Internship Report

Monitoring Biodiversity in Asubima Forest Reserve Ghana

FEM 70424

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Reg. nr. 840222-494-020

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Cover: Fig.1. Asubima Forest Reserve seen from the observation hut in November 2010 (Photo: Noor de Laat)

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Preface

Some people might grieve over the fact that 94% of Ghana's nature areas are in a dreadful condition. But in my eyes grieving does not solve the current and future problems caused by deforestation. Apart from understanding the situation today, we need good initiatives and solid plans to deal with nature.

During the fieldwork of my internship in Ghana I realized that plantations such as found in Asubima Forest Reserve are an answer to protecting the diversity of life. I am proud that I got the opportunity to work in Asubima Forest Reserve, for it is a teak plantation that is managed in a true sustainable way. While teak is grown as a cash crop, the old tree remainders, natural riparian forests, and wild life within them, are prevented from further degradation. The area now has guards, that protects the area from illegal activities and students come in to monitor biodiversity as to learn from these developments in the future. Every time we drove through the gates back to my temporarily home I could read the explanatory words painted on the wall of the nursery*: Forests for the Future*.

Fig.2. Form Ghana nursery (www.Formghana.com)

As a 'product' of my internship I have written this report on my activities and experiences at FORM International, the internship commissioner. This report forms an important part of the evaluation of the internship. Know-how, design and outcome of the study will be a property of FORM Ghana.

Introduction

The Upper Guinean forests in West Africa conceal a high number of endemic animal and plant species (Brooks et al. 2001) and therefore rank among the most important global biodiversity hotspots today (Myers et al. 2000; Bakarr et al. 2001).

Simultaneously, the West African forests are facing some serious problems. Logging, mining, hunting, and human population growth are placing extreme stress on tropical forests and are thereby threatening many species (Bakkar et al. 2001; Poorter et al. 2004; Ernst & Rödel 2005; Ernst et al. 2006; McCullough et al. 2007; Hillers et al. 2008a, b). Mean annual forest loss was 0.48-0.56% between 1990 and 2005, in West and Central Africa (FAO 2006). Although logging, mining and hunting have a devastating effect on biodiversity, we should not forget that many species will sooner or later come back to the regenerating forests. Dunn (2004) concluded that animal species richness after fragmentation can recover to assemblages similar to mature forests within 20-40 years, but the recovery of species composition takes substantially longer. Unfortunately there are not many studies like Dunn (2004) did. This general lack of data, together with the context dependent nature of existing studies on biodiversity recovery in secondary forests, limits our ability to make predictions about species conservation and species richness recovery (Gardner, 2010).

In Ghana, one of Africa's core forest regions, 94% of the forest reserves are in a dreadful condition, as a result of unsustainable harvesting in the past decades. The remaining forests are often highly fragmented and/or degraded. As a consequence, the restoration of degraded forests has become of major concern to the Government of Ghana and has become a key component of Ghana's Forest and Wildlife Policy and the Forestry Development Master Plan (1996-2020).

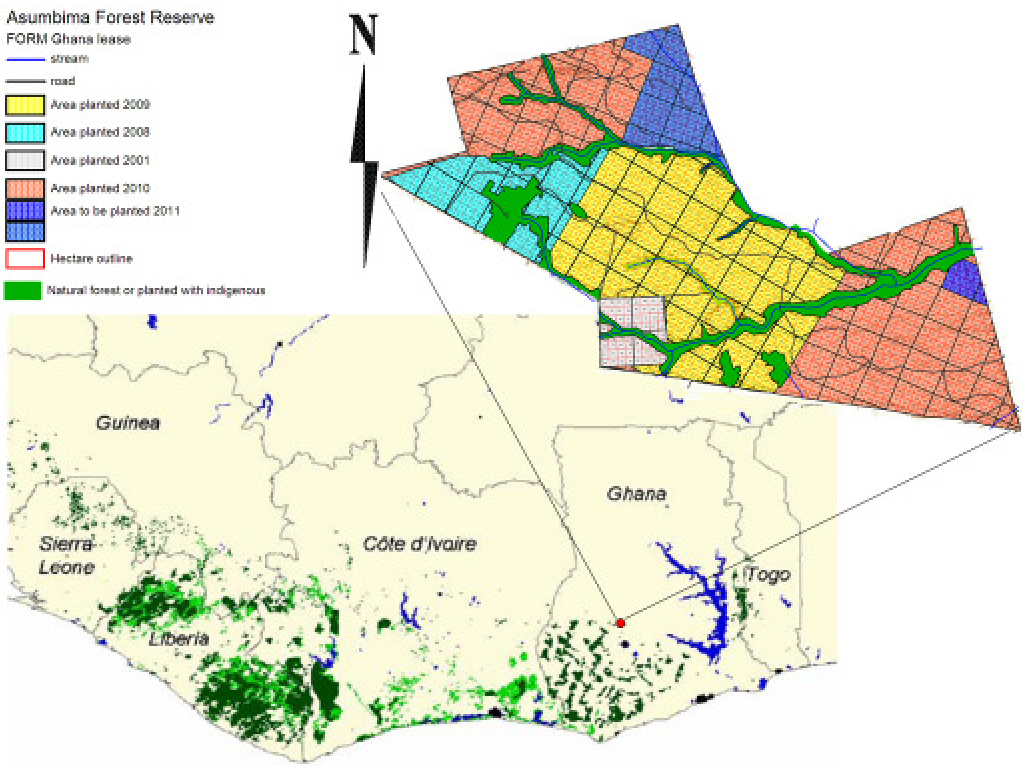

Fig.3. Asubima Forest Reserve is situated at the northern edge of the Upper Guinean forests in West Africa. (Adapted from Hillers, 2008 and FORM International)

In order to make reforestation activities operational, Ghana's government has developed a lease concept, attractive to foreign financers. In reaction to this, FORM International and Wienco Ghana Ltd established FORM Ghana Ltd., as a private joint venture. In 1997 FORM Ghana started reforesting parts of the previously highly degraded Asubima Forest Reserve near Akumadan in Ashanti Region of Ghana.

From the start, FORM Ghana committed itself to manage its plantations in a responsible and sustainable way, socially as well as economically and environmentally. More specifically, regarding the latter, FORM Ghana Ltd. set goals to conserve and restore biological diversity, water sources, and fragile ecosystems in or near its plantations. Consequently FORM Ghana operates in compliance with Ghana law and land lease rules and at the same time aimed at the principles and criteria of the Forest Stewardship Council (FSC). As a requirement for the implementation of the project in Ghana and in pursuance of FSC certification the company first conducted a Social and Environmental Impact Assessment (SEIA) in 2007 (Abeney et al 2007). In this assessment significant work was carried out on the current status considering both social and ecological values. Amongst other conclusions the inventory shows that no intact natural forests were present at the time of the study. FORM Ghana concluded it is necessary to manage its plantations in such a way that the restoration of the remaining natural vegetation, mostly situated along watercourses, is stimulated. Since then, buffer zones have been created up to 30m on both sides of the watercourses, running through the area. Where necessary, seedlings of indigenous species have been planted. In 2009 FORM Ghana received FSC certification.

In order to keep track of the biological diversity and as an important component for maintaining a sustainable management scheme and FSC certificate a solid and reliable monitoring plan is required. A few types of monitoring are used and aim at the type of information which is needed for management decisions. The following monitoring aspects are carried out:

1. General Company monitoring
2. Plantation monitoring,
3. Buffer zone monitoring,
4. Water quality monitoring
5. Fauna monitoring
6. Social monitoring (employees and population),

Recently, extra effort was put into the monitoring of the vegetation in riparian buffer zones and the area's planted with native tree species as well as monitoring of fauna. For this reason FORM Ghana invited a university student to design a monitoring system for biodiversity. The system has legibly been transferred to local employees. This study was carried out over a course of 4 months of which 6 weeks took place in Asubima Forest Reserve. The following a priori research questions were made and will be answered in this report.

What is a good Monitoring Plan for Biodiversity in a tropical degraded forest?

- What is monitoring?
- What is biodiversity?
- What is the best method for designing a monitoring plan for Biodiversity?
- What does a good monitoring plan for Biodiversity comprise?

Biodiversity

The mayor certification systems have very similar definitions of biodiversity. FSC states: “Biological diversity is the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.”

The general lack of data, on biodiversity loss and species-richness recovery in secondary forests calls for a pragmatic, case specific monitoring procedure (Gardner, 2010). Many ecologists and natural resource managers underpin this by mentioning the importance of monitoring (Strayer et al 1986; Likens 1989; Spellerberg 1994; Thompson et al. 1998; Franklin et al. 1999). Not only is monitoring important for documentation and detection of ecological responses, it can also be a tool to evaluate sustainable forest management and a means to show ecological responsibility towards investors and certification agencies, such as FSC and PEFC. For these reasons monitoring should be an integral part of all forest restoration projects.

An integral part of monitoring biodiversity is the Shannon Wiener Index, that provides a number with which differences in biodiversity can be assessed between different sites or one site at different times. The higher the index the more diverse the life forms in the area. The Shannon Wiener index can easily and quickly be calculated after every cycle of monitoring (once a year). And from the second year onwards comparisons can be made. A statistical computer program, SPSS, can be used to see if the sites differ. If the data is normally distributed, an ANOVA can be conducted. If the data are not normally distributed and if transformation is not of any help, a non-parametric test, the Kruskall-Wallis test, will be provided. Post Hoc tests can be carried out to see what the nature is of the differences. To visualize the results box plots can be created.

Calculation of the Shannon Wiener index

p_i = the proportion of individuals of species i in the sample

S=total number of different species in the sample

$$H' = -\Sigma(p_i \ln p_i)$$

The Shannon-Wiener index of diversity (J’)

$$J' = H'/(\ln S)$$

Fig. 4. Calculation of the Shannon Wiener index of biodiversity

In order to identify the species richness among plants in the area, a species effort curve will be made, This curve shows the gathered number of species with increasing number of samples. At the point where the curves stabilize, no new species were found when adding new samples. This asymptote will show the species richness of the site.

Monitoring

In the strictest sense of the word, monitoring is an activity in which one "observes, records, or detects (an operation or condition) with instruments that have no effect upon the operation or condition" (www.dictionary.com). More specific Lindenmayer and Likens (2010) distinguish 3 types of ecological monitoring, each with a different extent to which they can predict future processes and each with a difference in scale. *Curiosity-driven or passive monitoring* lacks specified questions, a higher goal other then curiosity and has no scientific experimental design. *Mandated monitoring* aims at gathering information assigned for government/political administration and it is often coarsely scaled. *Question-driven monitoring* deals with a clearly defined entity such as an ecosystem, a population or a species. The high predictive value of the last monitoring type can be of great value for ecologists, forest managers and decision makers. The latter will therefore serve as a model in developing a monitoring system for Asubima FR.

