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The Study Region and a Brief History of the Bili Project

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Introduction

In the 30 years following the initiation by primatologists of the first long-term chimpanzee (*Pan troglodytes*) field studies in the early 1960s, research sites were heavily-biased towards the far eastern and western edges of chimpanzees' distribution (Baldwin & Teleki, 1973; reviewed in McGrew, 1992). In the past 15 years, a number of additional sites have been established, many closer to the center of the species' range [Gashaka (Nigeria): Sommer et al., 2004; Goualougo (Republic of Congo): Morgan & Sanz, 2003; Loango (Gabon): Boesch et al., 2009]. However, as of 2004, a major gap remained in our knowledge about our close evolutionary cousins: the northern Democratic Republic of the Congo (DRC) (Figure 1). Although some data on chimpanzees have been collected in the Ituri Forest (Chapters 4 & 5), the majority of the Northern DRC remains *terra incognita* in terms of information about the resident apes, and even their presence or absence is unknown across large stretches of this remote landscape. This is an unfortunate gap, as the region is likely home to the largest remaining continuous population of chimpanzees (Butynski, 2001). In an attempt to fill in part of this lacuna in our knowledge, between 2004 and 2009 Thurston Hicks (TH) surveyed an area of approximately 35,000 km² encompassing two distinct eco-regions, on both sides of a major river, the Uele (Figure 2). A 950 km gap separates the Bili region from the nearest long-term chimpanzee study site in the west, Goualougo, and the nearest study site to the east, Semliki, is 680 km distant (Figure 3). The Ituri Forest lies 440 km to the southeast of Bili. Figure 4 gives a closer view of the study region, pinpointing survey areas across the Bili-Uele landscape. Figure 5 focuses on the 2004-2007 survey zone.

History of conservation in the region

The Bili-Uéré Domaine de Chasse is the largest protected area in DRC. Created in 1974 (République Démocratique du Congo Ministère des Travaux Publics et Infrastructures, 2007), it follows the border of the Central African Republic and covers a total area of 60,000 km² (Doumenge, 1990, cited from pers. com. with Direction Générale IZCN, Kinshasa 1988). The domaine de chasse is made up of seven blocks, including the Mbomu Reserve (Figure 6). Congolese Law 75.024 (July 22, 1975) and Law 2.002 (28 May 1982) distinguish between national parks and '*réserves de faune*' (Doumenge, 1990). Within '*réserves de faune*', there exist two subdivisions: '*les réserves de faune totales*' and '*les réserves de faune partielles*'; Bili-Uéré, as a domaine de chasse, is the latter. A domaine de chasse receives a low level of protection, and the regulations regarding its exploitation are somewhat vague¹.

¹ The definitions are as follows: '*Réserve de faune totale*': '*une aire mise à part pour la conservation, l'aménagement et la propagation de la vie animale sauvage, ainsi que pour la protection et l'aménagement de son habitat, dans laquelle la chasse, l'abatage ou la capture sont interdits, sauf aux autorités de la réserve ou sous leur contrôle, et où l'habitation ou toutes autres activités humaines sont interdites*' (cited from Doumenge, 1990). '*Réserve de faune partielle*': '*une aire mise à part dans laquelle l'exploitation de la faune est réglementée et contrôlée d'une manière particulière...*' (art. 1). Article 2 continues, regarding '*secteurs sauvegardés*': '*l'ordonnance ... peut soumettre à un régime particulier et, le cas échéant, interdire à l'intérieur du secteur la*

The importance of the Bili-Uéré Domaine de Chasse appears to have been overlooked by conservationists in the past. It is mentioned only briefly in *La Conservation des Ecosystèmes Forestières du Zaïre* (Doumenge, 1990) and is not included in Annexe 1 of ‘Aires protégées actuelles’ (in which the smaller Domaine de Chasse of Rubi-Télé is listed), Annexe 2 of ‘Sites supplémentaires prioritaires’, or even Annexe 3, ‘Sites supplémentaires d’intérêt local’, a surprising omission given that Bili-Uéré is the largest protected area in The DRC. The Institut Congolais pour la Conservation de la Nature, the Congolese governmental body primarily responsible for the enforcement of conservation laws in protected areas, was not active or even present at Bili-Uéré during the entire period TH spent in the region. Attention was brought to the area when, in 2002, Ammann entered into a collaboration with the Dutch wildlife conservation non-governmental organization (NGO) The Wasmoeth Wildlife Foundation (http://www.wasmoethwildlife.org/1st_update.php). The Wasmoeth Wildlife

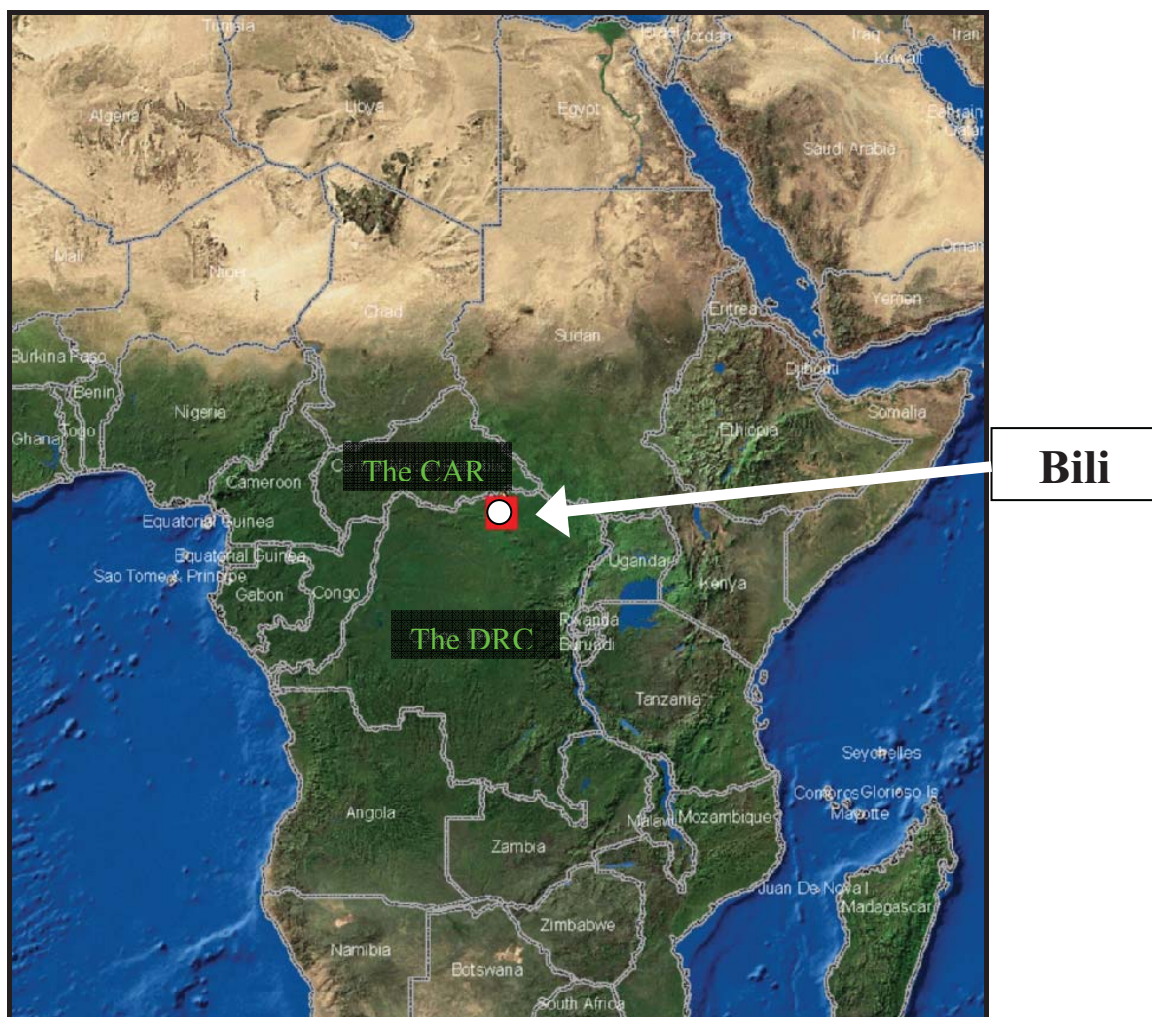


Figure 1. Central Africa, with the area of the current study highlighted. The Landsat ETM+ image files dated from 1999 and were downloaded from GLCF (Global Land Cover Facility) at <http://glcf.umiacs.umd.edu>. The CAR, Central African Republic; The DRC, The Democratic Republic of the Congo.

chasse et la pêche, les activités industrielles, commerciales, agricoles, pastorales ou forestières, l'exécution des travaux publics ou privés, l'extraction de matériaux concessibles ou non, l'utilisation des eaux, la circulation du public quelle que soit le moyen emprunté, toute action susceptible de nuire au développement de la faune et de la flore et, plus généralement, altérer le caractère du secteur' (cited from Doumenge, 1990).

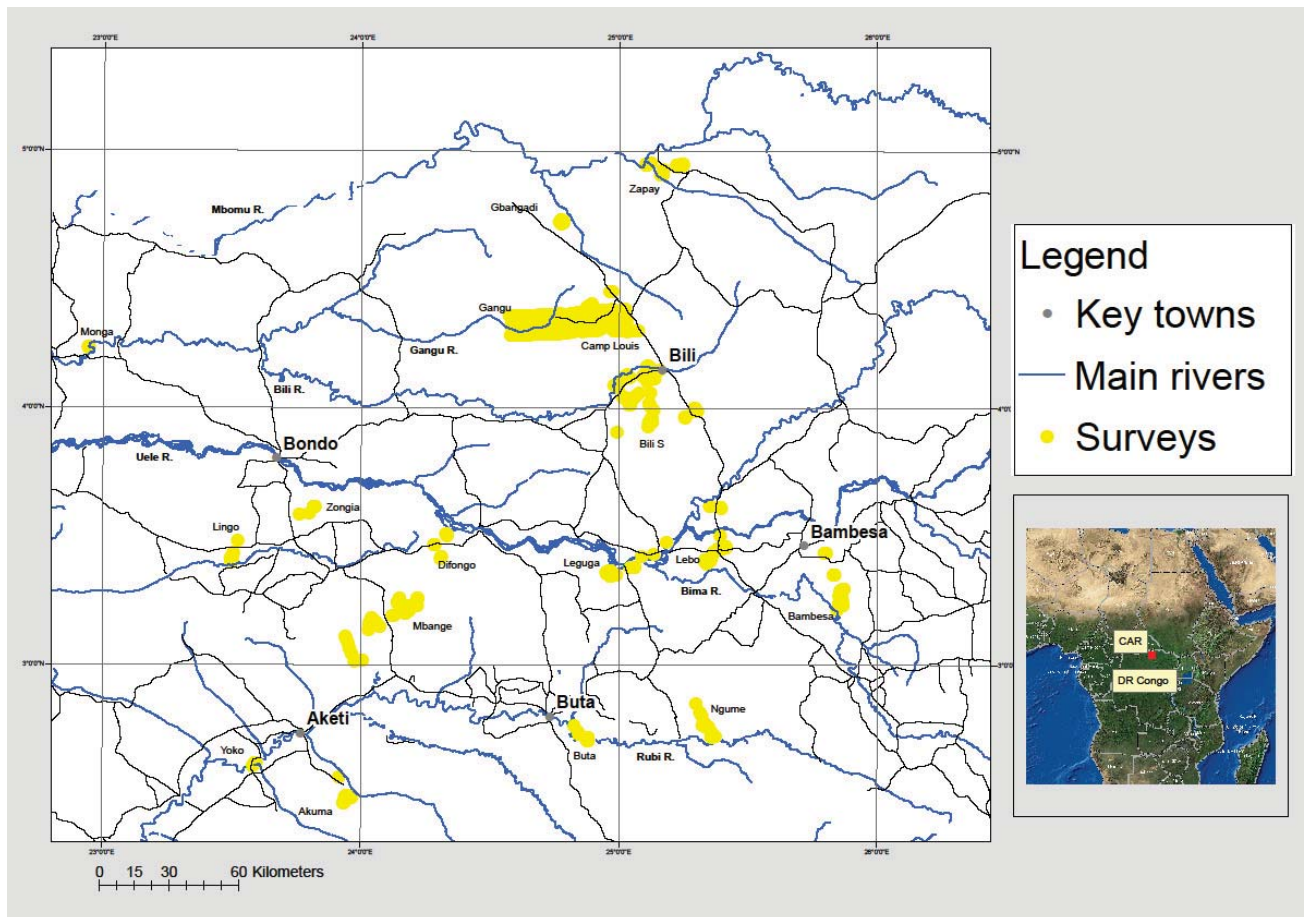


Figure 2. Map of the study area in the Northern DRC. Areas surveyed are highlighted in yellow. Data for rivers, roads, borders, and other geographical features were acquired from Le Référentiel Géographique Commun (2009) at <http://www.rgc.cd>. Black lines represent roads.

Foundation (henceforth referred to as The Foundation) initiated a community conservation project at Bili in which they purchased the coffee of the local Azande farmers' at a higher price than the market value, in exchange for the locals' support protecting the wildlife. Unfortunately, elephants continued to be poached in the area, leading to a 1-year suspension of the coffee-buying during the 2004-2005 season (The Wasmoth Wildlife Foundation, 2006). Ammann withdrew from the project in early 2005. In June 2007, within a 2-week period, a large number of gold miners were witnessed by Foundation staff invading the area. With the collaboration of the local chiefs and the regional Minister of Mines, they opened two gold mines within the Bili-Uéré Domaine de Chasse, within 100 km of Bili. This was not only a violation of Congolese law, but also of the terms of agreement between the Foundation and the local authorities. In September 2007, The Foundation withdrew its field staff and suspended its purchase of coffee from local merchants (Hicks, 2008). The research project was forced to work elsewhere. Between October 2007 and March 2009, TH and his team conducted surveys for large mammals, and in particular chimpanzees, between the Uele and Itimbiri / Rubi Rivers.

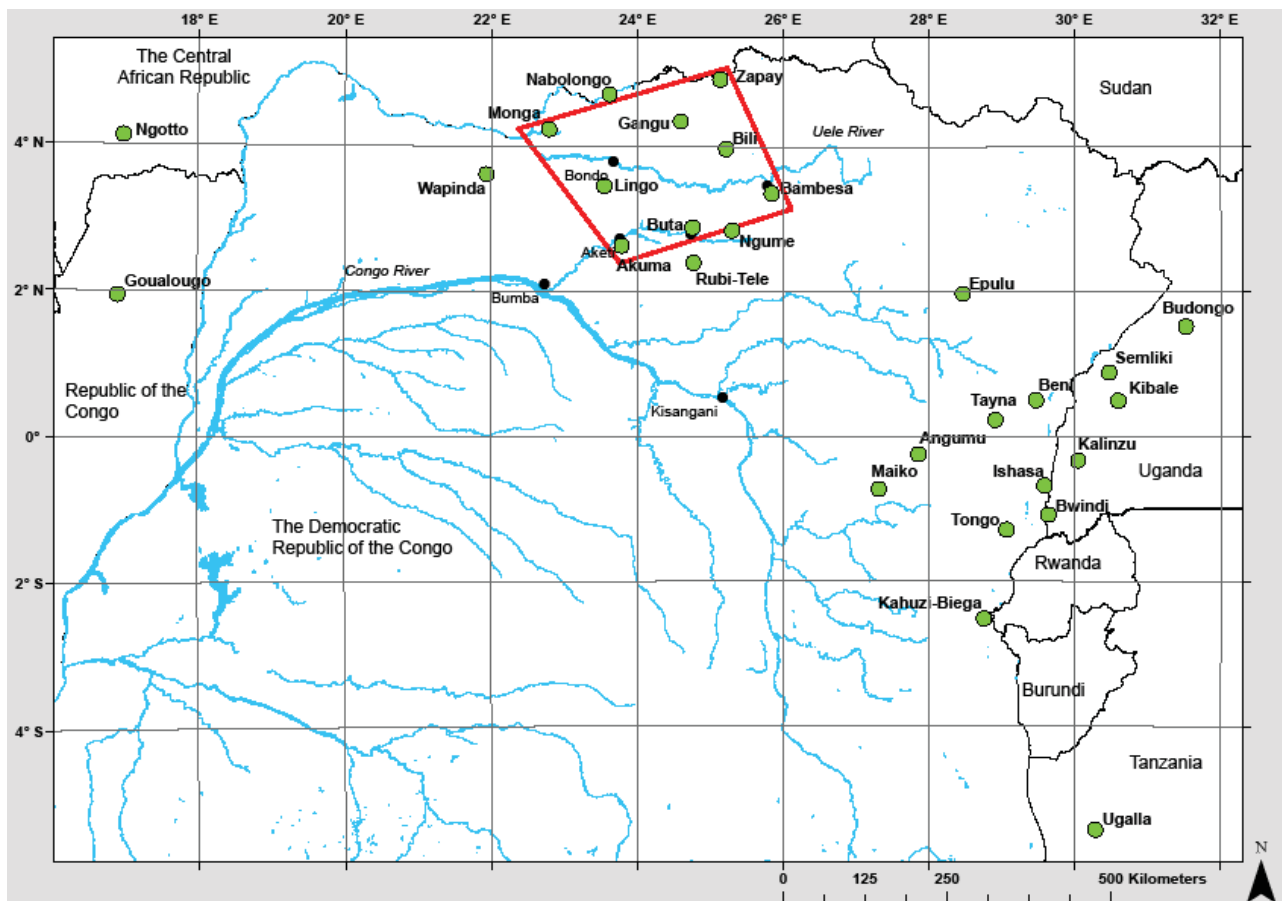


Figure 3. Map of the distribution range of Eastern chimpanzees (*Pan troglodytes schweinfurthii*), highlighting (inside the red square) study sites and surveyed regions. Data for rivers, roads, borders, and other geographical features were acquired from Le Référentiel Géographique Commun (2009) at <http://www.rgc.cd>.

