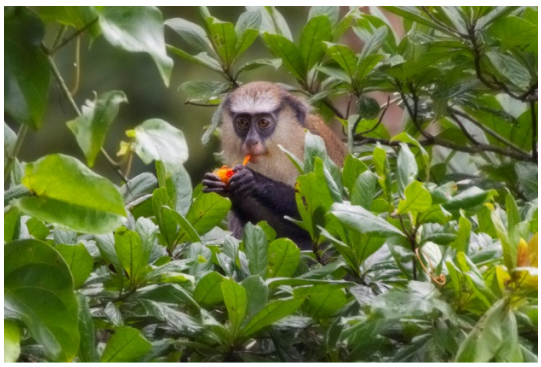
BIODIVERSITY MONITORING PLAN FOR THE GOLA REDD PROJECT

Dr Annika Hillers
Emma Tatum-Hume



1. Overview of the biodiversity monitoring plan

The biodiversity goals of the project are focused around maintaining and where possible improving forest cover and condition through out the project zone in order to maintain or increase habitat availability and connectivity for high conservation value forest dependent species. As described in the project document (See CCB PD G1.7 and G1.8), the project zone meets 3 of the criteria for high biodiversity conservation value at the species, ecosystem and landscape scales[1].

The biodiversity monitoring plan therefore has been devised to monitor the progress of the project in maintaining and improving the conservation value of the project zone at the species, ecosystem and landscape scale and project activities are designed to create positive biodiversity impacts against the without project scenario (see CCB PD B1). The overall impacts will be measured at two levels; the species level and the ecosystem and landscape level. The outputs and outcomes will be measured through progress at implementing project activities which in the long term will reflect in benefits for biodiversity.

The selection of indicators for monitoring the outputs-outcomes and impacts of the project followed a theory of change approach, using a causal model to predict the changes attributable to the project and thereby the most relevant indicators for monitoring progress (see theory of change diagram below). Given the species richness of the area, for some aspects of monitoring certain species have been chosen as indicators of overall biodiversity wellbeing, the indicators were selected as they reflect the overall health of the habitat or area of monitoring interest based on many years of prior conservation assessment (e.g. Klop et al 2008, Hillers 2013).

All field activities will be carried out by the research team who have many years of experience in collecting a wide range of biodiversity variables (see CCB PD G4.2) and work will be supervised by a conservation scientist.

[1] The monitoring of other HCV can be found in the social monitoring plan for the CCB

2. The theory of change

The monitoring plan has been developed following guidance from the CCBA Social and Biodiversity Impact Assessment Manual for REDD+ Projects (Richards & Panfil, 2011), which recommends the *theory of change* approach as an appropriate and cost-effective impact assessment approach for biodiversity monitoring of REDD+ projects. The 'theory of change' can be defined as "a theory-based evaluation tool that maps out the logical sequence of means-end linkages underlying a project and thereby makes explicit the expected results of the project and the actions or strategies that will lead to the achievement of results"[2].

The theory of change approach allows project developers to identify causal chains from project activities, to short-term outputs, from outputs to outcomes, and from outcomes to impacts through applying anticipated cause-and-effect sequences. This can be achieved through the monitoring of tangible outcomes to demonstrate that the causal chain is being followed, which in turn can provide confidence that the impacts will be achieved.

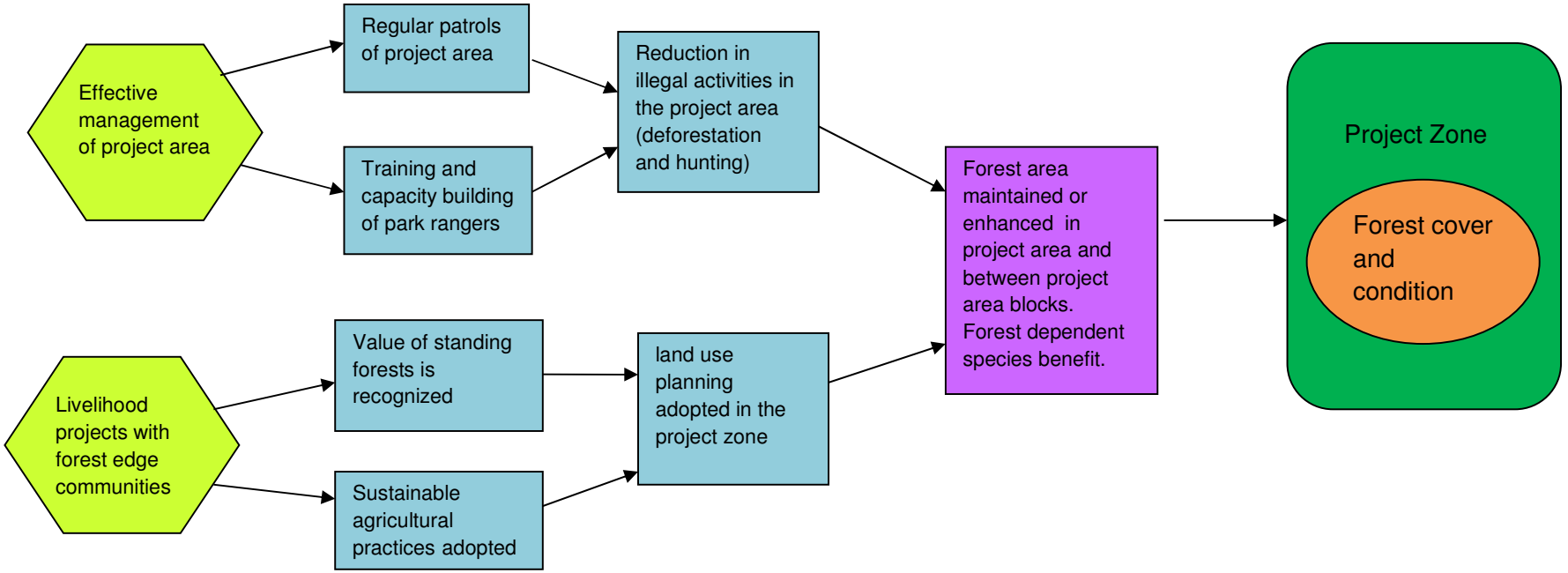
Figure 1. Causal chains underlying the theory of change

The overall impact of the project on biodiversity is intricately linked to the management and community livelihood activities of the project. The activities that will result in impacts on biodiversity are management and community related activities from the operational work of the forest rangers to the implementation of the community livelihoods programme (see activity results chain, figure 2,). The implementation of park operations and the monitoring of output and outcome indicators is outlined in section 3 (a) and in the SOPs for GRNP Park Operations (currently under development). The monitoring of the activities of the community livelihoods programme is outlined in section 3b and in the output and outcome monitoring for the Gola REDD project.

