Biodiversity, carbon stock and market value assessment for the SGSOC project area, Southwest region, Cameroon

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Cover picture: Aerial photography of Mana river at Mana footbridge, the southeastern entrance to Korup National Park, where industrial palm oil plantations border primary forest; by Markus Zehnder (reflecta tv)

Summary

We surveyed large mammals, birds as well as vegetation in the proposed 734.55 km² concession area of Herakles Farm/SGSOC in Southwest Cameroon, including the newly assigned plots (see decrees no. 2013/416, 2013/417 and 2013/418, as of November 2013). The aim was to provide carbon stock and market value estimates of the study area (including both the former proposed and recently assigned SGSOC concession area) as well as baseline information for a biodiversity assessment addressing the High Conservation Value (HCV) sub-categories 1.2 and 1.3 according to a best practice approach.

We carried out systematic direct and indirect large mammal surveys from 46 two-km transects and additionally recorded large mammals from recces (total survey effort 212 km) when moving in between transects. We identified and measured all trees larger 10 cm *dbh* (diameter at breast height) for vegetation analyses and carbon assessment at two 0.25 ha plots along each transect (total sampling area 21.25 ha). Also, we conducted 180 bird point counts of 10 min each from 20 transects (total survey effort 30 hours) located in the eastern part of the planned concession area.

Our large mammal survey revealed a total of 1,606 (direct and indirect) records of large mammals. All threatened wildlife species to be expected from the region (i.e. known from Korup National Park) were recorded, including Elliot's chimpanzee, forest elephant, buffalo, drill, red-capped mangabey and Preuss' red colobus. The area also holds populations of all lowland forest guenons (four species from the *Cercopithecus* genus) and the four duiker species known from and being characteristic for the Cross-Sanaga region. A comparison of all-sign encounter rates of large mammals between the study area and adjacent Korup National Park showed that the planned concession area may have similar or even higher abundances of duikers (blue and red duikers) and monkeys (crowned and red-eared monkey, drill and red-capped mangabey) but lower elephant and probably also lower chimpanzee abundance than Korup National Park. Dung and nest counts suggest that a small number of forest elephants is using the concession and/or need it as a corridor between protected areas but more information on elephant movements would be required to design corridors for this species at the landscape scale. Moreover, Elliot's chimpanzees were found to be present inside the eastern part of the concession, in four of the 46 grid cells surveyed. It is possible that these number a few dozen individuals. Elephant and drill encounters were made also within the concession area assigned in November 2013 (plot 'Nguti'), and chimpanzee and red colobus encounters close to it.

We recorded a total of 10,468 stems of trees representing a total number of 421 observed and 545 estimated species in the study area. More than 11 % of the recorded tree species and more than 10 % of the total stem count are of conservation concern (endemic to the region of SW Cameroon and NE Nigeria and/or listed with a higher threat category by IUCN or with Class A by the Cameroonian Wildlife law), including one species (*Cola praeacuta*)

being both listed as ‘critically endangered’ by the IUCN red list and endemic to the study region. The highest numbers of tree species relevant for conservation were observed in the western as well as central part of the proposed SGOSC concession.

During bird count sampling in the eastern part of the SGSOC project area, we obtained a total of 126 bird species. The estimated bird species richness is 143. We recorded a considerable number of large canopy birds (represented by eleven species of turacoes, hornbills and parrots) indicating intact a valuable forest habitat with large trees for feeding and nesting. Four of the recorded species are of conservation concern (grey parrot, red-fronted parrot, yellow-casqued hornbill and yellow-footed honeyguide). These species show a homogeneous distribution throughout the northeastern part of the study area, and, in the case of grey parrots and yellow-casquet hornbills, relatively high abundances.

We calculated mean carbon stock estimates from biomass of 259.2 tC/ha and 271.3 tC/ha resulting in total biomass carbon stocks of 19.0 GtC and 5.7 GtC for the former proposed and now issued SGSOC concession area, respectively. These estimates range slightly above the regional mean, which is mainly caused by relatively high values of basal area (40.7 m^2/ha) and stem density (490 stems/ha). Similar to the pattern of threatened tree species distribution, we found the highest estimates of carbon stock in the center and southwestern part of the SGSOC project area. By incorporating estimates for biomass in oil palm plantations and soil carbon stocks from literature, we quantified carbon emissions due to conversion of forest to oil palm plantation of 57.4 $GtCO_2e$ for the former proposed 60,000 ha plantation and 20.9 $GtCO_2e$ for the now issued 20,987 ha concession area. On the forest carbon market the figures correspond to total monetary values of 447,878,989 US$ and 163,041,575 US$, respectively.

According to the results of our biodiversity assessment, we conclude that a major proportion of the proposed SGSOC concession meets the criteria of the High Conservation Value sub-categories 1.2 and 1.3: We identify the whole northeastern part of the concession area to be HCV 1.2 (including the ‘Nguti’ plot from the recently issued concession) mainly due to its importance for the recorded endangered mammal species (chimpanzee, drill, forest elephant and red colobus) and its unique and diverse fish fauna. Particularly because of exceptionally high numbers of threatened and endemic tree species, we consider the center of the SGSOC project area as well as the southwestern part of the Ndian block to be HCV 1.2 and HCV 1.3 (including the plots 'Ikotti', 'Lipenja I', 'Mobenge'/'Ndiba', 'Beboka village', 'Kuma', 'Lipenja II', 'Mokange', ‘Ayong’ and ‘Sikam’ as well as the western section of the ‘Talangaye’ plot from the concession area assigned in November 2013). Due to its global importance for the conservation of the endangered and patchily distributed Four-digit Toad, we also grade the northern part of the Ndian block (plots ‘Mokango-Bima’ and ‘Massaka-Bima’) as HCV 1.2 and 1.3.

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1 Introduction

1.1 Background

The major reason for this study were the plans discussed during the last four years to establish a new industrial palm oil plantation in Southwest Cameroon. In 2009 the American agribusiness company Herakles Farms presented a document on a land lease for a 99-years concession designated to establish an industrial oil palm plantation in the south-western province of Cameroon. In the following, the company and its affiliate SG Sustainable Oils Cameroon (SG SOC) built up nurseries for oil palms. According to the project plans, the concession area of more than 73,000 hectares would eventually allow for about 60,000 ha of oil palm plantation (H&B Consulting 2011), being located in the midst of a number of protected areas, such as Korup National Park. As such, the proposed concession area is lying in the midst of the largest remaining contiguous forest block of the West African biodiversity hotspot (Mittermeier et al. 2005) which covers most of the biogeographic region known as the Gulf of Guinea forests (Oates et al. 2004). This area harbours an exceptional diverse species pool, including a unique assemblage of mainly threatened diurnal and nocturnal primates (the so-called 'Cameroon faunal group'), including the enigmatic Drill and the rarest form of the Chimpanzee, as well as many other large wildlife such as e.g. the threatened forest elephant.

The planned oil palm project in the study area already has raised much public attention, mainly stemming from the resistance against the project by leading scientists and several NGOs who dispute with the proponents about the expected social and ecological effects of the project. According to Cameroonian law and the RSPO guidelines the investor had to provide assessments on ecological and social impacts (ESIA) and of High Conservation Value (HCV). Both assessments classified the landscape in the concession area as primarily fragmented and degraded and, therefore, the company insisted that the plantation establishment goes along with highest environmental standards (H&B Consulting 2011; Asamoah 2011).

Based on various observations of methodological deficiencies as well as apparent misinterpretations within the ESIA and HCV assessment, it was of utmost importance to perform another independent study on the biodiversity and conservation value of these forests, which are to be converted to oil palm plantations.

On 25 November 2013, a modified and provisional (3 years) concession was issued to SG Sustainable Oils for the establishment of an oil palm plantation through presidential decree (see decrees no. 2013/416, 2013/417 & 2013/418). The assigned plots add up to about 20,000 ha and are located within the 'old' concession area and, therefore, also part of this study.

1.2 Objectives

The objectives of this study were

- to obtain a reliable biodiversity data base from the SGSOC project area using systematic sampling procedures,
- to estimate the carbon stored in the planned concession area and
- to assess its the conservation value addressing the High Conservation Value sub-categories 1.2 and 1.3.

2 Methods

2.1 Study area

The SGSOC project area is located in the tropical moist semi-deciduous and moist evergreen lowland forest zone in South West Cameroon between numbers of protected areas, namely the national parks Korup, Rumpi Hills and Bakossi Mountains as well as the wildlife sanctuary Banyang Mbo (see Figure 1). The area is part of the Cross-Sanaga forests, a continuous forest block between the Cross-River National Park in Nigeria and the Sanaga-River in Cameroon, which belongs to the important biodiversity hotspot of the Gulf of Guinea forests.

2.2 Survey design

General description and representativity

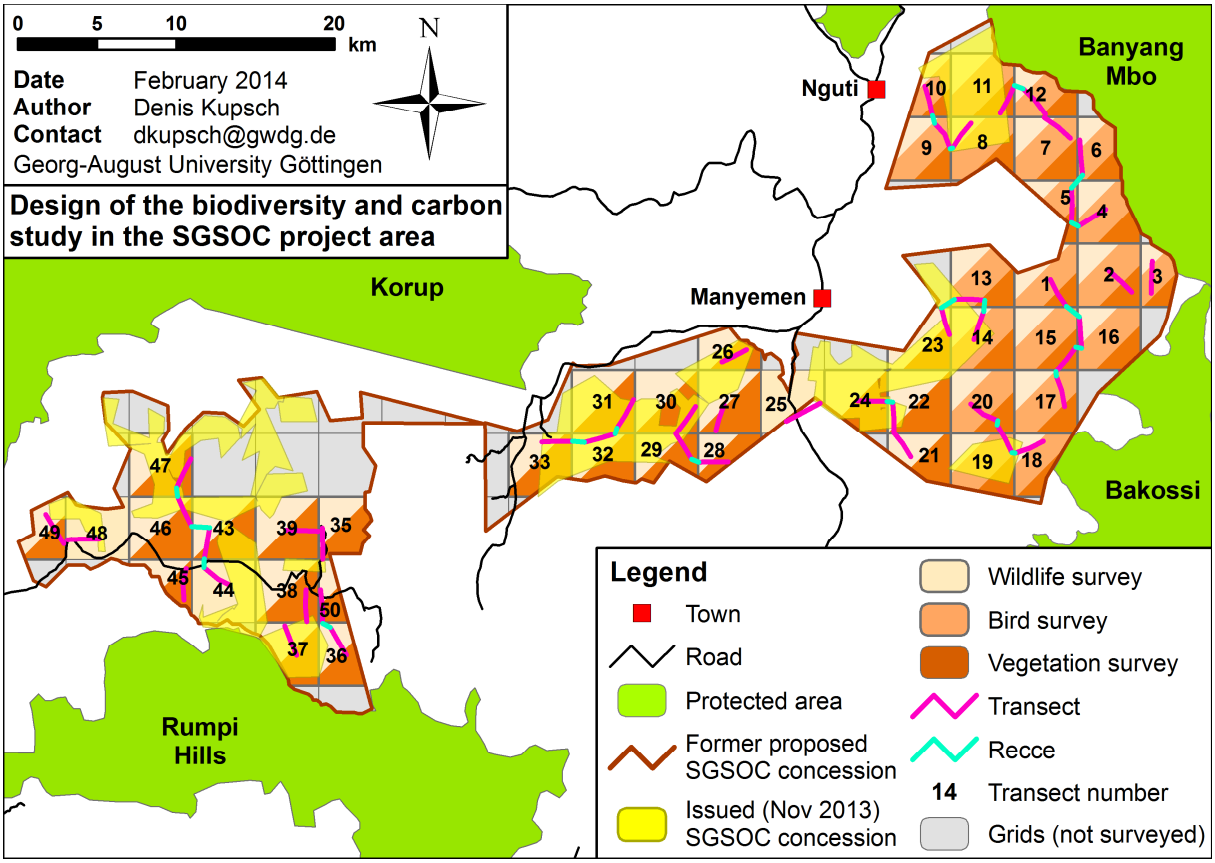

Figure 1 – Sample grid and locations of 2 km transects sampled for large mammals, birds and vegetation, inside the planned palm oil concession.

We superimposed a 4 km * 4 km grid on the proposed SGSOC concession covering an area of 734.55 km². We selected the 50 largest grid cells for biodiversity sampling and placed one two-km transect in each of those. Due to conflicts with villages and land teasers we could not establish transects in four grids (formerly grid numbers 34, 40, 41 and 42) resulting in 46 sampling grid cells covering an area of 583.1 km². Because of time-constraints, however, the

distribution of transects did not follow a completely random design. We therefore conducted a separate assessment of coverage of the various habitats, using the results of a land cover analysis conducted for the planned SGSOC concession area (Maschler 2012). We created (using ArcGIS 9.3) a 50 m buffer around the transects, intersected these with the land cover shapes of Maschler (2012) and compared the proportions of land use types. We found that there was no significant difference between both data sets (Table 1; Fisher Exact, two-sided: $p>0.05$).

Table 1 – Proportions of land use types around the used transects of this study compared to overall land use status in the SGSOC concession area; comparison based on the results of Maschler (2012)

	Land use share (in %)			
	Forest	Agroforestry	Settlement	Plantation
Land Cover Analysis (Maschler 2012)	87.80	11.70	0.32	0.18
Transects (this study)	88.16	10.90	0.83	0.11

According to the figures given in the presidential decrees 2013/416, 2013/417 and 2013/418, the total concession area issued to SGSOC in November 2013 was supposed to be 19,843 ha. However, after creating polygon features from the coordinates (see Figure 1), we measured a total area of 20,987 ha. The assigned plots are distributed throughout the entire former proposed SGSOC concession area leaving out the eastern part of the Kupe block.

Large mammal survey

Transects were cut with a minimum of disturbance, and survey teams followed the transect cutters with a minimum of one day in between transect cutting and surveying. The survey period was from April to June 2013. For direct large mammal sampling all of the 46 transects (except one: transect 25) were walked twice within the survey period (Figure 1), using a standard line transect approach (Buckland et al. 2001). Total survey effort amounting from these systematic line transects amounted to 182 km. These transect lines were also used to record indirect observations of large mammals (dung and Chimpanzee nests). In addition, large mammal records were obtained from discrete movements in between the systematic transects, in the form of recce walks. During these movements, both direct sightings and indirect signs of large mammals, such as dung or tracks, were noted. A survey effort of 29.9 km from such recces was accumulated. This results into a combined survey effort of L = 182 km + 29.9 km = 211.9 km for transects and recces combined.

No attempt was made to distinguish dung or foot prints of the two species of red duiker *Cephalophus ogilbyi* and *C. dorsalis*.

