Benin **Burkina Faso** **Niger** **Togo**

Aerial Total Count of the "W"-Arli-Pendjari-Oti-Mandouri-Keran (WAPOK) Ecosystem in West Africa

April-May 2003

By

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Definite Report February 2004

MIKE
Monitoring the Illegal Killing of Elephants

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This survey has been carried out thanks to the collaboration of some 20 observers from the different countries involved. As a field experience and a cross-border collaboration, it was unique in the sub-region.

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1. INTRODUCTION

The W-Arli-Pendjari-Oti-Mandori-Keran Ecosystem (WAPOK) constitutes the largest protected savannah ecosystem in West Africa. Noteably it covers portions of 4 West African countries, being Benin, Burkina Faso, Niger and Togo.

This ecosystem is of vital interest and its well-being is indispensable for the survival of the species it harbours. The ecosystem hosts not only the largest West African population of savannah elephants (*Loxodonta africana*) but also populations of rare species such as the western topi (*Damaliscus lunatus korrigum*), the leopard (*Panthera pardus*), the cheetah (*Acinonyx jubatus*) and the hunting dog (*Lycaon pictus*). It represents also a considerable economic interest and a source of varied income for a number of conservation stakeholders including the local communities.

For several years, in fact for several decades, some parts of the ecosystem were surveyed both by air and ground counts carried out more or less on a regular and frequent basis. (Poché 1974 ; Green 1979, 1988 ; Bousquet 1982 ; Delvingt 1987 ; Roth & al 1991; Marchand & al., 1993 ; Barry & al 1998, Chardonnet & al.,1999 ; Bouché 2000, 2002 ; Sinsin & al. 2000, 2001, 2002 ; Rouamba & al. 2002 a,b,c) while other parts were rarely or never counted.

In 1981 Bousquet & al. (1981) carried out a survey of only the Beninese and Burkinabé parts of the ecosystem. Frame & al. in 1991, mentioned the idea of carrying out a global survey at the ecosystem scale, excluding the Togolese part. Their proposal was not carried out due to lack of means.

In this vast ecosystem, the MIKE Programme covers 5 sites : the national parks (NP) of “W” Benin, “W” Burkina Faso, “W” Niger, of Pendjari in Benin and of Kéran in Togo.

One of the objectives of the MIKE Programme is to determine the trends and fluctuations of the illegal killing of elephant populations and to explain their causes. In order to be able to reach this goal, it is necessary to know the elephant population trends, and thus to carry out surveys on a regular basis.

In order to rationalise the cost of such an effort, it was decided to carry out a simultaneous survey of whole ecosystem including the management blocks not covered by the MIKE Programme (associated protected and hunting areas, the Arli National Park, etc…). This is justified by the fact that it would be difficult to determine the trends of an animal population distributed throughout the ecosystem if the latter is not entirely covered by the count.

The initial idea for the present operation was to cover the whole of the ecosystem area by a strip sample count, bringing three planes from Kenya especially equipped for that kind of work. However, the situation in Central and East Africa and logistical problems difficult to overcome rendered the operation impossible.

At that time, the wildlife authorities of the several countries involved as well as the ECOPAS, GTZ and PAUCOF projects were informed of the initiative of the MIKE

Programme. The ECOPAS and PAUCOF projects undertook to collaborate and to contribute financially to the operation.

Given the high cost of the operation and the opportunities offered by the survey, it was agreed that the other species of large mammal would also be included in the count.

In early January 2003, with the consent of the Director of the CITES MIKE, and further to the advice of Dr. I. Douglas-Hamilton, member of the MIKE Technical Advisory Group, and Dr. R. Olivier, it was decided that a total count be carried out.

2. STUDY AREA

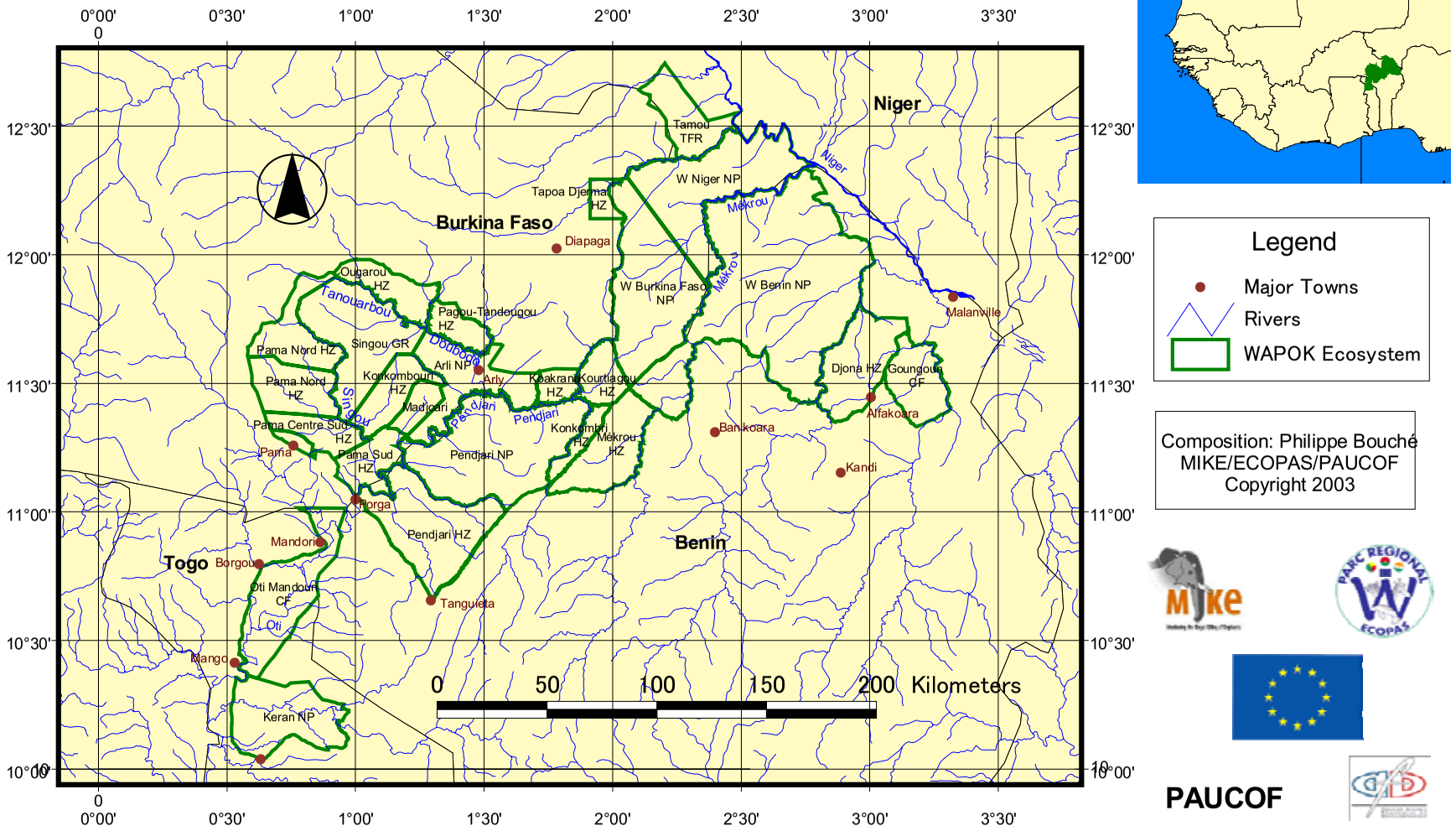
The W-Arli-Pendjari-Oti-Mandori-Keran Ecosystem (WAPOK) covers an area of 31,231.17 km². The ecosystem is composed by national parks and associated protected areas, as presented in Table 1.

The WAPOK Ecosystem is located between 9°95 and 12°85 North latitude and between 0°40 and 3°40 West longitude.

Table 1. Protected areas of the WAPOK ecosystem covered by the survey

Country	Protected area	Area (km²)
Benin	W National Park	5872.32
Benin	Goungoun Classified Forest	806.68
Benin	Djona Hunting Zone	1216.18
Benin	Pendjari Hunting Zone	1864.19
Benin	Konkombri Hunting Zone	265.74
Benin	Mékrou Hunting Zone	1090.68
Benin	Pendjari National Park	2826.85
Burkina Faso	W National Park	2411.69
Burkina Faso	Tapoa Djerma Hunting Zone	1223.69
Burkina Faso	Arli National Park	485.26
Burkina Faso	Kourtiagou Hunting Zone	601.13
Burkina Faso	Koakrana Hunting Zone	525.34
Burkina Faso	Pagou-Tandougou Hunting Zone	404.21
Burkina Faso	Ougarou Hunting Zone	654.73
Burkina Faso	Pama South Hunting Zone	839.20
Burkina Faso	Pama Central South Hunting Zone	825.54
Burkina Faso	Pama Central North Hunting Zone	1815.26
Burkina Faso	Pama North Hunting Zone	661.12
Burkina Faso	Singou Game Ranch	265.41
Burkina Faso	Konkombouri Hunting Zone	308.30
Burkina Faso	Madjoari Enclave	97.08
Burkina Faso	Pama Enclave	200.90
Niger	W National Park	2294.25
Niger	Tamou Total Faunal Reserve	789.03
Togo	Oti-Mandori Faunal Reserve	1484.48
Togo	Keran National Park	1401.91
Total		**31231.17**

Map 1. W-Arli-Pendjari-Oti-Mandouri-Keran (WAPOK) Ecosystem
Aerial Total Count. April-May 2003



Legend

- Major Towns
- Rivers
- WAPOK Ecosystem

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2.1 Climate

The WAPOK is located in the sudano-sahelian domain. The average annual temperature in Diapaga is 28°C and 30 to 34°C in Tanguiéta with average temperature amplitudes of 10 to 15°C.

As far as wildlife management is concerned, the weather is characterised by three seasons : a dry cool season from November to late February, a humid hot season from March to May, and a rainy season between June and October.

The harmattan (a dry cold wind from the North-East), blows during the dry cool season, while during the rainy season a monsoon wind blows from the South-West.

The WAPOK is located between the 600 and 1,200 mm isohyets. The rainfall follows a unimodal rhythm and varies between 800 and 1,100 mm in Benin, 750 and 1,000 mm in Burkina Faso and in Togo.

2.2 Hydrography

Availability of free water is a crucial factor for the survival of wildlife during the dry season. With the exception of several natural or artificial water holes, the majority of water sources are distributed along the seasonal streams which drain the ecosystem; of which the most important are the rivers of the Niger, Mékrou, Pako, Alibori, Oti, Pendjari, and their affluents called the Koakrana, Kourtiagou, Arli, Tanouarbou, Doubodo, and Singou.

However, most of these streams dry up during the dry season. The main rivers (Niger, Pendjari, Mékrou, Oti and Singou) are the only ones which can maintain water throughout the year in various places even when their flow is reduced to nil during the dry season. Several permanent ponds spread throughout the ecosystem also provide water for wildlife during the dry season.

Picture 1. Pendjari River

2.3 Vegetation

The habitat is characterised mainly by shrubby savannah to woodland. A progressively heavier woody density is noticed as one moves towards the south. Along the main rivers, there are forest galleries which are, themselves, bordered in some places by grassy floodplains.

The dominant species are Combretums (*Terminalia spp.* and *Combretum spp.*), *Vittelaria paradoxa* as well as *Acacias*, including *A. seyal, A. senegal* and *A. dudgeoni*.

The grass savannahs are characterised by *Combretum micranthum, C. glutinosum*, *Pterocarpus ericaneus*, *Danielia oliveri, Burkea africana, Crossopteryx febrifuga, Isoberlinia doka, Anogeissus leiocarpus* and *Afzelia africana.*

In the forest galleries there are predominantly *Anogeissus leiocarpus, Danielia oliveri* and *Terminalia spp.*

Picture 3. Singou plains

2.4 Local communities and their main activities

The surrounding communities are mainly represented by Gourmantché people but also by Djerma, Haoussa, Berba, Waama, Tangamba, Niendé, Tchokossi and Gangan. To such ethnic groups we should add the omnipresent Fulani found all around the ecosystem.

Around the borders of the ecosystem, 35,000 inhabitants live on the Burkinabé side (1995 population census), while 213,000 inhabitants live in the influence area of the National Park (NP) and Hunting Zone (HZ) of the Pendjari; 30,000 live along the borders (INSAE 1992). Around the Keran in Togo 16,750 inhabitants have been recorded (Dansomon 1985).

It should also be noted that on the Burkina Faso side exists the Madjoari enclave. In 1996, the population living in this enclave numbered at 5,810 inhabitants.

Subsistence agriculture is the main activity for the communities living around the Ecosystem. The main crops are millet, sorghum, maize, rice, peanuts, yam and sweet potatoes. Cotton is also grown in some places.

Other activities such as animal husbandry are more and more practiced around the ecosystem, notably transhumant herding by the Fulani during the dry season. Pastoralism is also practised by the sedentary ethnic groups of the region.

Fishing is also evident, mainly along the Doubodo, Arli, Pendjari and Niger rivers and in the Kompienga reservoir.

The ecosystem itself is a source of revenue for the local communities, chiefly from the activities of safari hunting and game-viewing.

The ecosystem is surrounded by towns such as Tanguiéta, Porga and Kandi in Benin, Diapaga, Fada N'Gourma, Pama and Tindangou in Burkina Faso, Mango in Togo.

Picture 4. Buildings and fields

3. METHOLOGY

3.1 Choice of a survey method

Given the initial goal of this operation – the counting of elephants - and given the important size of the ecosystem, an aerial survey was imperative.

As far as savannah elephants are concerned, aerial counting has been a successful reference for long and it is largely used in Southern, Eastern and Western Africa (Norton-Griffiths 1978, Douglas-Hamilton 1996, Bouché 2001, Omondi & al. 2002 a & b, Blake & al 2003).

Next, a choice was required between the implementation of an aerial sampling survey (Pennycuick & Western 1972, Norton-Griffiths 1978, Bouché 2001) and an aerial total count (Douglas-Hamilton 1996, Bouché 2001,2002).

Finally the aerial total count was selected. This technique consists in counting all the animals that are observed in the entire area to be counted. (Norton-Griffiths 1978, Douglas-Hamilton 1996, Bouché 2001, Omondi & al. 2002 a & b). The big disadvantage of this method remains its very high cost, given the rate of ground coverage of 100%. (Norton-Griffiths 1978, Douglas-Hamilton 1996, Bouché 2001, 2002)

Finally, the total count was retained, for the following reasons:

1. Airplanes available in the sub-region are under-equipped (absence of radar-altimeter) for a scientifically valid sampling strip-transect count (Pennycuick & Western 1972, Norton-Griffiths 1978);
2. The sampling count gives for each species results with small precision associated with important variances and thus important confidence Interval. (Craig, 2002). For a sampling rate of 20%, the results would probably produce a confidence interval not better than +/- 40% (Craig comm. pers.)
3. Results from sampling counts are most of the time not easy to compare, notably when done by different teams during different periods, sometimes even when the same teams execute them during the same periods. This can trigger doubts and debates between the census experts, the wildlife authorities and wildlife managers;
4. The entire crew, including the pilot, can participate in the count. This increases the probability of observing animals.
5. The total count gives a result that is easy to calculate (which consists of the sum of observed individuals), this does not require particular statistical treatment and is easily understandable by wildlife officers and managers. This has the advantage of removing doubts and debates as to the analysis and population figures and /or trends resulting from the count;
6. The results from the total count give a minimum number of individuals of each species. It is indeed not very probable that all individuals (even elephants) have been seen. Consequently, the estimation is considered as a minimum, therefore more precise and easier to manage by wildlife officers.
7. This technique was widely used with success for several years in Kenya and in South Africa using airplanes and helicopters.

3.2 Period of the year

This survey was undertaken in April and May during the hot dry season. The count was intended to be undertaken at the beginning of February; however, administrative and logistic problems delayed the operation, notably due to the fact that avgaz was unavailable in the region since June 2002 and that it was necessary to import it from Europe.

In April and May, the increased scarcity of water points has the effect that large herbivores tend to assemble in large herds near water. This situation does not hamper the application of the total count, given the fact that the ground is entirely covered. However, the heat could have influenced results, due to animals taking refuge in the deep shade and there is a risk that not all animals were sighted.

However, early rains in April 2003 had refreshed the atmosphere and undoubtedly contributed to the fact that animals are not forced to shelter too early from the sun (becoming less visible from the airplane after a given hour of the morning).

3.3 Period of the day

Given the dimension of the task, an average of 6 to 7 flight hours per day was necessary to cover the daily flight plan. The flights began in the morning between 05:45 and 06:00 and continued until each daily flight plan was completely executed.

3.4 Aircrafts

At the beginning 6 aircrafts were used during this survey, subsequently reduced to 5 and then 4 due to technical reasons and the overrunning of an airstrip by one aircraft. Five Cessna 172 and one Cessna 175 were used during the count.

Each of these aircraft had the following characteristics:

- High wings;
- Possible airspeed of 130 kph;
- Capacity of one pilot and 3 passengers

Picture 4. Cessna 175

Picture 5. Cessna 172 taking off

3.5 Maps

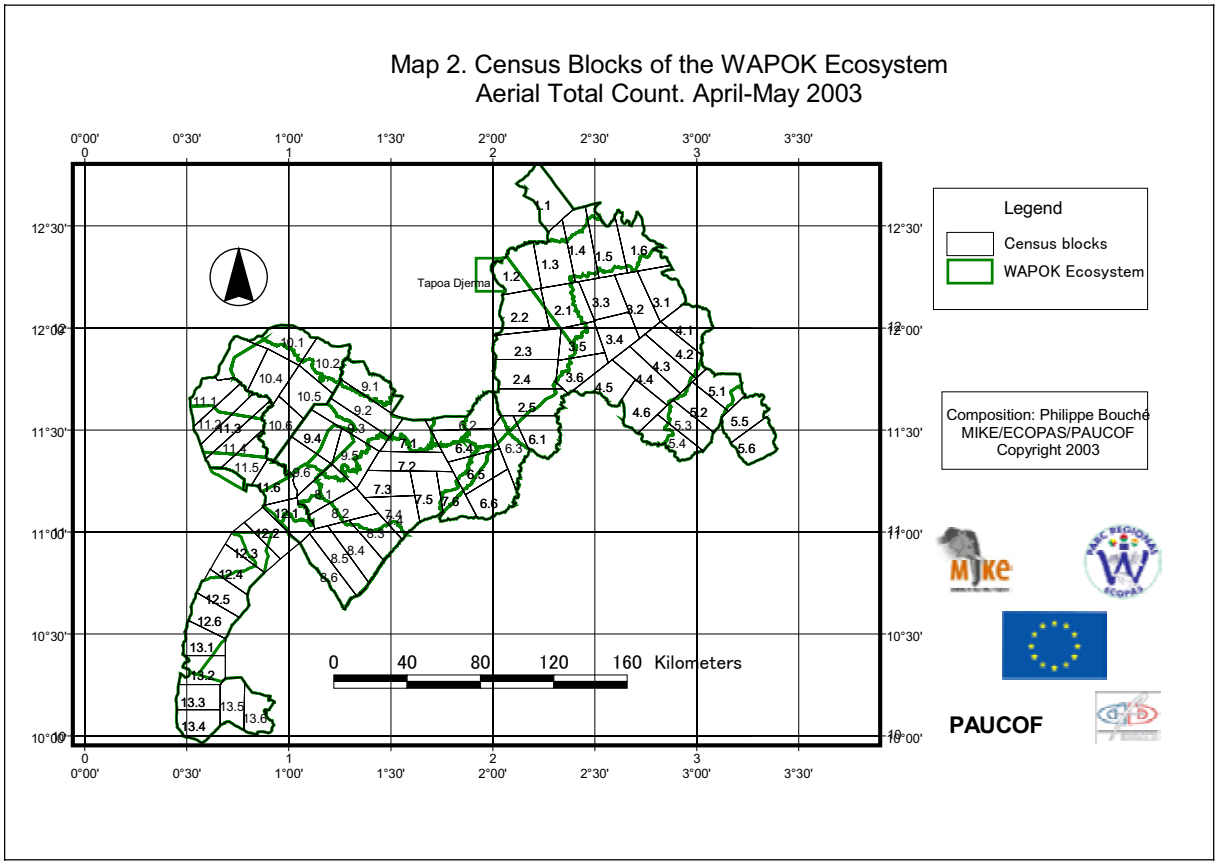
The first stage was to obtain a digitized map of the entire ecosystem. This was obtained from the digitized map supplied by the ECOPAS project, which covered the entire ecosystem in Benin, Burkina-Faso and Niger. It was completed by the digitizing of the Togolese part of the ecosystem from the IGN map at 1/200,000th. It must be noted that the basemap utilized differed somewhat from the basemap already used for the Pendjari NP. It is difficult for the authors to judge this point; the veracity of the basemap being beyond the scope of this study.

Using a Geographical Information System (GIS), the ecosystem was divided into daily counting zones whose size varied between 2,000 and 3,000 km², generally bordered by topographical features such as roads, rivers, cliffs, mountains or park limits. Given that elephants can travers several dozens of kilometres in a day, it was imperative to cover the largest area as possible each day in order to minimise as much as possible the risk of movement from one counting zone to an other and to reduce the risk of double counting. Each counting zone was then divided into 6 blocks of similar size. Each block was numbered and each was to be covered by one airplane and its crew. For example, Block 3.5 corresponds to Block n°5 of the counting zone of Day 3 (Map 2).

