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Réserve de Faune à Okapi

Post Conflict Faunal Baseline Surveys
2005 Central Sector " Zone Verte"

Data Presentation and Preliminary Interpretations
with a special emphasis on Elephants and Bushmeat Species

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WCS –DRC Program's Inventory and Monitoring Unit (IMU)

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Teresa Njeri. 12 pp.

N° 3.   *Rapport sur le braconnage à l'Eléphant et sur le commerce de l'ivoire dans et à la périphérie de la Réserve de Faune à Okapis.* December 2004**,** Christian Amboya, 33 pp.

N° 4. *Identifying conservation priorities for the recovery of the Maiko National Park*: *Post-conflict surveys of wildlife populations and human impact in the North Sector of the park.*
September 2005. Amsini, F, Grossmann, F, Hart, J., Kibambe, C., Nyembo, B., Vyahavwa, C.
39 pp.

TABLE OF CONTENTS

1. SUMMARY

- The report presents data on the distribution and abundance of selected large mammals and on human activities in the central sector (Zone Verte), of the Okapi Wildlife Reserve (RFO) in 2005, following nearly a decade of conflict.

- The RFO (13,700 km^2) protected some of the largest and most important populations of elephant, chimpanzee and okapi before the war. During the conflict, the RFO and its fauna became the target of major illegal hunting, in particular for elephant, duikers and other bushmeat species.

- With the end of conflict in 2004, and gradual return of security, inventory teams returned to the field to initiate post conflict assessment of the RFO's fauna, and threats to this.

- Post conflict baseline inventories were initiated in 2004 in the Edoro-Lenda blocks (500 km^2) near Epulu. A larger area, the Zone Verte, covering central one third of the RFO (5,600 km^2) was surveyed in 2005. Although both the Zone Verte and Edoro-Lenda blocks suffered from illegal hunting during the conflict, nevertheless these areas were in general better protected than many other sectors of the Reserve that were occupied by militias and national police involved in rampant poaching, especially for elephants.

- Reports of line transect censuses of elephants, okapi, duikers, primates, and chimpanzees are provided. Estimates of elephant, chimpanzee and duiker numbers are provided and evaluated.

- An over view of human activity within the zone is provided, with an emphasis on hunting.

- A preliminary assessment of the effect of the conflict in the zone indicates that elephants have been significantly impacted, and populations remain concentrated in the relatively safe zone around Epulu. Other specie, in particular primates, show little evidence of heavy hunting pressure. The results for chimpanzees, duikers and okapi can not yet be interpreted. Completion of the post conflict base line surveys and comparisons of pre and post conflict census results will be important.

- A post conflict faunal baseline is planned for the RFO upon completion of inventories in the north and southwest sectors of the reserve.

2. Introduction

The Réserve de Faunae à Okapis (RFO) covering 13,700 km^2 in the Ituri Forest, was established in 1992, and added to the list of World Heritage Sites in 1996. The Ituri Forest, is one of the biologically richest forest areas in DR Congo, with important populations of okapi, forest elephant, chimpanzees duikers and primates.

The RFO protects a major sample of The Ituri Forest's fauna, and the reserve is also an important homeland forest for about 15,000 Mbuti and Efe hunter-gatherers and about twice that number of shifting cultivators. Beginning in 2000, The ICCN and its partner NGOs have developed a zoning program for the RFO to the limit the extent of shifting cultivation and settlement, control the impact of traditional hunting and provide for integral protection of key areas. Updated information on faunal distribution and abundance, and on the impact of human activities in the RFO are essential for the success of the zoning, and the sustainability of the reserve.

During Congo's civil war (1996-2004), the RFO became a target for a wide range of illegal hunting. Militia and military-occupation of the RFO led to a major upsurge in elephant poaching in the period 2002-04. ICCN staff documented 17 tons of ivory moved out of the RFO in 2004 (Amboya 2004).[1] Illegal hunting and bushmeat trade proliferated in many areas where hunting had been almost non existant during the period before the war.

Despite major constraints and the prevailing insecurity perpetrated by roaming military and militia poachers, the Congolese National Parks Institute (ICCN) and its NGO partners, Wildlife Conservation Society (WCS) and Gillman International Conservation (GIC) managed to support some patrols in the central sectors of the RFO surrounding the ICCN headquarters at Epulu and including two Scientific Study Areas (*Terrains Scientifiques*) of Lenda and Edoro and adjacent forest. However, large areas of the RFO, in particular the north remained off limits to both ICCN patrols and NOG survey teams throughout the entire period.

The post conflict period for the RFO was initiated in late 2004 as military forces began to withdraw from their bases in and around the RFO, and significant portions of the reserve once again became accessible. Planning for a post-conflict inventory of the reserve was initiated in early 2005.

The overall vision for the post-conflict baseline inventory is to develop an information base that will better focus and strengthen conservation of the RFO and its buffer zone through the USAID/ CARPE Congo Basin Forest Partnership, and the UNF / UNESCO project for support for DRC's world heritage sites in danger. Specific goals for the RFO post conflict baseline include:
  1. Determine current distribution and abundance of important wildlife populations in the RFO and provide an evaluation of the impact of the conflict on the Reserve in comparison with pre conflict inventories. .
  2. Identify and prioritize threats to key biodiversity and guidelines for interventions to reduce these and specifically through the RFO zoning program.

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[1] Several very large seizures of ivory made in East Africa and East Asia over the last two years have been suspected to include DRC ivory. If this proves to be the case there is a high probability that RFO ivory is represented. Based on market surveys, field information and intelligence, the only major remaining potential ivory sources in DRC occur in the northeast of the country, including the RFO area. Some of these remnant elephant populations remain under serious threat at the time of this report. .

3. Evaluate different survey methods and designs that have been undertaken in the RFO over the past decades, with recommendations for a cost effective and timely faunal monitoring program.

The post conflict inventories were initiated first in the Lenda and Edoro areas (the study areas and surrounding forest, covering about 500 km^2) in late 2004. In early 2005, a new design was developed, and inventories were extended over the central third of the RFO (about 6000 km^2), an area referred to as the "Zone Verte" or green zone. (FIGURE 1). Since the Green Zone survey, militias have been withdrawn from the remainder of the RFO, and security has been re-established over the most of the remainder of the reserve. Surveys covering the remainder of the Reserve and its buffer zones are now planned as well.

Objectives of this report
This report provides first analyses of the green zone survey data, including the Edoro-Lenda zone inventories. This will be followed by the completed baseline assessment and threats assessment of the RFO and its management zones, once the remaining two thirds of the reserve can be surveyed.

Specific reporting provided here include:
* Overview of the RFO survey history, and presentation of the survey design and methods
* Analysis of the systematic transect data for elephant, okapi, chimpanzee, duikers and primates and human hunting
* Comparison of results in the green zone results with the Edoro-Lenda inventory sample.
* Preliminary Assessment of the post-conflict faunal status in the area covered by the survey.

Acknowledgements
We wish to thank WCS –PIGM field team leaders and their assistants for the data collection for these surveys. Special thanks to, Kahindo, Selemani and Albert Masanga the WCS – RFO and ICCN provided important logistical, administrative support and authorizations necessary for the field activities. Yvonne Egate assisted in data entry and management.

3 Survey History

The RFO has had the most comprehensive survey histories of any large forest area in DR Congo, both predating and during the war (TABLE 1).

This data base provides a potentially excellent opportunity to evaluate how the conflict has affected key fauna, and how human use of the forest has changed over the past decade. At present, the surveys during the conflict and post conflict period have been limited to areas that have had the longest history of ICCN control and most effective security—and, one assumes, better protection. It is urgent that the inventories now be extended into the areas of the RFO that did not have this protection in order to have a more comprehensive picture of the effect of the war, and the true status of the reserve.

TABLE 1. Inventories of large mammals and surveys of human activity in the RFO.

Survey Name	Period	Coverage	Report
Pre-conflict base line	1994-95	All of reserve (13,700 km^2). Random placement 5 km monitoring transect nodes	Conservation Biology 1996
Mike Pilot	2000-01	One third Reserve under ICCN control (4,500 k^2). Repeat survey of the 1994-5 transects	MIKE pilot project report
Post conflict Edoro-Lenda core zone	2004	Central sector, Terrains Scientifiques (500 km^2). Systematic transect placement with recces	This report
Zone Verte	2005	Central Sector under ICCN control (6,000 km^2). Systematic transect placement with recces. Repeat census of 1994-5 monitoring transects .	This report

4) 2004 - 2005 Post conflict survey design and inventory methods

The main objective of the surveys was to obtain estimates on mammal abundance and distribution for the entire reserve. However, insecurity in the north meant that the survey effort had to be stratified by accessibility at the time of the survey. The survey area was classified as either being accessible (Green Zone) or non-accessible (Red Zone). Rivers formed the major boundaries of the strata. The secure, or green zone covered a central area of the RFO of approximately 5,600 km², and encompasses both of the long term scientific study areas, of Edoro and Lenda.

Surveys where conducted in two phases. The first, pilot phase of the surveys covered the two scientific study areas of Edoro and Lenda and surrounding forest, approximately 500 km². These first post-conflict surveys were conducted to estimate population's densities of chimpanzee and *Cephalophus* as well as other bushmeat species in an area of low and controlled hunting impact. The high sampling intensity of these zones (sampling grid 2.5 x 2.5 km) will also permit an analysis of the effects of survey design on autocorrelation, thus providing guidelines for efficient survey placement. Finally the Edoro-Lenda study provided estimates of encounter rates for the entire RFO design.

The second phase covered the entire "Green Zone". Sampling grid for this inventory was approximately 5 x 5 km.

In addition, the original survey transects laid out in in 1995, and resurveyed in 2000 – 01 MIKE surveys were surveyed again in 2005. . These transects where placed in a random fashion and had various layouts. Data from these is not presented in this report.

TABLE 2 summarizes the survey designs and coverage . FIGURE 2 provides the design for the Edoro-Lenda pilot survey FIGURE 3. Provides shows the layout for the Zone Verte survey.

