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Managing Forest Wildlife for Human Livelihoods in the Korup-Oban Hills region, West-Central Africa

Information on the status of duikers in the Korup Support Zone, Cameroon, during 1999-2002

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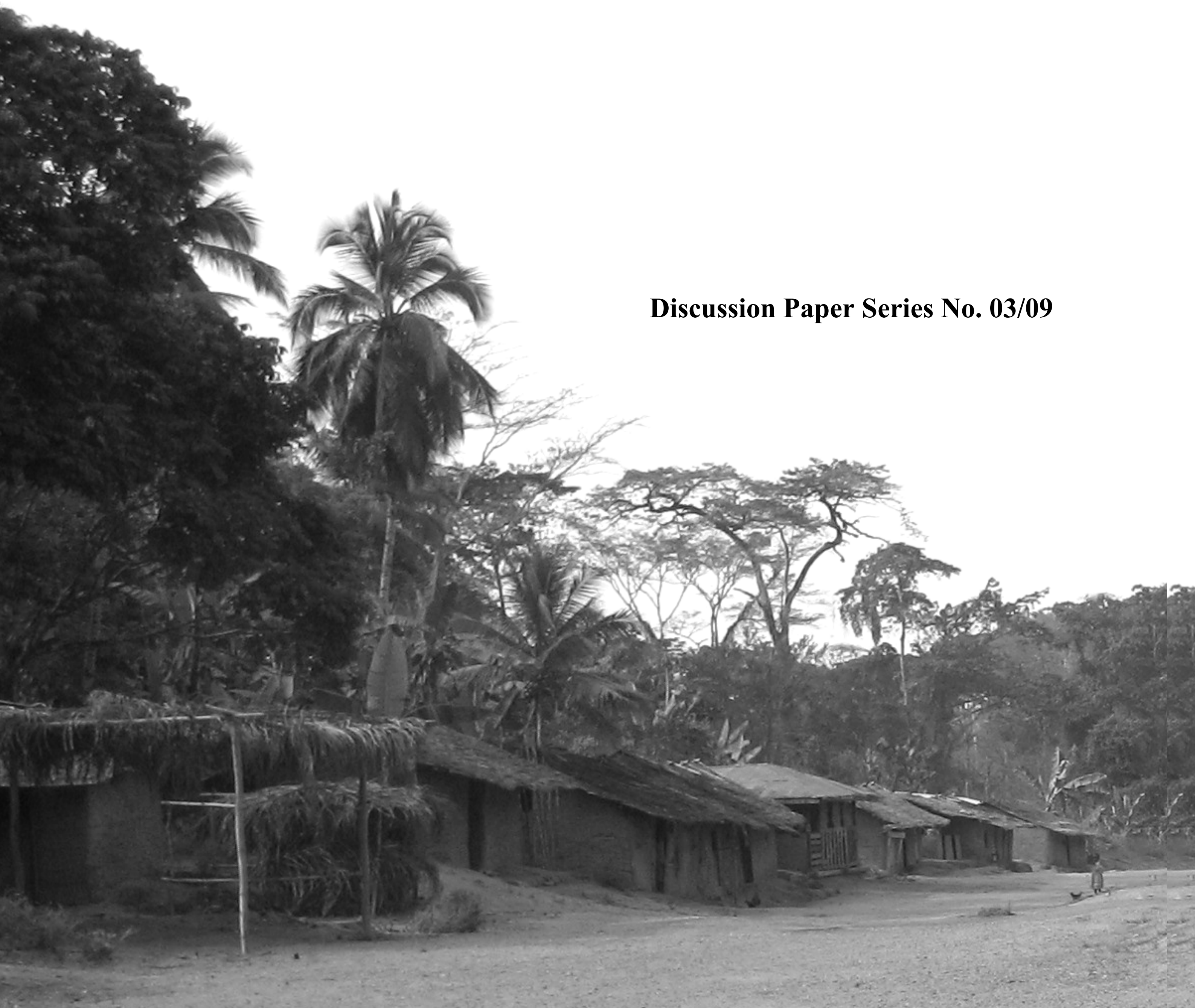