In each of the blocks, flight lines from east to west were generated using the GIS software of *ArcView 3.2* ™ by using the *DNR transect* ™ extension. East - West lines have the advantage of allowing equal luminosity for the observers on each side of the airplane. The interval between lines was fixed at 1km. Each flight line was extended by 2 km beyond the limits of the block to create an overlapping with the nearby blocks.

A UTM grid was overlayed on the map of each block. In this way, the transects could be flown on this grid using handheld GPS units.

Each evening, the flight lines to be run the following day by each crew were downloaded from the GIS *ArcView 3.2* ™ using the *DNR Garmin* ™ extension, on to each pilots GPS. During the flight, the pilots had only to follow the flight lines which appeared on the screen of their GPS to cover the entire surface of the block which had been attributed.


Map 2. Census Blocks of the WAPOK Ecosystem
Aerial Total Count. April-May 2003
Tapoa Djerma
0 40 80 120 160 Kilometers
Legend
Census blocks
WAPOK Ecosystem
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3.6 Counting

Each crew had one aircraft. A crew was constituted by one pilot, one Front Seat Observer (FSO) as well as two Rear Seat Observer (RSO) (Annex 3).

Each crew received one or several blocks to be counted each day. A map with the flight plan (including all the flight lines of the day) and the boundaries of the sub-block (s) were provided each evening in advance.

All elephant and buffalo (alive or dead) were counted. All other wild species were counted or estimated. Cattle, goats and sheep were approximately estimated and were recorded. The position of each group was recorded on a GPS. Each block was crossed by parallel flight lines with the aim of visually scanning the whole surface to record the exact position as well as the number of individuals of each group of animals. The scientific names of animals use the nomenclature of Kingdon (1997).

For each group of elephants, the composition was given as follows: number of adults (Ad), sub-adults (Sad) , young (y) and baby (BB).

The carcasses of elephants were recorded as follows:

> **F**: Fresh (less than 3 weeks old) = the carcass still has some flesh under the skin, the body is inflated. Vultures and other predators are probably present, and a pool of putrescent body liquid still wets the ground.
> **R**: Recent (more than 3 weeks but less than 1 year old) = presence of a circle of decay around the body where plants were destroyed. The skin is generally present and the bones are generally not very scattered (except when there are many predators in the zone)
> **O**: Old (more than 1 year old) = no circle of decay or destroyed plants. The carcass has now become a skeleton, with white bones (in humid zones, with no skin; in arid zones, the skin could still be there).
> **VO**: Very old (up to 10 years) = the bones crack and change to grey. The skeleton is no longer easily observed from the air.

Signs of human activities have been also taken into account:

- Villages
- Camps
- People
- Vehicles
- Bicycles
- Fields
- Fallow land
- Cattle (type, estimation)

3.6.1 Role of pilots

The pilot used the flight plan which appeared on the screen of his (her) GPS to navigate along the flight lines (Annex 3).

When a group of animals was spotted by a team member, two actions could happen:

- In case of small groups of animals easy to count, the pilot stayed on the flight line. The FSO recorded the observation on his (her) datasheet.
- In the case of large herds of elephant and buffalo (more than 10 individuals), or when they were too far away to be counted or photographed, the route could be interrupted at the request of one of the observers. The pilot could leave the line to catch up with the herd and make a loop above the group of elephant or buffalo so as to allow to count them exactly and then later rejoin the flight line where he (she) had left it. In case of other species, the pilot stayed on his (her) flight line.

The altitude was adapted according to the conditions (visibility, type of vegetation, etc.). An acceptable average height was situated between 200 and 400 feet.

The anticipated flight speed was set between 130 and 150 kph. The latter could reach 175 to 195 kph in the case of a back wind.

The pilot went beyond the block limit of 2 km (overlapping) in the neighbouring block.

The pilot counted animals whenever he felt comfortable to do so. In many cases, the pilot's position was particularly useful to draw the attention of observers to animals situated on the flight line.

3.6.2 Role of observers

Each FSO was equipped with a datasheet, a flight plan and a GPS *Garmin 72*™. The FSO was responsible for recording data on the datasheet. During the flight, the FSO recorded a waypoint (or the time), for the position of each group counted and photo numbers on datasheets.

The GPS recorded the exact flight route for later reconstruction of the route followed by each aircraft.

The FSO adjusted the observation strip as needed, in consultation with the RSO. The flight line was recorded on the map of the FSO, including all deviations for later comparisons with the GPS print out; but it was also necessary in case of a computer breakdown. The FSO had to ensure that the pilot over-flew the pre-established overlap in the neighbouring block and that he (she) respected the flight speed. The FSO had the prime responsibility of recording and placing all data on the map.

The RSO were responsible for the observation from their respective positions in the airplane and helped the other observers during the estimation of large herds. When an animal was observed, they called out clearly the species, the side of the plane

and the number of individuals (for example: elephant, right, 12). Very often, if there was a doubt on the exact number, the pilot left the line and circled around the herd until a definitive number was agreed upon by the crew.

The observers notified the pilot when it was necessary to photograph a herd that was too large to be counted with the naked eye (herd of 10 or more animals). The RSO estimated the number of individuals, which were photographed by the FSO.

3.6.3 Photographs

When a herd of buffalo or elephant numbering more than 10 individuals was observed, it was necessary to resort to photography. The FSO had to coordinate the operation in close collaboration with the pilot with the aim of ensuring the best possible alignment before beginning to count or to photograph the herds. The FSO recorded on his (her) datasheet, the sighting number (GPS), the species, film number and number of the photo taken as well as the estimation of the size of the herd.

In case the film was accidentally destroyed or if the camera did not work. A “blank” photo was taken in the hood or in the hand of the observer between the various herds or between the various series of photos of the same herd to allow a clear separation in the final photographic analysis. Films were labeled.

Lenses from 30 to 105 mm were used with 200 ASA slide film.

3.7 Finalisation of the data processing

It is not always possible to have clear and legible recording of the data during flight. Therefore, after each daily flight, each FSO dedicated one hour to neatly finalize the datasheet of the day. After neatly copying the original data, the FSO also put the map in neat form. The original datasheet and the flight maps were signed by each member of the team and collected in a file to be accessible to anybody desiring access.

A the end of the day, the ground team downloaded the data from the GPS on to the computers, and a map of the flight routes and the recorded waypoints was printed. The ground team used the *ArcView 3.2* ™ as well as an extension *DNR Garmin* ™ that permitted to download the contents of the GPS towards the GIS database. The FSO then had to check his (her) map and write the number of individuals of each species recorded (as well as the carcasses of elephant) next to each corresponding waypoint. At this level, any double observation within each block was eliminated after discussion with the pilot, FSO and coordinators. This map was checked and used for preliminary analysis by the coordinators.

Once the data keyed into the computer, the daily information from each crew was linked with waypoints recorded during the flight to establish a geo-referenced database containing all the observations and their respective positions.

From this database, it was possible to produce maps for each species as well as calculate numbers of observed populations.

The analysis of sighting maps also allowed to eliminate possible double counting between neighbouring blocks.

The analysis of the slides allowed to more precisely count the numbers of photographed groups. Slides were analyzed either by projection of the image on screen or by using a binocular magnifying glass.

4. RESULTS

4.1. Training

One of MIKE's objectives is capacity building and reinforcement in each State, including the field of the wildlife census. It had been the wish of the MIKE Sub-Regional Support Unit that the observers be officers appointed by each State. Although some countries already had some officers trained in aerial count, others never had a prior opportunity to carry out such an operation. It was then essential to train the whole team in techniques and procedures of aerial counting prior to the census.

Before conducting the census itself, 20 officers (3 from Benin, 10 from Burkina Faso, 3 from Niger, 4 from Togo) were trained as observers for the operation. A total of 31 flying hours and 38 minutes in 2 days (20 and 21 April 2003) were devoted to training observers.

At least one delegate from each country had a prior training as a FSO.

This training was also a good occasion for the pilots to familiarize themselves with the requirements of this type of work for which none had already experienced the opportunity to perform.

4.2. Counting effort

In total, 6 airplanes flew 624.33 hours (or 624h20 min) such as detailed as follows :

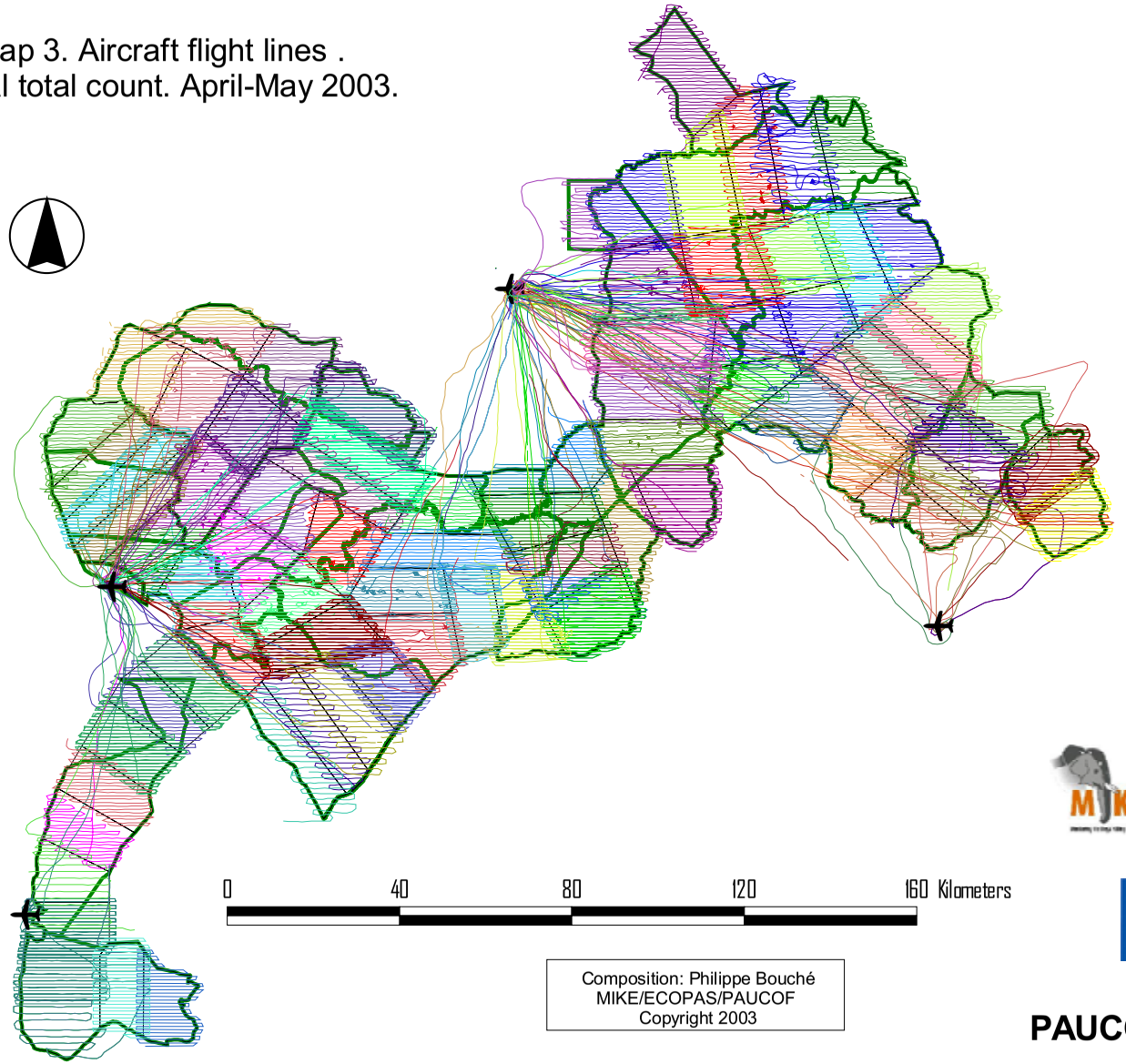
	Counting	Displacement	Ferry	Training	Total
Flying hours	287.93	136.3	168.47	31.63	624.33

- 287.93 hours were devoted only to the count.
- 136,3 hours were devoted to travel between the counting areas and the bases: this relatively high figure is explained by the low number of airstrips available near or within the ecosystem, at which the team would have found some lodging facilities. Besides, the HQ location was changed only once so as to avoid increasing logistical problems (transport of the teams, equipment and fuel).
- 168.47 hours were devoted to ferry flights from the aircrafts' usual airbase to the ecosystem. The high number of flight hours is explained by the fact that 4 planes came from Accra, Ghana, coming through Ouagadougou and that the distance to reach the ecosystem was significant.

The count itself represented 287.93 flying hours, that is an average scanning rate of 108.47 km²/hour (Map 3).

A total of 45,579.08 km of transect were flown during the survey, which gives an average speed of 158.3 kph.

Map 3. Aircraft flight lines .
Aerial total count. April-May 2003.



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4.3. Period of the day and counting

One of the concerns in the co-ordination of this operation was the following: considering that the census would take place during a period which is not generally considered appropriate due to the hot weather during that moment of the year (the flights occurring between 5:30 to 16:00), there was a risk that the animals would be under cover during the hot hours of the day, leading to an under-estimation of the populations due to a low number of animals observed.

Elephant

For each period of one hour of counting, the flying time by the different aircrafts and for the different blocks in which elephants were observed was calculated on the basis of a sample of 39 counting hours in 11 blocks for which we have sufficient data.

Figures 1a and b show that the number of flying hours (blue line) increases considerably between 5 :00 am and 7 :00 am ; as a matter of fact, most of the aircrafts left the base between 5 :00 and 6 :00 and needed differing times (depending on the distance) to reach their counting blocks. Counting effort became maximum between 7 :00 and 9 :00. Thereafter, the line representing flying time drops between 10 :00 and 11 :00 due to the fact that most of the planes were running out of fuel and, therefore, very little counting took place between 10 :00 and 11 :00. Next, the curve reaches a new peak which can be explained by the fact that after a break to allow the crews to take a rest and to refuel the aircraft, the latter took off again to finish the block they had started in the morning. The flights were over between 14 :00 and 16 :00, which explains why the curve drops by the end of the day.

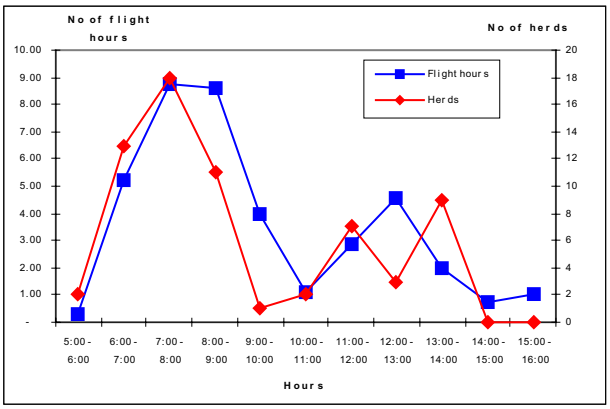


Figure 1a. Number of flight hours and observations of elephant herds during different periods of the day. A period is the interval between each exact hour .

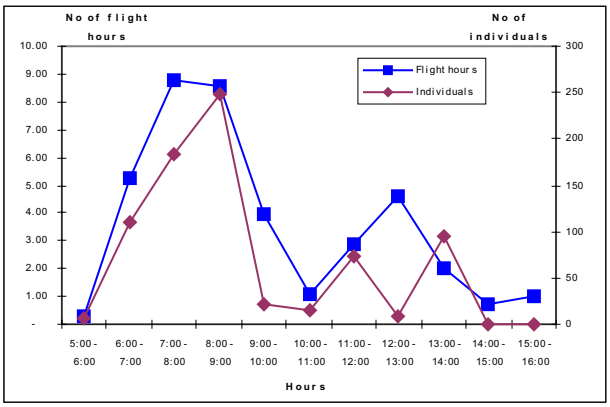


Figure 1b. Number of flight hours and observations of elephants observed during different periods of the day.

The red line (Figure 1a) illustrates the number of elephant herds observed and the purple line (Figure 1b) illustrates the number of individual elephants observed per hour of flying time.

In general, the higher the effort in counting hours between 7:00 am and 9:00 am the higher the number of herds and individuals observed.

Looking at the points on the graphs (Figure 1a&b) representing the hot hours, (after 9 :00), we notice that for an effort to count in the periods between 10 :00 to 11:00,

11:00 to 12:00, and 13:00 to 14:00 (all lower than between 9:00 and 10:00), the number of groups and individuals observed is proportionally higher. The counting effort between 12 :00 and 13 :00 is just a bit more higher than between 9 :00 and 10 :00 and the number of groups observed is higher, but on the other hand the number of individuals is lower, which means that several small herds (bulls, bachelor's clubs) have been observed during that period of the day (Figure 1a & 1b).

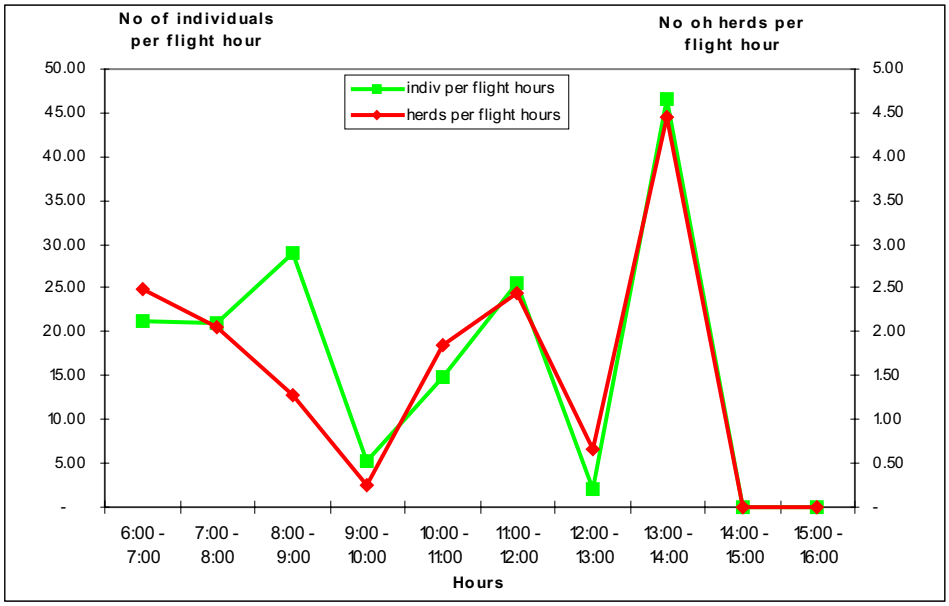


Figure 1c.Number of herds and individuals observed per flight hour during the different periods of the day

Figure 1c presents in red the number of herds observed per flight hour and in green the number of individuals observed per flight hour, for each 1 hour period of the day (from 6:00 to 7:00, from 7:00 to 8:00 etc…).

Both the number of herds and the number of individuals observed per flight hour drop after 9 :00.This could also be caused by the observers' fatigue or the fact that the herds are in the shade and are thus not visible.

It is noteable that between 10 :00 and 12 :00 and between 13 :00 and 14 :00 (the hottest hours of the day), the indices are high, even higher than those obtained during the cool hours of the day or between 12:00 and 13 :00.

Buffalo

The same analysis was performed for buffalo on the basis of 61 counting hours in 15 blocks. The graphs are presented in Figure 2a, 2b and 2c.

We notice also for buffalo (Figure 2a, 2b, 2c) that many observations were made during the hot hours of the day and that the indices are high also in the afternoon.

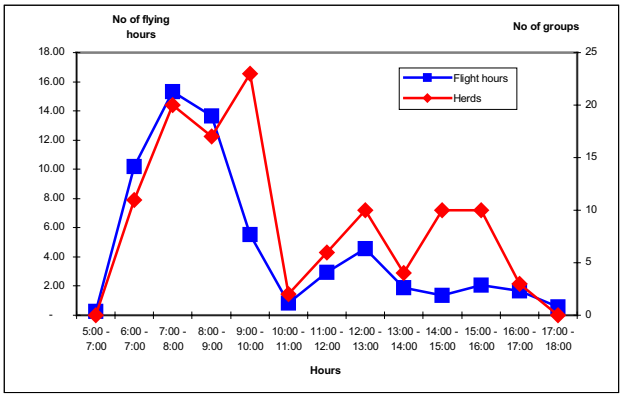


Figure 2a. Number of flight hours and observations of buffalo herds during different periods of the day. A period is the interval between each exact hour.

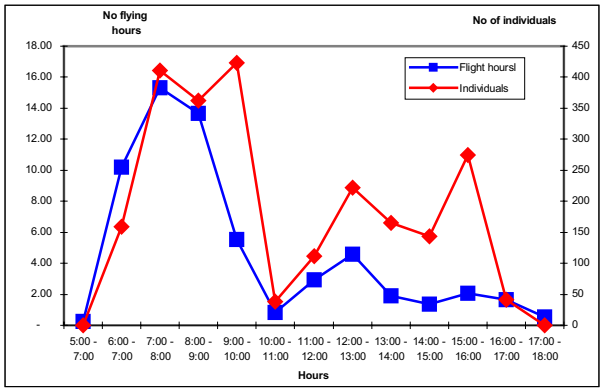


Figure 2b. Number of flight hours and observations of buffalo individuals during different periods of the day.

