustainability principles and test the indicators. For example, the tea is planted using mulch and intercrops to increase the levels of organic matter in the soil, embankments, micro-catchments and drainage systems enhance soil and water conservation and no insecticides, acaricides, or fungicides are used in the tea fields. In addition, a variety of habitats make up the tea plantation landscapes. Dispersed throughout the tea monocultures are patches of forests, small wetland areas and windbreaks consisting of indigenous and exotic trees. Riparian forests are also an integral part of the landscape and make up over 10% of the tea estates.

Adjacent to the Unilever Tea Zone in Kericho is the sprawling Mau Forest Complex, the largest forest block in Kenya and an important water catchment area forming one of the five main "water towers" of Kenya. It is against this background that we propose to undertake a comprehensive study aimed at assessing the avian diversity in the Unilever sustainable tea growing zones. Besides assessing the species assemblages in the various habitats in the tea estates, we will attempt to compare the species composition to that of continuous (indigenous) forests (Mau) in an endeavour to ascertain the benefits accruing for birds from sustainable agriculture. Because birds are a good indicator for many other forms of biodiversity, presence of certain bird species across the landscape will help gauge how well the sustainable agriculture is supporting forest-dependent biota in general.

Objectives

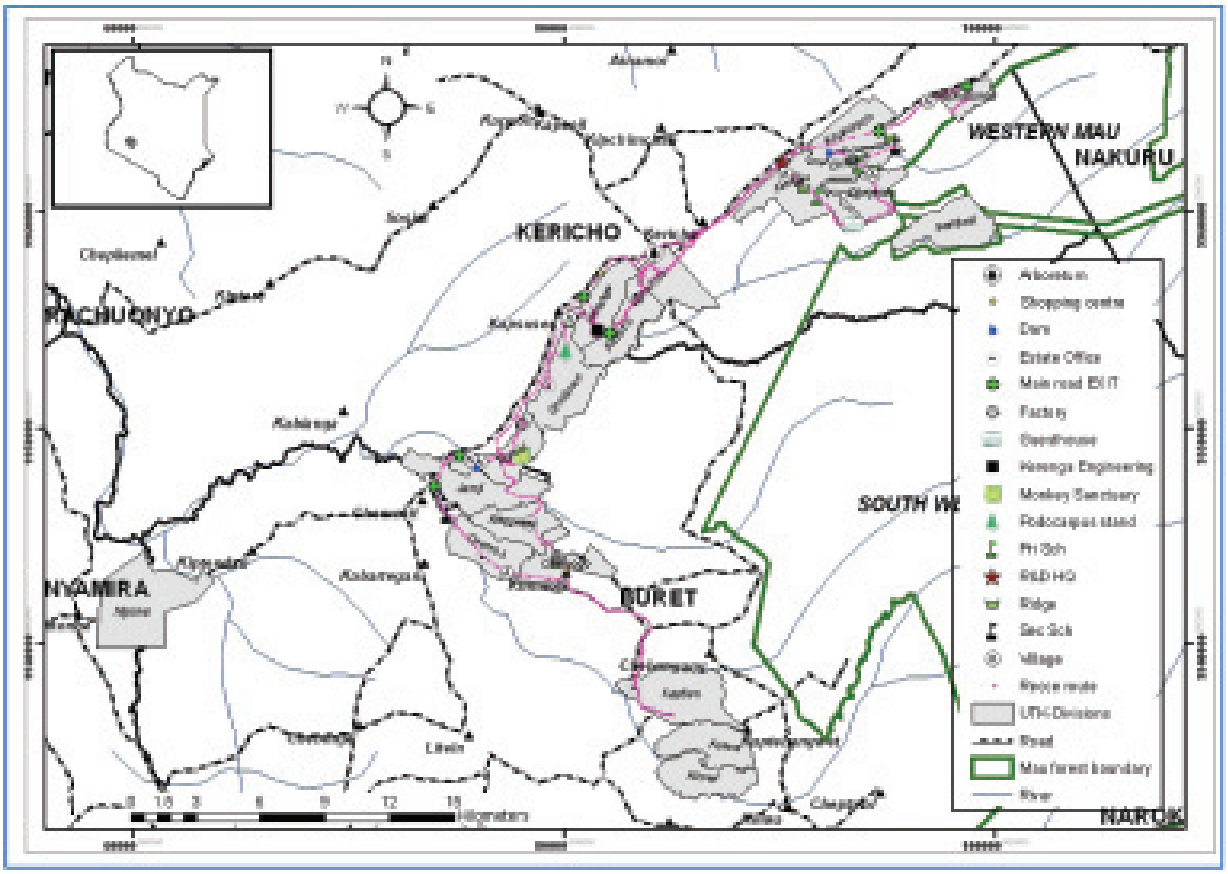
1. Carry out an inventory of birds across all habitats and administrative zones in the Unilever Tea Kenya, Kericho Estate
2. Establish linkages between birds of the sustainable tea zone and neighbouring ecosystems, with reference to past management practices
3. Identify key floral and landscape features that need to be protected or sustainably utilized
4. Identify any existing threats to biodiversity
5. Recommend ways of increasing the management and status of birds in the area
6. Develop monitoring strategies for birds in the tea zone.

Methods

Reconnaissance

A three-day reconnaissance survey was undertaken prior to the start of the study for the research team to acquaint itself with the Tea Estate, including the various administrative boundaries (Estates and Divisions) as well as distinct habitats within them which would be the focal points for sampling (Fig. 1). This reconnaissance enabled mapping of the entire area from GPS locations collected and facilitated planning for the fieldwork.

Figure 1: Administrative map of the larger Kericho area showing the location of the Unilever Tea Kenya Estate at Kericho, Kenya and the reconnaissance route followed. Inset map shows the location in Kenya



Study site

Unilever Tea Kenya: The Unilever Tea Estates in Kenya are located in the Limuru area, East of the Rift Valley (1,000 ha) and around Kericho, west of the Rift (13,159 ha). The Kericho area lies close to the Mau Forest Complex, an area of closed canopy forest designated as a Top Priority Forest for Conservation of Biodiversity, an Important Bird Area (Bennun & Njoroge 1999) high in bird species richness and one of Kenya's five 'Water Towers' under increasing threat (Akotsi et al. 2006).

Methods *contd.*

NATIONAL CONTEXT

The first Kenya Forest Policy (focussing on catchment protection and timber production) was written in 1957 and was revised in 'A Forest policy for Kenya' (Government of Kenya, 1968). In 1994 a new Forest Policy was adopted focussing on conservation, sustainable agriculture, sustainable benefits to alleviating poverty and promoting rural development.

The Agricultural act of 1986 states that a maximum of 30 metre riparian strip should not be cultivated, the soil destroyed or any vegetation cut within that strip. The new Forest At (2005) includes a provision for extending riparian forest to 50 m from the edge of rivers, and identifies the participation of the community in the management of the environment and natural resources.

UTK STATUS

11% (1.5% improvement in the last 5 years due to tree planting) of the land leased to UTK for tea cultivation west of the Rift Valley is occupied by natural forest, mainly along the edges of streams and small rivers. For many years, UTK has integrated protection of these areas with the production of tea and fuelwood (to use in factory boilers) in accordance with Unilever's Ecological Charter and Environmental Policy, and more recently under the Unilever Sustainable Tea Program (see details in Appendix IV). The result of this is that there has been good forest conservation along streams and rivers by contrast with elsewhere in Kenya. In addition to an Arboretum which the company has maintained for many years – three new arboreta – Chelimo, Cheymen and Theo Stanning garden, have been developed (see further).

IMPORTANT HABITATS WITHIN UTK

- *Riparian forest:* The tea-growing area near Kericho is in the AfroMontane forest. Extension planting within UTK boundaries as part of the 'Trees 2000' programme adds value to these areas as wildlife corridors and small reserves. One area is designated as a Monkey Sanctuary and supports a population of Black & White Colobus Monkeys *(Colubus polykomos)*. Two areas have been provided with picnic area facilities to enhance the enjoyment of the forest as a local leisure activity and to provide an educational resource. Theo Stanning garden has now been opened to the public and is fully operational

- *Forest fragments:* The many forest fragments within the Tea Estates house a range of native tree, shrub and herb species and are valuable parts of a landscape mosaic supporting bird and animal populations that use these areas as habitats and bird roosting areas during migrations. 'Trees 2000' extension planting is extending some of these areas and creating new small forest patches within the landscape

- *Arboreta:* The four Arboreta are of value for conservation and education. Trees have been labelled with Kipsigis (local) and Latin names. Small arboreta are being developed in each estate and close to villages for use by company employee's families and friends

Methods *contd.*

- *Wetlands:* Small areas of wetlands occur along the river in flatter areas and around the dams maintained for hydroelectricity production by UTK. Wetlands conservation and improvement is in the agenda of the Trees 2000 team

- *Converted/rehabilitated habitats* (tea, eucalyptus, windbreaks roadsides etc.): Although tea is an alien species grown as a monoculture, some local birds and animals e.g. Moles, Porcupine (genus Hystrix) do shelter and feed within the tea crop. Areas of *Eucalyptus and Grevillia* windbreaks are used by many species as part of a network of corridors across the landscape linking forest patches with the more extensive riparian forest.

Previous research

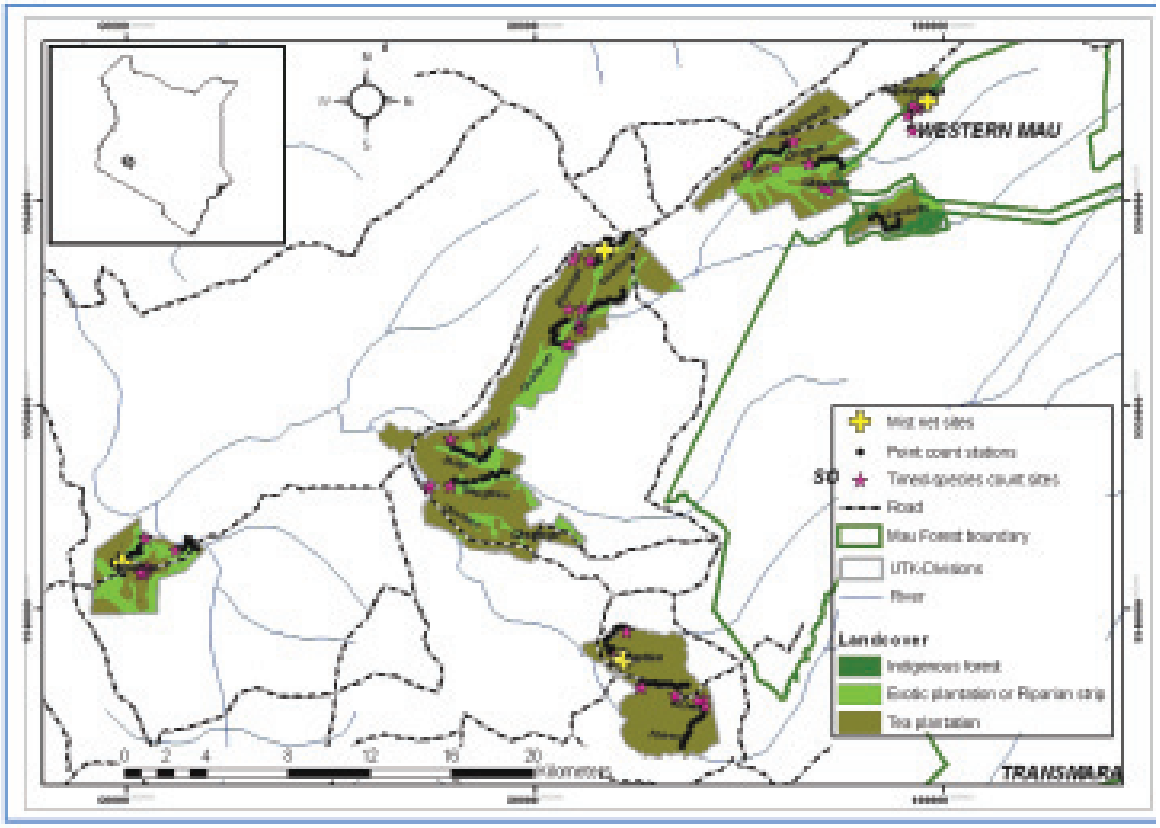
The Research and Development team and previous researchers in the Unilever Tea Estate at Kericho identified various species of flora and fauna within the Estates. Amongst the more than 10 mammal species include Red-tailed monkey *Cercopithacus ascanius*, Black-tipped mongoose *Mynax sanguineus*, Serval *Leptailurus serval*, Sykes monkey *Cercopithecus mitis*, Guereza colobus monkey *Colobus guereza*, African clawless otter *Aonyx capensis*, Vervet monkey *Cercopithecus aethiops*, and Root rat *Tachyorychtes rudii*. Besides more than 20 species of birds previously recorded, there were also reptilian records (Striped skink *Mabuya striata*, and Tropical house gecko *Hemidactylus mabouia*), several fishes (*Barbus paludinosus, Barbus neumayeri*) and crustaceans (Freshwater crab *Potamonautes neumannii*).