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Information on the status of duikers in the Korup Support Zone, Cameroon, during 1999-2002

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Abstract: This discussion paper summarizes the findings of earlier duiker surveys in the periphery of the Korup National Park, Cameroon during the period of 1999-2002 and introduces the research plan for 2009. It is anticipated that the findings of the planned 2009 surveys will permit, through comparisons with 1999-2002 findings, to estimate the change in the population density of the four sympatric duiker species.

Keywords: Bay duiker, Blue duiker, Ogilby's duiker, Yellow-backed duiker, distance sampling, transect surveys, Korup National Park, logging, dung surveys

1. Introduction

The Korup region in Cameroon holds populations of four duiker species: the blue duiker (*Philantomba monticola*), the bay duiker (*Cephalophus dorsalis*), Ogilby's duiker (*C. ogilbyi ogilby*) and the yellow-backed duiker (*C. sylvicultor*) (Payne, 1992; Waltert et al., 2006). As a basis for an understanding of the bushmeat socioecological system in the periphery of Korup National Park (former Korup Support Zone) and to assess potential impacts of logging on wildlife, the Korup-GTZ project established a communally assisted wildlife monitoring program around four villages. These surveys, carried out between 1999 and 2002, showed that all four species are present in the area. As a basis for fieldwork in 2009, this paper summarises findings on the status of duikers in the study area from this period.

2. Study Area

The study took place in the vicinity of Korup National Park, in south-western Cameroon. Four village forests were selected, two of which were situated in unlogged forest close to Korup National Park (Bajo and Mgbegati), and two (Bayip and Etinkem) were situated within a logging concession near the town of Nguti, where moderate to heavy selective logging was carried out. In each of these village forests, permanent, straight, 2-km long transects were established, covering an area of ~16 km^2 (see Waltert et al., 2002). The transects were parallel to and at least 200 m from each other (Figure 1).