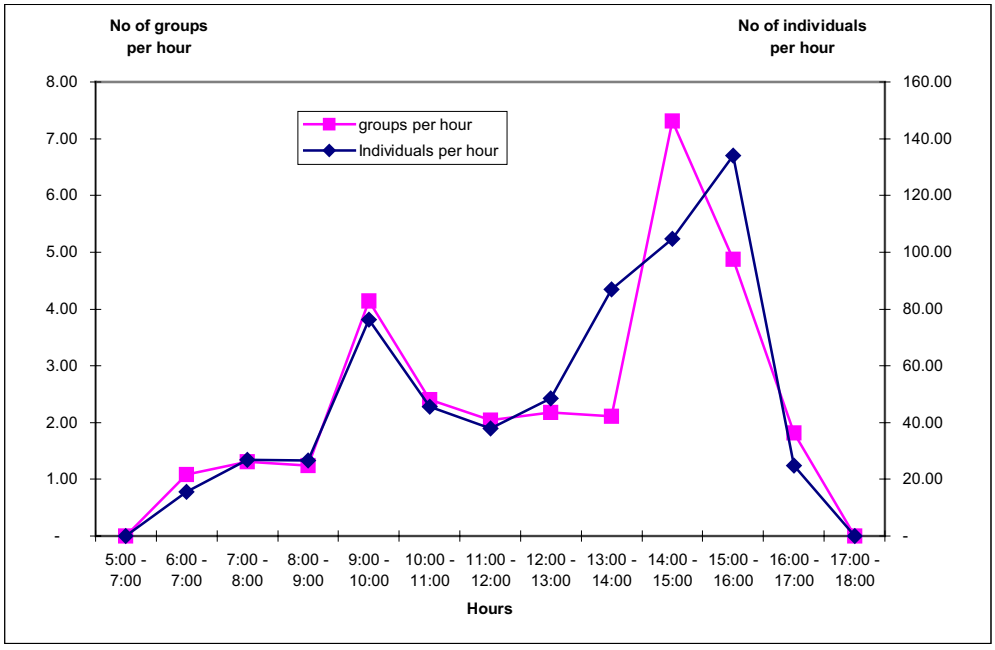


Figure 2c.Number of herds and individual buffalo observed per flight hour during different periods of the day.

We can conclude, therefore, that even if the heat may have played a role on the number of observations, it seems that for buffalo and elephant (having significant water requirements), the heat had only a moderate impact on the number of observations.

We would not, therefore, recommend that censuses be started at midday; however, as far as the total count in that season (hot season after the beginning of the rains and grass shoots) is concerned, we have to admit that operations conducted during the hottest hours in the late dry season allow, to make valid observations throughout the whole day.

It should be emphasized that the total aerial surveys carried out in Kenya in similar habitats (Douglas-Hamilton, 1996; Omondi & al. 2002 a, b) are also conducted during the whole day.

4.4. Count

When we will present and discuss census results such as the distribution, number of herds or individuals, we refer exclusively to the observations recorded during the aerial total count conducted in 2003 in the WAPOK ecosystem, the object of this report.

The results of the total count in the WAPOK wildlife ecosystem are shown on Table 1a and 1b. Figure 4 shows the overall distribution of species in the ecosystem.

The results per species are presented on the following pages.

For all the species of size smaller than Buffon's Kob, results are provided for the record.

While the detection of small-sized species from the aircraft needs experienced observers, it was the first operation of this kind for the majority of observers. However, even with experienced observers, it is impossible that all individuals would have been observed, for the following reasons :

1. the width of the observation strip was fixed at 500 m on each side of the plane (for a total observation band of 1km) ;
2. all observations of smaller species observed were made in a strip of about 100 to 200 m on both sides of the flight line, that is a nearly 200 to 400 m band (therefore ±1/5th to 2/5th of the observation band) ;
3. all the individuals in the 200 to 400m wide observation band could certainly not have been observed and counted.

Table 1a. Results of the Aerial Total Count of the WAPOK Ecosystem, Blocks 1 to 7

Species	Code	Test	Block 1						Block 2					Block 3						Block 4						Block 5						Block 6							Block 7					
		2.1, 2	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2	5.3	5.4	5.5	5.6	6.1	6.2	6.3	6.4	6.5	6.6	Tap	7.1	7.2	7.3	7.4	7.5	7.6
Flight duration			5:19	3:48	5:17	4:08	3:42	5:54	5:59	5:46	3:30	5:44	4:37	3:55	5:00	3:20	3:56	3:45	2:51	4:28	4:45	4:34	4:28	3:47	2:59	4:17	4:25	1:26	3:52	2:55	1:06	1:45	4:05	3:01	4:59	4:09	3:40	3:07	2:40	3:21	5:12	4:01	3:26	3:07
Date			22/4	22/4	22/4	22/4	22/4	22/4	23/4	23/4	23/4	23/4	23/4	24/4	24/4	24/4	24/4	24/4	24/4	25/4	25/4	25/4	25/4	25/4	25/4	26/4	26/4	26/4	26/4	26/4	26/4	30/4	30/4	30/4	30/4	30/4	30/4	oa*	1/5	1/5	1/5	1/5	1/5	1/5
Elephant	E	170	0	14	11	55	11	0	14	243	86	63	99	0	0	39	0	20	56	0	0	0	0	0	0	0	0	3	35	0	0	1	0	0	0	28	158	0	32	66	134	81	183	126
Buffalo	B	163	0	6	129	320	0	252	438	273	626	88	237	0	9	44	54	144	153	2	33	0	0	1	0	0	0	45	0	1	0	0	2	95	48	175	96	0	32	19	829	468	594	297
Roan	HI	265	0	120	62	46	48	31	89	27	36	13	191	57	41	29	68	58	85	67	75	82	88	2	49	3	86	110	101	0	1	24	87	27	176	73	178	24	193	131	151	95	77	74
Hippopotamus	HP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	169	0	0	0	4	50
West. Hartebeest	BU	100	0	1	34	3	5	0	0	3	0	3	19	4	0	0	18	11	19	0	0	1	9	0	0	0	65	5	30	0	0	0	27	42	58	24	43	0	26	45	83	79	7	40
Western Topi	DA	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0	21	0	0	0	4
Waterbuck	WA	0	0	0	0	0	0	0	21	0	0	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	6	10	0	0	10	13
Buffon's Kob	CB	12	0	5	42	3	0	5	12	0	9	3	13	0	4	8	2	4	6	0	3	11	3	0	0	0	1	3	3	0	0	5	2	0	116	2	16	0	65	14	31	1	7	0
Bohor reedbuck	RE	1	0	1	0	0	0	0	0	1	0	4	0	2	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	17	0	1	0	0	0	11	1	0	4
Red-Fronted Gaz	GFR	0	0	1	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bushbuck	GH	4	0	0	4	2	1	2	6	0	0	5	4	0	3	2	5	3	2	4	1	3	8	0	0	0	0	2	6	0	0	0	2	5	9	1	10	0	4	1	0	17	14	1
Oribi	OU	35	0	7	10	4	7	3	7	8	3	5	8	8	10	1	21	3	1	4	11	14	9	0	4	1	6	3	7	2	0	0	9	7	31	1	15	0	12	4	17	19	3	5
Grimm's duiker	CG	23	0	9	10	3	8	14	2	5	4	8	10	19	9	10	9	8	8	21	4	4	15	3	6	3	1	1	2	13	1	0	29	7	9	1	14	0	8	2	16	48	35	7
Warthog	PH	55	0	10	11	3	7	11	44	7	22	4	8	2	9	11	26	2	5	16	13	4	7	1	3	0	0	21	15	3	0	17	20	27	25	11	25	0	49	15	51	15	10	10
Anubis baboon	BA	15	0	2	2	7	1	17	3	7	1	14	13	0	1	3	19	38	36	6	0	19	33	0	0	0	0	2	18	0	0	1	6	6	25	1	24	0	28	16	21	2	1	26
Patas monkey	PA	3	1	0	0	1	0	0	1	2	0	1	0	3	1	21	7	14	3	4	0	0	2	0	1	3	0	1	2	4	11	0	12	1	2	0	0	0	19	1	0	0	0	0
Tantalus monkey	SV	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lion	L	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheetah	GU	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Side-striped jacka	CH	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	1	0	2	4	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Spotted Hyena	HY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honey badger	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porcupine	PE	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		856	1	176	315	453	90	335	638	576	787	219	602	96	89	168	231	308	376	128	141	139	174	7	64	11	159	196	220	23	13	48	197	219	576	367	581	0	643	345	1344	826	945	657
Cattle	BE	846	2927	1	266	502	2943	2620	0	314	15	0	200	137	500	0	3783	1310	1557	4628	1625	1435	3653	3402	1470	6820	5713	1309	1305	540	464	326	4156	1290	182	0	891	315	0	0	2	0	0	214
shoats**	CM	0	4915	0	0	0	230	624	0	60	0	0	0	135	0	0	0	0	30	30	0	0	0	294	43	15	0	0	150	100	236	91	815	0	0	0	0	100	0	0	0	0	0	0
Elephant	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carcass	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	O	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	VO	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* It has been realized during the count planning that the Tapoa Djerma ZC was not taken into account at the beginning. A new block was thus added with a new name. This modification had no influence on the survey results. The block has been covered properly.

** “shoats”: Sheep and Goats

Table 1b. Results of the Total Aerial Count in the WAPOK Ecosystem, Blocks 8 to13 and Totals

Species	Cod	Block 8						Block 9						Block 10						Block 11						Block 12						Block 13						Total
		8.1	8.2	8.3	8.4	8.5	8.6	9.1	9.2	9.3	9.4	9.5	9.6	10.1	10.2	10.3	10.4	10.5	10.6	11.1	11.2	11.3	11.4	11.5	11.6	12.1	12.2	12.3	12.4	12.5	12.6	13.1	13.2	13.3	13.4	13.5	13.6	BLOCKS
Flight duration		5:50	4:13	2:43	5:23	2:28	2:28	2:07	4:16	3:58	4:24	3:10	4:05	2:58	4:11	3:55	3:56	4:03	4:27	3:14	2:59	3:55	3:47	3:20	2:03	3:54	1:41	3:36	3:14	2:44	1:08	2:00	4:10	2:56	1:08	5:31	1:55	287:56
Date		2/5	3/5	3/5	3/5	3/5	2/5	4/5	4/5	4/5	4/5	4/5	4/5	5/5	5/5	5/5	5/5	5/5	5/5	6/5	6/5	6/5	6/5	6/5	6/5	7/5	7/5	7/5	7/5	7/5	7/5	8/5	8/5	8/5	8/5	8/5	8/5	1 à 13
Elephant	E	166	113	29	9	8	0	106	336	46	0	90	357	231	22	158	163	166	178	64	17	144	160	70	110	121	0	0	0	0	0	0	0	0	0	0	0	4592
Buffalo	B	505	565	171	202	76	0	0	282	5	0	253	274	0	7	5	114	36	726	9	93	509	612	123	180	140	0	0	0	0	0	0	0	0	0	0	0	10560
Roan	HI	253	170	25	100	67	15	121	248	81	70	144	254	14	220	285	415	124	363	305	183	247	257	216	80	83	0	0	0	0	2	0	0	0	0	0	0	7582
Hippopotamus	HP	21	31	0	0	0	0	3	111	108	0	45	22	0	17	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	693
West. hartebeest	BU	55	88	38	69	4	0	4	105	42	23	93	94	17	10	69	161	12	49	57	41	73	0	51	42	32	0	0	0	0	0	0	0	0	0	0	0	2033
Western Topi	DA	5	12	13	7	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	132
Waterbuck	WA	0	0	0	15	14	0	0	4	6	0	7	17	19	16	35	25	1	21	9	51	17	0	15	0	4	0	0	0	0	0	0	0	0	0	0	0	346
Buffon's Kob	CB	64	3	10	7	3	0	19	37	14	17	62	33	0	39	30	33	19	21	51	33	26	39	18	17	22	0	0	0	0	4	0	0	0	6	0	2	1040
Bohor reedbuck	RE	19	6	0	2	0	0	0	0	7	1	0	4	1	0	8	3	3	0	0	2	9	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	125
Red-Fronted Gaz	GR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Bushbuck	GH	1	2	3	19	4	8	5	12	0	3	2	1	2	11	1	13	7	4	0	3	7	8	0	2	4	0	0	0	0	1	0	0	0	0	0	0	254
Oribi	OU	17	14	6	2	11	1	3	18	8	4	2	20	11	18	10	86	16	29	11	3	30	1	11	3	9	0	0	0	0	0	0	0	0	0	0	0	669
Grimm's duiker	CG	16	41	20	33	3	3	12	14	16	31	2	23	4	35	7	16	22	13	16	10	15	14	6	7	3	0	3	0	2	11	0	0	0	4	0	1	812
Warthog	PH	50	54	4	7	0	0	13	41	23	2	19	60	7	18	17	49	12	29	16	19	20	40	11	14	8	0	0	0	0	3	0	0	0	2	0	0	1133
Anubis baboon	BA	128	54	1	0	0	0	0	10	0	0	21	101	0	4	0	8	0	0	3	0	7	0	6	15	58	0	0	0	0	4	0	0	0	0	0	0	834
Patas monkey	PA	9	0	4	1	0	0	0	0	0	0	0	0	0	0	4	0	0	1	1	2	0	4	0	0	3	0	0	0	0	1	0	0	0	2	0	0	153
Tantalus monkey	CA	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Lion	L	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Cheetah	GU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Side-striped Jackal	CH	3	0	0	0	0	0	0	3	0	0	0	1	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
Spotted Hyena	HY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Honey badger	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Porcupine	PE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total		1312	1153	324	473	190	27	298	1223	356	151	740	1263	306	417	631	1089	421	1434	547	459	1105	1135	527	484	549	0	3	0	2	26	0	0	0	14	0	3	31025
Cattle	BE	100	0	375	1	380	2825	105	550	480	353	510	977	270	495	400	0	0	0	352	410	5	70	1248	1025	1772	5577	1318	8111	2000	2525	3680	2600	0	391	1181	3595	101342
shoats**	CM	0	0	0	0	90	0	157	0	0	0	90	360	0	0	0	0	0	0	26	0	0	0	0	120	100	50	0	1518	50	365	440	80	0	0	50	80	11444
Elephant	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carcass	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	VO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3

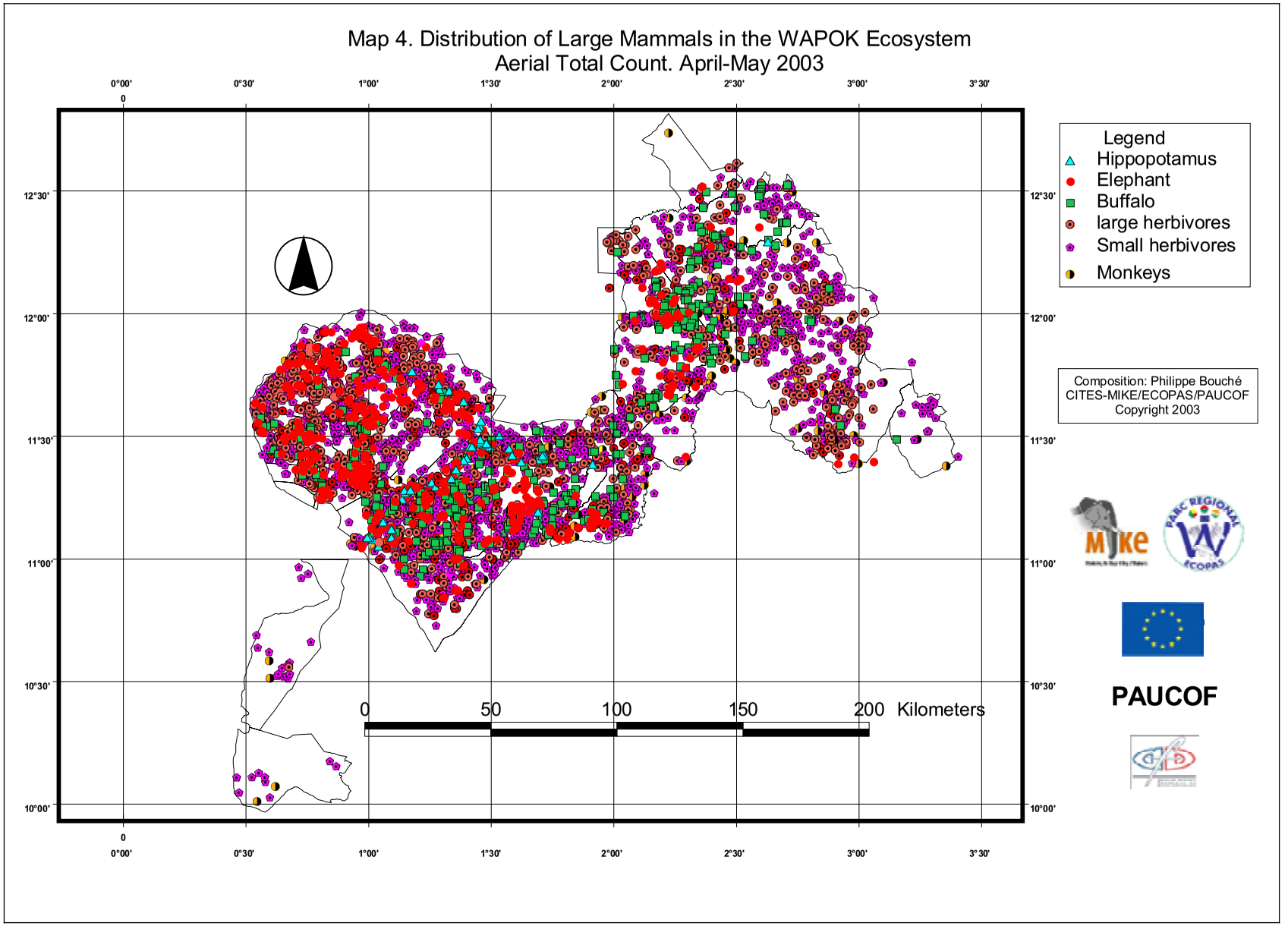

Map 4. Distribution of Large Mammals in the WAPOK Ecosystem
Aerial Total Count. April-May 2003
0°00'
0°30'
1°00'
1°30'
2°00'
2°30'
3°00'
3°30'
12°30'
12°00'
11°30'
11°00'
10°30'
10°00'
Legend
Hippopotamus
Elephant
Buffalo
large herbivores
Small herbivores
Monkeys
Composition: Philippe Bouché
CITES-MIKE/ECOPAS/PAUCOF
Copyright 2003
0
50
100
150
200
Kilometers
Mike
PARC REGIONAL
ECOPAS
PAUCOF

Table 2 summarizes the results obtained during this census for all species observed.

Table 2. Summary of the Observations, Number of Individuals, Density and Number of Individuals Observed per km covered.

Species	No of Obs	No of Ind	Density n/km²	No/km
Elephant	505	4592	0.1470	0.1007
Buffalo	417	10560	0.3381	0.2317
Roan	984	7582	0.2428	0.1663
Hippopotamus	50	693	0.0222	0.0152
Western hartebeest	249	2033	0.0651	0.0446
Western Topi	21	132	0.0042	0.0029
Defassa waterbuck	57	346	0.0111	0.0076
Buffon's Kob	402	1040	0.0333	0.0228
Bohor reedbuck	101	125	0.0040	0.0027
Red-fronted gazelle	3	8	0.0003	0.0002
Bushbuck	195	254	0.0081	0.0056
Oribi	470	669	0.0214	0.0147
Grimm's duiker	708	812	0.0260	0.0178
Warthog	370	1133	0.0363	0.0249
Anubis baboon	167	834	0.0267	0.0183
Patas monkey	58	158	0.0051	0.0035
Tantalus monkey	4	4	0.0001	0.0001
Lion	4	9	0.0003	0.0002
Cheetah	1	1	0.0000	0.0000
Side-strped jackal	28	29	0.0009	0.0006
Hyena	1	1	0.0000	0.0000
Honey badger	1	1	0.0000	0.0000
Porcupine	2	2	0.0001	0.0000
			-	-
Fresh Elephant Carcass	0	0	-	-
Recent Elephant Carcass	0	0	-	-
Old Elephant Carcasse	6	6	0.0002	0.0001
Very Old Elephant Carcass	3	3	0.0001	0.0001
Buffalo Carcass	1	1	0.0000	0.0000
			-	-
Cattle	1171	101329	3.2445	2.2231
"Shoats"*	306	11444	0.3664	0.2511

* « Shoats » : Sheep and goats

Area : 31231,17 km²
Distance covered : 45.479,08 km

In the subsequent text, the following abbreviations are used:

- NP: National Parks
- CF: Classified Forest
- HZ: Hunting Zone
- GR: Game Ranch
- TFR: Total Faunal Reserve

4.4.1. Elephant (*Loxodonta africana*)

Status

Knowing the status of this species constituted the basic reason for this sub-regional initiative. The results of the aerial total count are presented in Table 3.