A good monitoring plan has to meet certain conditions. According to Lindenmayer and Likens, (2010) a good monitoring plan should be accompanied by *questions, a conceptual framework, an experimental design and data integrity through repeatable application of appropriate field protocols*. Thayer et al (2003) state that a good monitoring system comprises *clearly defined project goals, objectives, and success criteria*. These should be established not only on the basis of science, but also on the goals and values of the local communities. Before construction commences, it is necessary to establish how progress toward these goals and objectives will be measured. Therefore this study is constructed in a way as to design a monitoring program, experience the monitoring program while conducting it and thirdly evaluating the monitoring program while enhancing it. As a result a reliable and replicable monitoring program will come forth.

It is up to professionals to design a monitoring program that meets views and interest of both management and local personnel. This way the goals of monitoring will most likely be reached. Stuart-Hill (2005, in Evans and Guariguata, 2008) provides some recommendations to establish this. First of all scientific research should be separated from monitoring. Secondly attention should be paid to building sustainable monitoring systems rather than obtaining data at all costs. Thirdly effort should be made to understand the working environment of local employees so as to realistically assess their capacity regarding monitoring. Hence a pilot study/ evaluation of the monitoring program is presented in this report. Fourthly the focus should be on topics that are dear to people working in the field. By means of knowledge transfer and keeping the latter Items in mind, local personnel will become trained specialists.

Flora

Conservation research and activities in African rain forests often focus on animals, particularly large mammals and birds. However, one cannot escape the fact that the plants define the forest environment. Tropical rainforests are home to a great diversity of plant species, representing many life forms. This diversity creates a wide range of habitat and foods for animals. As evidence for this, plant diversity tends to correlate well with overall species diversity. Given the wealth of taxonomic work on plants in many areas, plants tend to be more easily studied than other species-rich groups, such as insects. Patterns of plant abundance and diversity are also important to people. Loggers aim to cut and remove large trees and local communities use and trade foods, medicines and building material from the area. Authorized or unauthorized, the impact of these extractions should be monitored to asses whether management goals are being met (White & Edwards 2000).

A vegetation inventory is a necessary first step in a possible further detailed study. The aim of the inventory is to record the diversity of plant species found in the area and to estimate the abundance of each species. It provides the foundations for both ecological and socio-economic studies, since one must first identify the plants in order to identify an animal's diet, or the impact of logging on a habitat, patterns of food availability for frugivores, or use of medicinal plants by humans. Plus undertaking a botanical inventory will be a good training exercise, to become familiar with the botany of the area.

The first botanical inventory took place at the transition from wet to dry season. However a botanical inventory can be undertaken during all parts of the year and can be easily adapted to the time and personnel available.

Method used for the flora monitoring

Within the riparian buffer zone 21 GPS points were randomly selected with the program: "Map info". Two plots were made in the zones where indigenous species have been planted. These points each represent the middle of a round shaped permanent plot, sized 200m2 (radius=7,98 m). The centre of plots was indicated with a wooden stick and within each plot 5 temporary subplots of 1 m2 were made to measure herbs, grass and seedling cover.

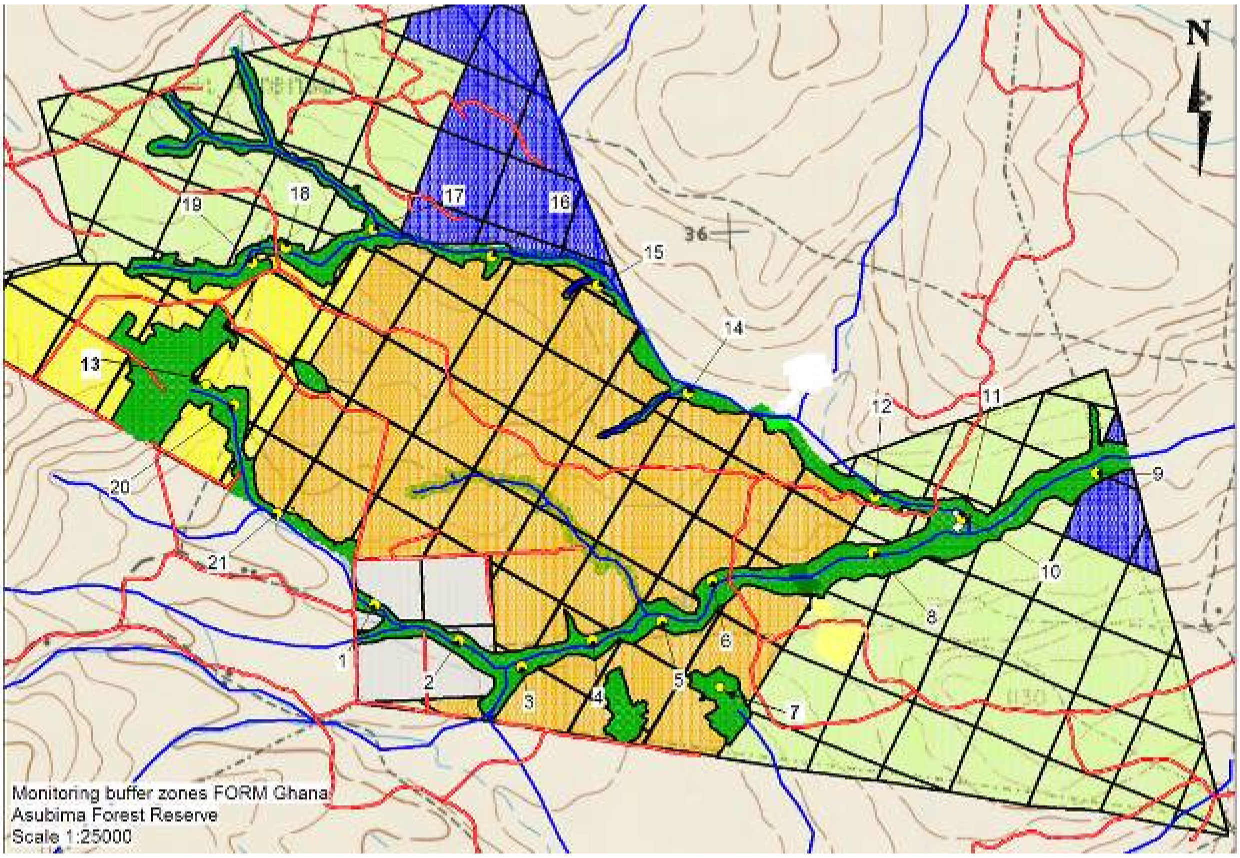

Fig. 5. Map of Asubima FR. The green areas are buffer zones. Plots where vegetation surveys take place are indicated with numbers 1 till 21. The area is divided in three sub zones; Plot 1-11 are in the sub zone "South", plot 12 and 14-19 are in the sub zone "North", plot 13, 20, 21 are in the sub zone "Waterfall".

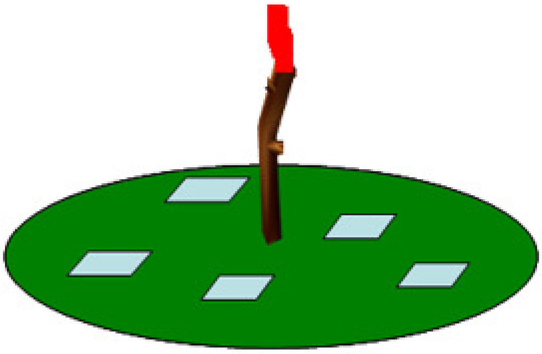

Fig 6. Floral biodiversity was measured in round plots of 200m². The middle of the plot corresponds with randomly chosen GPS coordinates. Within the plot, 5 subplots of 1m² were made to measure biodiversity in shrubs, herbs, grasses and juvenile trees. (photo: Noor de Laat)

Considering trees, measurements taken were: species (scientific name/ local name, number per species (only the ones that are higher than 1.30m), DBH, height, distance to the middle of the plot and angle (using a compass). Secondly presence/absence and species names of lianas were noted down. Thirdly for the shrubs, herbs, grasses and seedlings; species names along with their height and cover in % per species were written down. Coverage was only documented if more than 15-20% of the subplot was covered with a certain species. Lastly the presence of standing and lying dead wood was included. A qualified botanist helped identifying mainly woody species. Furthermore, for trees shrubs and grasses a guide-book was used (Hawthorn and Jongkind, 2008). If plants could not be identified with either the botanist of the guidebook, samples were taken and identification took place through Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi.

An example field sheet can be found in the Annex.

Results from the flora monitoring

Finding all the plant species names was a large undertaking. We identified in total 133 plant species from 41 plant families, in the 21 plots that were established. This number is likely to increase over time as the area will further develop. Out of 2000 species generally present in the Upper Guinean rainforest zone (Hall and Swaine, 1976), 79 tree species, 29 liana species, 10 herb species and 5 grass species were identified in Asubima FR. Because of the high botanical diversity in Ghana (Hall and Swaine, 1976) assembling of plant species list is best done in collaboration with a national herbarium or University. Contact was made with prof. Oduro from KNUST, who has expertise knowledge of the Kumasi region. KNUST provided help with identifying species that we could not identify ourselves. A field herbarium was made with help from KNUST and is present at the offices in Ghana.

Table 1. The number of different plant species found per plot in order from high to low.

Plot nr	8	20	9	4	3	1	6	12	14	2	11	10	18	15	5	13	16	17	21	19	7
Spp. found	26	25	24	23	22	21	21	20	20	19	18	16	14	11	10	10	9	9	9	8	6

An elaborated table with species, their family names, and their life-form (shrub tree, liana, herb, grass) can be found in the annex, along with the amount of plots in which a certain species occurs (Table 3.)

Table 4. displays the species found, in order of appearance. Most common species in the area was York (Broussonetia papyrifera), a tree species, present in 15 plots. Chromolaena odorata, a herb found in 14 plots, is the second most common species, followed by Antiaris toxicaria, a tree species and Griffonia simplicifolia, a liana species, both found in 9 plots.

The gathered number of species with increasing number of plots enabled the creation of a species-effort curve (Fig.7). Based on the curve, one could draw the conclusion that the sample size of 21 plots (in total 4200 m²) was not high enough to identify the species richness among plants in Asubima FR. The asymptote was not fully reached at 21 plots (4000m^2). New species are likely to be found when adding more sample plots.