FIGURE 1. La Réserve de Faunae à Okapi (RFO) showing areas covered by the first phase of the 2005 post conflict faunal inventories and hunting impact assessments.
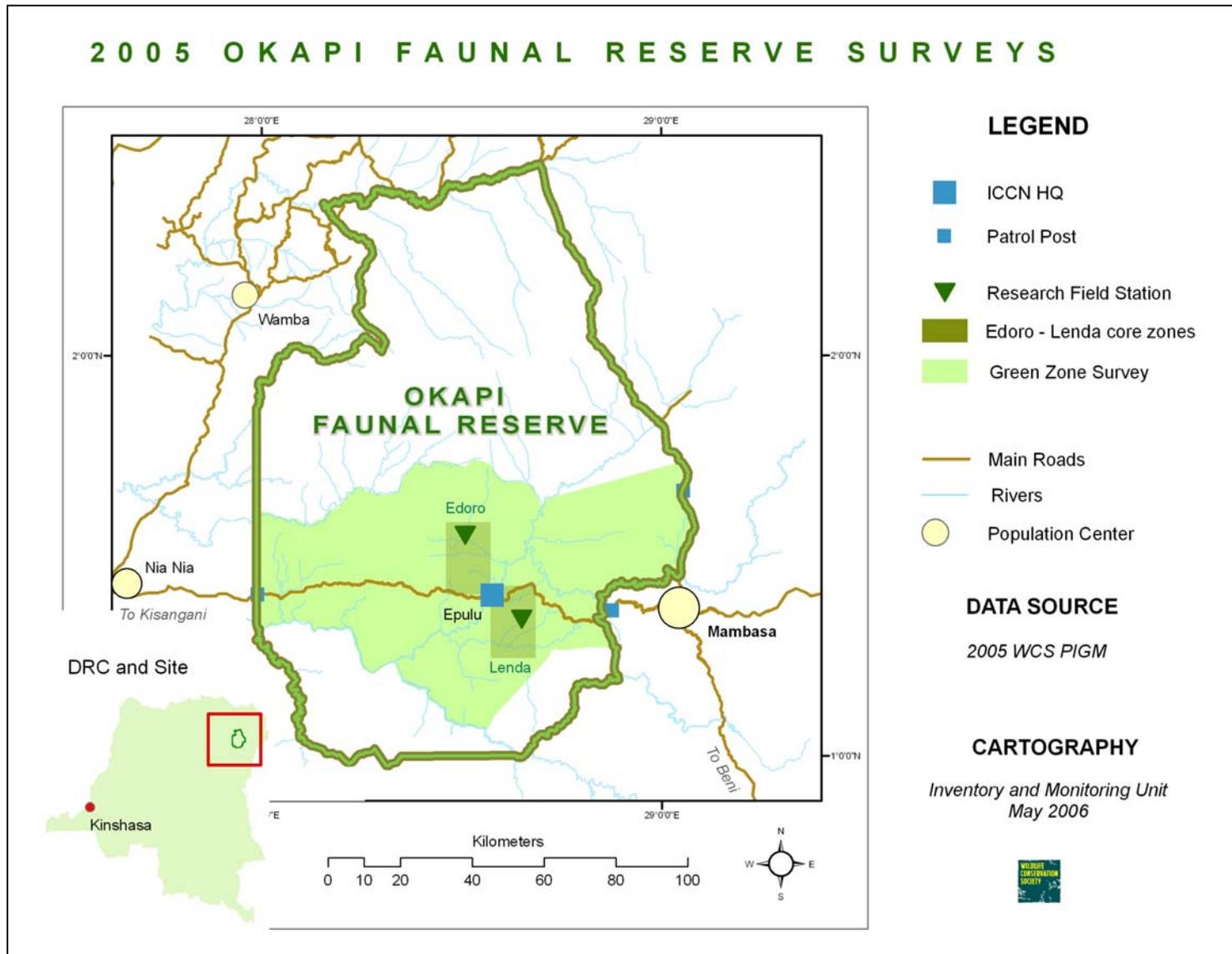
TABLE 2. 2004 –05 Post conflict surveys in the RFO.

Survey zone	Methods	Dates	Survey Area (km²)	Transect Length	Number of Transect (design)	Number of Transect (completed	Recces (km)
Lenda / Edoro Pilot	Systematic Transects and Recces	June – August 2004	500	1	82	68	~ 360
Green Zone	Systematic Transects and Recces	April – September 2005	5,596	1	61	59	830
1995 Monitoring transects	Transect	1995, 2000, April – September 2005	5,596 original layout 14,000	2.5	69	63	---

FIGURE 2. The Lenda-Edoro pilot zone survey was designed with a systematic placement of transects on a grid of about 2.5 x 2.5 km .

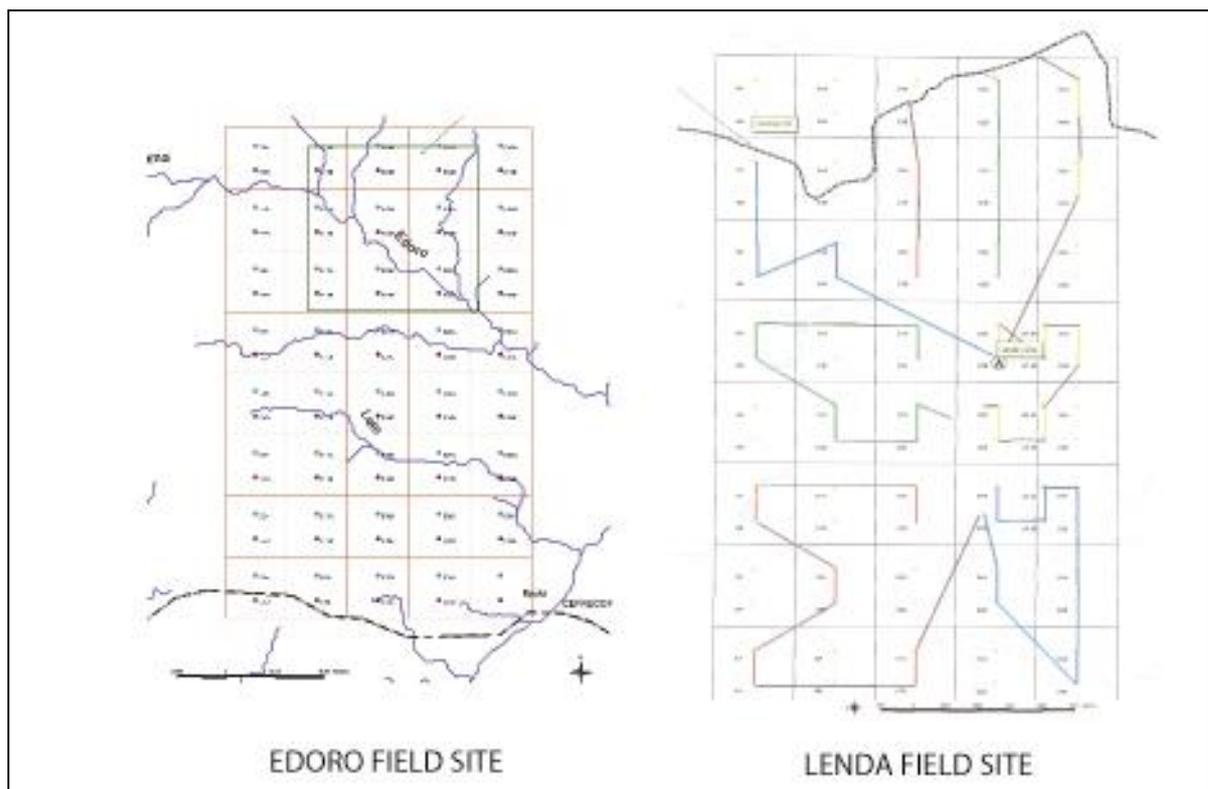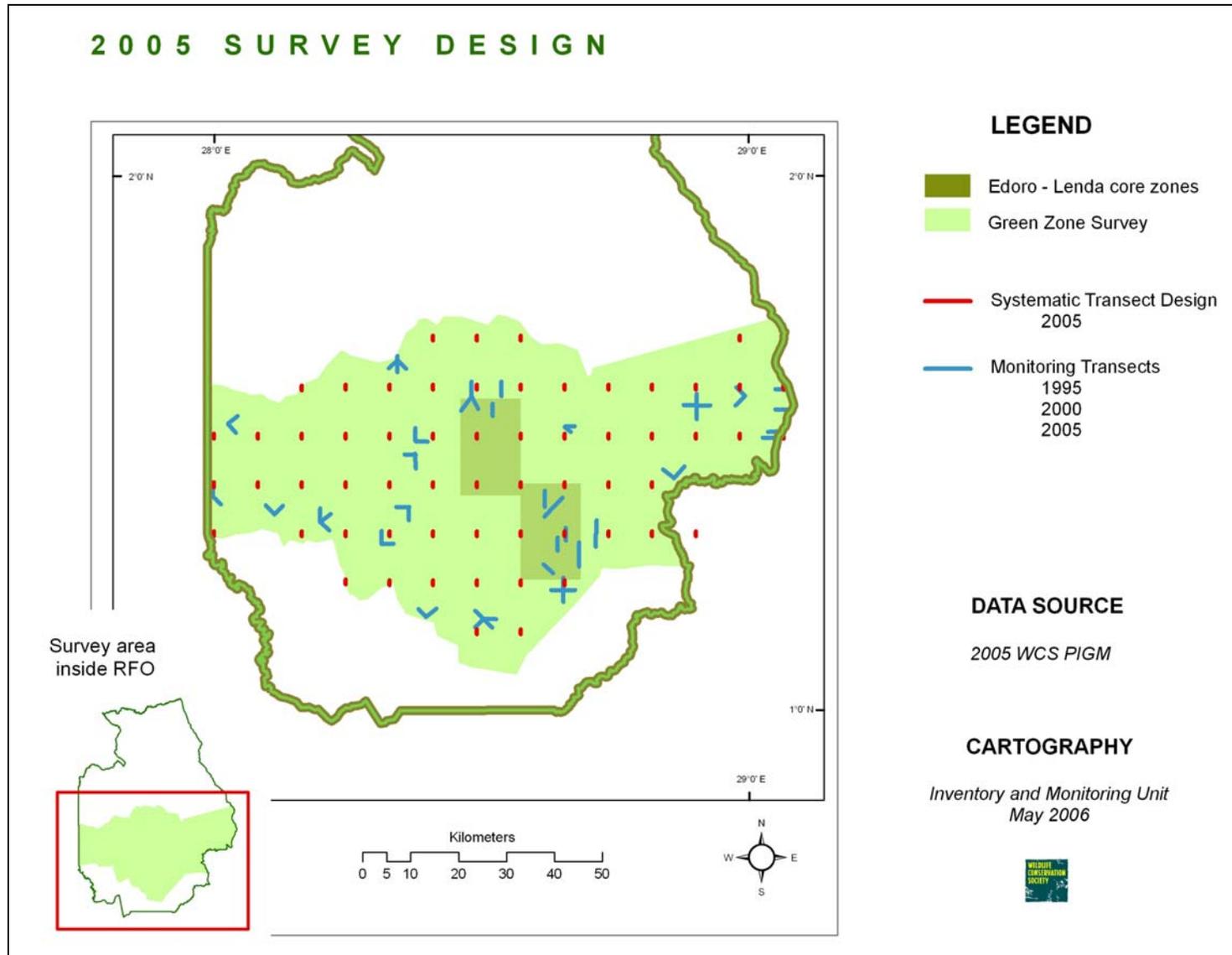EDORO FIELD SITE   LENDA FIELD SITE

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FIGURE 3. Zone Verte surveys included two designs for distribution of survey effort: A systematic transect placement separated by recces on a grid of 5 x 5 km, and a repeat survey (third census) of the original 1995 transects located within the zone.

Two methods were used by field teams for data collection, line transects and recce walks. Line transects for the systematic design were about 1000 m in length, and varied from 2.5 to 5 km for the 1995 monitoring transects. Recces varied in length. Both recces and transects followed compass lines. The major difference in data collection is that with transects, perpendicular distances from the line of travel to the observation are recorded. These distances are not measured on recces. In addition, compass line travel and of distance are measured more carefully on transects than on recces.

Transects have the advantage of providing data on abundance and detection, as well as distribution. However recces can cover larger areas than transects in a given time period.

Correlations between recce and transect encounter rates provide a basis for extrapolating results to larger areas. These will be investigated in a later report.

Most observations can be made directly from the line of travel (recce or transect), however, ape nests require mapping and more detailed measurements to estimate nest group centers

Field collection protocols for the line transects and recces are included in ANNEX 1.

In the report that follows data and results from the systematic transects are presented. Monitoring transect results will be presented upon completion of the base line surveys in the remaining sectors of the RFO.