Vegetation survey

At each transect, trees were recorded at two 0.25 ha (50 m * 50 m) vegetation plots placed arbitrary along each transect line. Only tree species with *dbh* (diameter at breast height) larger than 10cm were identified and measured for later basal area and carbon stock analysis. To minimize potential sampling biases we split up every vegetation plot in 25 separately marked subplots of 10 m * 10 m, and sampled these subplots consecutively. Due to conflicts with land owners and teasers we could not take samples at seven plots (one at transect 18, both at transects 25, 44 and 48) resulting in a total sample size of 43 grids cells (Figure 1) with 85 plots covering a total area of 21.25 ha.

Bird survey

We placed nine point stations every 250m along each transect and sampled birds (calls and direct sightings) for 10min at each point. To date, transects 1-20 in the eastern part of the SGSOC project area could be sampled (Figure 1) resulting in a total survey effort of exactly 30 hours.

2.3 Data Analysis

Overall conservation value assessment

For the recorded indicator groups (large mammals, trees and birds) we listed all species or subspecies of conservation interest, using information from the IUCN red list of threatened species (IUCN 2013) and the list of Class A animals protected through the Cameroonian Wildlife law (see Law no. 94/01 of 20 January 1994 and Order no. 0648/MINFOF of 18 December 2006) as well using information on the geographical range of each recorded species. The latter we extracted from the IUCN red list database for large mammals and from 'Global Biodiversity Information Facility' (GBIF 2013) as well as from Kenfack et al. (2007) for trees. We considered a species as endemic to the study region when its geographical range is restricted to the region if southwestern Cameroon and southeastern Nigeria. The listed species and their distribution will be used as the central criteria to assess the conservation value following the HCV approach (Brown et al. 2013; Mbolo & Esono 2008)

Population estimates for large mammals

We used direct and indirect encounters to calculate encounter rates (means ± standard errors) of large mammal species relevant for conservation. We compared these findings with the results of the large mammal survey in Korup National Park 2010 (see also Waltert 2012) using the Mann-Whitney-*U*-test.

Elephant dung data was analysed using an estimate of detection probability from pooled data of this survey and of dung data of Korup National Park, from a survey done in 2010 (see Waltert 2012). An estimate of production rate of 19.75 dung piles per day and a mean decay time of 110.8 days was used to convert dung density into elephant density (conversion factors from Nchanji & Plumptre 2001, data from Banyang Mbo sanctuary, no standard errors incorporated).

In estimating Chimpanzee population size, we used combined data from both Korup National Park and the SGSOC area, in order to be able to model detection probability reliably (total *n* = 39 nest clusters). We also used a conservative approach for the estimation of (expected) cluster size of *E(s)* = 1.8 nests per cluster (average cluster size was *E(s)* = 3.0), assuming that chimpanzee groups could have been smaller than those of Korup National Park. We, however, also assumed a proportion of nest builders of 0.83 in the population (Plumptre & Cox 2006).

Species richness estimates for trees and birds

Using data from the single plots as sampling units, we estimated species richness of trees and birds for the planned SGSOC concession area in EstimateS 9.1 (Colwell 2013). In order to produce reliable values for the lower boundaries of species richness and confidence intervals, we used the classic and bias-corrected formula of the Chao 1 species richness estimator (Chao 1984) for trees and birds, respectively.

Carbon stock estimation

Basically following the IPCC Guidelines for national greenhouse gas inventories (Eggleston 2006), we used equation (1) to estimate the total carbon stock of the SGSOC project area, where *CE* is the carbon stock estimate, *AGB* the above ground biomass, *BGB* the below ground biomass and *CF* the fraction of carbon of forest biomass. According to Eggleston (2006), we set *CF* = 0.47.

(1) $CE = CF * (AGB + BGB)$

To calculate the proportion of *BGB*, we used equation (2) with *R* representing the root-to-shoot ratio. For tropical moist forests Mokany et al. (2006) estimated a median ratio of *R* = 0.235.

(2) $BGB = R * AGB$

The estimation of above ground biomass follows a model developed by Chave et al. (2005) for tropical moist forests. Beside the diameter at breast height *dbh* that we obtained directly

from vegetation sampling this equation (3) requires the wood mass density ρ and tree height *H*.

(3) $AGB = exp(-2.977 + ln(\rho * dbh^2 * H)) = 0.0509 * \rho * dbh^2 * H$

Since it is often too time-consuming and costly to measure tree height in tropical forests, it is possible to estimate above ground biomass excluding height from a carbon model. However, Feldpausch et al. (2011) developed geographically based models to estimate height and, thus, reduce biases in estimating AGB. We used the equation (4) for trees of Central Africa.

(4) $H = exp(1.1525 + 0.05547 * ln(dbh))$

We obtained information on wood mass densities ρ for equation (3) from the 'Global Wood Density Database' (Chave et al. 2009; Zanne et al. 2009). To maximize the number of matches between the latter and our database, we standardized both species lists for synonymy using the African Plant Database (2013) and conform to the 'Angiosperm Phylogeny Group' (APG 2013). We could match 37% of the stems to species-specific wood density values. For 35% and another 16% we used the mean values for the genera and family, respectively. For not identified stems, we used the plot-mean wood density (2% of stems).

Carbon estimation of the concession issued in November 2013 is based on the data from those survey grid that show an overlap with the concession area of at least 5% (grids 8-11, 13, 14, 18-20, 22-24, 26, 27, 29-33, 36-39, 43, 46, 47, 49, 50; see also Figure 1).

Carbon market value

The carbon market value *MV* (= monetary value for *not* degrading forested area) is derived from the total amount of carbon emissions due to land use change *E* and the price obtainable on the forest carbon markets. According to the latest assessment of Forest Trends' Ecosystem Marketplace on the state of the forest carbon markets (mainly REDD initiatives; Peters-Stanley et al. 2013), the average price for carbon offsets in 2012 was *AP* = 7.8 US$/$tCO_2e$ (carbon dioxide equivalent).

(5) $MV = E * AP$

The total amount of carbon emissions *E* is calculated from the sum of the changes in biomass and soil carbon stock ΔCE and ΔSC (equation 6). We assumed that all biomass carbon content would get released to the atmosphere immediately after forest clearance. To convert the biomass and soil carbon stock into carbon dioxide equivalent (emissions) we used the factor *MF* = 3.664 (carbon atomic mass represents 12.01 g/mol of the CO_2 molecular mass of 44.01 g/mol).

(6) $E = (\Delta CE + \Delta SC) * MF$

Software

We used ArcGIS 9.3 to process and plot GIS data. Species richness was calculated using EstimateS 9.1 (Colwell 2013) and statistical analyses were made in R 2.15.2 (R Development Core Team 2013).

3 Results

3.1 Large mammals

During systematic transect sampling, a total of 1,407 large mammal records (all signs, including footprints, dung, nests and direct observations of groups) were obtained (Tables 2 and 3), representing a large mammal encounter rate of *n/L* = 1,407/182km = 7.7/km. During recces, a total of 199 large mammal records was obtained, resulting into a slightly lower encounter rate for recces of n/L = 199/29.9km = 6.7/km. The combined large mammal encounter rate (transects plus recces) is *n/L* = 1,606/211.9km = 7.6/km.

Most records were from red duikers (*Cephalophus ogilbyi/dorsalis*, *n*=452) and brush-tailed porcupine *Atherurus africanus* (*n*=381), followed by red river-hog *Potamochoerus porcus* (*n*=239), blue duiker *Philantomba monticola* (*n*=209), pangolins (*Manis spp.*, *n*=85) and smaller mongooses of the Viverridae family (*n*=76). Records of the water chevrotain *Hyemoschus aquaticus* (*n*=20), putty-nosed (*Cercopithecus nictitans nictitans, n*=34) and mona monkey (*Cercopithecus mona, n*=17), as well as of the forest giant rat (*Cricetomys emini, n*=14) were still relatively frequent and a remarkable total of *n* = 23 distinct elephant records (*Loxodonta africana)* were made.

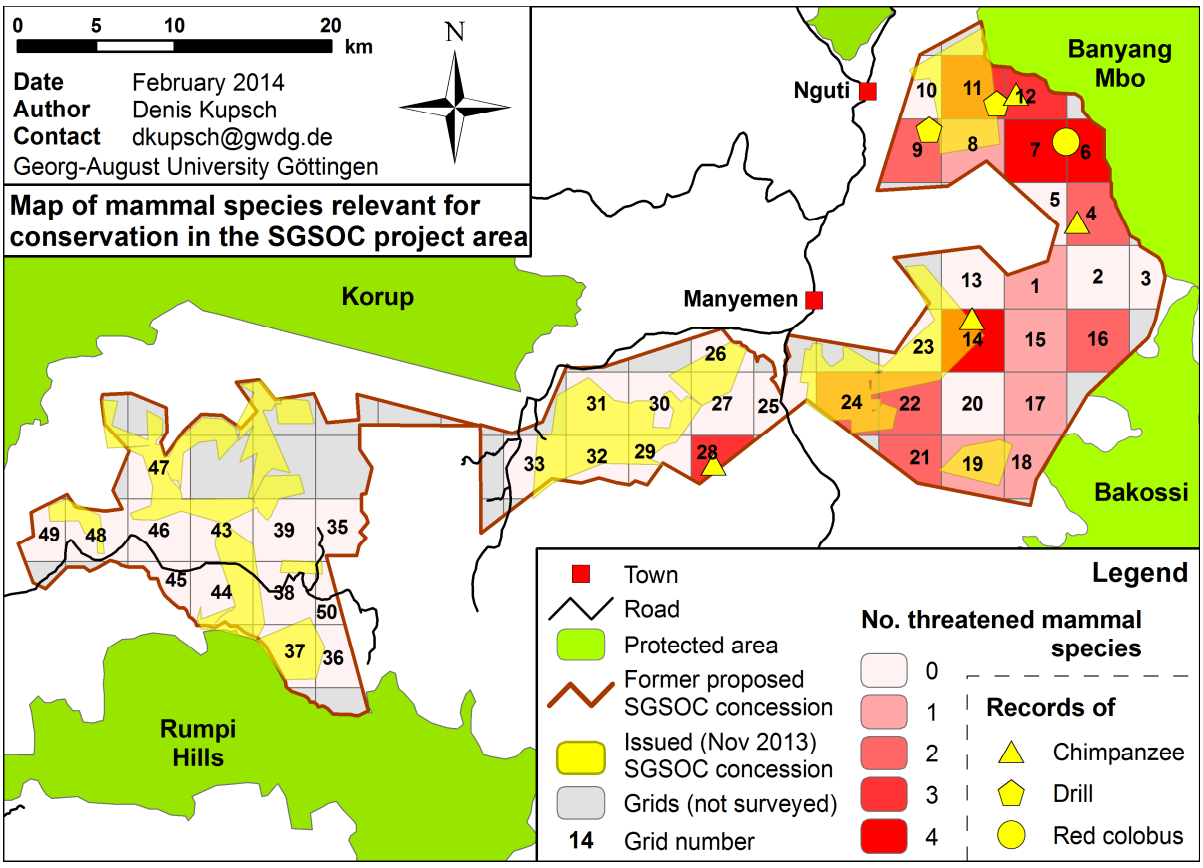

Figure 2 – Grid based distribution of large mammal species of conservation interest (listed with a higher threat category in the IUCN red list and/or as Class A animal in the Cameroonian Wildlife law; see also Table 2; note: map is produced without the records of the threatened Ogilby's duiker, one of two red duikers in the region together amounting to 452 counts with 235 only in Ndian block) recorded in the SGSOC concession area and areas with records of chimpanzee, drill or Preuss' red colobus

Table 2 - List of large mammal taxa relevant for large mammal conservation in SW Cameroon, and their presence in the former proposed SGSOC concession area.

English Name	Scientific Name	Presence in the concession[1]	IUCN status[2]	Population trend[2]	Appendix A - Wildlife law	Endemic to study region[2]
Brush-tailed porcupine	*Atherurus africanus*	*	LC	Unknown		
Bay duiker	*Cephalophus dorsalis*	*	LC	Decreasing		
Ogilby's duiker	*Cephalophus ogilbyi ogilbyi*	*	VU	Decreasing	*	
Yellow-backed duiker	*Cephalophus silvicultor*	*	LC	Decreasing	*	
Red-capped mangabey	*Cercocebus torquatus*	*	VU	Decreasing	*	
Red-eared monkey	*Cercopithecus erythrotis camerunensis*	*	VU	Decreasing	*	*
Mona monkey	*Cercopithecus mona*	*	LC	Unknown		
Putty-nosed monkey	*Cercopithecus nictitans nictitans*	*	LC	Decreasing		
Crowned monkey	*Cercopithecus pogonias pogonias*	*	VU	Decreasing	*	*
Preuss' guenon	*Cercopithecus preussi preussi*		EN	Decreasing	*	*
Civet	*Civettictis civetta*	*	LC	Unknown		
Cross River gorilla	*Gorilla gorilla diehli*		CR	Decreasing	*	*
Water chevrotain	*Hyemoschus aquaticus*	*	LC	Decreasing	*	
Central African elephant[3]	*Loxodonta africana (cyclotis)*	*	EN	Decreasing	*	
Drill	*Mandrillus leucophaeus leucophaeus*	*	EN	Decreasing	*	*
Elliot's chimpanzee	*Pan troglodytes ellioti*	*	EN	Decreasing	*	*
African leopard	*Panthera pardus pardus*		NT	Decreasing	*	
Blue duiker	*Philantomba monticola*	*	LC	Stable		
Red river hog	*Potamochoerus porcus*	*	LC	Decreasing		
Preuss' colobus	*Procolobus preussi*	*	CR	Decreasing	*	*
Forest buffalo	*Syncerus caffer nanus*	*	LC	Decreasing		
Bushbuck	*Tragelaphus scriptus*		LC	Stable		
Sitatunga[4]	*Tragelaphus spekei*	*	LC	Decreasing		

[1] based on 212 km survey effort (direct and indirect surveys)
[2] for info and definitions, see iucnredlist.org, accessed 31 October 2013
[3] information from http://www.iucnredlist.org/attachments/1244
[4] may confirm records for Korup NP

All other large mammals had fewer records. As for ungulates, the distinctive foot prints of Sitatunga (*Tragelaphus spekei, n*=3) were recorded, as were those of the Yellow-backed duiker *Cephalophus sylvicultor* (*n*=5). In addition, the presence of the forest buffalo *Syncerus caffer nanus* (*n*=7) was also confirmed. Out of the diurnal primates of the region, we recorded the Crowned (*C. pogonias*, *n*=4) as well as the red-eared (*C. erythrotis*, *n*=3) guenon, the drill (*Mandrillus leucophaeus*, *n*=3), red-capped mangabey (*Cercocebus torquatus*, *n*=2), and Preuss' red colobus *Piliocolobus preussi* (*n*=1), and made *n*=7 encounters with nests and signs of chimpanzees *Pan troglodytes ellioti*.