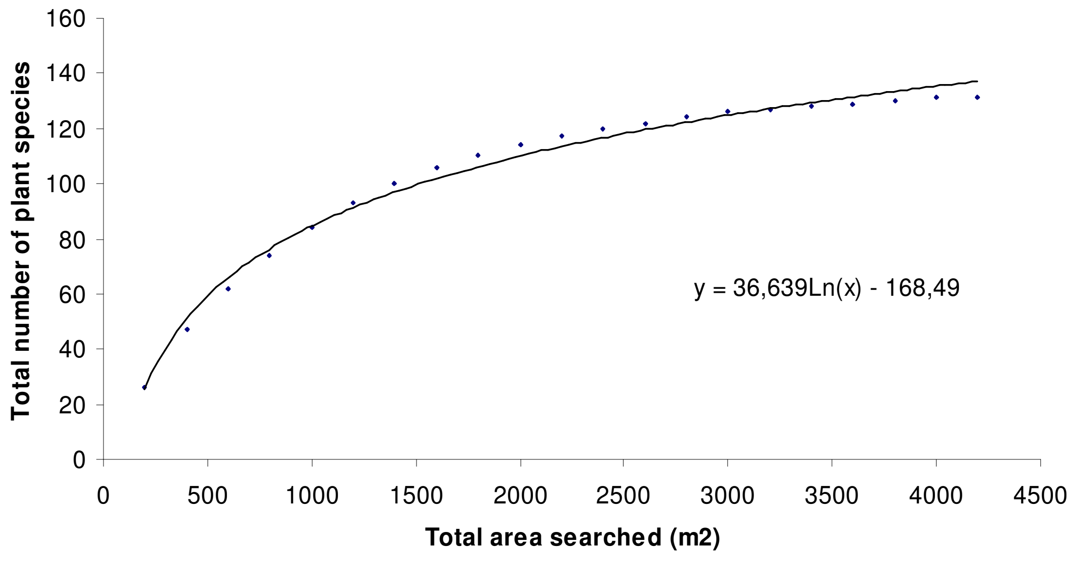

Fig. 7 Species effort curve for the riparian buffer zones in Asubima FR, 2010. The total number of species against increasing area searched is displayed. Twenty-one plots with a total area of 4200 m2 were searched. The formula agrees with the trend line and can be used for interpolation or extrapolation of the data.

The formula calculated for the trend line (displayed in Fig. 7), shows that an area of 1 ha (x= 10.000) in Asubima's buffer zone is expected to harbor 169 species. Hall and Swaine (1976) conducted a similar calculation for a closed canopy forest in the same region as Asubima, in 1971. They found an amount of 203 species per hectare. We could carefully state that there has been a decrease in species richness of about 17% compared to the situation in 1971. Management could set goals to increase the current biodiversity of 169 species per ha, to 203 species in 2020 in the buffer zones, by experimenting with and planting indigenous species that were lost in the past.

In order to monitor tree growth, a girth distribution per 0,25 ha was calculated, Compared to Hall and Swaine, who also conducted a girth class inventory, the distribution reflects that the area has been disturbed. Typically, an old growth forest would show a higher number of trees in the lower girth classes and a lower number of trees in the higher girth classes.

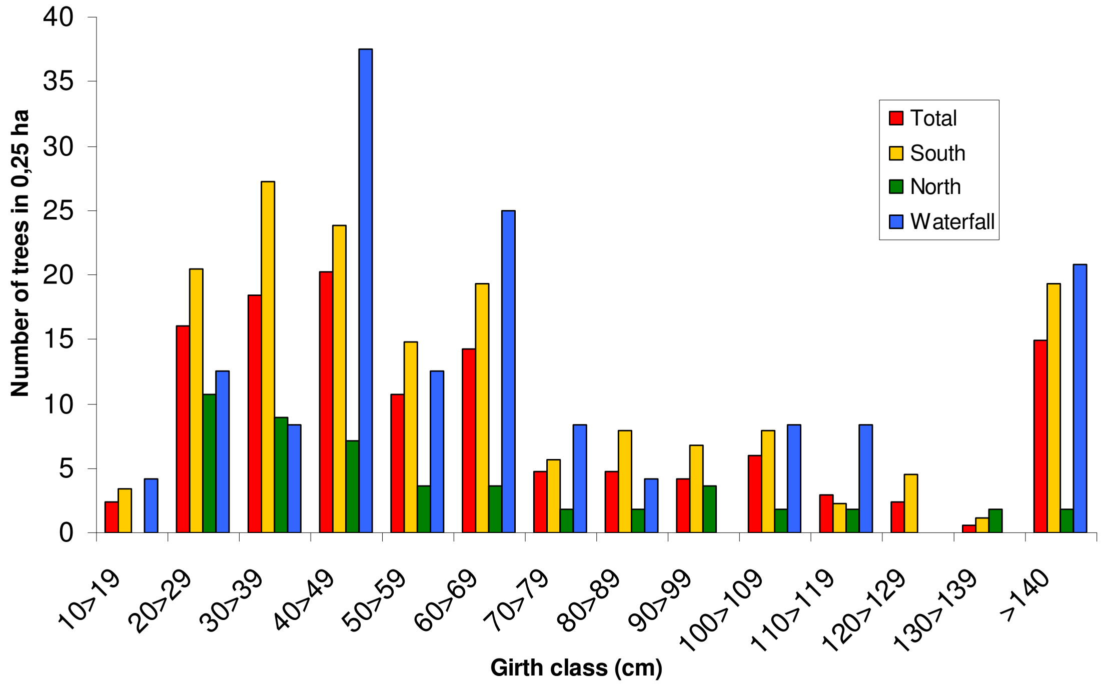

Fig. 8 Girth-class distribution of trees from 21 subplots (Total), and divided in subzone "South", subzone North , and subzone "Waterfall" measured in November 2010).

Evaluation of the flora monitoring

Before we started with our measurements we first took two days to establish the plots. This could be done easily with some extra man-force and a machete, causing some small changes to the environment. In the following two weeks, measurements were taken. The designed method worked well, however some small changes had to be made in the field sheets. For instance more spaces have been created to write down herbs, grasses and shrubs on the field sheets.

While in the field we could determine 90% of the tree, shrubs and liana species with help from a qualified botanist but much less could be determined from the herbs and grasses. After our recordings we brought unidentified samples from the field back to the office, so that we could identify them with help from a book (Hawthorne & Jongkind, 2006). The samples that we still could not identify after help from the book were later on brought to KNUST in Kumasi. At KNUST a team of three botanical specialist helped us to determine twenty out of forty unknown species. Cooperation was easy and in my eyes it can be even more fruitful in the future, if students from KNUST can study in Asubima FR and help can be found for identification purposes and confirmation of species found.

I could not calculate the Shannon Wiener index because plants were not measured in numbers but in coverage(%) However the creation of a species effort curve gives a very good impression on botanical diversity, especially after comparison with the results from Hall and Swaine (1976).

Fig. 9 If plant species could not be identified in the field, plant samples were taken and conserved in a self-made plant press, to be identified later on in the office. (photo: Noor de Laat)

Fauna

Amphibians

Fig. 10. Curious farmers looking at the frogs we caught (photo: Noor de Laat)

There is a general lack of knowledge of amphibians in the upper Guinean forests, especially those that are associated with forests. Despite the early start of herpetological work in West Africa in the late 19th century (Rödel et al 2008), knowledge has remained scarce and many geographical areas remained unstudied. Only in the mid 1990's research activities on West African amphibians increased significantly. Since then more than 80 articles on the biology of West African amphibians have been published (Rödel 2000). With 120 species listed (IUCN et a 2004) and new species constantly being described, especially the work during the last decade supported the status of the Upper Guinea forest region as an amphibian hotspot (Rödel et al. 2008; Rödel 1998, 2007; Rödel & Ernst 2000; Rödel & Bangoura 2004; Assemien et al 2006; Ernst et al 2008; Hillers et al 2008a,b)

Due to the extreme pressure on West African forests, especially strict forest amphibians are highly threatened. Unavoidably, many forest frogs, as well as ecological features as their niches and habitat, will remain unknown to us. This situation calls for exploration of the current frog communities and building knowledge on their restoration and reorganization after environmental impacts (Rödel et al. 2008).

The contemporary knowledge of West African amphibians already provides important directions for conservation that could also be useful for other taxonomic groups. In general, amphibians are very sensitive to habitat degradation (e.g., Wake 1991; Blaustein et al. 1994; Ernst et al. 2006). Indications come from the observed distribution patterns of endemism and diversity. It appears that many endemic and range-restricted forest frogs are unable to persist in logged or fragmented forests (Ernst & Rödel, 2005).

Unlike changes in species diversity and richness, the influence of their changing habitat has largely been neglected (e.g., Marsh & Pearman 1997; Tocher & Zimmerman 1997; Pineda & Halffter 2004). Indirect influences of forest fragmentation on amphibians have been suggested by Urbina-Cardona

et al.(2006). A general decrease in habitat quality has been seen as negative factor acting on amphibian diversity (Marsh & Pearman 1997; Pineda & Halffter 2004).
From a research in Cote d'Ivoire, it can be assumed that refuge areas for amphibians are characterized by high levels of biodiversity and high percentages of endemic tree and shrub species. Frogs react more to forest quality than to fragment size and fragmentation level (Hillers et al. 2008b). Furthermore it can be assumed that frogs might not only be good indicators for present forest environments, but also for the past environmental changes of the forest habitat. For this reason amphibians are regarded as good indicators for the development of the area and could be an important factor in a biodiversity monitoring protocol. It is expected that in the coming years, along the course of reforestation in Asubima, frog assemblages will change, from generalists species, or species representing degraded forest habitats to specialist species, or tree frogs, indicating the required improvement in environmental health.

Methods used for the monitoring of amphibians

We searched for and collected amphibians in all possible microhabitats at day time during one week. The search resulted in modest habitat modification, such as dismantling rotten logs and removing lianas. The species lists are accumulated by integrating the results of general collecting by a few investigators. The major assumption for using this technique is that differences in results caused by variation in technique and effort are smoothed out over time and that the area does not change during the sampling period. Asubima F.R. is however expected to change in the long run, and monitoring will be conducted in the course of at least a few years. Therefore it is very important to document proceedings in vegetation succession since amphibian species composition is expected to change simultaneously. The habitat changes will be monitored as explained previously in this monitoring protocol; see *vegetation monitoring*.