Methods *contd.*

Study design

Fieldwork was conducted over a three-week period between 6th and 28th March 2009. Following a reconnaissance survey, we elected to set sampling points progressively from the NE extension (Kapkatunga) down to South to Kaptien and SW to Ngoina (Fig. 2). We endeavoured to sample the continuous forest patches at Kapkatunga and Sambret, extensively sample all riparian strips and planted indigenous forests in the various estates, and have a representative sample of the exotic plantations and tea monoculture zones to complete the checklist.

Figure 2: Map of the Unilever Tea Kericho Estate landscape showing the major land use classes in the Estate. Sites where bird sampling was done are also indicated based on the methods used



Bird census

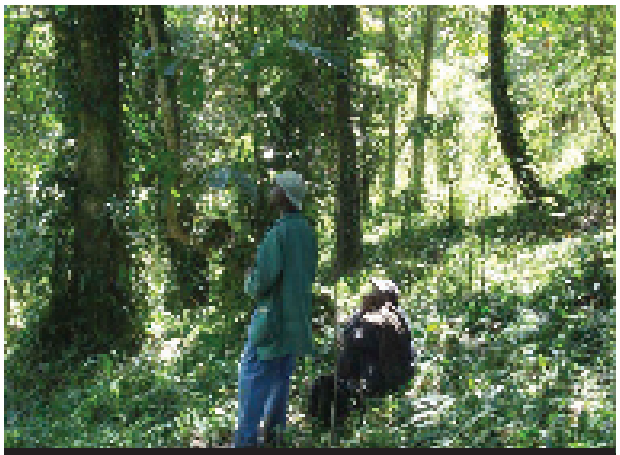
The two main systematic methods used to sample and census birds were timed-species counts (TSC) and point counts (PC). These aimed at building on from previous ornithological surveys of some of the Mau Complex forests blocks done by Bennun and Waiyaki (1991; 1992a; 1992b; 1993) and Githiru and colleagues (2008) in order to collect data that can be compared and establish if are any major differences in the avifaunal composition.

- Timed species-counts (TSCs): this technique is often used to build complete species lists quickly, and to establish the relative abundance of canopy and mid-level bird species (Davies 2002). TSCs were broadly spread over the entire study area in order to include all the different microhabitats present in the study site. Eighty five (85) 40-minute TSCs separated by at least 100 m were done in total (Fig. 2) across all

Methods *contd.*

the eight estates and various divisions within them (Table 1a&b). They were distributed in the following habitats: Indigenous-Eucalyptus edge (2); Eucalyptus Plantation (11); Indigenous Forest (15); Indigenous Forest edge (2); Planted indigenous forest (6); Riparian strip (31) and Tea Plantation (18). Data from this method were used in calculating an index of relative abundance called the TSC-Index.

- Point counts (PCs): although not as comprehensive as TSCs in building species lists,point counts are ideal for monitoring purposes and for making comparisons with habitat variables around each point (Davies 2002), both which were important for this study. Point count stations were systematically placed along transects set at each sampling zone. 136 point counts were done in total, each separated by 200-250 m from the next (Fig. 2) across all the eight estates and various divisions within them (Table 1a&b). Of the 136, a majority (102) were done in riparian strips of indigenous forest (the focal habitat for study), while the rest were done in the continuous forest block (19), Eucalyptus plantations (8) and disturbed forest (7). After a minute of settling down, bird census was done for 10 minutes at each point, and all distances to the birds seen estimated.



Conducting Point Counts: Titus Imboma (L) and David Lang'at (R)

Table 1a: Number of Point count stations and Timed-species counts undertaken in the eight Estates within the larger UTK- Kericho Estate

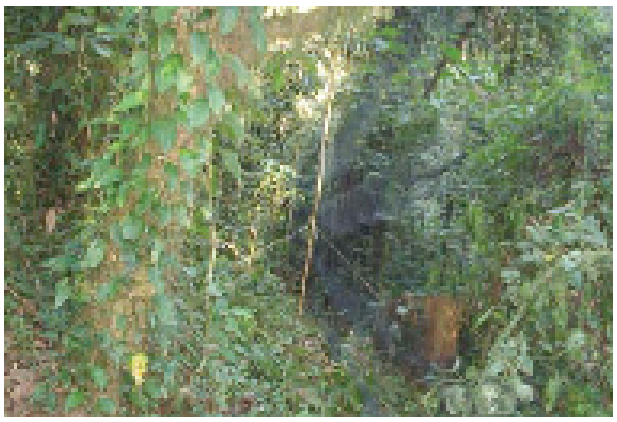
Estate S/No.	Estate	Point counts	Timed-species counts
1	Kapkorech	24	21
2	Cheymen	18	11
3	Kericho	30	19
4	Chebown	5	1
5	Jamji	20	13
6	Kapgwen	10	5
7	Kaptien	9	6
8	Koiwa	20	9
	Total	136	85

Methods *contd.*

Table 1b: Number of Point count stations and Timed-species counts undertaken in the various Divisions in UTK-Kericho Estate

S/No.	Estate	Division	Point count stations	S/No.	Estate	Division	Timed-species counts
1	Kapkorech	Chagaik	8	1	Kapkorech	Chagaik	7
1	Kapkorech	Chagaik-Kimugu	4	1	Kapkorech	Kapkatunga	14
1	Kapkorech	Kapkorech	12	2	Cheymen	Cheymen	5
2	Cheymen	Cheymen	5	2	Cheymen	Kimugu	4
2	Cheymen	Kimugu	5	2	Cheymen	Sambret	2
2	Cheymen	Sambret	8	3	Kericho	Kerenga	12
3	Kericho	Chelimo	9	3	Kericho	Kericho	2
3	Kericho	Kericho	9	3	Kericho	Masobet	5
3	Kericho	Kerenga	10	4	Chebown	Tagabi	1
3	Kericho	Masobet	2	5	Jamji	Jamji	1
4	Chebown	Tagabi-Jamji	5	5	Jamji	Ngoina	12
5	Jamji	Ngoina	20	6	Kapgwen	Chemosit	3
6	Kapgwen	Kapgwen	10	6	Kapgwen	Kapgwen	2
7	Kaptien	Kaptien	9	7	Kaptien	Kaptien	6
8	Koiwa	Kimari	10	8	Koiwa	Kimari	1
8	Koiwa	Koiwa	10	8	Koiwa	Koiwa	8
		Total	136			Total	85

- Mistnetting: In addition to the systematic sampling using the two methods above, the bird checklist was improved by opportunistic bird observations and targeted mistnetting. Mistnetting was done in four sites (Chelimo, Kapkorech, Kaptien and Ngoina; see Fig. 2) in the estate to check whether any skulking and secretive species may have been missed, to ring as many individuals as possible for possible future monitoring, and to obtain some pictures for presentation purposes. Mistnets were laid for one-and-a-half days at each of the four sites, and all birds captured were ringed with uniquely-numbered aluminium rings; standard biometric measurements were also taken.



Mistnetting

Methods *contd.*

Data analysis

SPECIES ACCUMULATION CURVES MODELLING

This simple test aimed to inform us how close the total number of species we recorded during the study was to the potential total number of species actually in the study area. We prepared a species accumulation curve using the progressive number of new bird species seen every day from Day 1 to Day 23 of our study. We then fitted an asymptotic model to our species accumulation curve of observed data, using nonlinear regression procedures (Gaidet et al. 2005), adopting the exponential equation of the linear dependence model (Soberón & Llorente 1993). This is practical for relatively less diverse assemblages of well known groups such as mammals, some tropical insects (Moreno & Halffter 2000; Soberón & Llorente 1993; Willott 2001), or birds as in this study. In this model, the predicted number of species S(p) added to the list decreases linearly as number of days sampled (p) increases:

$$S(p) = a/b\ [1-\exp(-b*p)]$$

where the parameter a represents the increase rate at the beginning of the sampling period and *a/b* is the asymptote (Gaidet et al. 2005; Soberón & Llorente 1993). The value of *'a'* was estimated as the mean rate of increase of new species over the initial 5 days including the 1st day (i.e., day 1-5).

TIMED SPECIES-COUNTS (TSC)

For each TSC, each bird species was assigned an index ranging from 0 to 4, depending on whether it was recorded during the first 10 minutes (= 4), second ten minutes (= 3), third ten minutes (= 2), fourth ten minutes (= 1); species not recorded during that specific TSC scored a '0'. An average score (*TSC Index*) was then computed over all (85) counts across the entire study area, which is an index of relative abundance of the species. To establish distribution patterns, the *encounter rate* was also computed based on the proportion of all TSCs in which a species was recorded.

POINT COUNTS (PC)

We assessed species relative abundance and distribution using the PC *occurrence index*, which is the proportion of counts where a given species was recorded.

FOREST DEPENDENCY

To explore forest dependency, bird species were classified either as forest-specialist (FF), forest generalist (F), forest visitors (small-f) or non-forest (non-f) species (Bennun et al. 1996); FF and F are dependent on forests, while small-f and non-f are not. The number of species in each of the four categories for the entire study area was obtained.

FEEDING GUILD

To explore species composition in terms of the feeding guilds, bird species were classified according to the main food type based on observations and literature. The number of species in each of the feeding category for the entire study area was obtained. The following nine categories were identified:

i. Insectivore: invertebrate feeder
ii. Frugivore: fruit-eater
iii. Granivore: seed-eater
iv. Raptor: birds of prey – meat-eater
v. Nectarinivore: nectar-feeder
vi. Piscivore: fish-eater
vii. Mulluscivore: snails and slugs eating
viii. Omnivore: no specific predominant food type of the above
ix. Algivore: algae-feeder

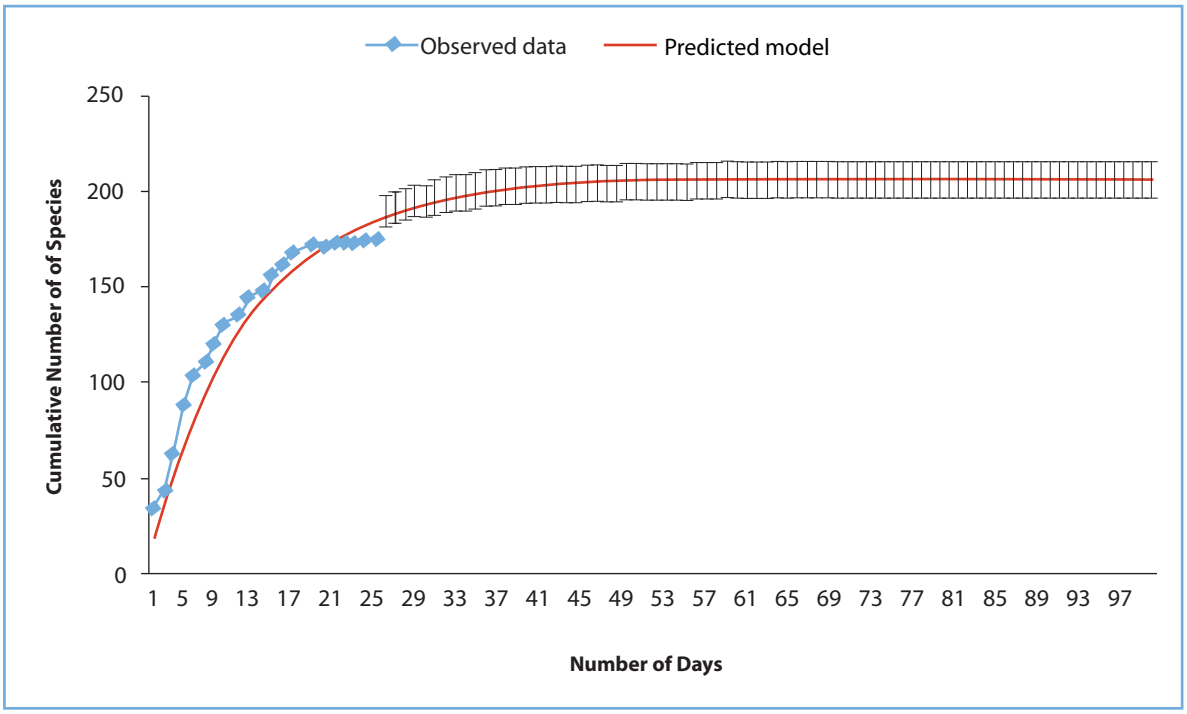
GENERAL ANALYSES

The data were analysed using STATISTICA program (StatSoft 2001).