5) Survey Coverage

The pilot survey in the Edoro-Lenda block was completed in two months, with about 630 km of track log over a 500 km^2 area. The survey of the green zone was completed after 5 month of field work and 830 km of track. In the ZoneVerte, all but transects of the systematic layout were completed. Excluded transects included one which was outside the RFO boundaries, and one that was inaccessible because it was on the south side of Epulu river. In addition most of the old 1995 transect were located and re-censused.

Full track log coverage of the Zone Verte inventory is shown in FIGURE 4.

6) Faunal Observations

Elephant

The majority of Elephant dung was found in the central areas of the green zone (FIGURE 5). In contrast to other areas in central Africa (Gabon, Republic of Congo, Cameroon), where elephants are most concentrated in remote areas, roads do not seem to be the determining factor for elephant distribution in the central RFO. Elephants occurred along the main road bisecting the RFO, and the Zone Verte, and regularly crossed the road.

Very little and no evidence of elephant activity was found toward the RFO boundaries, both to the east and west. High concentrations of elephant activity were found around the Epulu ICCN station and the study areas of Edoro and Lenda. Variation of encounter rates on the samples was high, with the largest number of dung found on one kilometer of transect being 31. No elephants where observed directly and the majority of dung was classified as old (FIGURE 6).

FIGURE 4. GPS track log showing coverage of the Zone Verte base line inventory.
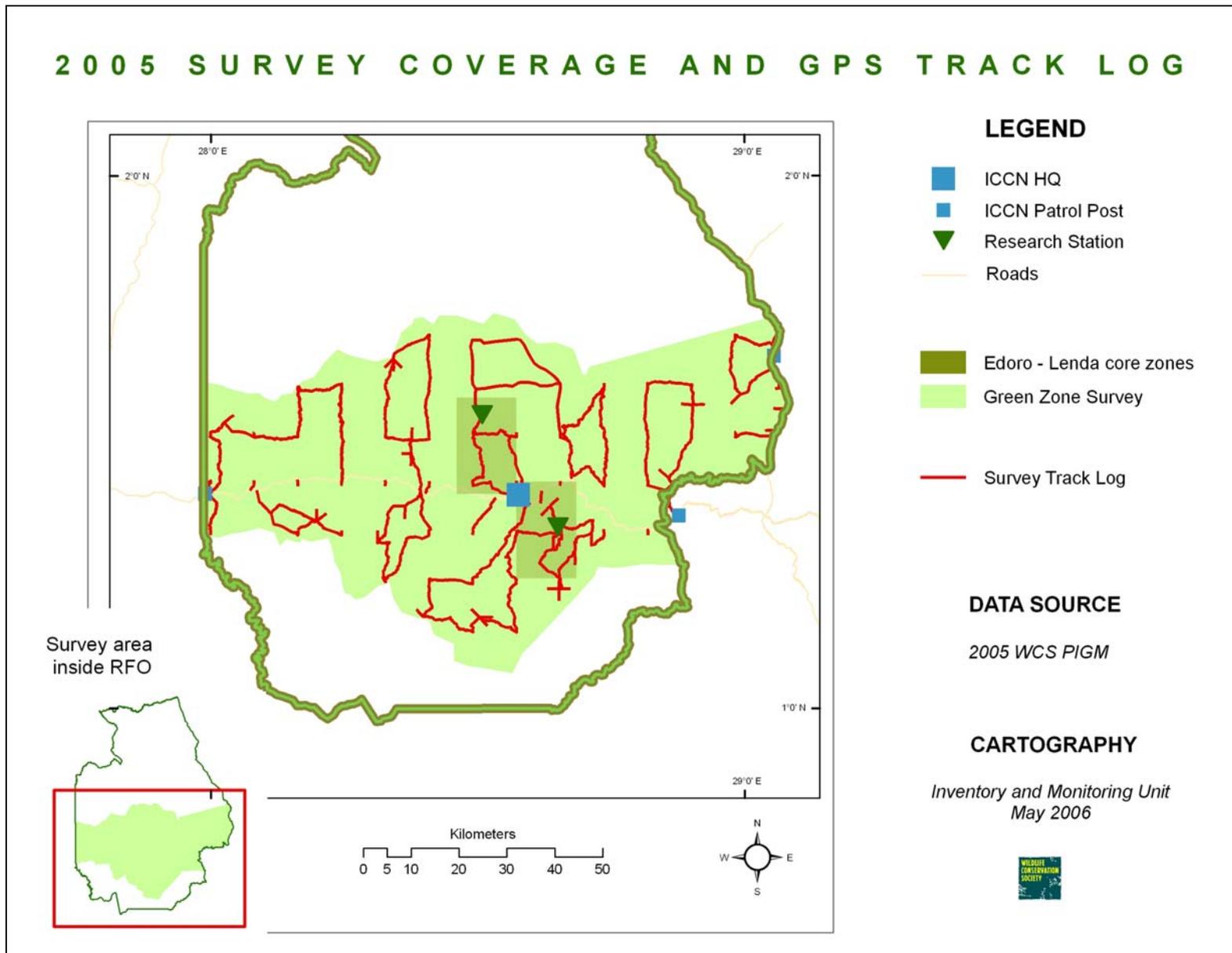
This spatial pattern of activity suggests that within the Zone Verte, elephants have retreated to the center of the RFO, associated with the better protection around the ICCN Epulu Station. The highly variable transect encounter rates, with high densities in some areas and absence elsewhere, could also occur if the animals seek out areas free of poachers.

FIGURE 5 Elephant distribution and relative abundance in the Zone Verte as measured by dung encounter rates along systematic transects.
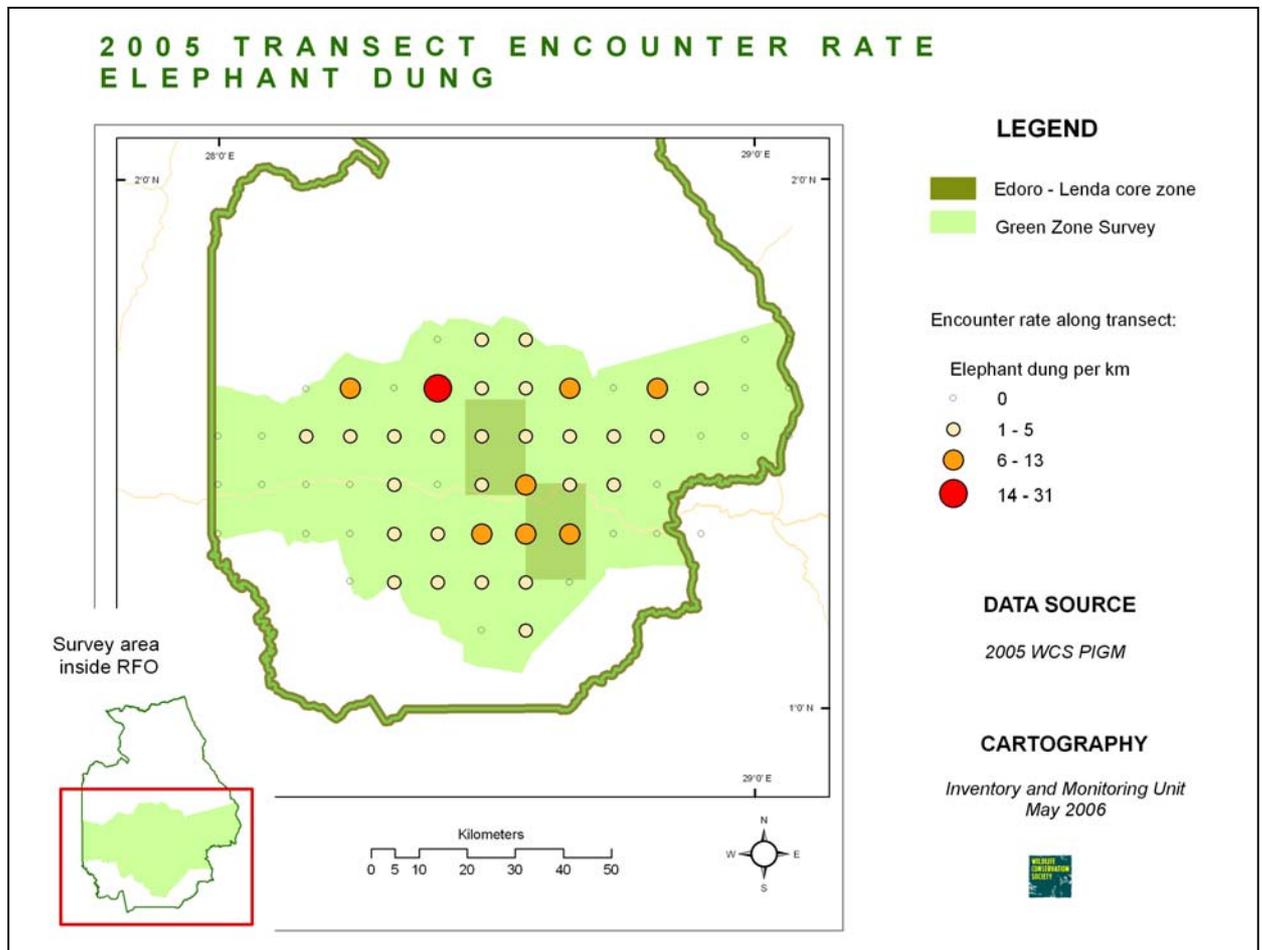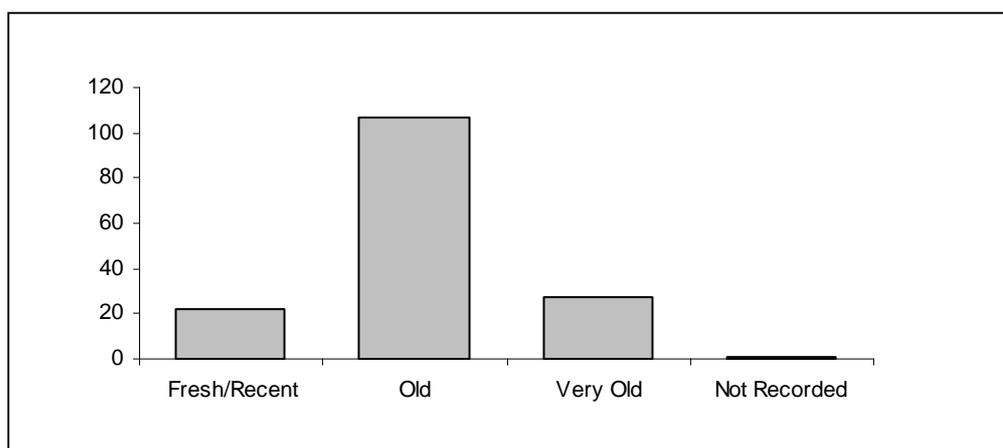

FIGURE 6. Age distribution of elephant crottes recorded on systematic transects .

Chimpanzee

Distribution of chimpanzees (determined by nest counts) is similar to hat of elephants in that chimpanzee occurrence is concentrated in the center of the zone and is infrequent toward to boundaries of the RFO (FIGURE 7). Nevertheless, chimpanzees are widespread, but high concentrations of nests were observed on only a few transects. Nest group size was on average small. Most nest "groups" consisted of a single nest. Only five nest groups contained more than two nests. (FIGURE 8).