General research methodology

Basic research procedure

Over the course of 2.5 years in the field, we maintained a consistent methodology while taking data on the chimpanzees. For the first 6 months of the 2004-2005 field season, at Camp Louis, our primary focus was on habituating the chimpanzees; during the following 5 months, we concentrated on transect work and exploring the remote Gangu Forest. Over the course of the 2006-2007 season, we established a new camp in the Gangu Forest, again focusing on locating the chimpanzees and making contact with them. For about half of this season, when we were unable to visit Gangu due to political turmoil surrounding the Congolese elections, we concentrated on surveying new forests, with the primary goals of increasing our understanding of the chimpanzees' abundance and distribution (Chapter 4), and comparing the apes' material culture between different forest regions (Chapter 5). During the 2007-2009 field season, we expanded upon the latter two strategies, conducting surveys over a much larger area, this time south of the Uele River. We no longer focused our efforts on contacting the chimpanzees themselves, although we did so when possible.

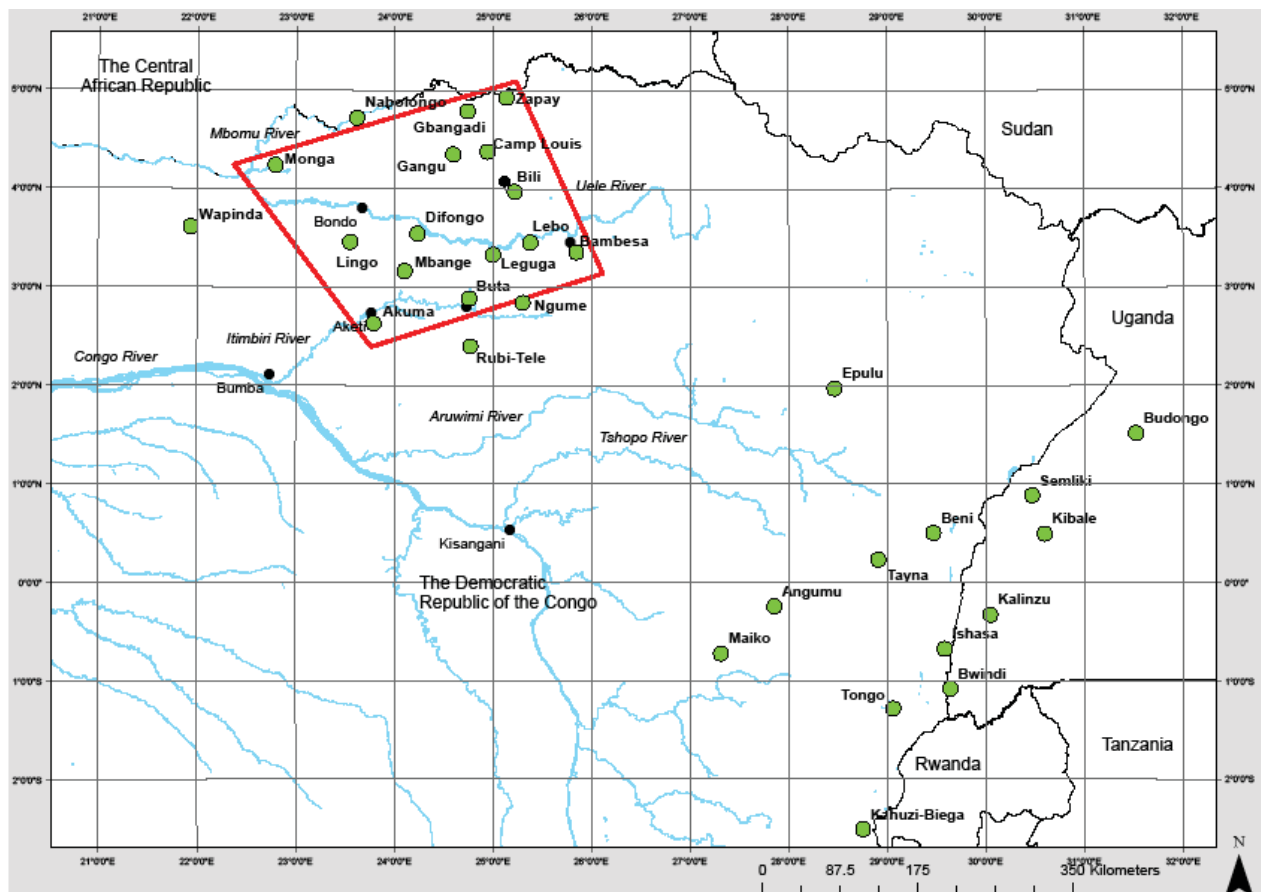


Figure 4. A closer view of the Northern DRC landscape, and our survey areas (inside the red square). Data for rivers, roads, borders, and other geographical features were acquired from Le Référentiel Géographique Commun (2009) at <http://www.rgc.cd>.

Whenever chimpanzees, their nest sites, tools, feeding remains, or other evidence were encountered, we would opportunistically collect as much data as possible (the full set of measures for each type of evidence is presented later in the thesis). We did the same for human evidence, and that of large mammals. Habitat-type was recorded on a regular basis and for all data points. Non-forested habitats included savanna (open grassland with scattered trees) and savanna woodland (savanna-edge low-canopy, partially-covered woodland with a mixed-grass understory). Human-disturbed areas included road-side oil palm forest, recently-cleared fields, and regenerated secondary forest. Forest-types included *Gilbertiodendron dewevrei* monodominant, mixed-species *Gilbertiodendron* forest, stream-edge forest, swamp forest, mixed species dry-ground forest, hillside forest, herb patch, and vine-tangle (in some cases these categories could be combined, such as ‘hillside *Gilbertiodendron*’ or ‘stream-edge herb patch’). Forest visibility was classified as dense (clear visibility ≤ 1 m), medium (clear visibility > 1 m and ≤ 5 m), and open (clear visibility > 5 m).

Survey methodology

Other than on our transect work, we did not walk randomly through the forests and savannas, but instead actively searched for chimpanzees and their nests. Therefore, our forest walks were not technically recces [defined in Walsh & White, 1999 as ‘researchers follow[ing] a path of least resistance along game trails and natural features (e.g., watercourses and ridges), cutting only enough vegetation to maintain a general compass bearing’] (see also

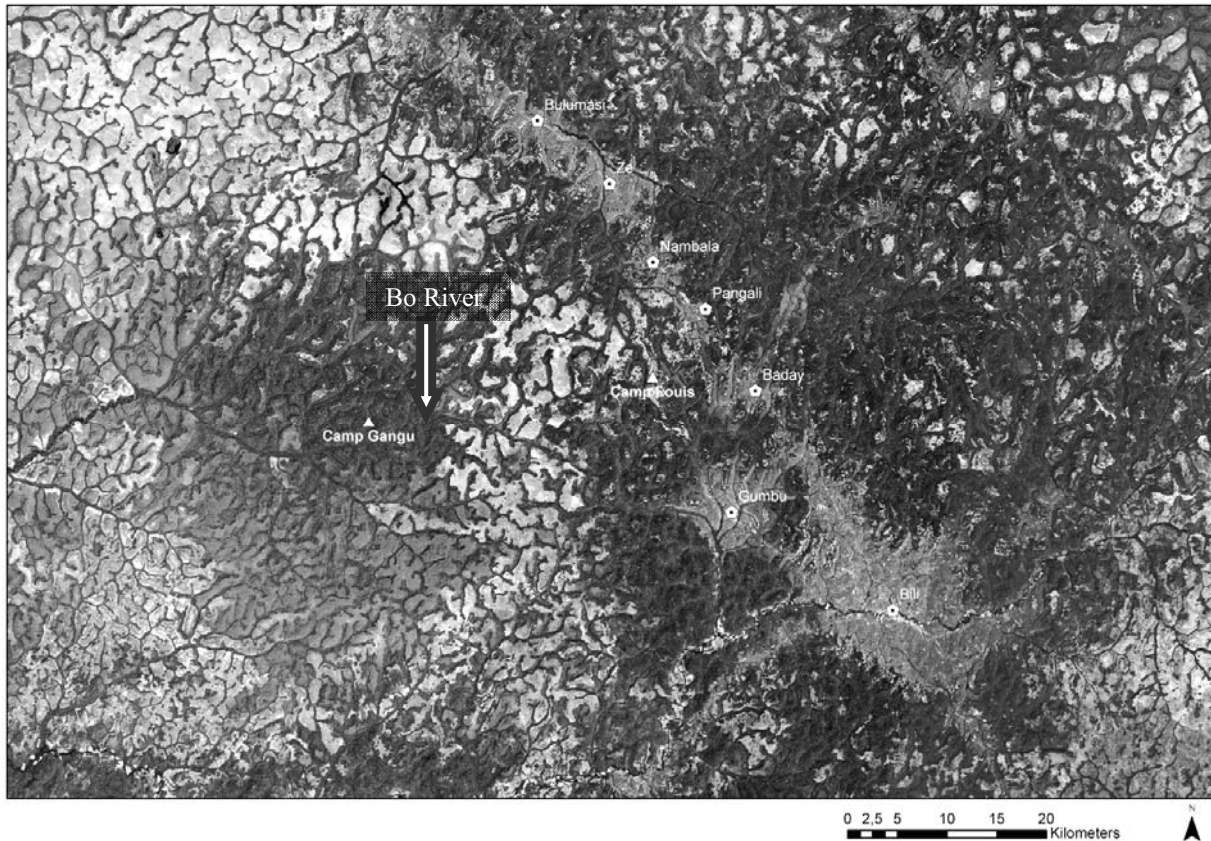


Figure 5. Map of the 2004-2007 study region in Northern DRC. The Gangu River can be seen just south of Camp Gangu, and the Bo River is indicated with a white arrow. The Landsat ETM+ image files dated from 2002 and were downloaded from GLCF (Global Land Cover Facility) at <http://glcf.umiacs.umd.edu>.

Hall, 1998; McNeilage et al., 1998). We will refer to them as ‘forest walks’, although some of the walks took place in savannas as well. We took regular GPS points as we progressed along our routes, at streams, trails, and other landmarks, and whenever we encountered evidence of humans or wildlife. Elevation above sea level was recorded by the GPS as well.

It was necessary to develop a means to compare encounter rates of chimpanzees, their nests, elephant dung, human sign, etc. across the different survey regions. For encounters with the chimpanzees themselves, we used the measure ‘hours in the forest’, which is described in Chapter 2. For all other data points (nests, tools, human sign, etc.), we use the measure ‘km walked in the region’. All waypoints taken on our forest/savanna walks were entered into the Garmin MapSource Program (Version 6.15.3; 1999-2008 Garmin Ltd. or its subsidiaries) and we used these points to reconstruct the daily routes. Daily routes were measured from waypoint to waypoint; this is the ‘route walked per day’ measure. Return trips along the same route made on the same day were not included in this measure, as it is unlikely that new chimpanzee nests or tools would have appeared in the time separating our first pass along the route and our later return to camp. However, when we retraced the same route the next morning, it would be counted as part of that day’s ‘km walked’. Often we would use a regular trail, either a hunting / fishing trail or, in the Camp Louis and Gangu areas, one cut by ourselves, for the first few kilometers of our day’s walk (elephant trails were sometimes used at Gangu). We would then usually leave these trails and ‘bushwhack’

following chimpanzee vocalizations. Table I gives the details of all forest surveys in the different study regions, including transects and the number of contacts with chimpanzees (see Chapter 2 for details on contacts).

During the 2004-2005 season, Camp Director Makassi as well as field assistant Ligada Faustin conducted separate surveys for chimpanzees in the Camp Louis and later Gangu forests. Faustin also took data in September 2006 while building the base camp in the Gangu Forest. To avoid possible problems with inter-observer reliability, data from these surveys will not be included in this thesis (except for unusual finds such as chimpanzee leopard-eating, described in Chapter 4). Towards the end of the 2007-2008 field season, although the majority of the data was gathered by TH, we began to use the data of three local field assistants trained in basic data collection². During the 2006-2007 season, field assistant Jeroen Swinkels (JS), after spending time with TH coordinating our data collection methods, conducted several independent surveys. This data will be included in many of the analyses, as well as the brief survey of the Difongo and Membulu Regions by Laura Darby (LD) in 2009. The expedition leaders of each survey are listed in Table I.

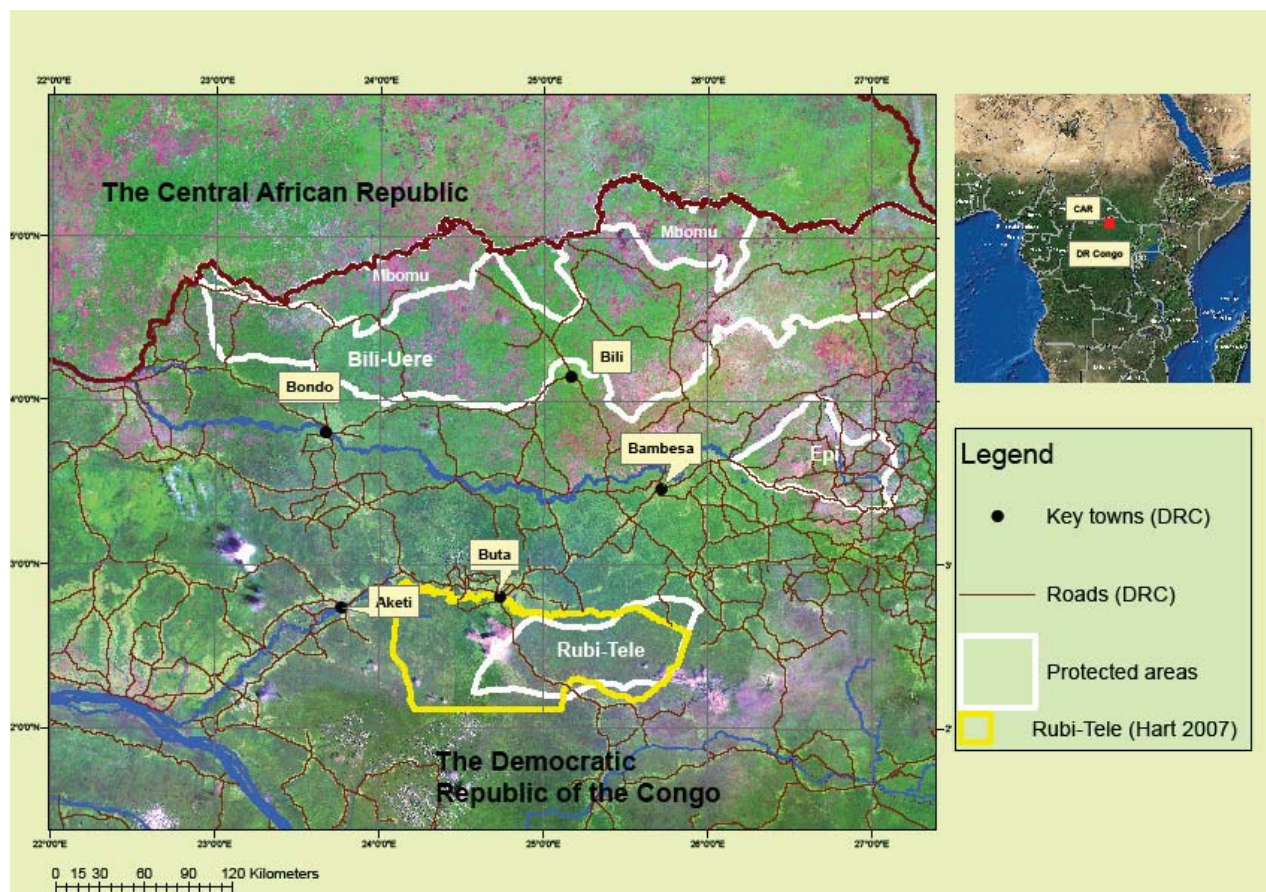


Figure 6. Map of the study region, showing protected areas and habitat-types. Dark green = forests, purple = savannas, light green = human-disturbed regions (including plantations, roads, villages and towns). The Landsat ETM+ image files date from 2000 and were downloaded from GLCF (Global Land Cover Facility) at <http://glcf.umiacs.umd.edu>. The geographical data used to map the rivers, roads, and protected areas are courtesy of the Référentiel Géographique Commun Pour la République Démocratique du Congo, www.rgc.cd. Hart (2007) found that a large piece of the Rubi-Tele Domaine de Chasse had been removed from recent official maps. This missing area has been restored here in yellow.

² Kisangola Polycarpe, Seba Koya, and Olivier Esokeli

Table I. Dates and geographical location of chimpanzee surveys, composition of survey teams, number of days spent in each forest region, and number of chimpanzee contacts in each; na= not applicable. TH = Thurston Hicks, JS = Jeroen Swinkels, LD = Laura Darby, PK = Polycarpe Kisangola, OE = Olivier Esokeli, SK = Seba Koya.