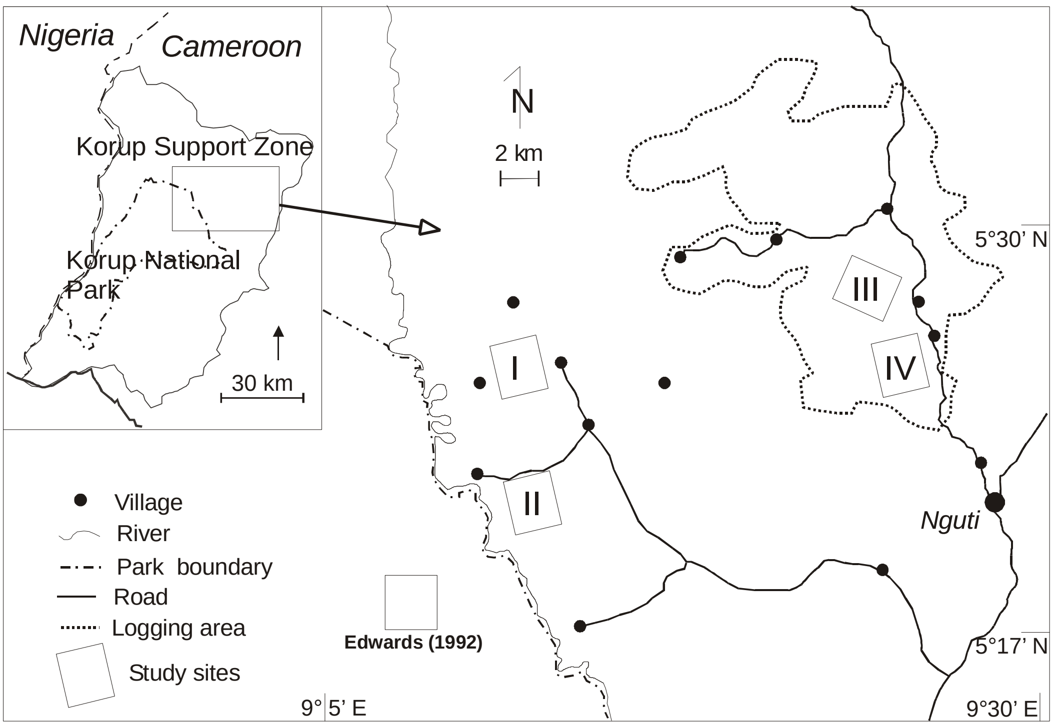

Figure 1: Location of the study sites referred to in this paper: I – Mgbegati (unlogged), II – Bajo (Unlogged), III – Bayip Assibong (Logged), IV – Etinkem (Logged).

3. Methods

3.1 Field work

In 1999, fieldwork was conducted in only three of the study sites (all except Etinkem) and only two transects were established at each site. In 2000 and 2001, six transects were established in all four sites. Table 1 shows the number of transects used per site each year.

The total survey effort was 972 km for diurnal transects and 574 km for nocturnal transects (counting only surveys unaffected by rain) (Table 2). Diurnal transects were conducted between 6.30 and 9.00 am and nocturnal surveys between 19.00 and 21.00 am with the help of flashlights. All surveys were carried out by experienced observers who were trained in distance estimation and understood the principles of Distance Sampling methodology (Waltert et al., 2006).

In addition, separate track counts were conducted during afternoon surveys (15:00 – 18:00am) from February 1999 to April 2002. Observers recorded signs (i.e. footprints and dung) of the four duiker species without measuring distances.

Table 1: Number of diurnal/nocturnal transects established and walked at each site each year

Year	Study Site			
	Bajo (diurnal/nocturnal)	Bayip (diurnal/nocturnal)	Etinkem (diurnal/nocturnal)	Mgbegati (diurnal/nocturnal)
1999	2/2	2/2		2/2
2000	4/4	6/6	6/4	6/6
2001	6/6	6/6	6/6	6/6

Table 2: Total survey effort (km) of diurnal and nocturnal transects at four 16 km²-study areas in the Korup Support Zone between 1999-2002.

	Study Site			
Survey	Bajo	Bayip	Etinkem	Mgbegati
Diurnal	276	308	154	244
Nocturnal	180	158	74	162

3.2 Data analysis

Data from the years 1999 – 2002 were pooled and analysed separately for diurnal and nocturnal surveys using DISTANCE 5.0 software. Two different analysis engines were used. First, the conventional distance sampling (CDS) engine was used. Second, the multiple covariates distance sampling (MCDS) engine was used, where the different study sites accounted for the covariates.

Distance data was manually grouped in order to improve model fit, judged by the Akaike information criterion (AIC), Chi-Square goodness-of-fit and visual examination. A global detection function from data across sites, but not species, was used. For further details on truncation width, grouping and model selection see Table 3.

The Analysis Of Variance (ANOVA) and the two-tailed t-test were the statistical models used to test for significant differences between the results. If no explicit comments are made about which data was used/compared, then the results of the ANOVA are based on data pooled from nocturnal and diurnal surveys as well as from the CDS and MCDS analysis. The yellow-backed duiker was often not included in the results due to limited data.

Table 3: Information on truncation width, grouping and model selection for the assessment of detection probabilities for duikers during nocturnal and diurnal at the Korup Support Zone (1999-2002).