FIGURE 7. Chimpanzee distribution and relative abundance in the Zone Verte as measured by nest group encounter rates along systematic transects.
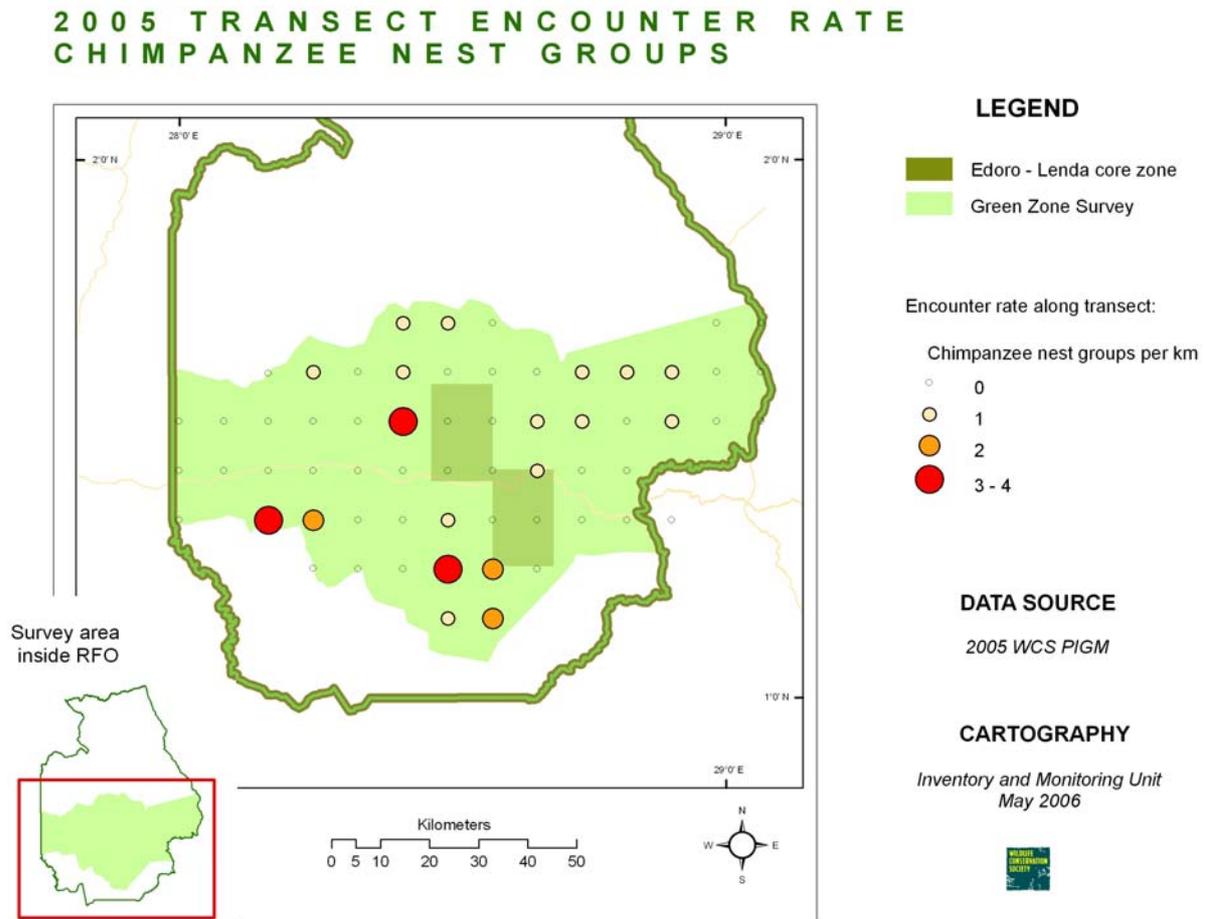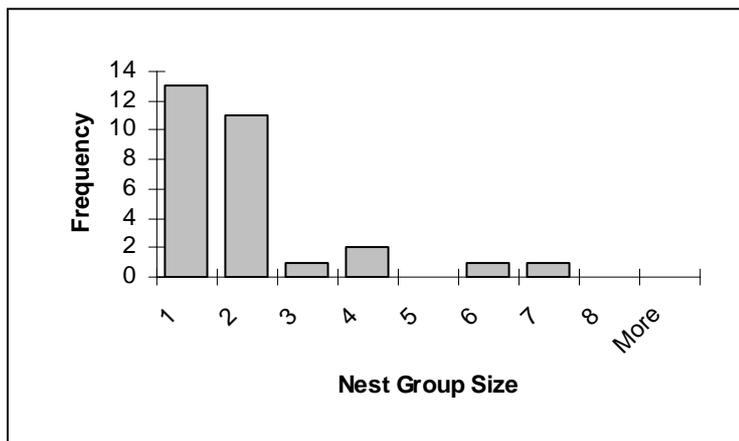

FIGURE 8. Chimpanzee nest group size recorded on Zone Verte systematic transects .

Okapi

Encounter rates of okapi sign on the transects were low and scattered (FIGURE 9). n total only nine observations of dung where made along 59 km of transect. Data are too few to reach any conclusions regarding the distribution, however okapi sign was found in both remote forest and along the borders of the reserve.

FIGURE 9 Okapi distribution and relative abundance in the Zone Verte as measured by dung encounter rates along systematic transects.
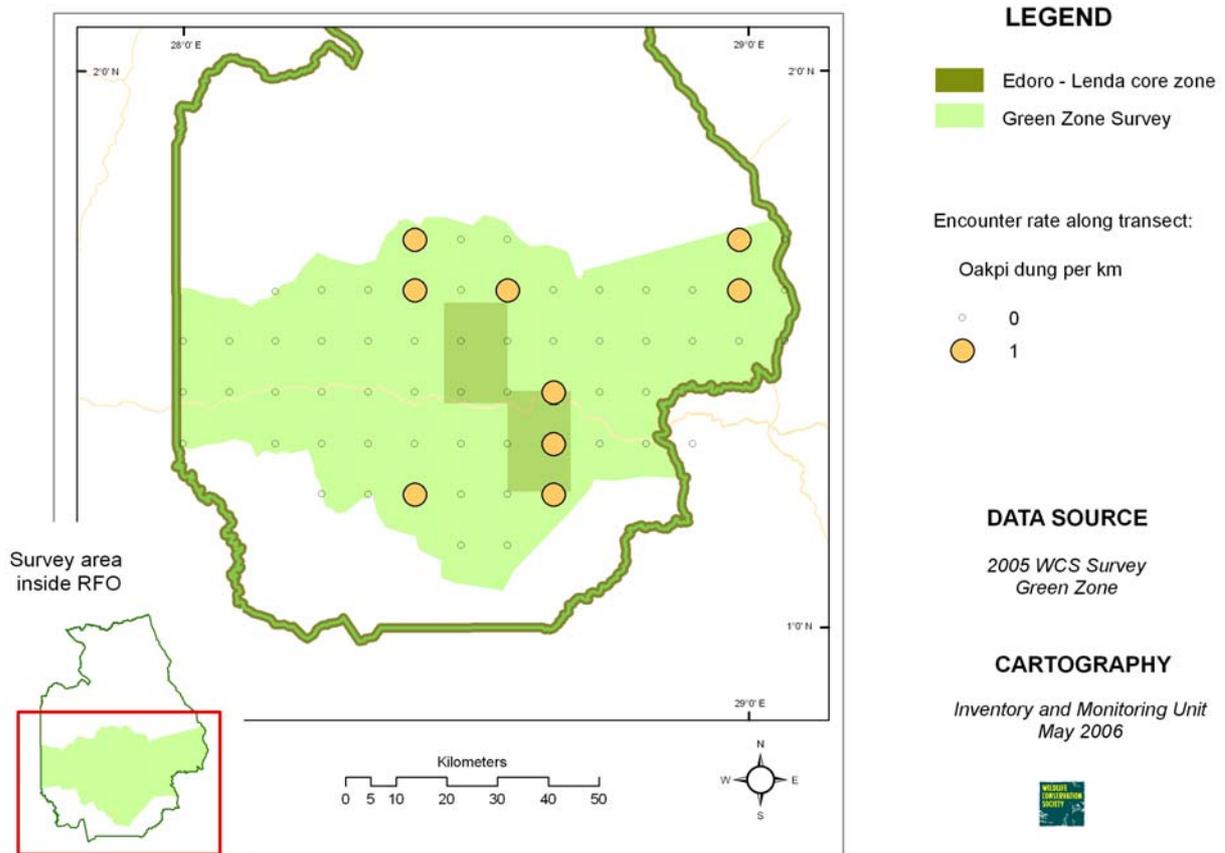
Duikers

Based on dung counts, duikers were scattered and not common (FIGURE 10). In the Zone Verte, 72% and in the Edoro-Lenda pilot, 73 %of all transects had no occurrence. These encounter rates were lower than expected. It is possible that this is a reflection of highly reduced duiker numbers following the war, but in fact two additional pieces of evidence suggest that the duiker populations are relatively robust through out the zone.

Dung counts indicate that over 50 percent of duiker records are for larger species, "red" duikers (5 species) and the even larger yellow-back duiker (TABLE 3). In heavily hunted populations these larger species decrease rapidly, and may represent less than 30 percent, or less of the community.

A comparison of the zone verte results (where hunting is widespread) with those of the Edoro-Lenda pilot (where hunting is less intensive) provides further evidence that duiker numbers are

not strongly reduced (FIGURE 11). Encounter rates between the two samples are roughly comparable, suggesting that major reductions have not occurred.

The low dung encounter rates remain a mystery and could be due to high dung disappearance decays rates during the survey period, or highly limited visibility to observers. More extensive comparisons of pre and post conflict results on the monitoring transects will likely prove useful in establishing the impact of the conflict on these primary bushmeat targets.

As with many other large mammals, duiker abundance was noticeably attenuated near the limits of the reserve.