Out of the recorded large mammal species, eight species are listed in the higher threat categories by IUCN (2013): One species, the Preuss red colobus is listed as 'critically endangered', three as 'endangered' (drill, chimpanzee and Central African elephant), and four as 'vulnerable' (Ogilby's duiker, crowned monkey, red-eared monkey and red-capped mangabey). Besides the already mentioned, the Water chevrotain is also listed as Class A under the Cameroonian Wildlife law.

All records of mammal species of conservation concern were made in the Kupe block of the concession area. Grid cells with chimpanzee, Preuss' red colobus and drill encounters are marked in Figure 2. Records of elephants were scattered widely throughout the eastern part of the planned concession (grids 1, 4, 7, 11. 12 and 16). However, we also recorded (albeit not plotted in Figure 2) *n* = 235 records of red duiker (i.e. the IUCN listed Ogilby's and Bay duikers) in the Ndian block.

As for the concession assigned in November 2013, plot 'Nguti' (decree no. 2013/416) needs to be highlighted. Here, we encountered drill and elephant within as well as chimpanzee and red colobus close to this potential plantation area. Also, we found the chimpanzee to occur in the plot 'Manyemen-Ebanga' and in the proximity to the plots 'Talangaye', 'Ayong' and 'Sikam' (all decree no. 2013/416).

Compared with data collected by WWF in Korup National Park in 2010 (see analysis by Waltert 2012), we found significantly higher encounter rates of red duiker, red river hog, blue duiker, putty-nosed monkey, buffalo and water chevrotain in the SGSOC project area than in Korup National Park, and lower (but not significant) encounter rates for elephant and chimpanzee than in Korup National Park (Table 3).

Table 3 - Numbers of observations (all signs), mean encounter rates with standard errors *SE*, from transect data (without recces) of the SGSOC project area and Korup NP (data of 2010). Ungulate observations are mainly indirect data, primate data mainly direct (except Chimpanzee: rate reflects nest group encounters).

	Study area 2013 (this study) (*n*=46 transects, *L*=182 km)			**Korup 2010** (WWF data; Waltert 2012) (*n*=81 transects, *L*=148 km)			**MW-*U*-test**	
	Total	Mean*	*SE***	Total	Mean*	*SE***	*U*	2-t. *P*
Red duiker	403	2.21	0.27	129	0.87	0.12	5.50	**<0.001**
Red river hog	196	1.08	0.15	6	0.04	0.02	8.77	**<0.001**
Blue duiker	186	1.02	0.15	44	0.30	0.06	5.66	**<0.001**
Putty nosed monkey	29	0.16	0.03	16	0.11	0.03	2.56	**0.010**
Elephant	17	0.09	0.04	57	0.38	0.1	-1.59	0.112
Water chevrotain	17	0.09	0.03	0	-	-		
Mona monkey	16	0.09	0.02	10	0.07	0.02	1.84	0.065
Buffalo	5	0.03	0.01	0	-	-		
Chimpanzee	5	0.03	0.01	15	0.1	0.04		
Crowned monkey	4	0.02	0.01	4	0.02	0.01		
African civet	3	0.02	0.01	5	0.03	0.02		
Drill	3	0.02	0.01	2	0.01	0.01		
Red eared monkey	3	0.02	0.01	4	0.03	0.01		
Yellow backed duiker	3	0.02	0.01	1	0.01	0.01		
Red capped mangabey	2	0.01	0.01	2	0.01	0.01		
Red Colobus	0***	-	-	3	0.02	0.01		
Totals	1,239			305				

*** as total/*L***

**** based on single transects as sampling units**

***** present, but detected during recces only**

Population estimates for elephants and chimpanzees

From the analysis of elephant dung data from the concession, we can estimate the population between 1-5 forest elephants for the 734.55 km² concession, as compared to 27-91 for the 1,260 km² Korup National Park (Table 4).

Table 4 - Number of elephant dung encounters *n* and dung encounter rate *n/L* [km^{-1}], as well as estimated elephant density *D* [ind*km^{-2}] and population size *N* for the proposed concession and Korup NP (data 2010). Based on subsets of dung data truncated at *w*=2.8 m and a dung detection probability estimate of *P*=0.65.

	Korup NP (2010) (*L*=151 km)	**Study area (2013)** (*L*=212 km)
n (untruncated)	114	4
n/L (untruncated)	0.38 (0.22-0.66)	0.02 (0.006-0.058)
D (95% C.I.)	0.04 (0.02-0.07)	0.002 (0.001-0.007)
N (95% C.I.)	49 (27-91)	2 (1-5)
% CV *D*	31.6	62.4

The estimated Chimpanzee density across the total concession area was about 5 times smaller than that estimated for Korup National Park, but the associated total population size estimate was 17 (95% CI: 8-63) using the rather conservative estimate 2 (Table 5).

Table 5 - Number of chimpanzee nest group encounters *n* and nest group encounter rate *n/L* [km^{-1}], as well as estimated chimpanzee density *D* [ind*km^{-2}] and population size *N* for Korup NP (data 2007-2010) and the proposed SGSOC concession (2013). *D* and *N* estimated from a distance data subset truncated to *w*=20 m and an estimated detection probability of *P*=0.57 (from the combined dataset). Estimates 1 & 2 are based on two different estimates of cluster size in the SGSOC concession, which are $E(s)_1$=1.8 and $E(s)_2$=3.0, respectively.

	Korup NP (2007-2010) (*L*=283.5 km)	**Study area (2013)** (*L*=212 km)	
		Estimate 1	Estimate 2
n (untruncated)	34	5	5
n/L (untruncated)	0.12	0.02	0.02
D (95% C.I.)	0.13 (0.07-0.24)	0.04 (0.01-0.14)	0.02 (0.01-0.09)
N (95% C.I.)	167 (91-305)	23 (7-103)	17 (8-63)
% CV D	28.5	75.2	75.9

3.2 Trees

During vegetation sampling, we recorded a total of 10,468 stems above *dbh* = 10 cm and a total of 421 tree species. Using the Chao 1 species richness estimator, we calculated an estimated tree species richness of 545 (95% CI: 495-629; Figure 3) for the total study area.

We obtained an exceptional long list of 48 tree species of conservation concern (Table 6). These 48 species account for 11.4 % of the total tree diversity. In total, we counted 1100 stems of those species of conservation concern representing 10.5 % of the total stem number. We recorded not less than 35 stems for one tree species listed as 'critically endangered' within the IUCN (2013) red list of threatened species (*Cola praeacuta*). Also, this species is known to occur solely in Southeast Nigeria and Southwest Cameroon. We listed 32 tree species with the IUCN status 'vulnerable' and another five as 'near

threatened'. We also recorded 13 tree species being endemic to the study region (including *Cola praeacuta*).

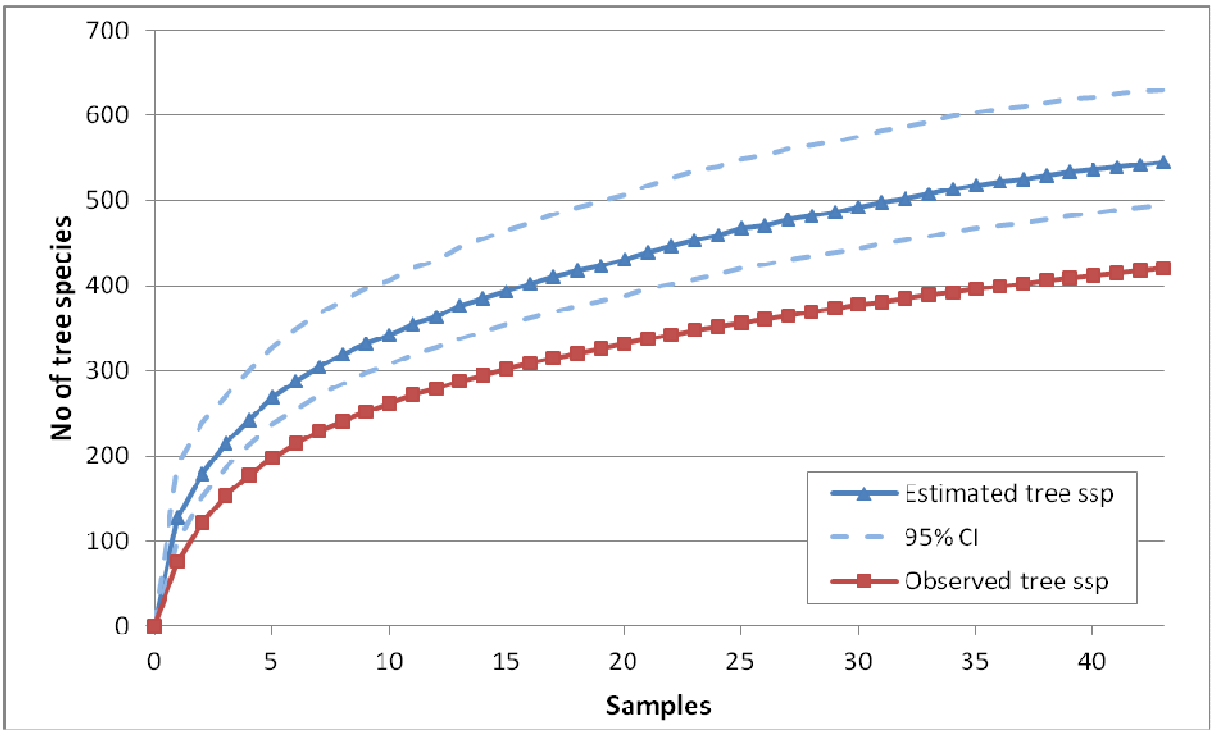

Figure 3 - Accumulation curves for observed plant species, as well as for estimated tree species (using the Chao 1 species richness estimator), for the proposed SGSOC concession area

Table 6 - List of tree species relevant for conservation (listed in the IUCN red list with at least NT and/or species endemic to region of SW Cameroon and SE Nigeria) recorded in the proposed SGSOC concession area with cumulated basal area and amount of stems counted

Species	IUCN status	Endemic to study region	Basal area (m^2)	Stems
Afrostyrax lepidophyllus	VU		1.42	34
Afzelia bipindensis	VU		0.08	4
Albizia ferruginea	VU		0.61	15
Allanblackia gabonensis	VU		6.13	88
Angylocalyx talbotii	VU		1.10	14
Antrocaryon micraster	VU		0.18	6
Aucoumea klaineana	VU		0.11	2
Baillonella toxisperma	VU		0.13	1
Brachystegia kennedyi	-	*	0.01	1
Calpocalyx heitzii	VU		3.42	32
Campylospermum mannii	-	*	3.07	13
Cleistopholis staudtii	VU		1.27	30
Cola praeacuta	CR	*	2.95	35
Craterispermum aristatum	-	*	0.53	14
Crotonogyne strigosa	VU		0.03	1
Dacryodes igaganga	VU		0.21	9
Daniellia klainei	NT		1.46	4

Dialium bipindense	NT		0.01	1
Dracaena talbotii	-	*	0.06	2
Drypetes staudtii	VU	*	3.42	37
Entandrophragma angolense	VU		0.12	1
Entandrophragma candollei	VU		0.19	1
Entandrophragma cylindricum	VU		2.18	17
Entandrophragma utile	VU		0.51	5
Eribroma oblongum	VU		2.96	34
Eugenia talbotii	-	*	1.33	24
Garcinia kola	VU		7.41	145
Guarea cedrata	VU		3.13	58
Guarea thompsonii	VU		3.56	15
Hymenostegia bakeriana	VU	*	0.35	3
Irvingia gabonensis	NT		7.31	87
Khaya ivorensis	VU		0.01	1
Lophira alata	VU		5.41	35
Lovoa trichilioides	VU		0.61	2
Macaranga occidentalis	-	*	0.05	1
Medusandra mpomiana	-	*	0.04	3
Milicia excelsa	NT		0.39	7
Nauclea diderrichii	VU		0.61	5
Nesogordonia papaverifera	VU		0.07	5
Pterygota bequaertii	VU		10.51	71
Rhodognaphalon brevicuspe	VU		0.02	1
Talbotiella eketensis	-	*	0.08	2
Terminalia ivoriensis	VU		1.33	22
Turraeanthus africanus	VU		8.00	76
Turraeanthus mannii	-	*	8.75	102
Uvariodendron connivens	NT		0.24	1
Uvariodendron giganteum	VU		1.81	30
Uvariopsis bakeriana	-	*	0.16	3

Most of the records of tree species significant for conservation were made in the central and western part (Ndian block) oft the SGSOC project area (Figure 4). In these areas, we found up to 14 threatened tree species per grid. However, also in the Kupe block of the concession tree species relevant for conservation were evenly distributed throughout the area.

For nearly all of the plots western and central part of the study area assigned to SGSOC in November 2013, we found exceptionally high numbers of threatened tree species ('Ikotti', 'Lipenja I', 'Mobenge'/'Ndiba' - all decree no. 2013/417; 'Beboka village', 'Kuma', 'Lipenja II', 'Mokange' - all decree no. 2013/418;'Ayong', 'Sikam' and the western part of 'Talangaye' – all decree no. 2013/416).