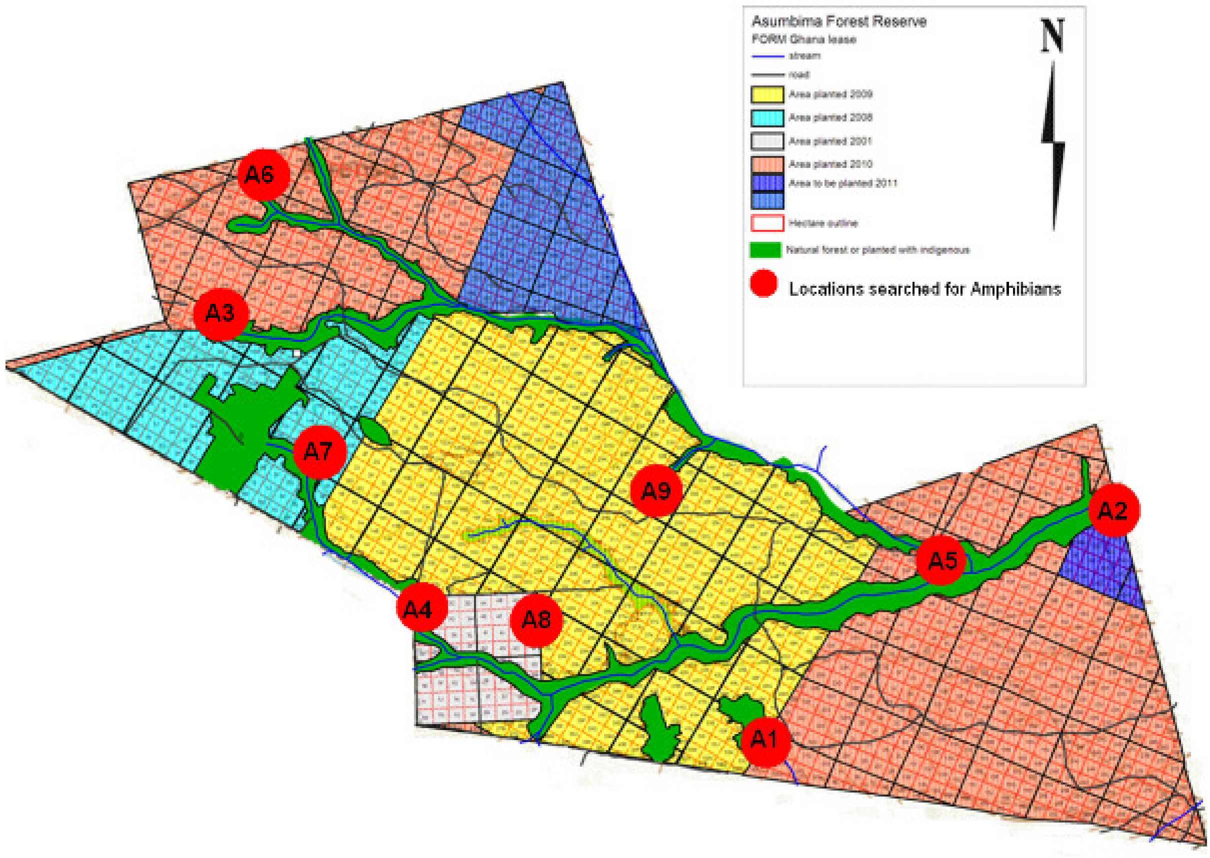

Fig.11 Asubima Forest Reserve with the locations that have been searched for amphibians.

Some remarks have to be made on the method used. First, one should not expect that short collecting visits to a single site can give much insight into the total number of species present. However, this is indeed not required as the data will be used to rank habitats in time according to relative species richness. Secondly when using short term sampling methods one has to be aware that the results are highly dependent on collecting methods, collectors' experience, level of sampling effort, weather prior to and during sampling (think of rain, dry season, Harmatan), habitat, and phenology of the amphibian species. Before comparisons can be made of the site at different times, any effect of these variables must be controlled as much as possible. Practically, this can be done by the use of a clearly described method, fixed persons investigating, a fixed planning and a fixed amount of time investigating. This report aims at determining how the proposed method can be optimized, so that after this pioneer research, monitoring can be done in a persistent way.

An example field sheet can be found in the Annex .

Results from the monitoring of amphibians

Eighteen frog and two toad species were found in Asubima F.R. in November 2010. Their scientific name, common name, status, habitat and number of individuals found, are shown in Table 5(Annex). The Shannon Wiener index of biodiversity (J') was calculated; J'= 0,639863. The different frog species found can tell us to a bigger or lesser extend something about their surrounding and the environmental health thereof, depending on the information available. If management wants to stimulate the presence of these amphibians knowledge on their ecology, can be helpful first step in taking action.

Fig. 12 Frogs found within Asubima Forest reserve; 1. Hyperolius nitidulus (in dry season); 2. Hyperolius concolor (male); 3. Kassina senegalensis; 4. Hyperolius concolor (female); 5. Phrynobatrachus calcaratus; 6. Ptychadena aff. aequiplicata (juvenile; aff. because the real aequiplicata – which is morphologically identical – is restricted to Central Africa, the West African populations is currently being described as a new species); 7. Leptopelis spiritusnoctis; 8. Phrynobatrachus gutturosus; 9. Arthroleptis cf. oecilonotus; 10.Hyperolius fusciventris burtoni (juvenile); 11. Amnirana albolabris (juvenile); 12. Hyperolius guttulatus (juvenile); 13. Amietophrynus maculates; 14. Arthroleptis spp.; 15. Phrynobatrachus plicatus; 16. Afrixalus dorsalis; 17. warty Arthroleptis (identification very uncertain); 18. Hyperolius picturatus; 19. Hoplobatrachus occipitalis; 20. Phrynobatrachus latifrons. (Photo's by John Eckly and Noor de Laat)

Description of the preferred habitat of the species

Afrixalus dorsalis (Fig.12-16) is widely distributed and common in bush land localities in the West African forests and in the humid savanna.

Amietophrynus maculatus (Fig.12-13) can be found in humid savannas. In West Africa, this species probably inhabits the areas covered, now and previously, by rainforest. It can also colonize large parts of savanna as long as there are rivers present.

The exact range of ***Arthroleptis cf. poecilonotus*** (Fig.12-9) cannot be given, as the identification of frogs belonging to this genus is extremely difficult currently. At Comoé National Park in Ivory Coast, the frogs are mainly associated with gallery and island forests, while moist savannas bearing a rich vegetation are also inhabited. In Lamto NP (Ivory Coast), this species is more common in savanna's. However, this frog is generally associated with rainforest; it is also found in swamps and gallery forests or degraded forests and clearances.

Hoplobatrachus occipitalis (Fig.12-19) is known to inhabit river banks, rock-pools and savanna ponds. This species is found mainly in savanna habitats but it has also been found in forested regions. They enter the forests along clearings and roads. The range of potential habitats includes both rivers and tiny puddles . The close relation of *H. occipitalis* to aquatic habitats has frequently been underlined (e.g. Schiøtz 1964, Poynton & Broadley 1985; in Rödel 2000)

Hyperolius concolor (Fig.12-2 and Fig.12-4) is a typical bush land species. It is abundant and easily seen on open localities in the forest and in gallery forests far up in the savanna.

Hyperolius guttulatus (Fig.12-12) seems to prefer large forest-swamps. It has not been observed on many localities, but present in vast numbers at suitable sites.

Hyperolius nitidulus (Fig.12-1) is found in the savannas of western Africa, as well as in scrublands, grasslands, and wetlands.

Hyperolius picturatus (Fig.12-18) and ***Leptopelis spiritusnoctis*** (7) are typically found in the interior of the upper Guinean forests.

Kassina senegalensis (Fig.12-3) is, as presently understood, to be abundantly distributed throughout the entire tropical savanna of Africa.

At Comoé National Park (Ivory Coast) ***Phrynobatrachus calcaratus*** (Fig.12-5) has been found exclusively in forests. In other parts of west africa, the frogs occur both in dense forests and in savannas. In Lamto NP, Phrynobatrachus calcaratus are most often found in gallery forests, but they also colonize savannas which have not been burned.

Phrynobatrachus gutturosus (Fig.12-8) lives in gallery forest-ponds and, very rarely, on the edges of savanna ponds. Published records includes primary rainforests, gallery forests and even northern Guinea savanna (Schiøtz 1963, Walker 1968, Hughes 1988; in Rödel (2000 b). However it is generally considered a forest species. Similar to Phrynobatrachus calcaratus, this species is quite common in savannas that have not been subject to annual burning.

Evaluation of the amphibian monitoring

Amphibians were hard to encounter in the buffer zones, that are most often densely vegetated in the lower layer. In this layer the investigators have to move, causing loud noises from fallen leaves and branches. This probably alarms wildlife, that most likely flees away. Even if measures are taken, such as not talking and splitting up, amphibians were less often encountered then expected. Another factor that is problematic yet logical, is that the amphibians found had colors such as grey, black, brown, or green. This strategy makes them almost disappear in their natural surrounding. Only after some distraction from human feet or hands will they jump away and this is the only way the amphibians could be encountered. Frogs could be most easily seen in the old teak stand, where canopy is almost closed and lower layer is open. Not only is it easy to walk around and search for frogs, it is also likely a nice and cool refuge for frogs coming from the buffer zones during the hot daytime.

The local employees that took part in this first survey found many amphibians both during and outside collection hours. They both showed a lot of enthusiasm in this part of the research. This is a good sign as they will continue the monitoring. Something to take into account is that photographing seemed to best way to file the amphibians. The first two days, we tried to catch the frogs with a net but this was very difficult, as the frogs are very small and escape easily, even after they have been caught in the net, or even after they have been put in a pot for conservation. When opening the pot or net, 8 out of 10 escaped instantly. Therefore I would advise to use a good camera (with strong zoom qualities) to make sure that identification can be done. When making pictures of these amphibian its is important to have a good camera and photographing skills, again because of the size of the amphibians and because different species can only be determined with information on the webbing of the feet and vocal sac in throat. This method requires new skills from local personnel and investment in new material.

After discussion with frog-specialists, Gilbert Odum from KNUST and Mark-Oliver Rödel from the Humboldt University Berlin, it seems to be a good option to collect specimens, preferably in two-fold. This is the only way to be 100% sure of a name and possibly describe new found species. This is so, because features like webbing and vocal sac can be best studied in detail from specimens. On the other hand, collecting specimens means killing frogs, and I think this goes against the idea of preserving frogs in the area, unlike collecting and noting down species for a scientific purposes.

As expected the frogs found, represent a disturbed forest ecosystem as most are grass, reed, or savannah dwelling species, or species indicated as omnipresent. In the future, when the canopy in the teak plantation closes, a shift in species is likely and desired to be observed, seen the fact that in this research more tree-frog species were observed in the older teak stand. The buffer zones, as currently present in the area, could not only serve as habitat but also as a highway for species to go in and out of the area. However exact prediction of species cannot be made.

All in all I think the frog assemblage in Asubima could give a strong indication on environmental health because frogs are sensitive to changes and strong respondents to developments in vegetation. The drawback from using frogs as indicators is that, experience has to be build up in local personnel and investigation methods are time consuming and costly. The collection itself could be done during 5 days, two hours around sunset, two hours around sundown and two hours around midnight. Two people should be enough to conduct the work. The search for frogs should be accurately time constraint. We had some problems with keeping schedule. But I think it is very important to go to a certain site, look for frogs and stop after 2 or three hours with affixed number of investigators. As long as this amount of time is the same for all the sites, sites can be compared.

An option is to invest in a course to be given by an amphibian specialist in how to catch, preserve and identify specimens. However In my eyes it would be better to invest in a good camera and a photography course for local personnel. Identification could be done in a specialized institute. For this purpose connections with specialists should be made and maintained. If these conditions are met, a strong monitoring protocol can be determined, relying on frogs and vegetation. If not, monitoring vegetation and birds should be a good alternative.