Species / anlysis engine	Diurnal			Nocturnal		
	Truncation width	Model selection; Adjustment terms	Intervals	Truncation width	Model selection; Adjustment terms	Intervals
Blue duiker / CDS	25	Uniform key; simple polynomial	3; unequal	30	Hazard rate key; none	3; equal
Blue duiker / MCDS	25	Halfnormal key; none	3; unequal	30	Halfnormal key; none	3; equal
Ogilby's duiker / CDS	40	Uniform key; simple polynomial	3; unequal	30	Uniform key; hermite polynomial	3; equal
Ogilby's duiker / MCDS	40	Halfnormal key; None	3; unequal	30	Halfnormal key; none	3; equal
Bay duiker / CDS				50	Uniform key; none	2; unequal
Bay duiker / MCDS				50	Halfnormal key; none	2; unequal

4. Results

4.1 Sightings

Blue duiker and Ogilby's duiker were encountered during both nocturnal and diurnal surveys at all four sites. In contrast, the bay duiker was seen not seen at the two logged study sites Bayip and Etinkem. Yellow-backed duiker was seen only once in unlogged forest at Mgbegati (see Table 4). Of the four species, the blue duiker was most often encountered, followed by Ogilby's and bay duikers (Table 5).

For the blue duiker, the distribution of the total number of nocturnal encounters within study sites differed significantly from that expected from the distribution of diurnal encounters (Chi-Square test, df=3, $p < 0.001$), mainly due to higher than expected nocturnal encounters in Bayip and lower than expected encounters in Etinkem. Similarly, the distribution of nocturnal encounters differed from that of the diurnal ones in the Ogilby's duiker (Chi-Square test, df=3, $p < 0.001$) but mainly due to higher than expected frequencies in Etinkem and lower than expected frequencies in Mgbegati.

Table 4: Frequency of duiker encounters during diurnal and nocturnal transect counts in the Korup Support Zone, 1999-2002.(untruncated data)

Species	Diurnal observations (972 km)	Nocturnal observations (574 km)
Blue duiker	59	185
Bay duiker	0	5
Ogilby's duiker	48	47
Yellow-backed duiker	0	1

Table 5: Number of duiker encounters per study site during diurnal and nocturnal transect counts in the Korup Support Zone from 1999-2002

Species	Study site			
	Bajo (diurnal/nocturnal)	Bayip (diurnal/nocturnal)	Etinkem (diurnal/nocturnal)	Mgbegati (diurnal/nocturnal)
Blue duiker	98 (24/74)	45 (15/30)	25 (2/23)	76 (18/58)
Bay duiker	4 (0/4)	0 (0/0)	0 (0/0)	1 (0/1)
Ogilby's duiker	45 (23/22)	13 (2/11)	13 (5/8)	24 (18/6)
Yellow-backed duiker	0 (0/0)	0 (0/0)	0 (0/0)	1 (0/1)

4.2 Track Counts

The distribution of duiker signs (footprint and dung) of the different species at the study sites was not completely consistent with those of the diurnal surveys (Tables 5 and 6). In particular, signs of Ogilby's duiker were most numerous in Bayip while direct encounters were lowest at this study site. There was no significant difference between numbers of direct observations and signs for the bay duiker and the yellow-backed duiker,

Table 6: Number of signs encountered per study site during track counts in the Korup Support Zone from February 1999- April 2002

Species	Study site				∑
	Bajo	Bayip	Etinkem	Mgbegati	
Blue duiker	885	2851	1132	945	5813
Bay duiker	51	7	61	3	122
Ogilby's duiker	900	2734	1083	2602	7319
Yellow-backed duiker	23	2	2	1	28

4.3 Encounter rates and density estimates

Overall, the blue duiker had the highest encounter rates among all species, followed by Ogilby's duiker and the bay duiker. When applying multiple tests, encounter rates were significantly different between the blue duiker and the bay duiker ($p < 0.001$), Ogilby's duiker and the bay duiker ($p < 0.01$), but not between the blue duiker and Ogilby's duiker.