FIGURE 9 duiker (all species) distribution and relative abundance in the Zone Verte as measured by dung encounter rates along systematic transects.
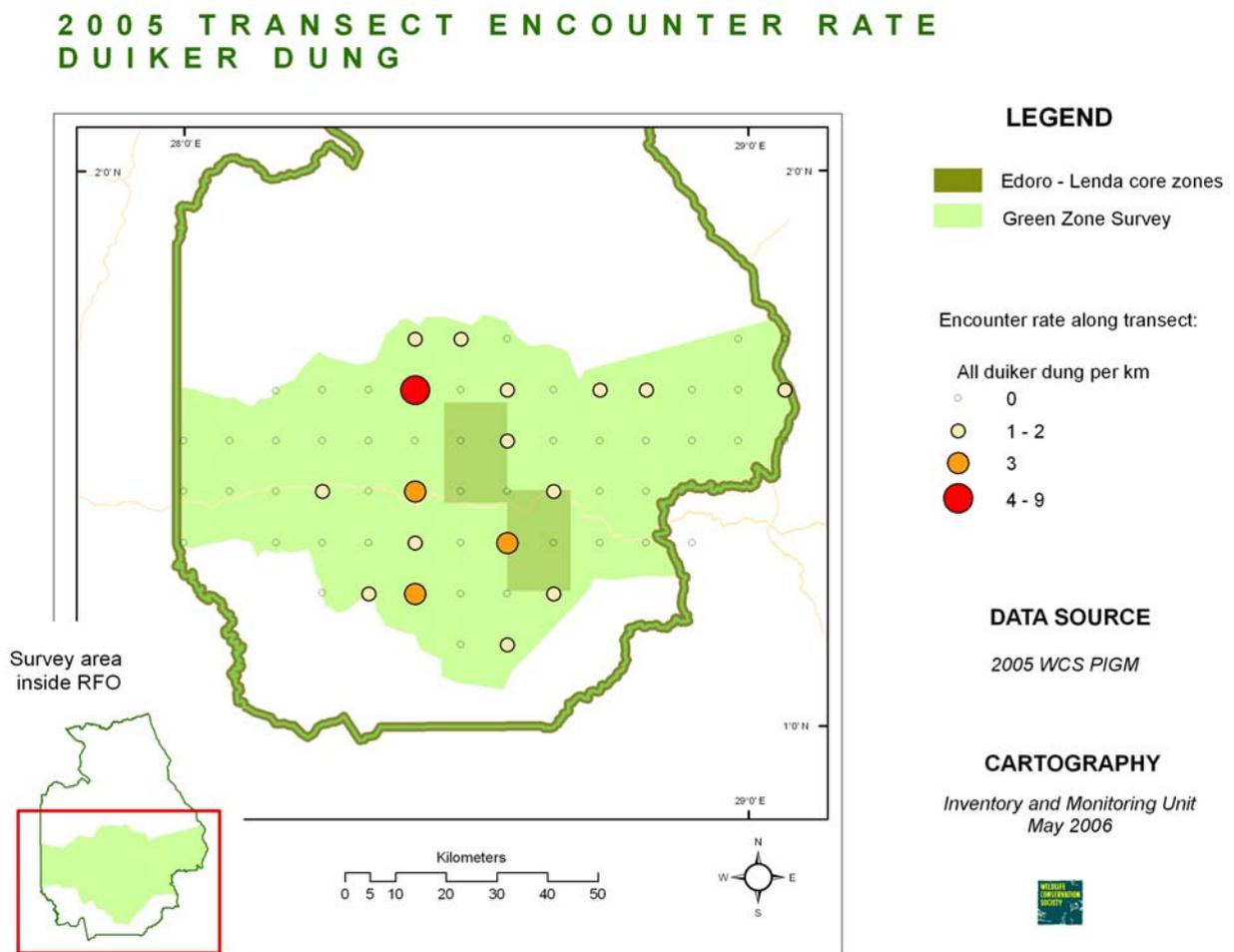
TABLE 3. Species composition of duiker pellet groups encountered along systematic transects in the Zone Verte.

Taxon	Total
Cephalophus monticola	12
Cephalophe rouge	9
Cephalophus sylvicultor	7
Grand Total	28

NOTE Cephalophes rouge includes *C. nigrigfrons, C. weynsi, C. leucgaster, and C. dorsalis,* and the chevrotain, *Hyemoschus aquaticus.* Dung of these species often cannot be determined to species.

FIGURE 11 Comparison of encounter rates of duiker pellet groups in the Edoro-Lenda pilot zone (A) and the Zone Verte (B). pellet g distribution and relative abundance in the Zone Verte as measured by dung encounter rates along systematic transects.

Primates

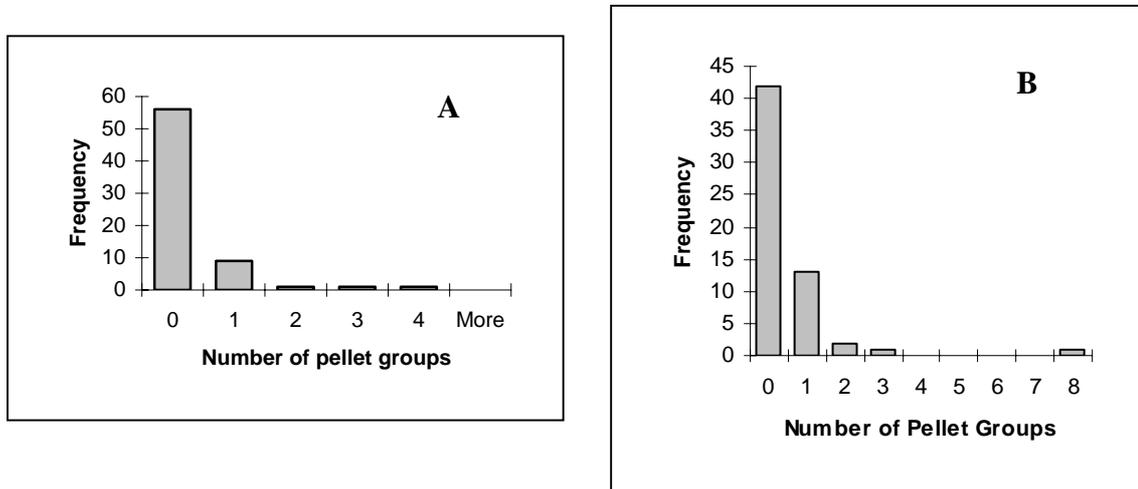In total 71 observations of primates where recorded along the transects. A breakdown of the species encountered is provided in TABLE 4. Vocalizations were the primary indicator of primate occurrence recorded by field teams.. Overall primates are widely distributed and found along the roads near settlement, as well as in remote forest. Highest concentrations were found in the central areas of the green zone. Nevertheless it is likely that some of the *Cercopithecus* species prefer the disturbed habitats around settlements.

Despite reports of hunting during the war, primates were widely encountered and in good numbers, and in general did not flee upon encounter—as is often the case with populations exposed to intensive hunting. This evidence suggests that the RFO's primates apparently were not excessively hunted, at least in the Zone Verte. Nine of the 12 anthropoid primate species (excluding apes) that occur in the RFO were recorded on the transects. Species not recorded included debrazza's and l'hoesti's monkeys, and the baboon (*Papio annubis*). The first two are either highly localized or discrete The baboon favors roads and disturbed habitats, both of which may have been under surveyed.

TABLE 4. Primate species recorded on systematic transects in Zone Verte survey.

Espece	Call	Dung	Nest	Seen	Grand Total
Cercocebus albigena	28	1		1	30
Cercocebus galeritus agilis	1			1	2
Cercopithecus ascanius	1				1
Cercopithecus hamlyni	2				2
Cercopithecus mitis	11			2	13
Cercopithecus wolfi denti	6			1	7
Colobus angolensis	1				1
Colobus badius	7			4	11
Colobus guereza	1				1
Galagoides demidovi			1	1	2
Not identified		1			1
Grand Total	**58**	**2**	**1**	**10**	**71**

FIGURE 12 Primate (all species) distribution and relative abundance in the Zone Verte as measured by direct encounters along systematic transects.
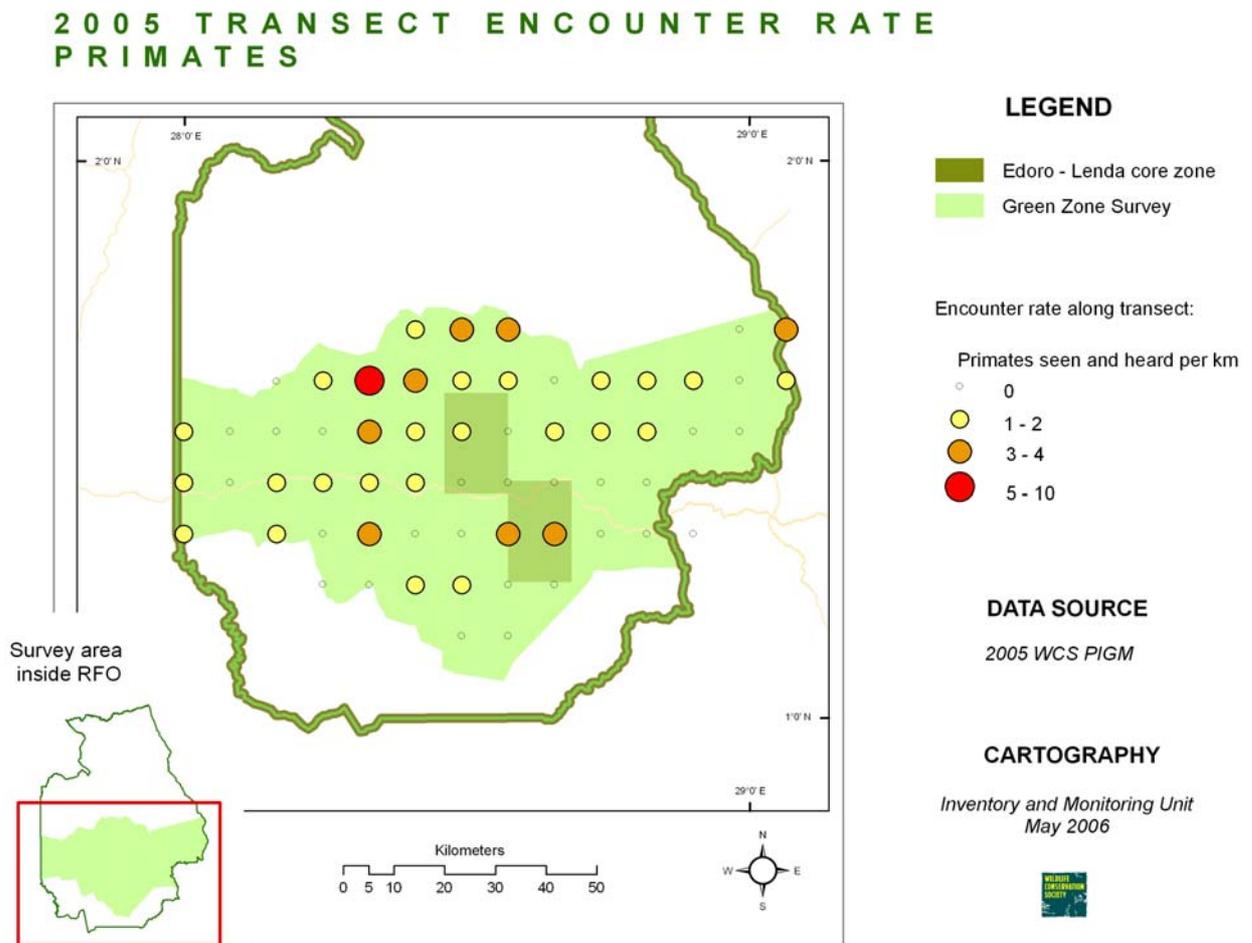
7) Human Hunting

Evidence of human hunting was found widely over the survey zones, except on the Scientific study areas, (Lenda and Edoro) which are intensively patrolled. Snare and net hunting sign were the most frequently encountered evidence of hunting. Most hunting sign was found within 20 km of the road bisecting the Zone Verte, although some hunting evidence was also recorded in more remote locations (FIGURE 13). Gun shots were only recorded once.

Evidence of human activity recorded on transects averaged 1.7 records / km. Hunting is the major human activity in the forest, representing over 20 % of all sign of human activity (TABLE 5) Signs of passage (paths, machete cuts, and broken branches to mark a trail) are the most frequent signs, but many of these are certainly associated with hunting activity.

Among hunting sign, snares, which are illegal method of hunting in the RFO were recorded more frequently than signs of hunting nets, a legal method. Further investigation to identify snare owners and their operations is required to halt the spread and control this destructive practice.