. Biodiversity impacts will be measured at the landscape level and at the species level following methodologies based on best scientific practice and implemented following standardized protocols.

[2] GEF Evaluation Office and Conservation Development Centre 2009

Figure 2 – overview of the theory of change activity results chain



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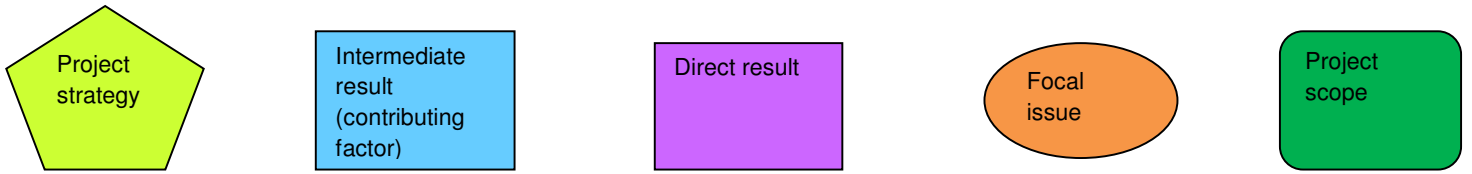

3. Monitoring Approach

a. Monitoring outputs and outcomes via Park Operation activities

Activity: Management of Project Area

Activity Overview: Activity to be implemented throughout the project to work towards meeting objective 1 (of Goal 1) - to protect the integrity of the GRNP.

The methods for collecting, processing, and reporting on Park Operations data are detailed in the SOP for GRNP Park Operations (currently under development).

Output Indicators

Output Indicator	Sampling Type/Product	Timing/Frequency
Number of Ranger patrols carried out	Reports generated using SMART™ software	Reports generated quarterly and prior to each validation event, on-going throughout the project
Distance (km) patrolled by Ranger patrol teams	Reports generated using SMART™ software	Reports generated quarterly and prior to each validation event, on-going throughout the project
Proportion of the project area covered by Ranger patrols (measured as the proportion of 1km UTM grid-squares visited by at least one Patrol)	Reports generated using SMART™ software	Reports generated quarterly and prior to each validation event, on-going throughout the project
Capacity building of forest Rangers	Employees training register	Refresher training annually and specialist training as required throughout the project.
Distance (km) of project area boundary re-brushed by boundary officer teams.	Boundary demarcation reports.	Reports delivered quarterly, on-going throughout the project
Number of concrete pillars erected along project area boundary	Boundary demarcation reports.	Reports delivered quarterly, during first 10 years of project
Number of *Heritaria sp.* seedlings planted on rehabilitated mining sites	Park Operations departmental reports	Reports delivered quarterly, during first 5 years of project

Outcome Indicators

Outcome Indicator	Sampling Type/Product	Timing/Frequency
Decrease in frequency of observations of illegal activity within project area	Reports generated using SMART™ software	Reports generated pre-validation, on-going throughout the project
Integrity of project boundaries maintained	Park Operations departmental reports	Reports delivered quarterly, on-going throughout the project
Carbon stocks increase in project area	Plot re-measurement surveys	Prior to each verification

B .Monitoring of outputs and outcomes via community development activities

Activity; Implementation of livelihood projects and other activities with forest edge communities (which is part of goal 2 of the Gola REDD project; sustainable natural resource management through out the project zone)

Through farmer capacity building in sustainable agriculture the activities of goal 2 aim to increase the yield of a variety of crops that are important for food security and income on existing crop-fallow lands thereby reducing deforestation pressures. Environmental awareness raising and land use planning activities will complement the livelihood activities to work towards empowering local communities to sustainably manage their natural resources.

The activities of goal 2 are detailed in the SIA synthesis report, and sections G3 and CM1.1, of the CCB project document, the methods for monitoring the activities of goal 2 are described in 'Output and Outcome monitoring of the Gola REDD project'. A subset of indicators that are being monitored for goal 2 have been selected to also serve as indicators of progress towards achieving positive biodiversity impacts following the theory of change logic in figure 2. The selected output and outcome indicators are shown below and in annex 1.

Output indicators

Output Indicator (and corresponding # in O&O monitoring document)	Sampling Type/Product	Timing/Frequency
# of environmental roadshows given (#61 and 62 in output and outcome monitoring for the Gola REDD project)		
# of nature clubs set up (#63 in output and outcome monitoring for		

the Gola REDD project)		
# of species specific awareness raising events carried out (monitored by the Research team)		
# of land use planning initiatives begun in community land (#49 in output and outcome monitoring for the Gola REDD project)		

Outcome indicators

Outcome Indicator (and corresponding # in O&O monitoring document)	Sampling Type/Product	Timing/Frequency
areas of forest with HCV set aside for conservation/low impact use (#52 and/or 48 in output and outcome monitoring for the Gola REDD project)		
Knowledge of forest and species values increased (#57 and 65 in output and outcome monitoring for the Gola REDD project and attitudes module in the longitudinal survey)		
# of communities adopting by-laws that include biodiversity elements (#51 in output and outcome monitoring for the Gola REDD project)		

c. Monitoring Impacts

Ecosystem and Landscape scale

The project will monitor changes in forest cover and condition as a result of project activities through out the project zone through the interpretation of satellite imagery and through ground work that monitors degradation and threats to biodiversity. A two-pronged approach will be used as remote sensing methods alone may not pick up on the finer spatial scale activities caused by degradation. Forest cover changes will be monitored through the interpretation of satellite imagery. The project will follow VCS methodologies and the approach is outlined in the VCS PD and in the baseline and monitoring reports (as well as briefly below in the methodology section 1). Threats to the condition of the forest will be monitored through the analysis of threat surveys that are completed by the forest rangers as they carry out their patrolling activities. The threat surveys collect data on a range of variables from visible signs of forest degradation such as tree stumps to freshly cut trails, encounters of gun cartridges, snares or mining pits.