Location	GPS coordinates	Survey period	Surveyor	No. days in forest	No. contacts	Avg. no. chimpanzee contacts per day in forest (out of 77 contacts)	No. surveys	Km walked
Camp Louis Forest 2004-2007	4°21'72"N, 24°56'72"E	Aug 04 – July 05, Aug 06 – Feb 07	TH (04-05) TH, JS (06-07)	262.5 (237 first season, 25.5 second season)	38 (Period 1: $n = 38$)	0.15 (Period 1: 0.16) (Period 2: 0)	174 (plus transects)	1277.9 ¹
Gangu Forest	4°19'34"N, 24°41'53"E	March – June 05 Aug 06 – Feb 07	TH (05, 06) TH, JS (07)	85 (37.5 first season, 47.5 second season)	28 (Period 1: $n = 6$) (Period 2: $n = 22$)	0.33 (Period 1: 0.16) (Period 2: 0.46)	104 (plus transects)	356.8 ²
Zapay Forest	4°57'01"N, 25°06'31"E	Dec 06	TH	8.0	1	0.13	13	49.9
Gbangadi	4°43'40"N, 24°46'60"E	Dec 06	JS	6.0	0	0	6	31.7
S Bili Forest	4°02'42"N, 25°02'11"E	July 06 – Nov 06	TH, JS	48.5	3	0.06	40	205.2
Nawege and N Uele (Zaza) Forests	3°37'14"N, 25°22'55"E 3°28'11"N, 25°10'73"E (Zaza)	Sept 06 (Nawege) Aug 08 (Zaza)	TH, JS (Nawege) TH, OE (Zaza)	5.0	0	0	7	16.2 ³
Monga Forest	4°14'12"N, 22°56'65"E	Jan 09	SK, OE	3.0	1	0.33	3	6.2
Lebo	3°24'43"N, 25°20'65"E	Sept 06 Aug 08	TH, JS (06) TH (08)	24.0	1	0.42	17	41.3
Lingo	3°24'83"N, 23°30'11"E	Nov 08	TH	9.0	1	0.11	8	38.5
Zongia	3°35'06"N, 23°45'75"E	Nov 08	TH	8.0	0	0	8	35.7
Mbange E	3°13'73"N, 24°10'25"E	Jan 09	TH	15.0	0	0	16	80.9
Mbange W	3°09'30"N, 24°02'88"E	Jan – Feb 08	TH	9.0	0	0	11	45.5
Leguga	3°21'38"N, 24°57'84"E	March 08	TH	14.0	2	0.14	18	48.5

Location	GPS coordinates	Survey period	Surveyor	No. days in forest	No. contacts	Avg. no. chimpanzee contacts per day in forest (out of 77 contacts)	No. surveys	Km walked
Bambesa (Bongenge)	3°13'70"N, 25°51'16"E	April 08	TH	10.0	0	0	11	46.5
Bambesa (Malembobi)	3°25'72"N, 25°47'91"E	April – May 08	TH	3.0	0	0	6	18.5
Aketi (Akuma)	2°29'36"N, 23°56'93"E	June 08	TH	4.0	0	0	8	23.5
Buta	2°48'82"N, 24°44'69"E	Sept 08	TH	3.0	0	0	7	25.6
Ngume	2°45'83"N, 25°20'15"E	Sept – Oct 08	TH	8.0	0	0	8	39.4
Aketi (Yoko)	2°36'43"N, 23°34'98"E	Nov 08	TH	6.0	1	0.17	3	1.0
Difongo	3°00'80"N, 23°58'53"E	Feb 09	LD, PK	8.0	0	0	8	33.8
Membulu	3°00'90"N, 24°02'65"E	Feb 09	LD, PK	6.0	1	0.17	6	27.5
All forests north of the Uele River	na	2005-2009	TH (04-05, 08) TH, JS (06-07)	418.0	71	0.17	344	1943.3
All forests south of the Uele River	na	2006-2009	TH, JS (06) Hicks (07-08) LD and others (09)	127.0	6	0.05	130	506.2
All non-Gangu forests	na	2004-2009	TH (04-08) TH, JS (06-07) LD and others (09)	459.5	49	0.11	370	2104.2
All forests	na	2004-2008	TH (04-08) TH, JS (06-07) LD and others (09)	544.5	77	0.14	474	2449.5

¹ Includes 99 km of transects.

² Includes 61 km of transects.

³ Total = 21.7 km, including OE's surveys.

Transect surveys

By March 2005, plans to habituate the chimpanzees in the forests around Camp Louis had been abandoned, and we embarked on a 4-month transect project. The goal was to explore the remote Gangu Forest while at the same time making methodical counts of all chimpanzee nests and other signs, as well as evidence of other large mammals such as humans, elephants, and carnivores.

In order to properly estimate chimpanzee densities, it is normally advised to follow a large number of short transect lines. Buckland et al. (2001) recommend 10-20 lines, and Buckland et al. (in press) prefer 20 lines to 10. However, considering that one of our main goals was exploration, and that accessing the Gangu Forest was difficult, we decided to cut 3

approximately 55 km long parallel transects and use them to access the forest, and counting nests and other evidence as we traveled. We walked a total of 160 km of transects, 99 km in the Camp Louis Forest and 61 km in the Gangu Forest. To select the starting point for our first transect, we randomly selected a point 1.5 km north of Camp Louis and had our cutting team cut east to the road and 40 km west. From there Camp Director Makassi cut by means of GPS navigation two additional transects 4 and 8 km south of the first one. Nest-counting generally followed 1-2 weeks after cutting. The transects were separated from one another by approximately 4 km north to south. The transect methodology is described in detail in Chapter 4 of this thesis.

Bushmeat Research and Surveys: Towns, Villages and Roads

Throughout the 5 year study, during our time in villages and towns (Table II), and also while traveling on the road (Table III), we recorded all bushmeat that we saw, whether it was smoked or fresh, the type of animal (primate, duiker, pig, etc.), and species if possible. Beginning in 2006, Congolese field assistants recorded all elephant parts and chimpanzee meat/orphans that they saw. In addition, in the towns of Buta and Aketi we conducted market surveys (which we had also done, but more informally, in Bili). Records were kept of all distances traveled along the roads, and our encounters with bushmeat as we traveled. Table III gives the road distances traveled, as well as means of transport and the observer. Our project workers kept records of chimpanzee and elephant meat seen along the roads starting in September 2007, during and after their departure from Bili (Chapter 6). The methodology of our bushmeat counts will be presented in detail along with the results in Chapter 6.

Rainfall

Between October 2004 and July 2005, daily rainfall measures were collected at the Camp Louis (Bili Forest) base camp. The rain was collected every morning at 7:00 hours by Dido Makeima (DM) or TH from a 16-cm-diameter metal rain gauge with an anti-evaporation cover, and the quantity of rainfall was measured using a plastic syringe marked in milliliters.

For the first month of the 2007-2008 field season, DM measured daily rainfall at our house in the town of Aketi using the same rain gauge. Unfortunately the apparatus was stolen, and so a new tin rain gauge (19.8 cm in diameter) was used in its place. As the new apparatus did not have a cover, during daylight hours, the amount of rain was measured immediately following each period of rainfall, in order to prevent evaporation.

Temperature

The study area is located within Central Africa's 'humid tropical' climate region (Doumenge 1990, Figure 3), which is characterized by a clear dry season (a period of lower rainfall and higher temperatures) of up to 3 or 4 months. Due to technical and logistical problems, little temperature data was collected in the Bili region. Between March and July 2005, maximum and midday (but not minimum) daily temperatures were measured daily at Camp Louis using a station and a maximum temperature thermometer. The thermometers were housed in a Stevenson screen, which had been constructed following the specifications acquired from the Los Angeles Pierce College Weather Station website:

<http://data.piercecollege.edu/weather/>.

Between October 2007 and November 2008, a full year of climate data was recorded by DM in the town of Aketi. As before, the readings were taken daily at 7:00 hours. In this case we used a standard high-low temperature thermometer without a Stevenson screen. One side of the thermometer was open to the air, but the other side was within a meter of the wall of the house, surrounded by the corridor on three sides. Because we cannot rule out that the

Table II. Days spent in cities, towns, and villages over the course of the study. TH = Thurston Hicks, JS = Jeroen Swinkels, LD = Laura Darby, PK = Polycarpe Kisangola, SK = Seba Koya, DM = Dido Makeima, MM = Michel Mokede.

Name	GPS coordinates	Type of settlement	North (N) or South (S) of Uele?	Dates	Surveyor	No. days in settlements, TH, JS, or LD (in parentheses are days spent by other project workers)	No. days in settlements, total
Bili 2004-2005	4°09'06"N, 25°10'57"E	Town	N	Aug-04-July-05	TH	58.5 (0)	58.5
Bili 2006-2007	4°09'06"N, 25°10'57"E	Town	N	July-06-Feb-08	TH, JS, DM	132 (91)	223
Bili Post-February 2007	4°09'06"N, 25°10'57"E	Town	N	Feb-Sept-08	SK, DM, MM, KP	0 (217)	217
Bili Totals 2004-2007	4°09'06"N, 25°10'57"E	Town	N	Aug-04-Sept-07	TH, JS, SM, SK, MM, KP	190.5 (308)	498.5
Zemio CAR 2005	4°59'98"N, 25°06'43"E	Town	N	Aug-04-Jan-05	TH	4 (0)	4
Zemio CAR 2006-2007	4°59'98"N, 25°06'43"E	Town	N	Aug-04-Jan-05	TH	8 (0)	8
Baday 2004-2005	4°21'43"N, 25°02'92"E	Village	N	Aug-04-July-05	TH	5 (0)	5
Baday 2006-2007	4°21'43"N, 25°02'92"E	Village	N	Aug-06-Jan-07	TH, JS	14 (0)	14
Bambilo	3°55'12"N, 24°46'17"E	Village	N	Jan-05	TH	2 (0)	2
Api	3°42'64"N, 25°24'22"E	City	N	Sep-06	TH	2 (0)	2
Malengoya 2006	3°32'38"N, 25°23'16"E	Village	S	Sep-06	TH, JS	2 (0)	2
Lebo 2006	3°27'75"N, 25°23'11"E	Village	S	Sep-06	TH, JS	2 (0)	2
Mandu	4°05'08"N, 25°00'76"E	Village	N	July-Oct-2006	TH, JS	11.5 (0)	11.5
Nambala	4°27'56"N, 24°57'66"E	Village	N	Aug-06	JS	7 (0)	7
Bakalakala	3°59'66"N, 25°16'52"E	Village	N	Aug-Sept-06	JS	9.5 (0)	9.5
Nawege	3°37'14"N, 25°22'55"E	Village	N	Sep-06	TH	2 (0)	2
Ilo (Zapay) Village	4°59'52"N, 25°08'93"E	Village	N	Dec-06	TH, SK	1.5 (1.5)	3
Nzalanzi (Zapay)	4°55'32"N, 25°15'21"E	Village	N	Dec-06	SK	0 (2)	2
Kpokpo	4°42'60"N, 25°10'05"E	Town	N	Nov-06	JS	3.5 (0)	3.5
Gbangadi Village	4°40'63"N, 24°44'49"E	Village	N	Dec-06	JS	1 (0)	1

Name	GPS coordinates	Type of settlement	North (N) or South (S) of Uele?	Dates	Surveyor	No. days in settlements, TH, JS, or LD (in parentheses are days spent by other project workers)	No. days in settlements, total
Zapay	5°01'27"N, 25°08'91"E	Town	N	Dec-06	SK, TH	2 (8)	10
Aketi	2°44'24"N, 23°47'27"E	City	S	Sept-07- March-09	TH, LD, DM, KP, SK	239 (309)	548
Buta	2°48'82"N, 24°44'69"E	City	S	Sept-07- March-09	TH, LD, DM, KP, SK	106 (71)	177
Kisangani	0°30'76"N, 25°11'62"E	City	S	Dec-07- Nov-08	TH	12.5 (0)	12.5
Likati	3°22'13"N, 23°53'22"E	Town	S	Nov-07	TH, LD, AS, KP	10.5 (7)	17.5
Bambesa	3°26'64"N, 25°41'49"E	City	S	May- April-08	TH	3.5 (0)	3.5
Bungide	3°21'14"N, 25°52'60"E	Village	S	Apr-08	TH	1 (0)	1
Bongenge	3°18'52"N, 25°52'43"E	Village	S	Apr-08	TH	1 (0)	1
Malembobi	3°28'76"N, 25°46'55"E	Village	S	April- May-08	TH, KP	4 (4)	8
Nekptolia	3°33'41"N, 25°50'71"E	Village	S	Apr-08	TH	1 (0)	1
Leguga	3°23'74"N, 25°01'92"E	Town	S	Mar-08	TH	6.5 (0)	6.5
Ngume	2°50'32"N, 25°18'09"E	Village	S	Sept-Oct- 2008	TH	2 (0)	2
Lingo	3°27'93"N, 23°31'13"E	Village	S	Nov-08	TH	3 (0)	3
Kulu	3°29'74"N, 23°44'53"E	Town	S	Nov-08	TH	3 (0)	3
Zongia	3°33'83"N, 23°43'63"E	Village	S	Nov-08	TH	1 (0)	1
Akuma- Bombanzo	2°32'85"N, 23°54'97"E	Village	S	Jun-08	TH	1 (0)	1
Dulia	2°57'74"N, 24°08'59"E	Town	S	Jan-Feb- 2008	TH	2 (0)	2
Mbange	3°09'60"N, 24°06'14"E	Village	S	Jan-08	TH	3 (0)	3
Titule	3°16'51"N, 25°31'21"E	Town	S	April- Aug-08	TH	7.5 (0)	7.5
Lebo 2008	3°27'75"N, 25°23'11"E	Village	S	Aug-08	TH	3 (0)	3
Zaza Village	3°28'11"N, 25°10'73"E	Village	N	Aug-08	TH	2 (0)	2
Mongongolo	3°26'67"N, 25°11'48"E	Village	S	Aug-08	TH	1 (0)	1

Table III. Road trips made by TH, JS, LD, and trained project staff, 2004-2009. Return trips along the road made on the same day were not counted in the totals. a. Truck, b. motorbike, c. bicycle, d. foot, e. total.

a. Truck voyages

Road region	Survey period	No. surveys	Km traveled by TH	Km traveled by other project workers	Total km traveled	Accompanied by project bikers or foot-travelers? (surveys / km)
Bili-Baday	Aug 04 – Sept 07	9	283	37.4	320.4	3 / 112.2
Baday-Zemio	na	0	0	0	0	0
Bili-Bambillo	na	0	0	0	0	0
Bili-API	Sept 06-Sept 07	2	60.4	100.4	160.8	1 / 100.4
Buta-Bambesa	Sept 07	2	0	330	330	2 / 330
Buta-Aketi	na	0	0	0	0	0
Buta-Kisangani	na	0	0	0	0	0
Bondo-Monga	na	0	0	0	0	0
Total	Aug 04-March 09	13	343.4	467.8	811.2	6 / 542.6

b. Motorbike voyages

Road region	Survey period	No. surveys	Km traveled by Hicks	Km traveled by Swinkels, Darby	Km traveled by other project workers	Total km traveled	Km side roads out of total (surveys / km)	Accompanied by project bikers or foot-travelers? (surveys / km)
Bili-Baday	Aug 04-Feb 07	23	647.5	86.6	66.5	800.6	0	0
Baday-Zemio	Nov-Dec 06	9	294.6	74.9	0	369.5	0	0
Bili-Bambillo	Jan 05	2	109.6	0	0	109.6	0	0
Bili-API	na	0	0	0	0	0	0	0
Buta-Bambesa	Sept 07-March 09	34	977.7	0	1137.7	2115.4	10 / 355.3	19 / 944.6
Buta-Aketi	Nov 07-March 09	59	1642.3	535.5	2245.2	4423	10 / 409.4	17 / 887.4
Buta-Ngume	Sept-Oct 08	4	145.6	0	0	145.6	0	4 / 145.6
Buta-Banalia	Dec 07-Nov 08	13	1020.8	176	715.2	1912	0	0
Banalia-Kisangani	Dec 07-Nov 08	9	360	120	659.4	1139.4	0	0
Bondo-Monga	Jan 09	2	0	0	234	234	0	0
Total	August 04 -March 09	155	5198.1	993	5058	11249.1	20 / 764.7	40 / 1977.6

c. Bicycle voyages

Road region	Survey period	No. surveys	Km traveled by Hicks	Km traveled by Swinkels, Darby	Km traveled by other project workers	Total km traveled	Km side roads out of total (surveys / km)
Bili-Baday	Dec 04- Oct 06	5	48.2	86.4	0	134.6	0
Baday-Zemio	Dec 04	3	109.6	0	0	109.6	0
Bili-Bambillo	na	0	0	0	0	0	0
Bili-API	na	0	0	0	0	0	0
Buta-Bambesa	Aug-Dec 08	5	0	0	563	563	0
Buta-Aketi	June 08-Jan 09	8	0	0	481.7	481.7	0
Buta-Ngume	na	0	0	0	0	0	0
Buta-Banalia	Sept 08	1	11.1	0	0	11.1	1/11.1
Banalia-Kisangani	na	0	0	0	0	0	0
Bondo-Monga	na	0	0	0	0	0	0
Total	Dec 04- Jan 09	22	168.9	86.4	1044.7	1300	1/11.1

d. Foot voyages

Road region	Survey period	No. surveys	Km traveled by Hicks	Km traveled by Swinkels, Darby	Km traveled by other project workers	Total km traveled	Km side roads out of total (surveys and km)
Bili-Baday	Aug 06-Jan 07	24	192.2	126.47	0	318.67	2 / 9
Baday-Zemio	Nov-Dec 06	6	16.1	29.3	0	45.4	0
Bili-Bambillo	July 06-Dec 06	17	136.5	48.9	0	185.4	3 / 20.3
Bili-API	Aug-Sept 06	12	98.6	55.33	0	153.93	0
Buta-Bambesa	Sept 07-Sept 08	13	72.94	5.67	0	78.61	3 / 20.3
Buta-Aketi	Nov 07-Jan 08	2	5	0	0	5	0
Buta-Ngume	na	0	0	0	0	0	0
Buta-Banalia	Sept 08	2	11.1	0	11.1	22.2	0
Banalia-Kisangani	na	0	0	0	0	0	0
Bondo-Monga	na	0	0	0	0	0	0
Total	July 06-Sept 08	76	532.44	265.67	11.1	809.21	8 / 49.6

e. Total voyages

Road region	Survey period	No. surveys	Km traveled by Hicks	Km traveled by Swinkels, Darby	Km traveled by other project workers	Total km traveled	Km side roads out of total (surveys and km)	Accompanied by project foot-travelers? (surveys and km)
Bili-Baday	Aug 04-Feb 07	61	1170.9	299.47	103.9	1574.27	2/9	3 / 112.2
Baday-Zemio	Dec 04-Dec 06	18	420.3	104.2	0	524.5	0	0
Bili-Bambillo	Jan 05-Nov 06	19	246.1	48.9	0	295	3/20.3	0
Bili-API	Aug 06-Sept 07	14	159	55.33	100.4	314.73	0	1 / 100.4
Buta-Bambesa	Sept 06-Oct 08	54	1050.64	5.67	2030.7	3087.1	18 / 392.61	21 / 1274.6
Buta-Aketi	Oct 07-March 09	69	1647.3	535.5	2726.9	4909.7	10 / 409.4	17 / 887.4
Buta-Ngume	Sept-Oct 08	4	145.6	0	0	145.6	0	4/ 145.6
Buta-Banalia	Dec 07-Nov 08	16	1043	176	726.3	1945.3	3 / 33.3	0
Banalia-Kisangani	Dec 07-Nov 08	9	360	120	659.4	1139.4	0	0
Bondo-Monga	Jan 09	2	0	0	234	234	0	0
Total	Aug 04-March 09	266	6242.84	1345.07	6581.6	14169.51	29 / 825.4	46 / 2520.2

cement walls of the house might have absorbed heat and affected the temperature readings, our temperature data at Aketi must be viewed with caution. Also, towns may be considerably hotter than neighboring forests, so it is not clear that the results can be compared directly with our climate data from Camp Louis.