Species accumulation curve

Overall, a total of 158 species were recorded from the point counts (with a total of 121 species), timed-species counts (142 species) and mistnetting (26 species). An extra 16 species were observed opportunistically, bringing a total of 174 species identified in total during the study (complete checklist in Appendix I). Of the 158 species, 49 were recorded in only one of the three methods (14 being unique for PC, 34 for TSC and one for mistnetting) underlying the value of having at least two methods in initial surveys. From the species accumulation curve, it was apparent that the complete avian community may not have been captured during this study (Fig. 3). Based on the upper and lower confidence limits of this estimate, the number of species expected for UTK-Kericho Estate is likely to be between 200 and 220 bird species.

Figure 3: Species accumulation curve based on an asymptotic model using nonlinear regression procedures for successive survey days in UTK-Kericho Estate



Species of interest

Thirty-six (36) of the 174 species seen were biome-characteristic species, being overwhelmingly from the Afrotropical Highland biome (30 species), with the rest (6) being representative of Guinea-Congo Forest biome (Appendix 1). Other interesting species recorded included seven species either considered globally Near-threatened or nationally

Results *contd.*

Scarce by the Ornithological sub-committee of the East African Natural History Society (Table 2a), and 24 Afrotropical and/or Palaearctic Migrants (Table 2b).

Table 2: Some of the species of interest encountered in the UTK-KERICHO ESTATE

2a: Globally- threatened and nationally-scarce species

Threat and Scarcity	Common name	Scientific name
Globally Near-threatened	Pallid Harrier	*Circus macroruurus*
	Semi-collared Flycatcher	*Ficedula semitorquata*
Scarce	Black Stork	*Ciconia nigra*
	Eurasian Nightjar	*Caprimulgus europaeus*
	Least Honeyguide	*Indicator exilis*
	Mountain Illadopsis	*Illadopsispyrrhoptera*
	White-tailed Crested Flycatcher	*Trochocercus albonotatus*
Regionally threatened	African Crowned Eagle	*Stephanoaetus coronatus*
Restricted-range	Hunter's Cisticola	*Cisticola hunteri*

2b: Afrotropical (AM) and Palaearctic (PM) Migrants

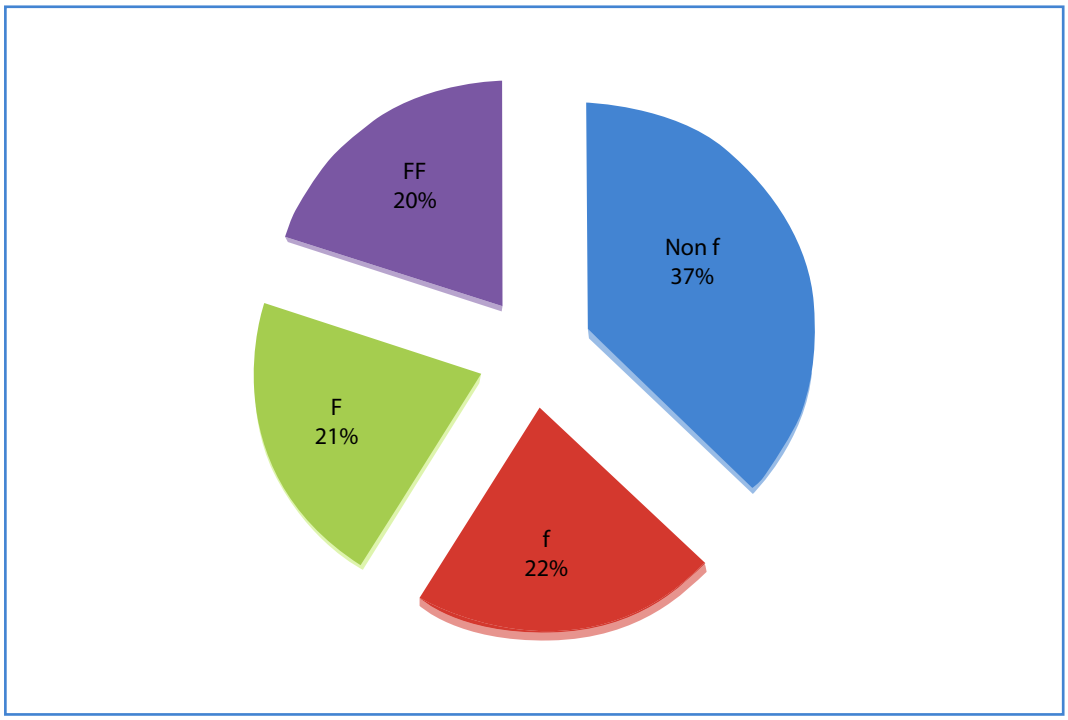
Migrant status	Common name	Scientific name
AM	Red-knobbed Coot	Fulicia cristata
AM	Yellow-billed Duck	Anas undulata
AM,PM	Broad-billed Roller	Eurystomus glaucurus
AM,PM	Grey Heron	Ardea cinerea
PM	Barn Swallow	Hirundo rustica
PM	Black Kite	Milvus migrans
PM	Black Stork	Ciconia nigra
PM	Blackcap Warbler	Sylvia atricapilla
PM	Common Buzzard	Buteo buteo
PM	Common Sandpiper	Actitis hypoleucos
PM	Eurasian Bee-eater	Merops apiaster
PM	Eurasian Hobby	Falco subbuteo
PM	Eurasian Nightjar	Caprimulgus europaeus
PM	Eurasian Swift	Apus apus
PM	Garden Warbler	Sylvia borin
PM	Green Sandpiper	Tringa ochropus
PM	Grey Wagtail	Motacilla cinerea
PM	Marsh Warbler	Acrocephalus palustris
PM	Olivaceous Warbler	Hippolais pallida
PM	Pallid Harrier	Circus macroruurus
PM	Sand Martin	Riparia riparia
PM	Semi-collared Flycatcher	Ficedula semitorquata
PM	Steppe Eagle	Aquila nipalensis
PM	Tree Pipit	Anthus trivialis
PM	Willow Warbler	Phylloscopus trochilus
PM	Yellow Wagtail	Motacilla flava

Results *contd.*

Forest-dependency analysis

Overall, the proportion of the different forest-dependency categories was almost even (Fig. 4), indicating even coverage of the indigenous forest and agricultural habitats in this landscape.

Figure 4: Proportion of the species assemblage falling under the four forest dependency categories



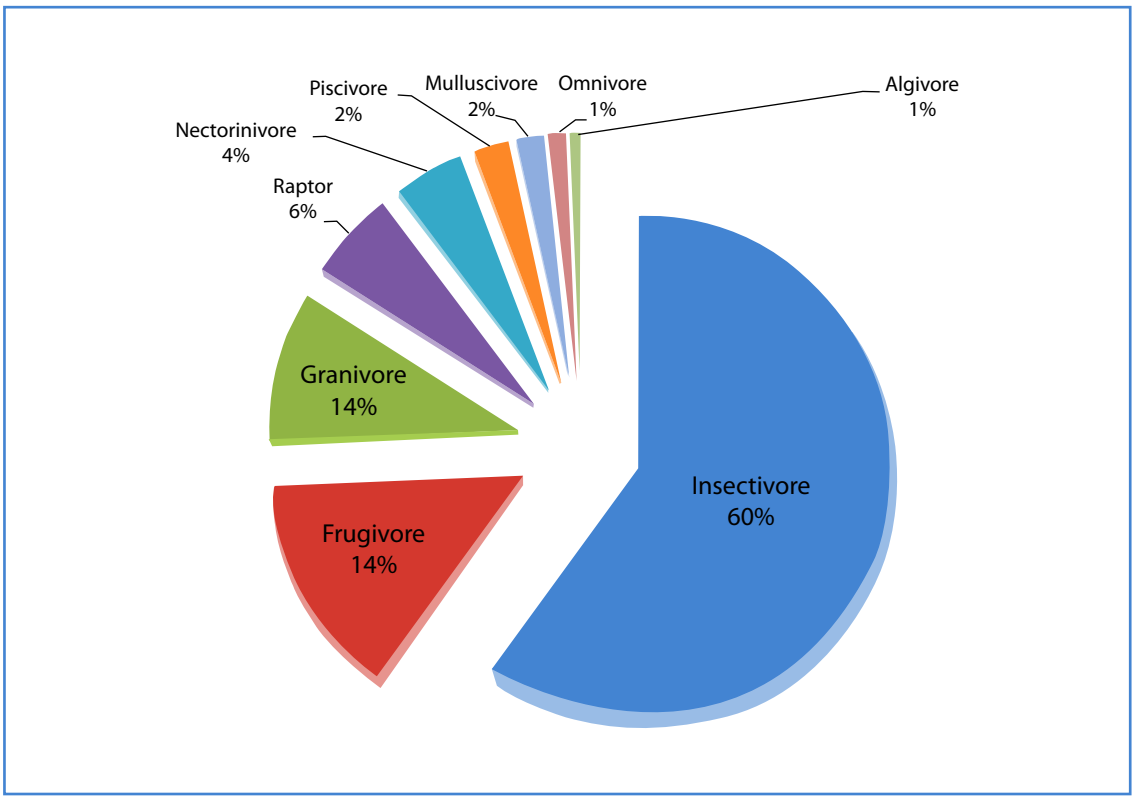
African Paradise Flycatcher (L) & Grey-backed Camaroptera (R)

Results *contd.*

Feeding guilds

Overall, the proportion of the different feeding guilds showed that insectivores dominated the species assemblage (Fig. 5).

Figure 5: Separation of the species assemblage by the dominant feeding guilds at the UTKKericho Estate



Encounter rate and species distribution

Point counts

From the point counts, Yellow-whiskered Greenbul and Common Bulbul were the commonest and most widespread species, occurring in about 70% of all the point count stations surveyed, and (except for one Division for the Greenbul) also in all the Divisions Point counts surveyed (Table 3).

Table 3: Top-ten commonest and most widespread species based on number of encounters by Point Count method at UTK-Kericho Estate (out of 136 PCs and 16 Divisions)

Common name	Total No of PCs	Common name	No. of Divisions
Yellow-whiskered Greenbul	99	African Paradise Flycatcher	16
Common Bulbul	93	Common Bulbul	16
Olive Sunbird	73	Yellow White-eye	16
Lühder's Bush-shrike	57	Black-faced Rufous Warbler	15
Grey-backed Camaroptera	54	Black-throated Wattle-eye	15
African Paradise Flycatcher	49	Lühder's Bush-shrike	15
Black-faced Rufous Warbler	49	Olive Sunbird	15
Yellow White-eye	49	Yellow-whiskered Greenbul	15
Northern Double-collared Sunbird	43	Grey-backed Camaroptera	14
Cabanis's Greenbul	37	Northern Double-collared Sunbird	14

Timed-species count

Based on the TSCs, Common Bulbul and Yellow White-eye were the commonest and mostwidespread species, occurring in more than 60% of all the TSCs surveyed, and in all but two of the Divisions surveyed (Table 4).

Table 4: Top-ten commonest species by number of encounters by Timed-Species Count method at UTK-Kericho Estate (out of 85 TSCs and 16 Divisions)

Common name	Total No of PCs	Common name	No. of Divisions
Common Bulbul	68	Common Bulbul	14
Yellow White-eye	51	Yellow White-eye	14
Yellow-whiskered Greenbul	40	Olive Sunbird	12
African Paradise Flycatcher	36	Yellow-whiskered Greenbul	12
Olive Sunbird	36	Barn Swallow	11
Grey-backed Camaroptera	32	Black-throated Wattle-eye	11
Northern Double-collared Sunbird	30	Lühder's Bush-shrike	11
Black Saw-wing	28	African Paradise Flycatcher	10
Barn Swallow	25	Black-faced Rufous Warbler	10
Black-faced Rufous Warbler	23	Grey-backed Camaroptera	10
Lühder's Bush-shrike	23	Northern Double-collared Sunbird	10

Mistnetting

Yellow-whiskered Greenbul was by far the commonest species caught in the nets, making up for 43% of all captures (Table 5; Appendix 2). Other common species captured in all four sites included the Olive Sunbird and Cabanis's Greenbul; Mountain Illadopsis was also captured in all sites but was far less common.