Species scale

Species have long been used as indicators of the health of a habitat. Species that are particularly susceptible to environmental or human disturbance, are present in the area at the beginning of the project activities and are relatively easy to encounter are those that make the most suitable indicators to monitor project attributable changes. The taxa, species and methodologies selected to monitor changes in the different habitats of the project reflect nearly 25 years of conservation research in the area carried out by the project partners. We have chosen a diversity of species and taxa in order to provide a broad understanding of the impact of the project on biodiversity. For example as different species will manifest changes at different rates, some species may change in distribution and abundance faster than others and may act as indicators of the beginnings of an uphill or downhill trend, this is especially true of the large bushmeat species such as Chimpanzees and pygmy hippos or those that are sensitive to disturbance such as the White necked Picathartes. Other species occupy different habitats within the forest and so by choosing a range of species we can monitor the impacts across the wider landscape e.g. pygmy hippos tend to be found along the forested margins of streams and rivers whilst Chimpanzees are found in undisturbed areas of near primary forest. As it is vital for the project management team to understand whether the operational and livelihood activities being implemented are having the desired biodiversity impacts, monitoring a wide range of species that provide indications of impact for different forest habitats or timescales are very useful and will enable management to adapt actions as appropriate.

Methodologies to measure longitudinal change in population status and range through out the project zone are based on best scientific practice and follow standardised protocols for data collection and analysis. Methodologies include bird surveys and point counts, camera trap surveys, mammal transects and nest surveys and are detailed in the methodology section.

Negative impacts

The project zone is of high conservation value as it contains a large and relatively well preserved example of Upper Guinean tropical forest containing a high diversity of HCV forest dependent species. As the project's main objective is to prevent the deforestation and degradation of this forest in the project area and wider project zone it is not anticipated that the project will have any negative impacts on biodiversity that specifically require monitoring. However it should be noted that the monitoring activities that are planned through out the project zone will capture any negative changes as well as positive impacts as changes in population status.

Beyond the project zone in the offsite zone, forest areas are patchy and degraded and do not contain the same level of biodiversity and high conservation value species that are found in the project zone, impacts to biodiversity in this area are therefore anticipated to be minimal. None-the-less as a result of project activities in the project zone, biodiversity may be affected by hunting displacement and so the project has a number of activities planned to raise environmental awareness and the provision of funds for communities to engage in sustainable development activities in the offsite

zone and the results of this and the impact on biodiversity will be monitored through PRA as well as species specific monitoring (see table 1 and outline of methodologies section).

High Conservation Values

As the project zone, and the project area in particular is a biodiversity hotspot and meets HCV1-3, indicators to monitor the effectiveness of measures to maintain or enhance HCV biodiversity are a central component of the biodiversity monitoring plan (see table 2).

Table 1: Identification of species indicators

Species	Group	Justification	Methodology
All terrestrial bird and mammal species, in particular HCV species including Western Chimpanzee Sooty Mangabey Jentinks Duiker Zebra Duiker Pygmy hippopotamus Forest elephant White breasted Guineafowl	Birds and Mammals	These species are all HCV species and are all forest dependent species. The presence/absence and abundance of these species will provide a measure of the pressure that biodiversity and the forest is under and monitor the success of protection efforts	Camera traps through out the project zone following a grid based methodology (see methodology 3)
Western red Colobus Western pied Colobus Diana monkey	Primates	These monkeys are not only indicators for the status of the forest habitat and for the pressure from hunting. They are also very important seed dispersers thus playing an important role in forest ecology. Furthermore, they are a diverse group with some species being dependent on relatively undisturbed forest, making them valuable indicators of forest conditions.	Primate surveys in the project area following line transect methodologies (see methodology 4)
Western Chimpanzee	Primate	This is an endangered species (HCV) under pressure from hunting and requiring large areas of suitable habitat. It is a good indicator of forest quality and disturbance	Line transect Nest surveys through out the project zone (see methodology 5)
Pygmy Hippopotamus	Mammal	This is an endangered species under threat from habitat loss and hunting. It is an indicator of disturbance and hunting pressure	Surveys, camera traps and dung sampling through out project zone and in offsite zone (see methodology 6)
White-necked Picathartes	Bird	Endemic and vulnerable species (HCV). Indicator of disturbance and changes to habitat.	Nest surveys in the project zone and offsite zone (see methodology 7)
Tai toad and other species	Amphibian	Amphibians are widely recognized as excellent indicators of the health status of a forest habitat and the Tai toad is an HCV species and therefore important to monitor	Plot sampling through out the project zone (see methodology 8)

