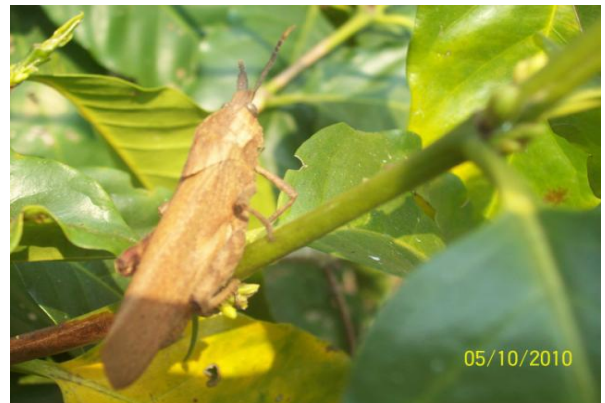


Satemwa Biodiversity Assessment

(Birds, Plants and Insects)



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Recommended Citation: Mzumara, T.I (2010), Satemwa tea estate Biodiversity Report,

ACKNOWLEDGEMENTS

I would like to thank Satemwa Tea Estate for fully funding this project. I appreciate the trust you had in me to carry out this educational, challenging and most fascinating task. Mr Alexander Kay (Finance Director) and Mr Rob Emmott (General Manager), thank you for ensuring all arrangements were in order for all our visits. Many thanks also go to my colleagues and friends Ms Trust Kasambala and Mr Hassan Patel for taking time to share their expertise to this study. Mr Gomani and all his staff, Mr C Mazombwe, thanks for all the assistant in the field work.

DEC 2010

Contents

ACKNOWLEDGEMENTS	2
Contents.....	3
INTRODUCTION.....	4
Objectives	4
METHODS.....	5
Study Site	5
Study Design	6
Bird Survey	6
Vegetation Survey.....	7
Insect Survey	7
RESULTS AND DISCUSSION.....	8
Bird diversity	8
Vegetation Diversity.....	12
Insect Diversity.....	17
CONCLUSION AND RECOMMENDATIONS.....	20
REFERENCES	21
APPENDICES	22
Appendix 1: List of bird species seen	22
Appendix 2: List of birds mist netted	26
Appendix 3: List of Insect Orders	27
Appendix 4: List Other plants growing in the Coffee Plantation	28
Appendix 5: Project Objective Achievement Analysis	29
Appendix 6: Suggested Way Forward	31

INTRODUCTION

The diversity and presence of life (biodiversity) on agricultural land is important for maintaining the health and productivity of farm lands. This statement is agreed on among many agriculture stakeholders worldwide. In 2005, Satemwa Tea Estate began to make several changes in their management to ensure that they also consider/accommodate the existence of biodiversity on the estate. These changes included the reduction in the use of chemicals and taking several steps to find a new system that would work well for both biodiversity and the coffee. The idea to grow coffee under shade is one such step that would encourage biodiversity. At the same time it ensured less extreme temperature, which then allows a healthier coffee crop that may actually resist pests naturally.

Biodiversity such as birds in the coffee fields may also actually help the coffee by preying on pests while other useful insects help with fertilisation. With such significant changes in the management of the coffee, the diversity and presence of life in the fields seemed to also have improved. This study was thus recommended to investigate the current status of biodiversity in the coffee plantation and the rest of the estate. During the Period of September and October 2010 a survey was carried out to look at the biodiversity that is present on Satemwa Estates in Thyolo, Southern Malawi. This study concentrated on three main taxa (birds, Plants and insects). The studies had four main objectives were:

Objectives

1. Compile bird lists for the coffee plantations and the natural forests with highlights on key species for the area
2. Create a simple monitoring system that will help collect data to monitor habitat quality using birds as an indicator species over time
3. Identify key tree species in the area and recommend species to be used in the current work to place more wildlife corridors and those that can be used as shade trees in the coffee
4. Compile a general list of beneficial and pest insect orders/families currently in the coffee and natural forests and investigate the potential for monitoring these.

METHODS

Study Site

Satemwa tea estate (STE) is located in southern Malawi, Thyolo District. The Estate covers an area of 1881.73ha and was established in 1923. The main produce of the estate is tea (900ha) whilst coffee is grown in an area totalling about 45 hectares. The estate has three operational areas namely Chawani, Satemwa and Mwalawathuzi as seen in Figure 1. Chawani in the West has an area that borders Thyolo Forest Reserve which once boasted one of the most diverse sub-montane forests in Malawi. A small section of this forest (20ha) lies within STE and still remains today as shown in Figure 1 below.

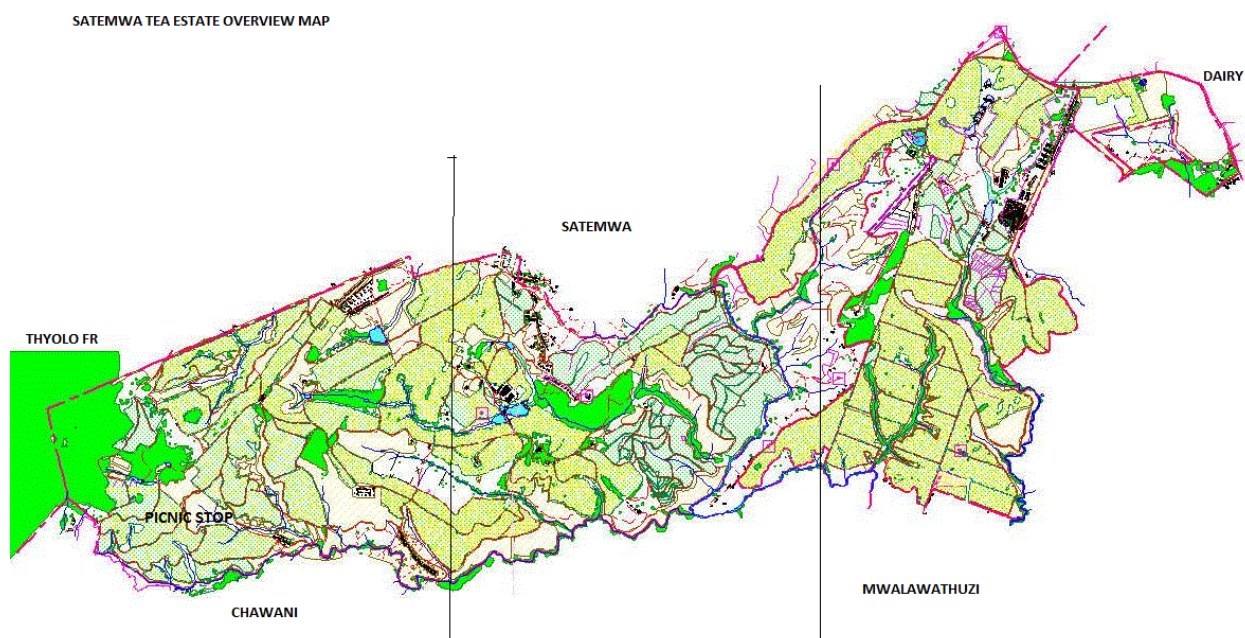


Figure 1: Satemwa Map - the light green areas show all the natural forest areas

The Satemwa area is the central part of the estate where the main administration offices can be found. The coffee plantations/fields are also located in this area. Much of the forest areas in this section are riparian forests along perennial streams. Some of these forests are characterised by large emergent eucalyptus trees. The Mwalawathuzi site to the south represents completely different vegetation from the other two. Much of this area is open miombo wood land. Riparian forests are present in a narrow strip on the border.