Flora and fauna

Throughout the study period, we recorded evidence of all mammal species we encountered, including sightings, dung, footprints, and feeding remains. Photographs and films were taken when possible. Animals were initially identified by their local names. Some species (elephants, okapis) left obvious sign allowing easy identification, but for those that did not, we used Jonathan Kingdom's (2007) field guide together with local expertise to attempt identification.

Flora was identified more opportunistically, with an obvious focus on plants used as food or nesting materials by the chimpanzees. During the 2006-007 season, JS collected a herbarium of chimpanzee-related plants, which were later identified by experts in Wageningen. TH and JS also took a number of photographs of plants (including many not used by chimpanzees), many of which were identified in Wageningen as well.

Results

Elevation

In Table IV we present the elevation above sea level of 10 important localities (see also Figure 7). Eight of these localities were climate stations. In our study area north of the Uele, elevations ranged from 420 to 823 meters above sea level (both points were in the Camp Louis Forest), although the majority of points were between 500 and 700 meters. South of the Uele the range was from 347 (Yoko, Aketi) to 816 (Mbage) meters above sea level, with again the majority of points between 500 and 700 meters.

Climate: comparison with historical data

Due to its remote location there is a paucity of historical information available on climate and rainfall for the northern DRC region. In addition, the climate data collected over this 2.5-year study was patchy and sometimes problematic (see below). However, a literature search did reveal several studies dating from the first half of the twentieth century, and some more recent data (Figure 7). Below, we present the results of our climate work, and then combine them with those from the literature in an attempt to elucidate the complex climatic patterns displayed across this region, which is transitional between the moist rainforests of the Congo basin and the drier and more seasonal Sahel to the north. It should be stressed that data was collected during this study at Bili and Aketi for only for 1 year per site, and for some measures not even for a full year, whereas the archival data was averaged over many years and thus gives a more representative picture of the climate.

Rainfall

In Table V and Figure 8, we present the average rainfall per month at Camp Louis, Bili (2004-2005) and Aketi (2007-2008), along with data from other climate stations (mostly dating from the first half of the twentieth century). Although we did not manage to collect a full year of rainfall data at Camp Louis, a clear seasonal pattern of rainfall was revealed, with not a drop of rain recorded between 23 November 2004 and 25 February 2005 (with only 5 mm of rain measured between 22 November and 5 March). Although no rainfall data was collected during the 2006-2007 field season at Bili, the same pattern was noted, with heavy rainfall between May and November, followed by a complete absence of rainfall for 2.5 months between 24 November and our departure on 6 February. During the dry season, the majority of streams in the Bili area dried up completely. The Gangu and Bo Rivers, which during the wet season rose to over 2 m high and were surrounded by large tracts of flooded forest, shrank during the dry season to knee-deep streams, eventually, in the case of the Bo, vanishing completely. A similar pattern of reduced rainfall between December and March, although less extreme, was observed 200 km to the south at Aketi (Figure 8). Figure 9 compares mean monthly and annual precipitation between multiple climate stations.

As can be seen in Table V, the amount and pattern of precipitation in Aketi during this study (2007-2008) was similar to that at Bambesa between 1922 and 1950 (Gerard, 1960). This is not surprising, as the latitudes of both cities are similar. For Bili, the best comparison is Tukpwo, an older weather station found only 108 km to the east-northeast of Bili, where rainfall data was collected between 1930 and 1954 (Gerard 1960). Although our year of data for Bili was incomplete, it appears to have received as much or more rainfall as had Tukpwo 50 years earlier (Figure 8). The dry season, however, was more starkly delineated at Bili, where not a drop of rain was recorded for 3 months. Nevertheless, the overall pattern appears to be similar. Interestingly, although Bili had less rainfall between November and March, this was counter-balanced by even more rainfall during 3 months of the rainy season than any other site for which we have data, including the Equatorial

Kisangani. The only other site with no rainfall during the dry season was Fort Crampel, far to the north in CAR (prior to 1945), which overall is much drier than any of the other sites. Bili, at least during our study period and based on our limited data, appears to have had similar amounts of rainfall as all of the other non-Sahel sites, but was also much more extreme in its wet-dry patterns. As mentioned before, the complete absence of rainfall between mid-November and mid-February at Bili was repeated during the 2006-2007 field season. It is of course possible that the Bili pattern would more closely resemble that of Tukpwo and the other stations if more than 1 year's worth of data were collected. As a whole, we can see that between Kisangani and Bili, there appears to be a gradient in seasonality of rainfall, although all of these regions appear to receive roughly similar amounts of rain annually.

Table IV. Elevation above sea level for the localities of key climate stations / research areas and other sites. Localities of climate stations are indicated with an asterisk (Bernard, 1945; Gerard, 1960 & this study).

Locality	Waypoint	Elevation (m)
Kisangani*	0°30'76"N, 25°11'62"E	436
Buta*	2°47'00"N, 24°47'00"E	450
Aketi *	2°44'02"N, 23°47' 27"E	380
Bambesa*	3°26' 00"N, 25°41'00"E	600
Bili	4°09'09"N, 25°10'16"E	569
Camp Louis (Bili)*	4°21' 72"N, 24°56'72"E	600
Camp Gangu (Bili)	4°19'34"N, 24°41'53"E	567
Tukpwo*	4°22'00"N, 25°55'00"E	700
Zapay	5°01'27"N, 25°08'91"E	586
Fort Crampel*	6°58'00"N, 19°10'00"E	450

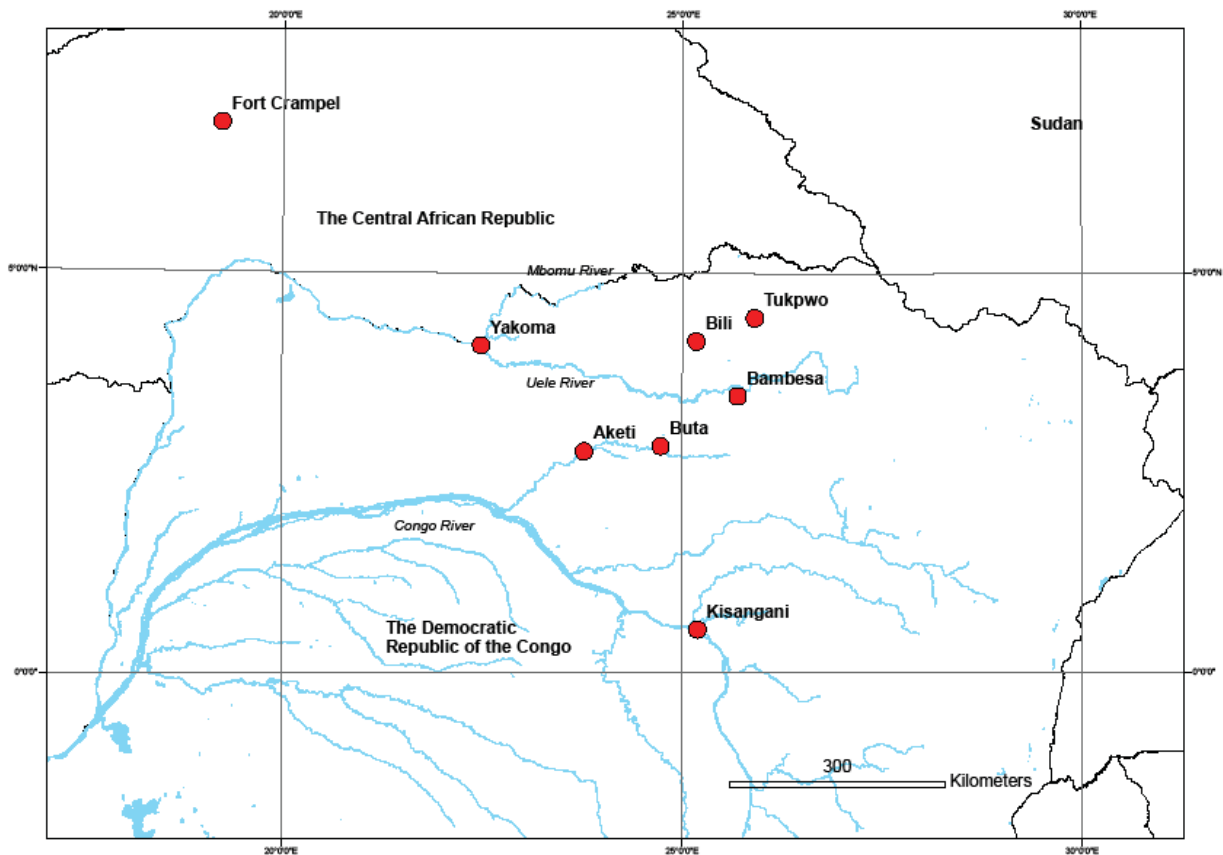


Figure 7. Map of weather stations described in the text.

Table V Monthly and annual precipitation (in mm) as recorded at eight stations: Tukpwo is 108 km at 85 degrees east of Camp Louis, and thus the closest long-term weather post to the Bili site. Fort Crampel is far to the north in the Central African Republic, but shares with Bili a complete lack of rain in the dry season. The Kisangani (0°30'N, 25°10'E) data comes from the World Climate Site: <http://www.worldclimate.com/cgi-bin/data.pl?ref=N00E025+2100+64040W>, derived from The Global Historical Climatology Network Volume 1 at <http://www.worldclimate.com/sources.htm#2100>. nr = not recorded.

Weather station	No. years of observation	J	F	M	A	M	J	J	A	S	O	N	D	Annual total
Aketi 2007-2008 (this study)	1	28	87	78	130	225	115	140	310	150	242	116	33	1652
Bambesa 1922-1950 (Gerard 1960)	28	34	76	133	197	206	154	181	209	212	212	129	36	1779
Bili 2004-2005 partial (this study)	0.7	0	5	83	174	270	206	nr	nr	nr	nr	265	0	> 1116
Tukpwo 1930-1954 (Gerard 1960)	24	30	50	95	160	180	170	186	220	215	205	115	24	1644
Yakoma 1930-1939 (Bernard 1945)	10	20	41	128	136	175	169	145	200	196	247	120	40	1617
Buta 1935-1939 (Bernard 1945)	5	26	69	116	194	149	111	107	141	175	204	140	50	1482
Kisangani 1951-1988 (World Climate website)	37	97	107	172	190	162	128	114	178	164	233	207	105	1857 ¹
Fort Crampel CAR Prior to 1945 (Bernard 1945)	—	0	0	10	95	105	140	135	270	140	75	25	0	995

¹ The total reads 1841 on the website.

Temperature

Tables VI and VII are comparisons of the climate data gathered over the course of this study with data acquired from other climate stations (mostly dating from the early part of the twentieth century). It is possible that climate patterns have changed since then, for instance under the influence of global warming or natural climate patterns (as described for Congo-Brazzaville by Samba et al., 2009).

Figure 10 presents minimum and maximum monthly temperatures for four long-term climate stations, the temperature data collected at Aketi between 2007 and 2008, and the five months of mean daily maximum temperature recorded at Bili. Figure 11 combines the temperature and rainfall data. They are presented in a progression from Kisangani (at the Equator) to more northerly sites.

The maximum daily temperatures (Figure 10) differed little across the study sites, except at the far northern site of Fort Crampel, which had higher overall maximum temperatures, because this location is dryer and less cloudy than the other sites. The readings for the 5 months at Bili were anomalously low compared to the other sites. A look at the site elevations in Table III rules out difference in elevation as a possible explanation for this. It could be because, unlike the other climate stations, Bili was located in the forest and not near a town or city, and thus was cooler.

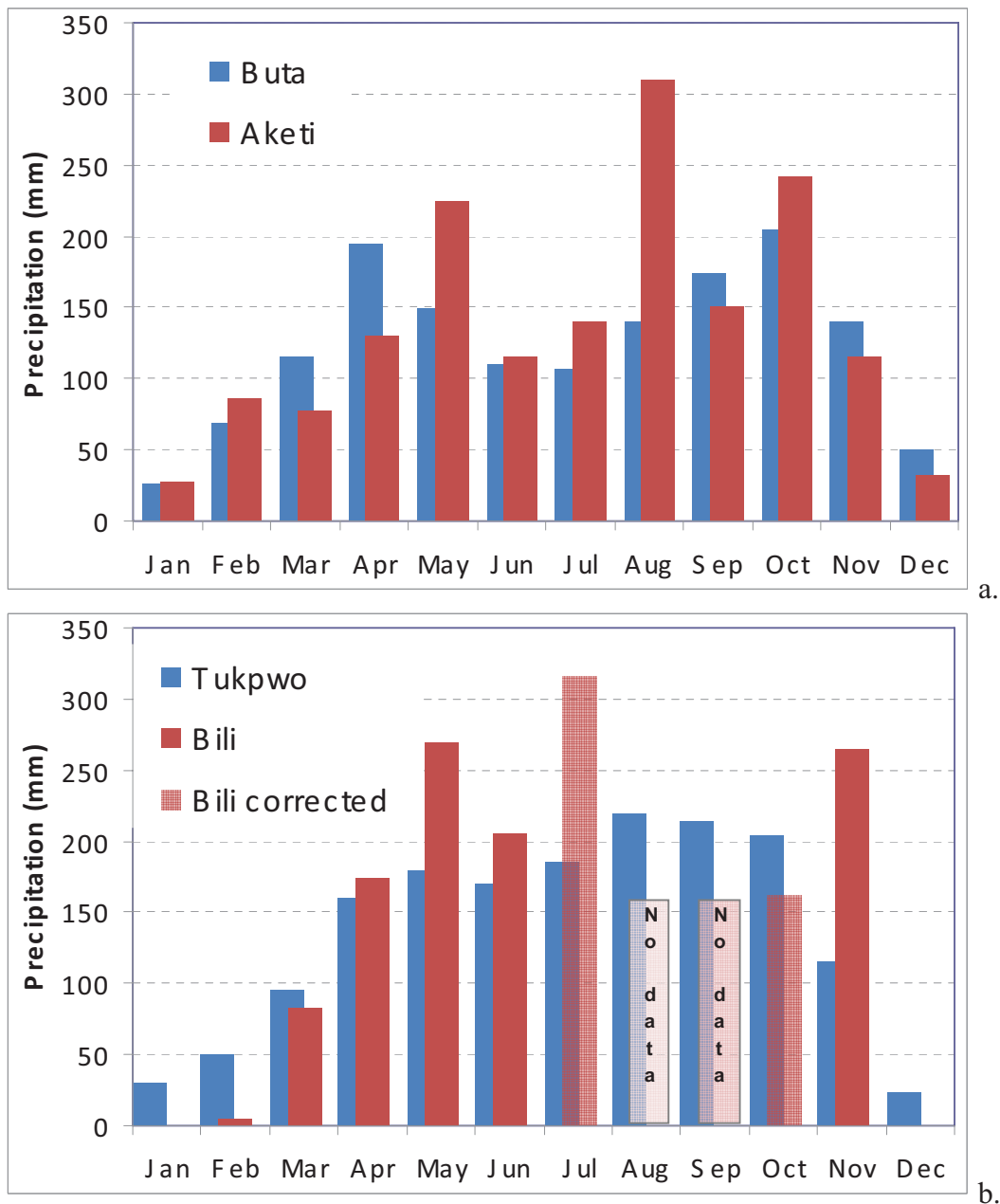


Figure 8. A comparison of monthly and annual precipitation: a. Aketi (this study) vs. Buta (Bernard 1945) and b. Bili (this study) vs. Tukpwo (Gerard 1960). As the Bili data for July and October were incomplete, an extrapolation was made using the mean precipitation per day and projecting that mean onto each of the missing days ('Bili corrected').