Table 2 Monitoring summary for HCV components of the Gola REDD project

HCV criteria	Parameter to be measured	Variable	Monitoring activities and measurement frequency	Indicators	Target
HCV 1 Globally, regionally or nationally significant concentrations of biodiversity values - threatened and endemic species	1. Species composition	1. Diversity of forest dependent bird community	Bird point counts (every 4-5 years, see methodology 7)	Abundance and diversity of species encountered	Stable or increasing populations, stable or increasing species distribution, decreasing threat encounter rate
	2. Population structure of species	2. a. Distribution of key species 2.b Abundance of key species	Camera traps, transect and plots surveys, nest surveys (every 1-5 years, see methodologies 3,4,5,6,8,9)	Abundance and diversity of species encountered	
	3. Species threat	3. Threat encounters	Threat encounter surveys (ongoing, monitored by the Operations team)	Number of cartridges and snares found in project area	
HCV 2 Globally, regionally, nationally significant large landscape –level areas where viable populations of natural populations occur in natural distribution and abundance	Ecosystem condition	Diversity and distribution of forest dependent bids and mammals	Camera traps, bird point counts, primate surveys (every 2-5 years, see methodologies 4,7)	Abundance and distribution of species encountered (reflecting the health of the forest)	Stable or increasing populations, stable or increasing distribution of species
HCV 3 Threatened or rare ecosystems	Ecosystem integrity	1. Forest cover 2. Forest enhancement	1. Interpretation of satellite images (before every verification event, see methodology 1) 2. Vegetation surveys (before every verification event, see methodology 2)	Change in forest cover and connectivity between forest blocks of the project area Changes in above ground	Forest cover maintained or increases within and between blocks of the project area and trees are growing to full potential

				biomass	

Methodologies

An overview of the methodologies that will be applied to gather the necessary data for monitoring biodiversity impact is found in the following section, with a summary provided in table 3. The standard operating procedures for each methodology are currently under development.

Table 3; Summary of methodologies; the parameters they monitor, the area they monitor and the frequency

Methodology	**Parameter**	**Area**	**Frequency**
1. Remote sensing	Changes in forest cover	Project zone and offsite zone	Before every verification event (approx every 3-5 years)
2. Carbon stock enhancement	Changes in quality of forest habitat	Project area	Before every verification event (approx every 3-5 years
3. Camera trapping	Changes in species distribution	Project zone	Every 2 years
4. Primate survey	Changes in abundance of forest dependent species	Project area	Every 5 years
5. Chimpanzee survey	Changes in quality of forest habitat and pressure on bush meat species	Project zone and offsite zone	Every 5 years
6. Pygmy hippo surveys	Changes in quality of forest habitat and pressure on bush meat species	Project zone and offsite zone	Every 3 years
7. Bird point counts	Changes in the health (quality) of forest habitat	Project zone	Every 4-5 years
8. Picathartes monitoring	Changes in the health (quality) of forest habitat and level of disturbance	Project zone and offsite zone	Annually
9. Amphibian surveys	Quality of forest habitat	Project zone	Every 2-3 years

1. Remote Sensing

Expected Outputs; Land cover maps of forest – non-forest in PA and LB

Justification; In order to monitor changes in forest cover compared to the baseline the Gola REDD project following SOPs developed for the baseline map, will analyze satellite images of the project area and leakage belt for landcover changes (Forest, Non-Forest).

Location: Project zone and offsite zone (Project area, leakage belt and wider Chiefdoms)

Implementation; Standard operating procedures

Methodology; See Carbon monitoring plan and Mitchard et al 2011, Mitchard 2012

Frequency/Timeframe: Before every verification (approximately every 3 years)

Previous work in GRNP: See Mitchard 2012

2. Carbon stock enhancement

Expected Outputs; Data on the above ground biomass stored in the Southern block of the project area.

Justification; See Carbon baseline synthesis report (Tatum-Hume et al 2013b)

Location: Gola South (GRNP)

Implementation; Standard operating procedures (Winrock 2012)

Methodology; see Carbon baseline synthesis report and carbon monitoring plan (Tatum-Hume et al 2013b and Winrock 2013). (The same subset of plots that provided the baseline carbon stock data for Gola South will be revisited and carbon stocks will be measured following the same SOPs as for the baseline.)

Frequency/Timeframe: Before every verification (approximately every 3 years)

Previous work in GRNP: See Tatum-Hume et al 2013b; Carbon Synthesis report.

3. Camera trapping

Expected outputs: The camera trapping study will give important information on the distribution of terrestrial mammals and birds in GRNP and the leakage belt. In combination with collected habitat data, the camera trap data will allow to get a better insight into single species' ecology, e.g. concerning habitat preference and activity patterns. Furthermore, this information will help to identify high priority conservation areas, based on the presence and abundance of HCV. These data will also allow for observation in changes of distribution and abundance over long term. Furthermore, the distribution data for those species for which enough data are collected (e.g. species with an acceptable capture rate) can be used in order to generate species occurrence models.

Justification: The use of remote triggered photographic camera units or 'camera trapping' to record the presence of animals has already proven to be an invaluable tool in conservation research. Indeed, it has been largely demonstrated over the last decade that camera-trapping is an appropriate method for mammal inventory in all environmental conditions, allowing a rapid assessment of wildlife conservation status (Silveira et al. 2003). The method is also efficient for inventories of cryptic animals, as well as for population studies of species for which individuals can be individually recognized by marks (Karanth, 1995; Carbone et al., 2001). The advantages of camera-trapping when compared to traditional census techniques (e.g. distance sampling) are in fact numerous: round the clock monitoring, non-invasive tool, etc. In the Gola context, camera traps will be (and have already proven to be) an invaluable tool for the monitoring of HCV species such as chimpanzee, sooty mangabey, different duiker species (e.g. Jentink's and Zebra duikers), pygmy hippopotamus, forest elephant, and White breasted guineafowl. Many of these species are very elusive and it is very difficult to record them using other common survey techniques such as transect sampling.