Birds

Like in Asubima FR, vast West African forests and savannas have previously been cleared for cultivation. The severe clearing has altered, amongst other features, the composition of bird life. If in primary forest an area is felled and left for regeneration, it is soon covered with dense second-growth trees and shrubs. This second –growth, though suited for certain species of forest birds, is unsuited to others and the latter, disappear. If the felled area is cultivated and kept from regeneration, grass appears on the cropped land and many of the secondary forest species are repelled and there is an invasion of savannah species. In a forest zone with primary forest, secondary forest and cultivation clearings, one encounters three quite dissimilar bird populations. Geographically in each others vicinity but ecologically separated, birds can give a good indication of the state of the art in the area. (Serle & Morel, 1977)

Method used for the monitoring of birds

In the past 47 bird species were found in Asubima FR (Abeney et al 2007). In order to identify bird species in this project, we followed pre-existing trails, quadrant lines and dirt roads as much as possible and when necessary we have cut a path of least resistance through the vegetation. This allowed us to work in small teams (hence cheaper), to move faster (hence to cover more area), and to minimize the potential impact of our survey activities in the area. The survey for birds was carried out in the teak plantation- and indigenous species-plantation.

The described method has the disadvantage that it produces biased data, because following existing human paths and trails will not give a representative sample of habitat types and human impact in the area. However densities can be efficiently calculated when the survey is combined with line transects sampling, like we did. We walked transects when birds were most active, around sunrise and sunset. This way they are more easily seen or heard. Transects walked in different seasons can give different results, particularly with birds that migrate from one area to the other in search for food and water. Changes between the wet and the dry season can have a strong effect on the quantity and quality of animals that are visible. Therefore it is important to census birds at least once a year, and always in the same season (White and Edwards 2000).

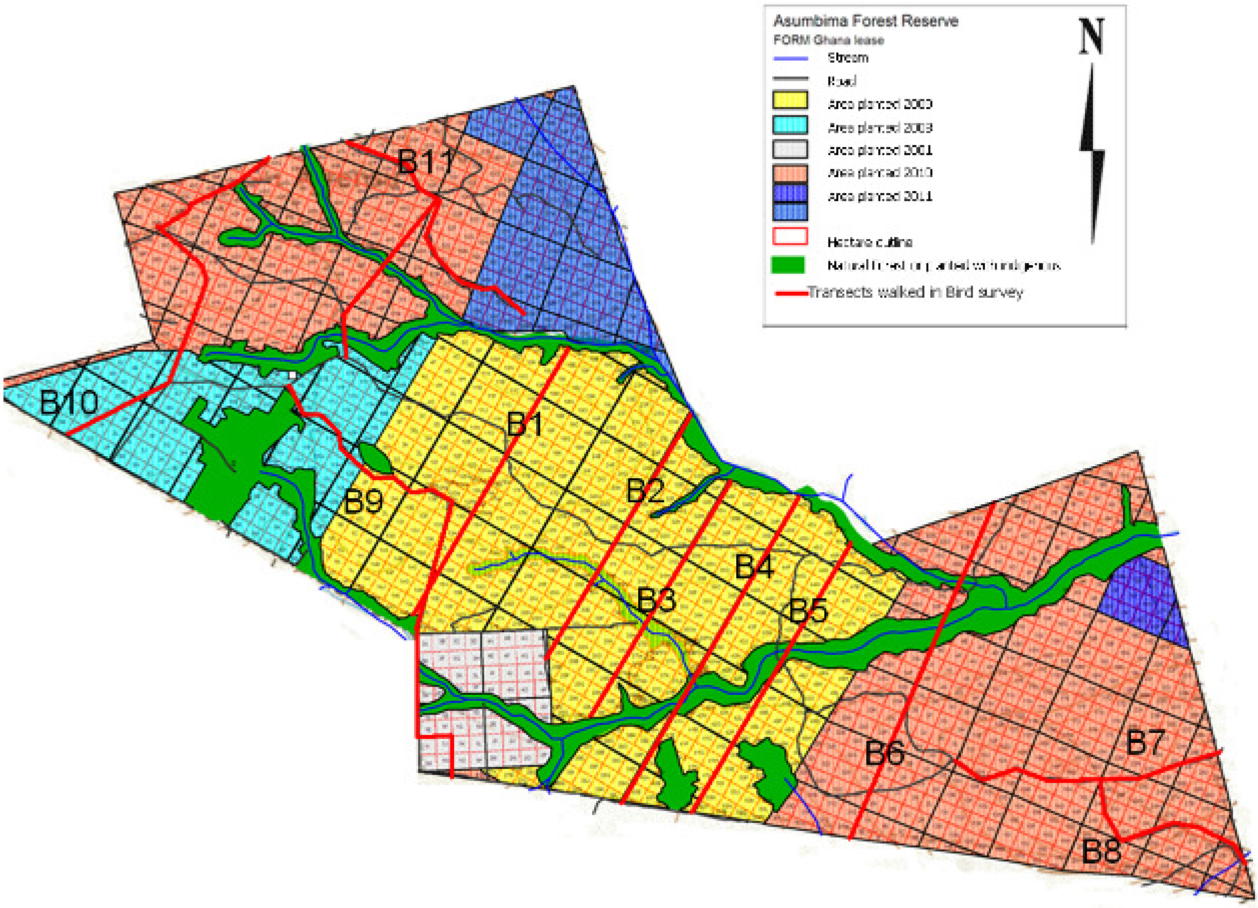

Fig. 13. Map of Asubima Forest reserve with transect B1-B11, the transects we walked in the bird survey

Results from the monitoring of birds

We took two days in determining where our transects could be best situated and subsequently established eleven transects, with a distance ranging from 815 m. to 2600 m (Fig.13). We observed 77 bird species. Family names and species per family, common name and status (as described in Sinclair & Ryan, 2003) can be found in the Annex (Table 6.). In total 77 species of bird were encountered in Asubima Forest Reserve. These species belong to 30 different families. Nearly all of these species are typical for savannah vegetation or open woodlands.

The Shannon Wiener index of biodiversity (J') was calculated; J'= 0,810726. Five bird species found are indicated as uncommon, thinly distributed or endangered. Those species are; the Bearded barbet, Black face firefinch, Gambaga flycatcher, Ibadan malimbe and Togo paradise wydah. Within the 13 km and 505 meters of transects, we found 5.7 bird species per km.

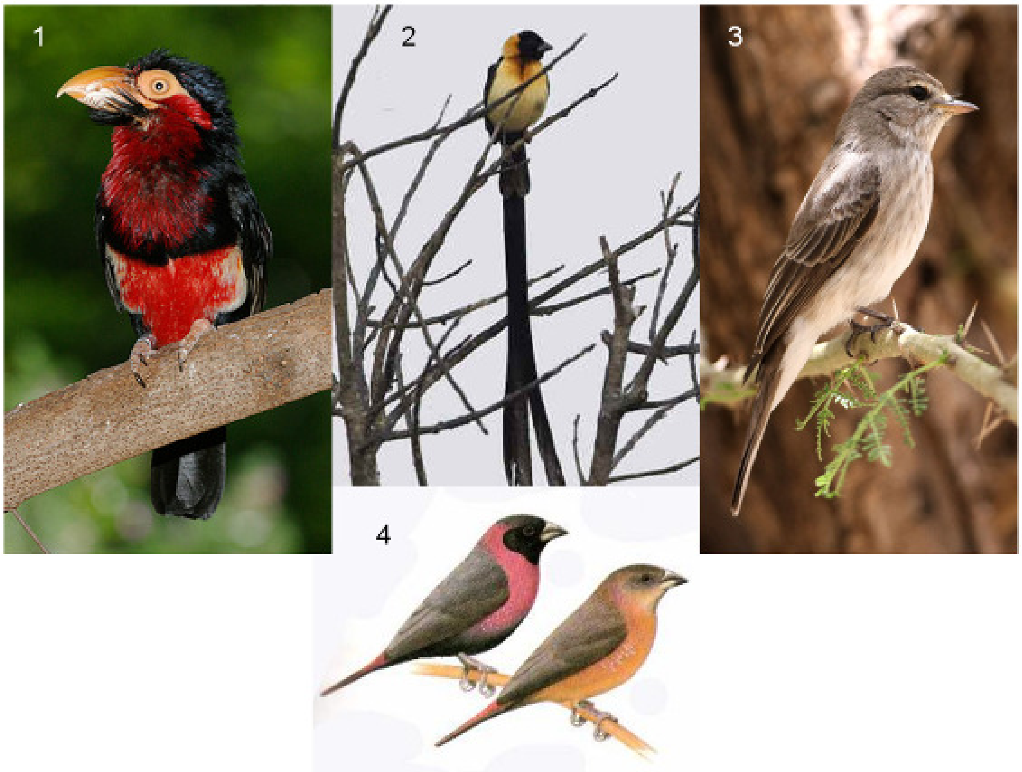

Fig.14. Uncommon, thinly distributed or endangered birds-species found in Asubima Forest Reserve: 1. Bearded barbet (Lybius dubius)(www.ejphoto.com); 2.Togo paradise wydah (Vidua togoensis) (www.worldbirds.eu); 4.Black face firefinch (Lagonostica larvata) (www.oiseaux.net) 3. Gambaga flycatcher (Muscicapa gambagae) (www.birdsofkuweit.com)

Unlike in the SEIA (Abeney et al., 2007), no distinction was made between zones, and vegetation types where birds are observed, since transects crossed the area through different vegetation types from north to south. Furthermore the SEIA was conducted in another season and before the development of the area. Consequently no comparison will be made here, between the different investigations.

Table 2. . The number of different bird species found per transect in order from high lo low.

Transect nr.	9	4	7	11	10	3	6	1	5	8	2
Spp. found	27	26	24	19	18	17	16	15	13	12	11

An elaborated table with species found per transect and observations per transect can be found in the Annex (Table 7.) The gathered number of species with increasing number of transects enabled the creation of a species-effort curve (Fig.15). Based on the curve, one could draw the conclusion that the sample size of 11 transects (in total 13505 m) was not high enough to identify the species richness among birds in Asubima FR. The asymptote was not fully reached at 21 plots (4000m^2). New species are likely to be found when adding more transects or by making the existing transects longer.