The minimum daily temperatures were roughly similar between the sites, except for Aketi, where they were higher. The Aketi data was taken only over a 1 year period, unlike at the other localities, and therefore the results may be atypical. The proximity of the Aketi thermometer to the cement wall may have also led to the higher minimum temperature readings. Fort Crampel was the only locality that showed extreme variation in minimum temperature between the dry season and the wet season.

In Figure 11 can be seen the difference between the maximum and minimum temperatures (amplitude) over the course of the year at each site. Bambesa and Tukpwo showed a similar pattern as Fort Crampel, with a larger daily amplitude in the dryer months.

At Fort Crampel this difference was more extreme, which is probably explained by the drier climate at Fort Crampel and a reduced cloud cover in the dry season. Increased cloud cover in the wet season leads to a reduction of insolation during daytime (and thus lower maximum temperatures), but also less loss of long-wave radiation during the night (and thus less nocturnal cooling). The temperature rises between November and March due to the higher position of the sun in the sky. Kisangani, on the Equator, had the same amplitude throughout the year, which is correlated to the more uniform amount of rain across the seasons (at least 100 mm per month).

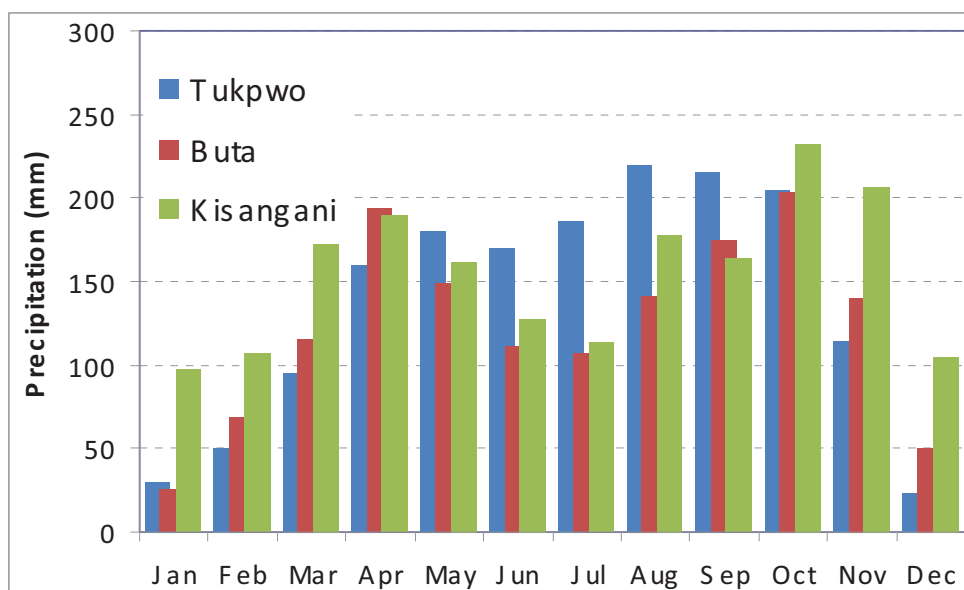


Figure 9. Comparisons of mean monthly precipitation between different climate stations.

Table VI. Mean daily minimum temperatures as recorded at six stations.

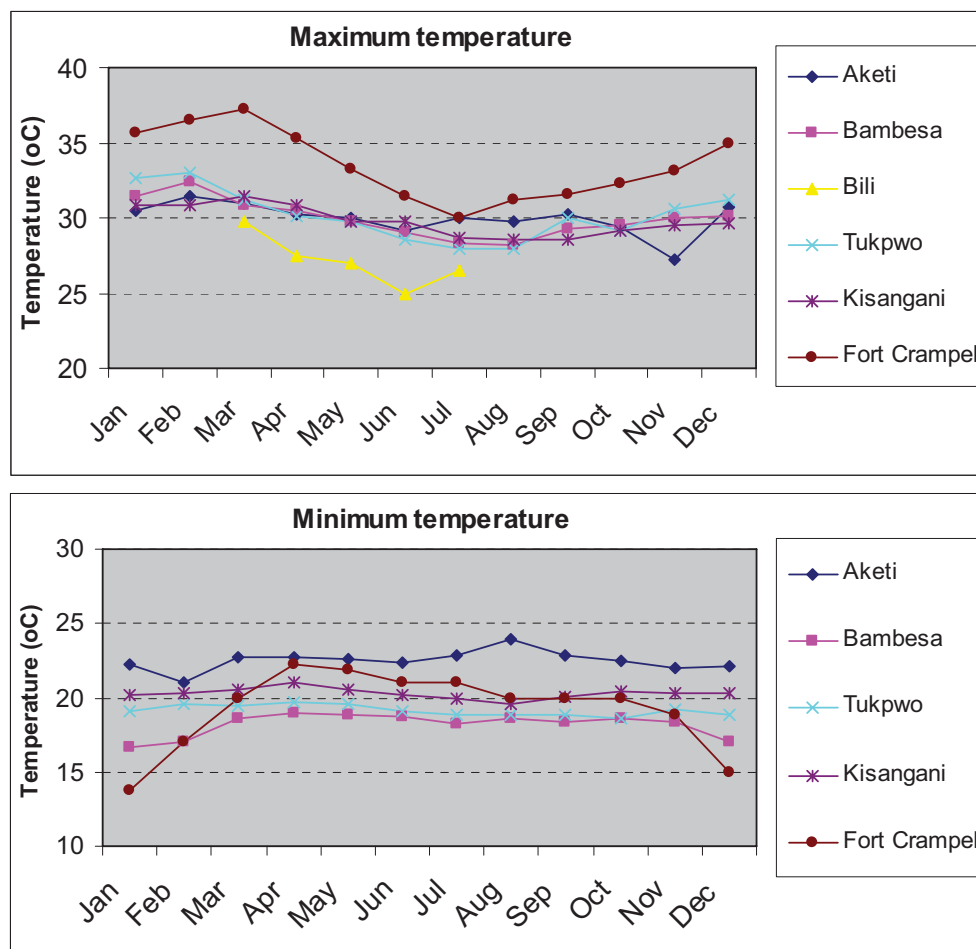
Weather station	No. years of observation	J	F	M	A	M	J	J	A	S	O	N	D	Annual average
Aketi 2007-2008 (this study)	1	22.3	21.0	22.8	22.7	22.6	22.4	22.9	24.0	22.8	22.5	22.0	22.1	—
Bambesa 1922-1950 (Gerard 1960)	8	16.7	17.0	18.6	19.0	18.9	18.7	18.3	18.6	18.4	18.6	18.4	17.0	18.2
Bili 2005 (this study)	Not recorded	—	—	—	—	—	—	—	—	—	—	—	—	—
Tukpwo prior to 1960 (Gerard 1960)	4	19.1	19.6	19.5	19.7	19.6	19.1	18.8	18.8	18.8	18.6	19.2	18.8	19.1
Kisangani 1937-1939 (Bernard 1945)	3	20.2	20.3	20.6	21.0	20.6	20.2	19.9	19.6	20.1	20.4	20.3	20.3	20.3
Fort Crampel prior to 1945 (Bernard 1945)	—	13.8	17.0	19.9	22.3	21.9	21.0	21.0	20.0	20.0	20.0	18.9	15.0	19.2

Table VII. Mean daily maximum temperatures as recorded at six stations.

Weather station	No. years of observation	J	F	M	A	M	J	J	A	S	O	N	D	Annual average
Aketi 2007-2008 (this study)	1	30.5	31.4	31.0	30.3	30.0	29.1	30.0	29.7	30.3	29.4	27.2	30.7	—
Bambesa 1922-1950 (Gerard 1960)	8	31.5	32.4	30.9	30.5	29.8	29.0	28.3	28.2	29.3	29.5	30.0	30.1	30.0
Bili 2005 (this study)	0.2	—	—	29.7 (11 days)	27.5 (27 days)	27.0	25.0 (29 days)	26.5 (12 days)	—	—	—	—	—	—
Tukpwo prior to 1960 (Gerard 1960)	4	32.6	33.0	31.2	30.1	29.8	28.6	28.0	28.0	? ¹	29.2	30.6	31.2	30.1
Kisangani, 1937-1939 (Bernard 1945)	3	30.8	30.9	31.4	30.8	29.7	29.8	28.7	28.5	28.6	29.1	29.5	29.6	29.8
Fort Crampel prior to 1945 (Bernard 1945)	—	35.7	36.5	37.3	35.3	33.3	31.5	30.0	31.2	31.6	32.3	33.1	34.9	33.6

¹ This appears in the original table as '20', but it is probably a misprint.

Figure 10. Comparisons of monthly temperatures between different climate stations. All of the data sets were for multiple years except for Aketi and Bili. No minimum temperature measures were recorded at Bili.¹



¹ For maximum temperature at Bili, three of the months had only partial data. For March, data was recorded from the 20-30; for April, from the 4 to the 30, and July, from the 1 to the 12. In addition, on June 17 and June 21 data was not recorded.

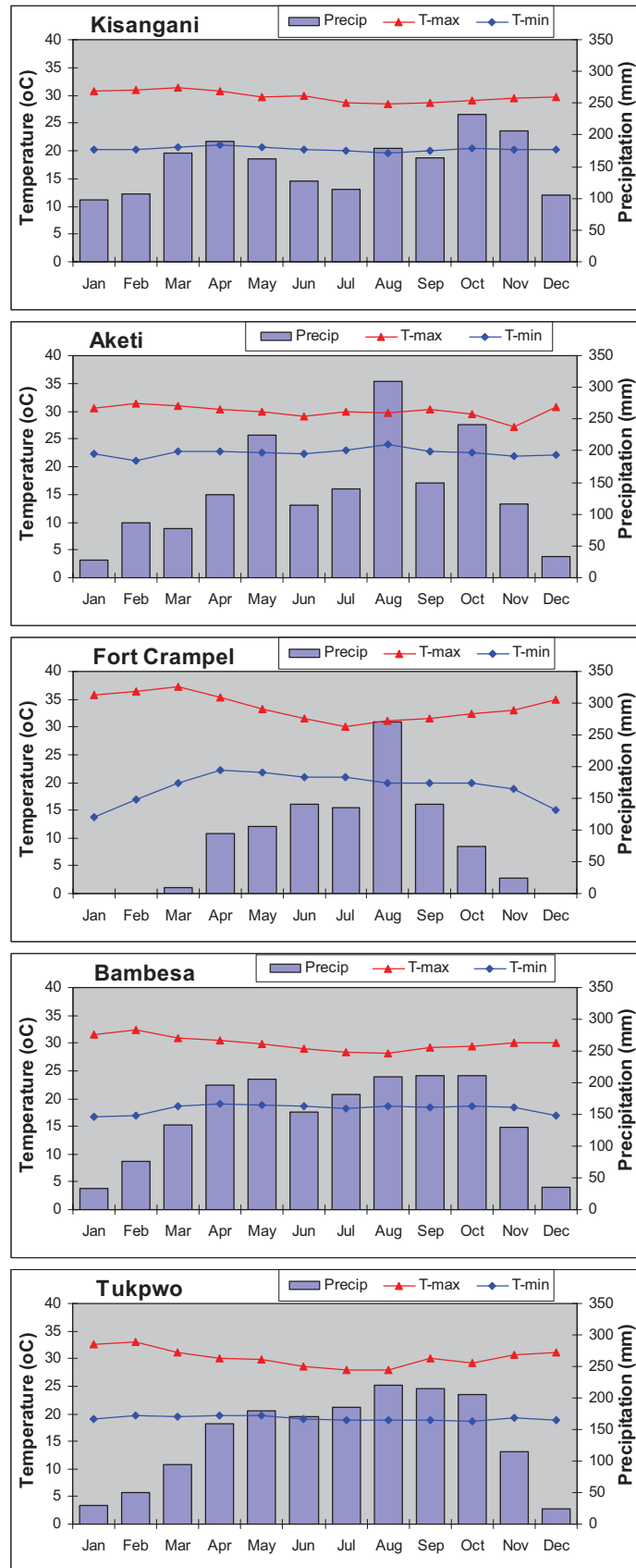


Figure 11. Monthly mean daily temperatures and precipitation, beginning at the equator (Kisangani) and progressing northwards to Fort Crampel.

Habitat

The geo-morphological make-up of the Bili-Uele area can be divided into ‘floodplains and terraces’ in the Buta-Aketi region just north of the Itimbiri / Rubi River, and ‘low plateaus’ along the south bank of the Uele River and between the Uele and Mbomu Rivers to the north (Doumenge 1990, Figure 2, page 16). In terms of its flora, our study area can be divided into two basic regions: the north of the Uele River is characterized by a mosaic of primary forest, savanna woodland and savanna which gradually becomes more arid and savanna-dominant the further north one travels. The *south* Uele is characterized by moist semi-deciduous tropical forests, which for the most part lack savannas (Doumenge, 1990: Figures 6 and 12). The forests are interlaced with numerous small streams, which, as described above, often dry up completely during the dry season, most notably north of the Uele. The streams are fringed with gallery forest in the savanna areas of the north, and in both the north and south (but particularly in the south) these stream-edge forests are often mono-dominant stands of *Gilbertiodendron dewevrei* (Gerard, 1960; Hicks, pers. obs.). The majority of the habitat in the south is old-growth primary tropical moist forest, but in areas along roads and near villages these have been replaced by cultivated fields, mono-dominant stands of oil palms, and regenerating dense forest, such as can also be seen in the north. ‘Islands’ of old-growth forest, such as the Gangu, exist to the north of the Uele, with only small patches of savanna woodland or savanna (see Figure 12 for images of some of the



Figure 12. a. Savanna in the Camp Louis (Bili) area. b. Savanna woodland, Camp Louis. c. *Gilbertiodendron* forest with chimpanzee nests, Buta. d. Seasonally- flooded swamp forest, Gangu (this stream dries up completely in the dry season).

different forest-types). In certain areas, such as Mbange West, Buta, and Akuma (see Figure 4 for their locations) the forest had a different structure: dense herb patches containing relatively few (but mostly large) trees extending over several square kilometers, the patches being separated from one another by strips of primary gallery forest (and Chapter 3, Figure 9, for images of this forest-type).

The flora

The region to the north of the Uele River is characterized by extensive areas of savanna and savanna woodland, mixed with islands of old-growth tropical moist forest (Figure 6). The savanna is interlaced with hundreds of small streams and river, many of which dry up in the dry season, and which harbor lush gallery forests. The savanna eco-type becomes progressively more predominant to the north towards the Mbomu River.

Figure 6 in Doumenge (1990, redrawn from White, 1981) categorizes the South Uele Forests and the forests south of Bili as '*forêt ombrophile planitaire guinéo-congolaise, type relativement humide*'. The area surrounding Bili and north to the border with CAR is characterized as a '*mosaïque de forêt ombrophile planitaire guinéo-congolaise et de formation herbeuse secondaire*.' The Bili area is interspersed with some regions of '*forêt ombrophile planitaire guinéo-congolaise, type relativement sec*'.

According to The World Wildlife Fund's (2007) report entitled 'Northern Congolian Forest Savanna-Mosaic', tree species common in the savanna woodlands and grasslands of this region include *Annona senegalensis*, *Burkea africana*, *Combretum collinum*, *Hymenocardia acida*, *Parinari curatelifolia*, *Stereospermum kunthianum*, *Strychnos* spp. and *Vitex* spp. We confirmed the presence of *Strychnos* species at Bili as well as an unknown *Combretum* species, which was extremely common in the savanna and savanna woodlands. According to the same report, common grasses are *Andropogon* spp., *Hyparrhenia* spp. and *Loudetia* spp (we identified *Panicum maximum*, *Pennisetum polystachion*, and an unknown *Hyparrhenia* species from the Bili savannas). Table VIII presents plant species identified by us and the experts at Wageningen.

In the lowland moist forest of the region, common tree species are listed by Burgess et al., 2004 (page 245) as *Julbernardia seretti*, *Cynometra alexandri*, and *Gilbertiodendron dewevrei*, which forms monodominant stands in some areas. From our own observations, the latter trees appeared to be much more common in forests south of the Uele than in those to the north. The former two species were not recorded by us. We were likely to have missed them if they were not used by the chimpanzees.

The fauna

Table IX shows the occurrence of large and small mammal species across our survey area. This is not intended to be a comprehensive list. Some differences existed in the focuses of our surveys. For example, the survey team in the Difongo area was looking only for evidence of elephants, okapis and chimpanzees; in those areas we have put question marks for the other species (i.e., 'no information'). In some cases, such as for bushbuck or some of the duiker species, it is possible that differences in local names between regions might have led to uncertainties in identification. For some extremely cryptic species, such as the golden cat (*Profelis aurata*), we will not assume that 'absence of evidence equals evidence of absence', and therefore failing positive evidence for their occurrence, we have marked their presence with a question mark.

Table VIII. Plant species identified in the different study regions, north and south of the Uele River, with local names and categorized by vegetation type and eco-type in which they were found. X = present, XX = abundant, - = absent, ? = unknown). Sampling was biased towards recording and collecting plant species used by chimpanzees, and also against savanna and savanna woodland species. (X = present, XX = abundant, - = absent, ? = unknown). - = indicates a conspicuous plant easily-recognized by TH and JS which we failed to see in a region, therefore it was likely absent. Plant-types: T = tree, H = herb, G = grass. Eco-types: F = forest, S= savanna, C = cultivated field, V = villages and roads.