Location: Project zone (GRNP and leakage belt)

Implementation: Standard Operating Procedure

Methodology: Between 12 and 20 camera traps will be deployed over a period of at least 30 days in selected locations for a period of six to eight months per year, in a two years interval. The basic layout will follow a 1 km^2-plot grid that has been used for camera trap deployment for previous camera trapping work in and around GRNP. Camera traps will be deployed in every second plot, unless specific habitat features require better coverage. The deployment of cameras will happen in the center of selected plots in the project zone. The coordinates of the plot center will be given to the responsible Research Technician before each deployment. GPS units and compasses will be used for the navigation to the target location. At the target location, the camera will be deployed following a detailed camera trap deployment protocol, e.g. concerning the selection of the tree where the camera will be attached, and the camera direction. Such a protocol also will be followed when the cameras are collected and redeployed, alongside with the habitat data collection. The latter was also established throughout previous camera trap surveys. At the beginning and end of each deployment, start and end pictures will be taken giving information on the date, time, location, camera number and team members, giving better control on the deployment process.

Previous work in GRNP:

Since 2008, camera traps in the Gola Forests have documented high mammal diversity and also recorded numerous bird species, as well species not recorded throughout other survey types and partly showing large range extensions (e.g. giant pangolin and honey badger). From 2008 to 2009 a baseline study was conducted using a 5x5 km grid, while from 2010 to 2013 a 1x1 km grid design was established. During the latter study, 270 camera trap deployments with more than 60,000 photographs gave invaluable insights into the presence and distribution of some rare and cryptic HCV species, such as Jentink's and Zebra duiker, pygmy hippo and white-breasted Guineafowl.

4. Primate survey:

Expected outputs: The primate survey inside GRNP will enable the project to follow the changes in the distribution and abundance of primates in the project area over the projects lifetime. The primates at Gola include several HCV species, such as western red Colobus, western pied Colobus, and Diana monkeys.

Location: Inside GRNP (project area)

Justification: Primate species in GRNP include several HCV species such as western red Colobus, western pied Colobus, and Diana monkey. These monkeys are not only indicators for the status of the forest habitat and for the pressure from hunting. They are also very important seed dispersers thus playing an important role in forest ecology. Furthermore, they are a diverse group with some species being dependent on relatively undisturbed forest, making them valuable indicators of forest conditions. Primate densities are some of the best known for all mammals in the Afrotropical forest, so provide a valuable way to compare forests.

Implementation: Standard Operating Procedure

Methodology: The chosen method is Distance Sampling along line transects which is considered the best and most widely accepted survey technique for forest monkeys (Plumptre 2000). Observers walk slowly along predefined transect lines and record all monkey groups encountered. For each group, the species, number of individuals and perpendicular distance to the transect line is recorded. The assumptions of this method are that i) monkeys directly on (or over) the transect line are detected with certainty, ii) distances are measured to the monkeys' initial locations prior to any movement caused by disturbance from observers, and iii) distances are measured accurately.

Sixty-four transects with a maximum transect length of 4 km totaling 174 km exist inside GRNP. They are arranged in a systematic segmented grid sampling layout designed in the software DISTANCE (Thomas et al. 2010). Transects were truncated where they met the forest boundary so some were less than 4 km. Future monkey resurveys should use these existing transects as much as possible which however will be shifted by 50 m to the side and will be straightened in order to avoid interference with tree plots and to have straight transects from North to South and with a strict orientation of transects on a West-East baseline.

Transects should be cleaned two weeks in advance of a survey but must not be cut widely (only enough space for team members to move through is necessary).

Surveys should take place between 7:00-11:00 am to ensure optimum monkey detections.

Frequency/Timeframe: Every 5 years

Previous work in GRNP:
The first primate survey in Gola was undertaken in the late 1980s (Davies 1987). This estimated primate densities using plot-based sweep sampling methods. A subsequent estimate of monkey densities based on

distance sampling along line transects in Gola forest was undertaken by the Gola Forest Programme in 2006 (Klop *et al.* 2008) and in 2011. The 2006 survey provides a baseline for following monitoring activities.

5. Chimpanzee survey:

Expected outputs:

1) Density estimates.
2) Distribution data.
3) Population trend over time.
4) Impact of human disturbance

Justification: The western chimpanzee is an Endangered species with a declining population and hence a high priority for conservation (Brncic et al. 2010). It requires large areas of suitable habitat to persist but besides habitat loss it is also persecuted for its perceived role in crop raiding, hunted for bushmeat and taken for the pet trade and medical research. Despite a high profile protected status in Sierra Leone, there continues to be substantial illegal activity with respect to chimpanzees. The most recent status survey and conservation action plan for western chimpanzees in Sierra Leone (Hanson-Alp et al. 2003; Brncic et al. 2010) identifies the GRNP as a priority site for the species. Methods for surveying chimpanzees are well developed, so it is one of the few large forest mammals for which reliable population density trend data can be collected. A recent survey of chimps in the Gola area (Ganas 2009) found a relatively large number in community forests adjacent to Gola Forest. It is therefore important to include community areas in the monitoring plan for this species.

Location: Project area (GRNP and leakage belt), parts of offsite zone

Implementation: Standard Operating Procedure

Methodology: Line transect surveys of chimpanzee nests are a widely practiced standard for surveying the species which is otherwise hard to approach in unhabituated populations. The field methods are easily taught to novice surveyors and do not require specialist skills that may take months to acquire. Identification of nests is relatively straightforward.

The used method is a standing crop count which is suitable for areas with lower nest encounter rates. It requires a separate estimate of nest decay rate which however is provided for GRNP and surroundings by Ganas (2009). Transects are usually 2 km long and are only cut to the extent that is necessary in order to walk through the vegetation. This allows for this method to be used also in the leakage belt (and the offsite zone) without creating conflict with communities and landowners (which might be the case when cutting permanent transects like for the primate survey). Furthermore, alongside the search for chimpanzee nests, data on other HCV species can be collected by looking for footprints, dung and other signs along transects. The same is true for signs of threat. These signs of human activity include logging, cartridge shells, gunshots, snares and traps, hunting camps, farming and mining. These are routinely recorded by GRNP staff but signs encountered on the chimpanzee transects should be recorded separately too.

Evidence of human activity in the forest should be recorded on the data sheet with GPS coordinates, the distance in meters along the transect, type of disturbance, and count where applicable (e.g. cartridge shells).