Study Design

Fieldwork was conducted over a three week period in September and October 2010 (3-10 Sept; 4-8 Oct; 25-29 Oct). A semi-stratified method was used to identify sampling points for all data collected. In general sampling started from the large natural forest on the border with Thyolo Forest Reserve, proceeding downwards passing through the forests around the administration offices and ending at the Dairy farm. The Map in Figure 1 was used to identify all the major natural forest areas to be visited. Sampling for insects however was done only for the coffee plantation and around the dairy farm. The methodology for each of the three taxa assessed is explained below.

Bird Survey

Sampling for birds was conducted in the coffee plantations at Satemwa, the sub-montane forests at Chawani, miombo forests around the dairy farm and all of the riparian forests between these sites. A combination of Timed Species Counts (TSC) and Point Counts (PC) were used to systematically enumerate bird species in these habitats.



Figure 2: White-Browed Scrub-Robin

Surveys were conducted from just before sunrise (4:30am) to about 10am when birds are known to be both active, and vocal. During a TSC the observer walked

hour long transects and recorded all birds seen or heard and the times that they were seen in that hour. Points were placed at 200m apart in places where more than one point was required. During a point count survey, the observer stood at each of the predetermined points on the site and spent five minutes at each point recording all the bird species seen and heard.

For each bird recorded the vertical vegetation layer it occupied (tree, understory, canopy, coffee, ground) was also recorded. Birds flying over were recorded. Species were classified as migratory or resident (non-migratory) and insectivorous or not following classification in Lack (1976) and Kellermann et al. (2008). Mist nets were used to sample four of the habitats (the submontane forest at Chawani, the riparian forest with emergent eucalyptus, the edge of coffee field and the riverside-woodland at the dairy farm). All birds that were caught in the nets were also ringed.

Vegetation Survey

At each of the points set for a point count, a 20m X 20m quadrant. Within the plot, percent shade cover and number, species, average height, and average diameter at breast height (DBH) of shade trees was recorded. A GPS was used to mark each point and determine elevation.



Figure 3: Mr Patel on transect

A tree was defined as any woody, non coffee plant >5 m tall, and a habitat patch as an area ≥ 10 m² of woody non coffee vegetation with elements >5 m tall, both of which birds can use as “stepping stones” to move through areas (Wunderle 1999). Saplings, herbs and other shrubs were also simply listed. In the coffee plantations all trees planted even those less than the specified measurements were listed together with the grasses, herbs and shrubs.

Insect Survey



Figure 4: Ms Kasambala Insect Sampling

The assessment for insects at Satemwa was done in the Coffee plantations and in the miombo woodland at the dairy farm. Purposive sampling within a large quadrant was used so that a crude picture of the insect population in the coffee plantations could be established. Individual coffee plants were sampled for all that was to be found on them.

An aerial net measuring 35cm in diameter and 85cm on its longest point was used in sampling flying insects in 25m X 25m quadrants. Handpicking and an aspirator were employed in sampling sedentary insects and other not actively flying insects. In the coffee plantation, the sampling unit was the coffee plant itself. The leaves, stem and ground were looked at for insects.

RESULTS AND DISCUSSION

Bird diversity







110 bird species were recorded on the estate. A detailed species list is provided in Appendix 1 and 2. Of these species, 83% were recorded in the riparian forests and the sub-montane forests in the Chawani and Satemwa areas. Birds recorded in the coffee plantation were either perched on the planted shade trees, on coffee plant itself, on the ground beneath the coffee or flying over the coffee fields. More species were recorded on transects near the forests than on transects that were deep in the coffee.

Species associated with open habitats such the African Yellow white-eye, Pipits, Dark-capped/Black-eyed bulbul and other small seedeaters were the most abundant in the coffee plantations. Species that are more dependent on forested habitats like wood doves and flycatchers were limited in their ability to disperse in the coffee fields. Hence there was a clear decline in numbers as one walked away from the forest. Large birds and frugivores like turacos, barbets and raptors were seen quite often flying over the coffee and occasionally perching in the trees. Large flocks of Palaearctic Migrants such as the European beaters and Barn swallows were seen feeding on insects above the coffee plantations in early October.

The behaviour of all the species mentioned above highlighted the importance of the riparian forest that lies close to the coffee plantation. Since the shade trees in the coffee are still at a young stage, many birds were recorded flying to and from the nearby large stretch of riparian forest. This shows that both the coffee and the forest patch are key habitats for the different needs of the birds recorded. These findings again emphasise that it is important to maintain the riparian forest in order to keep a highly diverse group of birds utilizing the coffee plantations. These findings are similar to those of a study in India who also found that distance of a coffee field to forest patch affected bird diversity in the field.

Though the trees grown to provide canopy in the coffee are still young, several species were recorded using these trees as perch sites. These included some surprising species such as the African Emerald cuckoo and Livingstone's Turaco. Table 1 gives a list of some of the species that were recorded feeding foraging in the coffee

Table 1: Birds recorded in the Coffee plantation

Species	Status	Details
1. Black-eyed Bulbul	Resident	An omnivore that's very common in the coffee plantations. Seen often times perched in the shade trees growing in the coffee.
2. Tropical Boubou	Resident	Insectivore. Relatively common in the coffee. Often heard calling near than seen. It usually forages on or near the ground. Its food includes amphibians, beetles, geckos, lizards, Lepidoptera (moths and butterflies), mantises, Orthoptera (crickets, grasshoppers and locusts), rodents, snakes and termites..
3. Bronze manikin 	Resident	Granivore. Mainly eats grass seeds supplemented with insects, doing most of its foraging on the ground, often taking advantage of feeding trays. Food items include; Arthropods, termites, Coleoptera (beetles), ants, spiders, fly larvae (Diptera)
4. Blue spotted wood dove 	Resident	Its diet has not been properly studied; however it is probably omnivorous, foraging mainly on the ground.
5. Yellow-fronted canary 	Resident	A seedeater. Eats seeds, flowers, leaves, nectar and insects, doing most of its foraging on the ground often along with other canaries and waxbills.
6. European Bee-eater 	Palearctic Migrant	Feeds exclusively on insects, eating mainly bees, wasps, flying ants and termites. It mainly hunts aerially, acrobatically hawking. It also catches insects from a perch, regularly returning to kill and feed on the caught prey item.
7. African Emerald Cuckoo	African Migrant	
8. Brown Crowned Tchagra 	Resident	Mainly eats insects and their larvae, doing most of its foraging on the ground, plucking prey from the base of plants. It also gleans them off leaves and branches in the canopy and occasionally catches prey aerially. Insect food items include; Orthoptera (crickets and grasshoppers), Lepidoptera (caterpillars), Coleoptera (beetles), mantid egg cases
9. Tambourine Dove 	Resident	
10. African Yellow White-eye	Resident	This mainly eats insects, doing most of its foraging in the tree canopy, gleaning prey from leaves and branches. It regularly joins mixed-species foraging flocks.