Table 3. Number of Observations, Individuals and Density of Elephant per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	5	54	0.01	1.18
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	2	36	0.03	0.78
Benin	Pendjari Hunting Zone	25	75	0.04	1.63
Benin	Konkombri Hunting Zone	4	79	0.30	1.72
Benin	Mékrou Hunting Zone	15	264	0.24	5.75
Benin	Pendjari National Park	92	713	0.25	15.53
Benin	Outside ecosystem boundaries	1	2		0.04
Burkina Faso	W National Park	54	740	0.31	16.11
Burkina Faso	Tapoa-Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	45	422	0.34	9.19
Burkina Faso	Kourtiagou Hunting Zone	0	0	-	-
Burkina Faso	Koakrana Hunting Zone	0	0	-	-
Burkina Faso	Pagou-Tandougou Hunting Zone	8	169	0.42	3.68
Burkina Faso	Ougarou Hunting Zone	17	218	0.33	4.75
Burkina Faso	Pama South Hunting Zone	20	181	0.30	3.94
Burkina Faso	Pama Central South Hunting Zone	30	170	0.32	3.70
Burkina Faso	Pama Central North Hunting Zone	35	337	0.40	7.34
Burkina Faso	Pama North Hunting Zone	19	95	0.12	2.07
Burkina Faso	Singou Game Ranch	97	660	0.36	14.37
Burkina Faso	Konkombouri Hunting Zone	24	282	0.43	6.14
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	7		0.15
Niger	W National Park	10	85	0.04	1.85
Niger	Tamou Total Faunal Reserve	1	3	0.00	0.07
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		505	4592	0.15	100.00

Elephants were observed 505 times, totaling 4,592 individuals. As well 15 more groups totaling 122 individuals may have been double-counted ; however, this is not absolutely certain. Nevertheless, it is possible that several other herds were missed.

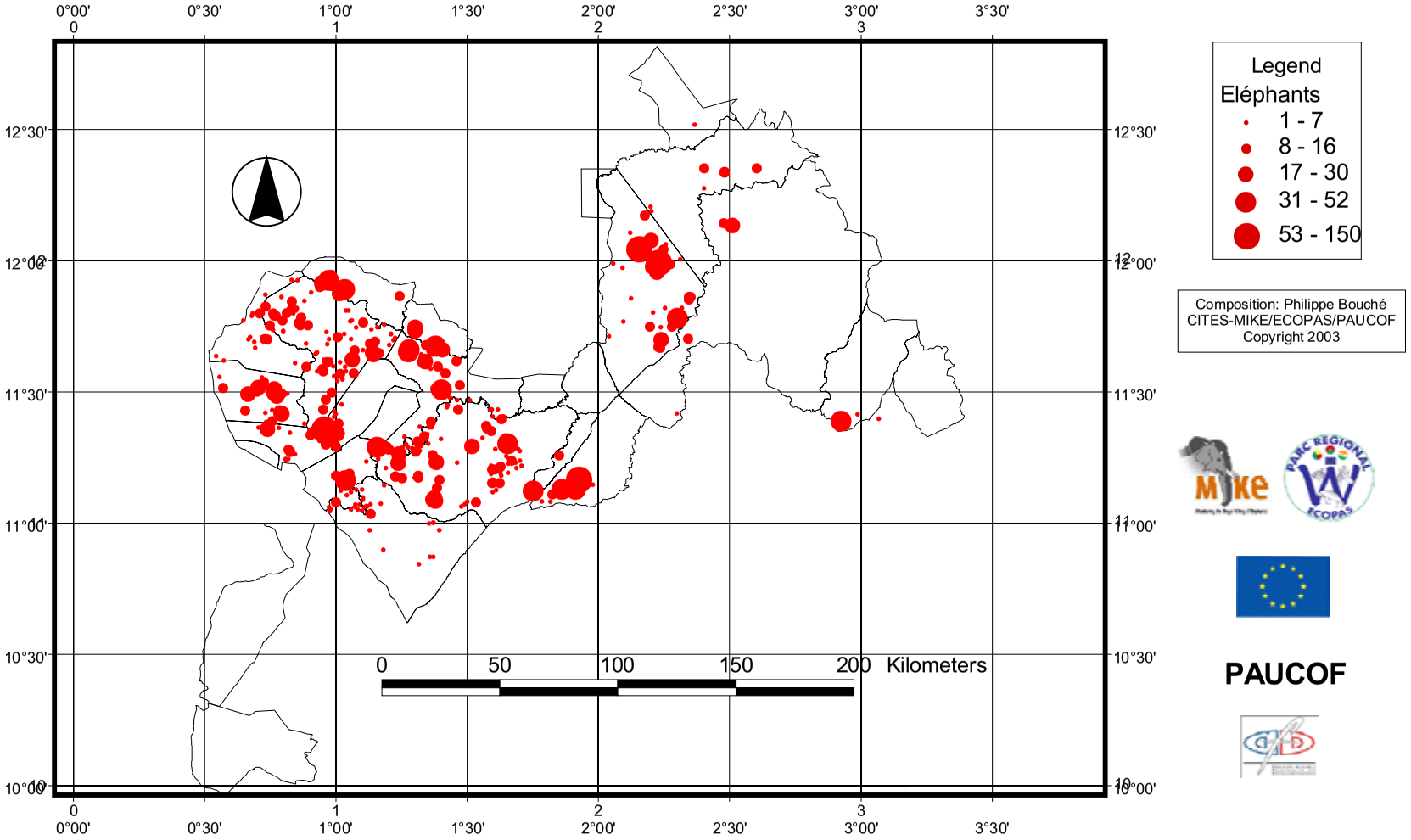
If the results are presented according to the criteria of the African Elephant Database :

Definite	Probable	Possible	Speculative
4,592	0	0	250

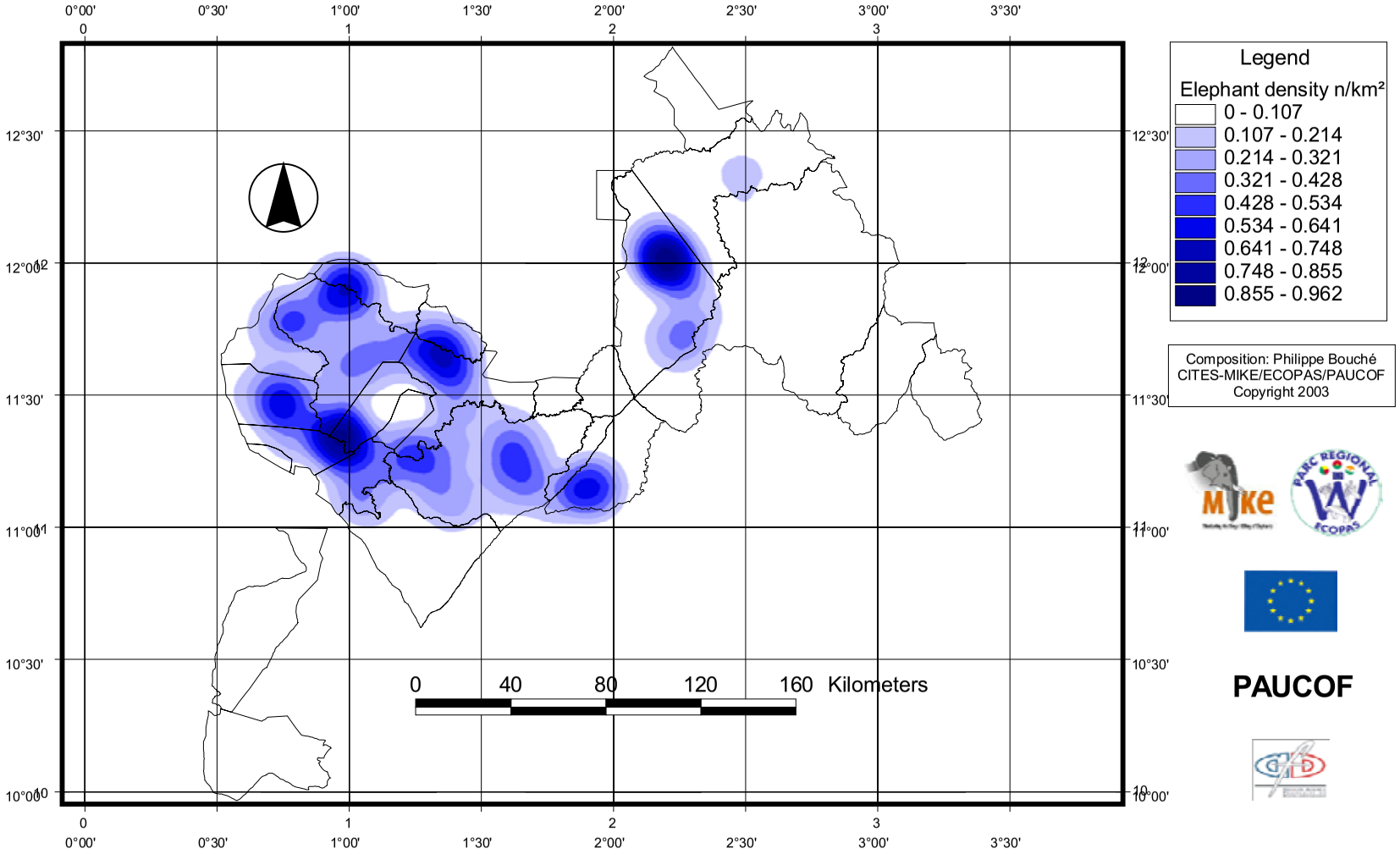
The number of “possible” comes from the fact that we assume that 5% of the “definite” population may have been missed by the observers.

An average of 9.11 ± 11.66 (SE) individuals per observation was calculated. The group size varied from 1 to 150 individuals.

Map 5. Distribution of Elephant in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Map 6. Distribution of Elephant Densities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



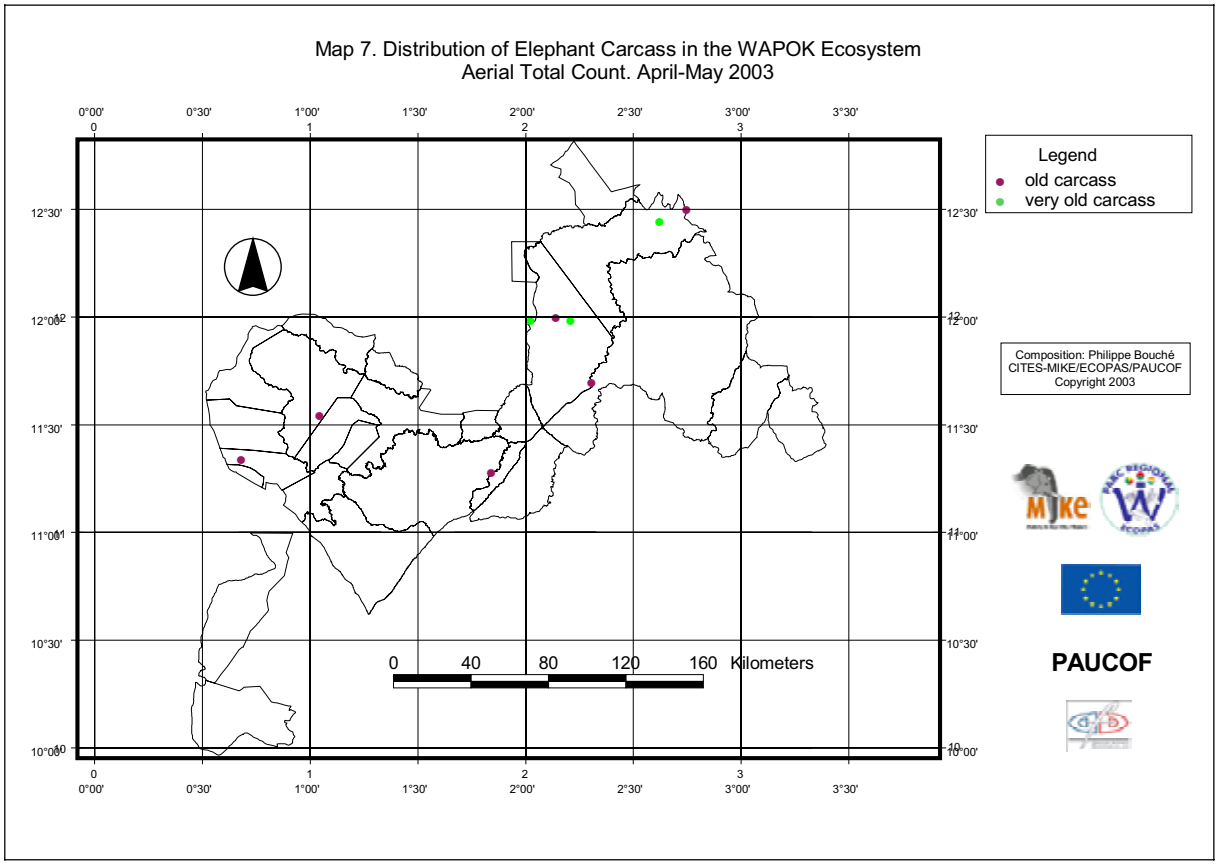
Elephant groups were fairly well distributed throughout the ecosystem except in the Oti-Mandori CF, the Keran NP, the W Benin and the Goungoun CF (Map 5).

The largest concentrations were observed in the 4 Pama HZ, the Singou GR, the Pendjari NP and the Arli NP; along the Mékrou, Tanouarbou and Doubodo rivers, as well as in the W NP Burkina Faso (Map 6).

Elephant carcasses were also counted : their distribution of carcasses observed was as follows :

Table 4. Number of Observed Elephant Carcasses per Protected Area.

Country	Protected Area	Carcass	
		old	very old
Benin	Pendjari National Park	1	0
Burkina Faso	W National Park	2	2
Burkina Faso	Pama Central South Hunting Zone	1	0
Burkina Faso	Singou Game Ranch	1	0
Niger	W National Park	1	1
Total		6	3



No fresh or recent carcasses were observed.

Population structure

Due to the partial recording of group composition, it was possible to accumulate some data on the elephant population structure.

From a sample of 249 elephant herds totaling 2,092 individuals for which the group composition was noted, it was possible to draw the following diagram (Figure 3). This diagram gives a brief idea of the elephant population structure of the ecosystem. It

would be difficult to draw further conclusions since without photographs of all the herds it is difficult to determine precise age classes.

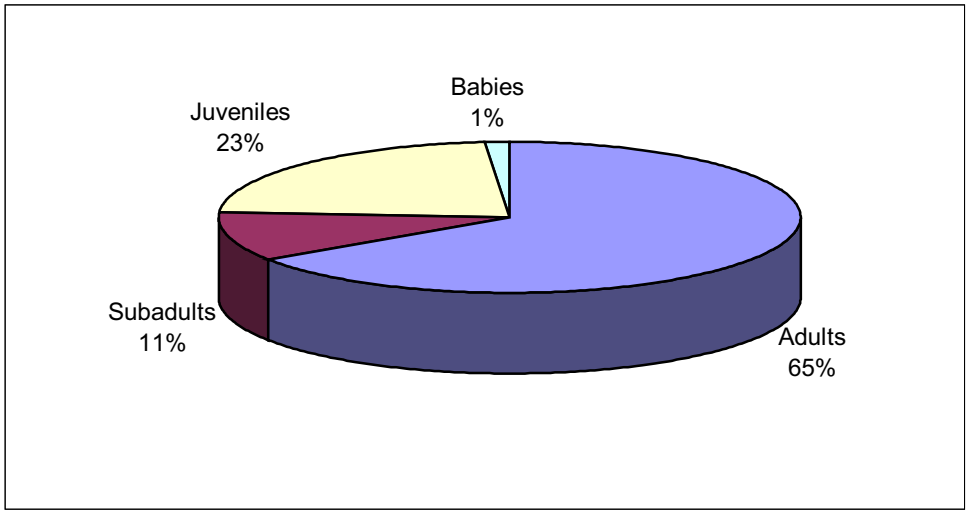


Figure3. Elephant Population Structure in the WAPOK Ecosystem (n=2092)

Picture 6. Elephant Herd in the Singou Valley

4.4.2. Buffalo (*Syncerus caffer brachyceros*)

The results for buffalo of the aerial total count are presented in Table 5.

Table 5. Number of Observations, Individuals and Density of Buffalo per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	21	424	0.072	4.02
Benin	Goungoun Classified Forest	1	1	0.001	0.01
Benin	Djona Hunting Zone	2	45	0.037	0.43
Benin	Pendjari Hunting Zone	11	225	0.121	2.13
Benin	Konkombri Hunting Zone	4	189	0.711	1.79
Benin	Mékrou Hunting Zone	15	255	0.234	2.41
Benin	Pendjari National Park	124	3421	1.210	32.40
Burkina Faso	W National Park	72	1400	0.581	13.26
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	13	399	0.326	3.78
Burkina Faso	Kourtiagou Hunting Zone	5	21	0.043	0.20
Burkina Faso	Koakrana Hunting Zone	3	9	0.034	0.09
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	0	0	-	-
Burkina Faso	Pama South Hunting Zone	17	423	0.704	4.01
Burkina Faso	Pama Central South Hunting Zone	15	333	0.634	3.15
Burkina Faso	Pama Central North Hunting Zone	23	1118	1.332	10.59
Burkina Faso	Pama North Hunting Zone	0	0	-	-
Burkina Faso	Singou Game Ranch	30	1034	0.570	9.79
Burkina Faso	Konkombouri Hunting Zone	4	20	0.030	0.19
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	2	73		0.69
Niger	W National Park	52	1153	0.503	10.92
Niger	Tamou Total Faunal Reserve	1	17	0.022	0.16
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		415	10560	0.338	100.00

Buffalo were observed 415 times, totaling 10,560 individuals. However, 9 more groups totaling 335 individuals may have been double-counted, although this is not a certainty. In brief, the number observed varies between a minimum of 10,560 individuals and a maximum of 10,895 individuals.

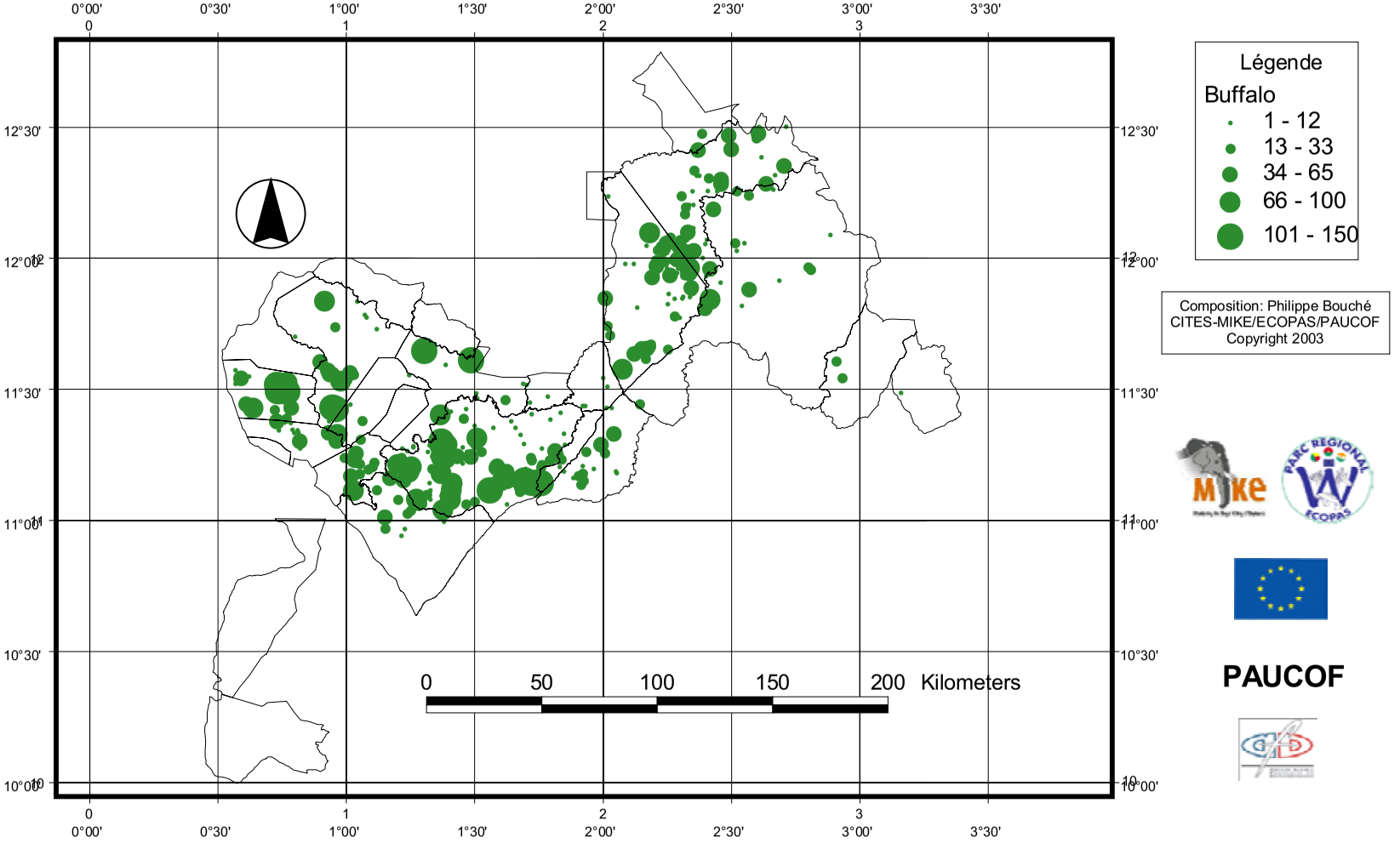
An average of 25.45 ± 30.67 (SE) individuals was calculated. The group size varied between 1 and 150 individuals.

Buffalo groups were well distributed throughout the whole ecosystem except in the Oti-Mandori CF, in the Kéran NP and the Goungoun CF.