FIGURE 13 Evidence of hunting (all species) distribution and relative abundance in the Zone Verte as measured by direct encounters along systematic transects.
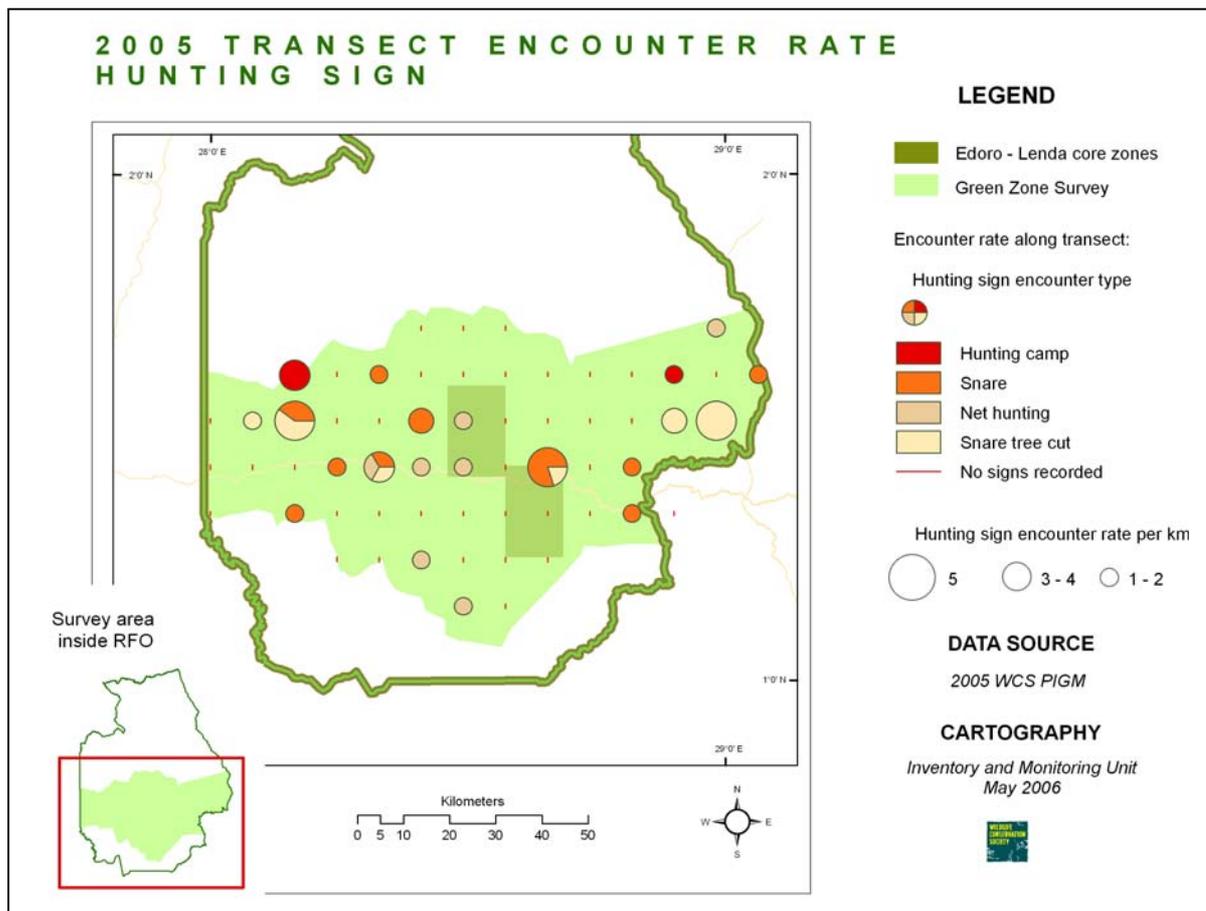
TABLE 5. Evidence of human activity recorded on the Zone Verte Survey

Type of Sign	Frequency	Percent total human activity
Machete cut	90	42.65
Path	76	36.02
Snare	15	7.11
Garden	15	7.11
Net hunt	7	3.32
Camp	4	1.90
Honey gathering	1	0.47
Road	1	0.47
Human encounter	2	0.94
Grand Total	211	100.00

8) Estimates of faunal abundance and impact of conflict

At this point only preliminary estimates of population densities are provided for selected fauna in the Zone Verte and Edoro-Lenda blocks. The software DISTANCE (Version 5) was used to determine density (per km^2) of indicators for elephant (dung), chimpanzee (nest groups) and duikers (crottes or pellet groups)d. from counts made on systematic transects. Details on the Distance analyses are provided in ANNEX 4.

Summary encounter rates and results of the Distance analysis are provided in TABLE 6. The table also includes comparative data on encounter rates of hunting evidence.

TABLE 6 Summary statistics for key indicators on faunal abundance and bushmeat hunting in the Edoro-Lenda and Zone Verte surveys.

Species	Survey zone	Number observations	Indicator encounter rate (per km)	Indicator density (per km^2)
Elephant (dung)	Edoro / Lenda	196	2.58 (CV 13.81, 95% CI 1.97 - 3.40)	576.75 (CV 15.30, 95% CI 426.49 - 779.95)
	Zone verte	156	2.46 (CV 24.73, 95% CI 1.51 – 4.01)	489.22 (CV 25.60, 95% CI 295.81 - 809.11)
Chimpanzee (nest groups)	Edoro / Lenda	33	0.38 (CV 22.23, 95% CI 0.25 - 0.59)	22.80 (CV 28.61, 95% CI 13.03 – 39.88)
	Zone verte	29	0.43 (CV 25.94, 95% CI 0.26 – 0.72)	17.19 (CV 32.53, 95% CI 9.15 – 32.31)
Okapi	Edoro / Lenda	11	0.16 (CV 92.26, 95% CI 2.97 9.94)	
	Zone verte	9	0.15	
Cephalophus spp (dung)	Edoro / Lenda	18	0.26 (CV 32.27, 95% CI 0.14 0.49)	63.897 (CV 37.36, 95% 31.133 - 131.14)
	Zone verte	28	0.42 (CV 29.21, 95% CI 0.24 - 0.75)	149.77 (77.22 - 290.45)
Primates (all, direct observation)	Edoro / Lenda	52	0.76	
	Zone verte	68	1.15	
Hunting sign (all)	Edoro / Lenda	24	0.35	
	Zone verte	39	0.66	

Conversion of encounter rates and density of indicators to estimates of anima numbers requires in addition to data on indicator density, additional information on the rate of production and decay (or disappearance) of the indicator. The basic formula for this conversion can be given as follows:

Animal density (number / km^2) = [Density of indicator (number / km^2) / mean decay rate of indicator (days)] /daily production rate of indicator (number / day).

Estimates of indicator production and decay rates and preliminary estimates of faunal densities are provided in TABLE 7.

TABLE 7. Production and decay estimates for indicators for selected fauna in the RFO

Species	Indicator	Daily production (number / day)	Decay / disappearance (days)	Source and Note
Elephant	Dung	13 - 20	50 - 70	Dung production estimates from literature; disappearance rates from RFO studies
Chimpanzee	Nest group	0.7 – 1.3	90 - 150	Estimates of nest reuse from RFO, disappearance rates from Gabon studies
Duikers	Pellet groups	5 – 8	15 - 30	Captive animal studies and controlled dung disappearance studies in RFO

TABLE 8 provides estimates of faunal numbers on the two survey zones.

TABLE 8. Estimates of densities and numbers of selected fauna in the Edoro-Lenda and Zone Verte Survey Zones.

Species	Survey	Indicator density estimates			Animal density (per km^2)		Numbers (Zone Verte)
		Lower	Mean	Upper	mean	range	
Elephant	E-L	243	577	780	0.57	0.41 – 0.76	
	ZV	296	489	809	0.48	0.29 – 0.79	1600 - 4400
Chimpanzee	E-L	13	23	40	0..35	0.19 – 0.60	
	ZV	9	17	32	0..25	0.13 – 0.48	730 - 2700
Duikers	E-L	31	64	131	1.50	0.31 – 1.30	
	ZV	77	150	290	1.75	0.70 – 3.12	3900 - 17500

Notes:
Survey: E-L: Edoro-Lenda; ZV: Zone Verte
Indicator estimates: Taken from Table 6.
Chimpanzee estimates: Nest groups x mean nests / group = 1.2.
Zone Verte animal numbers: range in density x 5,600 km^2

While the calculations presented in TABLES 6 – 8 represent preliminary results, to be treated with caution, the following observations can be made:

-- *Elephants:*   Major poaching took place in the RFO over the war, and continue up through 2005 (USFW ivory monitoring report). The Zone Verte and Edoro-Lenda areas were the least affected directly. Elephants are clustered in the center of this area, removed from the RFO boundaries, and close to the best-protected areas (Epulu and the study areas), even though these are areas of high human use. The war seems to have compressed elephants to a safe zone. This is causing increased human – elephant conflict.

It remains important to find out what remains of elephant populations in the areas of the RFO that suffered heavy hunting, and to develop a strategy to permit their recovery.

Elephants should remain a priority for monitoring, and additional methods such as monitoring of elephant clearings (*edos*) and continued undercover monitoring of elephant hunting is required to determine if efforts to control poaching are successful.

-- *Chimpanzees*. All evidence, including results of the USFWS-supported bushmeat monitoring program indicate that there was very little direct hunting of chimpanzees I nthe RFO over the conflict period.   A comparison of numbers and distribution pre and post conflict is required (this analysis is planned). Marginally hire estimates in the Edoro-Lenda core areas (better protected than the remainder of the Zone Verte) suggest that these sites remain important, even though they represent only a small area of the reserve. Chimpanzees appear to avoid the periphery of the reserve, suggesting that this area poses threats to them. It is difficult to interpret the small nest group size recorded, but this may be an effect of the last decade of conflict. Comparisons of pre and post conflict survey results will provide further insights.

-- *Okapi*. Okapi dung encounter rates were very low, and estimates of okapi number are not yet possible. Further work on defecation and dung decay rates will assist in interpreting results. We have no evidence that okapi were targeted during the conflict, but increased snaring pressure could certainly have led to higher mortality.

--*Duikers*. The results are difficult to interpret. Dung encounter rates are very low, suggesting that duikers have been almost eliminated. Yet the species composition of the dung counts (high proportion of larger species) suggests that populations are not doing badly. The estimates of pellet group decay rates may need to be re-evaluated. The wide range of encounter rates suggests that detection of pellet groups by observers may be a problem. This will require evaluation of field observers. One option is to initiate alternative census methods (such as direct counts by night light).

At present it is not possible to evaluate the impact of the conflict and the increased bushmeat hunting on duikers. Unbiased estimates of duiker numbers will be important in managing hunting zones in the RFO, so new information and answers and a solution to the methodological problems above is required.

-- *Primates*. All evidence indicates that primates have not been seriously impacted by the decade of conflict. Encounter rates are highest in remote areas of the Zone Verte. Primate troops are readily detectable, and a number of vulnerable species such as colobus regularly recorded.

*-- **Hunting***. Hunting is clearly widespread in the zone, though less evident in areas remote from roads. High encounter rates of illegal snares indicates that unsustainable hunting practices may be widespread, though this needs to be verified by additional community-based surveys. Correlations between hunting sign and duiker numbers may be revealing. Hunting rates are lower in the Edoro and Lenda samples ,indicating that protection of the study areas, which are embedded in these survey zones has been comparatively effective.

Next steps

The most important next step is to complete the post conflict baseline assessment in the remainder of the RFO.