Raptors recorded were also of special interest. A total 6 different species (Table 2) were seen recorded hovering round the field, then some later seeking perch positions in the near riparian forest. Of particular interest was the sighting of the Black eagle on three different consistent days whilst surveying the Coffee field. This may mean that the species is resident in a nearby area. This high diversity of raptors is evidence that there is a high diversity of prey items available around the coffee. This again can be credited to the minimal use of pesticides which possibly now allows for many small mammals and birds to be available as prey.

Table 2: Raptors and other large birds seen in coffee plantations.

COMMON NAME	
1.	Black Kite
2.	Gymnogene
3.	Verreux Black Eagle
4.	Westerb-banded Snake eagle
5.	Black headed Heron

Many other key species were recorded in the forests on the estate include the globally endangered Thyolo Alethe, the elusive African broadbill. The Thyolo Alethe is a mid-altitude forest whose survival depends on maintaining its unique habitat. Its existence is closely related to the occurrence of red ants as it is an ant following species. The provision of wildlife corridors would probably assist in spreading this species to other areas in the future. In general, in terms of species diversity, the coffee fields had a lower species diversity when compared with the other habitats.

Roles of birds

Birds provide some very important ecosystem services in farmlands. These services include insect control, rodent control and seed dispersal. Many tangible benefits are a direct result of these services. Outbreaks of crop pests can annually destroy hundreds of millions agricultural and forest products. Birds play a critical role in reducing and maintaining populations of pests in natural systems.

Insect eating birds were found in significant numbers in the coffee plantations. These birds are undoubtedly taking prey of many insects that are found in the field. Birds, especially

those species that forage on or close to the ground will take even the larvae of some beetles. One can assume that the more of these birds there are, the more pests are eaten.

However, despite strong associations of birds with shade trees, there have been no projects so far that could confirm that reduction of stem/berry borer by birds increases with increasing shade cover. Thus, while some results provide an incentive for bird conservation in coffee farms in general, they do not reveal clear evidence that pest reduction services are more pronounced with shade provision. There is need to explore the influence of surrounding habitats on bird consumption of insects, possible prey switching behaviours as pests become increasingly scarce and the influence of trophic interactions involving non avian natural enemies of insect pests in coffee.

Conservation actions

STE has already started well on actions that will encourage biodiversity conservation. The current management decision taken to place shade tree in the coffee is a key action in conserving biodiversity on the estate. It is however very important that the type of trees grown for shade in the coffee should be considered carefully.

There are of course, factors other than shade type that play a role in determining the bird community in the coffee fields. Some of these may be to do with other forms of human disturbance like hunting. It is important that workers in the coffee are warned against collecting eggs of ground nesting birds whilst they go about their duties. Others may actually go as far as to set traps in the fields, this should be strongly discouraged. A key approach is to educate workers on the various roles that birds play to ensure a good coffee harvest.

The riparian forest next to the coffee is an interesting habitat as it is characterised by very tall Eucalyptus that emerge from the natural forest. As this is an alien plant, one may be quick to recommend that these need to be removed to allow for a truly indigenous forest cover. However, during this survey, a pair of African Fish eagles and a pair of Black sparrow hawks were noted to be nesting in these large trees. Therefore removal of these trees should be approached with great caution. A recommended long term plan would be to leave the stands up until the trees planted in the coffee estate reach at least 15m in height and then gradually remove the Eucalyptus trees.

Vegetation Diversity

Over 250 species of plants were recorded in the Chawani area alone. More concentration was paid on large tree however general listings of shrubs and other smaller plants were also done. The full list can be obtained separate from this report. At least three alien invasive species have been recorded; *Lantana Camara*, *Rubus ellipticus* and *Pistia sp.* The first two are evident on the edges of some forest patches and there is need to devise some method to prevent them from complete invasion. The third plant is found growing over the water at fish ponds on the estate.

Several types of tree species have been planted in the STE coffee fields with the aim that in the near future these trees will provide shade to the coffee. These shade trees will also provide both ecological and economic benefits. There are many things that can be looked at when choosing shade trees for coffee. One common debate is whether to use indigenous or exotic trees. Though indigenous trees are often recommended, some may not necessarily be good to grow with coffee. Others work well but need some form management in order for them to provide the required shade. The tree Nthethe (*Acacia apolycantha*) is one of the indigenous species that has been planted and is being managed by removing lower sub branches to ensure that it grows taller and provides an upper level shade cover.

The goal desired goal in the coffee is to have different layers of shade thus the need to have trees that grow to different heights. These different layers will also provide habitat for different animal and plant species. Table 3 below highlights some of the trees planted in the coffee fields. Some of the indigenous trees listed were planted while others, such as *Tremma orientalis*, are growing naturally and are at sapling stage. Large naturally growing trees such as the cape fig tree are also available. When in fruit, the fig tree provides food for bats, insects and birds. It also providing good shade as is evident by the healthy coffee growing under it.

It is a worthwhile exercise to investigate which of the species occurring naturally in the area can be used as shade in the coffee. This is necessary to avoid using trees that may compete or affects in other ways the way the coffee grows/tastes. A shade that has similarities with the riparian forest close buy may act as an extension area for species resident in the forest.

Table 3: Tree species that have been planted for shade in the coffee

Scientific Name	Status	Other details
1. <i>Leucaena leucocephala</i>	Exotic	A small shrub or tree Introduced from tropical America. The <i>Leucaena</i> spp are fast growing leguminous trees which can reach 10m in two years. They offer no competition to coffee trees and are used widely as coffee shade trees. Their massive seed production is a drawback and can cause forest invasion. Seedless varieties are available.
2. <i>Tamarindus indica</i> (Bwemba)	Indigenous	Medium to large evergreen tree reaching 20-24m height. Mainly a low-altitude woodland tree. The extended crown of the tamarind offers shade Because of its resistance to storms it can also be used as a windbreak. However, <i>T. indica</i> is not very compatible with other plants because of its dense shade, broad spreading crown and allelopathic effects. Its association with coffee is questionable
3. <i>Melia azedarach</i> (India)	Exotic	Introduced from India and now naturalised in many areas. Widely planted as a shade tree in coffee plantations Fruits are very poisonous and it has been declared an invader in some countries
4. <i>Jatropha curcas</i> or <i>multifida</i>	Exotic	A sturdy shrub or small tree introduced from tropical America. Planted in arid areas for soil-erosion control. It is a Nitrogen-fixing soil improver: Tender branches and leaves are used as a green manure. All plant parts can be used as a green manure. Not recorded as a coffee shade tree elsewhere but can be considered for its Nitrogen fixing properties.
5. <i>Gliricidia sepium</i>		After <i>Leucaena leucocephala</i> , <i>gliricidia</i> is believed to be the most widely cultivated multipurpose tree. Especially good as a shade tree for coffee
6. <i>Senna (cassia) spectabilis</i>	Exotic	Tree provides forage for bees. Tree casts a useful shade and provides mulch. No records were found of it being used as a shade tree for coffee.
7. <i>Acacia polyacantha</i> sp. <i>Campylacantha (Nithethe)</i>	Indigenous	The wood of <i>A. polyacantha</i> ssp. <i>polyacantha</i> burns well, but the thorns make it difficult to handle. No records were found of it being used as a shade tree for coffee.
8. <i>Terminalia sericea</i> (naphini)	Indigenous	Recommended for reforestation, agroforestry, and land improvement. An easily established aggressive species. Since <i>T. sericea</i> shades out weeds and climax species are allowed to establish themselves. The tree improves sites by draining waterlogged soils, shading out weeds.
9. <i>Brachystegia spiciformis</i> (tsamba)	Indigenous	The flat crown provides fine shade however not mentioned to be used as a coffee shade tree elsewhere. Leaves are browsed by livestock. Flowers provide a good source of pollen and nectar, giving an excellent honey, which granulates very slowly. Trees are a good source of firewood and charcoal is intended for planting on headlands and rocky areas for bird and insect habitat
10. <i>Moringa oleifera</i> (chamwamba)	Exotic	<i>M. oleifera</i> is suited to areas where strong winds and long, dry spells occur simultaneously, causing serious soil erosion. The green leaves make useful mulch. The tree provides semi-shade, useful in intercropping systems where intense direct sunlight can damage crops.
11. <i>Albizia lebbek</i> (tanga tanga)	Exotic	The species is commonly grown as a shade tree in pastures, tea, coffee and cardamom plantations, and along avenues. Due to its extensive, fairly shallow root system, <i>A. lebbek</i> is a good soil binder and is recommended for eroded lands and erosion control, for example along river embankments. The nitrogen-rich leaves are valuable as mulch and green