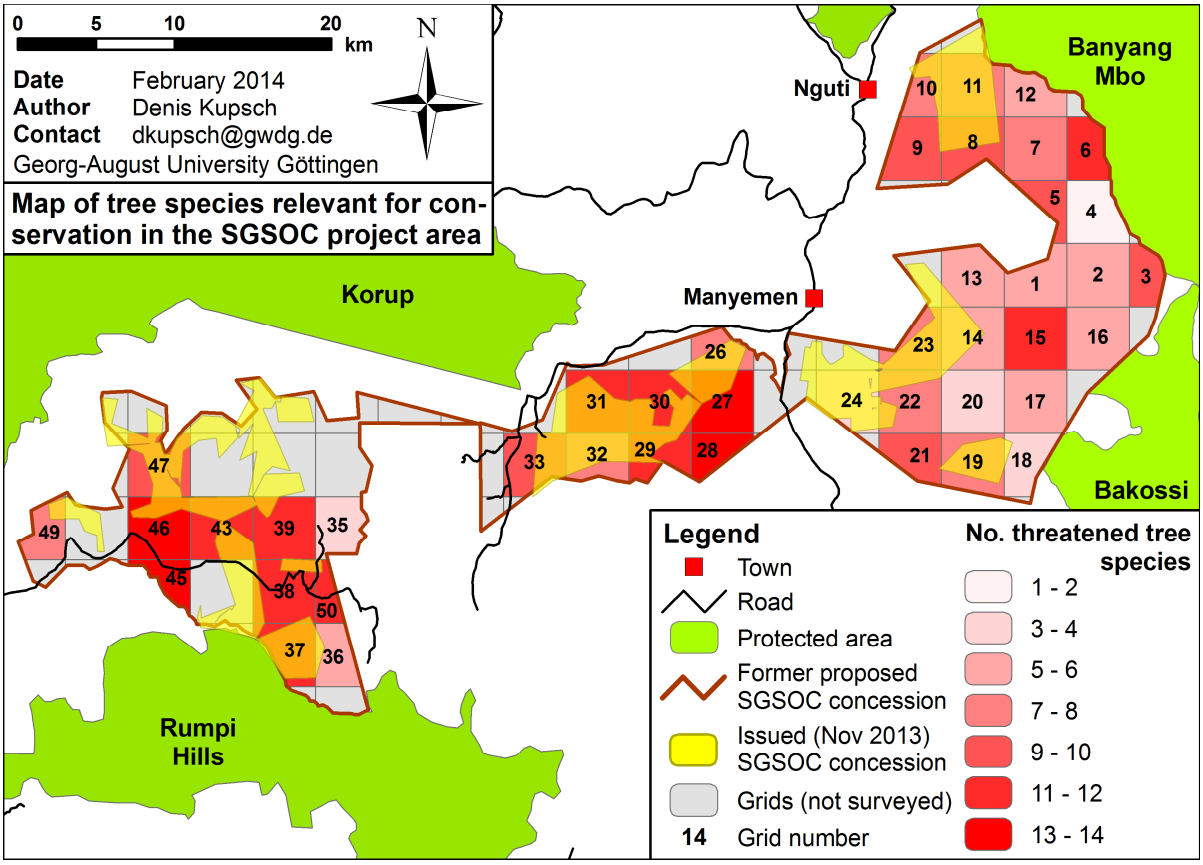

Figure 4 – Grid based distribution of tree species of conservation interest (listed with a higher threat category in the IUCN red list and/or trees endemic to study region; see also Table 3) recorded in the SGSOC concession area

3.3 Birds

During bird counts, a total of 126 bird species were recorded. Among these were relatively many records of large canopy birds, e.g. yellow-billed turaco (*n*=71), yellow-casqued hornbill (*n*=44), black-casqued hornbill (*n*=34), great blue turaco (*n*=30), white-tighed hornbill (*n*=28), grey parrot (*n*=18), piping hornbill (*n*=13), red-billed dwarf hornbill (*n*=3), white-crested hornbill (*n*=3), red-fronted parrot (*n*=2) and pied hornbill (*n*=1). All these species require the presence of large trees for nesting and feeding.

Based on the 20 transects sampled in the eastern part of the Kupe block, we estimated total bird species richness at 143 (95% CI: 131-176; see also Figure 5). However, since the bird survey was so far restricted to this part of the study area, this figure does not represent the whole planned concession.

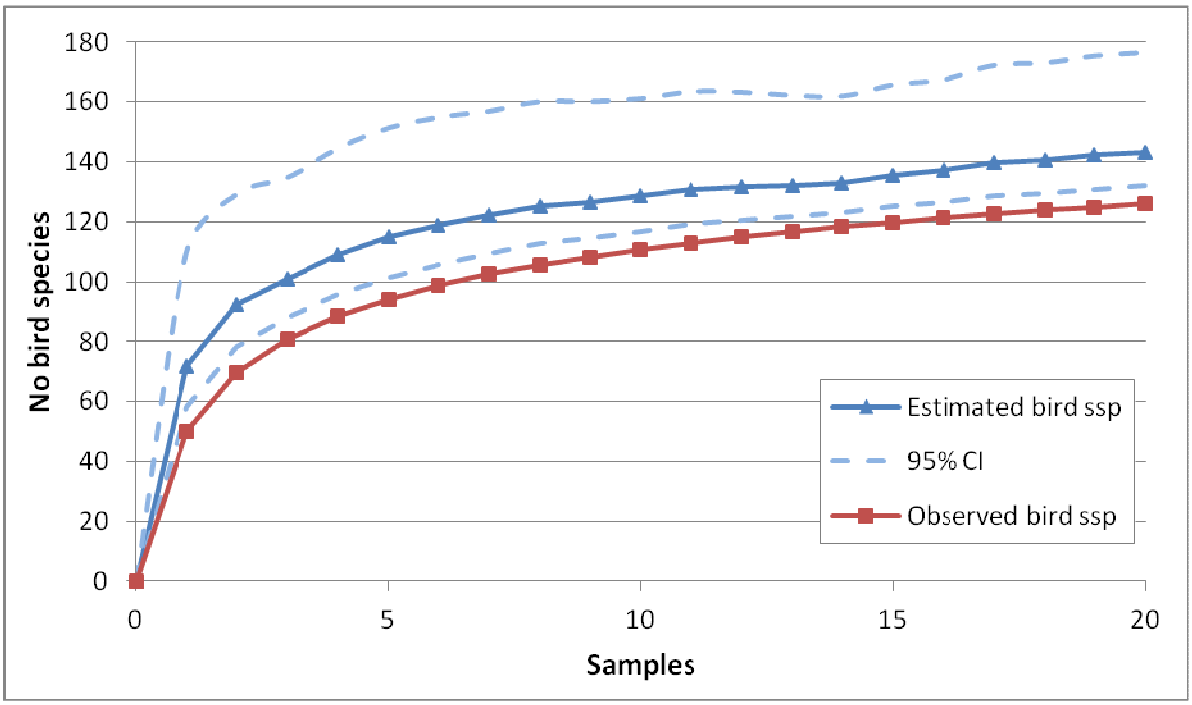

Figure 5 - Accumulation curves for observed bird species, as well as for estimated bird species (using the Chao 1 species richness estimator), for the proposed SGSOC concession area

We recorded four species listed as a Class A animal by the Cameroonian Wildlife law (Table 7): grey parrot (*n* = 18), red-fronted parrot (*n* = 2), yellow-casqued hornbill (*n* = 44) and yellow-footed honeyguide (*n* = 7). The relatively numerous records of the grey parrot and the yellow-casqued hornbill are remarkable since both of them are also listed as 'vulnerable' in the IUCN red list of threatened species (IUCN 2013).

Table 7 – List of bird species relevant for conservation (listed in the IUCN red list with at least NT and/or as Class A animal in the Cameroonian Wildlife law) recorded in the proposed SGSOC concession area with their occurrences during sampling

English Name	Scientific Name	IUCN status	Population trend	Appendix A - Wildlife law	Counts	Counts per hour
Grey Parrot	*Psittacus erithacus*	VU	decreasing	*	18	0.60
Red-fronted Parrot	*Poicephalus gulielmi*	LC	decreasing	*	2	0.07
Yellow-casqued Hornbill	*Ceratogymna elata*	VU	decreasing	*	44	1.47
Yellow-footed Honeyguide	*Melignomon eisentrauti*	DD	decreasing	*	7	0.23

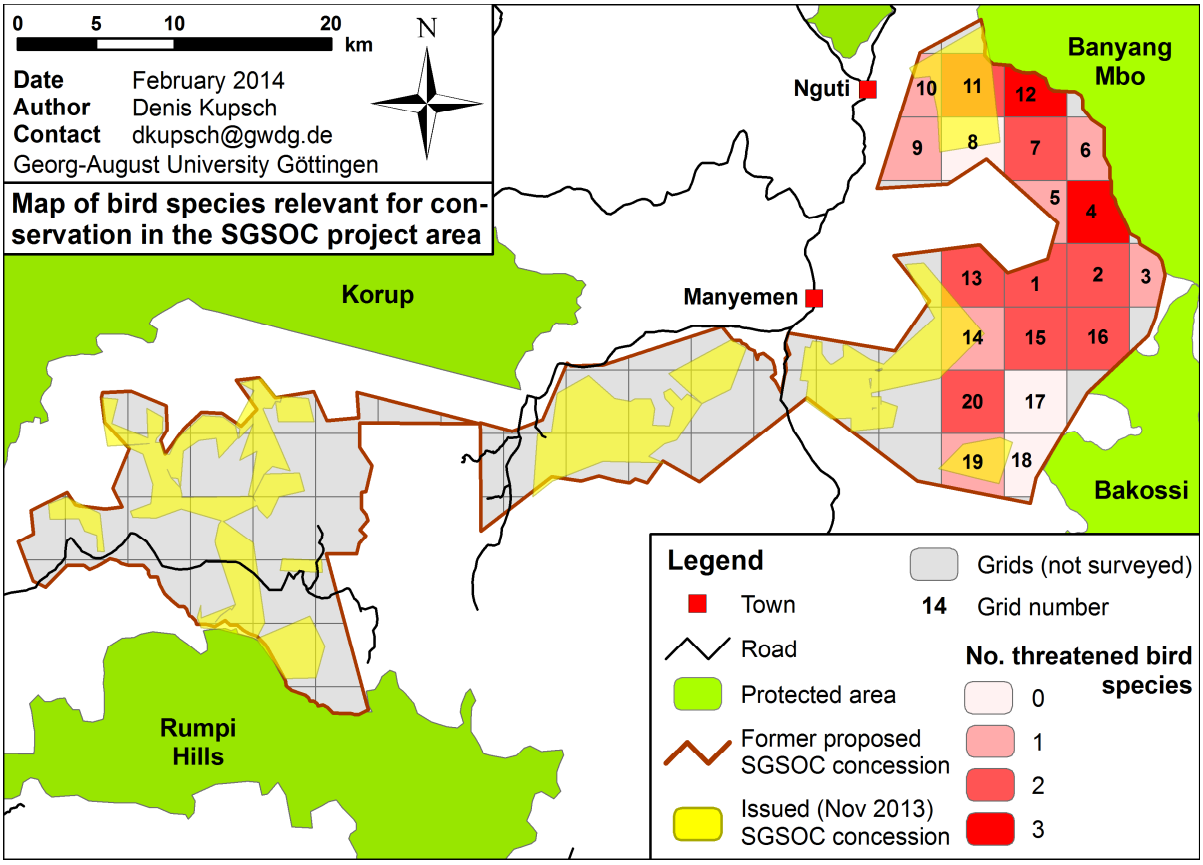

Figure 6 - Grid based distribution of bird species of conservation interest (listed with a higher threat category in the IUCN red list and/or as Class A animal in the Cameroonian Wildlife law; see also Table 4) recorded in the SGSOC concession area

3.4 Carbon stock estimates

We used the recorded vegetation data to calculate forest structure indicators and estimate above ground biomass, as well as carbon stock of the project area (Table 8). Compared to sampling plots of the surrounding forest areas (see Lewis et al. 2013), we found relatively high values for stem density (*SD* = 490 stems/ha) and basal area (*BA* = 40.7 m²/ha). Also, we recorded more stems (*n* = 508) and, consequently, a higher basal area (*BA* = 43.2 m²/ha) in the Ndian block than in the rest of the SGSOC project area. However, the forest of the study area showed a relatively low value for basal area-weighted wood mass density (*WD* = 0.58 g dry mass per cm³ fresh biomass) compared to other forests in the region (*WD* > 0.63 g/cm³), indicating considerable differences in tree species composition.

For the entire proposed concession area, we calculated a mean above ground biomass of *AGB* = 447.1 t/ha, resulting in a mean carbon stock estimate of *CE* = 259.2 tC/ha. Again, we found higher values for biomass and carbon in the Ndian block of the project area (*AGB* = 485.0 t/ha, *CE* = 281.1 tC/ha) compared to the Kupe block (*AGB* = 428.8 t/ha, *CE* = 248.6 tC/ha). The forest of the study area, therefore, ranges slightly above the mean biomass and carbon estimate of the Central African forests (*AGB* = 429 t/ha, *CE* = 249 tC/ha; Lewis et al. 2013).

Table 8 – Sampling area (*SA*), vegetation structure measures (stem density – *SD*, basal area – *BA*, wood mass density weighted by basal area – *WD* and above ground biomass – *AGB*) and carbon stock estimates (*CE*) of the proposed SGSOC concession area and comparable African forest plots; Kupe block relates to transects 1-30, Ndian 31-50

	SGSOC project area (this study)			Comparable African forests (Lewis et al. 2013)			
	Ndian block	Kupe block	***Total***	Takamanda	Ejagham	Banyang Mbo	***Central Africa***
***SA* (ha)**	7.00	14.25	***21.25***	9	2	8	***>200***
***SD* (n/ha)**	508	484	***490***	461	532	471	***425***
***BA* (m²/ha)**	43.2	39,9	***40,7***	30.1	30.0	28.6	***31.5***
***WD* (g/cm³)**	0.52	0.60	***0.58***	0.65	0.63	0.67	***0.64***
***AGB* (t/ha)**	485	429	***447***	384	389	339	***429***
***CE* (tC/ha)**	281	249	***259***	223	226	197	***249***

Extrapolating these findings, we calculated total estimates of AGB_{total} = 32.8 Gt above ground biomass and CE_{total} = 19.0 Gt biomass carbon stock for the entire proposed SGSOC concession area (and CE_{total} = 15.6 GtC for a proposed 60,000 ha plantation area, respectively).

