FLORA AND FAUNA STUDY IN THE TAIN II RESERVE

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REPORT AT A GLANCE

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Major Results

The field team found the Form Ghana Teak Concession area to provide habitat for at least 61 bird, 15 mammal and 57 flora species.

Summary of species recorded in the various management zones

	Total	Indigenous	Teak	Conservation	Admitted Farm
Large mammals	12	6	7	8	8
Small mammals	3	1	2	1	1
Birds	61	31	33	49	40
Flora	57	33	*	34	*

Some signs of hunting for bush meat (e.g. gun cartridges and dogs) and activities of Fulani herdsmen were observed in the concession. It is likely, that this has affected local abundance of fauna, particularly large mammals. Forest patches and old fallows within admitted farms were the most important land use type in terms of biodiversity conservation. However, these admitted farms are private owned and subject to clearing for farms. FORM Ghana should liaise with farmers to respect forest buffers or possibly negotiate with the Forestry Commission to relocate farmers from these areas.

Summary Conservation Recommendations

Recorded species of conservation interest on the IUCN Red List of Threatened Species (2018) included only one small mammal (Shrew; *Crocidura grandiceps*; Near Threatened). Also protected on CITES Schedule III was the African Civet (*Civettictis civetta*). Though not a target species, the Nile monitor (*Varanus niloticus*) which is also listed on CITES Schedule III was observed several times in inundated areas within the conservation areas. Recorded species of special conservation importance in Ghana were birds of the Family Ardeidae (Egrets) and Accipitridae (birds of prey). Four flora species were of conservation interest on the IUCN Red List of Threatened Species (2018) whiles eleven were star rated species of conservation interest. One tree species is also protected as a Schedule II species by CITES. Potential activities of concern include hunting and land clearing for subsistence farming in the admitted farms. These activities should be aggressively discouraged within the concession. Most mammal species were recorded in the admitted farm area whiles the conservation areas served as strongholds for a wide array of bird and butterfly species. The biodiversity plots (Plots 1, 2 and 3) seems to provide haven for many butterflies. Since butterflies were not part of this study, conscious efforts should be made to assess the butterfly assemblages in the area and potentially establish a butterfly sanctuary to raise the ecological importance of the area.

Summary of species of conservation interest recorded in the study area

	IUCN	CITES	WD	Star Rating
Large mammals		III		
Small mammals	NT			
Birds			I, I, I	
Flora	EN, VU, VU, VU	II		10

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1.0 BACKGROUND

For the effective conservation of the forest remnants and plantations, there is the need for scientific knowledge, which underpins managements' decisions and on-ground actions. However, the general lack of agriculture-based ecological research in Ghana limit our ability to make generalizations about the habitat requirements of species living in such landscapes, and hence suggest management recommendations. This limitation is further compounded by differences in the type, rate, intensity and economic interests of disturbances (land-uses) within agriculture landscapes compared with natural landscapes. A further complication is the large variation in habitat requirements among species (Jellinek et al. 2004), but also within species according to age. Consequently, conservation managers face significant uncertainty regarding the most appropriate management strategies for achieving long-term conservation outcomes for a diversity of native fauna species in off-reserve community lands.

Conserving native fauna in agriculture-dominated landscapes also requires understanding the biodiversity conservation potential of local land-use types. This knowledge may then be used to inform FORM Ghana and planners about priority habitat management decisions and activities so that native fauna occupying the area are adequately conserved. It is also vital to design a monitoring system for wildlife species in the Tain II Forest Reserve.

Plate 1: One of many hidden treasures in the Form Ghana Teak Plantation

1.1 THE FORM GHANA TEAK PLANTATION

The Form Ghana Lease [latitudes 7°34'30"N to 7°40'30"N and longitudes 2°31'45"W to 2°40'30"W] in the Tain II Forest Reserve has an area of 14,576ha and lies within the fire zone subtype of the dry semi-deciduous forest. It has a bi-modal rainfall pattern with a major and minor peak in June and October respectively. The main dry season is from November to March and there is a second dry spell in August. The mean annual rainfall is 1200mm and the maximum and minimum annual temperature for 26 years were 23.6^{o}C and 26^{o}C (Orgle, 1994). Relative humidity in the dry season ranges from 100% at night to 30% near midday when the harmattan is strongest.

It is possible to categorize the teak plantation into four main zones (conservation area, teak plantation, indigenous species area, and admitted farms) (Figure 3) based on local the management prescription. Conservation areas constituted natural forest fragments in low stages of human disturbances classified as slightly disturbed and moderately disturbed. Slightly disturbed forests had continuous upper canopy whilst moderately disturbed forests had broken canopy with little undergrowth. Teak plantation represented areas with monocultures of teak whilst indigenous area represented areas where indigenous species were planted as a means to restore forest cover. Farmland constituted old fallowed areas including thickets of *Chromolaena odorata* and sites actively used for the cultivation of a variety of food crops including maize and cassava. These areas were also used by Fulani herdsmen to graze their cattle.

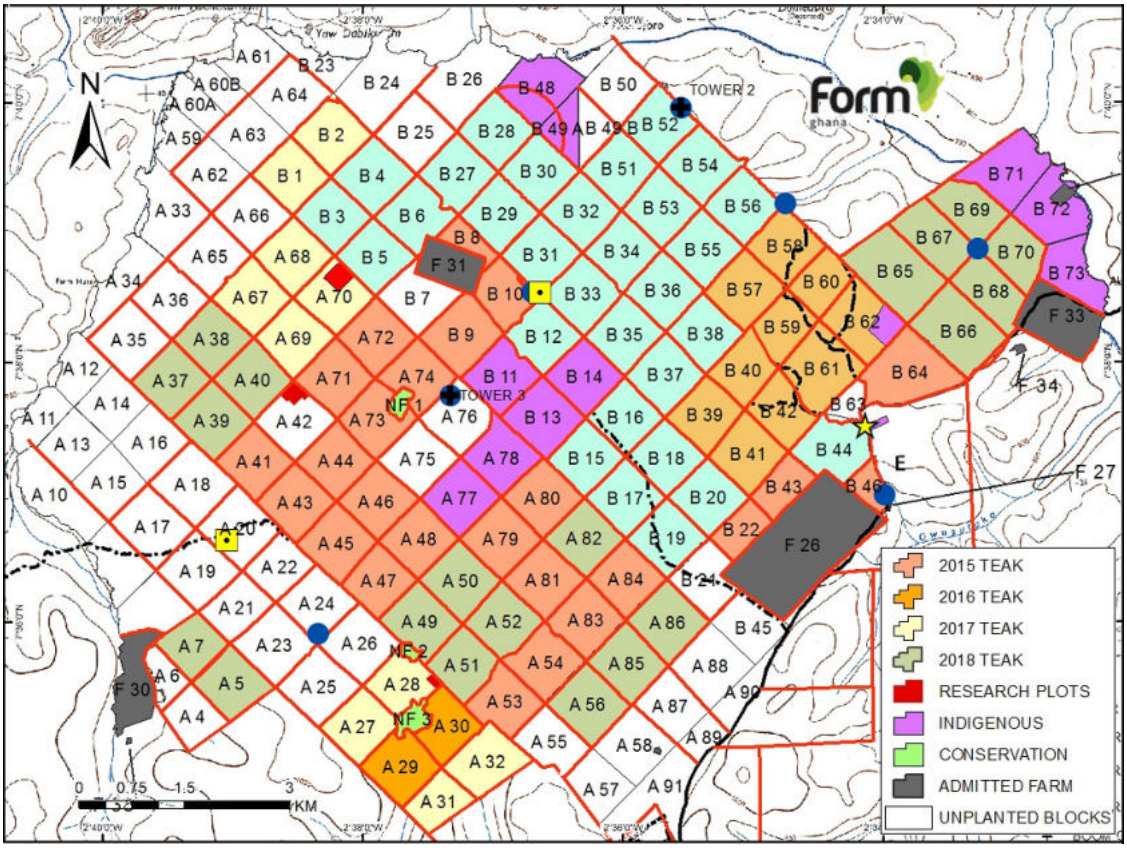

Figure 1: Map of Form Ghana Teak Concession in Tain II FR showing management areas

2.0 TERMS OF REFERENCE

1. Determine the status of flora and fauna species in the project area by using the following methodology;
    - Large mammal survey using transects walks, spoors (footprints, droppings, etc.)
    - Small mammal survey using live traps, spoor and other signs
    - Avifauna survey using bird netting (mist nets), sighting and vocalization records
    - Vegetation assessment
2. Investigate the presence of species of special conservation interest
3. Establish impact of plantation development activities towards local biodiversity

Plate 2: A civet footprint

2.1 PRODUCTS AND KEY DELIVERABLES

The expected outputs of this assignment are:

(i) A report of the inventory indicating: a description of the biodiversity status, flora and fauna species, their numbers and distribution, the methods used and the areas covered with appropriate recommendations for improving the biodiversity status available.

(ii) The factors that enhance and/or inhibit the status of the flora and fauna species in the area known.

3.0 METHODOLOGY

3.1 RECONNAISSANCE

Project area was visited in collaboration with project implementation team to familiarize the field team with Form Ghana's existing fauna transects and flora plots (Figure 1) for the intended survey and also predict logistical problems and test operational procedures. Depending on a number of factors, i.e. location of transects and plots, size of area, accessibility etc. at least, one day was spent for the reconnaissance.