12. <i>Albizia versicolor</i>	Indigenous	It makes a beautiful shade tree and can be planted along lands for much needed shade. <i>A. versicolor</i> is a nitrogen fixer. It fixes nitrogen and does not have an invasive root system. It can therefore be used in intercroppings.
13. <i>Persea Americana</i>	Exotic	Avocado is classified as an evergreen, although some varieties lose their leaves for a short time before flowering. The tree canopy ranges from low, dense and symmetrical to upright and asymmetrical. This tree has spread a lot into most of the natural forests at Satemwa. Control may be needed.
14. <i>Albizia gummifera</i>	Indigenous	The ability to associate with crops is indicated by the tendency to leave the tree standing in cultivated fields, intercropped with coffee in Ethiopia. The root system of <i>A. gummifera</i> holds soil and prevents gully erosion. Is a useful shade provider in pastureland. Known to fix Nitrogen. Known as a good mulch tree. Leaf litter abundant during the leaf shedding season.
15. <i>Pterocarpus angolensis (Mlombwa)</i>	Indigenous	Large tree growing to 16-20m in height. Mainly a woodland and wooded Savannah tree. Used for soil conservation and dune fixation. Nitrogen fixing: <i>P. angolensis</i> is capable of fixing atmospheric nitrogen. Cultivated for planting along headlands and rocky areas.
16. <i>Yellow Tabebuia tree</i>		A large shrub or trees growing to 50 m tall depending on the species. Many species are dry-season deciduous but some are evergreen. It is increasingly popular as a decking material due to its insect resistance and durability. Its many flowers appear on still leafless stems at the end of the dry season, making the floral display more conspicuous and attractive. The flowers are useful as honey plants for bees.
17. <i>Macaranga capensis (M'bwabwa)</i>	Indigenous	The species is used as a coffee shade tree in the Ethiopian highlands. This is a useful pioneer species with potential use in protecting soils on logged sites. It has a broad dense crown providing deep shade. Leaf litter from the tree enriches surrounding soil.
18. <i>Newtonia buchananii (Kweranyani)</i>	Indigenous	A large tree that can reach up to 40m in height. The tree protects riverine soil from erosion. Its crown gives light shade which may not injuriously affect other crops in agroforestry systems. The leaves are used in agriculture as mulch. <i>N. buchananii</i> has a graceful form, flat topped and tall, making an ideal choice for gardens, parks and homes
19. <i>Erythrina abyssinica (Chizumira)</i>	Indigenous	The species is used on stream banks and for soil conservation terraces. It is grown as a shade plant in coffee plantations and grazing fields. The roots of trees are infected by Rhizobia nodulate and fix atmospheric nitrogen. Leaf fall in the dry season is a source of mulch. It has the useful characteristic of sprouting from truncheons if cut just before flowering, and so can be used to make a live fence. It is usually combined with annual crops, especially when it is grown in rotation with coffee or cocoa.
20. <i>Khaya anthoeca (M'bawa)</i>	Indigenous	It is used as a shade tree and as a windbreak. Larvae of the white barred charaxes butterfly (<i>Charaxes brutus natalensis</i>) feed on the leaves of this tree. It is fairly fast growing, up to 1.5 m per year. It is also planted along waterways as shade trees, for soil protection and bird and insect habitat
21. <i>Breonavia salicina (Nehonya)</i>		are planted along waterways as shade trees, for soil protection and bird and insect habitat
22. <i>Macadamia</i>		These have just been added as a shade tree after a small experiment on the estate showed that the coffee grew well under the Macadamia shade.

Apart from growing trees in the coffee plantation itself, trees are also being planted in the areas such as the rocky outcrops around the coffee, along the water ways and in some fallow areas. Plans to introduce Macadamia as a shade tree have just been implemented in one of the fields. These different trees being planted in and around the plantation will aid to diversify its habitat. The shade tree community composition on an estate has a large influence on its animal diversity. Generally, estates with diverse shade tree species should support the richest array of species. Plantations dominated by native shade trees are far more attractive to biodiversity. However as earlier stated, not all native shade trees will grow with coffee. Therefore, though one can conclude that it is vital to retain native trees in coffee plantations, there is a need to have some sort of balance on diversity of both native and recommended exotics. It is also important to protect forests nearby in order that coffee plantations live up to their reputation as refuges for biodiversity.

The plots where the macadamia has been planted as a shade tree need to be monitored as to how much biodiversity they will support. There is need to monitor coffee growing under the *Tamarindus indica* trees because of its allelopathic effects. A study in Ethiopia, for example, showed that coffee taste differed depending on the shade tree that it had grown under. Tree species significantly affected beverage acidity, flavour, aftertaste and overall cup quality. In this particular study, it was shown that coffee samples collected under *Acacia abyssinica* and *Cordia africana* were more acidic, with better flavour and overall cup quality as compared to those collected under both *Albizia* species. This is why it is crucial to make wise choices in selecting shade trees for coffee. Though the Tamarind may not be grown in coffee it can be grown in the rocky areas or other habitat around the estate.

Some very useful trees have been recorded to occur naturally in the forest. Some of these are trees that can be considered as shade trees. An example is the medium sized tree *Tremma orientalis*. It can grow in a variety of habitats and its seed germinates readily with rapid growth. It is widely used in reclamation of soil as it establishes well in disturbed soils. *Erythrina abyssinica* is another tree that has been recorded in the forests that serves well as a shade tree. It also normally loses all its leaves at some stage in its life thus can contribute to mulch. Its bright red flowers also attract a lot of birds which may act as natural enemies of some insects.

Conservation Actions

The retention of tall trees on the estate will provide habitat for use by many birds. Trees and other shrub land can also act as a reservoir for pollinators. The current forest fragments found within the estate should be protected and will act as wildlife corridors. The rocky and shrub areas in between the coffee fields also serve different species. Some of the fallow areas that are not being used for anything can be planted with some of the trees suggested in Table 4 or any of those in the plant list. If they remain unattended to the alien and invasive species may take over and stunt natural regeneration.