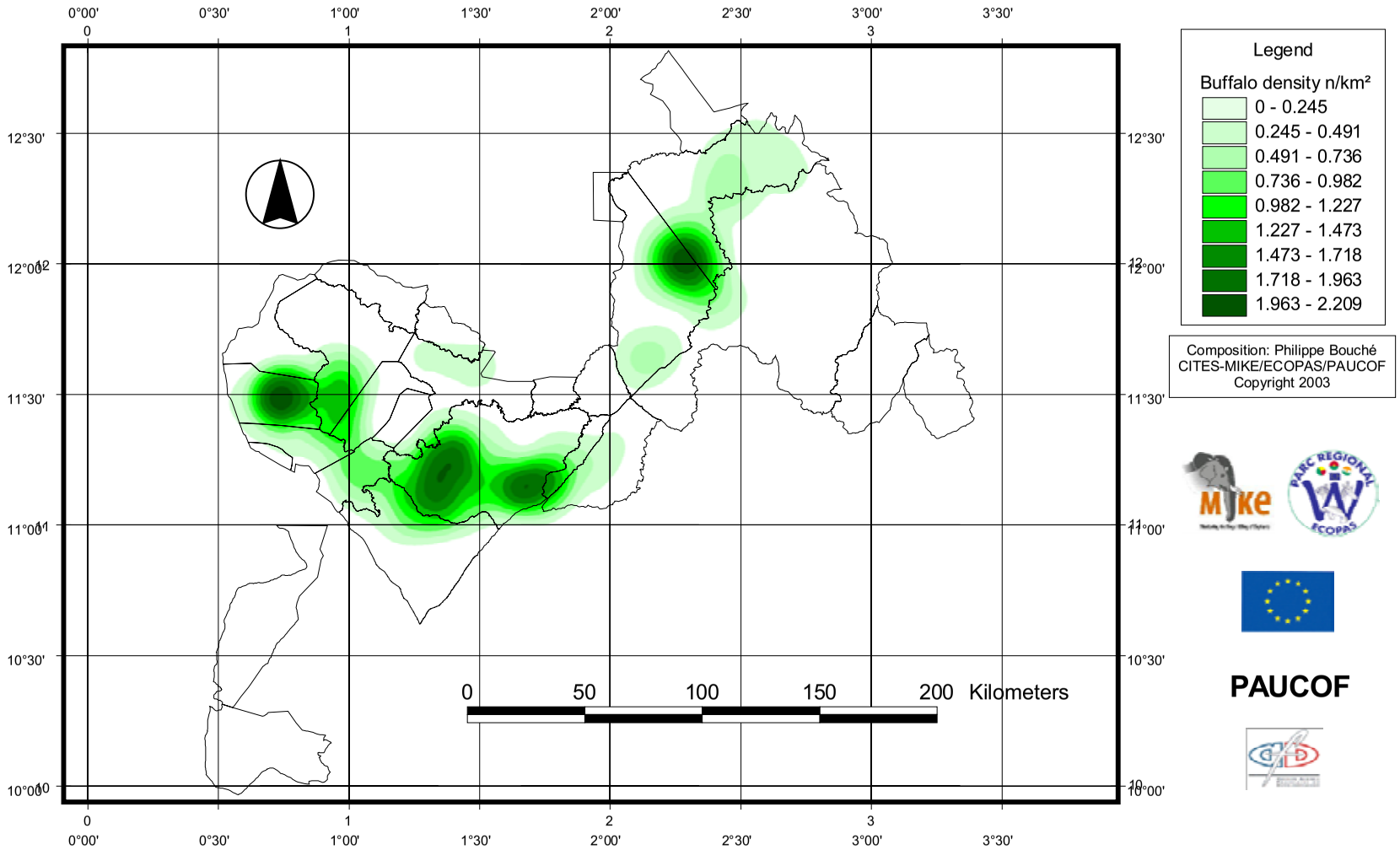
The largest concentrations were observed in the Pendjari NP along the Mékrou River, the hunting blocks of Pama and the Singou GR along the Singou River, and in the Burkina and Niger parts of “W” NP (Map 9).

Although the counting method is well adapted to the count of gregarious animals such as buffalo, the authors believe that they may have been under-estimated : individuals resting or taking refuge in the deep shade of gallery forests may have missed. The figures presented constitute therefore a minimum for the species.

Map 8. Distribution of Buffalo in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Map 9. Distribution of Buffalo Densities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.3. Hippopotamus (*Hippopotamus amphibius*)

The results recorded for this species can be summarized as follows :

Table 6. Number of Observations and Individual Hippopotamuses

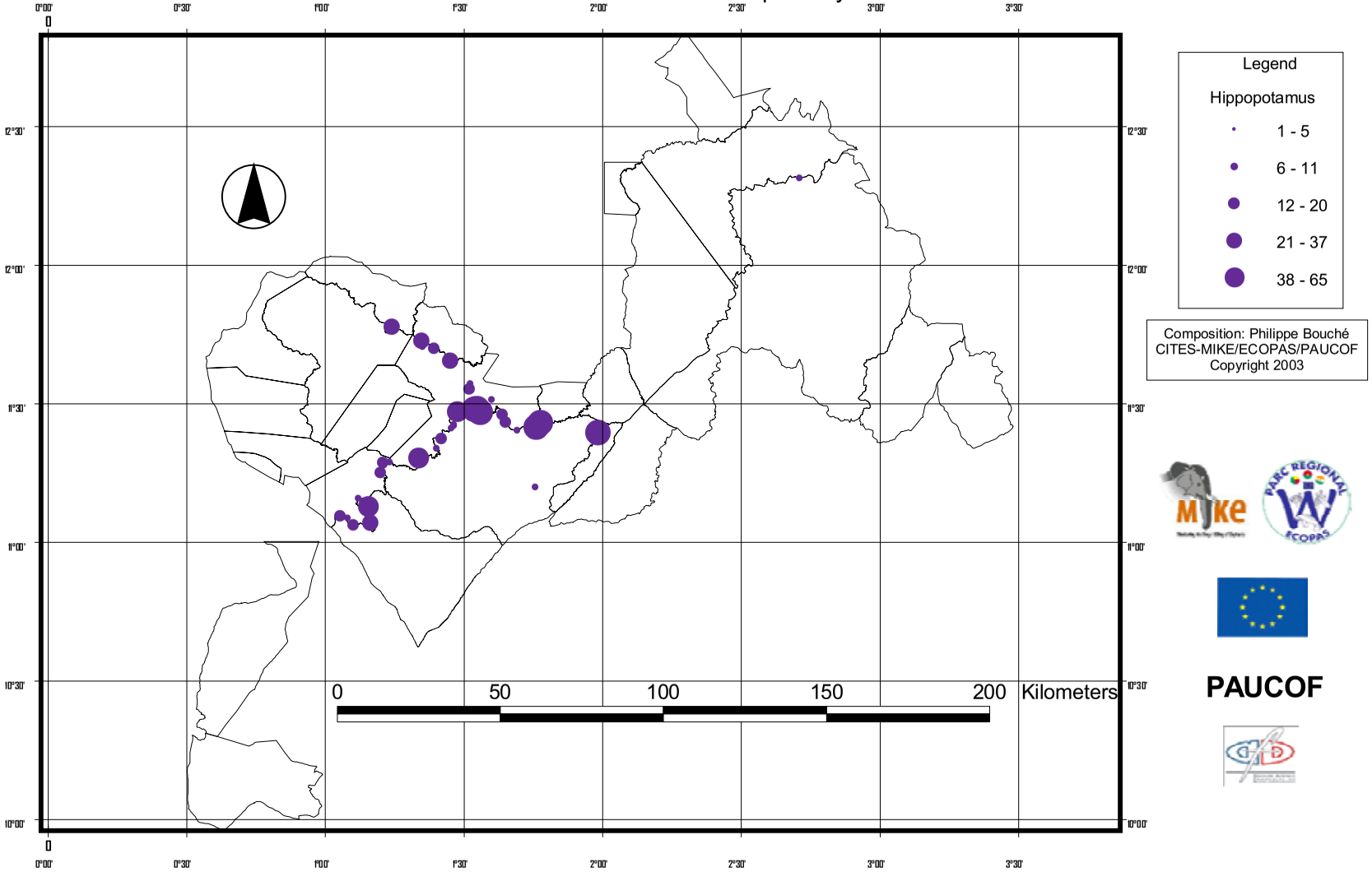
Rivers	No of Obs	No of Ind
Pendjari	41	617
Tanouarbou	1	17
Doubodo	4	42
Mékrou	1	3
Outside rivers in National Parks		
Pendjari NP	1	4
Arli NP	3	13
Total	51	696

Burkina Faso and Benin share certainly one of the largest hippopotamus populations in West Africa, mainly located along the Pendjari River.

This estimate certainly remains a minimum for the ecosystem. Curiously, no sighting of hippo was made in the Niger River, where its presence is confirmed, even though it can be assumed that all tributaries were dry at the time. A single observation of hippo was made in the Mékrou river.

An average of 13.86 ± 16.73 (SE) individuals was noted. The group size varied between 1 and 65 individuals.

Map 10. Distribution of the Hippopotamus in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.4. Roan Antelope (*Hippotragus equinus koba*)

The results of the aerial total count are presented in Table 7.

Table 7. Number of Observations, Individuals and Density of Roan Antelope per Protected Area

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	113	723	0.12	9.54
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	37	284	0.23	3.75
Benin	Pendjari Hunting Zone	39	323	0.17	4.26
Benin	Konkombri Hunting Zone	5	45	0.17	0.59
Benin	Mékrou Hunting Zone	30	255	0.23	3.36
Benin	Pendjari National Park	104	975	0.34	12.86
Benin	Outside ecosystem boundaries	1	3		0.04
Burkina Faso	W National Park	88	677	0.28	8.93
Burkina Faso	Tapoa Djerma Hunting Zone	5	32	0.16	0.42
Burkina Faso	Arli National Park	44	421	0.34	5.55
Burkina Faso	Kourtiagou Hunting Zone	14	129	0.27	1.70
Burkina Faso	Koakrana Hunting Zone	6	50	0.19	0.66
Burkina Faso	Pagou-Tandougou Hunting Zone	11	153	0.38	2.02
Burkina Faso	Ougarou Hunting Zone	31	168	0.26	2.22
Burkina Faso	Pama South Hunting Zone	30	302	0.50	3.98
Burkina Faso	Pama Central South Hunting Zone	25	255	0.49	3.36
Burkina Faso	Pama Central North Hunting Zone	73	597	0.71	7.87
Burkina Faso	Pama North Hunting Zone	68	479	0.58	6.32
Burkina Faso	Singou Game Ranch	170	1272	0.70	16.78
Burkina Faso	Konkombouri Hunting Zone	32	177	0.27	2.33
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	1		0.01
Niger	W National Park	52	240	0.10	3.17
Niger	Tamou Total Faunal Reserve	3	18	0.02	0.24
Niger	Outside ecosystem boundaries	1	1		0.01
Togo	Oti-Mandori Faunal Reserve	1	2	0.00	0.03
Togo	Keran National Park	0	0	-	-
Total		984	7582	0.24	100.00

Roan were observed at least 984 times totaling 7,582 individuals. However, 8 more groups totaling 101 individuals may have been double-counted, although this is not certain. In brief, the number observed varied between a minimum of 7,582 individuals and a maximum of 7,683 individuals.

An average of 7.71 ± 8.03 (SE) individuals was calculated. The group size varied between 1 and 47 individuals.

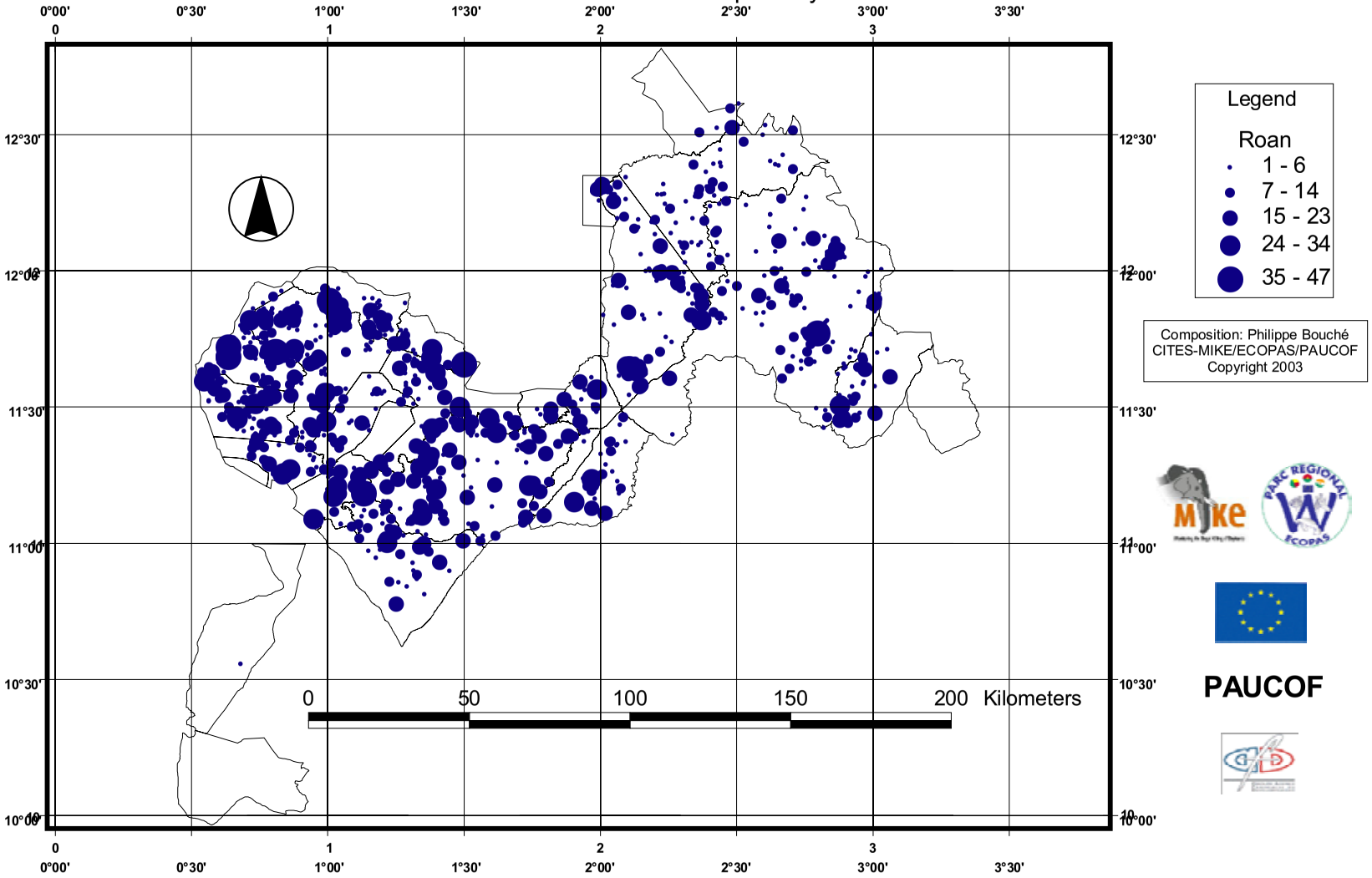
The observations were well distributed throughout the ecosystem with the exception of the Kéran NP and the Goungoun CF (Map 11). An individual has been recorded in the Oti-Mandori CF.

The largest concentrations were seen in the 4 Pama HZ, of the Singou GR and in the Pendjari NP and HZ, and to a lesser extent, in the W NP (Map 12).

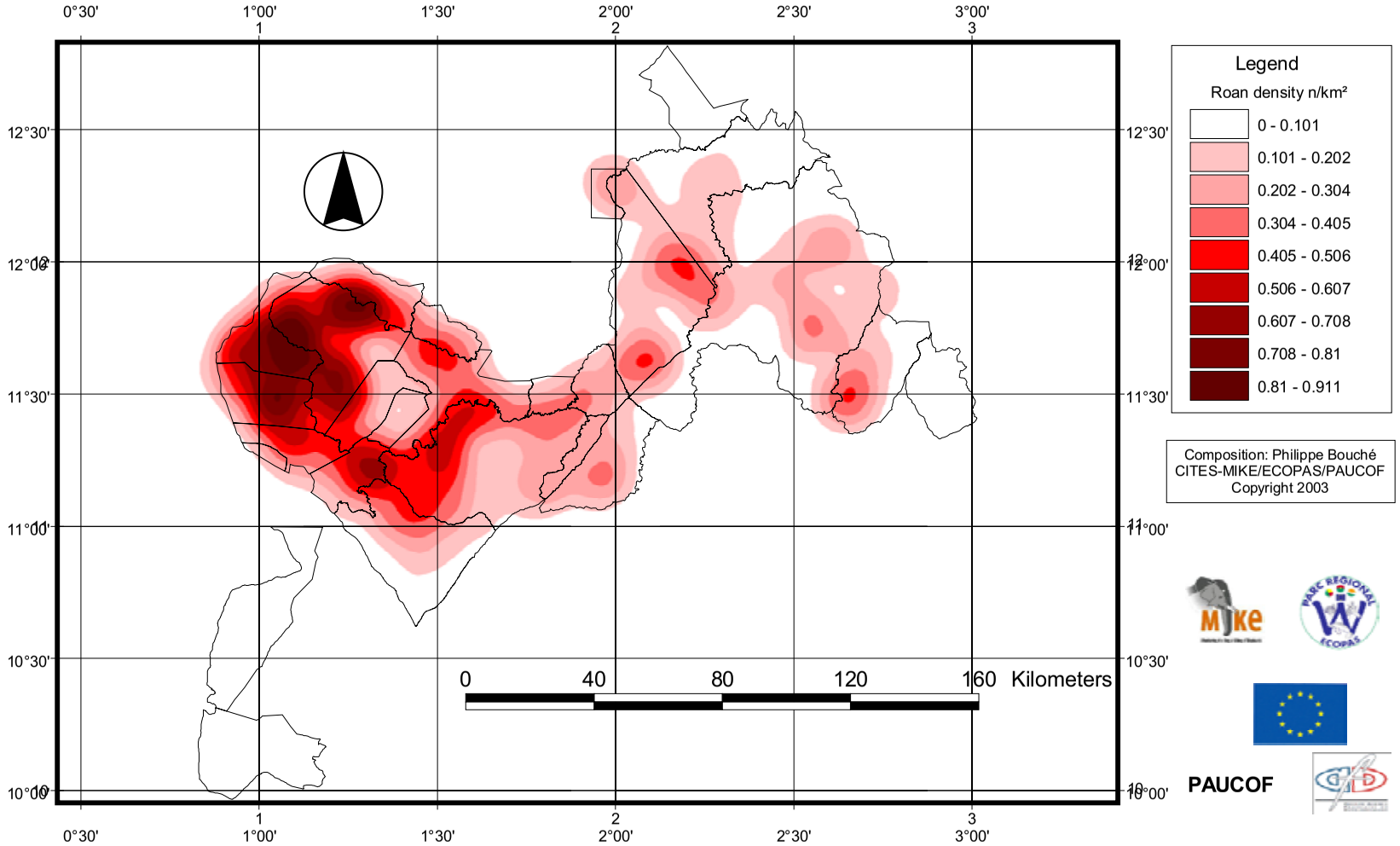
The authors believe that this species was certainly under-counted. As a matter of fact, it is difficult to spot standing animals beyond 300 m, and yet the observation strip used was 500 m on each side of the flight line (the maximum strip width between the aircraft and the furthest sighting was around 350 m). Besides individuals could have escaped to the observers' attention in the strip of 300 m on both sides of the flight line. It is thus certain that the roan population is higher than suggested by

the recorded figures. Given that 600 m (300 m x 2) represents only 60% of the observation strip of 1,000 m, it is highly probable that the roan count represents in the best hypothesis 60% of the reality.

Map 11. Distribution of Roan Antelope in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Map 12. Distribution of Roan densities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.5. Western Hartebeest (*Alcelaphus buselaphus major*)

The results of the aerial total count are presented in Table 8.

Table 8. Number of Observations, Individuals and Density of Western Hartebeest per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	15	93	0.016	4.57
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	6	71	0.058	3.49
Benin	Pendjari Hunting Zone	24	176	0.094	8.66
Benin	Konkombri Hunting Zone	5	26	0.098	1.28
Benin	Mékrou Hunting Zone	11	104	0.095	5.12
Benin	Pendjari National Park	45	339	0.120	16.67
Burkina Faso	W National Park	11	70	0.029	3.44
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	18	187	0.153	9.20
Burkina Faso	Kourtiagou Hunting Zone	3	24	0.049	1.18
Burkina Faso	Koakrana Hunting Zone	5	69	0.260	3.39
Burkina Faso	Pagou-Tandougou Hunting Zone	3	23	0.057	1.13
Burkina Faso	Ougarou Hunting Zone	5	31	0.047	1.52
Burkina Faso	Pama South Hunting Zone	8	83	0.138	4.08
Burkina Faso	Pama Central South Hunting Zone	5	69	0.131	3.39
Burkina Faso	Pama Central North Hunting Zone	11	81	0.097	3.98
Burkina Faso	Pama North Hunting Zone	17	127	0.154	6.25
Burkina Faso	Singou Game Ranch	32	278	0.153	13.67
Burkina Faso	Konkombouri Hunting Zone	12	74	0.112	3.64
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	50		2.46
Niger	W National Park	11	54	0.024	2.66
Niger	Tamou Total Faunal Reserve	1	4	0.005	0.20
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		249	2033	0.065	100.00

Western hartebeest were observed 249 times totaling 2,033 individuals. However, 10 more groups totaling 62 individuals may have been double-counted.