Results *contd.*

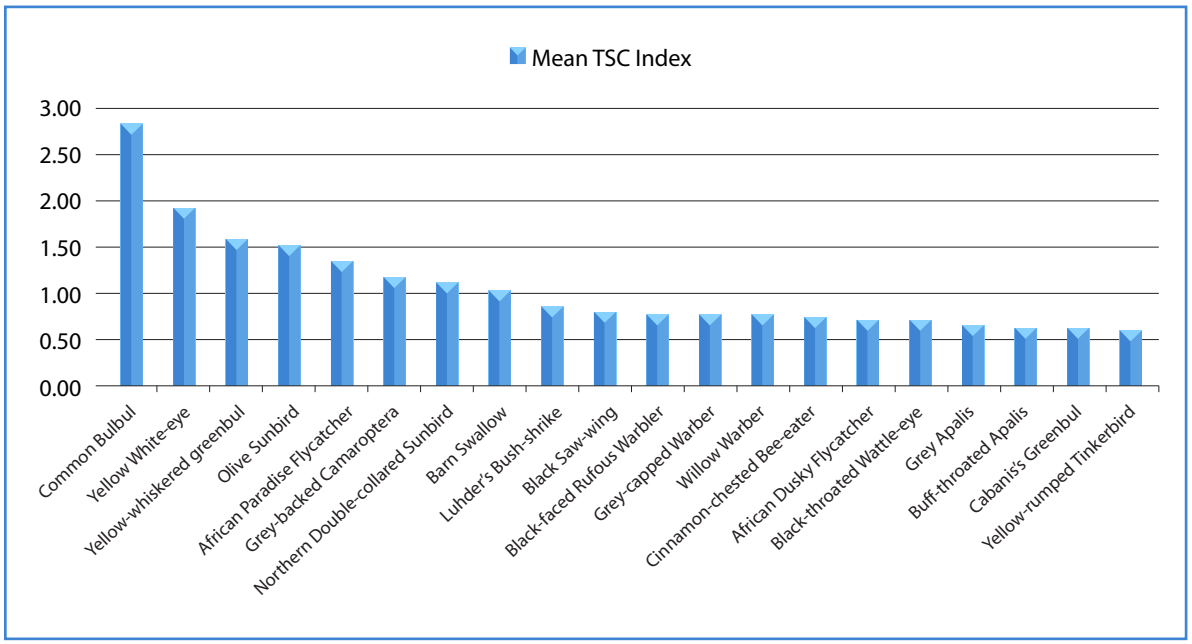
Table 5: Top-ten most frequently captured birds during the mistnetting sessions in the four sites at UTK-Kericho Estate

Common name	Chelimo	Kapkorech	Kaptien	Ngoina	Grand Total
Yellow-whiskered Greenbul	12	28	29	16	85
Olive Sunbird	4	23	9	2	38
Cabanis's Greenbul	9	8	2	2	21
Mountain Illadopsis	2	1	2	1	6
Snowy-headed Robin Chat		3		3	6
Brown-chested Alethe	1	2	2		5
Black-collared Apalis			4		4
Black-faced Rufous Warbler	1	2			3
Equatorial Akalat		1	2		3
White-tailed Crested Flycatcher	1	2			3

Commonness: relative abundance

Based on the TSC-Index (on a scale of 1-4), the commonest bird species was the Common Bulbul, followed by the Yellow White-eye and Yellow-whiskered Greenbul, respectively (Fig. 6).

Figure 6: Top-20 commonest species based on relative abundance measures using the TSC Index (scale of 1-4)

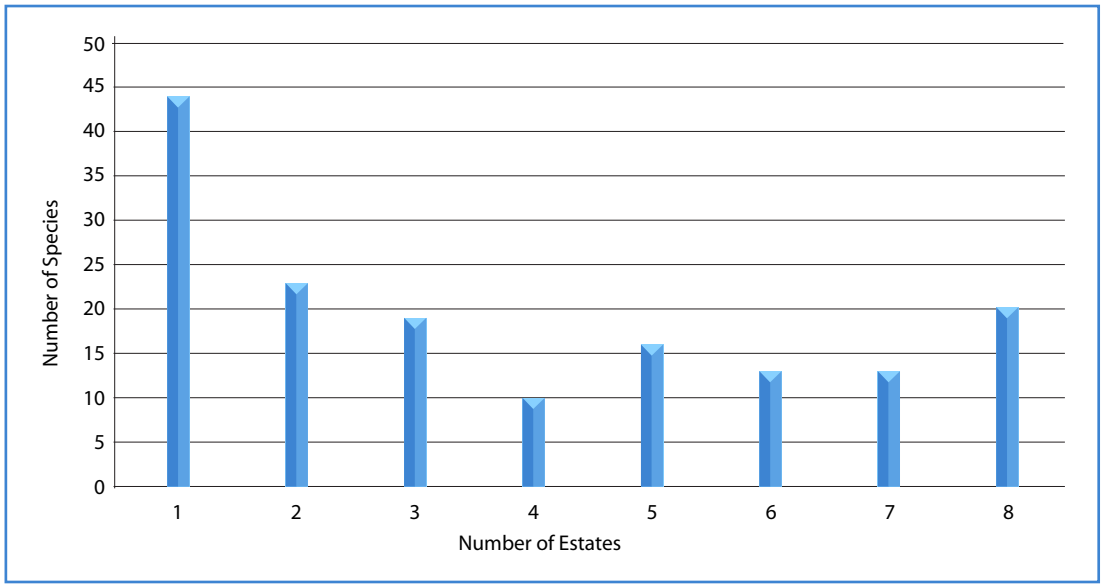


Results *contd.*

Species distribution across UTK Kericho Estate's Divisions

Overall, Kapkorech (99 species), Jamji (95) and Kericho (94) Estates had the highest number of species recorded within the Estate's Divisions. Number of species recorded for other Estates were: Cheymen (83), Koiwa (68), Kapgwen (61), Kaptien (53) and Chebown (43). Of the 158 species recorded during systematic sampling, 20 species occurred across all eight Estates (Fig. 7), whilst 44 species occurred in only a single Estate. Of these 44 Estate-unique species, Kapkorech (with 16 species) and Jamji (10) had the highest number of species. Contrastingly, the 16 unique species for Kapkorech included 5 FF, 5 F, no f and 6 non-f (including the African Crowned Eagle and Least Honeyguide), while the 10 unique species for Jamji (which included the drier Ngoina) included no FF, 2 F, 2, f and 6 non-f.

Figure 7: Occurrence of bird species across the 8 Estates of UTK-Kericho Estate



Bird species richness by habitat: TSC method

This habitat analysis took into consideration sampling effort hence used only data from the TSC method which were the most comprehensive with 142 species recorded in total. Though the greatest number of species was recorded in the Riparian strips, this habitat was also the most extensively sampled (Fig. 8). Indeed, the more telling figure of mean number of species recorded per TSC ranks indigenous forest habitats the highest, followed by riparian strips and monoculture plantations (Fig. 9).

Results *contd.*

Figure 8: Total number of species recorded in each of the 7 habitats sampled at UTK-Kericho using TSCs, and the number of TSC conducted in those habitats

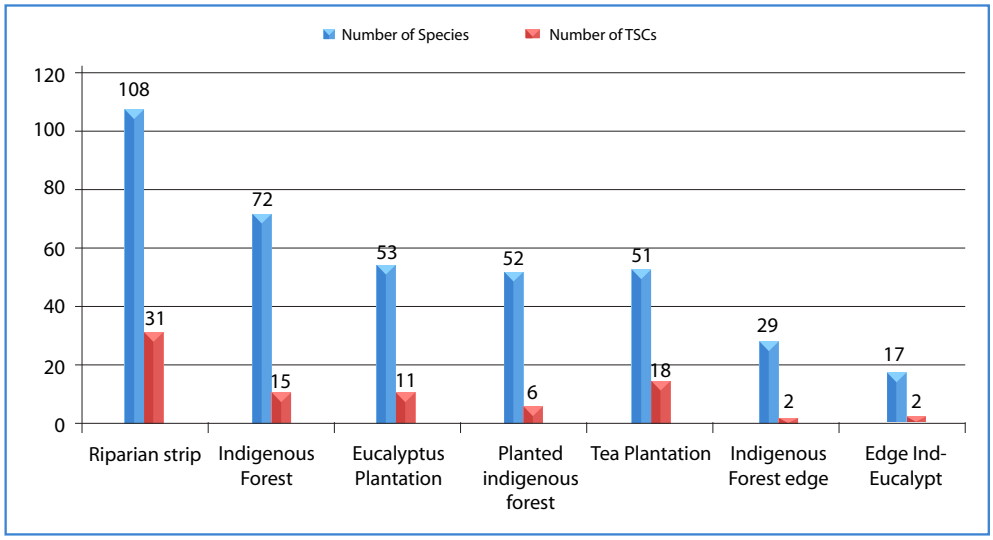
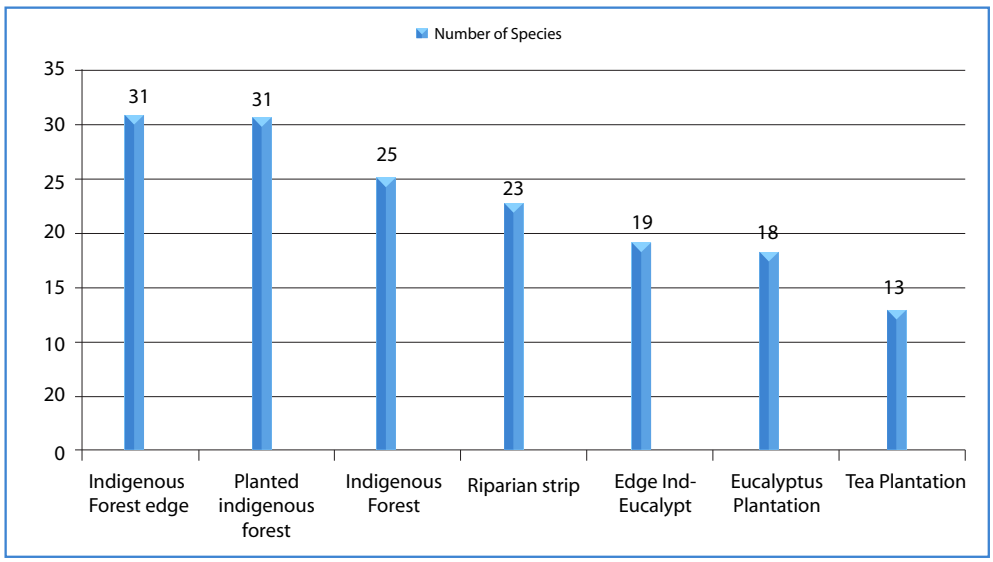


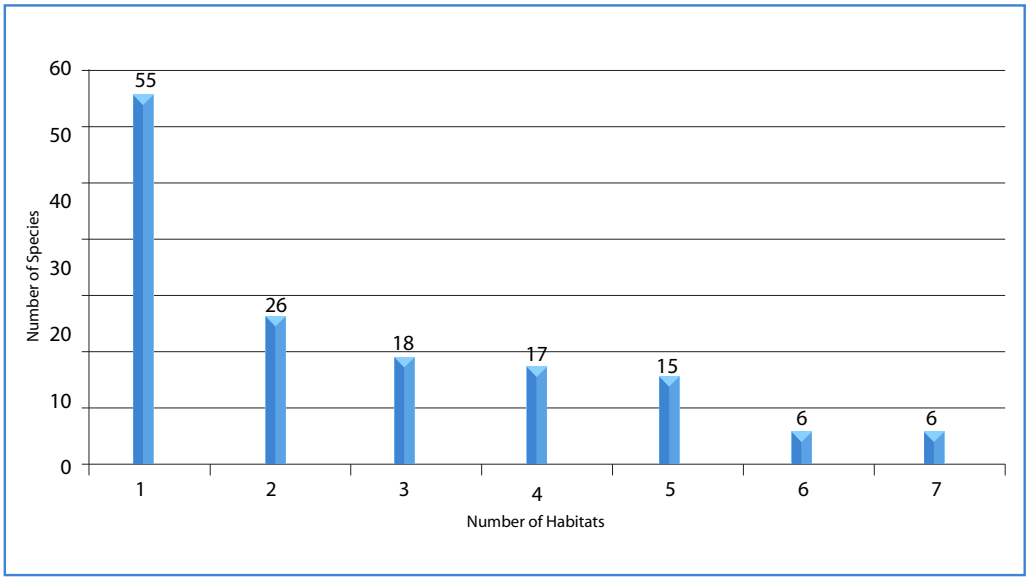
Figure 9: Mean number of species recorded per TSC in each of the seven habitats sampled in UTK-Kericho Estate



Of the 142 species, only 6 species occurred across all the seven different habitats, whilst 55 species occurred in only a single habitat (Fig. 10). Of these 55 habitat-unique species, Riparian strips (with 26 species) and Indigenous forest (10) combined for a total of 36. The 26 unique species for Riparian strips included 6 FF, 4 F, 4 f and 12 non-f, while the 10 unique species for Indigenous forest blocks (at Kapkatunga and Sambret) included 3 FF, 5 F, 0 f and 2 non-f. Lastly, ix species were recorded solely in the Eucalyptus plantations: African Crowned Eagle, Black-headed Heron, Pallid

Harrier, Ross's Turaco, White-browed Coucal and Blue-headed Coucal.