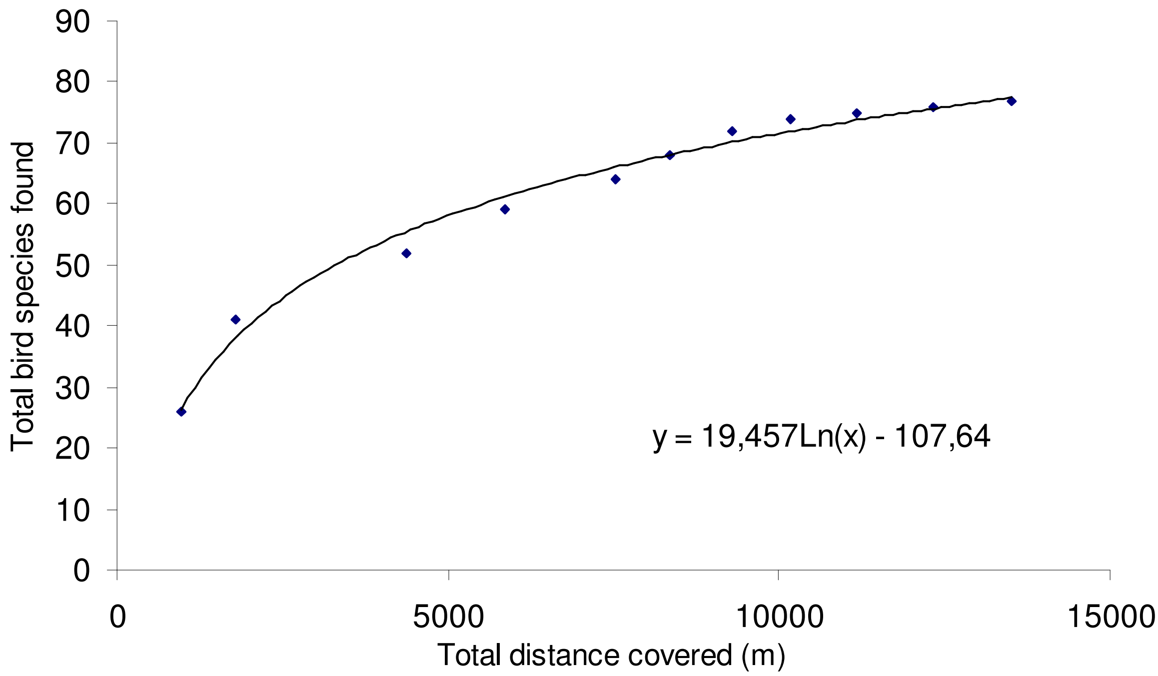

Fig. 15 Species effort curve for birds in Asubima FR, 2010. The total number of species against increasing distance searched is displayed. Eleven transects with a total length of 13.505m were searched. The formula agrees with the trend line and can be used for interpolation or extrapolation of the data.

In order to see how species are distributed and in what amount, Figure 8 was created.

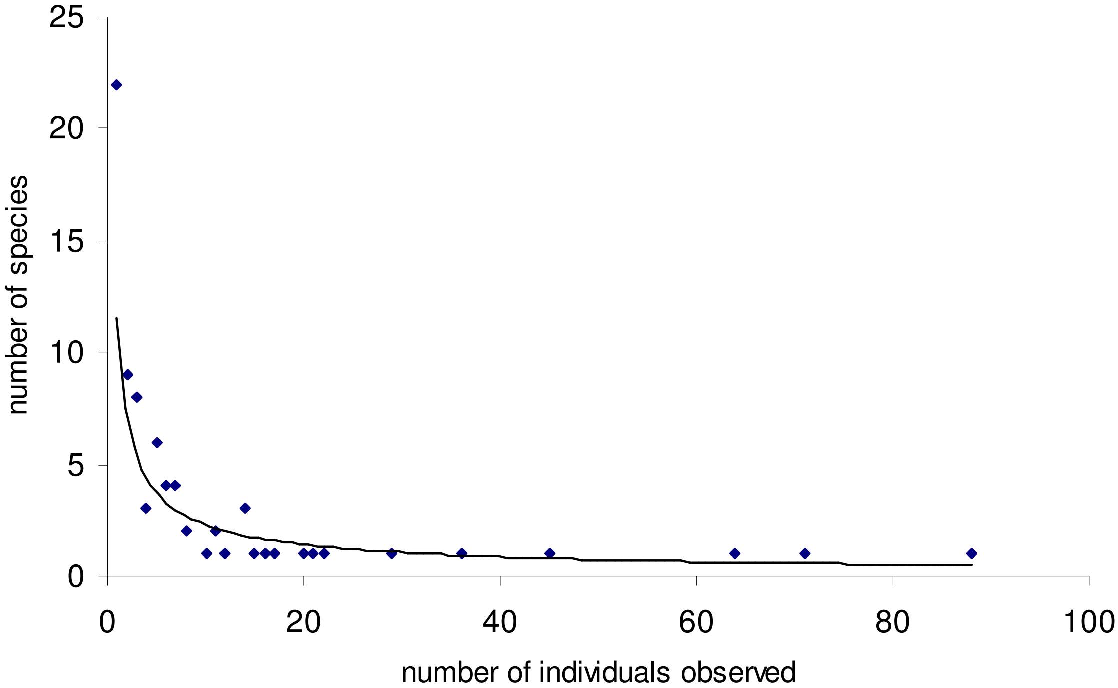

Fig.8 Number of individuals found per species. For twenty two species, just one individual was observed. On the other side, for some species we found high numbers of individuals, up to 74 observations for the common bulbul and 88 observations for the white throated bee eater.

Evaluation of the bird monitoring

Since the area is still rather open/ savannah like, most transects gave us the opportunity to detect birds within a wide distance from the path or road. We decided to note down all the birds that we could clearly see or hear. This in itself causes bias because bigger and slow moving species are more easily detected compared to smaller and fast moving species. Similar as with the frogs, some birds seemed alarmed and fled while we were on the move. Pictures could not be taken as the birds were to far, too fast, or too small. The quality of my camera could not cope with that.

A local bird specialist was hired to help us and teach us how to determine birds. Data on birds was more easily assessed compared to frogs. Unlike the frog part we could immediately look up the bird name. However, basic knowledge on birds is a necessity to have a first clue about the family and asses the species' name quickly. To establish this, the local employees would also have to build up a lot more experience by doing this kind of work more often. A course in recognizing birds would be beneficial. Along with a good field guide like Collin's birds of West Africa, a recording with bird sounds is available. Book and compact disk should be purchased to practice identification and should be studied well before the next monitoring moment in order to be independent from any external help. Good binoculars must also be bought, as this can make the work more easy and the outcome of the data more accurate. Lastly, some of the transects were covered in less then two hours. These could be prolonged so that more area is covered. If, for promotional purposes, pictures are required, a camera with strong zoom capacities is a necessity.

Conclusion

English

FSC states: "Biological diversity is the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems." In order to monitor biodiversity certain conditions have to be met. According to Lindenmayer and Likens, (2010) a good monitoring plan should be accompanied by *questions, a conceptual framework, an experimental design and data integrity through repeatable application of appropriate field protocols*. In accordance with these rules, a monitoring protocol for Asubima F.R. In Ghana was developed. In the first monitoring cycle we found 133 different plant species, 77 different bird species and 19 different frog species. The monitoring protocol that was designed before the first investigations took place, has been evaluated upon it's effectiveness. Some problems with the methods used have been identified. The option to monitor birds and vegetation is a cheaper and easier option compared to monitoring frogs. However since frogs are a very accurate indication on ecosystem functioning and considering the fact that the local employees were very motivated to conduct the frog search, I think it would be good to monitor frogs as well. With some small practical changes a new monitoring protocol is ready for use for the coming years (see the document: Monitoring Protocol Asubima FR). If done on a yearly basis, changes in biodiversity can be detected and evaluated for management purposes.

The main findings from this first assessment of biodiversity values are presented here below:

A total of 133 plant species has been found in the 21 vegetation plots established in the buffer vegetation. These species belong to 40 different families and represent trees, shrubs, lianas as well as herbs. The most common species are two invasive species called York (Broussonetia papyrifera) and Acheampong (Chromolaena odorata). The high presence of these species is indicative of severe degradation (by fire) of the vegetation in the area. The most common indigenous tree species is Kyenkyen (Antiaris toxicaria).

Eighteen frog and two toad species were found in Asubima F.R. in November 2010. Of these species almost all were typical of open grassland vegetation, while only one species was typical of forest vegetation.

In total 77 species of bird were encountered in Asubima Forest Reserve. These species belong to 30 different families. Nearly all of these species are typical for savannah vegetation or open woodlands. Five bird species found are indicated as uncommon, thinly distributed or endangered. Those species are; the Bearded barbet, Black Face firefinch, Gambaga Flycatcher, Ibadan Malimbe and Togo Paradise Wydah.

From these data it becomes very clear that species composition in Asubima is more representative for a savannah than for closed forest. With the restoration of the buffer vegetation along the water courses it is hoped this situation will change to a species composition representative for both high forest as well as savannah / teak forest. Through regular annual monitoring data will be collected to follow this development and to eventually change tactics if for example the vegetation in the buffer zones does not change.

Acknowledgements

First of all I would like to thank Paul Hol, director of FORM International, for giving me the opportunity to conduct my internship at FORM International. I would like to thank Tieme Wanders and Frans Bongers for supervising. Furthermore I would like to thank mr. Owusu, mr. Elikem and Mr. Odum, who respectively helped with identifying plants, birds and amphibians. I would also like to thank mr. Rödel who helped me with identifying frogs. I would like to thank mr. Fourie, the general manager of FORM Ghana, for structuring my thoughts and facilitating the tools and services I needed in this study. I would like to say special thanks to Rik Sools, for encouraging me and answering my questions, and of course also for the trips up and down the office. I would like to thank John Eckly for using some of his pictures. Last but not least, I would like to thank FONA (Fonds voor Onderzoek ten behoeve van Natuurbehoud) and Wing for providing me with a grant that enabled me to travel to Ghana.