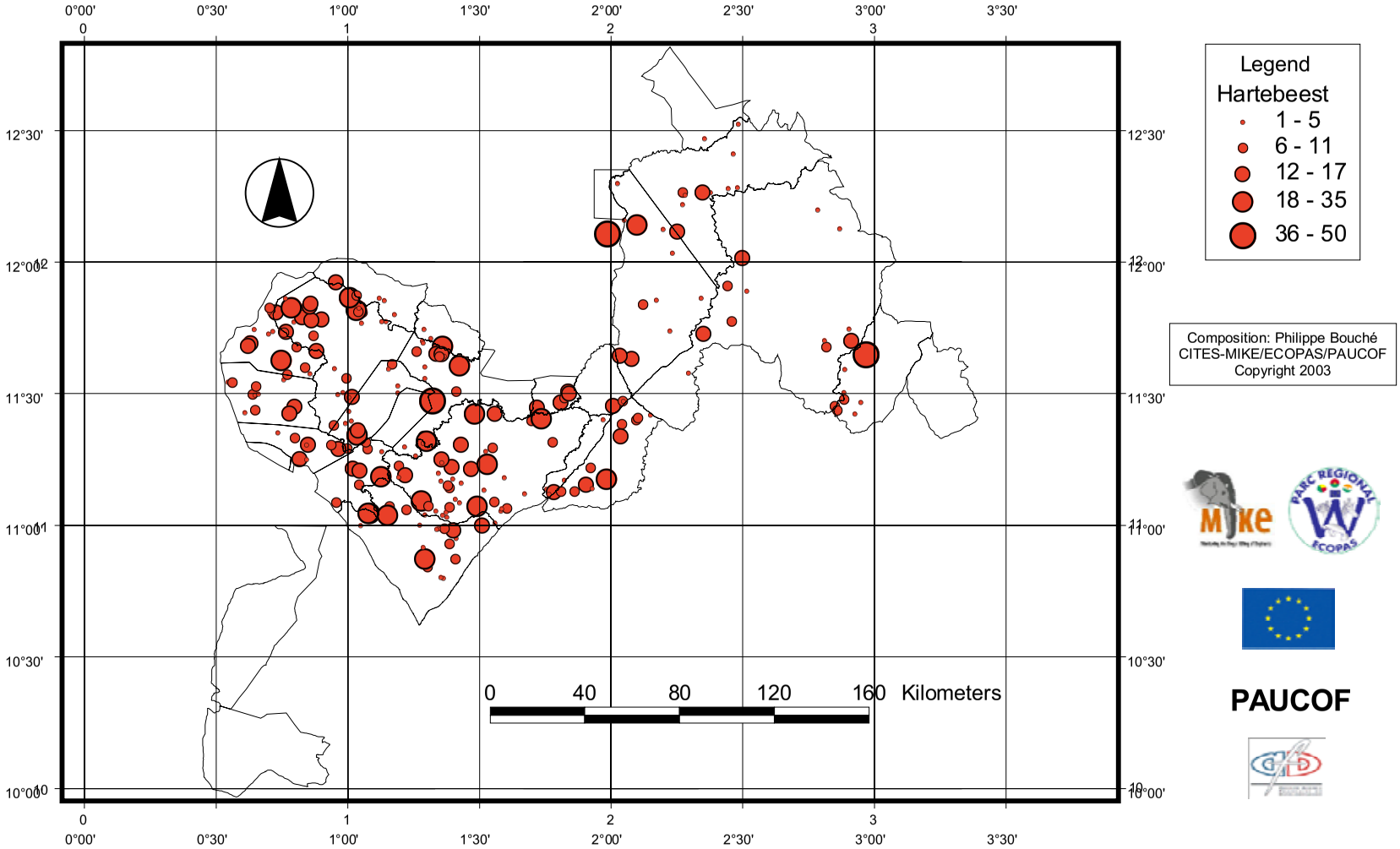
An average of 8.08 ± 8.18 (SE) individuals was calculated. The group size varied between 1 and 50 individuals.

Hartebeest were observed in the whole ecosystem except in the the Oti-Mandouri CF, the Kéran NP and the Goungoun CF (Map 14).

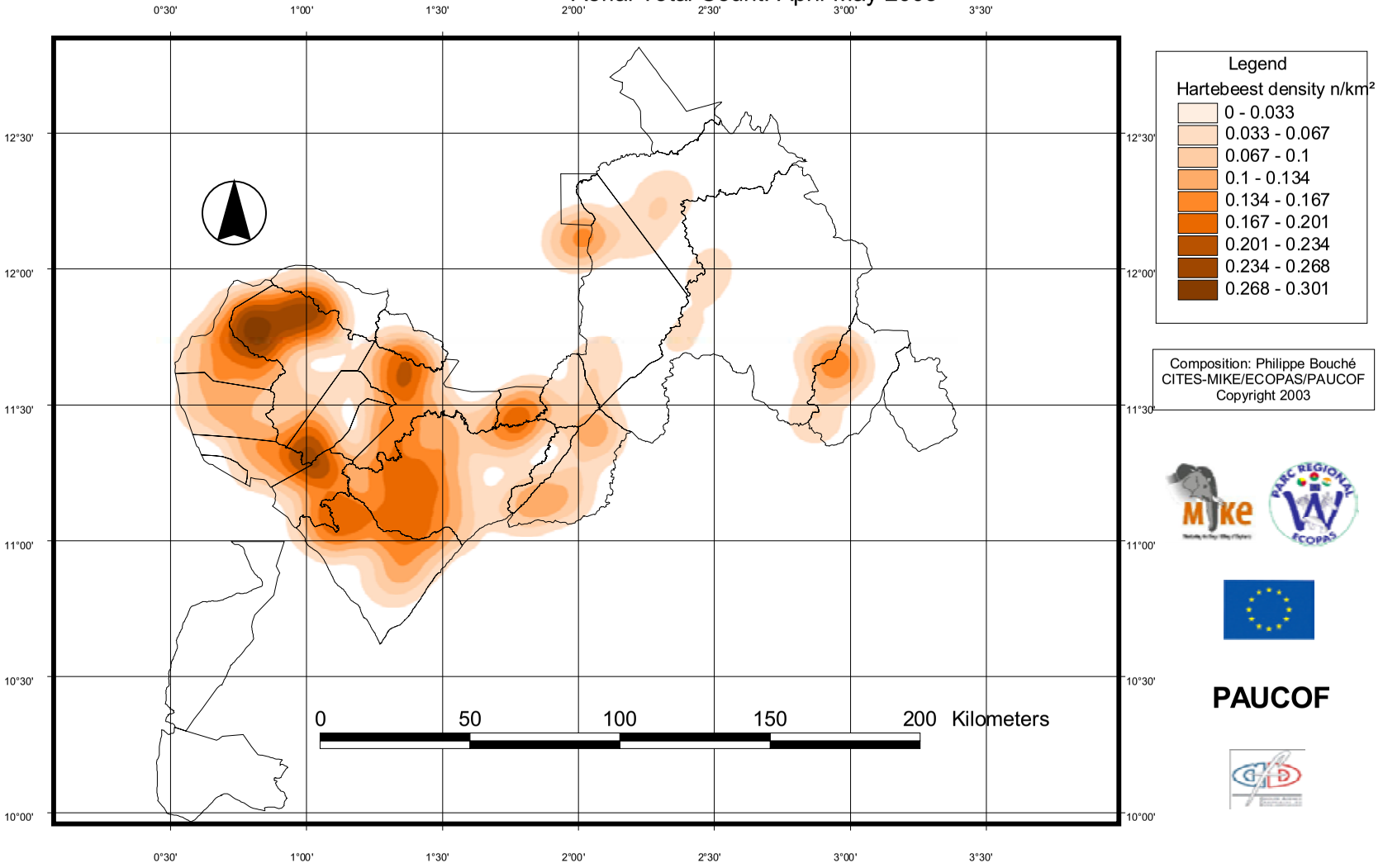
The largest concentrations were observed in the 4 Pama HZ, Singou GR, Arli NP, Pendjari HZ and NP; and to a lesser extent, in the W NP (Map 15).

The authors think that the species was certainly under-counted. It is difficult to spot standing animals beyond 300 m, while the observation strip extended 500 m on both sides of the flight line. As well, some individuals may have escaped from the observers' attention in the 300 m strip on both sides of the flight line. It is very likely, therefore, that the hartebeest population is considerably higher than suggested by this count.

Map 13. Distribution of Hartebeest in the WAPOK Ecosystem
Aerial total count. April-May 2003



Map 14. Distribution of Hartebeest Densities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.6. Defassa Waterbuck (*Kobus ellipsiprymnus defassa*)

The results of the aerial total count are presented in Table 9.

Table 9. Number of Observations, Individuals and Density of Defassa Waterbuck per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	2	3	0.001	0.87
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	0	0	-	-
Benin	Pendjari Hunting Zone	4	29	0.016	8.38
Benin	Konkombri Hunting Zone			-	-
Benin	Mékrou Hunting Zone	1	13	0.012	3.76
Benin	Pendjari National Park	6	38	0.013	10.98
Burkina Faso	W National Park	1	7	0.003	2.02
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	3	5	0.004	1.45
Burkina Faso	Kourtiagou Hunting Zone	0	0	-	-
Burkina Faso	Koakrana Hunting Zone	1	2	0.008	0.58
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	3	15	0.023	4.34
Burkina Faso	Pama South Hunting Zone	2	4	0.007	1.16
Burkina Faso	Pama Central South Hunting Zone	3	9	0.017	2.60
Burkina Faso	Pama Central North Hunting Zone	4	23	0.027	6.65
Burkina Faso	Pama North Hunting Zone	9	89	0.108	25.72
Burkina Faso	Singou Game Ranch	11	73	0.040	21.10
Burkina Faso	Konkombouri Hunting Zone	1	17	0.026	4.91
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Niger	W National Park	6	19	0.008	5.49
Niger	Tamou Total Faunal Reserve	0	0	-	-
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		57	346	0.011	100.00

This species was spotted 57 times during the survey, totaling 346 individuals. An average of 6.07 ± 5.11 (SE) individuals was calculated. The group size varied between 1 and 20 individuals.

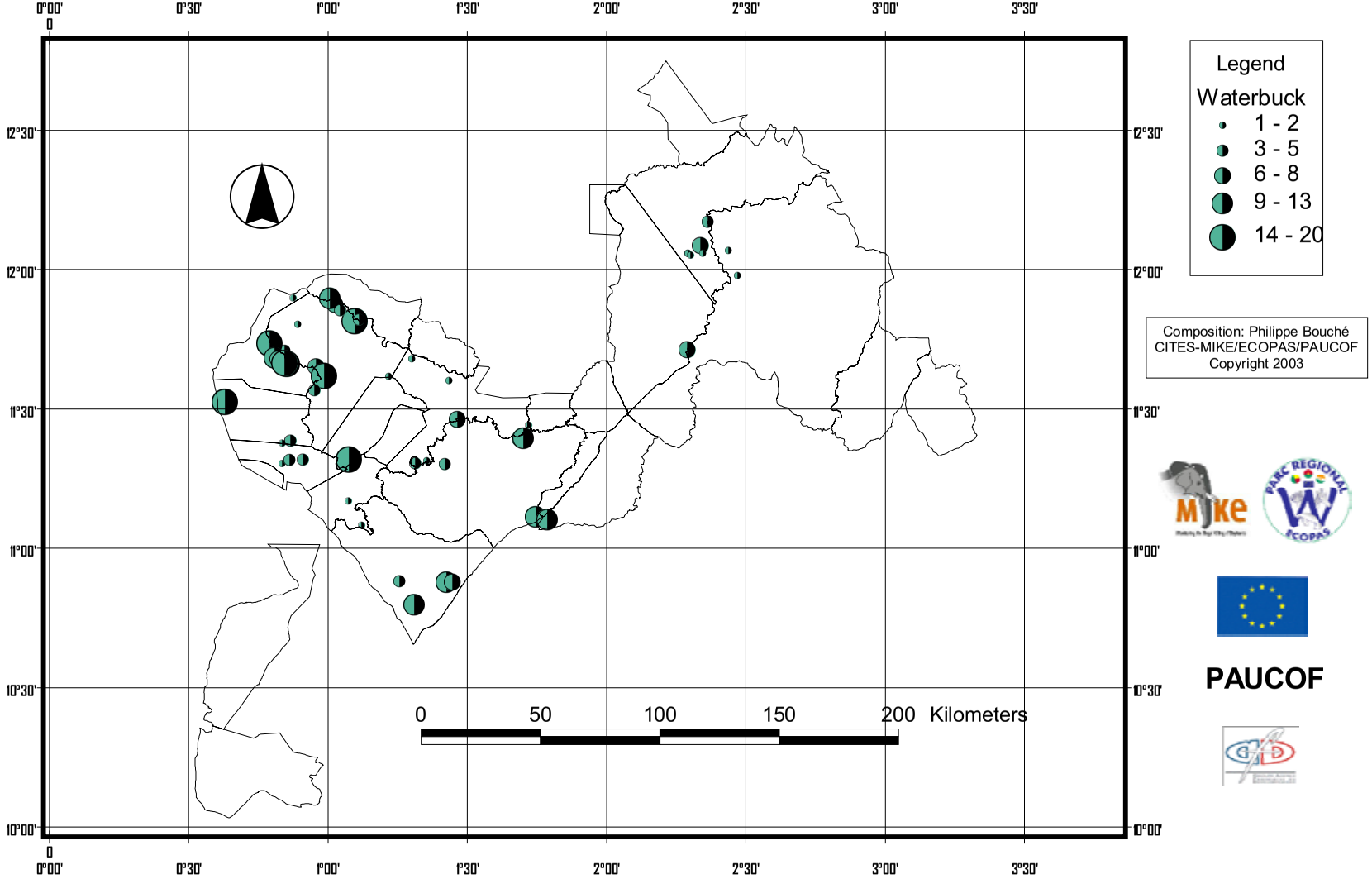
The largest concentrations were observed along the rivers Singou, the Tanouarbou, and to a lesser extent, the Pendjari and the Mékrou (Map 15).

The number of individuals observed is certainly less than the real population. Waterbuck, in spite of its relatively large size, is not easy to observe from the air as its colour and shaggy coat provide an effective camouflage; especially when observed from above it is difficult to distinguish from shadows and grass in the patchwork of shrubs and open ground it inhabits. Its behavior relative to the aircraft is that it remains motionless and flees only after the airplane has already crossed the 90° angle of sight along its trajectory, making it difficult to observe, especially at long distances. Many animals are likely to have been missed during the survey.

On the other hand, the size of the animal makes it possible to spot it from far (observation confirmed at 400 m) and it usually moves in herds which are even easier to spot once they begin to move. Some doubt persists as to the status of the waterbuck population in the ecosystem.

It is necessary to carry out further studies of this species in order to determine which problems it faces in this ecosystem.

Map 15. Distribution of Defassa Waterbuck in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.7. Western Topi (*Damaliscus lunatus korrigum*)

The results of the aerial total count are presented in Table 10.

Table 10. Number of Observations, Individuals and Density of Western Topi per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	0	0	-	-
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	0	0	-	-
Benin	Pendjari Hunting Zone	0	0	-	-
Benin	Konkombri Hunting Zone	2	6	0.02	4.55
Benin	Mékrou Hunting Zone	0	0	-	-
Benin	Pendjari National Park	8	66	0.02	50.00
Burkina Faso	W National Park	2	4	0.002	3.03
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	0	0	-	-
Burkina Faso	Kourtiagou Hunting Zone	2	38	0.08	28.79
Burkina Faso	Koakrana Hunting Zone	3	10	0.04	7.58
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	0	0	-	-
Burkina Faso	Pama South Hunting Zone	1	3	0.00	2.27
Burkina Faso	Pama Central South Hunting Zone	0	0	-	-
Burkina Faso	Pama Central North Hunting Zone	0	0	-	-
Burkina Faso	Pama North Hunting Zone	2	2	0.00	1.52
Burkina Faso	Singou Game Ranch	0	0	-	-
Burkina Faso	Konkombouri Hunting Zone	1	3	0.005	2.27
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Niger	W National Park	0	0	-	-
Niger	Tamou Total Faunal Reserve	0	0	-	-
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		21	132	0.004	100.00

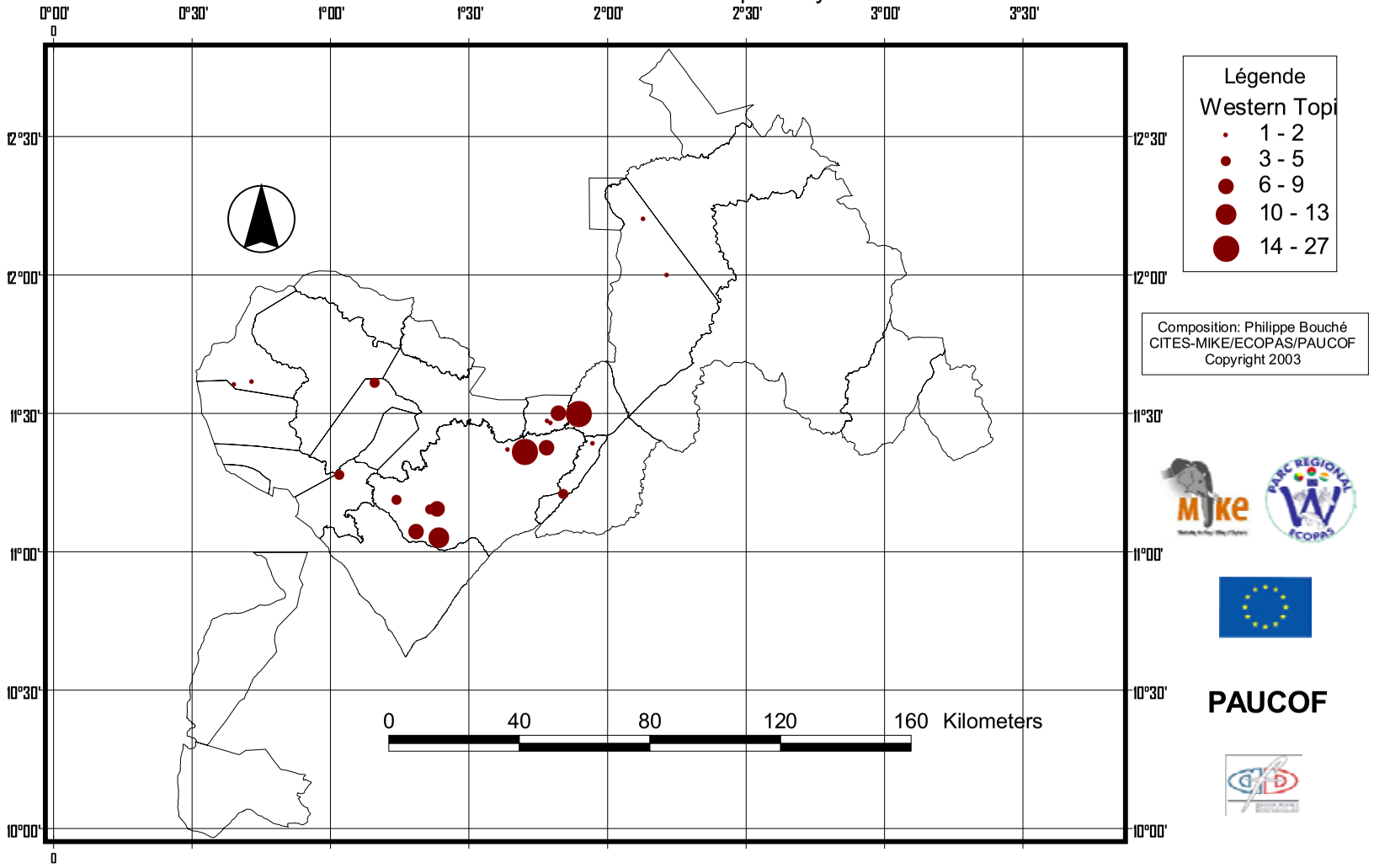
This rare species was seen only 21 times during the survey, totaling 132 individuals. It should be emphasized that this survey confirms the presence of the western topi in the « W » NP.

The largest concentrations were observed in the Pendjari NP and in the Kourtiagou and Koakrana HZ (Map 16).

An average of 6.9 ± 6.75 (SE) individuals per observation was seen. The group size varied between 1 and 27 individuals.

Given that the distance of the furthest observation didn't exceed 300 m from the aircraft, it is certain that entire herds of western topi were not observed during the survey. The combined population figures provided by this census constitute therefore an absolute minimum for this species.

Map 16. Distribution of Western Topi in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.8. Buffon's Kob (*Kobus kob kob*)

The results of the aerial total count are presented in Table 11.