Latin name	Family	Local name	Plant type	Eco-type	N Uele	S Uele
<i>Azelia africana</i>	Fabaceae	Kpai	T	F	X	-
<i>Aidia micrantha</i>	Rubiaceae	Ngbangindi	T	F	X	?
<i>Albizzia coriaria</i>	Fabaceae	Ngulu	T	F	X	?
<i>Angylocalyx spec.</i>	Fabaceae	Vugba	T	F	X	?
<i>Annonidium mannii</i>	Annonaceae	unknown	T	F	-	X
<i>Antiaris toxicaria</i> var. <i>weltwitschii</i>	Moraceae	Nyekunye	T	F	X	?
<i>Aulacocalyx jasminiflora</i>	Rubiaceae	Kpokpoki	T	F	X	?
<i>Barteria fistulosa</i>	Passifloraceae	Anondi	T	F	XX	XX
<i>Belenophora coffeoides</i>	Rubiaceae	Ngbangba	T	F	X	?
<i>Blighia welwitschia</i>	Sapindaceae	Lindikilo	T	F	X	?
<i>Bridelia ferruginea</i>	Phyllanthaceae	Kpotombala	T	F	X	?
<i>Chrysophyllum (Gambeya) lacourtiana</i>	Sapotaceae	unknown	T	F	-	X
<i>Caloncoba glauca</i>	Flacourtiaceae	Kuma	T	F	X	?
<i>Canarium schweinfurthii</i>	Bursaceae	Bundi	T	F	X	?
<i>Carapa procera</i>	Meliaceae	Bangala	T	F	X	?
<i>Ceiba pentandra</i>	Malvaceae	Vwula	T	F	X	X
<i>Celtis philipensis</i>	Cannabaceae	Banangbo	T	F	X	X
<i>Celtis prantlii</i>	Cannabaceae	Lukuswango	T	F	X	?
<i>Celtis tessmannii</i>	Cannabaceae	Akekeneke	T	F	X	?
<i>Chromolaena odorata</i>	Asteraceae	Sida	T	C	XX	XX
<i>Cleistopholis patens</i>	Annonaceae	Pongo Pongo	T	F	X	?
<i>Clerodendron schweinfurthii</i>	Verbenaceae	Bagbuku	T	F	X	?
<i>Coffea canophora</i>	Rubiaceae	Wild coffee	T	F	X	?
<i>Cola lobecitia</i>	Sterculiaceae	Kukuluku	T	F	X	?
<i>Cola urceolata</i>	Sterculiaceae	Ngbilimo	T	F	X	?
<i>Combretum mucronatum</i>	Combretaceae	Mbicolo	T	F	X	?
<i>Combretum paniculatum</i>	Combretaceae	Bamo	T	F	X	?
<i>Desplatsia dewevrei</i>	Malvaceae	Akamba	T	F	X	XX
<i>Diospyros canaliculata</i>	Ebenaceae	Dumo	T	F	XX	XX
<i>Diospyros iturensis</i>	Ebenaceae	Mbili	T	F	XX	XX
<i>Dracoena camerooniana</i>	Loganiaceae	Bamugbate	T	F	X	?
<i>Drypetes spec.</i>	Putranjivaceae	unknown	T	F	X	?
<i>Duboscia macrocarpa</i>	Malvaceae	unknown	T	F	-	X
<i>Elaeis guineensis</i>	Arecaceae	oil palm	T	FCV	XX	XX
<i>Erythrophleum suaveolens</i>	Fabaceae	Gelo	T	F	XX	-
<i>Ficus brachylepsis</i>	Moraceae	Nde	T	F	X	?
<i>Ficus elasticoides</i>	Moraceae	Nde	T	F	X	?
<i>Ficus louisii</i>	Moraceae	Nde	T	F	X	?
<i>Ficus mucuso</i>	Moraceae	Likuyo	T	F	XX	XX
<i>Ficus ovata</i>	Moraceae	Nde	T	F	X	?
<i>Ficus sp. unknown</i>	Moraceae	unknown	T	F	?	XX
<i>Funtumia elastica</i>	Apocynaceae	Mbolo	T	F	X	
<i>Garcinia ovalifolia</i>	Clusiaceae	Mwazi	T	F	XX	XX
<i>Garcinia spec.</i>	Clusiaceae	Batome	T	F	X	?
<i>Gilbertodendron dewevrei</i>	Caesalpinoideae	Angbolu	T	F	XX	XX
<i>Greenwaydendron spec.</i> (probably <i>G. suaveolens</i>)	Annonaceae	Zinga	T	F	XX	X
<i>Hallea stipulosa</i>	Rubiaceae	Kofo	T	F	X	X

Latin name	Family	Local name	Plant type	Eco-type	N Uele	S Uele
<i>Hugonia platysepala</i>	Linaceae	Nbatukpe	T	F	X	?
<i>Hymenocardia ulmoides</i>	Phyllanthaceae	Salanga	T	F	X	X
<i>Irvingia robur</i>	Irvingiaceae	Sabongoya	T	F	X	?
<i>Isolona congolana</i>	Annonaceae	unknown	T	F	X	?
<i>Khaya grandifolia /onthothera</i>	Meliaceae	Gagalaga	T	F	X	?
<i>Klainedoxa gabonensis</i>	Irvingiaceae	Vomwo	T	F	XX	X
<i>Laccosperma secundiflorum</i>	Arecaceae	Gao	T	F	XX	XX
<i>Leptaspis zeylanica</i>	Gramineae	Mangendu	T	F	X	?
<i>Leptonychia spec.</i>	Malvaceae	Zelengbo	T	F	X	?
<i>Maesopsis eminii</i>	Rhamnaceae	Ngbuka	T	F	X	?
<i>Mallobis opposifolius</i>	Lamiaceae	Balalo	T	F	X	?
<i>Manniophyton felvura</i>	Euphorbiaceae	Yude	T	F	X	?
<i>Margaritaria discoidea</i>	Phyllanthaceae	Banzele	T	F	X	X
	Icacinaceae	Ngazila	T	F	X	?
<i>Meisteria parsiflora</i>		Ngbangulu				
<i>Memecylon myrianthum</i>	Melastomataceae	Willinzolo	T	F	X	?
<i>Monodora angolensis</i>	Annonaceae	Ngbelengbele	T	F	X	?
<i>Musanga cecropiodes</i>	Moraceae	Kumbo Kumbo	T	FCV	XX	XX
<i>Myrianthus arboreus</i>	Cecropiaceae	Ngbinzo	T	F	XX	XX
<i>Ochtocosmus africana</i>	Linaceae	Willysango	T	F	X	?
<i>Ongokea gore</i>	Olacaceae	unknown	T	F	X	?
<i>Paramacrolobium coeruleum</i>	Fabaceae	Ketekele	T	F	X	?
<i>Parinari excelsa</i>	Chrysobalanaceae	Zingi	T	F	X	?
<i>Parkia filicoidea</i>	Fabaceae	Bimini	T	F	X	X
<i>Picalima spec.</i>	Aponcynaceae	Golugbe	T	F	X	?
<i>Pycnanthus angolensis</i>	Myristicaceae	Kulegboli	T	F	X	?
<i>Rauvolfia mannii</i>	Apocynaceae	Onongalako	T	F	X	XX
	Ochnaceae	Ngbakasa	T	F	X	X
<i>Rhabdophyllum arnoldiana</i>		Bakuma				
<i>Ricinodendron hendelowi</i>	Euphorbiaceae	Akete	T	F	X	?
<i>Kigelia africana</i>	Bignoniaceae	Gombu	T	F	X	?
<i>Rinorea claessensii</i>	Violaceae	Balwavulu	T	F	X	?
<i>Rinorea spec.</i>	Violaceae	Mbalapa	T	F	X	?
<i>Rothmannia urcelliformis</i>	Rubiaceae	Adwe	T	F	X	?
<i>Rothmannia whitefieldii</i>	Rubiaceae	Bilikpo	T	F	X	-
<i>Saba comorensis</i>	Apocynaceae	Linde, Ndefu	T	F	X	X
<i>Scaphopetalum dewevrei</i>	Malvaceae	libwanga (photo)	T	F	?	X
<i>Scottellia klaineana</i>	Flacourtiaceae	Ngiliatune	T	F	X	?
<i>Spondianthus preussi</i>	Phyllanthaceae	Ababu	T	S	X	?
<i>Strychnos camptoneura</i>	Loganiaceae	Buta	T	F	XX	X
<i>Strychnos spec.</i>	Loganiaceae	Tindu	T	F	X	?
<i>Strychnos spec.</i>	Loganiaceae	Burlumanza	T	F	XX	?
<i>Tabernaemontana spec.</i>	Apocynaceae	Ndakabali	T	F	X	?
<i>Trachyphrynium braunianum</i>	Marantaceae	Pilingi	T	F	X	?
<i>Treculia africana</i>	Moraceae	Apusa	T	F	X	?
<i>Trichilia rubescens</i>	Meliaceae	Zala	T	F	X	?
<i>Uapaca hendelotii</i>	Phyllanthaceae	Vula Vula	T	F	X	X
unknown Celastraceae	Celastraceae	Telege	T	F	X	?
<i>Afromomum spec.</i>	Zingiberaceae	Nonga	H	F	XX	X
<i>Afromomum sp. (savanna)</i>	Zingiberaceae	Savanna nonga	H	S	XX	-
<i>Costus afer</i>	Costaceae	Ngai	H	F	X	X
<i>Haumania spec.</i>	Marantaceae	Kombe	H	F	-	XX
<i>Halopegia azarea</i>	Marantaceae	Gbewilidewili	H	F	X	XX
<i>Hypselodelphis sp.</i>	Marantaceae	Ngondo	H	F	X	?
<i>Marantochloa congensis</i>	Marantaceae	Gole	H	F	X	X
<i>Marantochloa mannii</i>	Marantaceae	Gbeshila	H	F	X	X
<i>Marantochloa purpurea</i>	Marantaceae	Bazia	H	F	X	?
<i>Megaphrynium gaboniense</i>	Marantaceae	Mangungu	H	F	X	XX

Latin name	Family	Local name	Plant type	Eco-type	N Uele	S Uele
<i>Palisota</i> sp.(<i>hirsuta</i> ?)	Commelinaceae	Apropuse	H	F	X	X
<i>Sarcophrynium schweinfurthianum</i>	Marantaceae	Biloumo	H	F	X	X
<i>Arundinaria alpina</i>	Poaceae	Bamboo	G	FCV	XX	XX
<i>Hyparrhenia</i> spec.	Poaceae	unknown	G	S/SW	X	?
<i>Panicum maximum</i>	Poaceae	unknown	G	S/SW	X	?
<i>Pennisetum polystachion</i>	Poaceae	unknown	G	S/SW	X	?

Primates

Primates were abundant both to the north and south of the Uele River (Table IX) and the species assembly was broadly similar, with several important differences. Savanna-dwelling species such as patas monkeys and baboons were common to the north of the river. In the Bili Forests, baboons were abundant everywhere except for the Gangu Forest, where they were observed only once at its eastern edge, a few meters west of the Bo River. Patas monkeys were observed only once in the Camp Louis savanna, but were abundant in the Zapay area to the north. South of the Uele, patas were absent and baboons, while abundant, seemed to be primarily restricted to the cultivated field / forest interface. It is possible that the species is colonizing these areas following human agricultural incursions. Red-tailed guenons and crowned guenons were abundant across the entire region we surveyed. DeBrazza's monkeys were present but rare in the Camp Louis-Gangu forests, abundant in the swamp forests closer to Bili, and common in many of the South Uele forests, particularly in proximity to the Uele River. Agile mangabeys were common everywhere at a distance from the roads, but appeared to reach their highest abundance in the Gangu Forest. Grey-cheeked mangabeys were present but extremely rare north of the Uele; they were much more common to the south. The red colobus monkey was not present to the north of the Uele River, but was abundant in many of the forests to the south. We photographed a Dent's monkey to the north of the Uele River beside the road between Api and Bili, but we never saw this species farther north. South of the Uele, this species was rare in the forest, but common as bushmeat. At Camp Louis, TH filmed an unidentified species of small galago (probably *Galago thomasi* or *Galago demidoffi*). We saw no prosimians in the southern forests, but did see two pottos (*Periodicticus potto*) for sale, as an orphan and as bushmeat respectively.

Mixed-species groups composed of red-tailed guenons, crowned guenons, and agile mangabeys were encountered frequently in the Gangu Forest. To the south, in the Mbangé Forest, up to five monkey species, grey-cheeked mangabeys, agile mangabeys, red-tailed guenons, crowned guenons, and red colobus, could be found mixed together in noisy groups.

During our November 2008 boat trip, Dent's monkeys and red colobus were seen in the Aketi forests across the Itimbiri River from the Yoko / Akuma forests, and it is likely they were present south of the Itimbiri as well. Considering that both of these species of monkey were frequently encountered along the roads as bushmeat, it is likely that they are widespread south of the Uele River.

Large Mammalian Carnivores

Table X shows all evidence of large mammalian carnivores recorded over the course of our surveys. Four species were present in the Camp Louis – Gangu forest / savanna mosaic: leopards (*Panthera pardus*), hyenas (*Crocuta crocuta*), golden cats (*Profelis aurata*) and lions (*Panthera leo*). Although we did not find evidence of golden cats on our surveys, this elusive species was photographed near Camp Louis by Karl Ammann using a camera trap. Evidence of hyenas, as well as leopards, was also found at Zapay, and in the forests near Bili.

Table IX. Distribution of mammal species across the study areas (X = present, XX = abundant, - = absent, ? = unknown). The data include encounters with clear tracks / dung of the animals. Bold font represents South Uele forests, regular font North Uele forests. It should be kept in mind that we spent much more time in some areas (i.e. Gangu, Camp Louis) than others (i.e. Zaza).

Species	Cl	Ga	BIS	Gba	Zpy	Zz	Zg	Li	Df	Bu	Ng	MbW	MbE
Lion (<i>Panthera leo</i>)	x	x	-	-	-	-	-	-	-	-	-	-	-
Leopard (<i>Panthera pardus</i>)	xx	xx	x	xx	-	-	x	-	?	-	xx	-	x
Hyena (<i>Crocuta crocuta</i>)	xx	xx	x	-	x	-	-	-	-	-	-	-	-
Golden cat (<i>Profelix aurata</i>)	x ¹	?	?	?	?	?	?	?	?	?	?	?	?
Elephant (<i>Loxodonta spec.</i>)	x	xx	xx	x	-	x	xx	x	xx	-	-	x	xx
Buffalo (<i>Syncerus caffer namus</i>)	xx	x	xx	-	xx	x	-	-	-	-	-	x	-
Okapi (<i>Okapi johnstonii</i>)	-	-	-	-	-	-	xx	-	xx	-	xx	x	xx
Hippopotamus (<i>Hippopotamus amphibious</i>)	-	-	-	-	-	xx	-	-	-	-	-	-	-
Giant pangolin (<i>Manis gigantea</i>)	xx	xx	x	x	x	-	-	x	?	-	-	x	x
Giant forest hog (<i>Hylochoerus meinertzhageni</i>)	x	x	-	x	-	-	-	-	?	-	-	-	-
Red river hog (<i>Potamochoerus porcus</i>)	xx	xx	x	x	x	-	x	x	?	-	-	-	x
Warthog (<i>Phacochoerus africanus</i>)	xx	-	-	-	xx	-	-	-	?	-	-	-	-
Bongo (<i>Tragelaphus urycerus</i>)	x	xx	xx	x	xx	x	-	x	?	-	-	-	x
Bushbuck (<i>Tragelaphus scriptus</i>)	xx	-	?	?	-	-	-	-	-	-	-	-	-
Yellow-backed duiker (<i>Cephalophus silvicultor</i>)	xx	xx	x	x	x	-	x	-	?	-	xx	-	-
Chimpanzee (<i>Pan troglodytes</i>)	xx	xx	xx	xx	xx	xx	x	xx	xx	xx	xx	xx	xx
Olive baboon (<i>Papio anubis</i>)	xx	x ²	x	x	xx	-	x	-	?	-	x	xx	xx
Guereza colobus (<i>Colobus guereza</i>)	x	x	x	x	x	x	-	x	?	-	-	x	x
Red colobus (<i>Piliocolobus foai</i>)	-	-	-	-	-	-	xx	x	?	-	x	x	xx
Agile mangabey (<i>Cercocebus agilis</i>)	xx	xx	x	x?	-	x	x	x	?	-	x	xx	xx
Grey-cheeked mangabey (<i>Lophocebus albigena</i>)	-	x	x	?	-	x	x	x	x	-	x	x	xx
Patas monkey (<i>Erythrocebus patas</i>)	x	-	-	-	xx	-	-	-	?	-	-	-	-
Red-tailed guenon (<i>Cercopithecus ascanius</i>)	xx	xx	xx	x	x	x	xx	xx	?	x	x	xx	xx
Crowned guenon (<i>Cercopithecus pogonias</i>)	xx	xx	x	x	xx	-	x	x	?	-	x	-	xx
DeBrazza's monkey (<i>Cercopithecus neglectus</i>)	x	x	xx	-	x	x	x	-	?	-	-	-	x
Putty-nosed guenon (<i>Cercopithecus nictitans</i>)	-	-	-	-	-	-	x	-	?	-	-	xx	x
Dent's monkey (<i>Cercopithecus denti</i>)	-	-	-	-	-	-	-	-	?	x	-	-	-

Table IX. Continued

Species	Lg	Lb	Bg	Mb	Ak	Yk
Lion (<i>Panthera leo</i>)	-	-	-	-	-	-
Leopard (<i>Panthera pardus</i>)	-	x	xx	x	-	-
Hyena (<i>Crocuta crocuta</i>)	-	-	-	-	-	-
Golden cat (<i>Profelix aurata</i>)	?	?	?	?	?	?
Elephant (<i>Loxodonta spec.</i>)	-	-	xx	-	-	-
Buffalo (<i>Syncerus caffer namus</i>)	x	x	-	-	-	-
Okapi (<i>Okapi johnstonii</i>)	xx	-	-	-	-	-
Hippopotamus (<i>Hippopotamus amphibious</i>)	xx	-	-	xx	-	X
Giant pangolin (<i>Manis gigantea</i>)	x	-	-	-	-	-
Giant forest hog (<i>Hyloeocherus meinertzhageni</i>)	-	-	-	-	-	-
Red river hog (<i>Potamochoerus porcs</i>)	x	x	x	-	x	X
Warthog (<i>Phacochoerus africanus</i>)	-	-	-	-	-	-
Bongo (<i>Tragelaphus urycerus</i>)	x	x	-	-	-	-
Bushbuck (<i>Tragelaphus scriptus</i>)	-	-	-	-	-	-
Yellow-backed duiker (<i>Cephalophus silvicultor</i>)	-	-	-	-	x	-
Chimpanzee (<i>Pan troglodytes</i>)	xx	xx	xx	x	xx	xx
Olive baboon (<i>Papio anubis</i>)	x	xx	x	x	-	-
Guereza colobus (<i>Colobus guereza</i>)	-	-	-	-	-	-
Red colobus (<i>Piliocolobus foai</i>)	-	-	-	-	x	-
Agile mangabey (<i>Cercocebus agilis</i>)	x	x	x	-	-	x
Grey-cheeked mangabey (<i>Lophocebus albigena</i>)	x	x	x	-	x	-
Patas monkey (<i>Erythrocebus patas</i>)	-	-	-	-	-	-
Red-tailed guenon (<i>Cercopithecus ascanius</i>)	x	xx	xx	x	x	x
Crowned guenon (<i>Cercopithecus pogonias</i>)	x	-	x	x	x	x
DeBrazza's monkey (<i>Cercopithecus neglectus</i>)	x	x	x	-	x	x
Putty-nosed guenon (<i>Cercopithecus nictitans</i>)	x	-	-	-	x	-
Dent's monkey (<i>Cercopithecus denti</i>)	-	x	-	-	-	-

Cl = Camp Louis, Gangu = Gangu, Bl S = Bili and Bili South, Gba = Gbangadi, Zpy = Zapay, Zz = Zaza, Zg = Zongia, Li = Lingo, Bu = Buta, Ng = Ngume, Mb W = Mbange West, Mb E = Mbange East, Lg = Leguga, Lb = Lebo, Bg = Bongenge, Mb = Malembobi (Bg and Mb are two regions of Bambesa), Ak = Akuma, Yk = Yoko, Df = Difongo.