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ANNEXES

Field sheet vegetation

Vegetation survey
OBSERVERS ______________________ DATE/TIME ______________

PLOT NR. COORDINATES ______________________

HABITAT DESCRIPTION ______________________

____

DEAD WOOD: ______________________ CANOPY COVER (%) ______________

TREES

spp code	tree species	height (m)	DBH (cm)	dist.to middle (m)	angle °	Remarks

HERBS GRASS SHRUBS SEEDLINGS

nr subplot	spp code	Local name	Scientific name	cover (%) if > 15-20%	height (cm)

Field sheet amphibians

AMPHIBIANS

OBSERVER(S) DATE/TIME

GENERAL LOCALITY

Coordinates

HABITAT TYPE SEARCH TYPE

HABITAT DESCRIPTION

CANOPY COVER

WEATHER

SPECIES ID	INDIVIDUALS OBSERVED (C)=CALLING

TOTAL "SPECIMEN" RECORDS (chorus count as one)

APPROXIMATE AREA SEARCHED **m2** ENDING TIME

Field sheet birds

RECCE survey birds

OBSERVER(S) ____________________ DATE/TIME ____________________

GENERAL LOCALITY ____________________

SPECIFIC LOCALITY (+coordinates) start: ____________________

HABITAT TYPE ____________________ SEARCH TYPE recce / line transect

HABITAT DESCRIPTION ____________________

SLOPE/ ASPECT ____________________ CANOPY COVER ____________________

WEATHER ____________________

TEMPERATURE

air

SPECIES ACRONYMS OR ID	INDIVIDUALS OBSERVED (Count) (C)=CALLING/ (S)= SEEN

TOTAL "SPECIMEN" RECORDS ____________________

APPROXIMATE AREA SEARCHED ______ m ENDING TIME ____________________

ENDING COORDINATES ____________________

Material needed

material needed
•Map of the area
•Wooden sticks, 1m high (50 pieces)
•420 small sticks to indicate subplots
•GPS unit
•Machete
•Medicinal supplies and sufficient food
•Boots, clothes with long sleeves
•Compass
•Wrist watch
•Notebook and checklists
•Field sheets
•Pens, pencils, erasers etc.
•Light plant press
•Torch
•Permanent marker pen
•Book: Collins Birds of West Africa +cd
•Book: Woody plants of Western African forests
•Book: Tree frogs of Africa
•Binoculars
•Net
•Assorted specimen bags and bottles
•Flagging tape
•DBH tape
•Tape measure (10 m.)
•Clinometer
•Tape recorder
•Photo camera +batteries
•Lever arch file

Table 3: Plant species found in Asubima grouped per family

Table 3. Plant species found in Asubima FR in November and December 2010. Family name, species name, and life form (H=herb, L=liana, T=tree, R=rattan, S=shrub, F=fern) are displayed. When scientific name is unknown, local name is given in italic.

Family		Species	Life form
Acanthaceae	1	Asystasia spp.	H
	2	Asystasia spp.	H
	3	Lankesteria elegans	L
	4	Phaulopsis barteri	L
Anacardiaceae	5	Lannea welwitschii	T
	6	Mangifera indica	T
Annonaceae	7	Cleistopholis patens	T
Apocynaceae	8	Alstonia boonei	T
	9	Funtumia africana	T
	10	Landolphia micrantha	L
	11	Marsdenia magniflora	L
	12	Periploca nigrescens	L
	13	Rauvolfia vomitoria	T
	14	Strophantus hispidus	T
	15	Tabernaemontana africana	T
Araceae	16	Anchomanes difformis	L
	17	Cercestis afzelii	H
Asteraceae (Compositeae)	18	Chromolaena odorata	H
	19	Eclipta prostrata	H
	20	Erigeron floribundus	H
	21	Vernonia amygdalina	T
	22	Vernonia cinerea compositae	H
Bignoniaceae	23	Newbouldia faenis	T
	24	Newbouldia leavis	T
	25	Spathodea campanulata	T
Boraginaceae	26	Cordia millennii	T
Burseraceae	27	Canarium schweinfurthii	T
Celastraceae	28	Loeseneriella apocynoides	L
	29	Salacia owabiensis	L
Combretaceae	30	Terminalia superba	T
Commelinaceae	31	Palisota hirsuta	R
Cucurbitaceae	32	Momordica foetida	L
	33	Ruthalicia longipes	L
Dioscoreaceae	34	Dioscorea minutiflora	L
Dracaenaceae	35	Dracaena perrottetii	T
	36	Dracaene ovata	H
Euphorbiaceae	37	Alchornea cardifolia	T
	38	Macaranga barteri	T
	39	Mallotus oppositifolius	T
	40	Mareya micrantha	T
	41	Margaritaria discoidea	T
	42	Ricinodendron heudelotii	T

Fabaceae (Leguminosae-Mim)	43	Albizia adianthifolia	T
	44	Albizia ferruginea	T
	45	Albizia zygia	T
	46	Centrosema plumieri	L
	47	Griffonia simplicifolia	L
Leguminosae-Caes.	48	Anthonotha macrophylla	T
	49	Daniellia thurifera	T
	50	Distemonanthus benthamianus	T
	51	Chidlowia sanguinea	T
Leguminosae-Mim	52	Acacia kamerunensis	L
	53	Piptadeniastrum africanum	T
Leguminosae-Pap	54	Abrus canescens	L
	55	Dalbergia saxatilis	T
	56	Lonchocarpus sericeus	T
	57	Milletia zechiana	T
	58	Baphia nitida	T
	59	Amphimas pterocarpoides	T
Malvaceae(Bombacaceae)	60	Ceiba pentandra	T
	61	Bombax buonopozense	T
	62	Rhodognaphalon brevicuspe	T
Malvaceae (Sterculiaceae)	63	Nesogordonia papaverifera	T
	64	Cola gigantea	T
	65	Mansonia altissima	T
	66	Pterygota macrocarpa	T
	67	Sterculia rhinopetala	T
	68	Sterculia oblonga	T
	69	Sterculia tragacantha	T
	70	Triplochiton scleroxylon	T
Malvaceae (Tilliaceae)	71	Christiana africana	T
	72	Glyphaea brevis	T
Marantaceae	73	Hypselodelphis velutina	S-R
	74	Hypselodelphys triangulare	S-R
	75	Marantochloa congensis	S-R
	76	Marantochloa mannii	S-R
Marattiaceae	77	Marattia fraxinea	F
Meliaceae	78	Carapa procera	T
	79	Khaya ivorensis	T
	80	Trichilia monadelpha	T
	81	Trichilia prieureana	T
Moraceae	82	Antiaris toxicaria	T
	83	Broussonetia papyrifera	T
	84	Ficus exasperata	T
	85	Ficus sur	T
	86	Morus mesozygia	T
	87	Trilepisium madagascariense	T
Musaseae	88	Musa acuminata	S
Olacaceae	89	Olax subscorpioidea	T
	90	Strombosia pustulata	T
Palmae	91	Laccosperma opacum	L
	92	Raphia palma-pinus	T
Pandaceae	93	Microdesmis keayana	T

Passifloraceae	94	Adenia rumicifolia	L
Poaceae	95	Acroceras zizanoides	G
	96	Brachiaria deflexa	G
	97	Pennisetum purpureum	G
	98	Imperata cylindrica	G
	99	Rottboelia exaltata	G
Rubiaceae	100	Chassalia kolly	L
	101	Massularia acuminata	T
	102	Rutidea depuisii	L
Sapindaceae	103	Blighia sapida	T
	105	Blighia unijagata	T
	106	Blighia welwitschii	T
	107	Lecaniodiscus cupanioides	T
	108	Puallinia pinnata	L
Sapotaceae	109	Pouteria alnifolia	T
	110	Pouteria altissima	T
Solanaceae	111	Solanum torvum	L
Ulmaceae	112	Celtis mildbraedii	T
	113	Trema orientalis	T
Violaceae	114	Rinorea oblongifolia	T
	115	Rinorea afzelii	L
Vitaceae	116	Ampelocissus gracilipes	L
	117	Cissus aralioides	L
Zingiberaceae	118	Aframomum melegueta	S
	119	Aframomum spp.(Standfieldii-Zingebraceae)	R
Unknown	120	*Adankomilk*	H
	121	*Anansenkatie*	H
	122	*Anansetromohoma*	L
	123	*Ansurogya*	L
	124	*Cosonowede*	T
	125	*Fema*	T
	126	*Kbese*	T
	127	*Nyemekobere*	T
	128	Odenia rumicifolia	L
	129	*Osonowesamfee*	T
	130	*Sensam*	S-R
	131	*Sope*	T
	132	*Subaha*	T
	133	*Toantini*	L

Table 4: Plant species found in Asubima FR ranked by frequency

Table 4. Plant species found in Asubima in order of appearance from high to low.

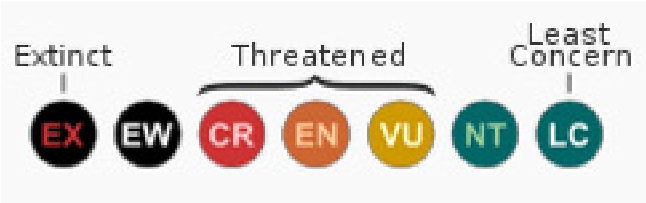
Species	life form	appears in nr of plots:
Broussonetia papyrifera	T	15
Chromolaena odorata	H	14
Antiaris toxicaria	T	9
Griffonia simplicifolia	L	9
Albizia zygia	T	7
Ceiba pentandra	T	7
Dioscorea minutiflora	L	7
Lecaniodiscus cupanoides	T	7
Pennisetum purpureum	G	7
Puallinia pinnata	L	7
Rutidea depuisii	L	7
Trichilia prieureana	T	7
Baphia nitida	T	6
Cleistopholis patens	T	6
Cordia millennii	T	6
Alchornea cardifolia	T	5
Ficus sur	T	5
Margaritaria discoidea	T	5
Adenia rumicifolia	L	4
Aframomum melegueta	S	4
Anansetromohoma	L	4
Blighia welwitschii	T	4
Cola gigantea	T	4
Dalbergia saxatilis	T	4
Ficus exasperata	T	4
Glyphaea brevis	T	4
Lannea welwitschii	T	4
Mareya micrantha	T	4
Massularia acuminata	T	4
Microdesmis keayana	T	4
Milletia zechiana	T	4
Rauvolfia vomitoria	T	4
Ricinodendron heudelotii	T	4
Rinorea oblongifolia	T	4
Spathodea campanulata	T	4
Sterculia tragacantha	T	4
Vernonia amygdalina	T	4
Alstonia boonei	T	3
Amphimas pterocarpoides	T	3
Carapa procera	T	3
Celtis mildbraedii	T	3
Hypselodelphys triangulare	S-R	3
Lonchocarpus sericeus	T	3
Mallotus oppositifolius	T	3

Marantochloa mannii	S-R	3
Morus mesozygia	T	3
Newbouldia faenis	T	3
Trema orientalis	T	3
Albizia ferrugunea	T	2
Bombax buonopozense	T	2
Funtumia africana	T	2
Kbese	T	2
Marattia fraxinea	FERN	2
Nesogordonia papaverifera	T	2
Newbouldia leavis	T	2
Olax subscorpioidea	T	2
Periploca nigrescens	L	2
Raphia palma-pinus	T	2
Imperata cylindrica	G	2
Terminalia superba	T	2
Triplochiton scleroxylon	T	2
Abrus canescens	L	1
Acacia kamerunensis	L	1
Acroceras zizanoides	G	1
Adankomilk	H	1
Aframomum spp.(Standfieldii-Zingebraceae)	R	1
Albizia adianthifoli	T	1
Ampelocissus gracilipes	L	1
Anansenkatie	H	1
Anchomanes difformis	L	1
Ansurogya	L	1
Anthonotha macrophylla	T	1
Asystasia acanthaceae	H	1
Asystasia spp.	H	1
Blighia sapida	T	1
Blighia sapida	T	1
Blighia unijagata	T	1
Brachiaria deflexa	G	1
Canarium schweinfurthii	T	1
Centrosema plumeri	L	1
Cercestis afzelii	H	1
Chassalia kolly	L	1
Chidlowia sanguinea	T	1
Christiana africana	T	1
Cissus aralioides	L	1
Cosonowede	T	1
Daniellia thurifera	T	1
Distemonanthus benthamianus	T	1
Dracaena perrottetii	T	1
Dracaene ovata	H	1
Eclipta prostrata	H	1
Erigeron floribundus	H	1
Fema	T	1