Figure 10: Occurrence of bird species across the seven habitats studied

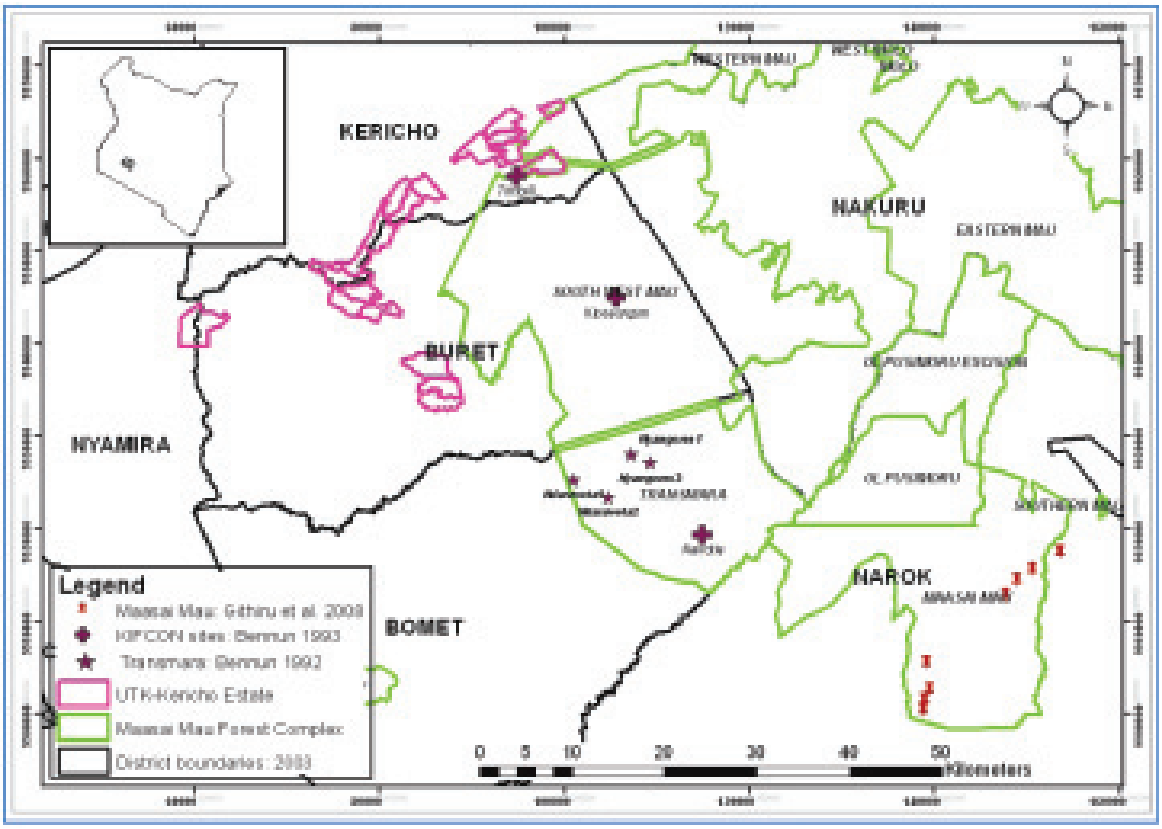


Comparison with other Mau studies

Three previous ornithological studies have been carried out in the Mau Forests neighbouring the Unilever Tea Kericho Estate. Two were carried out in the early 1990's by Bennun and Waiyaki under the KIFCON project in southwest Mau and Transmara forests which immediately border Unilever, while the third was done in 2007 in the further Maasai Mau Forest (MMF) (Fig. 11).

Results *contd.*

Figure 11: The Mau Forest Complex showing the sampling points of three previous studies in the Mau Forests (KIFCON, Maasai Mau and Transmara) juxtaposed against the current UTK-Kericho Estate survey points



In their KIFCON report, Bennun and Waiyaki (1993) (NB: they conducted their research in the sites indicated under Southwest Mau and Transmara forests in Fig. 11) found a total of 121 species, while the MMF study recorded 132 (compared to the total of 174 species under the current study). Together, there is a combined total of 248 unique species for all three studies. Of these, 120 species were unique to one of the three studies, 77 were recorded in at least two studies, whereas 51 were recorded in all three studies. The current study had the bulk of the unique species with 73, whilst KIFCON had 16 and MMF 31.

These differences were largely based on: (i) the presence of Palaearctic migrants in the KIFCON and Unilever lists which were conducted in September and March, respectively (the migration season) whereas the MMF survey was done in July when none of these migrants would be expected; and (ii) the fact that the MMF and Unilever surveys included agricultural areas and highland grasslands which have different species assemblages from forests (especially in the prevalence of granivores and non-forest species in the farmlands). Indeed, most of the 73 unique species for the current study were non-forest species (Fig. 12), but there were still forest-dependent species (FF and F) unique to this study (Table 6).

Figure 12: Forest-dependency status of the species unique to the current Unilever study; data labels indicate the forest dependency category and the corresponding number of unique species

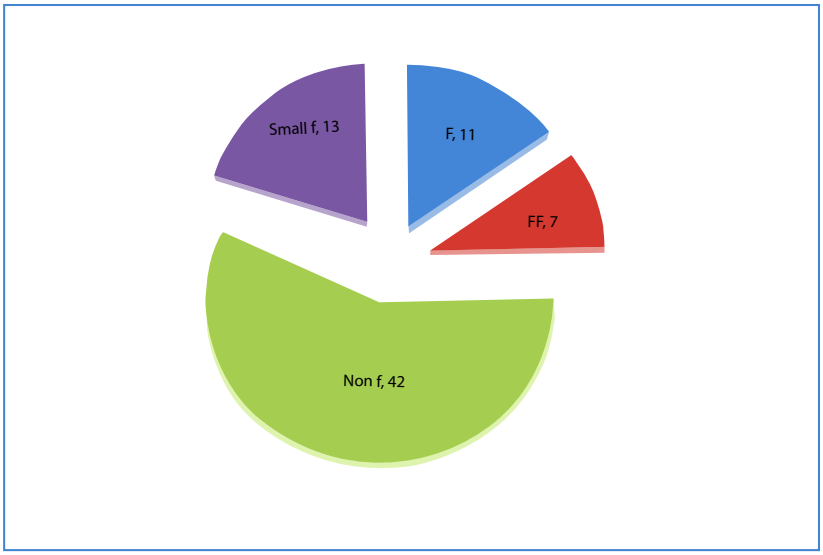


Table 6: Forest-dependent species (FF and F) unique to the Unilever study

Common name	Forest dependency
African Emerald Cuckoo	F
Buff-spotted Woodpecker	F
Cinnamon-bracken Warbler	F
Dark-capped Yellow Warbler	F
Green Hylia	F
Grey Wagtail	F
Northern Puffback	F
Ross's Turaco	F
Spectacled Weaver	F
Tambourine Dove	F
White-chinned Prinia	F
Black-fronted Bush-Shrike	FF
Buff-throated Apalis	FF
Dusky Tit	FF
Grey-winged Robin	FF
Lesser Honeyguide	FF
Purple-throated Cuckoo-shrike	FF
Yellow-spotted Barbet	FF

Discussion

Species list: composition and species of interest

The overall total of 174 species identified in this study is slightly higher but comparable to the 121 and 132 species recorded in the previous studies in the Maasai Mau Forests. It is also noteworthy that of these species, 49 were recorded in only one of the three methods (14 being unique for point counts (PC), 34 for timed-species counts (TSC) and one for mistnetting) underlying the value of having at least two methods in such initial surveys, especially combining PC and TSC. It is also likely that the 174 species list was not entirely comprehensive, with the models showing the complete species list for the entire UTKKericho Estate to be between 200 and 220 bird species.

A number of species of interest were recorded, including the globally Near-threatened Pallid Harrier and Semi-collared Flycatcher. Fine-banded Woodpecker has been previously considered a candidate Red Data Book species, whilst both Hartlaub's Turaco and Hunter's Cisticola are regional endemics (Bennun & Waiyaki 1992a). Overall, 30 of the 174 species recorded were Afrotropical Highland biome species, while six were Guinea-Congo Forest biome species. There was a sizeable representation of migrants with 24 species being either Afrotropical or Palaearctic Migrants.

Similar to previous studies in the Maasai Mau Forests (KIFCON: southwest Mau and Transmara; MMF: Maasai Mau Forest), about 40% of the species assemblage here was forest dependent (FF and F species; in the MMF study, 49% of the species recorded was forestdependent. This was not surprising because the greatest concentration of sampling effort was in the indigenous riparian strips as well as the retained indigenous forest block within the Unilever Tea Estate. *However, it does highlight the crucial significance of the retained forest as well as the riparian strips in conserving true forest dependent species.*

On the other hand, based on feeding guilds, the species composition was predominantly insectivorous. This proportion was similar to that for the previous Mau Forest studies, thereby suggesting it was, at best, only partially related to the lack of insecticide use under the Sustainable Agriculture Program. This would only be ascertained by comparison with work done in agricultural fields not implementing such a sustainable agriculture program.

However, it does indicate a similarity to natural systems which could suggests that the lack of pesticide use does help diminish the dissimilarity between this and the surrounding natural ecosystems. Additionally, presence of insectivorous birds could ensure retention of any positive ecosystem services related to pest control attributes of this guild.

Compared to the previous studies (which were done predominantly in forested habitat), the current study had the bulk of the unique species with 73 (KIFCON had 16 and MMF 31). These differences across the studies were largely based on: (i) the presence of Palaearctic migrants in the KIFCON and Unilever lists which were conducted in September and March, respectively (which is the migration season) whereas the MMF survey was done in July when none of these migrants would be expected; and (ii) the fact that the MMF and Unilever surveys included agricultural areas and highland grasslands which have different species assemblages from forests (especially in the prevalence of granivores and non-forest species in the farmlands).

Finally, while most of the unique species in the current study compared to the previous Mau studies were non-forest, still 18 of the 73 species were forest-dependent (FF and F) species. These could just have been missed in the previous studies. Yet, it still telling that this many forest-dependent species missed out in forest studies were recorded here, underscoring the fact that the Unilever Estate can potentially be important (either for breeding or dispersal) for forest birds as the Mau Forest Complex becomes increasingly disturbed and fragmented.

Discussion *contd.*

Species commonness

From the point counts, Yellow-whiskered Greenbul and Common Bulbul were the commonest and most widespread species, whereas based on the TSCs it was Common Bulbul and Yellow White-eye. From the mistnetting, Yellow-whiskered Greenbul was by far the commonest species. Lastly, the TSC-Index revealed that the commonest bird species was the Common Bulbul, followed by the Yellow White-eye and Yellow-whiskered Greenbul, respectively. In all, the greenbul, bulbul and white-eye were evidently the commonest species across UTK-Kericho Estate. Still, due the different methods sometimes showing slight differences in their commonest species, it is advisable to use more than one technique to get a more complete picture of the species composition and relative abundance.