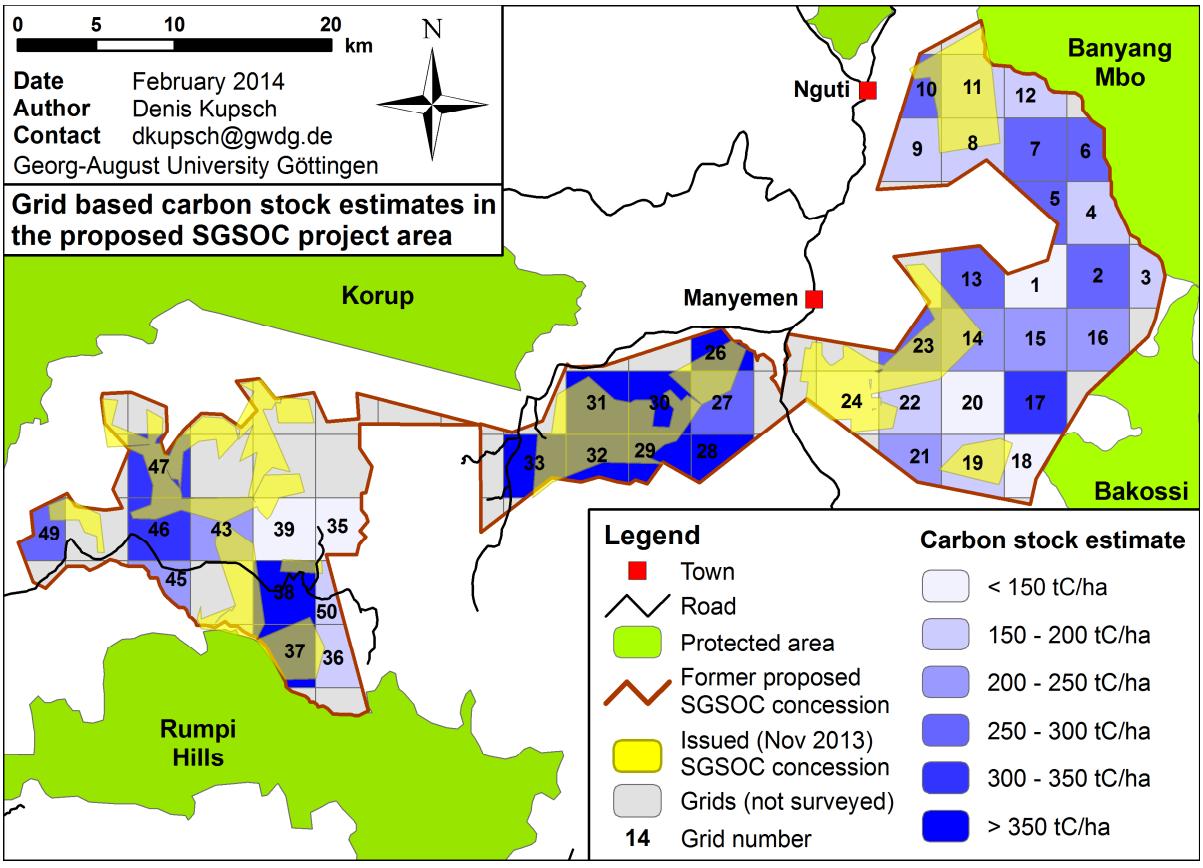

Figure 8 – Grid based illustration of carbon stock estimates in the proposed SGSOC concession area

A grid based analysis of carbon stock estimates supports the above mentioned findings that the carbon stock is not homogeneously distributed throughout the study area (Figure 8). We

can identify a clear pattern that is in accordance with the distribution we found for threatened tree species diversity: The highest rates of carbon ranging above *CE* = 300 tC/ha are located in the center and western part of the SGSOC project area. In the area east from Talangaye we calculated mean carbon estimates of around *CE* = 200 tC/ha.

For the concession area assigned in November 2013, we calculated slightly higher values of mean above-ground biomass (*AGB* = 468.2 t/ha) and carbon stock (*CE* = 271.3 tC/ha), which is mainly because the plots 'Talangaye', 'Manyemen-Ebanga' and 'Sikam' (all decree no. 2013/416) cover a large portion of the carbion rich center of the study area (Figure 8). But also plots in the Kupe block are located in areas comprising high carbon contents (plots 'Ikotti', 'Mobenge'/'Ndiba' - ´both decree no. 2013/417; 'Mokange' - decree no. 2013/418). Thus, the total area of 20,987 ha contains estimated totals of AGB_{total} = 9.8 Gt above ground biomass and CE_{total} = 5.7 Gt biomass carbon stock.

3.5 Carbon loss and market values

Referring to a considerable number of publications, Germer and Sauerborn (2008) quantified the above ground biomass in oil palm plantations including ground-cover vegetation at *AGB* = 62.5 t/ha and the below ground biomass at *BGB* = 20.0 t/ha, resulting in a carbon stock estimate of *CE* = 38.8 tC/ha. These figures represent time-averaged means of a typical 25-years economic life span of oil palm plantations. Taking these numbers and the findings on the carbon stock estimate from the SGSOC project area into account, we calculated a mean loss of biomass carbon of ΔCE = 220.4 tC/ha and ΔCE = 232.2 tC/ha for the former proposed and now issued SGSOC concession areas, respectively. Thus, the proposed establishment of 60,000 ha or 20,987 ha oil palm plantation would result in a total loss of biomass carbon of ΔCE_{total} = 13.2 GtC or ΔCE_{total} = 4.9 GtC, respectively.

Table 9 – Mean and total carbon emissions *E* (expressed in carbon dioxide equivalents) that would derive from conversion of the forested SGSOC project area (former proposed and finally issued) into oil palm plantation and related monetary values *MV* achievable at the forest carbon markets (based on Peters-Stanley et al. 2013)

	Former proposed SGSOC plantation area (60,000 ha)	**Issued (Nov 2013) SGSOC concession area** (20,987 ha)
E_{mean} **(tCO_2e/ha)**	957.0	996.0
E_{total} **($GtCO_2e$)**	57.4	20.9
MV_{mean} **(US$/ha)**	7,465	7,769
MV_{total} **(US$)**	447,878,989	163,041,575

Based on the figures given in the IPCC report of 1997 for mineral soils, Germer and Sauerborn (2008) numbered the mean soil carbon loss within one economical live span of an oil palm plantation (25 years) after conversion from intact forest at ΔSC = 40.8 tC/ha. The

conversion of 60,000 ha (former proposed plantation area) or 20,987 ha (now issued concession area) existing forest to oil palm plantation would entail a total soil carbon loss of ΔSC_{total} = 2.4 GtC and ΔSC_{total} = 0.8 GtC, respectively.

Assembling the estimates for both biomass and soil carbon losses, we quantify the potential total carbon dioxide emissions at E_{total} = 57.4 $GtCO_2e$ for the former proposed 60,000 ha plantation area and E_{total} = 20.9 $GtCO_2e$ for the now assigned 20,987 ha concession (Table 9). By adducting the average price of *AP* = 7.8 US$/tC paid on the international forest carbon markets in 2012 (Peters-Stanley et al. 2013), we found that conserving the forests in the proposed SGSOC concession area instead of converting them into oil palm plantation would generate *MV* = 7,465 US$/ha and *MV* = 7,769 US$/ha on average as well as MV_{total} = 447,878,989 US$ and MV_{total} = 163,041,575 US$ for the proposed 60,000 ha of plantation area and the newly issued concession area (November 2013), respectively.

4 Discussion

4.1 Biodiversity status of the SGSOC project area

The results of this study show that the area of the proposed SGSOC concession harbours high values in regard to biological diversity and species endemism.

With the exception of the gorilla, we recorded all large mammal species of conservation concern for the region, including Elliot's chimpanzee, drill, Preuss' red colobus and the forest elephant. Many of these even were encountered at higher rates in the study area than in Korup National Park. Albeit that population density and size estimates for chimpanzees and elephants were lower in our study area than those reported for Korup National Park, so far, there is an apparent lack of information on these species from areas outside protected areas. We expect all the confirmed species to use the study area for reproduction, which means it may directly support population viability, providing a more or less contiguous habitat. These records underline the importance of considering the management of the matrix of agroforestry systems, primary and secondary forests outside of protected areas in order to protect these species on the long term. Overall, more information would be required to address the issues of landscape matrix quality (permeability) and connectivity.

The small number of forest elephants estimated to have used the study area during the time of the survey indicates a year-round presence of this species which would go far beyond the notion that it may use it only as occasional corridor. But more research on elephant movements in the whole Southwest region, including adjacent Nigeria, would be required to design corridors for this species at appropriate spatial scales. The same is true for other large species.

The number of tree species recorded (421 spp.) in a covered area of just 21.25 ha is exceptionally high and compares well with what we known from Korup National Park. The 50 ha plot inside Korup National Park holds 473 tree species (all trees of *dbh* > 1 cm, Kenfack et al. 2007). Also the estimated total number of species for the concession (545 spp.) is remarkably high and confirms tree diversity estimates for comparably sized tropical forests.

More than eleven per cent of the tree species recorded were of conservation interest (48 spp.). One of these (*Cola praeacuta*) is both listed as 'critically endangered' by the IUCN red list and endemic to the study region. Considering its red list status, it is still relatively abundant in the study area (35 stems). However, a potential large-scale land use change within the concession may drastically increase its extinction risk.

When taking into account the tree species that Asamoah already listed 2011 for the SGSOC HCV Assessment (Table 10), we find a total number of 62 spp. of conservation concern within the planned concession area. Besides the threatened regional endemic *Cylicomorpha solmsii*, also *Berlinia hollandii* needs to be highlighted from that list. It is a rare forest tree with a narrow range known to occur in south-eastern Nigeria (IUCN 2013). If this new record

will be confirmed, the area of the SGSOC concession would play an important role in protecting the population of this endemic and endangered species.

Table 10 – Additional list of tree species relevant to conservation recorded in the concession by (Asamoah 2011) but not during this study

Species	IUCN status	Endemic to study region
Amanoa strobilacea	VU	
Angylocalyx oligophyllus	VU	
Berlinia hollandii	EN[1]	*
Cola butingii/umbratilis	VU	
Cola megalophylla	-	*
Cylicomorpha solmsii	VU	*
Garcinia epunctata	VU	
Hallea ledermannii/stipulosa	VU	
Oricia suaveolens	NT	
Placodiscus boya	VU	
Pouteria aningeri	NT	
Sapium aubrevillei	VU	
Schumanniophyton problematicum	VU	
Warneckia memecyloides	VU	

[1] **corrected to endangered, check iucnredlist.org; Asamoah (2011) mistakenly set no IUCN status**

We observed 126 and estimated a total of 143 bird species for the study area. However, since bird sampling could not be carried out throughout the entire concession, yet, these numbers are difficult to interpret and just account for the eastern part of the Kupe block of the SGSOC project area. Nevertheless, we recorded relatively high numbers of IUCN red-listed grey parrots (*n* = 18) and yellow-casqued hornbills (*n* = 44).

As one can see from Figure 6, the records of species relevant for bird conservation are evenly distributed throughout the sampled area. Given the fact, that we found higher tree diversities and carbon stocks (and thus, a higher total biomass as an indicator for intact high canopy forests) rather in the central and eastern part of the SGSOC concession (Figures 4 and 8), we expect these areas also to be a suitable habitat for these threatened bird species.

Recent surveys on fish and herpetofauna are in support of our findings on the high biodiversity value of the SGSOC project area. Schliewen and Bitja (2013) stated that the area of the eastern concession, which belongs to the Upper Cross zone, is characterized by high fish diversity and endemism. This area also contains relict fish assemblages and was therefore of major importance for African fish evolution. Beside other endemic fish species, Schliewen and Bitja (2013) recorded *Etia nguti*, which is a phylogenetic sister taxon to the majority of African cichlids and only occurs in the Upper Mamfue drainage. In addition, the same study revealed the presence of a fish species probably new to science, the cyprinid *Brycinus sp. aff. intermedius*, so far only known from the concession area. Conservation of

these waters is therefore of very high conservation priority. Schliewen and Bitja (2013) also found that the western part of the concession (Upper Ndian) harbours a fish fauna differing substantially from fish assemblages in Kupe block, which indicates a great total diversity of the entire SGSOC project area.

A rapid survey on the herpetofauna of the former proposed SGSOC concession area, Asamoah (2011) listed 51 species, which is more than Lawson (1994) found in Banyang Mbo sanctuary (46 ssp.) under a comparable sampling effort. Beside other threatened species, Asamoah (2011) also recorded more than 35 individuals of the endangered Four-digit Toad *Didynamipus sjostedti* in the northern part of the Ndian block of the proposed concession. This anuran species has an extremely narrow extent of occurrence and is known from fewer than five locations, e.g. Mount Cameroon and Oban Hills (IUCN 2013). Due to its patchy distribution, conservation of the Four-digit Toad highly depends on the rigorous protection of its few known populations, including the one revealed by Asamoah (2011).

4.2 Carbon stock and market value

We estimated a total biomass carbon stock of CE_{total} = 19.0 GtC and CE_{total} = 5.7 GtC for the former proposed and now issued SGSOC project area, respectively. These figures were derived from mean carbon stock estimates (*CE* = 259.2 tC/ha and *CE* = 271.3 tC/ha, respectively) ranging above the mean which Lewis et al. (2013) calculated for Central Africa (*CE* = 249 tC/ha) and other smaller comparable forest plots. This is mainly because both the basal area (*BA* = 40.7 m²/ha) and stem density (*SD* = 490 stems/ha) we recorded for in the study area were relatively high indicating a dense and intact forest structure, which is also in accordance with our finding on a high tree diversity. However, to some extent these figures may also be biased due to the small plot size of 0.25 ha. We assume that the total carbon stock estimate would slightly decrease when using larger plot sizes because these are less prone to sampling biases which Is especially important for quantitative analyses.

We found the highest estimates of carbon stock being closely related to tree species richness. Thus, the forest areas in the center and southwestern part store comparatively more carbon than the eastern part of the SGSOC project area.

A land-use change from existing forests to potential oil palm plantation would result in carbon dioxide emissions of E_{total} = 57.4 $GtCO_2e$ and E_{total} = 20.9 $GtCO_2e$ for the former proposed and now issued SGSOC concession, respectively. And, although the prices on the forest carbon market are fluctuating (and recently dropped mainly due to the European carbon prize crisis), this would still result in offset payments as high as MV_{total} = 447,878,989 US$ and MV_{total} = 163,041,575 US$, respectively. These remarkable values quite well illustrate that it is worth to reconsider the regional development strategy and weight potential revenues from taxes against those from carbon markets. Not least because payments from those initiatives could be used to support local and regional projects, while protecting the forests for wildlife as well as for future development of local communities.

4.3 Identification of high conservation values 1.2 and 1.3

The High Conservation Value 1, originally developed by the Forest Stewardship Council (FSC) to safeguard forest ecosystem with a high conservation value, is described as:

> 'Concentrations of biological diversity including endemic species, and rare, threatened or endangered species, that are significant at global, regional or national level' (Mbolo & Esono 2008).

We specifically address two of the sub-categories: HCV 1.2 –' Threatened and endangered species' and HCV 1.3 – 'Endemic species'.

Following the common and Cameroonian HCV interpretation (Brown et al. 2013; Mbolo & Esono 2008) we listed all large mammal and tree species of conservation concern (IUCN red-listed under a higher threat category, CITES listed/Class A listed by the Cameroonian Wildlife law and/or endemic at regional level) and illustrated their distribution within the study area. On this basis, we conclude that large areas of the proposed SGSOC concession represent a high conservation value 1.2 and 1.3.

We encountered chimpanzee, drill, forest elephant and Preuss' red colobus, throughout the area west of Banyang Mbo Wildlife Sanctury. Here, Schliewen and Bitja (2013) also recorded highly diverse fish assemblages, including *Etia nguti*. Considering the global importance of these species as well as their habitat needs, we identify the entire north-eastern part of the concession (grid cells 1 – 16) to be HCV 1.2.