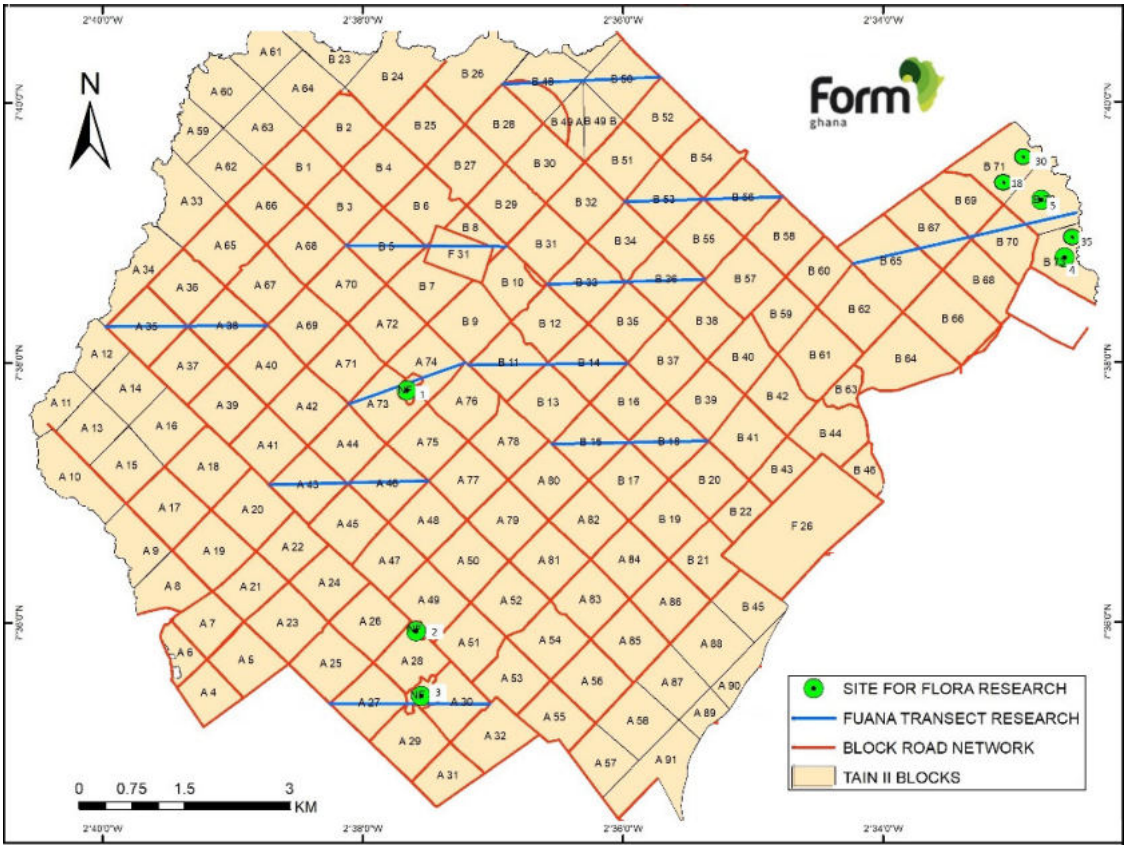

Figure 2: Map of Form Ghana Teak Concession in Tain II FR showing distribution of sampling plots and transects

3.2 BIOLOGICAL SURVEY

Transect methods

The survey team consisted of technicians in the taxonomically well-known groups (large mammal, small mammal, avifauna and flora) to ensure ready identification of organisms to the species level.

Large Mammal Survey

Large mammal surveys comprised both direct and indirect survey methods along existing transect lines using the line transect method (Burnham *et al.*, 1980; Buckland *et al.*, 1993, 2001). Both direct and indirect sampling methods were used to make a complete species list for the area. Direct sightings, vocalizations, dung (scats and pellets) and tracks (trails) counts were standardized and conducted systematically along line transects and also on ad hoc basis in the study area. Survey teams navigated with a compass and a GPS to reach the starting point of each transect.

Small Mammal Survey

A total of 50 Sherman live traps were used simultaneously. Traps were set along the existing transect lines in various habitat types. Traps were placed systematically at fixed intervals of 25m on each side of line transects. Majority of traps were placed on the ground, lightly covered with leaves, bark etc., whereas some were placed on fallen trees or lianas. Others were set close to heaped brushwood, network of aerial roots, holes in the ground or hollow trees. Trap sites were indicated by ribbons made of orange nylon rope fixed at eye height on twigs.

Plate 3: Field team inspecting a Sherman trap

Avifauna Survey

Transect walks along the existing transect lines were used. Transects were walked between the hours of 06:00 to 10:00 and 15:00 to 18:00 each day avoiding the afternoons during which period soaring temperatures were experienced and almost impossible to detect the birds All birds detected both visually and vocally while walking transects were identified and recorded. Additionally, mist netting were employed to capture the shy and cryptic understory bird species that are difficult to record during transect walks. Particular attention were paid to species of special interest, notably Upper Guinea endemics and near-endemics, rare or threatened species, key or unusual species.

Flora Assessment

Methodology

The current assessment adopted and modified the nested plot methodology used in the Akumadan project area developed by Noor de Laat. This is to enable some level of comparing the flora composition at different FORM Ghana project sites. The plots were marked with a wooden pole in the centre and the GPS coordinate recorded. Each plot consisted of a main plot of 500m^2 (radius: 12.62m), with two nested subplots of 3mx3m and 1mx1m respectively (Figure 2). This is different from the plot structure used at Akumadan area in 2015, where the main plot was 200m^2.

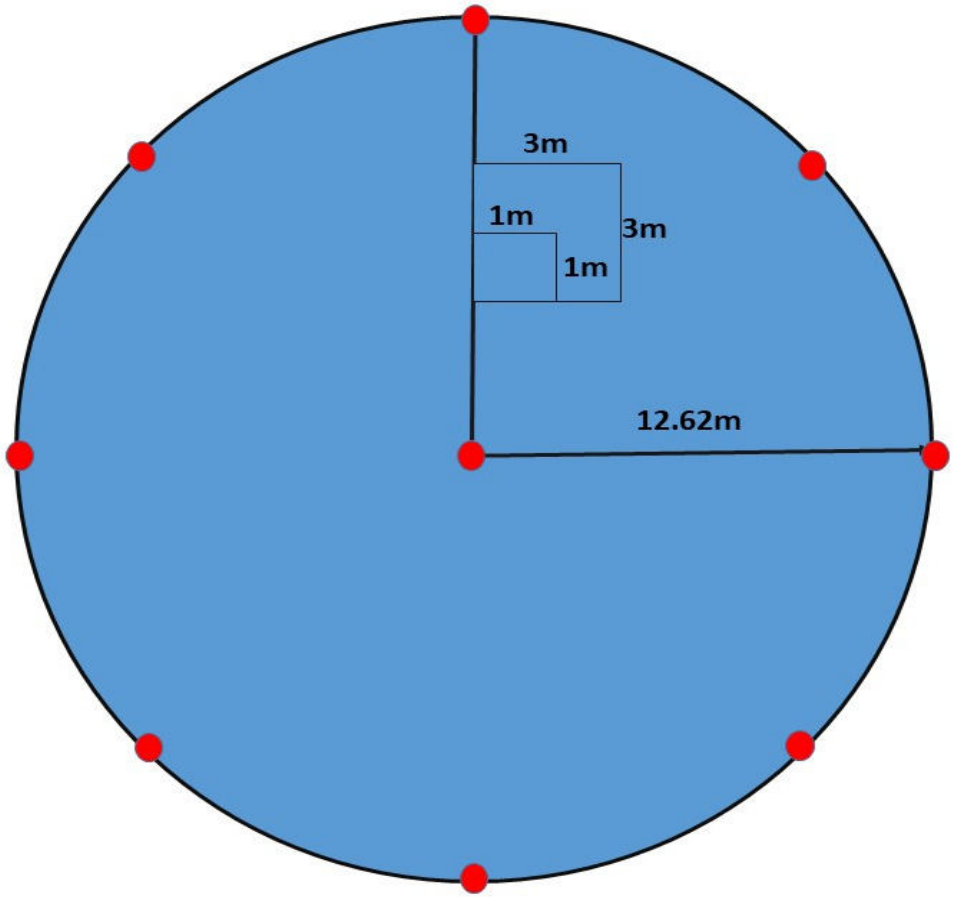

Figure 3: Outlook of the main plot and subplots

Plot one was relocated from the original coordinate provided because the plot center was in the middle of a *Chromolaena odorata* stand, plot five was also relocated because the whole plot fell in a grassland (spear grass) with little or no trees. The center of plot 18 fell in the middle of a *Pennisetum purpurum* stand, which is inundated during the rains with little or no tress.

Plate 4: Cutting through the vegetation to the plot centre

Enumeration procedure

The enumeration team was made up of a tree spotter, a recorder and an assistant(s). Moving clock-wisely from the north of the plot, all trees of 5cm and above were identified, measured and recorded from the main plots. The diameter measurement was done at breast height (1.3m) from the ground and in the case of buttressed trees 10cm above the point of convergence of the buttress. In the large subplot (3x3m), all lianas, shrubs and trees with DBH < 5cm were measured whereas in the small subplot (1x1m), all shrubs, herbs, grasses and juveniles were counted.