Species distribution: Estate and Habitats

Albeit with slightly different overall sampling effort, Kapkorech (99 species), Jamji (95) and Kericho (94) Estates had the highest number of species recorded within the Estate's Divisions studied. This could be attributed to the predominance of indigenous forest habitats especially in Kapkorech but also in Kericho, and the very diverse habitats for Jamji which included Jamji Division (wet) and Ngoina (drier). Indeed, of the 44 Estate-unique species, Kapkorech (with 16 species) and Jamji (10) had the highest number of species. Expectedly, the unique species for Kapkorech included mostly forest-dependent species such as the African Crowned Eagle and Least Honeyguide, while those for Jamji were mainly non-forest species.

The bird-habitat analysis was solely based on TSC data in order to control for differences in sampling effort amongst habitats. Indeed, although the greatest number of species was recorded in the riparian strips habitat, this habitat was also the most extensively sampled. Nonetheless, the more telling figure of mean number of species recorded per TSC does rank TSCs in the indigenous forest habitats the highest, followed by riparian strips and monoculture plantations. Unsurprisingly, due to specificity in habitat requirements, very few species (6) occurred across all the seven different habitats studies; the majority (55) were restricted to only a single habitat. Most of these habitat-unique species (36) were restricted to indigenous forests (riparian strips and the retained indigenous forest blocks at Kapkatunga and Sambret), with 18 being forest-dependent (FF and F) species. *This further highlights the crucial role played by the retained indigenous habitats within the Unilever Estate at Kericho in holding forest species that may otherwise not survive in the landscape.*

Conversation Issues and Recommendations

The following are key conservation issues that could be derived from this avian assessment:

Establish linkages between birds of the sustainable tea zone and neighbouring ecosystems:

UTK-Kericho Estate is clearly an important area for conservation of forest birds, which are closely linked to the avifauna of the neighbouring Mau Forest ecosystem. There are several important species for conservation both globally and nationally. Given the occurrence of these birds and the ever-growing levels of threat in the Mau ecosystem, the populations supported at Unilever may play an increasingly important role in the conservation of these species in future and so should be maintained

Identify key floral and landscape features that need to be protected or sustainably utilized

For the conservation of the forest birds that occur in the Unilever Estate boundaries, it is vital that the Sustainable Agriculture methods (as outlined in Appendix IV) are maintained. It is essential to maintain the indigenous forest riparian strips as well as the continuous forest block at Kapkorech and Sambret. While the riparian strips may largely play a connection role linking various habitats and ecosystems, the indigenous forest patch is large enough and close enough to the Mau Forest to sustain breeding populations of forest dependent species which is crucial.

Identify any existing threats to biodiversity

External threats: a major potential threat/problem facing the forest-dependent species within the Unilever Estate currently is related to human activities outside, given that the small-scale (subsistence and tea) farmers do not typically apply sustainable agriculture. Thus, there is the potential for introducing various negative effects from these neighbouring farms including predators and competitors. These effects will be reflected in the avifauna through varying species assemblages from the edge towards the interior of the Estate, keeping in mind changing habitats within the Estate.

Recommend ways of increasing the management and status of birds in the area

Riparian forest conservation and planting on UTK land is crucial for providing dispersal and other habitat for forest-dependent bird species. This key habitat can be enhanced by enrichment tree planting (especially of endemic or threatened species). Besides these strips, the blocks of forest including the continuous block at Kapkorech as well as the scatter of indigenous woodlots in the various arboreta, Monkey Sanctuary and *Podocarpus* stand will be crucial for providing extra habitat and 'stepping stones' for dispersing species. Moreover, in addition to habitat provision, the conservation of forest birds in the Estate will be bolstered through protection from hunting or inappropriate exploitation by company rules and education programmes.

Develop monitoring strategies for birds in the UTK-Kericho Estate

Monitoring: the long-term monitoring technique to be used for birds is the point counts method. A randomly generated list of GPS locations where point counts were undertaken during this baseline survey and which can be used for monitoring are listed in Appendix III. Point Count Stations for monitoring may need to be increased in a few Estates such as Chebown (which has only 3 points at the moment) and perhaps Kaptien and Kapgwen (with 5 each) to have about 8 PC Stations each. Nonetheless, the current list of 64 points are pretty well spread and should also provide useful data for monitoring forest birds across the estate.

Research recommendations

First, due to potential seasonal variations, it would be interesting to repeat this exercise in a different season in order to have a more complete picture. Secondly, further biological and life (natural) history research should be carried out on the forest birds within the UTKKericho farm to improving our understanding of how they use these habitats, i.e., whether for feeding, breeding or moving between different ecosystems. Lastly, monitoring should be maintained to check for trends in time and space, in order to understand effects of various practices (such the evolving Sustainable Agriculture) and also especially with the activities related to the neighbouring Mau ecosystem. This will help improve on the agricultural practices themselves for greatest benefit to the forest dependent birds and other fauna.

Conversation Issues and Recommendations *contd.*

Conclusion

Bordering the Mau ecosystem, the riparian forest conservation and planting on UTKKericho land has important functions in catchment protection for rivers flowing into Lake Victoria. This catchment value is gaining increasing importance in the face of the escalating rate of loss of forest in the neighbouring Mau Forest Complex. As shown in this paper, the indigenous forests (including the riparian strips, retained continuous forest blocks, arboreta and woodlots) are important habitat for true forest-dependent bird species as well as a feeding resource for local and migrating birds. They are also vital for the survival of small populations of mammals such as Harvey's Duiker (Cephalophus harvey) and several species of monkeys e.g., Colobus Monkey (*Colobus polykomos*), Velvet Monkey (*Cercopithecus aethiopia*) and Red Tail Monkey (*Cercopithecus ascanious*).

The retention of non-tea habitat (especially indigenous riparian strips and forest blocks) under the Sustainable Agriculture Initiative at UTK-Kericho Estate can thus indeed be said to be a key addition to the natural environment, providing important additional habitat for forest-dependent biodiversity. Through this, a wide range of plant and animal species are sustained, which contributes to maintaining the natural balance across this extensive landscape that includes the vast Mau ecosystem.

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Appendix I: Checklist of all bird species seen during the study in the two sites, showing their forest dependency category (as FF, F, small-f, non-f), feeding guild, threat (X = Nationally scarce; NT = Globally Near-threatened) and migratory (AM = Afrotropical migrant; PM = Palaearctic migrant) status and Biome-characteristic species (where AH: Afrotropical Highland Species; and G0-CF: Guinea -Congo Forests Biome)

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
Podicipedidae	5	Little Grebe	*Tachybaptus ruficollis*	Non f			Piscivore	
Phalacrocoracidea	26	Great Cormorant	*Phalacrocorax carbo*	Non f			Piscivore	
	27	Long-tailed Cormorant	*P. africanus*	Non f			Piscivore	
Ardeidae	47	Great Egret	*Casmerodius albus*	Non f			Insectivore	
	48	Grey Heron	*Ardea cinerea*	Non f		AM,PM	Insectivore	
	51	Black-headed Heron	*A. melanocephala*	Non f			Insectivore	
Scopidae	52	Hamerkop	*Scopus umbretta*	Non f			Insectivore	
Ciconiidae	54	Black Stork	*Ciconia nigra*	Non f		PM	Omnivore	X
	60	Yellow-billed Stork	*Mycteria ibis*	Non f			Mulluscivore	
Threskiornithidae	62	Hadada Ibis	*Bostrychia hagedash*	Non f			Mulluscivore	
Anatidae	79	African Black Duck	*Anas sparsa*	Non f			Insectivore	
	85	Yellow-billed Duck	*A. undulata*	Non f		AM	Insectivore	
Accipitridae	102	Black Kite	*Milvus migrans*	Non f		PM	Raptor	
	118	Pallid Harrier	*Circus macroruurus*	Non f		PM	Raptor	NT
	125	African Goshawk	*Accipiter tachiro*	Non f			Raptor	
	138	Common Buzzard	*Buteo buteo*	Non f		PM	Raptor	
	142	Augur Buzzard	*Buteo augur*	Non f			Raptor	
	148	Steppe Eagle	*Aquila nipalensis*	Non f		PM	Raptor	
	155	Long-crested Eagle	*Lophaetus occipitalis*	f			Raptor	
	157	African Crowned Eagle	*Stephanoaetus coronatus*	Non f			Raptor	
	158	Martial Eagle	*Polemaetus bellicosus*	Non f			Raptor	
Falconidae	165	Eurasian Hobby	*Falco subbuteo*	Non f		PM	Raptor	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
Rallidae	222	Black Crake	*Amaurornis flavirostris*	Non f			Insectivore	
	225	Common Moorhen	*Gallinula chloropus*	Non f			Insectivore	
	227	Red-knobbed Coot	*Fulicia cristata*	Non f		AM	Algivore	
Gruidae	230	Grey Crowned Crane	*Balearica regulorum*	Non f			Mulluscivore	
Scolopacidae	312	Green Sandpiper	*Tringa ochropus*	Non f		PM	Insectivore	
	314	Common Sandpiper	*Actitis hypoleucos*	Non f		PM	Insectivore	
Columbidae	354	African Green Pigeon	*Treron calva*	F			Frugivore	
	357	Tambourine Dove	*Turtur tympanistria*	F			Frugivore	
	358	Blue-spotted Wood Dove	*T. afer*	f			Frugivore	
	359	Emerald-spotted Wood Dove	*T. chalcospilos*	f			Frugivore	
	365	Olive Pigeon	*Columba arquatrix*	FF			Frugivore	
	369	Lemon Dove	*Aplopelia larvata*	FF			Frugivore	
	370	Red-eyed Dove	*Streptopelia semitorquata*	f			Frugivore	
	373	Ring-necked Dove	*S. capicola*	f			Frugivore	
Musophagidae	391	Ross's Turaco	*Musophaga rossae*	F			Frugivore	
	398	Hartlaub's Turaco	*Tauraco hartlaubi*	FF	Afrotropical Highlands		Frugivore	
Cuculidae	409	Red-chested Cuckoo	*Cuculus solitarius*	F			Insectivore	
	417	African Emerald Cuckoo	*Chrysococcyx cupreus*	F			Insectivore	
	419	Klaas's Cuckoo	*C. klaas*	f			Insectivore	
	420	Diederik Cuckoo	*C. caprius*	Non f			Insectivore	
	422	White-browed Coucal	*Centropus superciliosus*	Non f			Insectivore	
	426	Blue-headed Coucal	*C. monachus*	Non f			Insectivore	
Cuprimulgidae	457	Eurasian Nightjar	*Caprimulgus europaeus*	Non f		PM	Insectivore	X
Apodidae	469	African Palm Swift	*Cypsiurus parvus*	Non f			Insectivore	
	470	Eurasian Swift	*Apus apus*	Non f		PM	Insectivore	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
	475	Mottled Swift	*A. aequatorialis*	Non f			Insectivore	
	479	Little Swift	*A. affinis*	Non f			Insectivore	
Coliidae	480	Speckled Mousebird	*Colius striatus*	Non f			Granivore	
Trogonidae	484	Narina Trogon	*Apaloderma narina*	F			Frugivore	
Alcedinidae	488	Woodland Kingfisher	*Halcyon senegalensis*	Non f			Insectivore	
	495	Malachite Kingfisher	*Alcedo cristata*	Non f			Insectivore	
	499	Giant Kingfisher	*Megaceryle maxima*	Non f			Piscivore	
Meropidae	501	Eurasian Bee-eater	*Merops apiaster*	f		PM	Insectivore	
	514	Cinnamon-chested Bee-eater	*M. orebates*	F	Afrotropical Highlands		Insectivore	
Coraciidae	522	Broad-billed Roller	*Eurystomus glaucurus*	f		AM,PM	Insectivore	
Phoeniculidae	525	White-headed Wood-hoopoe	*Pheoniculus bollei*	FF			Insectivore	
Bucerotidae	550	Black-and-white-casqued Hornbill	*Bycanistes subcylindricus*	F	Guinea-Congo Forests		Frugivore	
Capitonidae	553	Grey-throated Barbet	*Gymnobucco bonapartei*	F			Frugivore	
	563	Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*	F			Frugivore	
	566	Yellow-spotted Barbet	*Buccanodon duchaillui*	FF	Guinea-Congo Forests		Frugivore	
	570	Spot-flanked Barbet	*Tricholaema lacrymosa*	Non f			Frugivore	
	571	Yellow-billed Barbet	*Trachylaemus purpuratus*	FF	Guinea-Congo Forests		Frugivore	
Indicatoridae	586	Scaly-throated Honeyguide	*Indicator variegatus*	f			Insectivore	
	588	Lesser Honeyguide	*I. minor*	FF			Insectivore	
	590	Least Honeyguide	*I. exilis*	FF			Insectivore	X