Beside another chimpanzee encounter, we recorded exceptionally high numbers of both threatened *and* endemic tree species, such as *Cola praeacuta* (endemic and CR-listed), *Drypetes staudtii* or *Hymenostegia bakeriana* (both VU-listed and endemic), in the center of the concession, all the way from Talangaye to Banyo (grid cells 27 – 33) as well as in the southwestern part of the Ndian block (grid cells 37 – 50). Therefore, both these areas meet HCV criteria 1.2 *and* 1.3.

According to these evaluations, we conclude that from the concession assigned in November 2013 the plot 'Nguti' and 'Manyemen-Ebanga' (both decree no. 2013/416) meet HCV criterion 1.2 most notably due to the occurence of endangered mammal species. In addition, we catogerize the plots 'Ayong' and 'Sikam' as well as the western section of the 'Talangaye' plot (all decree no. 2013/416) as HCV 1.2 and 1.3 due to their importance as potential chimpanzee habitat and exceptional richness of threatened and endemic tree species. Since the latter equally accounts for the plots 'Ikotti', 'Lipenja I', 'Mobenge'/'Ndiba' (all decree no. 2013/417), 'Beboka village', 'Kuma', 'Lipenja II' and 'Mokange' (all decree no. 2013/418), we classify them as HCV 1.2 and 1.3.

Since we could not sample the remaining four grids in the northern part of the Ndian block, we can not make a statement on the HCV of this area. However, it is likely that we would at least encounter a high floral diversity because it is located between the above declared

areas of HCV and the Korup National Park. In addition, Asamoah (2011) recorded the endangered Four-digit Toad *Didynamipus sjostedti* in the North and North-East of Lipenja I (referring to the recently assigned plots 'Mokango-Bima' and 'Massaka-Bima'; both decree no. 2013/418), which supports our view, that these areas should be treated as HCV forests of criteria 1.2 and 1.3.

Asamoah (2011) did not record a noteworthily number of threatened mammal species in the entire concession area. Comparing these results with our findings, we learn that biodiversity assessments will always produce false negatives. This is particularly true when dealing with wildlife and limited financial means and sampling periods. Therefore, we need to keep in mind that we can not exclude the occurrence of threatened mammal species, such as chimpanzee or forest elephant, in the western part of the proposed concession as they do in Korup National Park (Waltert 2012). Generally, we believe that the entire study area is of utmost importance to fauna and flora for ensuring habitat connectivity and population viability.

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Appendices

Table A1 – IUCN status, geographical range, cumulated basal area and number of recorded tree species in the proposed SGSOC concession area

Species	APG III Family	IUCN status	Range	Basal area (m²)	Stems
Afrostyrax kamerunensis	Huaceae	-	L Gui - Cong	0.38	9
Afrostyrax lepidophyllus	Huaceae	VU	L Gui - Cong	1.42	34
Afzelia bipindensis	Fabaceae	VU	L Gui - Cong	0.08	4
Albizia adianthifolia	Fabaceae	LC	Africa	3.67	58
Albizia ferruginea	Fabaceae	VU	Gui - Cong	0.61	15
Albizia zygia	Fabaceae	-	Gui - Cong	1.40	47
Allanblackia floribunda	Clusiaceae	-	Gui - Cong	0.26	6
Allanblackia gabonensis	Clusiaceae	VU	L Gui	6.13	88
Allanblackia kisonghi	Annonaceae	-	L Gui - Cong	0.30	17
Allophylus africanus	Sapindaceae	-	Africa	0.02	1
Allophylus hirtellus	Sapindaceae	-	L Gui	0.09	3
Alstonia boonei	Apocynaceae	-	Gui - Cong	1.20	23
Amphimas ferrugineus	Fabaceae	-	L Gui	0.25	8
Angylocalyx pynaertii	Fabaceae	-	L Gui - Cong	0.16	9
Angylocalyx talbotii	Fabaceae	VU	L Gui	1.10	14
Aningeria sp	Sapotaceae	-	-	0.44	1
Anisophyllea meniaudii	Anisophylleaceae	-	U & L Gui	1.74	14
Anisophyllea purpurascens	Anisophylleaceae	-	L Gui	0.03	1
Anisophyllea sororia	Anisophylleaceae	-	L Gui	1.35	27
Annickia chlorantha	Annonaceae	-	L Gui - Cong	3.18	40
Anonidium mannii	Annonaceae	-	Gui - Cong	17.34	207
Anthocleista schweinfurthii	Gentianaceae	-	Gui - Cong	0.15	5
Anthocleista vogelii	Gentianaceae	-	Gui - Cong	0.62	9
Anthonotha fragrans	Fabaceae	-	U & L Gui	0.93	14
Anthonotha macrophylla	Fabaceae	-	Gui - Cong	7.57	112
Antiaris africana	Moraceae	-	U & L Gui - Cong	0.41	2
Antiaris sp	Moraceae	-	-	2.50	12
Antiaris toxicaria	Moraceae	-	Pantropics	0.02	1
Antidesma laciniatum	Phyllanthaceae	-	U & L Gui	1.12	15
Antidesma vogelianum	Phyllanthaceae	-	L Gui - Cong	3.11	34
Antrocaryon klaineanum	Anacardiaceae	-	L Gui	0.10	2
Antrocaryon micraster	Anacardiaceae	VU	Gui - Cong	0.18	6
Araliopsis soyauxii	Rutaceae	-	L Gui	0.82	23
Artocarpus heterophyllus	Moraceae	-	Pantropics	0.08	1
Aubrevillea kerstingii	Fabaceae	-	Gui - Cong	0.08	1
Aucoumea klaineana	Burseraceae	VU	Africa	0.11	2
Aulacocalyx caudata	Rubiaceae	-	L Gui	0.03	2
Aulacocalyx jasminiflora	Rubiaceae	-	L Gui - Cong	0.15	8
Aulacocalyx sp	Rubiaceae	-	-	0.03	1
Aulacocalyx talbotii	Rubiaceae	-	L Gui	0.51	16
Baikiaea insignis	Fabaceae	-	Gui - Cong	0.05	1
Baillonella toxisperma	Sapotaceae	VU	L Gui	0.13	1
Bambusa vulgaris	Bambuseae	-	Pantropics	-	5
Baphia capparidifolia	Fabaceae	-	L Gui	4.24	18

Baphia laurifolia	Fabaceae	-	U & L Gui	0.26	4
Baphia nitida	Fabaceae	LC	Africa	0.01	1
Baphia polygalacea	Fabaceae	-	U & L Gui	0.01	1
Baphia sp1	Fabaceae	-	-	0.11	8
Barteria fistulosa	Passifloraceae	-	L Gui - Cong	6.24	51
Beilschmiedia acuta	Lauraceae	-	L Gui - Cong	0.40	3
Beilschmiedia jacques-felixii	Lauraceae	-	L Gui	1.43	43
Beilschmiedia sp1	Lauraceae	-	-	3.31	35
Beilschmiedia sp2	Lauraceae	-	-	0.23	7
Beilschmiedia sp3	Lauraceae	-	-	0.31	6
Beilschmiedia sp4	Lauraceae	-	-	0.19	2
Beilschmiedia sp5	Lauraceae	-	-	0.16	1
Berlinia bracteosa	Fabaceae	-	U & L Gui	14.97	183
Berlinia craibiana	Fabaceae	-	L Gui	0.40	14
Berlinia grandiflora	Fabaceae	-	Gui - Cong	0.51	8
Blighia sapida	Sapindaceae	-	Pantropics	0.41	12
Blighia sp	Sapindaceae	-	-	0.01	1
Blighia welwitschii	Sapindaceae	-	U & L Gui - Cong	0.01	1
Bombax buonopozense	Malvaceae	-	U & L Gui - Cong	0.03	1
Brachystegia cynometroides	Fabaceae	LC	U & L Gui	2.77	57
Brachystegia kennedyi	Fabaceae	-	Nig - Cam	0.01	1
Brachystegia laurentii	Fabaceae	-	L Gui - Cong	0.08	4
Brachystegia sp	Fabaceae	-	-	0.41	7
Bridelia micrantha	Phyllanthaceae	-	Africa	3.34	24
Bridelia sp1	Phyllanthaceae	-	-	0.07	3
Bridelia sp2	Phyllanthaceae	-	-	0.83	4
Caloncoba glauca	Flacourtiaceae	-	L Gui	0.18	2
Calpocalyx dinklagei	Fabaceae	-	Gui	0.76	8
Calpocalyx heitzii	Fabaceae	VU	L Gui	3.42	32
Campylospermum mannii	Ochnaceae	-	Nig - Cam	3.07	13
Canarium schweinfurthii	Burseraceae	-	Africa	3.62	70
Canthium sp1	Rubiaceae	-	-	1.42	26
Canthium sp2	Rubiaceae	-	-	0.01	1
Carapa dinklagei	Meliaceae	-	L Gui	7.21	76
Carapa grandiflora	Meliaceae	-	Pantropics	0.02	1
Carapa procera	Meliaceae	-	Pantropics	2.90	31
Carica papaya	Caricaceae	-	Pantropics	0.17	13
Ceiba pentandra	Malvaceae	-	Africa	0.73	7
Celtis tessmannii	Malvaceae	-	L Gui - Cong	0.79	15
Chytranthus sp	Sapindaceae	-	-	2.55	56
Chytranthus talbotii	Sapindaceae	-	U & L Gui	0.61	4
Cleistopholis glauca	Annonaceae	-	U & L Gui - Cong	1.05	9
Cleistopholis patens	Annonaceae	-	Gui - Cong	7.50	73
Cleistopholis staudtii	Annonaceae	VU	L Gui	1.27	30
Coelocaryon preussii	Myristicaceae	-	L Gui - Cong	2.77	38
Cola altissima	Malvaceae	-	L Gui	0.10	3
Cola caricaefolia	Malvaceae	-	U & L Gui	1.25	14
Cola cauliflora	Malvaceae	-	L Gui	0.02	1
Cola chlamydanta	Malvaceae	-	U & L Gui - Cong	7.77	71
Cola digitata	Malvaceae	-	U & L Gui	0.06	4

Cola laterita	Malvaceae	-	Africa	4.65	68
Cola lepidota	Malvaceae	-	L Gui	19.03	306
Cola marsupium	Malvaceae	-	L Gui	0.20	3
Cola nitida	Malvaceae	-	U & L Gui - Cong	1.19	25
Cola pachycarpar	Malvaceae	-	L Gui	0.33	7
Cola praeacuta	Malvaceae	CR	Nig - Cam	2.95	35
Cola rostrata	Malvaceae	-	L Gui	2.92	54
Cola sp1	Malvaceae	-	-	0.09	2
Cola sp2	Malvaceae	-	-	0.03	2
Cola verticilliata	Malvaceae	-	U & L Gui	3.86	45
Craterispermum aristatum	Rubiaceae	-	Nig - Cam	0.53	14
Croton sp	Euphorbiacea	-	-	0.05	2
Crotonogyne strigosa	Euphorbiacea	VU	L Gui	0.03	1
Cylicodiscus gabunensis	Fabaceae	-	U & L Gui	1.14	11
Cyrtogonone argentea	Euphorbiacea	-	L Gui	0.08	1
Dacryodes buettneri	Burseraceae	-	L Gui	0.04	2
Dacryodes edulis	Burseraceae	-	L Gui	2.56	56
Dacryodes igaganga	Burseraceae	VU	L Gui	0.21	9
Dacryodes klaineana	Burseraceae	-	U & L Gui	1.46	17
Dacryodes macrophylla	Burseraceae	-	L Gui	0.46	3
Daniellia klainei	Fabaceae	NT	L Gui	1.46	4
Dasylepis blackii	Achariaceae	-	L Gui	3.91	30
Desbordesia glaucescens	Irvingiaceae	-	L Gui - Cong	2.28	37
Detarium macrocarpum	Fabaceae	-	U & L Gui	0.05	6
Dialium bipindense	Fabaceae	NT	L Gui	0.01	1
Dialium dinklagei	Fabaceae	-	U & L Gui	0.01	1
Dialium mannii	Fabaceae	-	L Gui	0.17	12
Dialium pachyphyllum	Fabaceae	-	L Gui	4.01	19
Dialium sp1	Fabaceae	-	-	0.01	1
Dialium sp2	Fabaceae	-	-	0.02	1
Dialium sp3	Fabaceae	-	-	0.02	1
Dialium zenkeri	Fabaceae	-	L Gui - Cong	2.18	4
Dichaetanthera africana	Melastomastaceae	-	Gui - Cong	0.03	1
Dichostema glaucescence	Euphorbiacea	-	L Gui - Cong	7.83	117
Didelotia africana	Fabaceae	-	L Gui	3.71	36
Didelotia letouzeyi	Fabaceae	-	L Gui	0.02	2
Diogoa zenkeri	Olacaceae	-	L Gui - Cong	13.44	186
Diospyros gabunensis	Ebenaceae	-	U & L Gui	0.91	9
Diospyros gracilescens	Ebenaceae	-	L Gui	0.04	3
Diospyros hoyleana	Ebenaceae	-	Gui - Cong	0.46	13
Diospyros iturensis	Ebenaceae	-	L Gui - Cong	2.99	57
Diospyros sp1	Ebenaceae	-	-	0.02	1
Diospyros sp2	Ebenaceae	-	-	0.02	1
Diospyros zenkeri	Ebenaceae	-	L Gui	3.39	33
Discoglypremna caloneura	Euphorbiacea	-	Gui - Cong	0.87	15
Distemonanthus benthamianus	Fabaceae	-	U & L Gui	0.73	20
Dracaena talbotii	Ruscaceae	-	Nig - Cam	0.06	2
Drypetes sp1	Putrangivaceae	-	-	0.26	5
Drypetes sp2	Putrangivaceae	-	-	0.07	1