Management action needs to be taken on forest edges where the shrub *Rubus ellipticus* (Himalayan yellow berry) is taking over. It is unlikely that the shrub can be completely eradicated since birds, human and other animals fiercely disperse the fruit. It also can regenerate from its root which makes it difficult to clear. A possible action is to simply cut off its branches once it starts to produce flowers. This will ensure that it doesn't fruit thus halting dispersal by animals. The current action to manually remove the water weed *Pistia sp* should continue and may be the best removal method.

Provision of suitable habitats for instance woodlots for honey-producing systems, would be an innovative idea for providing habitat for biodiversity. These habitats will also contribute to reducing erosion. There are a number of trees that are occurring naturally in the forest patches that can be considered as shade tree for the coffee. The table below gives a brief of a few of such trees;

Table 4: Other trees recommended as shade trees for Coffee

Tree Species Name	Other Details
1. <i>Tremma Orientallis</i> (<i>Mpefu</i>)	Rapidly grows on disturbed soil helping in soil conservation. Often planted as a shade tree in coffee in other countries. Birds are very fond of the fruit. Seedlings and cuttings are viable methods of propagation.
2. <i>Albizia adiantifolia</i> (<i>chigwenembe,</i> <i>ntangatanga</i>)	It is good for soil conservation purposes. The tree is valued for the shade it provides to tea and cacao plantations. Many farmers plant this tree on hilly ground for soil conservation purposes, often inter-cropped with food crops. At least two handsome butterflies with blue markings, the blue spotted charaxes (<i>Charaxes cithaeron</i>) and the satyx charaxes (<i>Charaxes ethalion</i>)

	breed on this species.
3. <i>Toona ciliate</i> (<i>sendeleya</i>)	Trees may be planted as firebreaks. Reclamation: <i>T. ciliata</i> has been planted for reforestation. A popular avenue tree planted along roadsides
4. <i>Bridelia micrantha</i> (<i>Mpasa</i>)	<p>It makes an excellent shade tree, not only in the garden but also on the farm, after only 3 years, forming a neatly shaped crown. It is grown in banana and coffee plantations for its shade. The trees form a canopy under which various other plants germinate and grow, establishing new riparian vegetation.</p> <p>The roots are extensive and bind the soil effectively, they can be used along eroded drainage lines and streams where the natural vegetation has been removed. The trees can be planted in areas that flood during rainy seasons The leaves are used for mulching. Commonly intercropped and managed by small-scale farmers.</p>
5. <i>Trichilia Emetica</i> (<i>Msikidzi</i>)	Planting <i>T. emetica</i> greatly assists in soil conservation. A worthwhile tree to provide shade and protection for livestock, and an excellent tree for the garden with its fast growth and wide crown. It never grows very high and has an evergreen, spreading crown.

Insect Diversity

Twenty-one insect families were recorded on the estate. Grasshoppers, ants and beetles were the most abundant followed by bugs and butterflies. These were mostly found both on the coffee plants and on the vegetation growing in between rows of coffee bushes. The large amount of dead vegetation on the ground provides good habitat for various insects. Overall there is a significantly varied amount of different insects in the coffee plantations. Evidence of some very large stem borers were observed to be attacking some of the Acacia trees although infestation was not serious. It would be interesting to investigate these more and identify which stem borers these are and if the cause any danger to the trees or coffee.

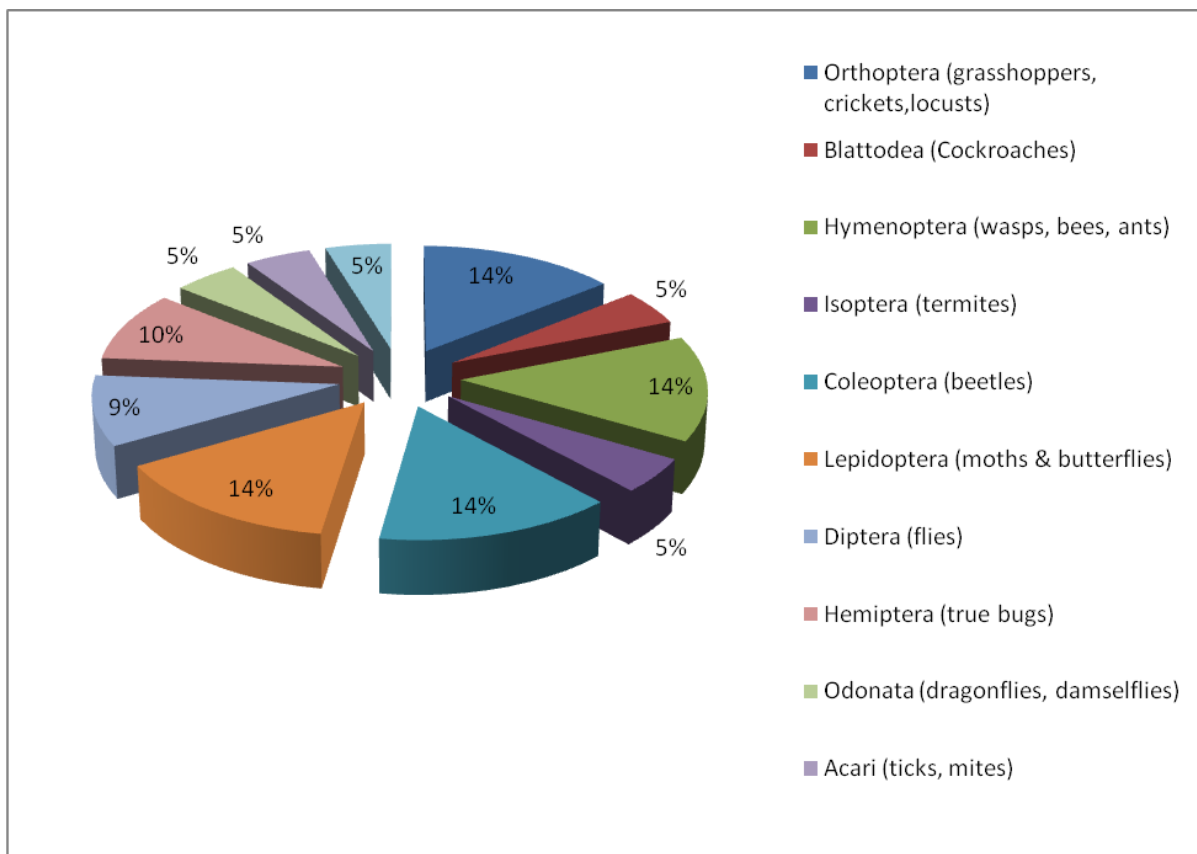


Figure 5: Percentage of Insect Orders found in the coffee fields

A few coffee plants were found to have been attacked by termites. Soft insecticides can be used in the case of extensive termite damage. Scale insects were also observed in the fields. Dung beetles were observed in the daily section of the estate. Evidence of leaf miner and leaf skeletoniser was also observed through the damaged leaves of coffee plants. Leaf skeletoniser damage symptoms were not as severe as that for leaf miners but both appeared under control. Given the time limitation on this study it was rather difficult to do a more detailed type of sampling in the whole area. However it does appear that there is a natural diversity of insects.