Encounter rates derived from nocturnal surveys were usually higher than those derived from diurnal surveys (Table 7), except for the Ogilby's duiker at Mgbegati which had a similar encounter rate in both methods. However, these differences were significant only for the blue duiker (2-tailed t-test $p < 0.01$). There were no significant differences in the encounter rates between the four field sites for any of the four species.

The density estimates for the three duiker species are (nearly) significantly different from each other (blue duiker > bay duiker: $p < 0.001$; Ogilby's duiker > bay duiker: $p < 0.1$; blue duiker > Ogilby's duiker: $p < 0.001$) (Tables 8 and 9) with the blue duiker having the highest estimates followed by Ogilby's duiker and the bay duiker (ANOVA post-hoc tests).

For the blue duiker, density estimates based on the nocturnal surveys are significantly higher than the ones based on the diurnal survey ($p < 0.001$). Still, nocturnal survey density estimates from most study sites were within the confidence interval of the estimates based on the diurnal surveys, except for Bayip and Etinkem in the MCDS analysis (Table 9), where they are considerably higher.

Density estimates for the blue duiker were not significantly different between the four sites. However, when data from sites are pooled according to logged (Bayip and Etinkem) and unlogged sites (Bajo and Mgbegati), differences between densities are significant with slightly higher blue duiker ($p < 0.1$) densities in the unlogged/undisturbed sites.

Also in Ogilby's duiker, density estimates based on nocturnal surveys were significantly higher than those based on diurnal surveys ($p < 0.05$). Though, for most study sites, they are within the confidence interval of the diurnal estimate (except for Bayip in the CDS analysis, which resulted in a higher estimate). Moreover, density estimates for Ogilby's duiker are not significantly different between the four sites. When the sites are pooled into unlogged/undisturbed (Bajo and Mgbegati) and logged/disturbed (Bayip and Etinkem) sites, then the differences between the densities are also not significant for Ogilby's duiker. But if the outlier from the MCDS analysis for Bayip (7.08) is removed, then the difference between the estimates becomes significant ($p < 0.05$) with higher densities for the unlogged/undisturbed sites.

Regarding the bay duiker, the density estimates based on the nocturnal surveys are significantly higher than the ones based on the diurnal surveys ($p < 0.05$). There are also significant differences between the four sites ($p < 0.001$) except for Bayip compared to Etinkem. When the sites are pooled into unlogged/undisturbed (Bajo and Mgbegati) and logged/disturbed sites (Bayip and Etinkem), then the differences between the densities are significant for the bay duiker ($p < 0.05$) with higher densities for the unlogged/undisturbed sites.

Furthermore the density estimates differ between the two different analysis engines. While the estimates derived from the MCDS analysis are mostly higher, there are some exceptions. For the blue duiker the density estimate for Etinkem based on the nocturnal surveys is higher for the CDS analysis. The density estimates based on diurnal and nocturnal surveys for the Ogilby's duiker are higher for Bajo and Etinkem in the CDS analysis. For the bay duiker density estimates do not differ between the two analysis engines. Though, all the differences are not significant.

Table 7: Encounter rates [Encounters of duikers per km] based on the diurnal and nocturnal transect counts from 1999-2002 for each study site individually

Species	**Study site**			
Count	**Bajo** (95% CI)	**Bayip** (95% CI)	**Etinkem** (95% CI)	**Mgbegati** (95% CI)
Blue duiker diurnal c.	0.08 (0.05-0.12)	0.05 (0.03-0.08)	0.01 (0.001-0.1)	0.07 (0.04-0.13)
Blue duiker nocturnal c.	0.4 (0.25-0.63)	0.19 (0.15-0.23)	0.28 (0.17-0.47)	0.36 (0.24-0.53)
Ogilby's duiker diurnal c.	0.08 (0.02-0.34)	0.01 (0.002-0.26)	0.02 (0.003-0.15)	0.07 (0.05-0.11)
Ogilby's duiker nocturnal c.	0.1 (0.06-0.17)	0.07 (0.03-0.15)	0.11 (0.03-0.44)	0.04 (0.01-0.1)
Bay duiker diurnal c.	0	0	0	0
Bay duiker nocturnal c.	0.02 (0.01-0.05)	0	0	0.01 (0.002-0.02)

CI, confidence interval

Table 8: Density estimates [Individuals per km2] based on the diurnal and nocturnal transect counts from 1999-2002 for all study sites together and each study site individually; derived from CDS analysis engine.