Drypetes staudtii	Putrangivaceae	VU	Nig - Cam	3.42	37
Duboscia macrocarpa	Malvaceae	-	L Gui - Cong	4.53	57
Elaeis guineensis	Arecaceae	-	Pantropics	1.95	21
Endodesmia calophylloides	Clusiaceae	-	L Gui	0.02	1
Englerophytum sp1	Sapotaceae	-	-	0.98	35
Engomegoma gordonii	Olacaceae	-	L Gui	2.33	25
Entandrophragma angolense	Meliaceae	VU	Africa	0.12	1
Entandrophragma candollei	Meliaceae	VU	U & L Gui - Cong	0.19	1
Entandrophragma cylindricum	Meliaceae	VU	Gui - Cong	2.18	17
Entandrophragma utile	Meliaceae	VU	U & L Gui - Cong	0.51	5
Eribroma oblongum	Malvaceae	VU	U & L Gui - Cong	2.96	34
Eriocoelum macrocarpum	Sapindaceae	-	L Gui	0.83	2
Erismadelphus exsul	Vochysiaceae	-	L Gui	0.93	7
Erythrina excelsa	Fabaceae	-	U & L Gui - Cong	0.02	2
Erythrophleum ivoriense	Fabaceae	-	U & L Gui	0.01	1
Erythroxylum mannii	Erythroxylaceae	-	U & L Gui	0.54	14
Eugenia callophyloides	Myrtaceae	-	U & L Gui	0.33	6
Eugenia sp	Myrtaceae	-	-	0.01	1
Eugenia talbotii	Myrtaceae	-	Nig - Cam	1.33	24
Euphorbia kamerunica	Euphorbiacea	-	Africa	0.03	2
Fagara macrophylla	Rutaceae	-	L Gui - Cong	5.62	49
Ficus craterostoma	Moraceae	-	Africa	0.02	1
Ficus exaspirata	Moraceae	-	Africa	0.34	6
Ficus mucuso	Moraceae	-	Africa	1.74	25
Ficus sp1	Moraceae	-	-	0.13	5
Ficus sp2	Moraceae	-	-	0.02	2
Ficus vogeliana	Moraceae	-	U & L Gui	0.03	2
Fillaeopsis discophora	Fabaceae	-	L Gui	0.01	1
Funtumia elastica	Apocynaceae	-	Gui - Cong	11.46	162
Gaertnera bieleri	Rubiaceae	-	L Gui - Cong	0.11	3
Gambeya africana	Sapotaceae	-	L Gui - Cong	0.02	1
Garcinia conrauana	Clusiaceae	-	L Gui	0.83	29
Garcinia gnetoides	Clusiaceae	-	U & L Gui	0.09	1
Garcinia granulata	Clusiaceae	-	U & L Gui	1.64	16
Garcinia kola	Clusiaceae	VU	Gui - Cong	7.41	145
Garcinia mannii	Clusiaceae	-	L Gui	19.30	282
Garcinia ovalifolia	Clusiaceae	-	Gui - Cong	1.22	11
Garcinia smeathmannii	Clusiaceae	-	Gui - Cong	0.01	1
Garcinia sp1	Clusiaceae	-	-	0.07	1
Garcinia sp2	Clusiaceae	-	-	0.06	6
Gilbertiodendron brachystegioides	Fabaceae	-	L Gui	0.75	29
Gilbertiodendron dewevrei	Fabaceae	-	Gui - Cong	0.03	1
Gilbertiodendron sp	Fabaceae	-	-	0.17	2
Glossocalyx brevipes	Monimiaceae	-	L Gui	0.43	3
Glyphaea sp	Malvaceae	-	-	1.38	2
Greenwayodendron suaveolens	Annonaceae	LC	Africa	0.48	22
Guarea cedrata	Meliaceae	VU	Gui - Cong	3.13	58
Guarea glomerulata	Meliaceae	-	L Gui	0.27	9

Guarea thompsonii	Meliaceae	VU	Gui - Cong	3.56	15
Harungana madagascariensis	Hypericaceae	-	Africa	1.11	18
Heisteria parvifolia	Olacaceae	-	U & L Gui	0.59	13
Heudelotia africana	Burseraceae	-	Africa	0.01	1
Homalium africanum	Salicaceae	-	U & L Gui	4.51	61
Homalium letestui	Salicaceae	-	U & L Gui	3.70	41
Homalium longistylum	Salicaceae	-	Africa	6.10	100
Honnoa klaineana	Simaroubaceae	-	L Gui	0.07	1
Hunteria sp	Apocynaceae	-	-	0.32	3
Hunteria umbellata	Apocynaceae	-	Gui - Cong	2.57	37
Hylodendron gabunense	Fabaceae	-	L Gui - Cong	9.82	134
Hymenostegia afzelii	Fabaceae	-	U & L Gui	2.25	39
Hymenostegia bakeriana	Fabaceae	VU	Nig - Cam	0.35	3
Hymenostegia sp1	Fabaceae	-	-	0.03	1
Hymenostegia sp2	Fabaceae	-	-	0.01	1
Hypodaphnis zenkeri	Lauraceae	-	L Gui	0.07	4
Irvingia gabonensis	Irvingiaceae	NT	U & L Gui	7.31	87
Irvingia grandifolia	Irvingiaceae	-	L Gui - Cong	1.99	30
Irvingia robur	Irvingiaceae	-	Gui - Cong	3.17	23
Irvingia Smithii	Irvingiaceae	-	Gui - Cong	0.09	1
Isolona campanulata	Annonaceae	-	U & L Gui	0.02	1
Ixora sp	Rubiaceae	-	-	1.77	1
Julbernardia seretii	Fabaceae	-	L Gui - Cong	0.42	1
Keayodendron bridelioides	Euphorbiacea	-	U & L Gui	0.01	1
Khaya ivorensis	Meliaceae	VU	U & L Gui	0.01	1
Khaya sp	Meliaceae	-	-	1.02	33
Klaineanthus gaboniae	Euphorbiacea	-	L Gui	9.09	87
Klainedoxa gabonensis	Irvingiaceae	-	L Gui - Cong	3.89	43
Klainedoxa trillesii	Irvingiaceae	-	Gui - Cong	0.02	1
Laccodiscus pseudostiplaris	Sapindaceae	-	L Gui - Cong	0.03	1
Lannea welwitschii	Anacardiaceae	-	Africa	0.35	5
Lansianthera africana	Icacinaceae	-	L Gui	0.98	12
Leonardendron gabunense	Fabaceae	-	L Gui	0.04	1
Leonardoxa africana	Fabaceae	LC	L Gui	7.04	30
Leptaulus daphnoides	Icacinaceae	-	Africa	0.01	1
Leptonychia pallida	Malvaceae	-	L Gui	0.01	1
Lophira alata	Ochnaceae	VU	U & L Gui	5.41	35
Lovoa trichilioides	Meliaceae	VU	U & L Gui	0.61	2
Macaranga barteri	Euphorbiacea	-	U & L Gui	4.35	22
Macaranga monandra	Euphorbiacea	-	Gui - Cong	6.83	90
Macaranga occidentalis	Euphorbiacea	-	Nig - Cam	0.05	1
Macaranga schweinfurthii	Euphorbiacea	-	Gui - Cong	1.27	14
Macaranga sp	Euphorbiacea	-	-	0.37	2
Maesobotrya barteri	Phyllanthaceae	-	L Gui	1.60	30
Maesobotrya dusenii	Phyllanthaceae	-	L Gui	1.05	30
Maesopsis eminii	Rhamnaceae	-	Africa	0.54	6
Magnistipula glaberrima	Chrysobalanaceae	-	L Gui	0.45	4
Magnistipula tessmannii	Chrysobalanaceae	-	L Gui	0.34	2
Mamea africana	Clusiaceae	-	Gui - Cong	6.50	62
Mangifera indica	Anacardiaceae	-	Pantropics	0.35	9

Manikara obovata	Sapotaceae	-	Africa	3.28	16
Maprounea membranacea	Euphorbiacea	-	U & L Gui	0.01	1
Maranthes chrysophylla	Chrysobalanaceae	-	U & L Gui	0.18	4
Maranthes glabra	Chrysobalanaceae	-	Gui - Cong	0.02	1
Maranthes sp	Chrysobalanaceae	-	-	0.03	1
Mareya micrantha	Euphorbiacea	-	Gui - Cong	0.08	1
Mareyopsis longifolia	Euphorbiacea	-	L Gui - Cong	2.33	77
Margaritaria discoidea	Phyllanthaceae	-	Africa	2.02	35
Markhamia lutea	Bignoniaceae	-	Africa	0.17	1
Massularia acuminata	Rubiaceae	-	Gui - Cong	2.41	5
Medusandra mpomiana	Malvaceae	-	Nig - Cam	0.04	3
Memecylon sp	Melastomastaceae	-	-	0.02	1
Microcos coriacea	Malvaceae	-	L Gui	0.16	2
Microdesmis puberula	Pandaceae	-	L Gui - Cong	0.38	14
Milicia excelsa	Moraceae	NT	Africa	0.39	7
Mitragyna ciliata	Rubiaceae	-	U & L Gui	1.43	17
Monodora myristica	Annonaceae	-	Africa	0.02	1
Monodora tenuifolia	Annonaceae	-	Africa	3.42	46
Monopetalanthus letestui	Fabaceae	-	L Gui	12.63	78
Morinda lucida	Rubiaceae	-	U & L Gui	0.64	4
Musanga cecropioides	Urticaceae	-	Africa	17.47	144
Myrianthus arboreus	Urticaceae	-	Africa	2.17	31
Myrianthus preussii sbsp preussii	Urticaceae	-	L Gui	0.08	1
Nauclea diderrichii	Rubiaceae	VU	Gui - Cong	0.61	5
Nauclea sp1	Rubiaceae	-	-	0.11	2
Neoboutonia glabrescens	Euphorbiaceae	-	Gui - Cong	0.04	1
Nesogordonia papaverifera	Malvaceae	VU	Gui - Cong	0.07	5
Octoknema affinis	Olacaceae	-	L Gui - Cong	0.15	3
Olax latifolia	Olacaceae	-	L Gui	0.03	3
Olax sp	Olacaceae	-	-	1.99	7
Omphalocarpum elatum	Sapotaceae	-	U & L Gui	0.24	6
Omphalocarpum procerum	Sapotaceae	-	Gui - Cong	0.06	3
Ongokea gore	Olacaceae	-	Gui - Cong	0.80	7
Oubanguia alata	Lecythidaceae	-	L Gui	1.81	33
Oubanguia laurifolia	Lecythidaceae	-	L Gui	0.54	4
Ouratea myrioneura	Ochnaceae	-	U & L Gui	3.44	26
Pachypodanthium staudtii	Annonaceae	-	Gui - Cong	0.08	5
Panda oleosa	Pandaceae	-	L Gui - Cong	4.89	27
Parabelinia bifoliolata	Fabaceae	-	L Gui - Cong	0.02	1
Parinari exselsa	Chrysobalanaceae	-	Africa	0.04	2
Parkia bicolor	Fabaceae	LC	Gui - Cong	0.10	8
Parkia nitida	Fabaceae	-	South America	0.02	2
Pausinystalia macrosceras	Rubiaceae	-	L Gui	0.05	3
Pentaclethra eetveldeana	Fabaceae	-	L Gui	0.11	6
Pentaclethra macrophylla	Fabaceae	-	Gui - Cong	0.51	12
Pentadesma butyracea	Cluciaceae	-	U & L Gui	0.24	5
Pentadesma grandifolia	Clusiaceae	-	L Gui	0.98	2
Persea americana	Lauraceae	-	Pantropics	0.15	5
Petersia africania	Lecythidaceae	-	Gui - Cong	0.02	1

Petersianthus macrocarpus	Lecythidaceae	-	Gui - Cong	3.40	26
Petitiocodon parviflorum	Rubiaceae	-	L Gui	0.51	3
Picralima nitida	Apocynaceae	-	Gui - Cong	0.62	12
Piptadeniastrum africanum	Fabaceae	-	Gui - Cong	26.86	219
Piptostigma oyemense	Annonaceae	-	L Gui	0.06	3
Placodiscus sp1	Sapindaceae	-	-	1.89	17
Placodiscus sp2	Sapindaceae	-	-	0.02	1
Plagiostyles africana	Euphorbiacea	-	L Gui - Cong	0.02	1
Pleiocarpa bicarpellata	Apocynaceae	-	L Gui - Cong	0.06	4
Poga oleosa	Anisophylleaceae	-	L Gui - Cong	0.11	8
Polyceratocarpus parviflorus	Annonaceae	-	U & L Gui	0.05	2
Polyphaeria macrophylla	Rubiaceae	-	Gui - Cong	0.78	25
Protomegabaria stapfiana	Phyllanthaceae	-	U & L Gui	2.39	53
Pseudospondias microcarpa	Anacardiaceae	-	Gui - Cong	9.10	137
Psidium guajava	Myrtaceae	-	Pantropics	0.87	3
Pterocarpus mildbraedii	Fabaceae	-	Africa	0.08	1
Pterocarpus soyauxii	Fabaceae	-	L Gui	2.76	32
Pterocarpus sp1	Fabaceae	-	-	1.38	4
Pterygota bequaertii	Malvaceae	VU	Gui - Cong	10.51	71
Pycnanthus angolensis	Myristicaceae	-	Africa	25.10	257
Raphia hookeri	Arecaceae	-	U & L Gui	0.56	6
Rauvolfia caffra	Apocynaceae	-	Gui - Cong	2.74	13
Rauvolfia macrophylla	Apocynaceae	-	L Gui	0.26	6
Rauvolfia mannii	Apocynaceae	-	L Gui - Cong	0.01	1
Rauvolfia vomitoria	Apocynaceae	-	Gui - Cong	0.12	8
Rhaptopetalum sp	Lecythidaceae	-	-	0.22	15
Rhodognaphalon brevicuspe	Malvaceae	VU	U & L Gui	0.02	1
Ricinodendron heudelotii	Euphorbiacea	-	Africa	1.21	18
Rinorea detata	Violaceae	-	Africa	0.51	3
Rinorea kamerunensis	Violaceae	-	L Gui	0.14	1
Rinorea lepidobotrys	Violaceae	-	U & L Gui	0.56	10
Rinorea oblongifolia	Violaceae	-	Africa	11.55	126
Rothmannia hispida	Rubiaceae	-	U & L Gui	0.80	4
Santiria africana	Burseraceae	-	Gui - Cong	31.76	228
Santiria balsamifera	Burseraceae	-	Gui - Cong	0.24	10
Santiria tremari	Burseraceae	-	Gui - Cong	2.99	34
Sapium sp	Euphorbiacea	-	-	0.72	5
Scaphopetalum blackii	Malvaceae	-	L Gui	2.80	23
Scaphopetalum sp	Malvaceae	-	-	0.71	4
Schefflera barteri	Araliaceae	-	Africa	2.51	25
Schumanniophyton magnificum	Rubiaceae	-	L Gui - Cong	0.04	2
Scorodophlocus zenkeri	Fabaceae	-	L Gui - Cong	0.12	1
Scottelia klaineana	Achariaceae	-	Gui - Cong	1.77	4
Scyphocephalium mannii	Cluciaceae	-	L Gui	3.86	23
Scytopetalum klaineanum	Scytopetalaceae	-	L Gui	0.73	19
Sibangea similis	Putrangivaceae	-	L Gui	1.56	16
Sindoropsis letestui	Fabaceae	-	L Gui	1.54	45
Sorindeia grandifolia	Anacardiaceae	-	L Gui	0.06	1
Sorindeia juglandifolia	Anacardiaceae	-	U & L Gui	2.13	54