The transect survey design will be the same as in Ganas (2009), which however will be extended to all areas of the leakage belt. The previous survey is based on 104 transects of 2 km length each, except from those

transects stopping at the Liberian border and therefore being shorter. Transects are laid out in a systematic segmented grid sampling design using the software DISTANCE (Thomas et al. 2010).

Frequency/Timeframe: Every 5 years

Previous work in GRNP:
GRNP conducted a chimpanzee survey in 2009 (Ganas 2009) to obtain a baseline estimate of the distribution and abundance of chimpanzees throughout Gola forest and some selected community forests near the Reserve. The density was 0.27 chimpanzees/km^2 (CV=20.6), with a total population estimate of 305 individuals. In the framework of a recent national Chimpanzee survey (Brncic et al. 2010), more accurate data were collected on nest duration rates throughout the country, allowing a re-analysis of the Gola dataset and yielding a new density estimate of 0.25 chimpanzees/km^2 corresponding to a total population of 270 individuals (95%CI: 159-468; CV=27.9).

6. Pygmy hippo survey:

Expected outputs:

1) Detailed distribution data for pygmy hippos in and around GRNP.
2) Increased knowledge on population size of pygmy hippos in and around GRNP.
3) Observation of potential population changes in and around GRNP.
4) Increased knowledge on habitat use/requirements of pygmy hippos.

Justification: The pygmy hippopotamus (or pygmy hippo, *Choeropsis liberiensis*) is an Endangered species found only in four countries of the Upper Guinea region of West Africa (Sierra Leone, Liberia, Guinea, Côte d'Ivoire). Estimates from >15 years ago suggest there may be less than 3000 individuals remaining in the wild, although these estimates are likely high. Faced with threats from logging, farming, hunting, and clearing for settlements, the population is expected to decrease by at least 20% over the next 20 years (Lewison & Oliver 2008).

To date, very little is known about the ecology and behaviour of pygmy hippos. It is a secretive, nocturnal mammal that lives either singly or in pairs (mothers and calves). It tends to spend the day hidden in swamps, wallows or rivers and sometimes in hollows under the banks of streams. It favours heavily forested regions, but it is dependent on water and usually remains close to streams (Lewison & Oliver 2008)

In Sierra Leone, pre-war estimates approximated (a very general estimate) between 80-100 animals in the country, more recent estimates are a bit higher (Mallon et al. 2011), citing the Gola Forests as the last main refuge for these animals in the country. Therefore, monitoring pygmy hippo populations in GRNP is of utmost priority for the GRNP to ensure that the pygmy hippo does not disappear from Sierra Leone. In the Gola area, pygmy hippos seem to be more abundant in community forest areas and swamps close to bigger streams than inside GRNP (Ganas 2008, Hillers & Muana 2011). In the light of current and future agricultural activities, including inland valley swamp farming, it therefore is absolutely important to use knowledge on pygmy hippo distribution and abundance for land use planning, in order to avoid conflicts between important pygmy hippo habitats and agricultural activities of communities.

Location: Project area (GRNP and leakage belt), parts of offsite zone along big streams

Implementation: Standard Operating Procedure

Methodology:

Presently, there are no established methods for surveying/monitoring pygmy hippos. In the past, including around GRNP, researchers relied on community reports, indirect evidence, or visual sightings of the animals, using non-systematic methods. In and around GRNP recce transects that follow river and stream courses have been employed as the primary survey method. Since it is fairly established that pygmy hippos are tied to water, it is reasonable to think that following these areas to document signs of their presence is the best method currently available. The advantage of this method is that more than one location can be verified as containing hippos as observers can search the general area for signs. The disadvantage of this method is that observers are typically present in the area only over a few days at a time over the year. However, GRNP is starting to develop and test a standardized survey design surveying 200 m strips along streams in 200 m intervals.

Also camera traps will be used in order to study the distribution of pygmy hippos and defining their population size, assuming that individual pygmy hippos can be distinguished on cameras. Camera trap pictures might also give information on the sex and age class of the animal, and frequency of use of the area.

Frequency/Timeframe: Every three years

Previous work in GRNP:

In 2008/2009, a first baseline survey was done in and around GRNP for the presence of pygmy hippos, primarily based on reports from the local population. During this baseline survey eight general regions in the Gola area were identified as used pygmy hippo habitats. More extensive surveys from 2010 to 2011 done under the “Across the River –a transboundary Peace Park for Sierra Leone and Liberia” project showed a wider distribution of pygmy hippos, especially along bigger streams (Moa, Moro, Mano) in the community areas around GRNP.

Based on the first survey a map of the potential distribution of pygmy hippos was compiled using modeling with Maxent. Further surveys will verify the presence or absence of pygmy hippos compared to this map of potential distribution based on suitable habitats. No standardized survey techniques or conservation genetics were used in the early surveys, but current survey works that started in May 2013 are developing and testing a standardized design and samples for conservation genetic analyses are being analyzed.

7. Bird point counts:

Expected outputs:

1. Extent of occurrence of a wide range of birds throughout GRNP and leakage belt
2. An index of abundance derived from repeatable methods for a wide range of birds
3. With successive surveys, a trend reflecting population status of birds in GRNP and leakage belt.
4. Bird community composition data for analysis with habitat data and for assessment over time (habitat changes will result in changes in composition of bird communities)

Justification

GRNP and its surroundings (including Tiwai Island) were shown to harbor a rich bird community (326 species; Demey 2011), including many forest specialists of the Upper Guinea Forest region and 11 threatened as well

as numerous Near Threatened species. The global population sizes of these species are poorly known and the population trajectories less so, though declining numbers are inferred for most of them as a result of ongoing forest loss. Understanding the size and status of the population being protected by GRNP as well in the leakage belt is important when assessing the global status of these species. Furthermore changes in forest bird populations are largely driven by the extent and quality of forest habitat (though hunting may be important for guineafowl and hornbills). Thus changes in the bird community will reflect changes in their forest habitat which will be especially important with regard to potential forest cover changes in the leakage belt. Processes acting at a larger scale, such as climate change, may also be having an impact, but these are poorly understood.