Species count	**All sites** (95% CI)	**Study site**			
		Bajo (95% CI)	**Bayip** (95% CI)	**Etinkem** (95% CI)	**Mgbegati** (95% CI)
Blue duiker diurnal c.	1.62 (1.19-2.21)	2.39 (1.52-3.75)	1.48 (0.89-2.45)	0.36 (0.05-2.84)	2.25 (1.25-4.06)
Blue duiker nocturnal c.	7.35 (5.76-9.38)	9.40 (5.90-14.98)	4.42 (3.45-5.67)	7.36 (4.42-12.25)	8.21 (5.57-12.10)
Ogilby's duiker diurnal c.	1.03 (0.47-2.27)	2.18 (0.54-8.79)	0.13 (0.03-0.50)	0.38 (0.05-2.81)	1.43 (0.94-2.18)
Ogilby's duiker nocturnal c.	1.90 (1.10-3.28)	2.41 (1.45-4.01)	1.68 (0.77-3.68)	2.61 (0.64-10.67)	0.89 (0.33-2.40)
Bay duiker diurnal c.	-	-	-	-	-
Bay duiker nocturnal c.	0.07 (0.04-0.14)	0.22 (0.09-0.51)	-	-	0.06 (0.02-0.24)

CI, confidence interval

Table 9: Density estimates [Number of individuals per km2] based on the diurnal and nocturnal transect counts from 1999-2002 for all study sites together and each study site individually; derived from MCDS analysis engine.

	All sites	**Study site**			
Species count	(95% CI)	**Bajo** (95% CI)	**Bayip** (95% CI)	**Etinkem** (95% CI)	**Mgbegati** (95% CI)
Blue duiker diurnal c.	3.98	3.99 (1.2-13.3)	1.98 (1.12-3.53)	0.42 (0.04-4.05)	9.53 (4.89-18.58)
Blue duiker nocturnal c.	9.46	11.19 (7.03-17.8)	9.59 (6.69-13.75)	5.59 (3.38-9.24)	11.46 (7.74-16.97)
Ogilby's duiker diurnal c.	1.14	1.93 (0.48-7.75)	0.54 (0.01-22.94)	0.37 (0.04-3.13)	1.71 (1.03-2.84)
Ogilby's duiker nocturnal c.	3.42	2.01 (1.2-3.38)	7.08 (2.92-17.14)	1.8 (0.44-7.39)	2.8 (0.91-8.69)
Bay duiker diurnal c.	-	-	-	-	-
Bay duiker nocturnal c.	0.07	0.22 (0.09-0.51)	-	-	0.06 (0.02-0.24)

CI, confidence interval

As expected, encounter rates derived from the sign counts were significantly higher than the ones derived from the transect counts (Table 10) ($p < 0.001$).

Using encounter rates from each year and study site as samples in a one-way ANOVA, encounter rates derived from the sign counts are significantly lower for the bay duiker compared to the blue duiker ($p < 0.001$) and Ogilby's duiker ($p < 0.001$); for the yellow-backed duiker compared to the blue duiker ($p < 0.001$) and Ogilby's duiker ($p < 0.001$), but not between the blue duiker and Ogilby's duiker and not between the bay duiker and the yellow-backed duiker. Furthermore, these encounter rates are not significantly different between the unlogged/undisturbed sites (Bajo and Mgbegati) and the logged/disturbed sites (Bayip and Etinkem) for any duiker species, except for the blue duiker for which field teams encountered significantly more signs in the logged sites than in the unlogged sites ($p < 0.01$).