All trees were identified to the species level and specimens of unidentified trees were collected and sent to Resource Management Support Centre's herbarium for identification. Species local name, diameter at breast height, and estimated height were call to the recorder who in turn calls back the same information to ensure that the right information was recorded.

Diameter tape is used to measure the diameters. The diameter at breast height ('dbh' or '1.3m') of each sampled tree is measured over bark with the diameter tape. The breast height position was generally at 1.3m above ground level. However, there are some reasons to deviate sometimes from this standard "breast height" and execute the diameter measurements at another position on the sample tree. These were as follows:

- Sample trees with buttresses: the stem diameter was measured approximately 30cm above the buttress.
- Sample trees with aerial or stilt roots: the stem diameter was measured at 1.3m above the beginning of the stem.
- Forked trees were regarded as two sample trees if the fork is below 1.3m.
- Consequently, forked trees were regarded as one tree if the fork is above 1.3m.

Plate 5: An enumeration team measuring diameter at breast height using the diameter tape

Tree height was defined as the total length from the ground up to the tip of the tallest vertical branch of the sample tree. As the measurement of the tree height is very time consuming, mostly not very accurate and additionally not very important to increase the precision of floral information, it is recommended to only estimate the stem height in meters. An assistant stood on the foot of the sample tree and held a using Raffia pole as reference of 2m-length in his hand. However, height of lianas were not measured.

Factors affecting Fauna Abundance

Various notes, particularly of ecological and human factors that might explain the distribution of animals were made at encounter points of all the target species of interest in the concession area.

3.3 GPS READINGS

The transect positions for the faunal surveys are indicated in Table 1.

Table 1: GPS readings of start and end points of line transects for fauna

	Start point			**End point**		
Transect	**Point**	**Latitude (N)**	**Longitude (W)**	**Point**	**Latitude (N)**	**Longitude (W)**
1	1	7°35'22.71"N	2°37'01.14"W	2	7°35'23.24"N	2°38'15.11"W
2	3	7°37'05.38"N	2°37'29.50"W	4	7°37'03.63"N	2°38'42.91"W
3	5	7°37'23.92"N	2°35'20.86"W	6	7°37'22.58"N	2°36'32.83"W
4	7	7°38'00.06"N	2°35'57.87"W	8	7°37'59.14"N	2°37'11.45"W
5	9	7°37'59.58"N	2°37'13.91"W	10	7°37'41.17"N	2°38'05.68"W
6	11	7°38'17.06"N	2°38'44.05"W	12	7°38'17.06"N	2°39'58.84"W
7	13	7°38'53.84"N	2°36'53.82"W	14	7°38'54.13"N	2°38'07.12"W
8	15	7°39'16.53"N	2°34'46.66"W	16	7°39'14.56"N	2°35'59.30"W
9	17	7°40'11.83"N	2°35'43.20"W	18	7°40'08.91"N	2°36'55.00"W
10	19	7°39'09.25"N	2°32'29.66"W	20	7°38'45.86"N	2°34'13.53"W
11	21	7°38'31.49"N	2°35'20.86"W	22	7°38'30.52"N	2°36'32.83"W

The plot positions are indicated in Table 2.

Table 2: GPS readings of points for flora plots

Plot	**Center point**	
	Latitude (N)	**Longitude (W)**
1	7°37'46.43"N	2°37'39.43"W
2	7°35'56.41"N	2°37'35.73"W
3	7°35'26.44"N	2°37'33.24"W
4	7°38'48.40"N	2°32'36.74"W
5	7°39'15.81"N	2°32'46.93"W
30	7°39'37.79"N	2°32'54.53"W
18	7°39'33.70"N	2°32'51.70"W
35	7°38'59.20"N	2°32'35.11"W

3.4 DATA ANALYSIS

3.4.1 Fauna Assessment

An indirect technique such as an index count, which produces relative numbers based on encounter rates, was used to estimate species densities.

Animal sign density = [number of signs / total distance walked]----------(1)

Index counts relate animal numbers to an index of animal signs detected along line transects (Buckland *et al*., 2001; Barnes *et al*., 1997).

A software; EstimateSWin800 Version 8.0.0 (Colewell, 2006) was used to determine species diversity and richness in the various vegetation types.

Where appropriate, simple descriptive statistics was used and results presented in the form of graphs, tables and charts for easy observation and understanding.

3.4.2 Flora Assessment

Calculation of parameters

$$\text{Tree density} = \frac{\text{Total number of trees in all plots}}{\text{Total sampled area}}$$

$$\text{Relative density} = \frac{\text{Number of a particular species}}{\text{Total number of species}}$$

3.5 CONSERVATION STATUS

The conservation status of the fauna in the study areas were assessed using the Global (International Union for the Conservation of Nature (IUCN) Appendix 1a; and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1b and national (Ghana Wildlife Laws) criteria (Appendix 1c).

3.5.1 Global Criteria

3.5.1.1 International Union for Conservation of Nature and Natural Resources

The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (2016) provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria (Appendix 1a). The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; and taxa that cannot be evaluated because of insufficient information (Data Deficient).

3.5.1.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora

Roughly 5,000 species of animals and 29,000 species of plants are protected by CITES against over-exploitation through international trade. Each protected species or population is included in one of three lists, called Appendices (explained below). The Appendix that lists a species or population reflects the extent of the threat to it and the controls that apply to the trade. Appendix I includes species that are threatened with extinction and are or may be affected by trade. Appendix II includes species that are not necessarily threatened with extinction, but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with

the survival of the species in the wild. Appendix III includes species that are not threatened with extinction globally.

3.5.2 National Criteria

Ghana Wildlife Division

Ghana's wildlife laws (Ghana Wildlife Conservation Regulations, 1995) also categorize animal species into two main schedules based on the level of protection required for the particular species. The complete list is also provided in Appendix 1b.

Star Rating System

The importance of flora species based on their individual threat from over-exploitation and forest degradation were rated based on the Star Rating System developed by Hawthorne and Abu-Juan (1995) (Appendix 1c).

Plate 6: A pose for the camera by the assessment team

4.0 FINDINGS

4.1 MAIN MANAGEMENT ZONES AND LANDUSE TYPE

4.1.1 Description of land-use types

Fauna (large mammals, small terrestrial mammals and avifauna) and flora abundances were estimated from four major management zones: conservation area, teak plantation, indigenous species area and admitted farms. The vegetation type within each management zone is described in Table 3. Riparian vegetation constituted all sensitive wetland vegetation. Riparian vegetation constituted a small percentage of each of the four management zones but were generally considered as areas of high conservation value because of the potential sensitive biota associated with them.

Table 3: Description of management zones surveyed in the study area

#	Management Zone	Description
1	Conservation Area	• Natural forest fragments in low stages of human disturbances • Classified as slightly disturbed and moderately disturbed.
1	Teak Plantation	• Monocultures of *Tectona grandis* at various stages of growth.
2	Indigenous Species	• Areas where indigenous species were planted as a means to restore forest cover
3	Admitted Farms	• Actively farmed areas used for the cultivation of a variety of food crops including maize and cassava • Old fallowed areas. • Presence of *Chromolaena odorata* in heavily degraded areas.

4.2 FAUNA AND FLORA ABUNDANCE IN MANAGEMENT ZONES

The conservation area ranked highest in terms of bird species richness and diversity, followed by the admitted farm, teak plantation and then the indigenous species area (Table 6). Nevertheless, the admitted farm contributed the highest medium to large mammal species richness and diversity in the entire concession (Table 4). Small mammals were generally rare.

Table 4: Fauna diversity indices generated by EstimateSWin800

	Diversity Index				Richness Index			
Management Zone	Birds	Medium to large mammals	Small mammals	Flora	Birds	Medium to large mammals	Small mammals	Flora
Conservation Area	3.55	1.68	0.00	2.95	86.0	7.5	1.0	45.0
Teak Plantation	3.23	1.80	0.00	*	47.0	7.0	1.0	*
Indigenous Species	3.16	1.58	0.00	3.02	36.5	7.0	1.0	37.0
Admitted Farms	3.24	2.04	0.00	*	65.5	9.0	1.0	*

On the other hand, flora species diversity was slightly higher in the indigenous area whiles species richness was high in the conservation area (Table 4).

Generally, the conservation area, followed by the admitted farm yielded the highest number of individuals (Figure 4, Table 5) and species (Figure 5, Table 6). Comparatively lower numbers were recorded in the indigenous area and teak plantation. Although small mammal species diversity was relatively high in the indigenous area, more individuals were recorded in the admitted farm area.