Soyauxia gabonensis	Medusandraceae	-	L Gui	0.78	21
Spathodea campanulata	Bignoniaceae	-	Africa	0.04	1
Staudtia kamerunensis	Myristicaceae	-	Gui - Cong	8.95	111
Staudtia stipitata	Myristicaceae	-	L Gui - Cong	1.11	22
Stemonocoleus micranthus	Fabaceae	-	Gui - Cong	0.01	1
Sterculia tragacantha	Malvaceae	-	Gui - Cong	1.10	26
Strombosia grandifolia	Olacaceae	-	U & L Gui	4.21	64
Strombosia pustulata	Olacaceae	-	Gui - Cong	13.65	108
Strombosia scheffleri	Olacaceae	-	Gui - Cong	3.22	55
Strombosia sp1	Olacaceae	-	-	0.39	4
Strombosia sp2	Olacaceae	-	-	0.30	4
Strombosia sp3	Olacaceae	-	-	1.98	19
Strombosiopsis tetrandra	Olacaceae	-	L Gui - Cong	45.04	525
Symphonia globulifera	Cluciaceae	-	Africa	2.51	47
Synsepallum msolo	Sapotaceae	-	Africa	0.07	1
Synsepallum stipulatum	Sapotaceae	-	L Gui - Cong	0.10	2
Syzygium rowlandii	Myrtaceae	-	U & L Gui	0.35	10
Syzygium sp	Myrtaceae	-	-	0.02	2
Syzygium staudtii	Myrtaceae	-	Gui - Cong	0.04	4
Tabernaemontana brachyanta	Apocynaceae	-	L Gui	8.78	108
Tabernaemontana crassa	Apocynaceae	-	Gui - Cong	7.87	66
Talbotiella eketensis	Fabaceae	-	Nig - Cam	0.08	2
Tapura africana	Dichapetalaceae	-	L Gui	4.79	70
Tarenna sp1	Rubiaceae	-	-	4.03	68
Tarenna sp2	Rubiaceae	-	-	0.03	1
Terminalia ivoriensis	Combretaceae	VU	U & L Gui	1.33	22
Terminalia superba	Combretaceae	-	Gui - Cong	2.71	28
Tetraberlinia bifoliolata	Fabaceae	-	L Gui	1.92	14
Tetrapleura tetraptera	Fabaceae	-	Gui - Cong	0.78	7
Theobroma cacao	Malvaceae	-	Pantropics	2.05	26
Treculia acuminata	Moraceae	-	L Gui	20.94	284
Treculia africana	Moraceae	-	Gui - Cong	0.02	2
Treculia obovoidea	Moraceae	-	L Gui - Cong	0.01	1
Tricalysia sp1	Rubiaceae	-	-	0.07	3
Tricalysia sp2	Rubiaceae	-	-	0.03	1
Tricalysia sp3	Rubiaceae	-	-	0.04	1
Trichilia heudelotii	Meliaceae	-	Gui - Cong	6.91	54
Trichilia monodelpha	Meliaceae	-	Gui - Cong	0.01	1
Trichilia tessmannii	Meliaceae	-	U & L Gui	0.79	11
Trichilia welwitschii	Meliaceae	-	L Gui - Cong	0.13	7
Trichoscypha acuminata	Anacardiaceae	-	L Gui - Cong	5.78	57
Trichoscypha klainei	Anacardiaceae	-	L Gui	0.01	1
Trichoscypha patens	Anacardiaceae	-	L Gui	0.02	2
Trichoscypha preussii	Anacardiaceae	-	U & L Gui	0.01	1
Trichoscypha sp1	Anacardiaceae	-	-	0.01	1
Trichoscypha sp2	Anacardiaceae	-	-	0.01	1
Trichoscypha sp3	Anacardiaceae	-	-	0.60	21
Trichoscypha sp4	Anacardiaceae	-	-	0.06	1
Trichoscypha sp5	Anacardiaceae	-	-	0.06	1
Trichoscypha sp6	Anacardiaceae	-	-	0.06	1

Tridesmostemon omphalocardoides	Sapotaceae	-	L Gui - Cong	0.08	1
Trilepisium madagascariense	Moraceae	-	Africa	0.38	4
Turraeanthus africanus	Meliaceae	VU	U & L Gui	8.00	76
Turraeanthus mannii	Meliaceae	-	Nig - Cam	8.75	102
Uapaca guineensis	Euphorbiacea	-	Africa	1.67	21
Uapaca staudtii	Phyllanthaceae	-	L Gui	26.32	231
Unknown	Malvaceae	-	-	2.08	18
Unknown1	-	-	-	0.03	1
Unknown2	-	-	-	0.06	2
Unknown3	-	-	-	0.04	1
Unknown4	-	-	-	0.14	1
Unknown5	-	-	-	0.30	2
Unknown6	-	-	-	0.04	2
Uvariastrum pierreanum	Annonaceae	-	U & L Gui	0.21	4
Uvariodendron connivens	Annonaceae	NT	U & L Gui	0.24	1
Uvariodendron giganteum	Annonaceae	VU	L Gui	1.81	30
Uvariodendron sp	Annonaceae	-	-	0.23	6
Uvariopsis bakeriana	Annonaceae	-	Nig - Cam	0.16	3
Vernonia conferta	Asteraceae	-	Gui - Cong	0.02	2
Vernonia frondosa	Asteraceae	-	U & L Gui	0.03	2
Vitex grandifolia	Lamiaceae	-	U & L Gui	9.83	124
Vitex sp1	Lamiaceae	-	-	0.06	1
Vitex sp2	Lamiaceae	-	-	0.06	1
Voacanga africana	Apocynaceae	-	Africa	1.23	12
Warneckia jasminoides	Melastomastaceae	-	L Gui - Cong	1.27	26
Warneckia pulcherrima	Melastomastaceae	-	L Gui	2.68	24
Xylopia acutiflora	Annonaceae	-	Gui - Cong	0.86	10
Xylopia aethiopica	Annonaceae	-	Gui - Cong	0.98	4
Xylopia villosa	Annonaceae	-	U & L Gui	0.05	2
Zanthoxylum heitzii	Rutaceae	-	L Gui	2.88	11
Zanthoxylum sp	Rutaceae	-	-	0.02	1

Table A2 – Encounter rates of recorded bird species in the proposed SGSOC concession area

Englisch Name	Scientific Name	Records per hour
African green pigeon	*Treron calvus*	0.34
African grey parrot	*Psittacus erithacus*	0.60
Ansorge's greenbul	*Eurillas ansorgei*	0.64
Bare-cheecked trogon	*Apaloderma aequatoriale*	0.13
Bates's sunbird	*Cinnyris batesi*	0.03
Black and white flycatcher	*Bias musicus*	0.03
Black bee-eater	*Merops gularis*	0.07
Black capped apalis	*Apalis nigriceps*	0.40
Black capped illadopsis	*Illadopsis cleaveri*	0.20
Black casqued wattle hornbill	*Ceratogymna atrata*	1.14
Black cuckoo	*Cuculus clamosus*	0.91
Black headed oriole	*Oriolus larvatus*	1.14
Black sparrowhawk	*Accipiter melanoleucus*	0.03
Black throated coucal	*Centropus leucogaster*	0.50
Blue billed malimbe	*Malimbus nitens*	0.40
Blue breasted kingfisher	*Halcyon malimbica*	0.27
Blue cuckoo-shrike	*Coracina azurea*	0.64
Blue headed crested flycatcher	*Trochocercus nitens*	1.17
Blue headed wood dove	*Turtur brehmeri*	1.64
Blue spotted wood dove	*Turtur afer*	0.03
Blue throated brown sunbird	*Cyanomitra cyanolaema*	0.87
Blue throated roller	*Eurystomus gularis*	0.10
Bristle nosed barbet	*Gymnobucco peli*	0.80
Brown chested alethe	*Pseudalethe poliocephala*	0.37
Brown illadopsis	*Illadopsis fulvescens*	0.50
Buff spotted woodpecker	*Campethera nivosa*	0.17
Buff throated apalis	*Apalis rufogularis*	0.64
Cameroon sombre greenbul	*Andropadus importunus*	0.03
Cardinal woodpecker	*Dendropicos fuscescens*	0.03
Cassin's spinetail	*Neafrapus cassini*	0.03
Chestnut breasted negrofinch	*Nigrita bicolor*	0.13
Chestnut wattle-eye	*Platysteira castanea*	0.87
Chocolate backed kingfisher	*Halcyon badia*	0.37
Collared sunbird	*Hedydipna collaris*	1.27
Common bulbul	*Pycnonotus barbatus*	0.10
Crested malimbe	*Malimbus malimbicus*	0.10
Eastern bearded greenbul	*Criniger chloronotus*	1.11
Emerald cuckoo	*Chrysococcyx cupreus*	0.13
Fire crested alethe	*Alethe castanea*	1.11
Forest robin	*Stiphrornis erythrothorax*	1.41
Forest swallow	*Petrochelidon fuliginosa*	0.07
Fraser's forest flycatcher	*Fraseria ocreata*	0.27
Fraser's sunbird	*Deleornis fraseri*	0.60
Golden greenbul	*Calyptocichla serinus*	0.17

Great blue turaco	*Corythaeola cristata*	1.01
Green backed woodpecker	*Campethera cailliautii*	0.10
Green crombec	*Sylvietta virens*	0.10
Green hylia	*Hylia prasina*	1.37
Green sunbird	*Anthreptes rectirostris*	0.10
Grey crowned negrofinch	*Nigrita canicapilla*	0.03
Grey longbill	*Macrosphenus concolor*	1.71
Grey throated barbet	*Gymnobucco bonapartei*	0.10
Hairy breasted barbet	*Tricholaema hirsuta*	1.11
Harrier hawk	*Polyboroides typus*	0.10
Honeyguide greenbul	*Baeopogon indicator*	0.30
Icterine greenbul	*Phyllastrephus icterinus*	1.01
Klaas's cuckoo	*Chrysococcyx klaas*	0.20
Least honeyguide	*Indicator exilis*	0.03
Lemon bellied crombec	*Sylvietta denti*	0.17
Little greenbul	*Eurillas virens*	5.33
Little grey greenbul	*Eurillas gracilis*	0.30
Long tailed hawk	*Urotriorchis macrourus*	0.03
Many colour bush-shrike	*Telophorus multicolor*	0.20
Naket faced barbet	*Gymnobucco calvus*	0.34
Nkulengu rail	*Himantornis haematopus*	0.03
Olive bellied sunbird	*Cinnyris chloropygia*	0.03
Olive green camaroptera	*Camaroptera chloronota*	0.70
Olive longtail cuckoo	*Cercococcyx olivinus*	0.37
Olive sunbird	*Cyanomitra olivacea*	3.32
Pale breasted illadopsis	*Illadopsis rufipennis*	0.70
Pale fronted negrofinch	*Nigrita luteifronsan*	0.23
Pied hornbill	*Tockus fasciatus*	0.03
Piping hornbill	*Bycanistes fistulator*	0.44
Pygmy kingfisher	*Ispidina picta*	0.07
Rachel's malimbe	*Malimbus racheliae*	0.03
Red bellied paradise flycatcher	*Terpsiphone rufiventer*	1.04
Red billed dwarf hornbill	*Tockus camurus*	0.10
Red chested cuckoo	*Cuculus solitarius*	0.80
Red chested owlet	*Glaucidium tephronotum*	0.07
Red eyed puffback	*Dryoscopus senegalensis*	0.10
Red fronted parrot	*Poicephalus gulielmi*	0.07
Red headed antpecker	*Melanerpes erythrocephalus*	0.07
Red rumped tinkerbird	*Pogoniulus atroflavus*	0.44
Red tailed bristlebill	*Bleda syndactylus*	3.02
Red tailed greenbul	*Criniger calurus*	1.61
Red vented malimbe	*Malimbus scutatus*	0.03
Rufous crowned eremomela	*Eremomela badiceps*	0.03
Rufous flycatcher thrush	*Neocossyphus fraseri*	0.40
Rufous sided broadbill	*Smithornis rufolateralis*	0.37
Scaly francolin	*Pternistis squamatus*	0.07
Shining blue kingfisher	*Alcedo quadribrachys*	0.30

Shining drongo	*Dicrurus atripennis*	1.07
Sjöstedt honeyguide greenbul	*Baeopogon clamans*	0.03
Slender billed greenbul	*Stelgidillas gracilirostris*	0.40
Speckled tinkerbird	*Pogoniulus scolopaceus*	0.37
Splendid glossy starling	*Lamprotornis splendidus*	0.07
Spotted greenbul	*Ixonotus guttatus*	0.37
Superb sunbird	*Cinnyris superbus*	0.30
Swamp palm bulbul	*Thescelocichla leucopleura*	0.03
Tambourine dove	*Turtur tympanistria*	0.37
Velvet mantled drongo	*Dicrurus modestus*	0.10
Western nicator	*Nicator chloris*	1.74
White bearded greenbul	*Criniger ndussumensis*	0.03
White breasted negrofinch	*Nigrita fusconotus*	0.27
White browed forest flycatcher	*Fraseria cinerascens*	0.07
White crested hornbill	*Tropicranus albocristatus*	0.10
White spotted flufftail	*Sarothrura pulchra*	2.75
White spotted wattle-eye	*Platysteira tonsa*	0.27
White tailed ant-thrush	*Neocossyphus poensis*	0.57
White thighed hornbill	*Bycanistes albotibialis*	0.94
White throated bee-eater	*Merops albicollis*	0.27
Wood warbler	*Phylloscopus sibilatrix*	0.03
Xavier's greenbul	*Phyllastrephus xavieri*	0.13
Yellow bellied wattle-eye	*Platysteira concreta*	0.07
Yellow billed barbet	*Trachyphonus purpuratus*	0.57
Yellow billed turaco	*Tauraco macrorhynchus*	2.38
Yellow browed camaroptera	*Camaroptera superciliaris*	0.91
Yellow casqued wattle hornbill	*Ceratogymna elata*	1.47
Yellow crested woodpecker	*Dendropicos xantholophus*	0.10
Yellow footed flycatcher	*Muscicapa sethsmithi*	0.13
Yellow footed honeyguide	*Melignomon eisentrauti*	0.23
Yellow longbill	*Macrosphenus flavicans*	1.01
Yellow rumped tinkerbird	*Pogoniulus bilineatus*	4.09
Yellow spotted barbet	*Buccanodon duchaillui*	3.18
Yellow whiskered greenbul	*Eurillas latirostris*	4.73
Yellowbill	*Ceuthmochares aereus*	0.64