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
Picidae	606	Fine-banded Woodpecker	*Campethera tullbergii*	FF	Afrotropical Highlands		Insectivore	
	607	Buff-spotted Woodpecker	C. nivosa	F	Guinea-Congo Forests		Insectivore	
	610	Cardinal Woodpecker	*Dendropicos fuscescens*	f			Insectivore	
Hirundinidae	651	Plain Martin	*Riparia paludicola*	Non f			Insectivore	
	652	Sand Martin	*R. riparia*	Non f		PM	Insectivore	
	657	Wire-tailed Swallow	*Hirundo smithii*	Non f			Insectivore	
	660	Barn Swallow	*H. rustica*	Non f		PM	Insectivore	
	663	Red-rumped Swallow	*H. daurica*	Non f			Insectivore	
	667	Lesser-striped Swallow	*H. abyssinica*	Non f			Insectivore	
	670	White-headed Saw-wing	*Psalidoprocne albiceps*	f			Insectivore	
	672	Black Saw-wing	*P. holomelas*	f			Insectivore	
Montacillidae	673	African Pied Wagtail	*Motacilla aguimp*	Non f			Insectivore	
	675	Grey Wagtail	*M. cinerea*	F		PM	Insectivore	
	676	Mountain Wagtail	*M. clara*	FF			Insectivore	
	677	Cape Wagtail	*M. capensis*	Non f			Insectivore	
	678	Yellow Wagtail	*M. flava*	Non f		PM	Insectivore	
	689	Tree Pipit	*Anthus trivialis*	f		PM	Insectivore	
Pycnonotidae	702	Yellow-whiskered Greenbul	*Andropadus latirostris*	F			Frugivore	
	703	Slender-billed Greenbul	*A. gracilirostris*	FF			Frugivore	
	704	Shelley's Greenbul	*A. masukuensis*	FF	Afrotropical Highlands		Frugivore	
	713	Cabanis's Greenbul	*Phyllastrephus cabanisi*	FF			Frugivore	
	725	Joyful Greenbul	*Chlorocichla laetissima*	F	Afrotropical Highlands		Frugivore	
	729	Common Bulbul	*Pycnonotus barbatus*	f			Frugivore	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
Timallidae	737	African Hill Babbler	*Pseudoalcippe abyssinica*	FF	Afrotropical Highlands		Insectivore	
	751	Mountain Illadopsis	*Illadopsispyrrhoptera*	FF	Afrotropical Highlands		Insectivore	X
Turdidae	761	Equatorial Akalat	*Sheppardia aequatorialis*	FF	Afrotropical Highlands		Insectivore	
	766	Grey-winged Robin	*S. polioptera*	FF			Insectivore	
	769	Cape Robin Chat	*Cossypha caffra*	f			Insectivore	
	774	Snowy-headed Robin Chat	*C. niveicapilla*	F			Insectivore	
	778	Brown-chested Alethe	*Alethe poliocephala*	FF			Insectivore	
	794	Common Stonechat	*Saxicola torquata*	Non f			Insectivore	
	816	Olive Thrush	*Turdus olivaceus*	F			Insectivore	
	818	African Thrush	*T. pelios*	f			Insectivore	
	826	Abyssinian Ground Thrush	*Zoothera piaggiae*	FF	Afrotropical Highlands		Insectivore	
Muscicapidae	831	African Dusky Flycatcher	*Muscicapa adusta*	F			Insectivore	
	833	Swamp Flycatcher	*M. aquatica*	Non f			Insectivore	
	840	White-eyed Slaty Flycatcher	*Melaenornis fischeri*	F	Afrotropical Highlands		Insectivore	
	849	Semi-collared Flycatcher	*Ficedula semitorquata*	Non f		PM	Insectivore	NT; X
Sylviidae	860	Marsh Warbler	*Acrocephalus palustris*	f		PM	Insectivore	
	863	Olivaceous Warbler	*Hippolais pallida*	Non f		PM	Insectivore	
	869	Garden Warbler	*Sylvia borin*	f		PM	Insectivore	
	870	Blackcap Warbler	*S. atricapilla*	F		PM	Insectivore	
	873	Willow Warbler	*Phylloscopus trochilus*	f		PM	Insectivore	
	876	Brown Woodland Warbler	*P. umbrovirens*	FF	Afrotropical Highlands		Insectivore	
	879	Green Hylia	*Hylia prasina*	F	Guinea-Congo Forests		Insectivore	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
	884	Cinnamon-bracken Warbler	*Bradypterus cinnamomeus*	F	Afrotropical Highlands		Insectivore	
	886	Black-faced Rufous Warbler	*Bathmocercus rufus*	FF			Insectivore	
	891	Dark-capped Yellow Warbler	*Chloropeta natalensis*	F			Insectivore	
	894	Red-faced Cisticola	*Cisticola erythrops*	Non f			Insectivore	
	898	Hunter's Cisticola	*C. hunteri*	Non f	Afrotropical Highlands		Insectivore	
	924	Tawny'flanked Prinia	*Prinia subflava*	f			Insectivore	
	926	Banded Prinia	*P. bairdii*	F			Insectivore	
	927	White-chinned Prinia	*P. leucopogon*	F			Insectivore	
	933	Grey-backed Camaroptera	*Camaroptera brachyura*	f			Insectivore	
	940	Chestnut-throated Apalis	*Apalis porphyrolaema*	F	Afrotropical Highlands		Insectivore	
	942	Buff-throated Apalis	*A. rufogularis*	FF	Guinea-Congo Forests		Insectivore	
	945	Grey Apalis	*A. cinerea*	FF			Insectivore	
	948	Black-throated Apalis	*A. jacksoni*	FF			Insectivore	
	950	Black-collared Apalis	*A. pulchra*	F	Afrotropical Highlands		Insectivore	
	957	Grey-capped Warbler	*Eminia lepida*	f			Insectivore	
	967	White-browed Crombec	*Sylvietta leucophrys*	FF	Afrotropical Highlands		Insectivore	
Zosteropidae	983	Yellow White-eye	*Zosterops senegalensis*	f			Insectivore	
Paridae	988	Dusky Tit	*P. funereus*	FF			Insectivore	
	990	White-bellied Tit	*Parus fringillinus*	f			Insectivore	
Monarchidae	1000	African Blue Flycatcher	*Elminia longicauda*	f			Insectivore	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
	1002	White-tailed Crested Flycatcher	*Trochocercus albonotatus*	FF	Afrotropical Highlands		Insectivore	X
	1007	African Paradise Flycatcher	*Terpsiphone viridis*	f			Insectivore	
Platysteiridae	1013	Chin-spot Batis	*Batis molitor*	Non f			Insectivore	
	1019	Common Wattle-eye	*Platysteira cyanea*	f			Insectivore	
	1020	Black-throated Wattle-eye	*P. peltata*	F			Insectivore	
Laniidae	1039	Grey-backed Fiscal	*Lanius excubitoroides*	Non f			Insectivore	
	1043	Common Fiscal	*L. collaris*	Non f			Insectivore	
Malaconotidae	1048	Brown-crowned	*Tchagra Tchagra australis*	Non f			Insectivore	
	1053	Black-fronted Bush-Shrike	*Maloconotus nigrifrons*	FF			Insectivore	
	1055	Doherty's Bush-Shrike	*M. dohertyi*	F	Afrotropical Highlands		Insectivore	
	1063	Lühder's Bush-Shrike	*Laniarius luehderi*	F			Insectivore	
	1064	Tropical Boubou	*L. aethiopicus*	f			Insectivore	
	1071	Northern Puffback	*Dryoscopus gambensis*	F			Insectivore	
Campephagidae	1079	Purple-throated Cuckoo-shrike	*Campephaga quiscalina*	FF			Insectivore	
	1080	Grey Cuckoo-shrike	*Coracina caesia*	FF	Afrotropical Highlands		Insectivore	
Oriolidae	1087	Black-headed Oriole	*Oriolus larvatus*	f			Frugivore	
Corvidae	1095	Pied Crow	*Corvus albus*	Non f			Omnivore	
Sturnidae	1100	Stuhlmann's Starling	*Peoptera stuhlmanni*	FF	Afrotropical Highlands		Frugivore	
Nectariniidae	1140	Collared Sunbird	*Anthreptes collaris*	F			Nectarinivore	
	1143	Olive Sunbird	*Nectarinia olivacea*	FF			Nectarinivore	
	1146	Green-headed Sunbird	*N. verticalis*	F			Nectarinivore	
	1149	Amethyst Sunbird	*N. amethystina*	f			Nectarinivore	

Family	OsC No.	Common name	Scientific name	Forest dependency	Biome	Migrant status	Feeding Guild	Threat
	1152	Variable Sunbird	*N. venusta*	f			Nectarinivore	
	1159	Northern Double-collared Sunbird	*N. preussi*	F	Afrotropical Highlands		Nectarinivore	
	1179	Bronze Sunbird	*N. kilimensis*	f	Afrotropical Highlands		Nectarinivore	
	1180	Golden-winged Sunbird	*N. reichenowi*	f	Afrotropical Highlands	AM	Nectarinivore	
Passeridae	1184	House Sparrow	*Passer domesticus*	Non f			Granivore	
	1185	Rufous Sparrow	*P. rufocinctus*	Non f			Granivore	
	1187	Grey-headed Sparrow	*P.griseus*	Non f			Granivore	
Ploceidae	1205	Baglafecht Weaver	*Ploceus baglafecht*	f	Afrotropical Highlands		Granivore	
	1210	Spectacled Weaver	*P. ocularis*	F			Granivore	
	1211	Black-billed Weaver	*P. melanogaster*	FF	Afrotropical Highlands		Granivore	
	1240	Brown-capped Weaver	*P. insignis*	FF	Afrotropical Highlands		Granivore	
Estrildidae	1269	Grey-headed Negrofinch	*Nigrita canicapila*	F			Granivore	
	1279	Abyssinian Crimsonwing	*Cryptospiza salvadorii*	F	Afrotropical Highlands		Granivore	
	1285	Red-headed Bluebill	*Spermophaga ruficapilla*	F			Granivore	
	1299	Yellow-bellied Waxbill	*Estrilda quartinia*	f			Granivore	
	1303	Common Waxbill	*E. astrild*	Non f			Granivore	
	1304	Black-crowned Waxbill	*E. nonnula*	f			Granivore	
Fringillidae	1333	African Citril	*Serinus citrinelloides*	f	Afrotropical Highlands		Granivore	
	1343	Streaky Seedeater	*S. striolatus*	f	Afrotropical Highlands		Granivore	
	1344	Thick-billed Seedeater	*S. burtoni*	FF	Afrotropical Highlands		Granivore	

Appendices

Appendix II: Number of individual birds captured during the mistnetting sessions in the four sites at UTK-Kericho Estate

Common name	Chelimo	Kapkorech	Kaptien	Ngoina	Grand Total
Yellow-whiskered Greenbul	12	28	29	16	85
Olive Sunbird	4	23	9	2	38
Cabanis's Greenbul	9	8	2	2	21
Mountain Illadopsis	2	1	2	1	6
Snowy-headed Robin Chat		3		3	6
Brown-chested Alethe	1	2	2		5
Black-collared Apalis			4		4
Black-faced Rufous Warbler	1	2			3
Equatorial Akalat		1	2		3
White-tailed Crested Flycatcher	1	2			3
Abyssinian Crimsonwing		2			2
Black-billed Weaver		2			2
Black-throated Wattle-eye		1		1	2
Grey-backed Camaroptera				2	2
Grey-winged Robin				2	2
Tambourine Dove			1	1	2
White-browed Crombec			2		2
Abyssinian Ground Thrush	1				1
African Dusky Flycatcher		1			1
Banded Prinia		1			1
Common Bulbul			1		1
Common Wattle-eye				1	1
Grey-headed Negrofinch				1	1
Lemon Dove			1		1
Red-headed Bluebill		1			1
Shelley's Greenbul			1		1
Grand Total	**31**	**81**	**53**	**32**	**197**

Appendix III: Randomly selected Point Count GPS locations which are points for future bird monitoring