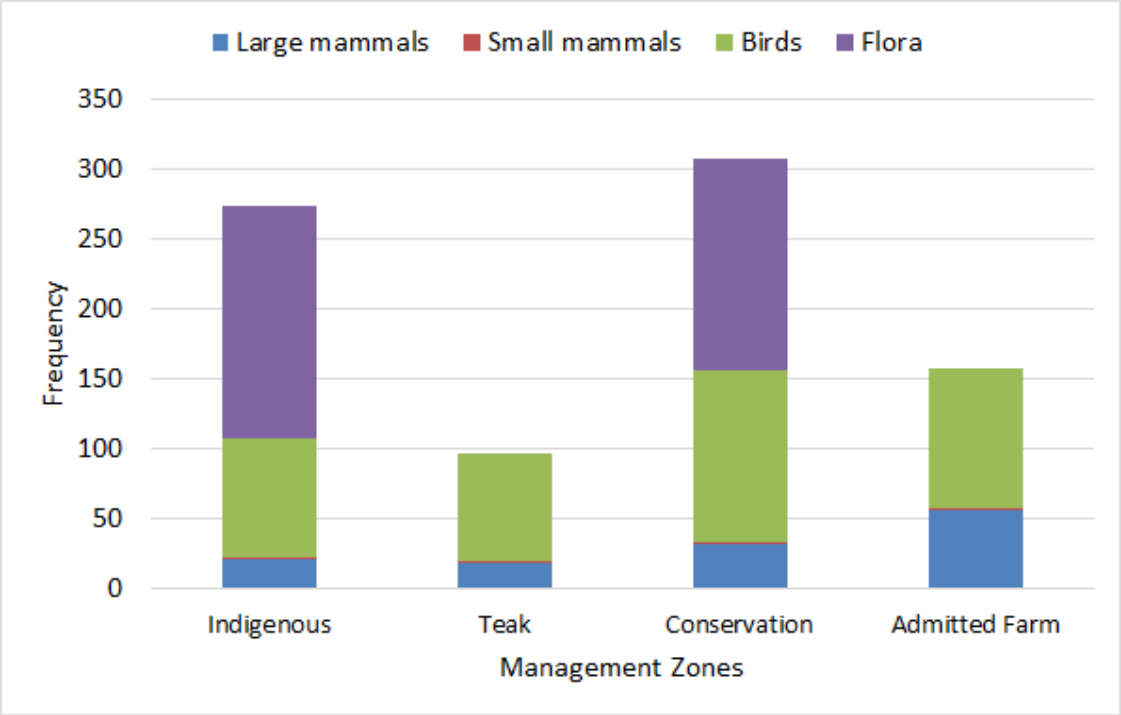

Figure 4: Total number of signs recorded in the various management zones

Table 5: Total number of signs recorded in the various management zones

	Indigenous	Teak	Conservation	Admitted Farm
Large mammals	21	18	32	56
Small mammals	1	2	1	1
Birds	85	77	123	101
Flora	166	*	151	*

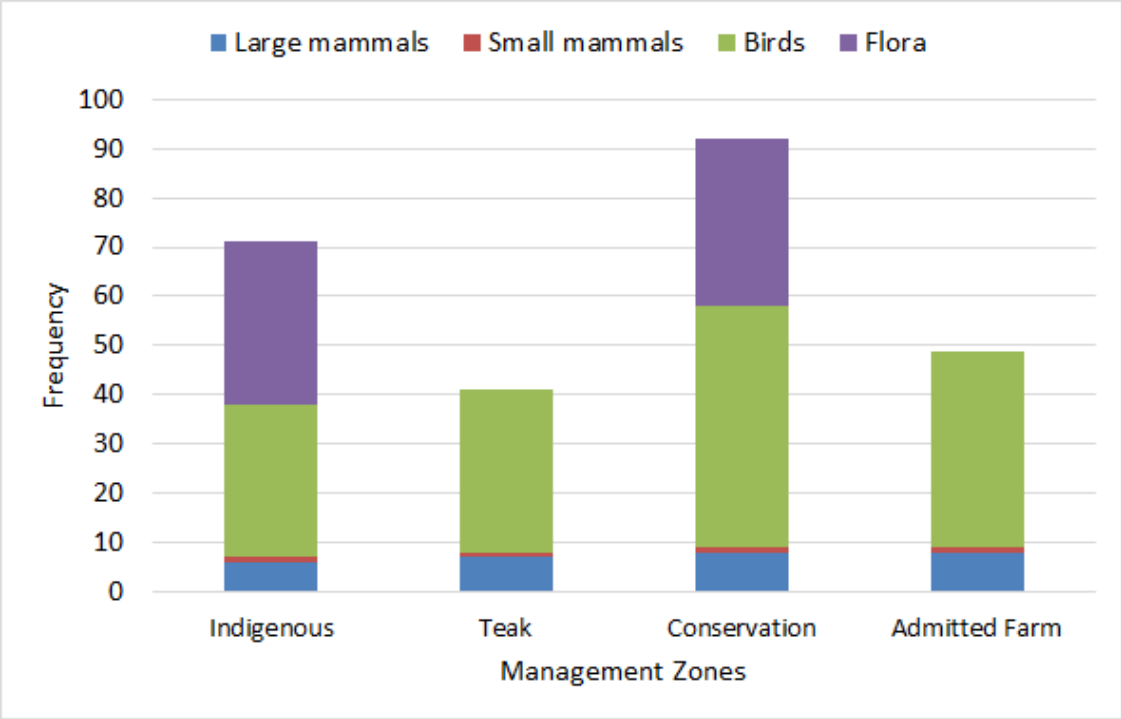

Figure 5: Total number of species recorded in the various management zones

Table 6: Total number of species recorded in the various management zones

	Indigenous	Teak	Conservation	Admitted Farm
Large mammals	6	7	8	8
Small mammals	1	1	1	1
Birds	31	33	49	40
Flora	33	*	34	*

4.2.1 MAMMALS

Three main general mammal taxonomic groups (rodents, carnivores and ungulates), representing 11 Families, 14 Genera, and 15 Species were confirmed in the project area during the survey. The admitted farm ranked highest with a record of 10 mammal species, followed by conservation area (8), teak (8) and indigenous area (7) (Table 7).

Table 7: Mammal abundance recorded in the various management zones

	Indigenous	Teak	Conservation	Admitted Farm
Number of Species	7	8	8	10
Number of Individuals	25	20	28	62

A total of 135 terrestrial mammal signs were recorded: 62 signs in the admitted farm area, 28 signs in the conservation, 25 signs in indigenous areas, and 20 signs in the teak plantation.

Rodents constituted the largest group (7 species) whiles carnivores were restricted to just three species. Bushbuck (*Tragelaphus scriptus*), Striped Ground Squirrel (*Euxerus erythropus*) and Cusimanse mongoose (*Crossarchus obscurus*) were the most widespread species, occurring in all four management zones (Figure 6). Apart from the Marsh Cane Rat (*Thryonomys swinderianus*) and Fire-footed Rope Squirrel (*Funisciurus pyrropus*) which were recorded in three management zones, all other species were not very common but restricted species and were recorded in not more than two management zones. Fifty percent (50%) of the species were recorded in the teak plantation.

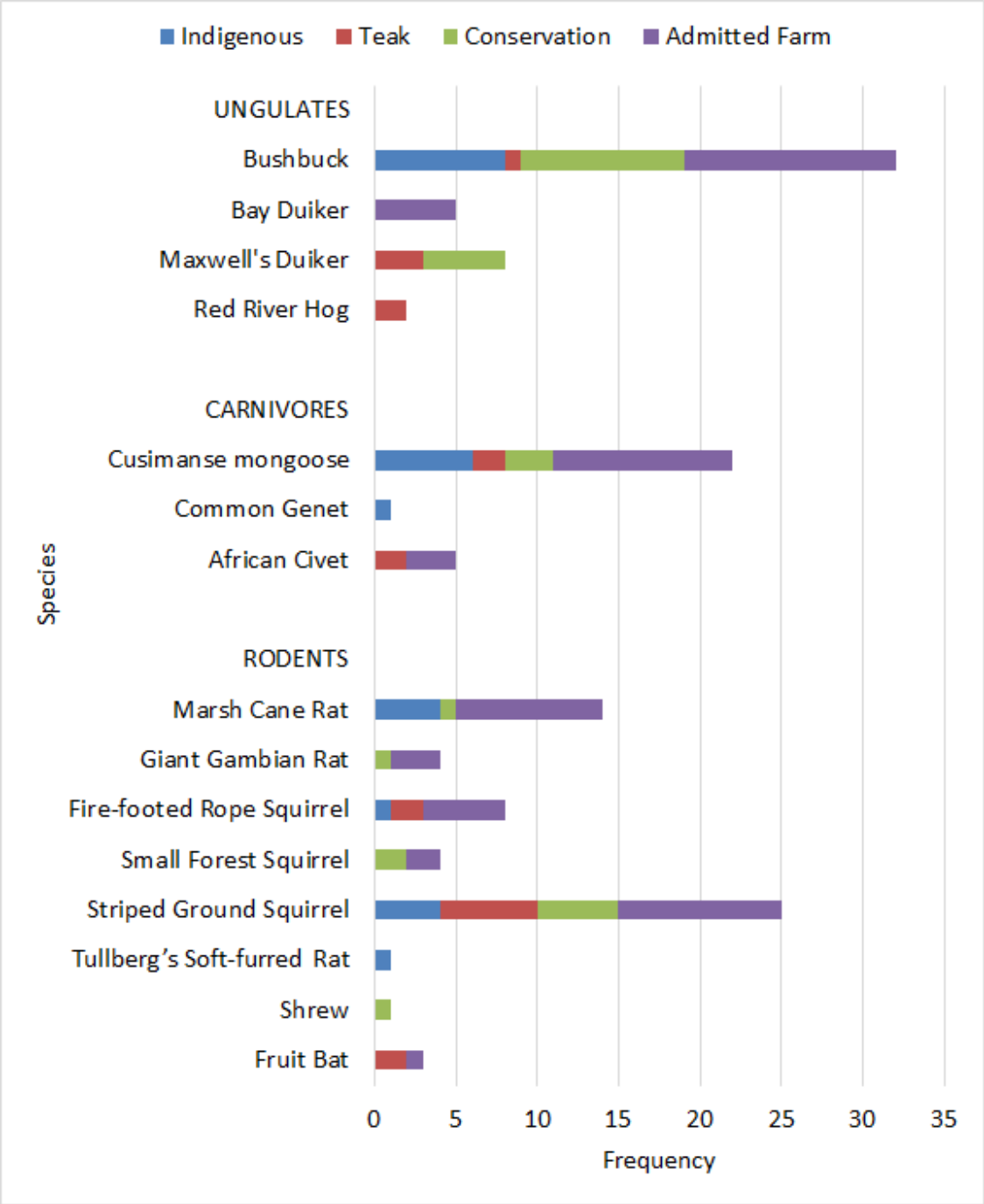

Figure 6: Abundance of mammal signs recorded in the study area

The shrew (*Crocidura grandiceps*) is listed as Near Threatened on the IUCN Red List of Threatened Species (2018) whiles the civet is protected by Appendix III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