This should be followed by a threats analysis that will be designed to inform interventions to protect the RFO and its ke fauna and habitats.   An important outcome for the threats analysis will be an evaluation of management proposals and boundaries for the RFO 's mangement zones.

The rich RFO data set affords the opportunity for further analyses that can better inform on the status of the areas fauna, and the impact of human activities, as well as methods to better monitor the site. The following are planned or underway:.

- Investigate the possibility of pooling all three data sets (core 2004, 2005 systematic and 2005 random) in order to increase the sample size for chimpanzee, duikers and chimpanzee.
  - Analysis and investigate the effects of autocorrelation using the intense systematic transects.
  - Time series analysis on the monitoring transects over pre and post war period, using three time surveys (1995, 2000, 2005)
  - Analysis and map the recce voyage data.
  - Correlate chimpanzee and elephant data with recce segments for modelling spatial utilization, especially investigating this in relation to threats.

ANNEX 1.Field Protocol

WCS / ICCN
Programme d'Inventaire De la Réserve de faune à Okapi 2004-05

PROTOCOLE POUR FICHES DE RECCES ET TRANSECTS

Une ficher pour un Transect ou pour un Recce.
Le Chef d'Equipe Réglager son montre avec le Chronomètre GPS

Entête

DATE
Ecrivez la date, avec l'ordre : jour-mois-année. Ecrivez le mois en lettres, pas en chiffres.

CHEF D'EQUIPE
Ecrivez le nom de Chef d'Equipe. Sur verso, écrivez les noms de tous les membres technique, et leur attribution.

SECTEUR
Donnez le Secteur du travail

TRANSECT ID
Ecrivez le numéro d'identification de transect

CONDITIONS CLIMATIQUE
Voir Protocole nid

WP DEPART
Fournir le Numero de Waypoint

LAT / LONG DEPART
Ecrivez en Degrés Décimaux

HEURE DEPART
Ecrivez en format de 24h

BEARING DEPART
Donnez la direction de boussole

WP FIN
Fournir le Numero de Waypoint

LAT / LONG FIN
Ecrivez en Degrés Décimaux

HEURE FIN
Ecrivez en format de 24h

MAP SOURCE FICHIER
Ecrivez

NOMBRE WP

NOMBRE TRACK POINTS

DISTANCE TOTALE

EPE

FICHES NIDS

FICHES VEG

FICHIER PHOTO

Tableaux

HEURE
TOPOFIL
NO WAYPOINT
ALTITUDE
HABITAT
  CLASSE
       Foret   FOR
       Foret / Bambou mixte   FBM
       Bambou   BAM
       Marais   MAR
       Ericaceae/Afroalpine   ALP
       Clairière   CLA
       Autre (a definir)

  CANOPEE
       Fermé   FER
       Degagé   DEG
       Ouverte (sans arbres)   OUV

  SOUS BOIS
       Sericostachyus + ou ++   SER
       Fougeres + ou ++   FOU
       Mimulopsis + ou ++   MIM
       Autre (a definir)

TOPOGRAPHIE
  Topographie
       Sommet   SOM
       Pente   PEN
       Vallée   VAL
       Plaine   PLA

  DECLINAISON
       Plat : pas de pente   PLT
       Faible – Modèré   MOD
       Forte : grimpage a quatre   FRT
       Falaise : acces impossible   FAL

OBSERVATION

CLASSE	CATEGORIE / ESPECE	TYPE	CODE	Mesure perpendiculaire	Note
Faune		Vu	VU	**Oui**	Centre groupe
		Entendu	ENT	Non	
		Crotte	CRO	**Oui**	Millieu de crotte
	Donner le nom d'espèce	Nid	NID	**Oui**	Mesure du premier nid vu de transect
		Broutage	BRO	Non	
		Trace	TRA	Non	Observation prioritaire : Piste récente priorité gorilles
		Carcasse	CAR	Non	
		Autre (Définir)			
Humaine	Passage	Fournir un BREVE description	PAS	Non	Observation prioritaire : pistes récentes
	Piège	• Type de piège, etc	PIE	**Oui**	Au tige
	Mine		MIN	Non	
	Charbon	• Historique ou autres	CHAR	Non	
	Coupe Bambou		CP BAM	Non	Prioritaire : coupes récentes
	Coupe bois	• Personne / groupes responsable	CP BOIS	Non	
	Agriculture		AGR	Non	
	Non déterminé ou Autre (définir)				

AGE
    Récent / Actif   REC / ACT
    Vieux / non actif   VUX / NOACT

NOMBRE
    Nombre vu

PHOTO
    Numero de photo

EPE
    Donnez le EPE au moment de WP.

NOTES

Liste Equipment Recce-Transect

Bureau Mobile
Fiches de réserves (toute note sera mise sur la fiche)
    recces, transect
    nids
    carcasse

Protocoles
Marqueurs,
Crayons réserves
Ruban « flagging »

Fil de réserve pour topofil
Mettre ruban
GPS
Piles de réserve
Boussole

Ziplock sachets en plastiques (pour GPS, photo, dans la cas de pluie)
Lime
Lampe torche
briquet
Machette
Scotch pour antenne (tres important)
Casquette pour l'antenne externe (a être porter par le boussolier)
Leatherman
Trousseau médicale

Annex 2. Distance Analyses

Elephant, Edoro-Lenda

A total of 196 observations of dung piles where recorded on this survey. Of these, 106 dung observations where recorded in the Lenda study area (No of transects = 42) and 90 in the Edoro study area (No of transects = 26).

The detection function was fit using the pooled observations from both study areas. Data were truncated at 3.7m distance, removing 20 observations from analysis.. No data irregularities where identified.

Four models where fitted, half normal with hermite adjustment, uniform with a simple polynominal adjustment, half normal with a cosine adjustment and uniform with cosine adjustment. All models were very similar, with AIC values (715.68 – 715.75). The half-normal function with a hermite polynomials adjustment was selected having the lowest value. Goodness of Fit for final model was 0.2870 on 7 df). Model fit and data histogram are shown below, followed by table providing summary statistics ..
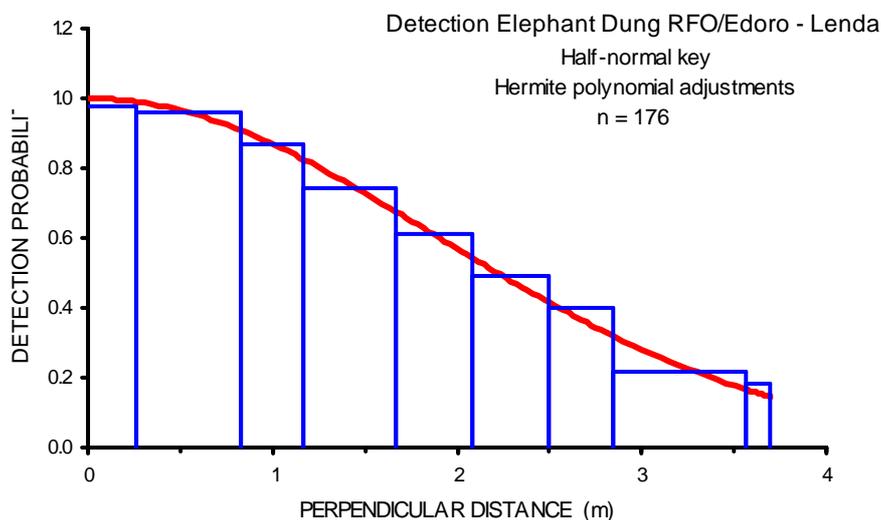
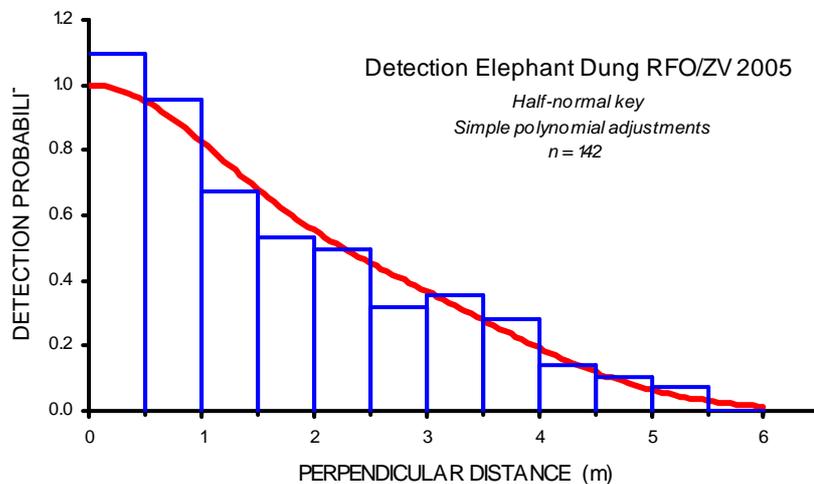| Parameter	Estimate	Standard Error	% CV	95% Confidence interval
Encounter rate (n/ km)	2.58	0.36	13.81	1.97 - 3.40
Density	576.75	88.24	15.30	426.49 - 779.95
Number	288,380	44,118	15.30	213,250 - 389,970
Effective strip width (m)	2.24	0.15	6.57	1.97 - 2.55

Component Percentages of Var(D)

 Detection probability : 18.5
 Encounter rate   : 81.5

Elephant, Zone Verte

The Zone Verte elephant dataset was truncated at 6 meter. This resulted in 10% of data truncation, with a sample size of 142 crottes used for the analysis. Transect encounter rate are provided in the first diagram below. A half normal model with a simple polynomial adjustment terms was used to fit the data and was selected over a Hazard rate model. The DISTANCE output for the chosen model is given in the following diagram.

A good CV of just above 25 % was obtained. Variability between transects (patchy elephant distribution) and a large number of transects without any observation are likely to explain higher CV%.

Detection Elephant Dung RFO/ZV 2005
Half-normal key
Simple polynomial adjustments
n = 142
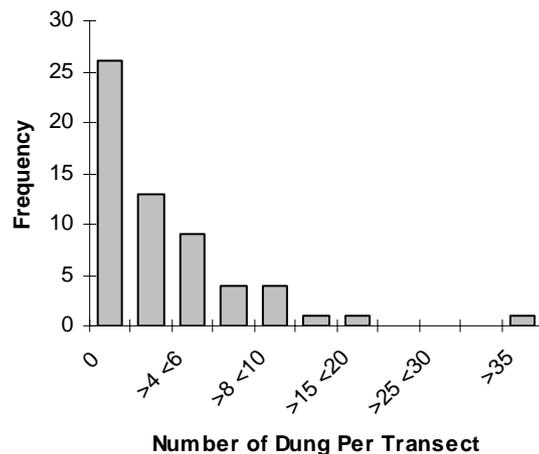
Parameter	Estimate	Standard Error	% CV	95% Confidence interval
Encounter rate (n/ km)	2.46	0.60	24.73	1.51 - 4.01
Density	489.22	125.24	25.60	295.81 - 809.11
Number	2,737,900	700,880	25.60	1,655,500 - 4,528,100
Effective strip width (m)	2.52	0.17	6.63	2.21 - 2.87

Chimpanzee, Edoro-Lenda

On all transects chimpanzee nest data was collected (n=68). A total of 33 nest groups observations where recorded. 24 nest where observed in the Lenda pilot area and 9 in the Edoro area. Data was truncated to 15 m from transect line, yielding a pooled sample of 22 nest groups. A Half-normal function with a cosine adjustment was chosen by visual inspection of the output. Detection probability (to center of nest group) is shown in the figure below. Distribution followed by a table summarizing detection function statistics.