¹Presence confirmed by Karl Ammann with a camera trap photograph.

²Baboons were seen only once during our months spent in the Gangu Forest, at its very eastern edge on the west bank of the Bo River.

Table X. Encounter rate for large mammalian carnivores across the different study regions. We recorded evidence of lions, hyenas, and leopards in forests north of the Uele, whereas only evidence of leopards was found south of Uele.

Location	No. days in forest	Kms walked	Leopard traces (dung and tracks) per km	Leopards heard / seen per day	Hyena traces (dung and tracks) per km	Hyenas heard / seen per day	Lion traces (dung and tracks) per km	Lions heard / seen per day
Camp Louis Transects 2005	na	99	0.02	0 (per km)	0.01	0 (per km)	0	0 (per km)
Gangu Transects 2005	na	61	0.07	0.02 (per km)	0.02	0 (per km)	0	0 (per km)
All Transects 2005	na	160	0.04	0.006 (per km)	0.01	0 (per km)	0	0 (per km)
Camp Louis Forest All 2004-2007 ¹	262.5	1277.9	0.02	0.07	0.01	0.16	0.0008	0.004
Gangu Forest All 2004-2007 ²	85	345.4	0.03	0.07	0.02	0.07	0.01	0.02
Bili – Bili S Forests 2006	28	112.9	0.02	0	0	0.05	0	0
Nambala Forest 2006	7	9.0	0.11	0	0	0	0	0
Bakalakala Forest 2006	9.5	28.9	0.1	0	0	0	0	0
So Forest 2006	11	63.4	0	0.1	0	0	0	0
Gbangadi Forest 2006	6	31.7	0.1	0	0	0	0	0
Zapay Forest 2006	8	49.9	0	0	0.02	0.3	0	0
Lebo Forests / Mongongolo 2006-2008	24	41.3	0	0	0	0	0	0
Lingo Forest 2007	9	38.5	0	0	0	0	0	0
Zongia Forest 2007	8	35.7	0.03	0	0	0	0	0
Mbange All Forests 2008	24	126.4	0.02	0	0	0	0	0
Leguga Forest 2008	14	48.5	0	0	0	0	0	0
Bambesa All Forests 2008	13	65.0	0.08	0	0	0	0	0
Buta Forest 2008	3	25.6	0	0	0	0	0	0
Ngume Forest 2008	8	39.38	0.1	0	0	0	0	0
Akuma Yoko Forests 2008	10	25.55	0	0	0	0	0	0

¹ Includes 99 km of transects.

²Includes 61km of transects.

JS documented hyena and lion prints on the main road between Baday and Zapay near the town of Kpokpo. Locals report abundant lions in the savannas between Bili and Ango, and claim that solitary lions occasionally travel as far south as the Uele River across from Leguga. We encountered lion prints at Camp Louis, and also in the Gangu Forest 5 km from the nearest savanna (Figure 13a). Hyena prints (always solitary) were seen frequently at Camp Gangu, 10 km from the nearest savanna (Figure 13b), and the camp was once visited by a hyena. Hyenas and leopards were abundant in the Camp Louis area, where they were

heard almost nightly. However, on the transects, we found four times more traces of leopards and two times more of hyenas at Gangu than at Camp Louis. Lions appear to be relatively rare in the area, and, according to our Zande trackers, they follow migrating herds of buffalo from area to area. According to locals, neither lions nor hyenas are found to the south of the Uele River, and we found only evidence of leopards on our surveys of this more continuously-forested region.

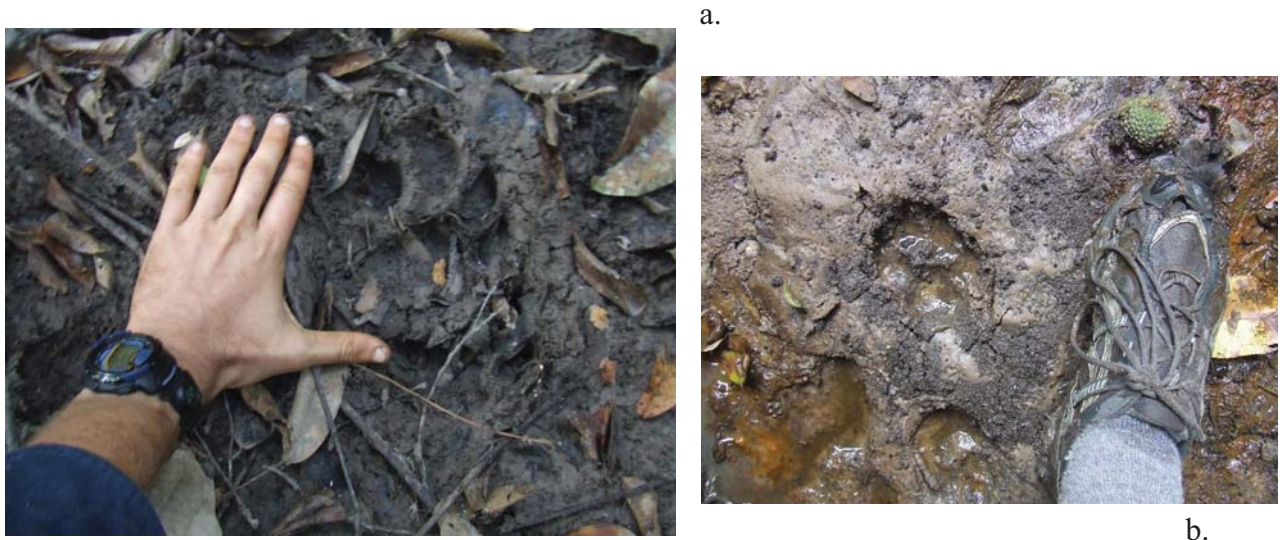


Figure 13. a. Lion footprint, Gangu Forest 2007. b. Hyena footprint, Gangu Forest, August 2006. c. Lion footprint near Camp Louis.

Elephants

As can be seen in Table XI, evidence of elephants was common in the Bili area. Across the region there generally existed a strip of about 15 km adjacent to each major road in which elephant sign was rare or absent. Beyond this distance elephant signs would increase dramatically. This became particularly clear when we conducted our transect work in the Camp Louis-Gangu area. No elephant sign was found to within about 10 km west of the road, and then within a few kilometers it became increasingly abundant, until elephant dung was encountered at a high rate in the Gangu Forest (Figure 14). Our transect work showed that elephant dung was encountered at over ten times the rate at Gangu than in the forests closer to the roads. Gangu was criss-crossed with hundreds of fresh elephant trails. During the 2004-2005 season, elephants never came further east than Dikpai-Nambala, 10.5 km southwest of the nearest road. However, in the 2006-2007 season, we found abundant elephant traces near Camp Louis, 8.4 km southwest of the road, and at one point even within 5.5 km of the road. In general, elephants seemed to move closer to the roads and villages during the wet season, when the high savanna grass offered them cover. To the south and southwest of Bili, we found elephants 10 -15 km from the town of Bili. On one occasion, JS observed multiple elephant footprints crossing the main road 15 km southwest of Bili. He also found abundant elephant evidence surrounding the Bili-API road at Bakalakala. Further north the story was different: according to locals, elephants were eliminated from the border region with Central African Republic (Zapay) within the last 20 years. We found no traces of them there, despite an otherwise intact fauna of buffalo, red river hogs, chimpanzees, and bongo.

Table XI. Encounter rate for elephants across the different study regions.

Location	No. days in forest	Kms walked	Elephant dung per km	Elephant traces per km
Camp Louis Transects 2005	na	99.0	0.21	0.68
Gangu Transects 2005	na	61.0	1.6	6.04
All Transects 2005	na	160.0	0.75	2.73
Camp Louis Forest All 2004-2007 ¹	262.5	1277.9	0.08	0.1
Gangu Forest All 2004-2007 ²	85	356.8	0.59	1.18
Bili – Bili S Forests 2006	28	112.9	0.03	0.06
Nambala Forest 2006	7	9.0	0	0
Bakalakala Forest 2006	9.5	28.9	0.14	0.38
So Forest 2006	11	63.4	0.03	0.17
Gbangadi Forest 2006	6	31.7	0	0.06
Zapay Forest 2006	8	49.9	0	0
Lebo Forests and Mongongolo 2006-2008	24	41.3	0	0.02
Lingo Forest 2007	9	38.5	0.05	0
Zongia Forest 2007	8	35.7	0.08	0.14
Mbange West Forest 2008	9	45.5	0	0.15
Mbange East Forest 2008	15	80.9	0.26	0.26
Mbange All Forests 2008	24	126.4	0.17	0.22
Leguga Forest 2008	14	48.5	0	0
Bambesa All Forests 2008	13	65.0	0.15	0.25
Buta Forest 2008	3	25.6	0	0
Ngume Forest 2008	8	39.4	0	0.03
Akuma Yoko Forests 2008	10	25.6	0	0.04
Difongo 2009	6	33.8	0.18	nr

¹ Includes 99 km of transects.

² Includes 61 km of transects.

South of the Uele River, the pattern of elephant distribution was patchier and more complex. Elephants were present along most of the Uele River, on one or both sides. To the south, we found abundant traces at Lingo, Zongia, Difongo, and Bambesa; to the north we found their traces at Zaza just across from Leguga. Elephants were missing from Leguga (despite an otherwise intact fauna and very few signs of humans) and also from Lebo. According to the locals this absence was due to poachers from Buta targeting them in the mid-1990s. We found abundant traces of elephants in the Mbange East region north of Aketi, but at less than half of the encounter rate as at Gangu. The large quantity of elephant sign at Mbange East was surprising, as in the recent past there had been heavy mining activity in the region. Closer to Aketi, and in the forests to its south, we found no signs of elephants, except for dung and signs seen by one of our field assistants approximately 60 km to Aketi's southeast (in the Yoko Forest); this was probably a relict population. In the Aketi Forests we did however find many ancient elephant pit traps (as we had at Lebo), indirect testimony to the former presence of the species (none of these old pit traps were seen north of the Uele). Finally, in the Buta and Ngume Forests we found no elephant sign, and locals told us they had been exterminated within the last 25 years (the only sign we found of them was one approximately 25-year-old carcass lacking its ivory in the Ngume Forest).

Other Fauna (Table IX)

Okapi (*Okapia johnstoni*) were found only to the south of the Uele River, and were (judging by dung encounter rates) extremely abundant in some patches of forest, such as Leguga, Zongia and Mbange. They appeared to be completely absent from the forests to the east of the relatively small tributary of the Uele, the Bima River (shown on the map in Figure 2), despite the fact that the forest-types seemed similar and there were still elephants and many chimpanzees there (thus indicating that human predation is an unlikely explanation for their absence). Okapi sign was also absent south of the town of Aketi and in proximity to the town of Buta. Locals assured us that the species had been present in those areas before, but

had recently been hunted out by Bangalema nomadic hunters, along with the elephants. Buffalo (*Syncerus caffer nannus*) were widespread and common in the Camp Louis – Bili area, but were more rare in heavily-forested areas like Gangu. They were abundant up to the border of the Central African Republic, at Zapay, and in most areas surveyed north of the Uele. South of the Uele they were much less common, occurring sporadically in some forest patches, such as at Mbange. Films taken of buffalo at Camp Louis revealed them to belong to the forest subspecies, although a possible savanna buffalo or hybrid was filmed in a large herd encountered on the savanna between Camp Louis and Gangu.

Hippopotamuses (*Hippopotamus amphibious*) were reported by locals to be present in the Bili River, although we never found their traces. They were abundant all along the Uele River, and we also found their dung in a tributary of the Itimbiri River within 20 km of Aketi. Locals told us that they were also present in the Bima River, but that in the Rubi River bordering Rubi-Télé the species has been completely hunted out by diamond miners.

A wide range of duikers occurred in all of the regions surveyed, including blue (*Cephalophus monticola*), bay (*Cephalophus dorsalis*), and yellow-backed (*Cephalophus syvicultor*) duikers. Three species of suid (the warthog *Phacochoerus africanus*, the red river

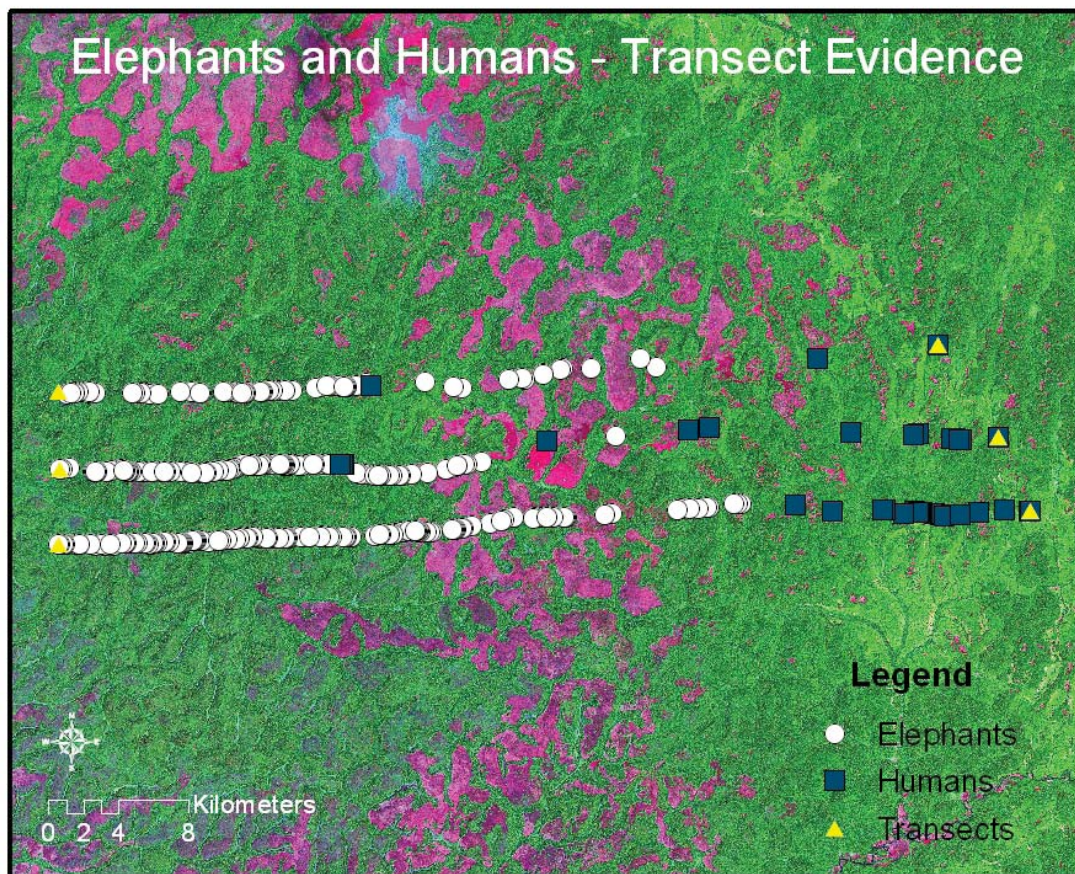


Figure 14. Map showing encounter rate of elephant and human sign on our 2005 transects: a mirror distribution. White circles refer to elephant sign (dung, trails, prints or auditory observations), and blue squares refer to human encounters or signs. The Landsat ETM+ image files dated from 1999 and were downloaded from GLCF (<http://glcf.umiacs.umd.edu>).

hog *Potamochoerus porcus*, and the giant forest hog *Hyloechoerus meinertzhageni*) were found in the Camp Louis area, but only evidence of the red river hog was found south of the

Uele River. Bongo (*Tragelaphus uryceros*) and sitatunga (*Tragelaphus spekei*) were found in most of the areas surveyed, the sitatunga being limited to swampy areas. The bushbuck (*Tragelaphus scriptus*) was abundant near the savanna – forest edges around Camp Louis, but not seen elsewhere (perhaps because the local trackers in other areas had a different name for it). The species was definitely not present in the Gangu Forest, however. Burrows dug by the ardvark (*Orycteropus afer*) were found in nearly all of the regions surveyed, in both forests and savannas, but were particularly common in the savanna region of Bili. Tree pangolins (*Phataginus tricuspis*) were encountered in the Camp Louis and Gangu areas, and were also seen at Akuma, Mbangé East, Mbangé West, and Ngume. Giant pangolins (*Manis gigantea*) were present across the region and their traces were fairly common.