4.2.2 BIRDS

Sixty-two (62) Species, belonging to 47 Genera and 27 Families were recorded on transects. The conservation area ranked highest with a record of 49 bird species, followed by the admitted farm (40 species) and then teak plantation (33 species) and indigenous area (31 species) (Table 8).

Table 8: Bird abundance recorded in the various management zones

	Indigenous	Teak	Conservation	Admitted Farm
Number of Species	31	33	49	40
Number of Individuals	85	77	123	101

A total of 386 bird signs were recorded: 123 signs in the conservation area, 101 signs in the admitted farm, 85 signs in the indigenous area and then 77 signs in the teak plantation.

More than 60% of the species recorded belong to the Families Columbidae, Bucerotidae, Pycnonotidae, Cisticolidae and Ploceidae (Figure 7). The Red-eyed Dove, *Streptopelia semitorquata* (relative abundance of 10.3%), Tambourine Dove, *Turtur tympanistria*, (8.2), African Grey Hornbill, *Tockus nasutus* (6.4%) and the Common Bulbul, *Pycnonotus barbatus* (6.2%) were some of the most recorded and widespread bird species.

Apart from members of the Family Bucerotidae (Hornbills) which are typical forest species, most of the birds recorded were either forest fringe species or birds of degraded forests.

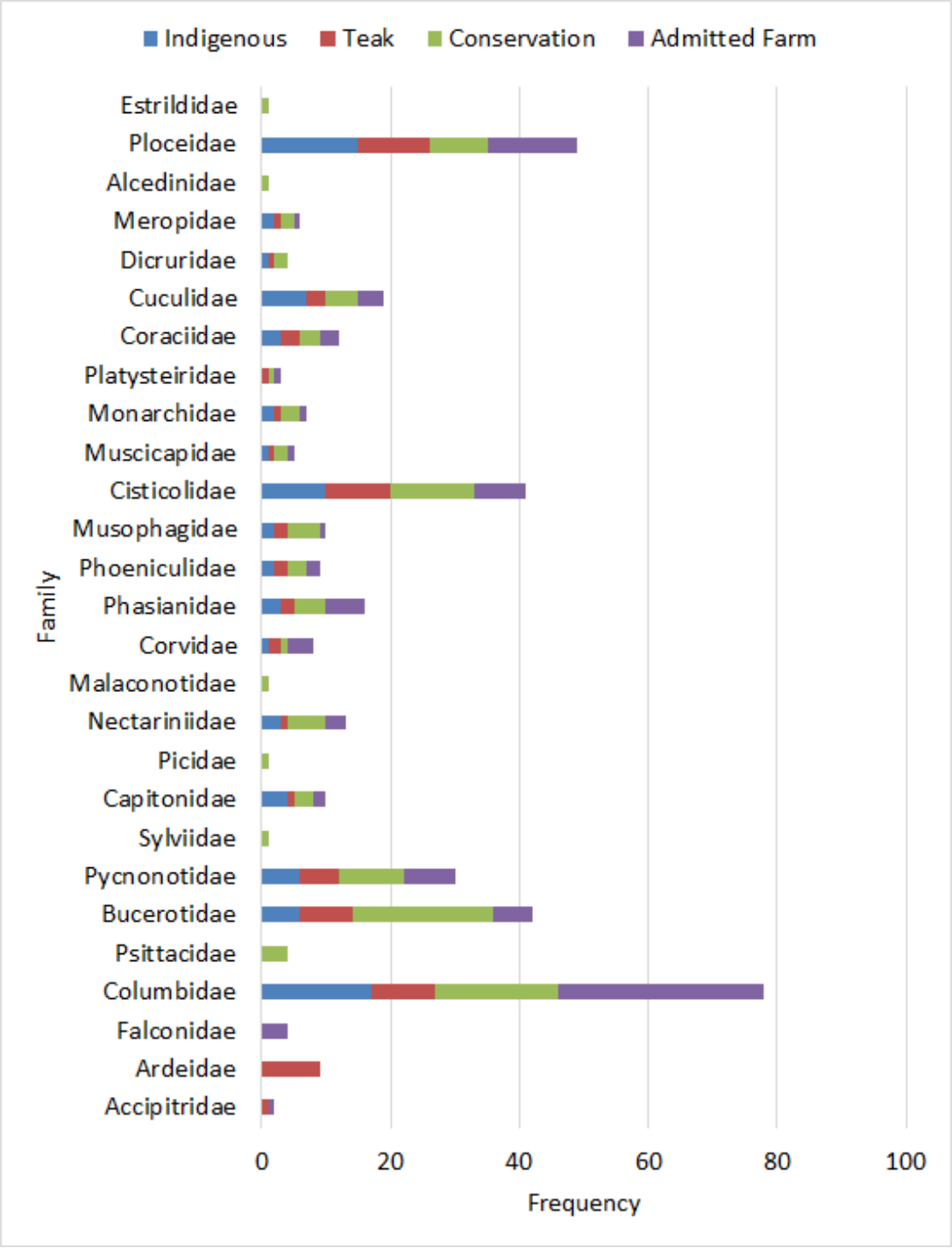

Figure 7: Abundance of birds recorded in the study area

None of the recorded birds are of significant conservation importance on the IUCN List of Threatened Species or any CITES Appendix. However, members of the Families Ardeidae

(Herons and Egrets) and Accipitridae (birds of prey) are of special conservation importance in Ghana and are listed in Schedule 1 of the Ghana Wildlife Conservation Regulations (1995) (Appendix 1c).

Plate 7: A juvenile bird of prey (*Gypohirax angolensis*)

4.2.3 FLORA

Flora representing 21 Families, 49 Genera, and 57 Species were confirmed in the study area during the survey (Figure 8). *Tectona grandis* (teak) was concentrated in the plantations. *Blighia unijugata* (Akyebere) ranked highest in abundance with relative density of 12.62%. This was followed by *Anogeissus leiocarpus* (Kane) with relative density of 8.57% and then 6.62% for *Lonchocarpus sericeus* (Sante). *Chromolaena odorata*, an invasive herb species was relatively abundant (6.62%). Very rare species included *Uvaria chamae, Rauvolfia vomitoria, Funtumia elastica, Macaranga hurifolia, Albizia ferruginea, Pterocarpus erinaceus, Anthocleista nobilis, Triplochiton scleroxylon, Mansonia altissima,*

Ficus exasperate, Milicia excelsa, Morus mesozygia, Citropsis articulate, Chrysophyllum perpulchrum and *Salacia africana* with relative densities lower than 0.50%.