Most insects are seen as beneficial because of the economic significance of pollination. It has been observed in pollinator-dependent crop species that pollinators increase yield. Pollinators like bees provide free services so it's important to provide suitable habitats for them to stay. Diverse habitats are necessary in maintaining beneficial insects on and near agriculture estates. These habitats can be obtained through planting trees in fallow land and forests as well as woodlots. However coffee can also self pollinate so it is good that there is a balance of all insects (beneficial or not) in the field.

Control of Stem/berry Borer

One of the most serious threats to coffee production in Southern Africa is the white coffee stem borer, *Monochamus leuconotus* (Pascoe) (Coleoptera: Cerambycidae). *M. leuconotus* is endemic to Africa and mainly attacks Arabica coffee grown at altitudes of below 1,700m where it may make the cultivation of coffee uneconomical. Coffee stem borer (CSB) was previously managed by application of Aldrin and Dieldrin. However these chemicals have been banned due to their persistence in the environment and subsequent threat to non-target organisms.

CSB appears to have re-emerged as a serious pest in Malawi. Management of STE expressed concern over how the borer has crippled the coffee industry. Most growers have actually abandoned growing the plant. Due to such complaints from other countries such as Zimbabwe, a study was carried out to quantify the efficacy and potential of control methods:

1. An integrated management strategy, involving control measures obtained from project trials was recommended, including adult stem borer hand picking, bark smoothening, chemical treatment (quarter rate of Fipronil or Chloropyrifos), hunting for larvae, and uprooting and burning infested coffee trees.
2. Bark smoothening was recommended to be done in October/November each year just before the flight period and then two months later to destroy the young larvae in Southern Africa.
3. Hand picking of larvae should also be done promptly before extensive damage occurs so that the trees can recover their full potential.
4. All the coffee trees that have lost their economic potential due to stem borer should be uprooted during the course of attack and should be promptly burned before the larvae hatch into adults. It is expensive to uproot all attacked trees unless the CSB incidence is more than 50% and the coffee is less than six years old because the death rate tends to be higher in young coffee trees than in mature trees.

Coffee is difficult to grow without the use of pesticides. Plants such as Neem, Black pepper, and India have been planted in the coffee for their useful properties as natural insecticide.

Time will tell as to how well they work against destructive insects such as the stem borer.

CONCLUSION AND RECOMMENDATIONS

There is a need for biodiversity and agriculture to work together. Therefore finding space for wildlife in and around crops is highly recommended and very likely to increase yields. Trees, for example, help in soil and water conservation, insects (e.g. bees) and birds pollinate plants and enhance fruit production. Birds can also act as organic pest control and seed dispersal agents. Insects and micro-organisms like earthworms, dung beetles and bacteria decompose waste leading to increased soil fertility.

There is need to develop plan of action for the control of invasive alien species. A tree nursery for locally occurring indigenous trees should be set up. This will supply plants to be grown around the estate. A simple monitoring system for birds in the coffee plantations should be set up. This is very important as it would produce future evidence as to the impact of the shade tree once they have fully matured. Monitoring can be done by occasional bird watchers being encouraged to submit the list of species they see each time. Or it can be more systematic with specific times set up (e.g. twice a year) and specific transects that are walked and all birds seen and heard recorded.

Simple labels to some of the plants with interesting edible or medicinal properties can be added in the coffee. Guests visiting the plantation will be able to know a little more about the trees that have been planted there. It is important to promote coffee that is grown under a tree canopy, the floristic composition and structural characteristics of the shade canopy can greatly influence its suitability for biodiversity. Birds in several coffee-growing regions have been found to prefer coffee plantations under a native, mature shade.

A more detailed and systematic study to sample all the potential areas in which insects are known to inhabit would be most beneficial. This will give a better understanding of what's happening in terms of pest insects. Biodiversity is not a threat to agriculture; it is the key to its sustainability. The failure to recognize the wider role of biodiversity in agricultural landscapes means that insufficient attention has been paid to the risks associated with the loss of important ecosystem services. Bio diverse agriculture provides services that increase the ability to respond to climate and other environmental risks. I hope that this report will assist in making STE even more informed of their conservation initiatives.

REFERENCES

Hergoz, F. (1994). Multipurpose shade trees in coffee and cocoa plantation in Cote d'voire. *Agroforestry Systems* 27: 259-267

Perfecto et al. 1996. Habitat changes in Colombian coffee farms under increasing management intensification. Published in [Endangered Species Update](#) Publication Date: 01-JUL-03 Format: Online Delivery: Immediate Online Access

O'Brien, T.G. & Kinnaird, M.F. 2003. Caffeine and Conservation. *Science* 25 April 2003: Vol. 300 no. 5619 p. 587

M. D. Johnson¹, J. L. Kellermann² & A. M. Stercho¹ and Vandermeer, (2008) Pest reduction services by birds in shade and sun coffee in Jamaica

Karl L Evans, Ana S.L Rodrigues, Steven L Chown and Kevin J Gaston Protected areas and regional avian species richness in South *Biol. Lett.* 2006 2, 184-188

JHERIME L. KELLERMANN, MATTHEW D. JOHNSON, AMY M. STERCHO,

AND STEVEN C. HACKETT† Ecological and Economic Services Provided by Birdson Jamaican Blue Mountain Coffee Farms *Conservation Biology* Volume 22, No. 5, 2008

www.biodiversityexplorer.org

www.agroforestry.org

Githiru, M., Karimi, S. & Imboma, T. 2009. Unilever Kenya Ltd. (Kericho): Avifaunal Assessment Report. Unilever Tea Kenya Ltd., Nairobi.

Yadessa, A., Burkhadt, J., Denich, M., Woldemariam, T., Bekele, E., Goldbach, H., Effect of different Indigenous shade trees on the quality of wild Aradica Coffee in the Afromontane Rainforests of Ethiopia.

Perrins, et al. Biodiversity in Agricultural Landscapes: Saving Natural Capital without Losing Interest, *Conservation Biology*, Volume 20, No. 2

APPENDICES

Appendix 1: List of bird species seen

NB: Migrant status notes: AM=African Migrant; R=Resident; P=Palearctic Migrant; B= Breeder; W = Wintering species

Common Name	Scientific Name	Feeding Guild	Migrant Status
African Emerald Cuckoo	<i>Chrysococcyx cupreus</i>	Insectivore	AM/R
African Broadbill	<i>Smithornis capensis</i>	Insectivore	RB
African fish Eagle	<i>Haliaeetus vocifer</i>	Raptor	RB
African Golden Oriole	<i>Oriolus auratus</i>	Frugivore	RB
African golden weaver	<i>Ploceus xanthops</i>	Granivore	RB
African paradise flycatcher	<i>Terpsiphone viridis</i>	Insectivore	RB
African yellow White-eye	<i>Zosterops senegalensis</i>	Insectivore	RB
Amythest Starling	<i>Cinnyricinclus leucogaster</i>	Omnivore	AM/RB
Arrow marked Babbler	<i>Turdoides jardineii</i>	Insectivore	RB
Ashy blue Flycatcher	<i>Muscicapa aquatic</i>	Insectivore	RB
Augur Buzzard	<i>Buteo augur</i>	Raptor	RB
Barn Swallow	<i>Hirundo rustica</i>	Insectivore	PW
Black headed Heron	<i>Ardea melanocephala</i>	Insectivore	RB
Black eagle	<i>Aquila verreauxii</i>	Raptor	RB
Black eyed bulbul	<i>Pycnonotus tricolor</i>	Omnivore	RB
Black headed Apalis	<i>Apalis melanocephala</i>	Insectivore	RB
Black headed Oriole	<i>Oriolus larvatus</i>	Frugivore	RB
Black shouldered Kite	<i>Elanus caeruleus</i>	Raptor	RB
Black Sparrow hawk	<i>Accipiter melanoleucus</i>	Raptor	RB
Blue spotted wood dove	<i>Turtur afer</i>	Frugivore	RB
Broad billed Roller	<i>Eurystomus glaucurus</i>	Insectivore	AMB