PC	Estate	Estate S/No.	Division	GPS No.	Date	Time	Latitude	Longitude	Northing	Easting	Altitude (m)
1	1	Kapkorech	Chagaik	272	12-Mar-09	8:50 AM	-0.34306	35.35407	9962004.139	94030.882	2065
2	1	Kapkorech	Chagaik	274	12-Mar-09	9:57 AM	-0.34491	35.35000	9961799.067	93577.155	2055
3	1	Kapkorech	Chagaik	280	13-Mar-09	6:54 AM	-0.33820	35.33702	9962541.695	92129.588	2063
4	1	Kapkorech	Chagaik	282	13-Mar-09	7:59 AM	-0.33968	35.33345	9962377.623	91731.587	2051
5	1	Kapkorech	Chagaik-Kimugu	285	13-Mar-09	9:11 AM	-0.34126	35.32668	9962202.336	90976.780	2038
6	1	Kapkorech	Kapkorech	230	9-Mar-09	7:47 AM	-0.31432	35.40384	9965189.186	99578.924	2164
7	1	Kapkorech	Kapkorech	233	9-Mar-09	9:28 AM	-0.31830	35.39875	9964748.204	99011.572	2170
8	1	Kapkorech	Kapkorech	243	10-Mar-09	6:45 AM	-0.32001	35.39394	9964558.633	98475.348	2123
9	1	Kapkorech	Kapkorech	247	10-Mar-09	9:07 AM	-0.32867	35.39392	9963599.530	98473.460	2181
10	1	Kapkorech	Kapkorech	249	10-Mar-09	10:19 AM	-0.32955	35.39285	9963502.026	98354.196	2171
1	2	Cheymen	Cheymen	267	12-Mar-09	6:35 AM	-0.34606	35.36332	9961672.268	95062.376	2103
2	2	Cheymen	Cheymen	269	12-Mar-09	7:33 AM	-0.34229	35.36087	9962089.710	94789.045	2066
3	2	Cheymen	Cheymen	271	12-Mar-09	8:24 AM	-0.34273	35.35597	9962040.769	94242.717	2065
4	2	Cheymen	Kimugu	340	17-Mar-09	8:32 AM	-0.47317	35.19898	9947584.413	76743.686	1763
5	2	Cheymen	Kimugu	342	17-Mar-09	9:25 AM	-0.47107	35.19462	9947816.776	76257.341	1755
6	2	Cheymen	Kimugu	344	17-Mar-09	10:03 AM	-0.46771	35.19048	9948188.732	75795.451	1756
7	2	Cheymen	Sambret	253	11-Mar-09	7:10 AM	-0.37033	35.38803	9958985.382	97818.529	2265
8	2	Cheymen	Sambret	255	11-Mar-09	8:05 AM	-0.37301	35.38552	9958688.453	97538.798	2289
9	2	Cheymen	Sambret	257	11-Mar-09	9:04 AM	-0.37122	35.38125	9958886.504	97062.629	2226
10	2	Cheymen	Sambret	264	11-Mar-09	10:26 AM	-0.36921	35.37608	9959108.881	96486.102	2191
1	3	Kericho	Chelimo	291	14-Mar-09	6:39 AM	-0.37621	35.26823	9958328.534	84460.783	1899
2	3	Kericho	Chelimo	294	14-Mar-09	7:41 AM	-0.38083	35.26385	9957816.581	83972.588	1917
3	3	Kericho	Chelimo	297	14-Mar-09	8:46 AM	-0.38450	35.25886	9957409.822	83416.326	1920
4	3	Kericho	Kericho	300	14-Mar-09	9:52 AM	-0.38925	35.25383	9956883.426	82855.655	1902
5	3	Kericho	Kericho	307	15-Mar-09	7:39 AM	-0.40455	35.26597	9955189.295	84210.166	1915
6	3	Kericho	Kericho	310	15-Mar-09	8:49 AM	-0.40640	35.25955	9954984.045	83494.363	1910
7	3	Kericho	Kerenga	319	16-Mar-09	6:43 AM	-0.41394	35.24216	9954147.939	81555.563	1853
8	3	Kericho	Kerenga	322	16-Mar-09	8:11 AM	-0.41768	35.23642	9953733.353	80915.674	1869
9	3	Kericho	Kerenga	325	16-Mar-09	9:25 AM	-0.42226	35.23658	9953226.032	80933.760	1843
10	3	Kericho	Kerenga	328	16-Mar-09	10:33 AM	-0.42450	35.24108	9952978.150	81435.691	1843
1	4	Chebown	Tagabi-Jamji	335	17-Mar-09	6:26 AM	-0.47118	35.20862	9947805.443	77818.590	1783

Appendix III: Randomly selected Point Count GPS locations which are points for future bird monitoring

PC	Estate	Estate S/No.	Division	GPS No.	Date	Time	Latitude	Longitude	Northing	Easting	Altitude (m)
2	4	Chebown	Tagabi-Jamji	337	170-Mar-09	7:14 AM	-0.47461	35.20625	9947425.343	77554.504	1774
3	4	Chebown	Tagabi-Jamji	339	17-Mar-09	8:02 AM	-0.47379	35.20137	9947515.879	77010.251	1753
1	5	Jamji	Ngoina	361	19-Mar-09	6:44 AM	-0.52597	35.04731	9941724.949	59831.815	1695
2	5	Jamji	Ngoina	363	19-Mar-09	7:23 AM	-0.52084	35.04815	9942293.388	59925.147	1699
3	5	Jamji	Ngoina	365	19-Mar-09	8:11 AM	-0.51847	35.04869	9942556.010	59985.213	1650
4	5	Jamji	Ngoina	367	19-Mar-09	9:06 AM	-0.51658	35.05314	9942765.722	60481.419	1674
5	5	Jamji	Ngoina	369	19-Mar-09	10:01 AM	-0.51438	35.05413	9943009.539	60591.689	1647
6	5	Jamji	Ngoina	376	20-Mar-09	6:32 AM	-0.51501	35.07979	9942941.507	63453.704	1605
7	5	Jamji	Ngoina	378	20-Mar-09	7:28 AM	-0.51187	35.07792	9943289.263	63244.924	1615
8	5	Jamji	Ngoina	380	20-Mar-09	8:34 AM	-0.51046	35.07530	9943445.301	62952.612	1615
9	5	Jamji	Ngoina	382	20-Mar-09	9:20 AM	-0.51436	35.07453	9943013.160	62866.996	1679
10	5	Jamji	Ngoina	384	20-Mar-09	10:30 AM	-0.51491	35.07236	9942952.075	62625.006	1667
1	6	Kapgwen	Kapgwen	347	18-Mar-09	6:31 AM	-0.48135	35.21611	9946679.334	78654.464	1731
2	6	Kapgwen	Kapgwen	349	18-Mar-09	7:16 AM	-0.48291	35.21173	9946506.256	78166.122	1764
3	6	Kapgwen	Kapgwen	351	18-Mar-09	8:06 AM	-0.48364	35.20737	9946425.119	77679.957	1770
4	6	Kapgwen	Kapgwen	353	18-Mar-09	9:14 AM	-0.48510	35.20189	9946263.045	77068.936	1769
5	6	Kapgwen	Kapgwen	355	18-Mar-09	10:09 AM	-0.48538	35.19638	9946231.682	76454.492	1761
1	7	Kaptien	Kaptien	391	21-Mar-09	6:36 AM	-0.56084	35.26107	9937877.198	83673.296	1915
2	7	Kaptien	Kaptien	393	21-Mar-09	7:41 AM	-0.55784	35.25979	9938209.410	83530.353	1914
3	7	Kaptien	Kaptien	395	21-Mar-09	8:33 AM	-0.55382	35.26082	9938654.768	83644.924	1926
4	7	Kaptien	Kaptien	397	21-Mar-09	9:45 AM	-0.54974	35.26424	9939106.939	84025.998	1905
5	7	Kaptien	Kaptien	399	21-Mar-09	10:46 AM	-0.55003	35.26887	9939075.140	84542.298	1913
1	8	Koiwa	Kimari	418	23-Mar-09	6:46 AM	-0.60246	35.29303	9933269.495	87240.063	1965
2	8	Koiwa	Kimari	420	23-Mar-09	7:46 AM	-0.59840	35.29465	9933719.316	87420.393	1970
3	8	Koiwa	Kimari	422	23-Mar-09	8:39 AM	-0.59592	35.29631	9933994.134	87605.303	2027
4	8	Koiwa	Kimari	424	23-Mar-09	9:46 AM	-0.59135	35.29809	9934500.453	87803.438	2022
5	8	Koiwa	Kimari	426	23-Mar-09	10:55 AM	-0.58891	35.30182	9934770.991	88219.163	2042
6	8	Koiwa	Koiwa	404	22-Mar-09	6:41 AM	-0.57538	35.29525	9936269.129	87485.604	2052
7	8	Koiwa	Koiwa	406	22-Mar-09	7:38 AM	-0.57548	35.29045	9936257.705	86950.392	2048
8	8	Koiwa	Koiwa	408	22-Mar-09	8:27 AM	-0.57468	35.28579	9936345.978	86430.724	2026
9	8	Koiwa	Koiwa	410	22-Mar-09	9:20 AM	-0.57428	35.28148	9936389.970	85950.109	2016
10	8	Koiwa	Koiwa	412	22-Mar-09	10:09 AM	-0.57457	35.27660	9936357.494	85405.982	2004

Appendix IV: Indicators of Unilever's Sustainable Agriculture Program

Indicators for the Sustainable Agriculture Program

1. Soil fertility/health. Soil is fundamental to agricultural systems, and a rich soil ecosystem contributes to crop and livestock performance. Sustainable agriculture practices can improve beneficial components of the soil's ecosystem.

   Typical parameters: number of beneficial organisms, soil organic carbon.

2. Soil loss. Soil eroded by water and wind can lose both structure and organic matter, so diminishing the assets of an agricultural system. Sustainable agriculture practices can reduce soil erosion. Typical parameters: soil cover index, soil erosion.

3. Nutrients. Crops and livestock need a balance of nutrients. Some of these can be created locally (e.g. nitrogen), and some must be imported. Nutrients are lost through cropping, erosion and emissions to the air. Sustainable agriculture practices can enhance locally produced nutrients and reduce losses.

   Typical parameters: amount of inorganic nitrogen/phosphorus/potassium applied, balance of nitrogen/ phosphorus/potassium over crop rotations.

4. Pest management. When pesticides are applied to crops or livestock, a small but significant proportion can escape to water and air, kill beneficial or non-target wildlife or accumulate in foods, thus affecting human health and ecosystems. Sustainable agriculture practices can substitute natural controls for some pesticides, so reducing dependence on externally introduced substances.

   Typical parameters: amount and type of pesticides (active ingredient) applied.

5. Biodiversity. Agriculture has shaped most ecosystems in the world, and biodiversity can be improved or reduced by agricultural practices. Some biodiversity is highly beneficial for agriculture. Sustainable agriculture practices can improve biodiversity – both by 'greening the middle' of fields as well as 'greening the edge'.

   Typical parameters: biodiversity on site, habitat for natural predator systems, cross boundary effects.

6. Product value. Product value is a measure of the desired outputs of an agricultural system. Sustainable agriculture practices should be able to maintain or improve product value. Typical parameters: total value of produce per ha., nutritional value, including minerals, ratio of solid waste reused/ recycled over solid waste disposed to landfill.

7. Energy. Although the energy of sunlight is a fundamental input to agriculture, the energy balance of agricultural systems depends on the additional energy supplied from non-renewable sources. Sustainable agriculture practices can improve the energy balance and ensure that it remains positive - there is more energy coming out than going in.

   Typical parameters: total energy input/total energy output, renewable to non-renewable energy inputs.

8. Water. Some agricultural systems make use of irrigation water, others pollute or contaminate ground or surface water with pesticides, nutrients or soil. Sustainable agriculture practices can make targeted use of any inputs, and so reduce losses.

   Typical parameters: amount of water used, leaching and runoff of N/P/K to surface and ground water.

9. Social/human capital. Finding ways to ensure we use natural resources sustainably demands initiatives in the social sphere such as collective action, the sharing of new knowledge, and continuous innovation. Sustainable agriculture practices can improve both social and human capital in order to ensure normal outputs. The prime responsibility for this should remain with the local community, leading to realistic and actionable targets.

   Typical parameters: group dynamics/organisational density of rural community, rate of innovation.

10. Local economy. Agricultural inputs (goods, labour, services) can be sourced from many places, but when they come from the local economy, the expenditure helps to sustain local businesses and livelihoods. Sustainable agriculture practices can help to make the best use of local and available resources in order to increase efficiency. Typical parameters: amount of money/profit spent reinvested locally, employment level in local community.

Notes

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