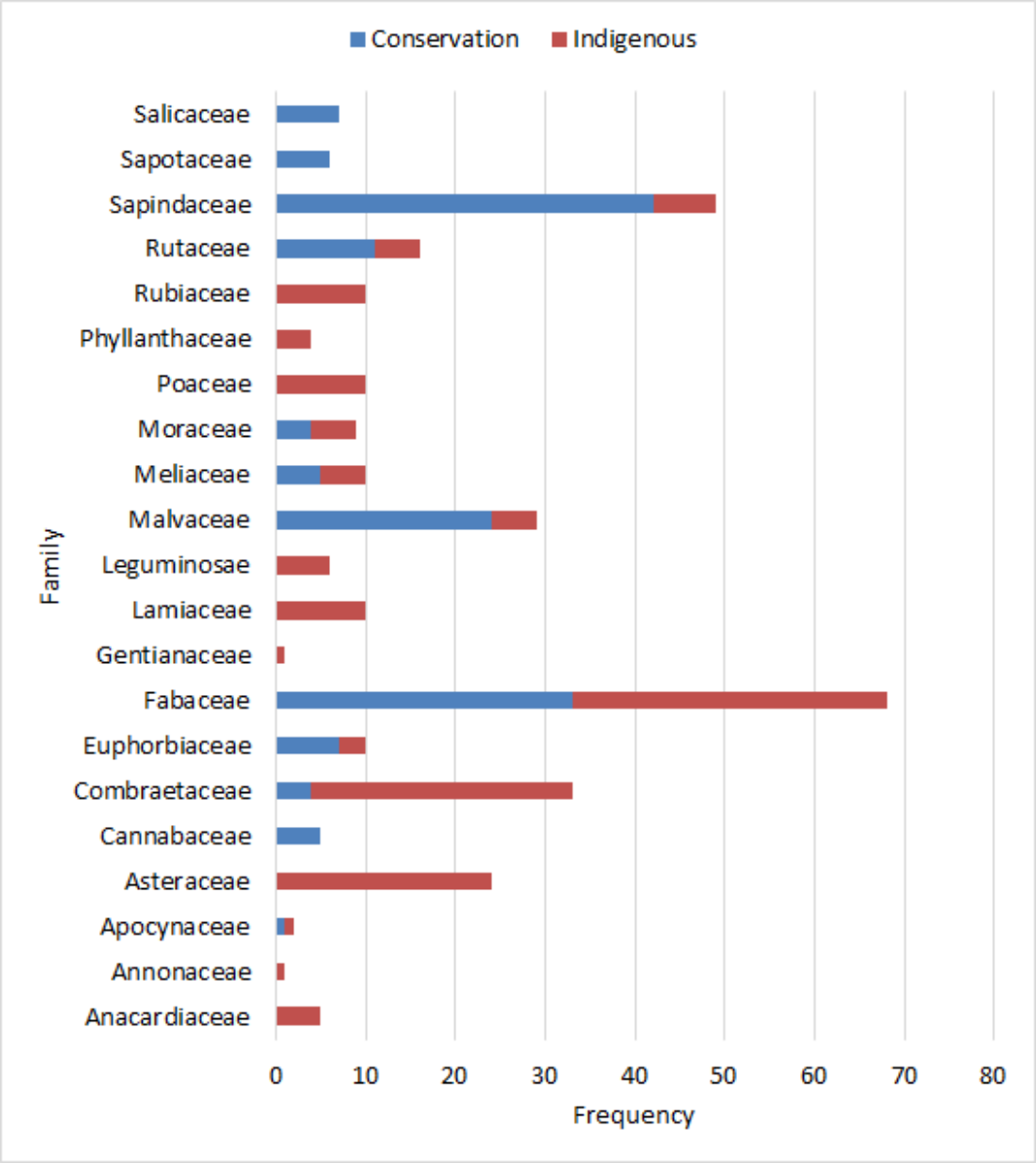

Figure 8: Abundance of flora (Families) recorded in the study area

The conservation area ranked highest with a record of 34 flora species but was lower in terms of number of total individual trees (151). The indigenous area however had a higher total number of trees (166 individuals) constituting 33 flora species (Table 9).

Table 9: Flora abundance recorded in the indigenous and conservation areas

	Indigenous	Conservation
Number of Species	33	34
Number of Individuals	166	151

Plate 8: A young teak tree bustling with energy

4.2.3.1 DBH Class Distribution

There are many younger individuals than mature trees in both populations (i.e. conservation and indigenous areas) and the relation of DBH classes to number of individuals follow an exponential model closely (Figure 9). The conservation area particularly follows this model more closely. In general, there are very few trees bigger than 20 cm DBH with the largest tree (41.6cm) occurring in the conservation area.

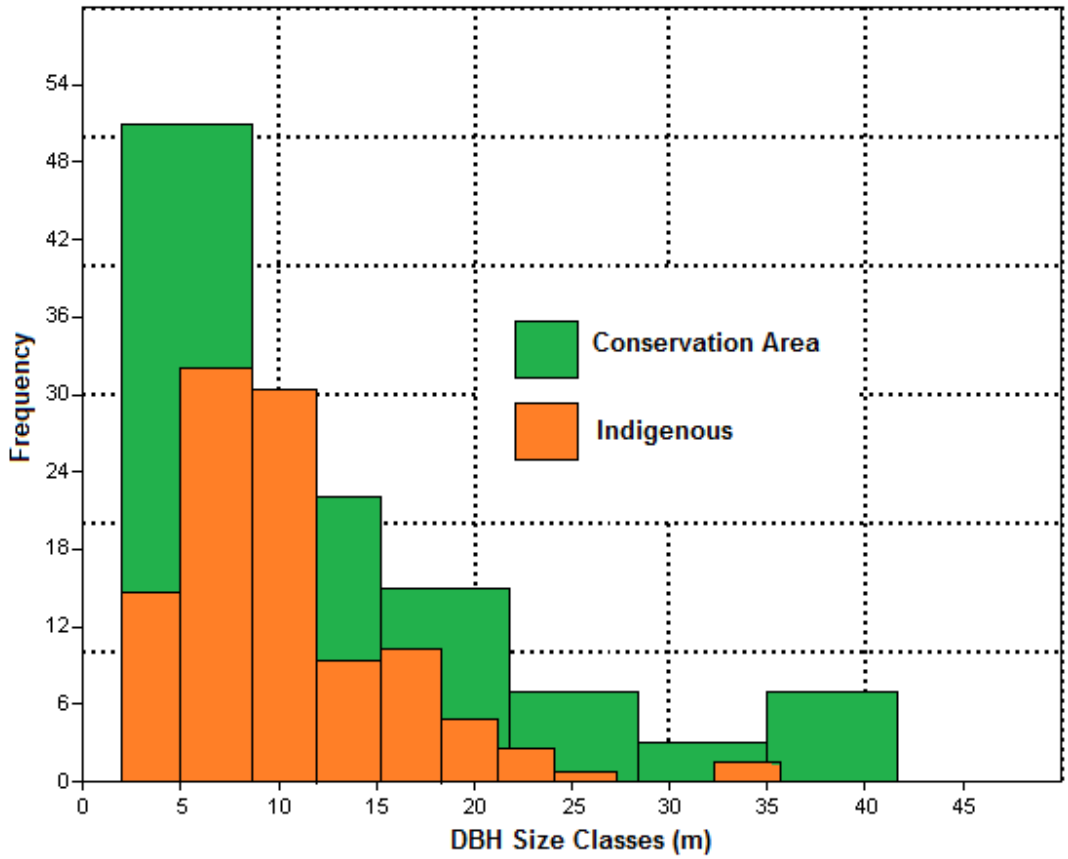

Figure 9: Size (DBH) class distribution of trees recorded in sample plots

4.2.3.2 Height Class Distribution

The mean height class distributions of the two vegetation types recorded in the various plots are shown in Figure 10.

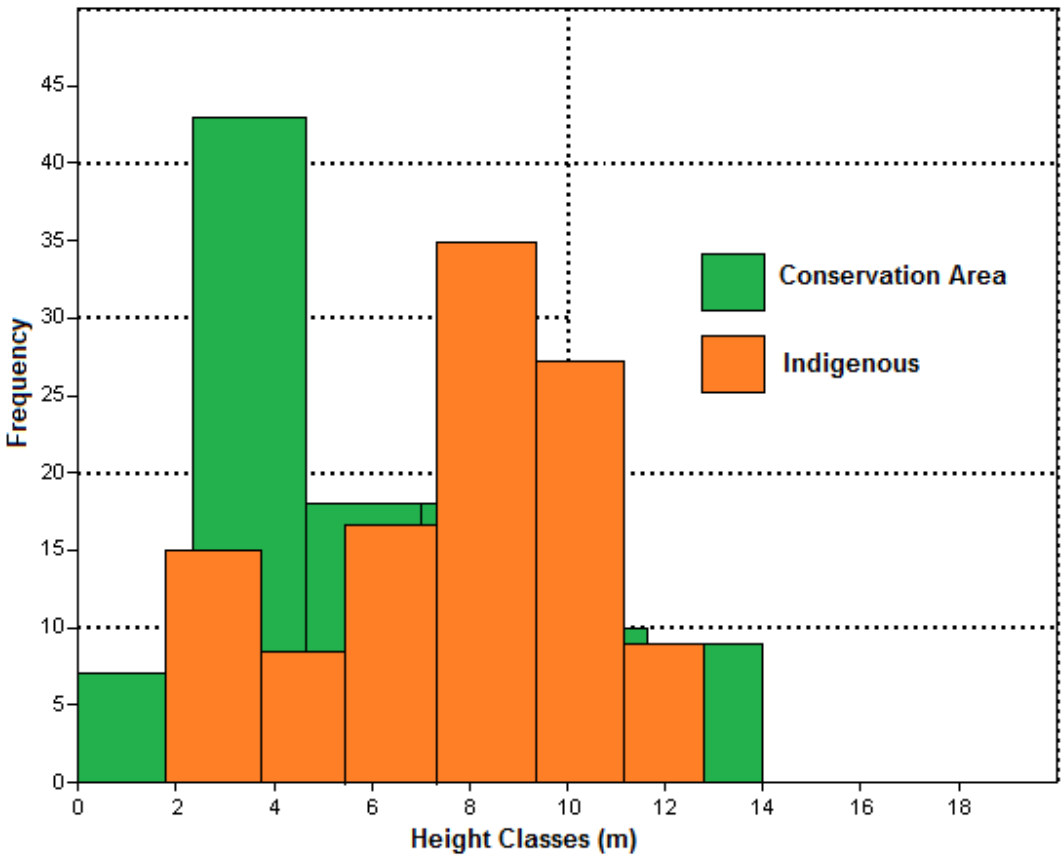

Figure 10: Vegetation height class distribution recorded in sample plots

There seems to be low similarity between the height class distributions recorded in the conservation and indigenous areas. Generally, there were taller younger individuals in the conservation area compared to taller older individuals in the indigenous area. Comparatively, the size class in the indigenous area followed the "normal" logarithmic representation (Richards 1998) better. No tree exceeded a height class of (>14.0m). In addition, no individual in the indigenous area was less than 1.8m tall. The height class

range of (0.0m - 2.0m) in the conservation area were open areas which represented thickets and herbs.