Bronze manikin	<i>Spermestes cucullata</i>	Granivore	RB
Brown crowned Tchagra	<i>Tchagra australis</i>	Insectivore	RB
Burchell's coucal	<i>Centropus burchelli</i>	Insectivore	RB
Cannabis bunting	<i>Emberiza cabanisi</i>	Granivore	RB
Bully Canary	<i>Serinus sulphuratus</i>	Granivore	RB
Cape robin	<i>Cossypha caffra</i>	Insectivore	RB
Cardinal woodpecker	<i>Dendropicos elachus</i>	Insectivore	RB
Cinnamon Dove	<i>Aplopelia larvata</i>	Frugivore	RB
Common swift	<i>Apus apus</i>	Insectivore	RB
Common Fiscal Shrike	<i>Lanius collaris</i>	Insectivore	RB
Common Waxbill	<i>Estrilda astrild</i>	Granivore	RB
Dark backed forest Weaver	<i>Ploceus bicolor</i>	Frugivore	RB
Eastern Saw wing	<i>Psalidoprocne orientalis</i>	Insectivore	RB
Emerald spotted Wood dove	<i>Turtur chalcospilos</i>	Frugivore	RB
Eurasian Oriole	<i>Oriolus oriolus</i>	Frugivore	PW
Evergreen forest warbler	<i>Bradypterus lopezi</i>	Insectivore	RB
European Bee-eater	<i>Merops apiaster</i>	Insectivore	PM
Fork tailed Drongo	<i>Dricrurus adsimilis</i>	Insectivore	RB
Gymnogene	<i>Polyboroides typus</i>	Carnivore	RB
Golden-Weaver	<i>Ploceus subaureus</i>	Frugivore	RB
Green backed Chamaroptera	<i>Camaropectera brachyura</i>	Insectivore	RB
Collared sunbird	<i>Hedydipna collaris</i>	Nectarinivore	RB
Grey headed Sparrow	<i>Passer diffusus</i>	Granivore	RB
Hamerkop	<i>Scopus umbretta</i>	Carnivore	RB
Hueglins Robin Chat	<i>Cossypha heuglin</i>	Insectivore	RB
Jameson's Firefinch	<i>Locogonosticta rhodopareia</i>	Granivore	RB

Little greenbul	<i>Andropodus virens</i>	Insectivore	RB
Little Sparrowhawk	<i>Accipiter minullus</i>	Raptor	RB
Livingstone's Turaco	<i>Tauraco livingstonii</i>	Frugivore	RB
Long tailed Mountain Wagtail	<i>Motacilla clara</i>	Insectivore	RB
Malachite kingfisher	<i>Alcedo cristitata</i>	Franivore	RB
Lesser Masked weaver	<i>Plocees intermedus</i>	Granivore	RB
Olive Bushshrike	<i>Malaconotus olivaceus</i>	Carnivore	RB
Olive Sunbird	<i>Nectarinia olevacea</i>	Nectarivore	RB
Olive Thrush (split)	<i>Turdus olivaceus</i>	Insectivore	RB
Pale Batis	<i>Batis soror</i>	Insectivore	RB
African Palm Swift	<i>Cypsiurus parvus</i>	Insectivore	RB
Pied Crow	<i>Corvus albus</i>	Omnivore	RB
Pied kingfisher	<i>Ceryle rudis</i>	Carnivore	RB
African Pied Wagtail	<i>Motacilla aguimp</i>	Insectivore	RB
Richards Pipit	<i>Anthus richardi</i>	Insectivore	RB
Southern Puffback	<i>Dryoscopus cobla</i>	Insectivore	RB
Purple crested Turaco	<i>Tauraco porphyreolophus</i>	Frugivore	RB
Rameron Pigeons	<i>Columba arquatrix</i>	Frugivore	AMB
Red eyed dove	<i>Streptopelia semitorquata</i>	Frugivore	RB
Red-capped Cisticola		Insectivore	RB
Red-capped Robin	<i>Cossypha natalensis</i>	Insectivore	RB/AMW
Red-faced Crimsonwing	<i>Cryptospiza reichenovii</i>	Granivore	RB
Red-throated (Peters's) Twinspot	<i>Hypargos niveoguttans</i>	Granivore	RB
Scally-throated Honeyguide	<i>Indicator variegates</i>	Insectivore	RB
Silvery cheeked hornbill	<i>Bycanistes brevis</i>	Frugivore	RB/AMB
Southern Citril	<i>Serinus hypostictus</i>	Granivore	RB

Speckled Mousebird	<i>Colius striatus</i>	Frugivore	RB
Square-tailed Drongo	<i>Dicrurus ludwigii</i>	Insectivore	RB
Stone Chat	<i>Saxicola torquata</i>	Insectivore	RB
Tambourine Dove	<i>Turtur tympanistria</i>	Frugivore	RB
Tawny flanked Prinia	<i>Prinia subflava</i>	Insectivore	RB
Trilling Cisticolla	<i>Cisticola woosnami</i>	Insectivore	RB
Tropical Boubou	<i>Laniarius aethiopicus</i>	Carnivore	RB
Trumpeter Hornbill	<i>Bycanistes bucinator</i>	Frugivore	RB
Western banded Snake eagle	<i>Circaetus cinerascens</i>	Raptor	RB
White eared Barbets	<i>Stactolaema leucotis</i>	Frugivore	RB
White-browed scrub-robin	<i>Cercotrichas paeon</i>	Insectivore	RB
Wire tailed swallow	<i>Hirundo smithii</i>	Insectivore	RB
Yellow billed Kite	<i>Milvus aegyptius</i>	Raptor	AMB/PW
Yellow-rumped bishop	<i>Euplectis capensis</i>	Granivore	RB
Yellow-rumped Tinkerbird	<i>Pogoniulus bilineatus</i>	Frugivore	RB
Yellow streaked Bulbul	<i>Phyllastrephus flavostriatus</i>	Omnivore	RB
Yellow throated Longclaw	<i>Macronyx croceus</i>	Carnnivore	RB
Yellow-bellied sunbird	<i>Nectarinia venusta</i>	Nectarinivore	RB
Yellow-breasted Apalis	<i>Apalis flavida</i>	Insectivore	RB
Yellow-fronted canary	<i>Serinus mozambicus</i>	Granivore	RB
Yellow-throated Petronia (Sparrow)	<i>Petronia superciliaris</i>	Granivore	RB