Human presence and impact

Human population density

Table XII presents human population data taken from a variety of local and national sources. Buta is the largest city in the region, with 45,208 people (Monographie de la Province Orientale, Kinshasa, 2005). The survey region to the north of the Uele River has only three major settlements and a population density ranging from 3.5 to 5.2 people per km² (Rapport Annuel Territoire de Bondo, 2008). In contrast, South Uele has a number of major cities and towns, and many mining camps. The population density in the South Uele survey region ranges from 6.2 to 18.4 people per km² (Monographie de la Province Orientale, Kinshasa, 2005).

Ethnicity

Over the course of the study, we worked with several ethnic groups. North of the Uele, the majority of villagers were Azande, while in towns such as Bili, immigrants from other Congolese ethnicities were also present. Some Azande also lived in settlements hugging the south bank of the Uele River, but the majority of indigenous South Uele people were Baboa (in Buta and Bambesa) and Babenza (in Aketi). Each of these major groupings was made up of a number of sub-groups. Various fisher-folk such as the Bakango and the Lokele

Table XII. Human population density across the study area.¹ ‘People per km²’ was calculated from information in the sources listed. nl = not listed. (a) Territories²; (b) Collectivities Guamonge and Bossou (the primary study area from 2004-2007), and (c) Key cities^{3 4}

a.					
Territory	Area in km ²	Population 2004 (Kinshasa report 2005)	Population size (local census estimates: ^a = 2006, ^b = 2007)	People/km ² (2004 census)	People/km ² (calculated from local censuses ^a = 2006, ^b = 2007)
Bondo	38,075	196,901	216,901 ^b	5.17	5.70 ^b
Ango	34,704	71,892	98,833 ^b	2.07	2.84 ^b
Buta	8,098	125,428	263,913 ^a	15.49	32.59 ^a
Aketi	25,417	157,860	121,830 ^b	6.21	4.79 ^b
Bambesa	9,128	167,976	147,578 ^a	18.40	16.17 ^a
Poko	22,909	189,630	291,003 ^b	8.28	12.70 ^b
Total	148,331	909,687	1,140,058 ^b	6.13	7.69 ^b

b.			
Collectivity	Area in km ²	Population size	People/km ²
Guamonge	5,334	18,452	3.46
Bosso	4,670	25,774	5.52

Table XII. Continued.

c.

City	GPS coordinates	Census 1984	2004 (MONUC)	2004 (Kinshasa report 2005)	Population size from local census estimates: 2007	Calculation 2009
Bili	4°09'06"N, 25°10'57"E	nl	nl	nl	6,335†	nl
Bondo	3°47'25"N, 23°40'03"E	11,000	16,292	17,618	nl	19,601
Bambesa	3°26'64"N, 25°41'49"E	nl	13,197	14,271	nl	nl
Buta	2°48'82"N, 24°44'69"E	28,133	46,642	45,208	nl	50,130
Likati	3°22'13"N, 23°53'22"E	nl	nl	nl	nl	nl
Titule	3°16'51"N, 25°31'21"E	nl	nl	nl	nl	nl
Aketi	3°26'64"N, 25°41'49"E	21,656	35,486	34,800	28,772	38,588
Ango	4°01'42"N, 25°51'70"E	nl	7,394	7996	nl	nl
Bumba	2°12'38"N, 22°33'29"	nl	89,289	nl	-	nl

¹ Sources for Tables XIIa and XIIb, and column 4 in Table XIIc:

Aketi: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire de Aketi: Rapport Annuel Territoire de Aketi, Exercice 2007. 28 février 2008. Census carried out from Aketi, by the Administrateur de Territoire Théophile Zungalani, Chef de Bureau.

Bondo: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire de Bondo: Rapport Annuel Territoire de Bondo, Exercice 2007. 8 avril 2008. Census carried out from Bondo, by the Administrateur de Territoire Lufuluabo Bukoko.

Buta: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire de Buta: Rapport Annuel Territoire de Buta, Exercice 2006. 17 décembre 2006. Census carried out from Buta, by the Administrateur de Territoire Emmanuel Nzambi-Wisi, Chef de Division.

Ango: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire d'Ango: Annuel Territoire de Ango, Exercice 2007. 15 janvier 2008. Census carried out from Ango, by the Administrateur et Chef de Territoire Jean-Paul Kuzo Kanzenya, Chef de Division.

Poko: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire de Poko: Annuel Territoire de Poko, Exercice 2007. 12 janvier 2008. Census carried out from Poko, by the Administrateur et Chef de Territoire Emmanuel Nzambi-Wisi, Chef de Division.

Bambesa: République Democratique du Congo, Province Orientale, District du Bas-Uélé, Territoire de Bambesa: Annuel Territoire de Bambesa, Exercice 2006. 25 octobre 2007. Census carried out from Bambesa, by the Administrateur et Chef de Territoire Jean-Claude Mayaminyoya M. E., Chef de Division.

² Source for Columns 3 and 6 of Table VIc:

Helders 2009. The World Gazetteer, an online repository of population data, at <http://world-gazetteer.com/wg.php?x=&men=gcis&lng=en&des=wg&srt=npan&col=abcdefghijklmnoq&msz=1500&geo=-46>. Stefan Helders, 2009. The Gazetteer presents data based on censuses conducted by the DRC officials and, when these are not available, makes calculations based on secondary sources.

³ Sources for Column 2 of Table VIa:

Aderibho, Pete (Archange). August 2008 Les districts des Uele et Les groupes armés non-controlés. Une autre face des crises en République Democratique du Congo. Report ISEAV – ARU, August 2008.

Kyalangilwa, J. 22 January 2007. Nouvelles entités provinciales (Constitution de 18 février 2006).

⁴ Source for Column 4 of Table VIc: United Nations MONUC DPKO – GIS Unit Map, September 22, 2004. Urban Population Map. Map Number KINSUB1614.

[http://www.reliefweb.int/rw/fullMaps_Af.nsf/0/870AEB3188D5D25485257046006B924F/\\$File/monuc_POP_cod09_0505.pdf?OpenElement](http://www.reliefweb.int/rw/fullMaps_Af.nsf/0/870AEB3188D5D25485257046006B924F/$File/monuc_POP_cod09_0505.pdf?OpenElement)

⁵ Source for Columns 2 and 3 of Table VIa, Column 2 of Table VIb and Column 5 of Table VIc: Monographie de la Province Orientale, Kinshasa March 2005. République Démocratique de Congo Ministère du Plan; Unité de Pilotage du Processus DSRP KINSHASA / GOMBE

† The population for Bili was not listed separately in the official census. The figure here is for the Ngbanze Groupement of Bosso, which according to our local informants is approximately synonymous with the town of Bili.

plied the Uele River in their canoes. We were told by our Babenza contacts that a nomadic hunting people called the Bangalema were invading their forests from the southeast. We rarely met these people because they tended to avoid settlements and live in the forest. In and around Buta and Aketi there were also a large number of recent immigrants from all over

DRC and elsewhere; most of them had apparently arrived in the last decade following expansion of informal sector mining in the region.

Human influences: yearly burning of the savannas and cultivation, past and present

A striking feature of the landscape in the Bili area is the yearly burning of the savannas by the Azande. This burning generally begins during the dry season around late December, and gains maximum intensity around early February, when vast tracts of savanna between Baday and the Bo River, and elsewhere, are burned. This is carried out all the way to the border with the Central African Republic. Burning to the south was usually on a more local scale, for the purpose of clearing fields. At Bili this was also a reason for burning, but the locals also said that they burned savannas in order to facilitate walking through them to their fishing grounds in forest streams. Worryingly, in the city of Buta and to a lesser extent in Aketi, we observed a growing charcoal trade (Figure 15a), which has the potential of destroying much wildlife habitat, as it already has in the eastern DRC (Jenkins, 2008; Lawlor et al., 2009). Hundreds of bags of charcoal were observed being sold at markets and by the sides of the streets in Buta and Aketi.

Interviews with local Azande (Bili) and Benza (Aketi) farmers and personal observation indicate that the locals practice shifting cultivation and abandon their fields to the forest after about 3-5 years of use. Until about 50 years ago, Belgians planted cotton extensively throughout the Bili area, and oil palm groves, wild-growing manioc and other signs of past cultivation from this period can be found patchily all the way west from the main road to the Bo River (Figure 5), where they abruptly stop. Past and present cultivation is much more extensive to the south of the Uele River near Buta, Aketi and Bambesa, with



a.



b.

Figure 15. Human exploitation of forests south of the Uele River. a. The charcoal industry is becoming entrenched in Buta. b. Diamond miners near Buta.

large-scale agricultural projects initiated by the Belgians such as at INERA, Bambesa, remaining active to this day (in addition to shifting cultivation frequently found bordering roads and towns).³

Hunting

The subject of human hunting and the bushmeat trade will be covered in detail in Chapters 3 and 6. In Table XIII, we present the encounter rate of human evidence across the different study regions, while in Table XIV, we present the encounter rate for snares, cartridges, and hunting camps.

Gold and diamond mining

No evidence of industrial-scale logging was found in any of the areas surveyed, although we have reports that the SIFORCO logging company is approaching the Aketi region from the southwest (in fact, in Aketi and Buta a local ‘cottage industry’ has developed of pilfering fuel from the logging company and transporting it to Buta and other towns for sale on the black market. We frequently encountered these thieves transporting large drums of oil from west to east). However, diamond and gold mining was extensive and spreading rapidly into the countryside from the south to the north (Figure 15b). Table XV shows our encounter rate of fresh / recent and old gold and diamond mines in the different forest regions. More than 65 times the number of new or recent mines were found in the forests to the south of the Uele than to the north, whereas there were only eight times as many old (>20 years) mines in the south than in the north. In the north we found only old extinct mines, and we never saw anyone with mining pans and shovels (a common sight along the roads to the south). This situation would change rapidly in June 2007, when foundation workers witnessed thousands of gold miners pouring into Bili over a 2-week period.

Table XIII. Human evidence found per km walked in the forest, across study regions¹.

Forest region	Km walked	No. hunting signs	Avg no. / km	No. mining signs	Avg no. / km	No. signs of forest use	Avg no. / km	No. signs of presence	Avg no. / km	Total no. signs	Avg no. / km
Camp Louis	1230.6	9	0.01	6 ²	0.01	6	0.01	63	0.05	84	0.07
Gangu	327.4	3	0.01	11 ²	0.03	2	0.01	6	0.02	22 ³	0.07
Bili-Bili S	88	29	0.33	0	0	2	0.02	102	1.16	133	1.51
Zapay	50	9	0.18	0	0	2	0.04	17	0.34	28	0.56
Bongenge -Malembobi	65	13	0.20	0	0	6	0.09	118	1.82	137	2.11
Leguga	49	4	0.08	1	0.02	1	0.02	12	0.25	18	0.37
Lebo - Mongongolo	31	6	0.19	0	0	1	0.03	27	0.87	34	1.10
Zongia - Lingo	74	39	0.53	6	0.08	5	0.07	17	0.23	67	1.72
Mbange E	81	38	0.47	92	1.14	8	0.10	28	0.35	166	2.05
Mbange W	46	106	2.33	33	0.73	7	0.15	32	0.70	178	1.68
Buta - Ngume	65	46	0.71	8	0.12	5	0.08	111	1.71	170	2.62
Akuma - Yoko	26	15	0.59	0	0	1	0.04	24	0.94	40	1.54
All N Forests	1696	50	0.03	17	0.01	12	0.01	188	0.11	267	0.16
All S Forests	437	267	0.61	140	0.52	34	0.08	369	0.84	810	1.85
All Forests	2133	317	0.15	157	0.07	46	0.02	557	0.26	1077	0.51

¹ This table includes only surveys conducted by TH.

² Three of the mines in the Gangu Forest and all of the mines in the Camp Louis Forest were decades old.

³ At Gangu, 15 of the 22 items of human evidence (68%), including all of the mines, were found within 5 km of the east edge of the Gangu Forest, between the west bank of the Bo River and the savanna. No human evidence was found further than 10 km west of the Gangu Forest’s east boundary; thus the Gangu Forest proper can be considered virtually untouched by humans.

³ The train system, however, is no longer functional. In addition, the roads are in a state of disrepair, and locals frequently complain that they are no longer able to export cash crops, and thus have no way to make a living.

Table XIV. Hunting evidence found per km walked in the forest, across study regions.¹

Forest region	Km walked	No. cartridges	Avg no. / km	No. snares	Avg no. / km	No. of hunting camps	Avg no. / km	No. hunting signs other	Avg no. / km	Total no. signs	Avg no. / km
Camp Louis	1230.6	0	0	1	0.001	6	0.01	2	0.001	9	0.01
Gangu	327.4	0	0	0	0	2	0.01	1	0.003	3	0.01
Bili-Bili S	88	9	0.10	7	0.08	4	0.05	9	0.10	29	0.33
Zapay	50	1	0.02	5	0.10	3	0.06	0	0	9	0.18
Bongenge-Malembobi	65	0	0	2	0.03	3	0.05	8	0.12	13	0.20
Leguga	49	0	0	2	0.04	1	0.02	1	0.02	4	0.08
Lebo - Mongongolo	31	0	0	2	0.07	2	0.07	2	0.07	6	0.19
Zongia - Lingo	74	24	0.32	4	0.05	7	0.09	4	0.05	39	0.53
Mbange E	81	9	0.11	14	0.17	7	0.09	8	0.10	38	0.47
Mbange W	46	8	0.18	70	1.54	10	0.22	18	0.40	106	2.30
Buta - Ngume	65	3	0.05	32	0.49	5	0.08	6	0.09	46	0.71
Akuma - Yoko	26	1	0.04	11	0.43	3	0.05	0	0	15	0.58
All N Forests	1696	10	0.01	13	0.01	15	0.01	0	0	38	0.02
All S Forests	437	45	0.10	150	0.34	38	0.09	47	0.11	280	0.64
All Forests	2133	55	0.03	163	0.08	53	0.03	47	0.02	318	0.15

¹ This table includes only surveys conducted by TH.

Table XV. Numbers and encounter rate (the latter in parentheses) for gold and diamond mines (old or new) in the different forest regions. Old = more than 20 years old, new = within the last 20 years.

Locality	Km in Forest	Mining evidence per km traveled		
		Gold pits(old/new)	Diamond pits(old/new)	All mines(old/new)
Camp Louis	1230.94	$n = 6 / 0$ (0.005 / 0)	$n = 0 / 0$ (0)	$n = 6 / 0$ (0.005 / 0)
Gangu ¹	326.99	$n = 3 / 7$ (0.01 / 0.02) ²	$n = 0 / 0$ (0)	$n = 3 / 7$ (0.01 / 0.02) ²
Bili S	87.64	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)
Zapay	49.93	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)
Bongenge -Malembobi	64.99	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)
Leguga	48.52	$n = 0 / 0$ (0)	$n = 0 / 1$ (0 / 0.02)	$n = 0 / 1$ (0 / 0.02)
Lebo - Mongongolo	31.03	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)
Zongia - Lingo	74.2	$n = 4 / 0$ (0.05 / 0)	$n = 0 / 2$ (0 / 0.03)	$n = 4 / 2$ (0.05 / 0.03)
Mbange E	80.93	$n = 0 / 0$ (0)	$n = 4 / 84$ (0.05 / 1.04)	$n = 4 / 84$ (0.05 / 1.04)
Mbange W	45.48	$n = 0 / 0$ (0)	$n = 8 / 25$ (0.18 / 0.55)	$n = 8 / 25$ (0.18 / 0.55)
Buta - Ngume	64.98	$n = 0 / 0$ (0)	$n = 0 / 6$ (0 / 0.09)	$n = 0 / 6$ (0 / 0.09)
Akuma - Yoko	25.55	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)	$n = 0 / 0$ (0)
All N Forests	1695.5	$n = 9 / 7$ (0.005 / 0.004)	$n = 0 / 0$ (0)	$n = 9 / 7$ (0.005 / 0.004)
All S Forests	435.68	$n = 4 / 0$ (0.009 / 0)	$n = 12 / 118$ (0.03 / 0.27)	$n = 16 / 118$ (0.04 / 0.27)

¹ This table includes only surveys conducted by TH.

² These gold pits were found at the very east edge of the Gangu Forest, to the east of the Bo River. No evidence of mining, old or recent, was found deeper into the Gangu Forest.

Acknowledgements

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