Four of the recorded flora are species of conservation interest on the IUCN Red List of Threatened Species (2018) namely Rosewood, *Pterocarpus erinaceus* (Endangered; EN), *Albizia ferruginea* (Vulnerable; VU), *Afzelia africana* (Vulnerable; VU) *and Pterygota bequaertii* (Vulnerable; VU). (Pterocarpus erinaceus) is also protected by Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Furthermore, the highest number of individuals were recorded among the green star category, followed by scarlet star category, red star category, pink star category with the blue star recording the least number of individuals (Figure 11). Missing from the list were black and gold star species.

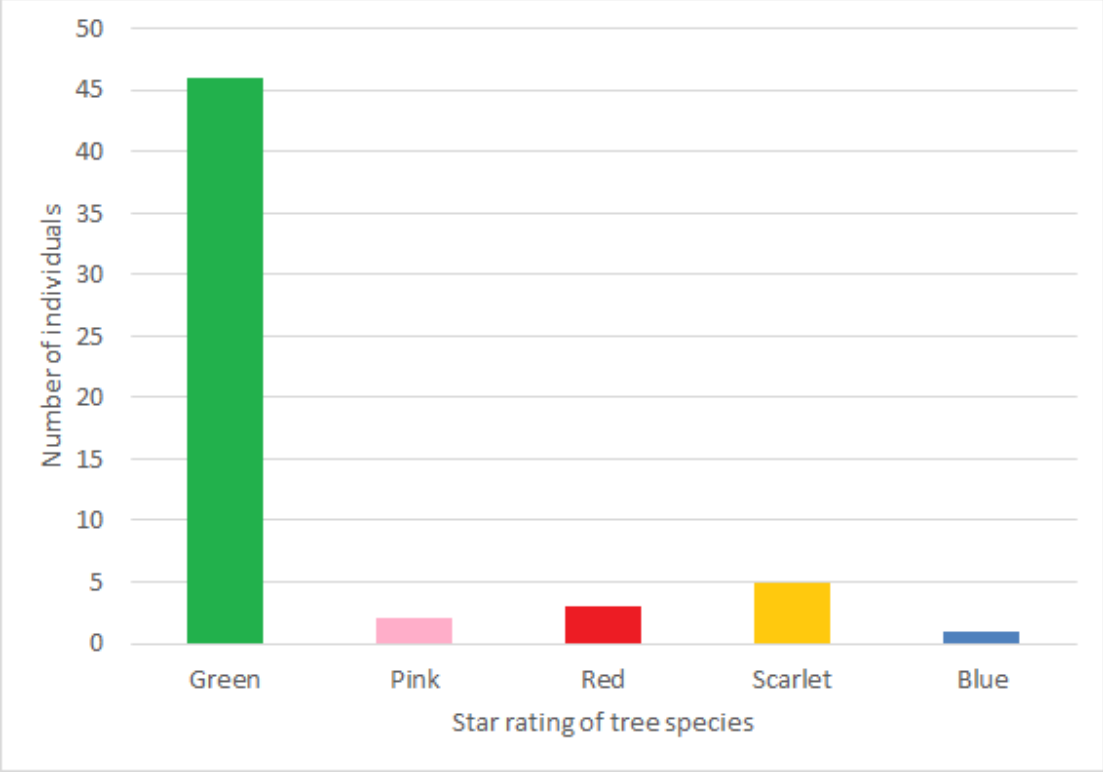

Figure 11: Star ratings of flora recorded in sample plots

4.3 SPECIES DYNAMICS

Sixty-two (62) bird species were confirmed in the current 2018 biological survey compared to the sixty (60) in the 2012 survey (Table 10). Out of the 60 species recorded in 2012, only 23 species (38%) were common species in the 2018 biological survey. Majority of bird species (37 species) representing 62% were not verified.

Table 10: Comparison of bird species recorded in the 2012 and 2018 biological surveys

Family	2012	2018	Common species	Unverified species	New species
Accipitridae	1	1	0	1	2
Ardeidae	0	1	0	0	1
Falconidae	1	2	1	0	1
Columbidae	5	4	3	2	1
Psittacidae	0	1	0	0	1
Bucerotidae	2	2	2	0	0
Pycnonotidae	6	5	3	3	2
Sylviidae	3	1	0	3	1
Capitonidae	2	5	0	2	5
Picidae	2	1	1	1	0
Nectariniidae	4	5	2	2	3
Malaconotidae	0	1	0	0	1
Corvidae	0	1	0	0	1
Phasianidae	1	2	1	0	1
Phoeniculidae	2	1	1	1	0
Musophagidae	1	2	1	0	1
Cisticolidae	1	7	0	1	7
Muscicapidae	5	2	1	4	1
Platysteiridae	0	1	0	0	1
Coraciidae	2	1	0	2	1
Cuculidae	3	6	3	0	3
Dicruridae	2	1	0	2	1
Meropidae	1	1	1	0	0
Alcedinidae	1	1	0	1	1
Ploceida	9	5	3	6	2
Estrildidae	4	1	0	4	1
Paridae	1	0	0	1	0
Apodidae	1	0	0	1	0
Number of species	60	61	23	37	40

Nevertheless, 40 new species (67% of the 2012 survey) were identified in the 2018 survey. Majority of common species that were identified in both surveys represented Families of Columbidae (Doves), Pycnonotidae (Bulbuls), Cuculidae (Coucals) and Ploceidae (Weavers) which are mostly generalist species and can withstand various levels of habitat modification. Key species that were not verified in 2018 belonged to the Families Sylviidae (Warblers), Muscicapidae (Flycatchers) and Estrildidae (Finches). It is likely these species may be sensitive to the habitat modifications as a result of plantation activities. Interestingly, the same group was also represented by the Families Pycnonotidae and Ploceidae. Newly recorded species in 2018 were largely represented in Capitonidae (Barbets and Tinkerbirds), Nectariniidae (Sunbirds), Cisticolidae (Camaropteras) and some members of Cuculidae. These species seem to have benefitted from the teak-modified landscapes.

Generally, the mammal population seem to be faring quite well within then study area and their species dynamics did not change significantly between the 2012 and current 2018 biological surveys (Table 11).

Table 11: Comparison of mammal species recorded in the 2012 and 2018 biological surveys

Family	2012	2018	Common species	Unverified species	New species
Bovidae	1	1	1	0	0
Antelopinae	2	2	1	1	1
Suidae	1	1	1	0	0
Thryonomyidae	1	1	1	0	0
Sciuridae	1	3	1	0	2
Hystricidae	1	0	0	1	0
Cricetomyinae	1	1	1	0	0
Herpestidae	2	1	1	1	0
Viverridae	2	2	1	1	1
Muridae	3	1	1	2	0
Soricidae	1	1	1	0	0
Pteropodidae	0	1	0	0	1
Number of species	16	15	10	6	5

However, there were some key unverified species in 2018 including, the Royal Antelope (*Neotragus pygmaeus*), Brush-Tailed Porcupine (*Antherurus africanus*), Marsh Mongoose (*Atilax paludinosus*), Blotched Genet (*Genetta tigrina*) and two small murid mammal species. Most of these species are forest specialists and are likely to have been affected by plantation activities.

Plate 9: A hunter with a gun and dogs on 'business as usual'

The species *Crocidua grandiceps* is of specific interest to FORM Ghana as it is rare and threatened. Its presence has been confirmed in both surveys, but very low densities and relatively short sampling period preclude detailed analysis on an estimate of population size to be done. It is anticipated that Form Ghana will continue to safeguard its habitat in the conservation areas (current specimen was caught near flora Plot 2) in order to ensure their continuous survival.

5.0 DISCUSSION

The conservation areas occupy a critical position, which gives special interest and significance to the identity and distribution of species within the study area. The area was found to support the most diversity of wildlife with 57 vertebrate species identified. The commonest birds were coucals (Cuculidae), bulbuls (Pycnonotidae) and pigeons and doves (Columbidae). The area in general has a rich avifauna with at least 49 recorded species and this may be mainly due to the abundance and variety of insect life forms emanating from the diversity of plant types in the area that provides food. The mammalian fauna of the conservation area is however not very impressive, with about only eight (8) recorded species. The generally low record of mammalian signs and particularly of small mammals in the study area corresponds well to established low densities in plantation habitats.

The original faunal composition of the study area was undoubtedly very diverse and complex in nature. However, due to ongoing human activities, populations of several large mammal, particularly canopy dwelling primates, birds and possibly reptile species might have been reduced in numbers. On the other hand, some fauna including some antelope species are adapted to secondary or colonizing forests and might have persisted or even increased (Struhsaker and Oates, 1995). In addition, most antelopes, especially duikers, can probably withstand hunting pressure to a greater degree than other more susceptible species including primates. Similarly, all of the recorded mammalian species are not entirely dependent on primary or mature forest cover. Many of the species recorded within the study area are considered to be habitat generalists, capable of surviving in both mature forest and degraded and highly fragmented habitat.