Location: Project zone (GRNP and leakage belt)

Implementation: Standard Operating Procedure

Methodology: Systematic surveys across wide areas using line transects or point counts are a widely used method for tracking trends in bird populations over time since they provide representative data for the whole site in question and provide suitable data for making comparisons between areas and against a range of covariates. Point counts are preferred in situations where data collecting whilst moving through the habitat along transects might be compromised by the difficulty of traversing the terrain. It is also easier to relate point count observations to environmental data collected at the same locations.

Frequency/Timeframe: Every 4-5 years

Previous work in GRNP
A number of bird surveys have been undertaken in and around GRNP in the past (e.g. Klop et al. 2008, Demey 2011), mostly concentrating on compiling species lists or with a focus on a particular species, such as Gola Malimbe and White-necked Picathartes. Also point counts were undertaken (Klop et al. 2008).

8. *Picathartes* monitoring:

Expected outputs:

1. Accurate estimate of the White-necked *Picathartes* population size in the Gola area.
2. Trends in colony status including comparison of protected and unprotected colonies.
3. Assessment of threats to existing colonies.
4. Trends in breeding parameters from focal colonies.

Justification: The White-necked Picathartes (*Picathartes gymnocephalus)* is a restricted-range species endemic to Upper Guinea rainforests. Its distribution is highly fragmented with small, scattered populations in five West African countries: Guinea, Sierra Leone, Liberia, Ivory Coast, and Ghana (BirdLife International 2009). The global population size is estimated at less than 10,000 individuals, which, together with the rapid degradation of Guinean rainforests, classifies the species as Vulnerable under IUCN/BirdLife threat criteria (BirdLife International 2009). An International Species Action Plan was developed in 2004 in order to address some of the key threats to the species and with a vision to improve its conservation status from “Vulnerable” to “Near-Threatened” by 2014 (Thompson et al. 2004). In particular, the Action Plan aims to stabilize or increase White-necked Picathartes populations at strongholds. Hence, because GRNP is known as a stronghold for this

species in Sierra Leone and West Africa, efforts should be made to ensure the long-term viability of the Gola Forest population. The White-necked Picathartes is monitored on a yearly basis since 2009 in and around GRNP. Most of the 70 currently known Gola colonies are not inside GRNP, but outside in the leakage belt and some even in the offsite zone. Previous surveys showed that colonies inside GRNP are often smaller than outside GRNP, but are more stable, while the colonies in the community areas are often threatened especially by agricultural activities. It is thus of utmost importance to include data on White-necked Picathartes in future land-use planning for agriculture in order to avoid conflicts between important Picathartes habitats and agriculture.

Location: Project area (GRNP and leakage belt), parts of offsite zone

Implementation: Standard Operating Procedure

Methodology: The White-necked Picathartes breeds mainly in small colonies on rock-faces, under a forest canopy. The species is shy and silent, hence breeding sites are often difficult to find. Since 2006, the set of colony sites monitored by GRNP was established on the basis of information gathered both during previous surveys (Allport et al. 1989; Thompson 1997) and interviews conducted in local villages around GRNP. Monitoring is based on nest data collection at colony sites located within and around GRNP. Currently, about 70 colonies are known inside and around GRNP. These are monitored on a yearly basis during the peak breeding period, lasting from October to January. To monitor the population status, each colony is visited once during this period by a team of two research technicians. Each visit to an active rock-face should not exceed 45 min. to minimize disturbance.

During this visit, active and inactive nests are counted (also those under construction). A sketch of the rock face is done with all nests, the slope of the rock is measured and the distance of nests from each other and from the ground. Furthermore, the number of eggs, chicks and adults is counted as well as some habitats parameters, including observations of human activities which might threaten the persistence of colonies (and have been shown to often cause abandonment of colonies).

In addition to the yearly monitoring work, which should include also surveys at abandoned next sites for at least three years after they were found to be abandoned, it is important to enquire from communities about new colonies and to also check on known rocks inside GRNP in case new colonies are founded on these rocks. The search for new colonies can also be done based on maps created through predictive range mapping.

Frequency/Timeframe: Yearly, for four months (October-January)

Previous work in GRNP:
In Sierra Leone, active colonies are currently known from at least six forest reserves with an overall population estimated at 1,080 individuals in 1990-1994 (Thompson 1997). Largest numbers are recorded in the Kambui Hills (158km^2) and in the Gola Forest (748km^2) (Thompson 1997). Based on Allport et al. (1989) and on his own notes, Thompson (1997) estimated in 1994 that the Gola Forest alone supported a minimum of 152 active nests (36 active colonies) with a breeding population of ca. 300 individuals (assuming that each nest was occupied by a pair), which is one of the largest remaining concentrations of White-necked Picathartes in West Africa (Thompson 1997). The most recent census data collected in and around GRNP from 2006 to 2010 found 40 active colony sites, with a maximum of 158 active nests (Monticelli et al. 2011). During the most recent Picathartes surveys, the number of known colonies increased further, and during the last breeding

season 2012/2013 70 colonies were visited, however, some if them being abandoned. Despite increasing survey effort in recent years, it is likely that more White-necked Picathartes colonies remain to be discovered within GRNP.

A maximum entropy model has been developed on the basis of known colony sites (Monticelli et al. 2011). This predictive map constitutes the basis to search for additional breeding sites inside GRNP. The picathartes database is being updated in the light of new information gathered during the annual monitoring sessions, including GPS coordinates for any newly-discovered site. Once a new active site has been found, it is included in the annual monitoring of priority sites.

9. Amphibian monitoring:

Expected outputs:

1. The composition of amphibian communities in and around GRNP is known and gives important information on the health status and its changes of different forest habitats.
2. The distribution and abundance of amphibian species of conservation concern is known.