Hypselodelphis velutina	S-R	1
Khaya ivorensis	T	1
Laccosperma opacum	L	1
Landolphia micrantha	L	1
Lankesteria elegans	L	1
Loeseneriella apocynoides	L	1
Macaranga barteri	T	1
Mangifera indica	T	1
Mansonia altissima	T	1
Marantochloa congensis	S-R	1
Marsdenia magniflora	L	1
Momordica foetida	L	1
Musa Acuminata	S	1
Nyemekobere	T	1
Odenia rumicifolia	L	1
Osonowesamfee	T	1
Palisota hirsuta	R	1
Phaulopsis barteri	L	1
Piptadeniastriun africanum	T	1
Pouteria alnifolia	T	1
Pouteria altissima	T	1
Pterygota macrocarpa	T	1
Rhodognaphalon buonopozense	T	1
Rinorea afzelii	L	1
Rottboelia exaltata	G	1
Ruthalicia longipes	L	1
Salacia owabiensis	L	1
Sensam	S-R	1
Solanum torvum	L	1
Sope	T	1
Sterculia rhinopetala	T	1
Sterculia oblonga	T	1
Strombosia pustulata	T	1
Strophantus hispidus	T	1
Subaha	T	1
Tabernaemontana africana	T	1
Toantini	L	1
Trichilia monadelpha	T	1
Trilepisium madagascariense	T	1
Vernonia cinerea compositae	H	1

Table 5: Information on the frog species encountered

Table 5. Nineteen frog species were found in Asubima forest reserve in November 2010. Scientific names are shown and when present common name.
*Information on status is based upon the International Union for Conservation of Nature (IUCN). Current classification according to IUCN divides status in seven groups



EX= Extinct, EXW= Extinct in the wild, CR= Critically endangered, EN= Endangered, VU= Vulnerable, NT= Near threatened, LC= Least Concern.

** Information about Habitat was acquired through www.amphibiaweb.org

	Scientific name	Common name	Status *	Habitat**	nr indiv.
1	Afrixalus dorsalis	Striped Spiny Reed Frog	LC	Bushland	1
2	Amnirana albolabris	-	LC	unknown	1
3	warty Arthroleptis	-	-	unknown	1
4	Amietophrynus maculatus	Flat-backed Toad	LC	Savanna	7
5	Arthroleptis cf. poecilonotus	-	LC	Omnipresent	1
6	Arthroleptis spp.	-	-	unknown	1
7	Hoplobatrachus occipitalis	Crowned bullfrog	LC	Aquatic	2
8	Hyperolius concolor	-	LC	Bushland	1
9	Hyperolius fusciventris burtoni	-	LC	unknown	1
10	Hyperolius guttulatus	-	LC	Swamps in forest	1
11	Hyperolius nitidulus	-	LC	Savanna	1
12	Hyperolius picturatus;	-	LC	Forest	2
13	Kassina senegalensis;	Senegal kassina	LC	Savanna	1
14	Leptopelis spiritusnoctis;	-	LC	Forest	2
15	Phrynobatrachus calcaratus	-	LC	Omnipresent	46
16	Phrynobatrachus gutturosus;	-	LC	Omnipresent	21
17	Phrynobatrachus latifrons	-	LC	Omnipresent	16
18	Phrynobatrachus plicatus;	-	LC	unknown	1
19	Ptychadena aff. aequiplicata	-	LC	unknown	1

Table 6: Bird species found in Asubima FR.

Table 6. 77 bird species were found in Asubima F.R. in December 2010. Family, species name, common name and status as described in Sinclair and Ryan (2003) are displayed.

Family		Species	Common name	Status*
Accipitridae	1	Accipiter tachiro	African Goshawk	Common
	2	Elanus caeruleus	Black shouldered Kite	Common
	3	Kaupifalco monogrammicus	Lizard buzzard	Locally common resident, nomadic in drier areas
	4	Polyboroides typus	African Harrier Hawk	Fairly Common
Alcedinidae	5	Alcedo quadribrachys	Shining-blue Kingfisher	Common
	6	Ispidina picta	African pygmy Kingfisher	Common resident and intra-African migrant
Bucerotidae	7	Tockus fasciatus	African pied Hornbill	Common
	8	Tockus nasutus	African Grey Hornbill	Common
Cisticolidae	9	Camoroptera brachyura	Grey-backed Camaroptera	Common
	10	Cisticola cantans	Singing Cisticola	Common
	11	Cisticola juncidis	Zitting Cisticola	Common
	12	Cisticola lateralis	Whistling Cisticola	Common
	13	Cisticola melanurus	Short winged Cisticola	Locally common
	14	Cisticola robustus	Stout Cisticola	Common
Columbidae	15	Streptopelia decipiens	African Mourning Dove	Locally Common
	16	Streptopelia semitorquata	Red eyed Dove	Common
	17	Streptopelia vinacea	Vinaceous Dove	Common to abundant
	18	Treron calvus	African green Pigeon	Common subject to local movements
	19	Turtur afer	Blue-spotted Wood-dove	Fairly common resident, and local migrant in N.
	20	Turtur tympanistria	Tambourine Dove	Common
Coraciidae	21	Coracias cyanogaster	Blue-bellied Roller	Resident and intra African migrant, common in W. becoming increasingly scarce in E
	22	Eurystomus glaucurus	Broad-billed Roller	Locally common resident and intra African migrant
Corvidae	23	Corvus albus	Pied Crow	Common and widespread
Cuculidae	24	Centropus grillii	Black Coucal	Uncommon to locally common resident and intra-African migrant
	25	Centropus leucogaster	Black throated Coucal	Locally common, but secretive
	26	Centropus senegalensis	Senegal Coucal	Uncommon to locally common resident or partial migrant
	27	Chrysococcyx caprius	Diderick Cuckoo	Common resident and intra-African migrant
	28	Chrysococcyx klaas	Klaas's Cuckoo	Common resident and intra-African migrant
Dicruridae	29	Dicrurus adsimilis	Fork-tailed Drongo	Locally common, usually in pairs
Estrildidae	30	Estrilda melpoda	Orange cheeked Waxbill	Common
	31	Lagonostica larvata	Black face Firefinch	Nowhere common and thinly distributed
	32	Lagonostica rara	Black-bellied Firefinch	Locally common
	33	Pyrenestes ostrinus	Black bellied Seedcracker	Fairly common but easily overlooked
	34	Spermestes bicolor	Black and White Maniken	Common
	35	Spermestes cucullata	Bronze Mannikin	Abundant
Falconidae	36	Falco ardosiaceus	Grey Kestrel	Common
	37	Falco tinnunculus	Common Kestrel	Uncommon
Halcyonidae	38	Halcyon senegalensis	Woodland Kingfisher	Common resident and intra-African migrant
Indicatoridae	39	Indicator indicator	Greater Honeyguide	Scarce to locally common
Lybiidae	40	Lybius dubius	Bearded Barbet	Uncommon and localised

Megaluridae	41	*Bradypterus*	Warbler (un-idd)	
Meropidae	42	Merops albicollis	White-throated bee-eater	Common intra-African migrant
	43	Merops pusillus	Little bee-eater	Common
Monarchidae	44	Terpsiphone rufiventer	Red-bellied paradise flycatcher	Common
Motacillidae	45	Macronyx croceus	Yellow throated Longclaw	Common
Muscicapidae	46	Bradornis pallidus	Pale Flycatcher	Locally common
	47	Muscicapa adusta	African dusky Flycatcher	Common
	48	Muscicapa caerulescens	Ashy (blue-grey) Flycatcher	Common
	49	Muscicapa gambagae	Gambaga flycatcher	Uncommon and thinly distributed
Musophagidae	50	Crinifer piscator	Western Grey Plantain eater	Common
	51	Tauraco leucolophus	White crested Turaco	Locally common
	52	Touraco macrorhynchus	Verreaux's Turaco	Common
Nectariniidae	53	Anthreptes aurantium	Violet tailed sunbird	Locally common
	54	Antreptes longuemarei	Western violet backed Sunbird	Uncommon to locally common
	55	Cinnyris superbus	Superb Sunbird	Common
	56	Cinnyris venustus	Variable (yellow bellied) Sunbird	Common
	57	Cyanomitra olivacea	Olive Sunbird	Common
	58	Cyanomitra verticalis	Green headed sunbird	Common
	59	Nectarinia cyanolaema	Blue throated brown Sunbird	Common, active
Phasianidae	60	Peliperdix albogularis	White throated francolin	Uncommon to locally common
	61	Pternistis bicalcaratus	Double spurred Spurfowl (Francolin)	Common in drier areas of W-Africa
Phoeniculidae	62	Phoeniculus purpureus	Green-wood Hoopoe	Common
Picidae	63	Dendropicos fuscescenss	Cardinal Woodpecker	Common
Ploceidae	64	Anaplectes rubriceps	Red headed Weaver	Locally common
	65	Euplectes hordeaceus	Black winged bishop	Locally common
	66	Malimbus ibadanensis	Ibadan Malimbe	Endagered, uncommon to rare
	67	Malimbus scutatus	Red-vented Malimbe	Fairly common
	68	Ploceus cucllatus	Village weaver	Common
	69	Ploceus melanocephalus	Black headed Weaver	Locally common
	70	Quelea erythrops	Red headed Quelea	Locally common nomad and intra African migrant
Pycnonotidae	71	Pycnonotus barbatus	Common Bulbul	Abundant
	72	Thescelocichla leucopleura	Swamp palm Bulbul	Common
Sturnidae	73	Lamprotornis chalcurus	Bronze tailed glossy Starling	Locally common
	74	Lamprotornis splendidus	Spledid Glossy Starling	Locally common to abundant
Sylviidae	75	Sylvietta brachyura	Northern Crombec	Common
Sylvioidea	76	Hylia prasina	Green Hylia	Common
Viduidae	77	Vidua togoensis	Togo paradise Whydah	Uncommon and thinly distributed

Table 7: Information on the bird transects

Table 7. Transect number, distance of transect, number of birds found per transect, number of bird species found per transect and, time of sampling (M= morning, A= afternoon) are displayed.

transect nr.	disctance covered (m)	# observations	# spp found	time
1	1.670	41	15	M
2	985	41	11	A
3	940	36	17	A
4	970	97	26	M
5	815	34	26	A
6	1.170	37	17	M
7	815	145	26	A
8	1170	35	25	M
9	2600	59	26	A
10	880	47	18	M
11	1.490	115	19	A