Table 11. Number of Observations, Individuals and Density of Buffon's Kob per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	24	52	0.009	5.00
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	5	6	0.005	0.58
Benin	Pendjari Hunting Zone	20	42	0.023	4.04
Benin	Konkombri Hunting Zone	4	35	0.132	3.37
Benin	Mékrou Hunting Zone	7	17	0.016	1.63
Benin	Pendjari National Park	65	171	0.060	16.44
Benin	Outside ecosystem boundaries	1	2		0.19
Burkina Faso	W National Park	16	34	0.014	3.27
Burkina Faso	Tapoa Djerma Hunting Zone	1	1	0.005	0.10
Burkina Faso	Arli National Park	30	103	0.084	9.90
Burkina Faso	Kourtiagou Hunting Zone	3	19	0.039	1.83
Burkina Faso	Koakrana Hunting Zone	4	27	0.102	2.60
Burkina Faso	Pagou-Tandougou Hunting Zone	7	24	0.059	2.31
Burkina Faso	Ougarou Hunting Zone	13	31	0.047	2.98
Burkina Faso	Pama South Hunting Zone	16	73	0.121	7.02
Burkina Faso	Pama Central South Hunting Zone	8	13	0.025	1.25
Burkina Faso	Pama Central North Hunting Zone	34	55	0.066	5.29
Burkina Faso	Pama North Hunting Zone	44	95	0.115	9.13
Burkina Faso	Singou Game Ranch	55	125	0.069	12.02
Burkina Faso	Konkombouri Hunting Zone	16	26	0.039	2.50
Burkina Faso	Madjoari Enclave	1	1	0.003	0.10
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	13		1.25
Niger	W National Park	19	32	0.014	3.08
Niger	Tamou Total Faunal Reserve	3	31	0.039	2.98
Togo	Oti-Mandori Faunal Reserve	2	4	0.003	0.38
Togo	Keran National Park	3	8	0.006	0.77
Total		402	1040	0.033	100.00

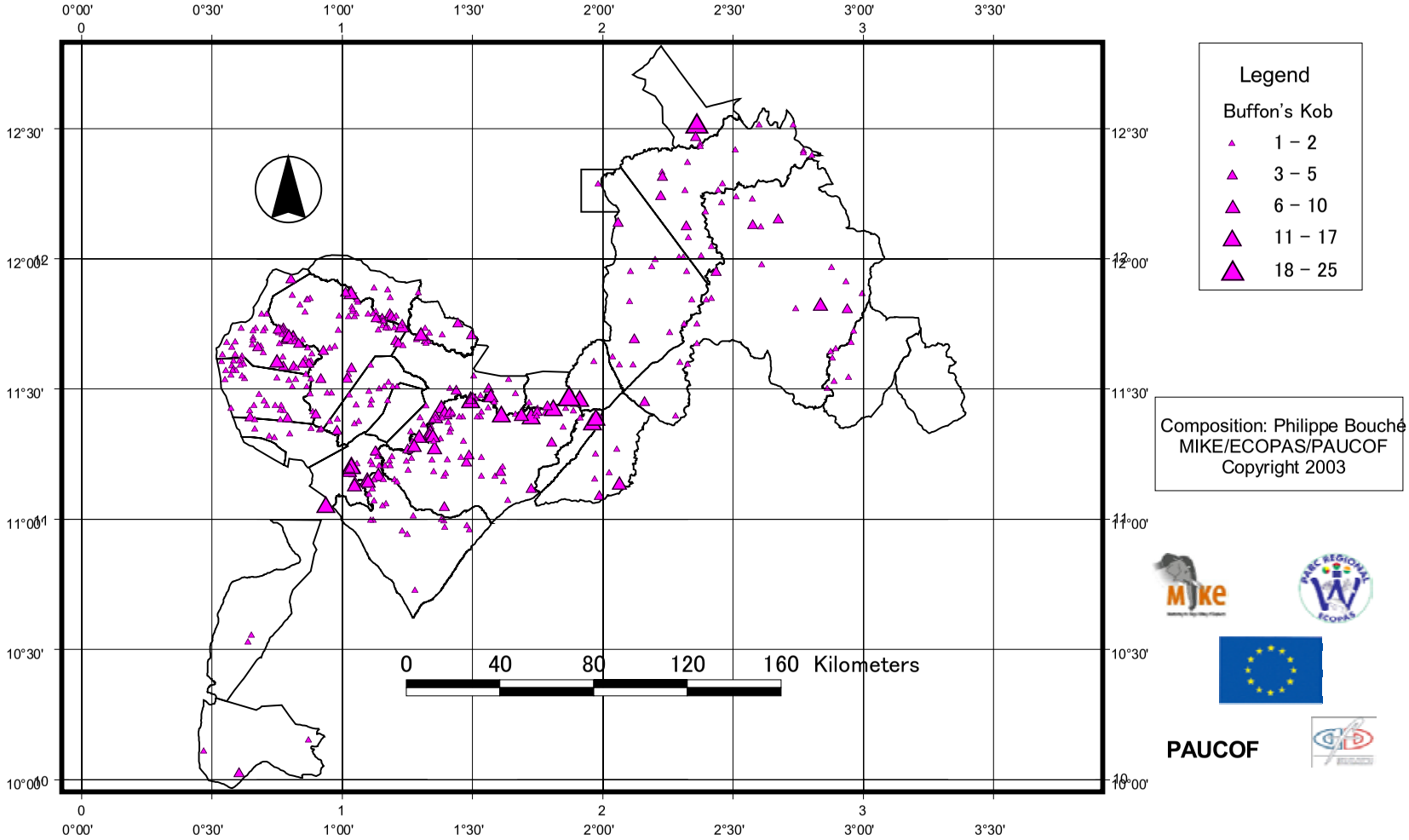
This species was seen 402 times during the survey, totaling 1,040 individuals.

The largest concentrations were observed along the rivers of the Pendjari, Singou, Tanouarbou and Doubodo (Map 17).

An average of 2.57 ± 2.88 (SE) individuals per observation was seen. The group size varied between 1 and 25 individuals.

Given that the distance of the furthest observation didn't exceed 250 m from the aircraft, it is certain that neither all individuals nor all herds of this species were observed during the survey. The combined population figures provided by this census constitute therefore an absolute minimum for this species

Map 17. Distribution of Buffon's Kob in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.9. Bushbuck (*Tragelaphus scriptus scriptus*)

The results of the aerial total count are presented in Table 12.

Table 12. Number of Observations, Individuals and Density of Bushbuck per Protected Area.

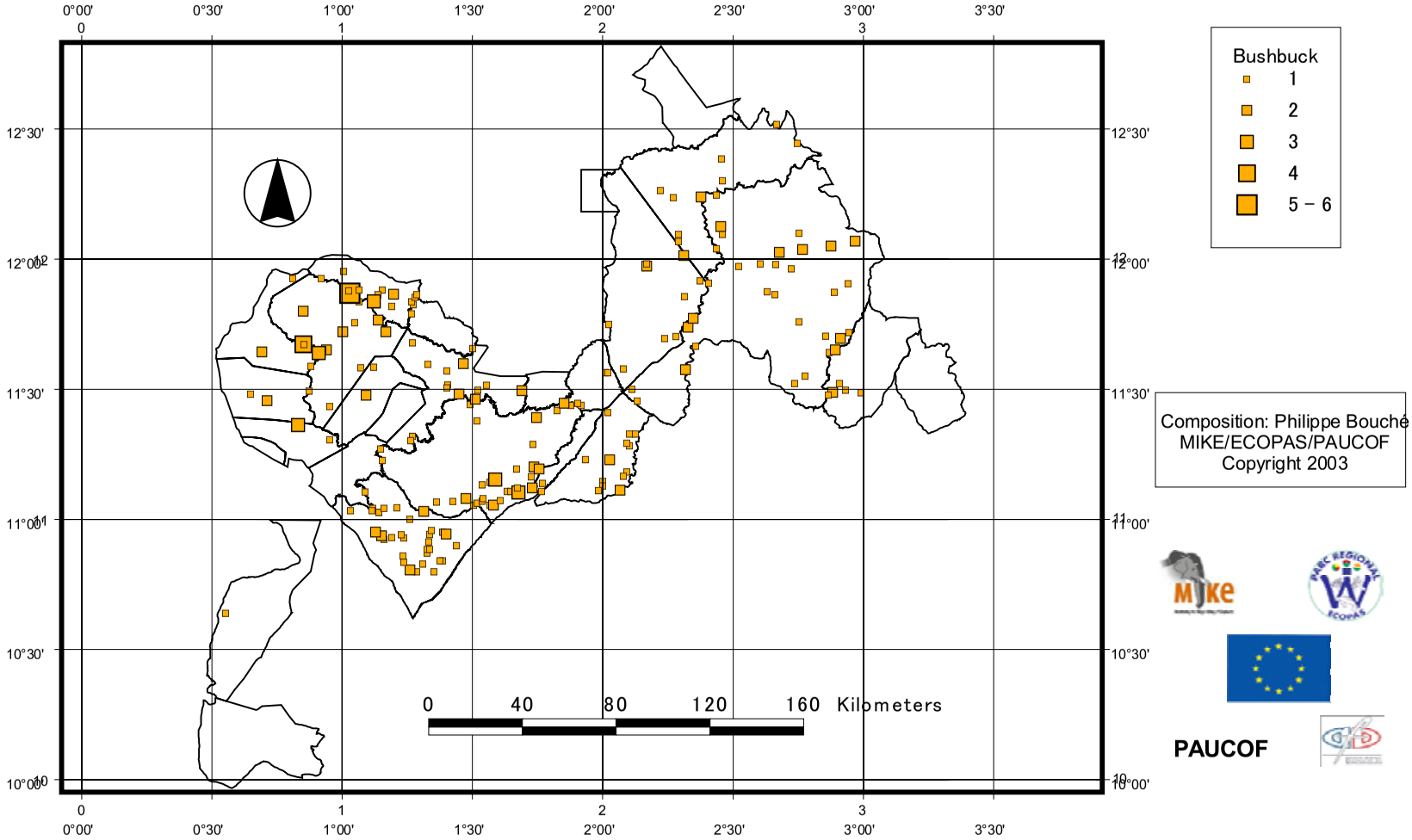
Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	28	36	0.006	14.17
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	5	7	0.006	2.76
Benin	Pendjari Hunting Zone	31	36	0.019	14.17
Benin	Konkombri Hunting Zone	2	2	0.008	0.79
Benin	Mékrou Hunting Zone	13	15	0.014	5.91
Benin	Pendjari National Park	31	42	0.015	16.54
Benin	Outside ecosystem boundaries	2	3		1.18
Burkina Faso	W National Park	9	11	0.005	4.33
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	11	14	0.011	5.51
Burkina Faso	Kourtiagou Hunting Zone	5	6	0.012	2.36
Burkina Faso	Koakrana Hunting Zone	0	0	-	-
Burkina Faso	Pagou-Tandougou Hunting Zone	3	3	0.007	1.18
Burkina Faso	Ougarou Hunting Zone	11	14	0.021	5.51
Burkina Faso	Pama South Hunting Zone	3	3	0.005	1.18
Burkina Faso	Pama Central South Hunting Zone	2	4	0.008	1.57
Burkina Faso	Pama Central North Hunting Zone	3	4	0.005	1.57
Burkina Faso	Pama North Hunting Zone	4	7	0.008	2.76
Burkina Faso	Singou Game Ranch	18	31	0.017	12.20
Burkina Faso	Konkombouri Hunting Zone	2	3	0.005	1.18
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Niger	W National Park	11	12	0.005	4.72
Niger	Tamou Total Faunal Reserve	0	0	-	-
Togo	Oti-Mandori Faunal Reserve	1	1	0.001	0.39
Togo	Keran National Park	0	0	-	-
Total		195	254	0.008	100.00

In all, 195 observations of bushbuck (totaling 254 individuals) were made; which represents an average of 1.3 ± 0.63 (SE) individuals per observation. The group size varied between 1 and 6 individuals.

Bushbuck are distributed throughout the ecosystem but are more prevalent in the Singou GR and in the Pendjari NP and HZ (Map 18).

It is obvious that the aerial count gives a very incomplete picture of the real situation for this species. Given its small size, its cryptic colour and the relatively closed habitat it frequents, it is unlikely that all individuals were counted. As a matter of fact, bushbuck were rarely observed at more than 100 m from the flight line.

Map 18. Distribution of Bushbuck in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.10. Warthog (*Phacochoerus africanus africanus*)

The results of the aerial total count are presented in Table 13.

Table 13. Number of Observations, Individuals and Density of the Warthog per Protected Area.

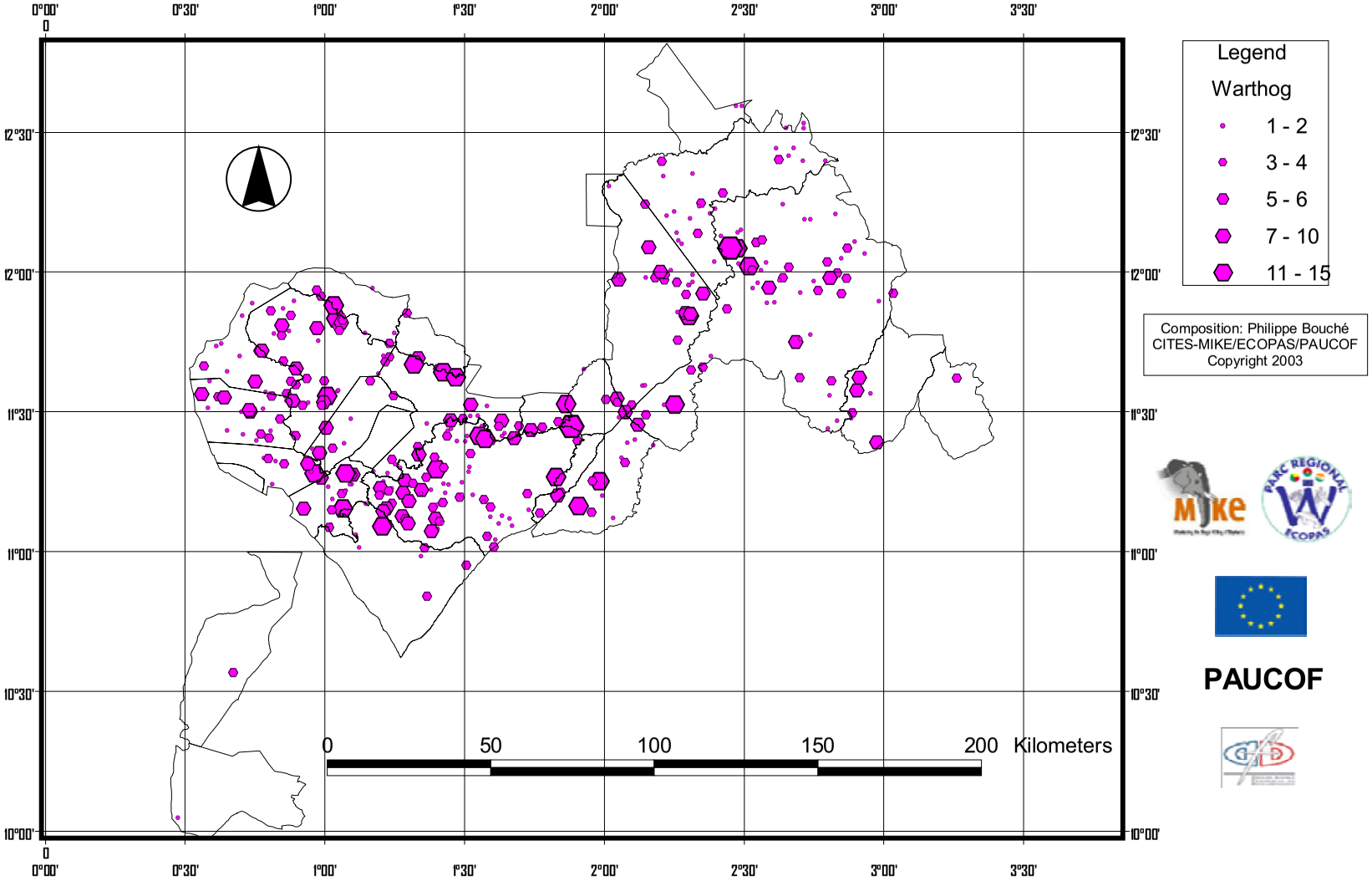
Country	Protected Area	No Obs	No Ind	Density	%
Benin	W National Park	55	157	0.027	13.86
Benin	Goungoun Classified Forest	1	3	0.004	0.26
Benin	Djona Hunting Zone	6	26	0.021	2.29
Benin	Pendjari Hunting Zone	8	22	0.012	1.94
Benin	Konkombri Hunting Zone	3	13	0.049	1.15
Benin	Mékrou Hunting Zone	11	38	0.035	3.35
Benin	Pendjari National Park	72	231	0.082	20.39
Benin	Outside ecosystem boundaries	3	7		0.62
Burkina Faso	W National Park	32	96	0.040	8.47
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	23	75	0.061	6.62
Burkina Faso	Kourtiagou Hunting Zone	8	45	0.093	3.97
Burkina Faso	Koakrana Hunting Zone	4	14	0.053	1.24
Burkina Faso	Pagou-Tandougou Hunting Zone	2	9	0.022	0.79
Burkina Faso	Ougarou Hunting Zone	7	22	0.034	1.94
Burkina Faso	Pama South Hunting Zone	15	52	0.087	4.59
Burkina Faso	Pama Central South Hunting Zone	9	30	0.057	2.65
Burkina Faso	Pama Central North Hunting Zone	22	61	0.073	5.38
Burkina Faso	Pama North Hunting Zone	16	44	0.053	3.88
Burkina Faso	Singou Game Ranch	34	104	0.057	9.18
Burkina Faso	Konkombouri Hunting Zone	8	25	0.038	2.21
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	3	7		0.62
Niger	W National Park	24	43	0.019	3.80
Niger	Tamou Total Faunal Reserve	2	4	0.005	0.35
Togo	Oti-Mandori Faunal Reserve	1	3	0.002	0.26
Togo	Keran National Park	1	2	0.001	0.18
Total		370	1133	0.036	100.00

In all, 370 observations of warthog totaling 1,133 individuals were made; which represents an average of 3.06 ± 2.11 (SE) individuals per observation. The group size varied between 1 and 15 individuals.

Warthog are distributed troughout the ecosystem. The largest concentrations were observed along the rivers (Mékrou, Pendjari, Singou, Tanouarbou and Doubodo) (Map 19).

Like the other small-sized species it is obvious that the aerial count gives only an incomplete picture of the real situation for this species. Given its small size and its earth-tone colour, it is unlikely that all individuals were counted. As a matter of fact, observations of warthog seen more than 200 m from the flight line are rare, while the counting strip used in this census reached 500 m on both sides of the flight line.

Map 19. Distribution of Warthog in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.11. Bohor Reedbuck (*Redunca redunca redunca*)

This species is also relatively difficult to see from the air. The aerial total count produced figures which are certainly under-estimated. The results are presented in Table 14.

Table 14. Number of Observations, Individuals and Density of Bohor Reedbuck per Protected Area.

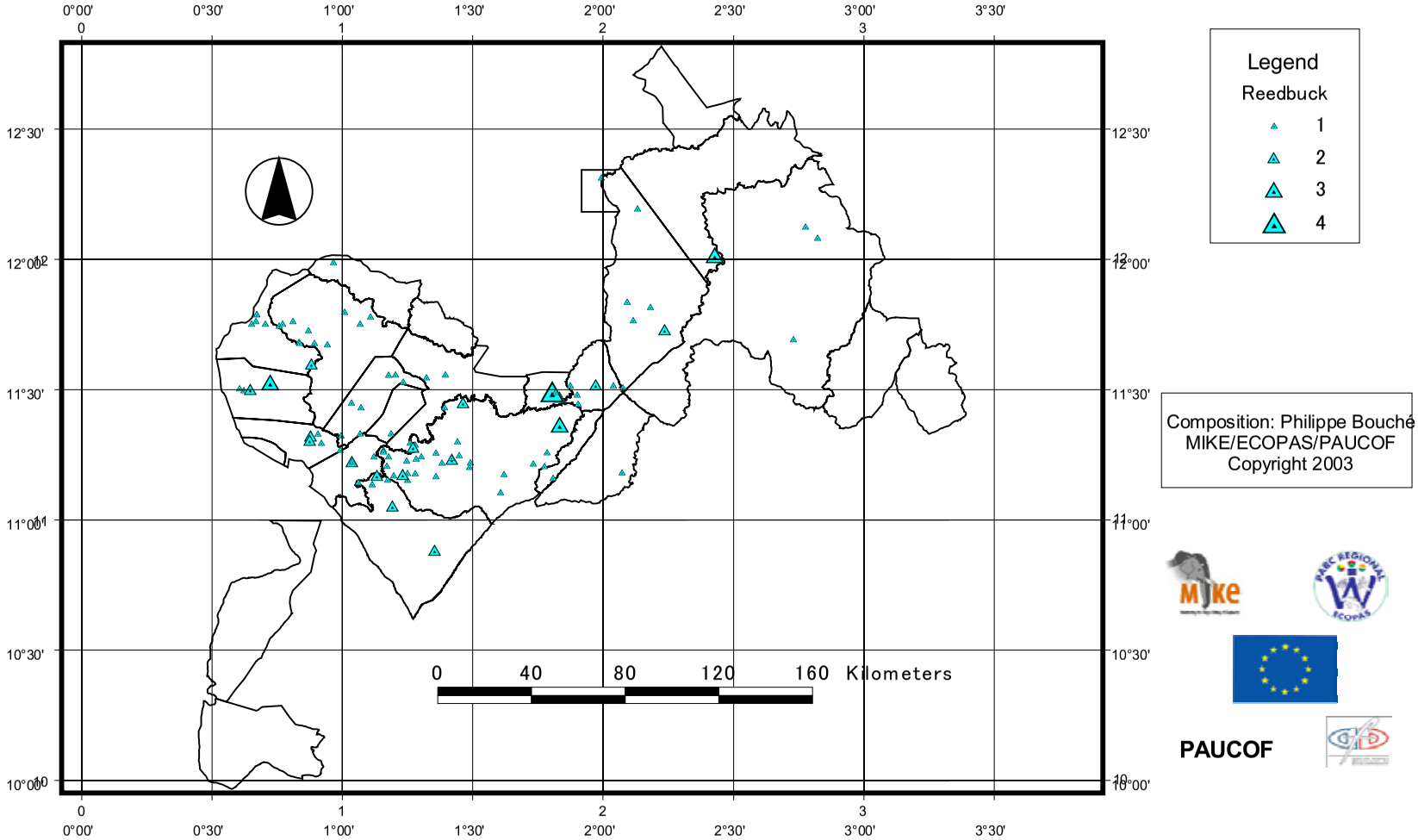
Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	3	3	0.001	2.40
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	0	0	-	-
Benin	Pendjari Hunting Zone	6	9	0.005	7.20
Benin	Konkombri Hunting Zone	1	1	0.004	0.80
Benin	Mékrou Hunting Zone	1	1	0.001	0.80
Benin	Pendjari National Park	30	35	0.012	28.00
Burkina Faso	W National Park	6	7	0.003	5.60
Burkina Faso	Tapoa Djerma Hunting Zone	1	1	0.005	0.80
Burkina Faso	Arli National Park	4	5	0.004	4.00
Burkina Faso	Kourtiagou Hunting Zone	6	7	0.014	5.60
Burkina Faso	Koakrana Hunting Zone	4	8	0.030	6.40
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	1	1	0.002	0.80
Burkina Faso	Pama South Hunting Zone	3	4	0.007	3.20
Burkina Faso	Pama Central South Hunting Zone	5	7	0.013	5.60
Burkina Faso	Pama Central North Hunting Zone	4	7	0.008	5.60
Burkina Faso	Pama North Hunting Zone	6	7	0.008	5.60
Burkina Faso	Singou Game Ranch	11	11	0.006	8.80
Burkina Faso	Konkombouri Hunting Zone	7	7	0.011	5.60
Burkina Faso	Madjoari Enclave	1	1	0.003	0.80
Burkina Faso	Pama Enclave	0	0	-	-
Niger	W National Park	1	3	0.001	2.40
Niger	Tamou Total Faunal Reserve	0	0	-	-
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		101	125	0.004	100.00

For this species, 101 observations were made, totaling 125 individuals; which represents an average of 1.24 ± 0.55 (SE) individuals per observation. The size group varied between 1 and 4 individuals (Map 20).