Blighia unijugata (green star) was found to be the most abundant plant species on the plantation. This species are mostly found in undisturbed evergreen forests and the presence of this species in abundance could be considered as an indicator of forest richness in terms of biodiversity. Recorded star rating of species, included green, pink,

red, scarlet, and blue stars, however investigations revealed a high proportion of green star species. These species are common in Ghana and are of no particular conservation concern (Hawthorne and Gyakari, 2006). The scarlet star species constituted 45% of the star-rated plant species and in addition to the blue star rated species, they constitute a great conservation concern because of their degree of threats from exploitation (Hawthorne and Abu-Juam, 1995). The low to nearly absent representation of black star species and gold star species is due to the fact that they are rare in Ghana (Hawthorne and Gyakari, 2006) and hence, areas that they are found needs special conservation measures.

5.1 FACTORS AFFECTING DISTRIBUTION OF ANIMALS

Bush meat is an important source of protein for the local population and observations on the ground indicated that animals were actively hunted with shotguns. Most encountered indices of hunting consisted of empty cartridge cases and these were mainly seen along animal trails or footpaths. Also the presence of Fulani herdsmen and the feeding activities of their cattle was identified as a major source of disturbance to wildlife habitat. Most of the areas the field team encountered cattle were badly trampled resulting in serious habitat destruction. An examination of these human activities including hunting within the study area suggested that distance to the boundaries accounted for a large proportion of variation in their distribution. In particular, hunting and cattle grazing activity increased towards the plantation boundaries. For that matter, fauna abundance was observed to be lower on some peripheral transects.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

6.1.1 Priority Biodiversity Hotspots

Priority biodiversity hotspots (high conservation value area) identified in the study area are the conservation areas within the plantation area. An added importance is that the only fauna species of international conservation interest, the shrew (*Crocidura grandiceps*) which is listed as Near Threatened on the IUCN Red List of Threatened Species (2018) was recorded in the conservation area. Three out of the four flora species of international conservation interest were also confined to the conservation areas. Fortunately, Form Ghana has set aside these areas as 'no go' areas for wildlife management. Hence, the conservation areas could form the basis for establishment of high conservation value areas within the plantation where wildlife management is incorporated into existing land use. Its implementation will have long-term significant and positive implications for a wide range of wildlife. Admitted farms by nature of their diverse land uses also produced a relatively high diversity of species.

Apart from the very high bird diversity within the conservation areas, these sites were also associated with an exceptionally high abundance and diversity of insect life, particularly butterflies. The importance of butterflies in pollination services in the plantation cannot be overemphasized. Butterflies transport pollen to plants that are a good distance from each other, hence ensuring a good mixing of genes. Plants including teak, benefit from this increase in genetic diversity. Recently researchers have learned that the pollen, stuck to a butterfly's long tongue, stays fresh for a good time and ensures this valuable pollination at a distance. Furthermore, a number of flowers are completely dependent on butterflies for pollination.

6.1.2 Threats

Enforcing a hunting regulation is difficult due to the fact that a number of private farms are located within the general plantation area. Hence, one may accept the inevitability of the presence of local communities in the plantation; nevertheless, more effort should be channeled into salvaging the situation now, in order to reduce deterioration of the status of wildlife in the future. Agreements should be made with the Fulani herdsmen to graze their cattle in specified areas which can be monitored.

6.2 RECOMMENDATIONS

6.2.1 Regulating Human Activities

Education on the importance of creating additional no-go forest buffers around the conservation areas within the plantation area in order to adequately conserve them should be intensified. Form Ghana could erect large advertising billboards displaying the various species in such rich bio-diverse areas (including waterbodies and rivers in other areas of the plantation) as a means of educating staff and locals.

Recent pressure from the international timber markets, mainly from Asia and other destinations on rosewood (***Pterocarpus erinaceus***) have resulted in an explosive, illegal and well-organized system of unsustainable chainsaw activity, permits, and exports of this precious hardwoods, though there is a national ban on the export of the commodity. Looking forward, Form Ghana should intensify protection in the restoration area where rosewood was identified to ensure its survival.

Crocidura grandiceps is an uncommon species endemic to Africa and threatened by habitat loss. It has been recorded in the rainforests of Western and parts of West Central Region of Africa from Guinea, Côte d'Ivoire, Ghana, W Nigeria, and possibly Cameroon.

Its habitat is primary and degraded rainforest, hence Form Ghana should endeavour to protect the established conservation areas and minimize plantation activities close to the area. For instance, buffers should be left around these conservation areas and activities like chemical application (e.g. fertilizers, weedicides, insecticides, etc.) restricted in these zones.

6.2.2 High Conservation Value (HCV) Areas

There is the need to establish more intensively managed high conservation value areas in addition to the already established conservation areas within the plantation, where absolutely no human activity occurs. Admitted farms within the plantation area should be given precedence because of the high biodiversity that exists there and also as a means of reducing unauthorized human activities within the plantation. Identified priority refuge include a large admitted farm (F31) in the northern section of the plantation. This area alone contributed 47% of the total mammal signs and 75% of all mammal species recorded in the current survey. As a matter of urgency, Form Ghana should negotiate with the Forestry Commission to relocate farmers from these areas. Due to its location within the plantation, most farmers will take advantage and commit offences in the heart of the plantation. Gaining control over F31 is an effective way of limiting human activities and forest clearing activities in the heart of the plantation. As a first step, Form Ghana should liaise with farmers to respect forest buffers when planting.

In addition to delineating the admitted farm area, Form Ghana should also ensure strict adherence to a minimum of 30m buffer to rivers and streams in order to safeguard their integrity. This could be expanded if necessary and should be given priority in tree planting exercises. Creating and subsequently expanding intensively managed refuges within the concession forms the basis of establishing internal wildlife corridors within the larger landscape and is an effective way of curtailing illegal forest clearing activities, whilst enhancing landscape connectivity (Harvey *et al*., 2006).

6.2.3 Potential of Butterfly Sanctuary

The conservation area could offer something that is perhaps unique to Ghana and only comparable to the Bobri Butterfly Sanctuary in the Ashanti Region of Ghana. There are many tourists and researchers who would delight in the opportunity to spot and study butterflies in the area. Camp-sites could be established close to conservation area for both research and tourist intentions. Form Ghana could restrict the number of tourists entering the plantation at any one time to avoid over-crowding. If this tourist and research experience is well managed, it could form the central feature on which to base conservation publicity for Form Ghana. This innovation itself is an opportunity that stands Form Ghana in good stead to enjoy support from many sides, especially government, ecologists and NGOs.

An inventory of the butterfly species in the conservation area is thus needed to appreciate the status and diversity of the butterfly community for potential establishment as a butterfly sanctuary for research and tourist purposes.

Plate 10: Large bushbuck footprint

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8.0 APPENDICES

Appendix 1a: The International Union for Conservation of Nature and Natural Resources (IUCN, 2016)

The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (2016) provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria. The main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e. Near Threatened) (http://www.redlist.org)

The following categories have been developed:

(1) EX (Extinct) - No reasonable doubt that the last individual has died
(2) EW (Extinct in the Wild) - Known only to survive in captivity or as a naturalized populations well outside its previous range
(3) CR (Critically Endangered) - The species is in imminent risk of extinction in the wild
(4) EN (Endangered) - The species is facing an extremely high risk of extinction in the wild
(5) VU (Vulnerable) - The species is facing a high risk of extinction in the wild
(6) NT (Near Threatened) - The species does not meet any of the criteria that would categorize it as risking extinction but it is likely to do so in the future
(7) LC (Least Concern) - There are no current identifiable risks to the species
(8) DD (Data Deficient) - There is inadequate information to make an assessment of the risks to this species

Appendix 1b: Ghana Wildlife Conservation Regulations (1995)

The following categories have been developed:

(1) **Schedule 1** – the hunting, capturing or destroying of any species listed in this schedule is absolutely prohibited
(2) **Schedule 2** – the hunting, capturing or destroying of any species listed in the schedule is absolutely prohibited between 1 August and 1 December in any year. The hunting, capturing or destroying of any young or adult accompanied by his young of any specie listed in this schedule is absolutely prohibited at all times.
(3) **Schedule 3** – the hunting, capturing or destroying of any species listed in the schedule is absolutely prohibited between 1 August and 1 December in any year.

Appendix 1c: Star Rating and Weight Categories of trees (Hawthorne and Abu-Juam, 1995)

STAR	**COMMENTS**
BLACK (BK)	Urgent attention to conservation of populations needed. Rare internationally, and at least uncommon in Ghana. Ghana must take particular care of these species
GOLD (GD)	Fairly rare internationally and or locally. Ghana has some inescapable responsibility for maintaining these species
BLUE (BU)	Widespread internationally but rare in Ghana, or vice versa. It may be in Ghana's interests to pay attention to protecting some of these species.
SCARLET (SC)	Common, but under pressure from exploitation. Exploitation needs to be curtailed if usage is to be sustainable. Protection on all scales vital.
RED (RD)	Common but under pressure from exploitation. Need careful control and some tree by tree area protection.
PINK (PK)	Common and moderately exploited. Also non-abundant species of high potential value.
GREEN (GN)	No particular conservation concern
OTHERS	Non-forest species, or excluded from analysis for other reasons