Appendix 2: List of birds mist netted

Name	Strawberry Dam	Chawani Bungalow	Riparian	Admin	Dairy	Kanjedza
African Broadbill	1					
African Yellow White-eye	1					
Blue-spotted Wood-Dove				1		
Dark-capped (Black-eyed) Bulbul		1	1		6	1
Golden-Weaver					21	
Green-backed Camaroptera (split)		1				
Jameson's Firefinch					1	1
Little Greenbul (incl. "Hall's")	2	1	1	8		
Olive Sunbird	1	12				1
Red-throated (Peters's) Twinspot			2		2	
Tambourine Dove						1
Tawny-flanked Prinia					1	
Tropical Boubou		1				
White-browed (Heuglin's) Robin-Chat			1			
White-browed (Red-backed) Scrub-Robin		1				
Yellow bellied sunbird		1	1			
Yellow-breasted Apalis					2	
Yellow-throated Petronia (Sparrow)					1	
	5	18	6	9	34	4

Appendix 3: List of Insect Orders

Common English name	Order	Suborder	Family
1. Grasshoppers	Orthoptera	Caelifera	Locustidae Acrididae
2. Cicadas	Orthoptera	Caelifera	Cicadidae
3. Crickets	Orthoptera	Caelifera	Gryllidae
4. Cockroaches	Blattodea		
5. Ants	Hymenoptera	Apocrita	Formicidae Cynipidae
6. Termites	Isoptera		
7. Beetles	Coleoptera	Polyphaga	
8. Bees	Hymenoptera	Apocrita	Apidae
9. Wasps	Hymenoptera	Vespidea	
10. Butterflies	Lepidoptera	Rhopalocera	
11. Flies	Diptera	Nematocera	Simuliidae
12. Housefly	Diptera		Muscidae
13. Dung beetles	Coleoptera		Scarabaeoidea
14. Coffee berry borer	Coleoptera		Curculionidae
15. Coffee leaf miner	Lepidoptera		Lyonetiidae
16. Coffee leaf skeletonizers	Lepidoptera		Epiplemididae
17. Scale insects	Hemiptera	Sternorrhyncha	
18. Bugs	Hemiptera	Homoptera Heteroptera Auchenorrhyncha	
19. Dragon flies	Odonata		
20. Red coffee mites	Acari		Tetranychidae
21. Spiders	Araneae		

Appendix 4: List Other plants growing in the Coffee Plantation

Species Name
1. <i>Acacia polyacantha</i>
2. <i>Achyranthus aspera</i>
3. <i>Agathisanthemum bujeri</i>
4. <i>Ageratum conyzoides</i>
5. <i>Albizia antinesiana</i>
6. <i>Alternanthera sessilis</i>
7. <i>Amaranthus hybridus</i>
8. <i>Amaranthus lividus</i>
9. <i>Arachis sp</i>
10. <i>Asystasia gangetica</i>
11. <i>Bidens pilosa</i>
12. <i>Canna indica</i>
13. <i>Celocia trygria</i>
14. <i>Centella asiatica</i>
15. <i>Cissampelos mucronata</i>
16. <i>Commelina benghalensis</i>
17. <i>Cyanotis nodiflora</i>
18. <i>Cyperus sp</i>
19. <i>Desmodium intortum</i>
20. <i>Domboya burgessiae</i>
21. <i>Dyschoriste verticillaris</i>
22. <i>Eragrostis sp</i>
23. <i>Faidherbia albida</i>
24. <i>Galinsoga purilliflora</i>
25. <i>Gladiolus dallen</i>
26. <i>Glycine wightii</i>
27. <i>Helichrysum splendidum</i>
28. <i>Hibiscus rhoda</i>
29. <i>Hyparrhenia cymbaria</i>
30. <i>Hyperrhenia filipendula</i>
31. <i>Hypoestes forskali</i>
32. <i>Ipomoea malvaceae</i>
33. <i>Ipomoea pes-caprae</i>
34. <i>Ipomoea rubens</i>
35. <i>Ipomoea shirambensis</i>
36. <i>Justisia striata</i>
37. <i>Khaya anthotheca</i>
38. <i>Lantana camara</i>
39. <i>Leucaenia leucocephala</i>

40. <i>Macaranga capensis</i>
41. <i>Melia azedarach</i>
42. <i>Melinis repens</i>
43. <i>Mellettia Uasaramensis</i>
44. <i>Momordica foetida</i>
45. <i>Mucuria puggei</i>
46. <i>Musa paradisiaca</i>
47. <i>Ocimum gratissimum</i>
48. <i>Oxalis cormiculata</i>
49. <i>Panicum sp</i>
50. <i>Pavonia colummella</i>
51. <i>Pavonia urens</i>
52. <i>Pennisetum purpurea</i>
53. <i>Peristrophe bicalyculata</i>
54. <i>Peristrophe bicalyculata</i>
55. <i>Phoenix dactylifera</i>
56. <i>Plectranthus sp</i>
57. <i>Psidium guajava</i>
58. <i>Richardia sp</i>
59. <i>Ricinus communis</i>
60. <i>Rorippa nast</i>
61. <i>Rubus ellipticus</i>
62. <i>Ruellia prostrata</i>
63. <i>Sida acuta</i>
64. <i>Sida rhomboidea</i>
65. <i>Solanum incamum</i>
66. <i>Solanum nigra</i>
67. <i>Sonchus oleracium</i>
68. <i>Spermacoce dibrichiata</i>
69. <i>Thumbergia alata</i>
70. <i>Thumbergia petersiana</i>
71. <i>Toona ciliate</i>
72. <i>Tremma Orientalis</i>
73. <i>Tridax procumbens</i>
74. <i>Urena lobata</i>
75. <i>Urena lobata</i>
76. <i>Vernonia achoensis</i>
77. <i>Vernonia myriantha</i>
78. <i>Veronia mifriantha</i>

Appendix 5: Project Objective Achievement Analysis

OBJECTIVE	ACHIEVED or NOT
Compile bird lists for the coffee plantations and the natural forests with highlights on key species for the area	List available in appendix 1 and 2. Species of interested highlighted in text.
Create a simple monitoring system that will help collect data to monitor habitat quality using birds as an indicator species over time	Suggestions made in the section on conservation and recommendations
Identify key tree species in the area and recommend species to be used in the current work to place more wildlife corridors and those that can be used as shade trees in the coffee	Plant species list provided of both tree and shrubs. Easily propagated natural trees stated in Table 2
Compile a general list of beneficial and pest insects orders/families currently in the coffee and natural forests and investigate the potential for monitoring these	Provided in appendix 3 and text

Appendix 6: Suggested Way Forward

This report serves as a baseline for the biodiversity of Satemwa Tea Estate. The lists provided for birds, insects and plants are not conclusive, they will need to be improved with time. Birds in particular are known to inhabit different habitats at different times of the year, thus it is certain that there are many other bird species that have not been reported as they were not present at the time of this study. Thus it is important to repeat this study at a different time in the year such as just after the rains. A suggested monitoring plan is presented below for continued work.

Date	Details / Objective
March	I assume the rains would have reduced by this time. It would be good to revisit the coffee plantations and see what else is in there. Update current list, note Migrants still on site,
June	Note what birds are around during the coldest time of the year, how are they using the different habitats available
Oct	Repeat the sampling again and compare with 2010 results

This suggested 5 day sampling at different times of the year can be repeated each year or at intervals that best suit the Estates needs. During these days bird ringing work can also be carried out while on site.