Justification: Amphibians are known to be excellent indicators for the health status of a forest habitat. True forest species are sensitive to forest degradation and fragmentation and the composition of amphibian communities differ between pristine and disturbed forests (e.g. Hillers et al. 2008). During two surveys the amphibians in the project zone were shown to harbor a high number forest species, all being endemics to the Upper Guinean forest ecosystem and some of them being threatened, with one species being Critically Endangered and thus HCV toad species *Amietophrynus taiensis*. While amphibians are seriously declining on a global level, the amphibians in the project zone are facing serious threats due to the loss of forest habitats and agricultural encroachment. Being one of the last remaining larger forest areas in the Upper Guinean forest ecosystem and ranking among the most diverse forests in terms of amphibians in West Africa, the long term monitoring of amphibians will not only serve to know more about the amphibians and their status in the project zone but changes in distribution and abundance will also give important information about changes in the quality of forest habitats which will be important for HCV amphibian species as well as of other taxonomic groups.

On a regional and global level the protection of the Gola amphibians is of high importance.

Location: Project zone (GRNP and community forests in leakage belt)

Implementation: Standard Operating Procedure

Methodology: Amphibians will be monitored using 1 ha-plots in selected forest habitats. The standardized survey will focus in leaf-litter amphibians, which include two HCV species (the Critically Endangered *Amietophrynus taiensis* and the Endangered *Phrynobatrachus annulatus*) that are diurnal and thus can be monitored during the day. Inside GRNP, these plots should be covering different existing habitat types (swamps, drier areas, flat areas and hills) and in the leakage belt remaining community forests. At least 30-40 plots should be monitored two to four times yearly, covering the rainy and the dry season (e.g. ten in Gola Central, five in Gola South, five in Gola North and 10-20 in community forest). Plots should be surveyed by at least two persons for a period of two hours (or one hour with four persons) per visit. During this visit, observers

will walk slowly and systematically through the plot and perform visual and acoustic encounter surveys, i.e. they will catch those frogs they see, count the frogs they see but cannot catch (in case they are able to identify them) and also record the number of calling males that are not captured (see e.g. Hillers et al. 2008). The captured animals will be kept in plastic aquaria or ziplock bags until the searching time for each visit is over. After each visit the frogs captured in each plot will be determined and sexed which will allow for the calculation of (relative) encounter rates for each species and also for the compilation of distribution maps. Furthermore, basic habitat features will be collected in each plot.

In order to get an idea about the complete amphibian community in each plot, in addition to diurnal plot surveys, each plot can be visited once in the rainy season also at night time. These night surveys will focus in acoustic sampling.

Frequency/timeframe: Every 2-3 years

Previous work in GRNP:

Two major amphibian surveys were done on and around GRNP in 2009 (Hillers 2009) and from 2010 to 2012 (Hillers in prep.). These surveys revealed a high species diversity for the Gola Forests (43 species) including many endemics to the Upper Guinean forests and four threatened species (*Amietophrynus taiensis, Phrynobatrachus annulatus, Hylarana occidentalis, and Conraua alleni*). Furthermore, several Near Threatened species were recorded as well as one species new to science that is likely endemic to the Gola Forests in Sierra Leone and Liberia, thus potentially being highly threatened. Further surveys are likely to record even more species. So far, no species-focused amphibian work has been done, but a 6-months project focusing on the Critical Endangered Taï toad (*Amietophrynus taiensis*) will start in October 2013 in order to gain more knowledge on its distribution and abundance. The only record of this species was done in only one location inside Gola Central in 2009 when four individuals were found. However, no other records of this rare species were made.

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Annex 1 – Biodiversity monitoring framework

Project strategy	Output Indicator	Source for verification	Timing/ Frequency	Outcome Indicator and desired change	Source for verification	Timing/ Frequency	Impact Indicator and desired change	Source for verification	Timing/ Frequency
Protection of the integrity of the project area to prevent habitat loss, fragmentation, species loss and loss of connectivity (G1)	# of patrols carried out	monthly reports (from activities of all forest rangers)	Ongoing	Decrease in signs of illegal activity in the project area	Annual threat monitoring report (from activities of forest ranger monitoring team)	Ongoing	No significant loss to the Upper Guinean forest within the GRNP	Interpretation of satellite images	prior to each verification event
	# of km patrolled by forest rangers	Monthly reports (from activities of all forest rangers)	Ongoing	Integrity of project boundaries maintained	Monthly reports from boundary team	Ongoing	No Significant loss of HCV species in project area	Results of species monitoring work	As per SOPs
				carbon stocks increase in project area	plot re-measurement surveys	prior to every verification event			
	Proportion of the project area visited	Annual Park operations report	Annual						
	Refresher training for forest rangers	Annual park operations report	Annual						
Work with Forest edge communities to avoid loss of habitat and species in the project zone and	# of environmental roadshows given (#61 and 62 in output and outcome monitoring for the Gola		Annual	areas of forest with HCV set aside for conservation/low impact use (#52 and/or 48 in output and	Landuse planning reports	annually	HCV species maintained in project zone	Results of species monitoring work	As per SOPs

maintain connectivity between the forest blocks (G2)	REDD project)			outcome monitoring for the Gola REDD project)					
	# of nature clubs set up (#63 in output and outcome monitoring for the Gola REDD project)		annually	Knowledge of forest and species values increased (#57 and 65 in output and outcome monitoring for the Gola REDD project and attitudes module in the longitudinal survey)	Longitudinal survey	annually	corridors maintained between project area blocks	interpretation of satellite images, condition of forest corridors based on species monitoring reports	Prior to each verification event and as per SOPs
	# of species specific awareness raising events carried out (monitored by the Research team)	reports	annually	# of communities adopting by-laws that include biodiversity elements (#51 in output and outcome monitoring for the Gola REDD project)		Annually from year 3			
	# of land use planning initiatives begun in		annually						

	community land (#49 in output and outcome monitoring for the Gola REDD project)								