Detection chimpanzee nest group RFO/Edoro-Lenda
Half-normal key
Hermite polynomial adjustments
n = 22
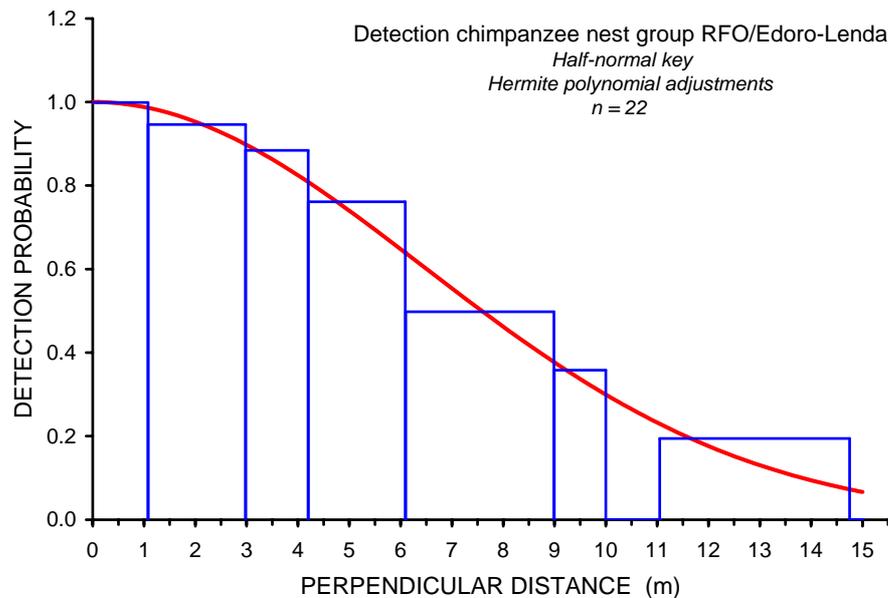
Parameter	Estimate	Standard Error	% CV	95% Confidence interval
Encounter rate (n/ km)	0.38	0.085	22.23	0.25 - 0.59
Density	22.80	6.52	28.61	13.03 - 39.88
Number	11,400	3,261	28.61	6,517 - 19,942
Nest Group	2.13		13.17	1.62 - 2.80
Effective Strip Width	8.46	1.52	18.00	5.83 - 12.27

Component Percentages of Var(D)

Detection probability : 39.6
Encounter rate   : 60.4

Chimpanzee, Zone Verte

Nest group data was truncated at 16 meters. This removed only three observations (n = 26) but improved model fit with a very wide shoulder. A half-normal model was chosen from visual inspection of the histogram. However due to the small sample size the CV of the estimate remained above 30%. Variation in the detection probability between nest groups contributed a 36 % to the overall variance of the estimates. Detection function model (to nest group center) and data histogram are provided below, followed by summary statistics.


Detection chimpanzee nest group RFO/ZV 2005
Half-normal key
Cosine adjustments
n =26
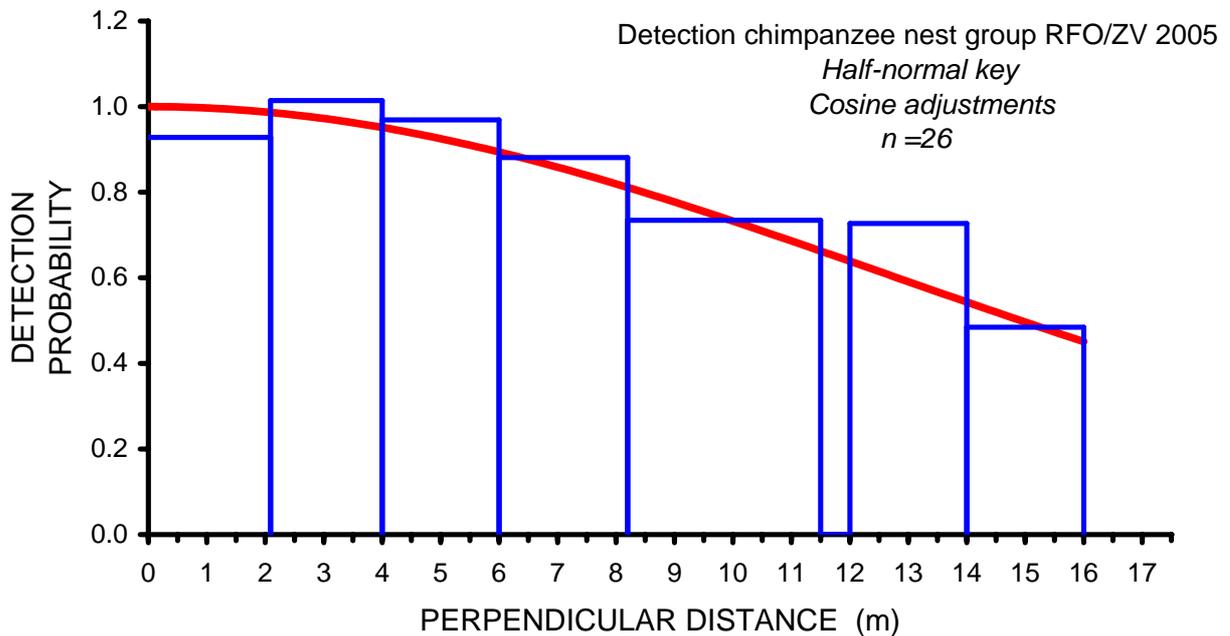
Parameter	Estimate	Standard Error	% CV	95% Confidence interval
Encounter rate (n/ km)	0.43	0.11	25.94	0.26 - 0.72
Density	17.19	5.59	32.53	9.15 - 32.31
Number	96,224	313	32.53	51,206 – 180,820
Effective Strip Width	12.60	2.47	19.62	8.44 - 18.80

Component Percentages of Var(D)

Detection probability : 36.4
Encounter rate   : 63.6

Duikers, Edoro-Lenda

Dung for all species pooled. Data were truncated at 4 m, with total sample of 18 crottes used
for the DISTANCE analysis. A Half-normal model was applied. Low sample size contributed
to the high CV for this analysis. Detection model and data table belw.
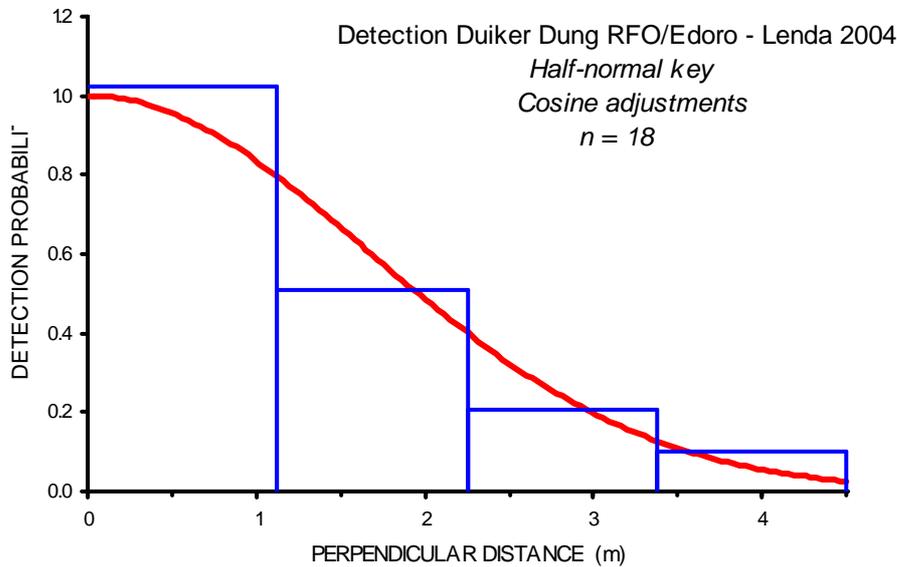
Parameter	Estimate	Standard Error	% CV	95% Confidence interval	
Encounter rate (n/ km)	0.26471	0.85410E-01	32.27	0.14124	0.49610
Density	63.897	23.873	37.36	31.133	131.14
Number	31949.	11937.	37.36	15566.	65571.
Effective Strip Width	2.0713	0.39014	18.84	1.3969	3.0714

Component Percentages of Var(D)

Detection probability : 25.4
Encounter rate   : 74.6

Duikers, Zone Verte

Dung for all species pooled for analysis, with data truncation at 2.2 m (25 pellet groups, of a total of 29 recorded).   A half normal model was imposed and model fit was satisfactory. Detection function and tabular summary below..
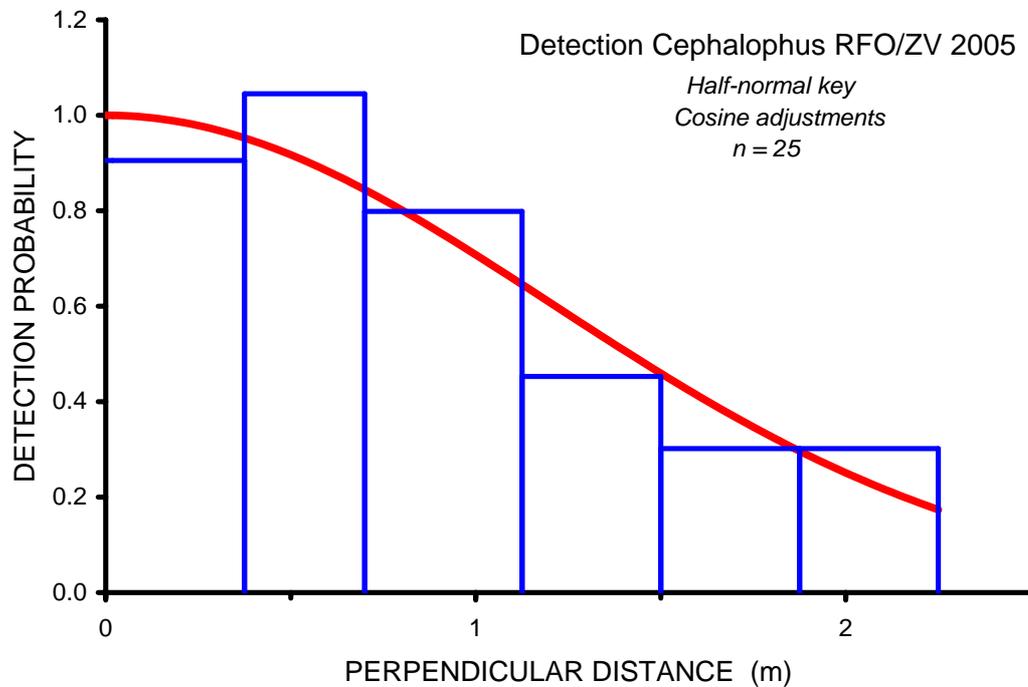
Parameter	Estimate	Standard Error	% CV	95% Confidence interval
Encounter rate (n/ km)	0.42378	0.12377	29.21	0.24 - 0.75
Density	149.77	51.278	34.24	77.22 - 290.45
Number	838100	0.28695E+06	34.24	432,160 - 1,620,500
Effective Strip Width	1.4148	0.25280	17.87	0.98 - 2.04

Component Percentages of Var(D)

Detection probability : 27.2
Encounter rate   :   72.8