Table 10: Encounter rates [Encounters of signs per km] based on sign counts from 1999-2002 for each study site individually.

Species	Study site			
	Bajo (range)	Bayip (range)	Etinkem (range)	Mgbegati (range)
Blue duiker	3.073 (1.766-6.318)	9.256 (8.302-11.573)	6.432 (5.840-7.110)	3.171 (2.865-3.486)
Ogilby's duiker	3.125 (1.930-6.682)	8.877 (7.840-10.854)	6.153 (5.915-6.427)	8.732 (7.633-10.071)
Bay duiker	0.177 (0.008-0.591)	0.023 (0.000-0.049)	0.347 (0.298-0.402)	0.010 (0.000-0.020)
Yellow-backed duiker	0.080 (0.031-0.197)	0.006 (0.000-0.012)	0.011 (0.011-0.012)	0.003 (0.000-0.010)

Table 11: Additional results of the diurnal and nocturnal transects counts from 1999-2002 in the Korup Support Zone.

Species count	CDS analysis engine			MCDS analysis engine		
	ESW	AIC	P	ESW	AIC	P
Blue duiker diurnal c.	17.88	106.07	0.72	8.96	8	0.36
Blue duiker nocturnal c.	22.19	345.61	0.74	16.4	8	0.55
Ogilby's duiker diurnal c.	25.81	83.93	0.65	21.23	8	0.53
Ogilby's duiker nocturnal c.	20.71	90.16	0.69	10.39	8	0.35
Bay duiker nocturnal c.	50	6.96	1			

ESW, effective strip width [m]; AIS, Akaike information criterion; P, probability of detection

5. Discussion

The results indicate that the blue duiker is the most common species in the study area, followed by Ogilby's duiker, bay duiker and yellow-backed duiker. The density estimates derived from DISTANCE 5.0 with the CDS (Table 7) and MCDS analysis engine (Table 8) have to be handled with care due to small sample size for some species and/or sites. Small sample size is probably also the cause for the bay duiker density estimates being consistent between both analysis engines.

The results show that there is a discrepancy between the estimates based on the diurnal and those based on the nocturnal transects. This is linked to the ecology of the different species. While the blue duiker and Ogilby's duiker appear to be diurnal, the bay duiker seems to be nocturnal and the yellow-backed duiker was found to be crepuscular (Payne, 1992; Newing, 2001; Wilson, 2005).

The density estimates of the four research sites are all lower than those obtained by Payne (1992) inside the Korup National Park. This might be due to efficient poaching control in the Park and/or a general population decline between 1992 and 2002. It is sure that hunting pressure in the village forests was considerable even in 1999, while poaching during Payne's survey in Korup National Park was certainly considerably lower.

Although all four species were recorded by one or the other survey method at each site, direct observations of all four species were only made at one unlogged site near the Park, and three at the other unlogged site (also close to the park). It would therefore still be necessary to confirm the presence of the two rare species (yellow-backed and bay duiker) by conducting additional research.

By conducting line transect surveys in 2009, we want to compare results from the village forests and the national park with the data of previous surveys. Such a comparison would permit to detect population density changes. In addition, our research will help to assess which assessment method will produce most reliable results on population densities of the different duiker species. We are going to use transects counts (diurnal and nocturnal), dung counts, playback calls and net hunts. As stated by Koster and Hart (1988) "it is desirable, if not essential, to utilize two or more independent methods to estimate the size of any given population. These methods should be chosen so as not to entail the same assumptions."

In addition, we want to ascertain the habitat preferences of the different duiker species that are described in this paper. The results available so far suggest that all species prefer undisturbed forest, because the densities were often the highest in the sites close to the Park

(Bajo and Mgbegati). Especially for Ogilby's duiker, a preference for closed canopy forest has been previously reported (Newing, 2001; Wilson, 2005).

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