It is obvious that the aerial count gives only an incomplete picture of the real situation for this species. Given its small size and bland colour, it is unlikely that all individuals were counted. As a matter of fact, observations of reedbuck at more than 200 m from the flight line are rare (the counting strip reached 500 m on both sides of the flight line).

It is also possible that occasionally reedbuck were mistaken for Buffon's kob and oribi, and vice-versa.

Map 20. Distribution of Bohor Reedbuck in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.12. Oribi (*Ourebia ourebi quadriscopa*)

This species is also difficult to see from the air. The results are presented in Table 15.

Table 15. Number of Observations, Individuals and Density of Oribi per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	72	91	0.015	13.60
Benin	Goungoun Classified Forest	1	2	0.002	0.30
Benin	Djona Hunting Zone	10	13	0.011	1.94
Benin	Pendjari Hunting Zone	19	27	0.014	4.04
Benin	Konkombri Hunting Zone	2	3	0.011	0.45
Benin	Mékrou Hunting Zone	13	19	0.017	2.84
Benin	Pendjari National Park	62	77	0.027	11.51
Benin	Outside ecosystem boundaries	1	1		0.15
Burkina Faso	W National Park	42	59	0.024	8.82
Burkina Faso	Tapoa Djerma Hunting Zone	1	1	0.005	0.15
Burkina Faso	Arli National Park	26	30	0.025	4.48
Burkina Faso	Kourtiagou Hunting Zone	11	17	0.035	2.54
Burkina Faso	Koakrana Hunting Zone	8	14	0.053	2.09
Burkina Faso	Pagou-Tandougou Hunting Zone	6	9	0.022	1.35
Burkina Faso	Ougarou Hunting Zone	17	26	0.040	3.89
Burkina Faso	Pama South Hunting Zone	14	24	0.040	3.59
Burkina Faso	Pama Central South Hunting Zone	12	13	0.025	1.94
Burkina Faso	Pama Central North Hunting Zone	19	28	0.033	4.19
Burkina Faso	Pama North Hunting Zone	18	30	0.036	4.48
Burkina Faso	Singou Game Ranch	79	133	0.073	19.88
Burkina Faso	Konkombouri Hunting Zone	9	15	0.023	2.24
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	1		0.15
Niger	W National Park	22	28	0.012	4.19
Niger	Tamou Total Faunal Reserve	4	5	0.006	0.75
Niger	Outside ecosystem boundaries	1	3		0.45
Togo	Oti-Mandori Faunal Reserve	0	0	-	-
Togo	Keran National Park	0	0	-	-
Total		470	669	0.021	100.00

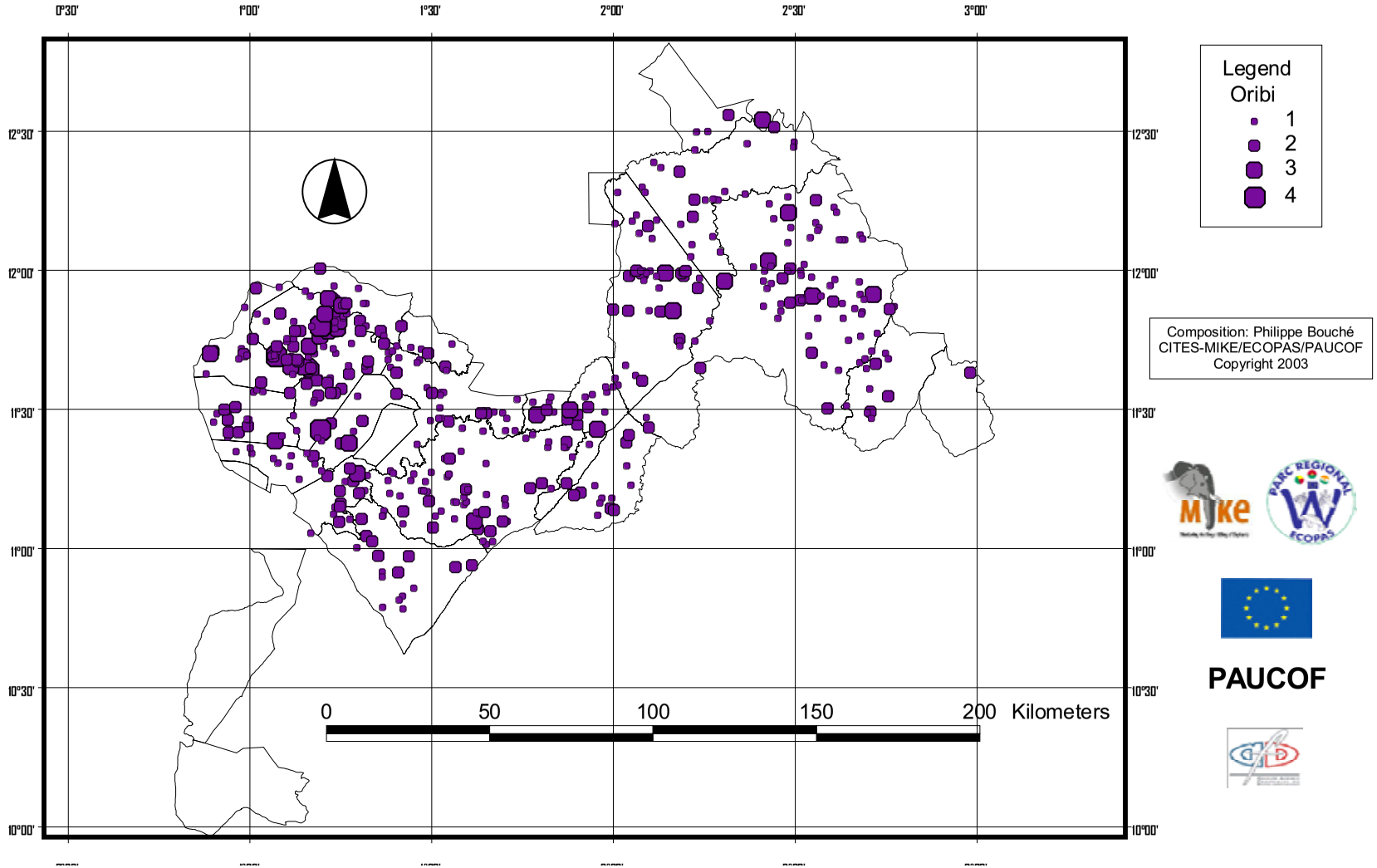
For this species, 470 observations were made totaling, 669 individuals; which represents an average of 1.43 ± 0.64 (SE) individuals per observation. The group size varied between 1 and 4 individuals.

Oribi are distributed throughout the ecosystem except in the Oti-Mandouri CF and the Kéran NP (Map 21).

The largest concentrations were observed in the Singou GR.

It is obvious that the aerial count gives a very incomplete picture of the real situation for this species. Given its small size, it is unlikely that all individuals were counted; observations of oribi made at more than 100 m from the flight line were rare (the counting strip reached 500 m on both sides of the flight line).

Map 21. Distribution of Oribi in the WAPOK Ecosystem
Aerial total count. April-May 2003



4.4.13. Grimm's Duiker (*Sylvicapra grimmia coronata*)

The results are presented in Table 16.

Table 16. Number of Observations, Individuals and Density of Grimm's duiker per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	107	122	0.021	15.02
Benin	Goungoun Classified Forest	13	13	0.016	1.60
Benin	Djona Hunting Zone	3	3	0.002	0.37
Benin	Pendjari Hunting Zone	22	23	0.021	2.83
Benin	Konkombri Hunting Zone	126	149	0.053	18.35
Benin	Mékrou Hunting Zone	67	71	0.038	8.74
Benin	Pendjari National Park	4	4	0.015	0.49
Benin	Outside ecosystem boundaries	6	6		0.74
Burkina Faso	W National Park	47	57	0.024	7.02
Burkina Faso	Tapoa Djerma Hunting Zone	1	1	0.005	0.12
Burkina Faso	Arli National Park	9	11	0.023	1.35
Burkina Faso	Kourtiagou Hunting Zone	30	34	0.028	4.19
Burkina Faso	Koakrana Hunting Zone	13	19	0.072	2.34
Burkina Faso	Pagou-Tandougou Hunting Zone	11	11	0.027	1.35
Burkina Faso	Ougarou Hunting Zone	23	28	0.043	3.45
Burkina Faso	Pama South Hunting Zone	11	11	0.018	1.35
Burkina Faso	Pama Central South Hunting Zone	6	6	0.011	0.74
Burkina Faso	Pama Central North Hunting Zone	26	28	0.033	3.45
Burkina Faso	Pama North Hunting Zone	24	32	0.039	3.94
Burkina Faso	Singou Game Ranch	60	69	0.038	8.50
Burkina Faso	Konkombouri Hunting Zone	40	46	0.070	5.67
Burkina Faso	Madjoari Enclave	6	6	0.019	0.74
Burkina Faso	Pama Enclave	0	0		-
Burkina Faso	Outside ecosystem boundaries	3	5		0.62
Niger	W National Park	32	36	0.016	4.43
Niger	Tamou Total Faunal Reserve	0	0		-
Togo	Oti-Mandori Faunal Reserve	9	12	0.008	1.48
Togo	Keran National Park	5	5	0.004	0.62
Togo	Outside ecosystem boundaries	4	4		0.49
Total		708	812	0.026	100.00

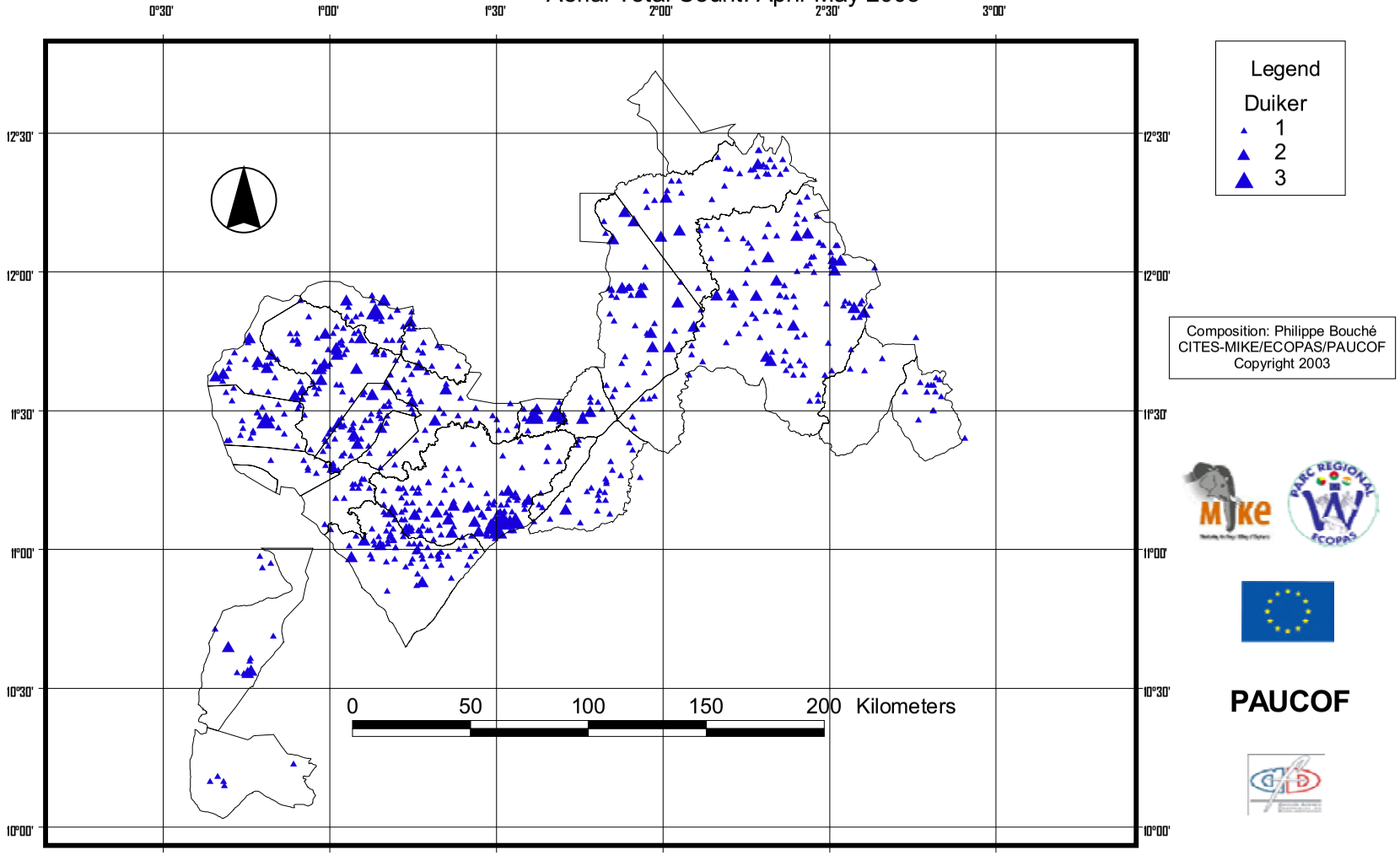
For this species, 708 observations were made, totaling 812 individuals; which represents an average of 1.15 ± 0.38 (SE) individuals per observation. The group size varied between 1 and 3 individuals.

The Grimm's duiker were observed throughout the ecosystem except in the Tamou TFR (Map 22). A possible reason for the lack of observations in Tamou may be explained by the fact that the first day of census was undertaken in that area and the crew may not have had enough experience to count such small animals. Duikers were observed within but also outside the ecosystem in all the countries involved, except for Niger; sometimes in the middle of fields near inhabited areas.

The largest concentrations were observed in the south of the Pendjari NP in the HZ of Koakrana, Kourtiagou and Konkombouri, as well as in the Singou GR (Map 22).

Because of its small size and its colour, Grimm's duiker is difficult to spot from the air, even for experienced observers. It is highly unlikely that all individuals were counted, so, it is possible to state that the ecosystem-wide population of Grimm's duiker is certainly much larger. Specific studies of the species, ground surveys and ecological monitoring would provide additional information.

Map 22. Distribution of Grimm's Duiker in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



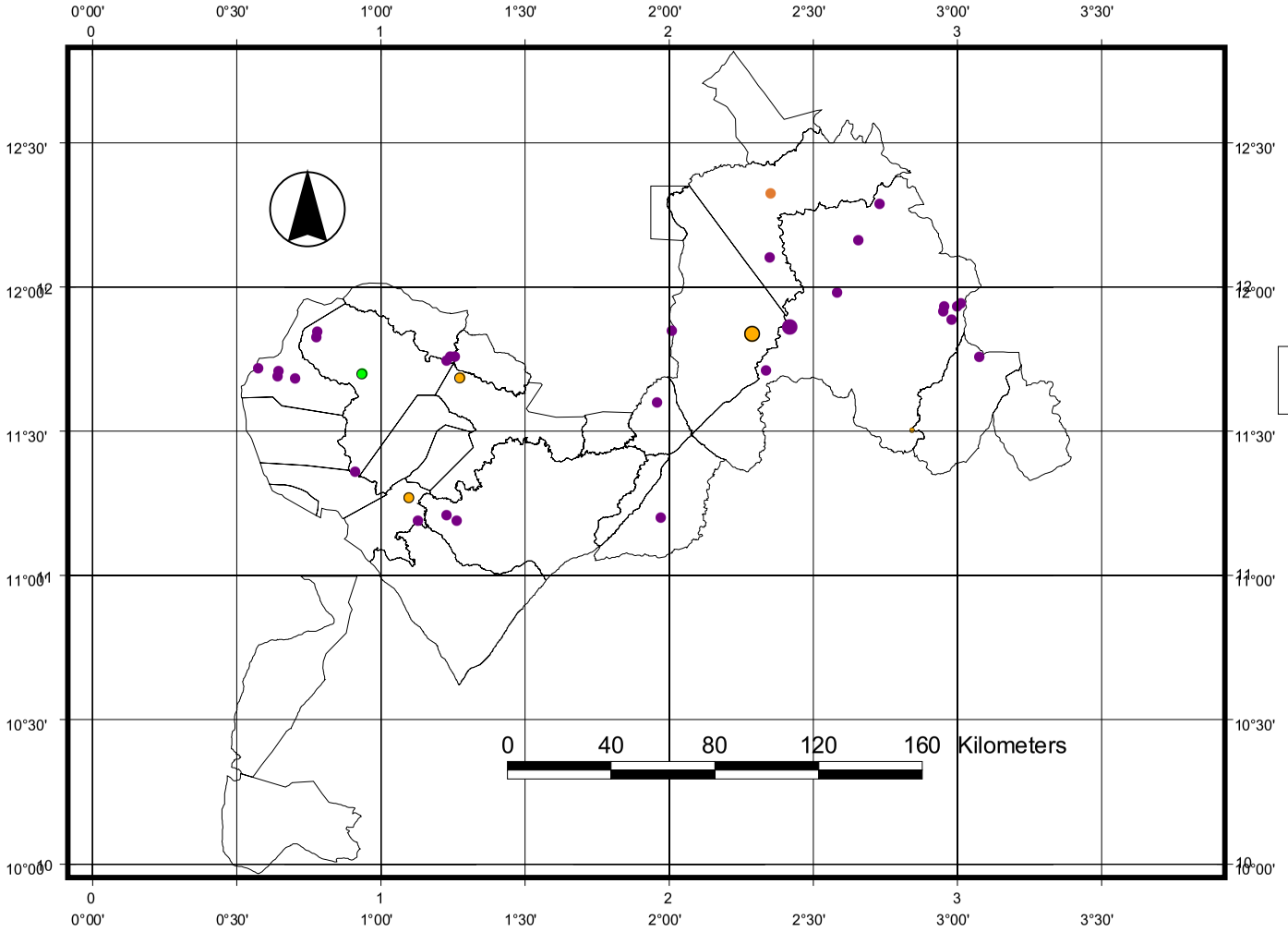
4.4.14. Large carnivores

In general large carnivores are quite difficult to observe and it is particularly so from an airplane.

The carnivore most sighted was the side-stripped jackal (*Canis adustus*) followed by the lion (*Panthera leo*). An uncertain observation of cheetah (*Acinonyx jubatus*) and that of a spotted hyena (*Crocuta crocuta*) were recorded as well (Map 23).

The results presented are largely insufficient to draw any conclusions and are only included here for the record.

Map 23. Distribution of Large Carnivores in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Legend
Lion
1
2
3 - 4
Hyena
Cheetah
Jackal
1
2

Composition: Philippe Bouché
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PAUCOF

4.4.15. Monkeys

During this survey, 3 monkey species were recorded: the anubis baboon (*Papio anubis*), the Patas monkey (*Cercopithecus (Erythrocebus) patas*), and the Tantalus monkey (*Cercopithecus aethiops tantalus*).

Anubis Baboon

The results of the total aerial count are presented in Table 17

Table 17. Number of Observations, Individuals and Density of Anubis Baboon per Protected Area.

Country	Protected area	No of Obs	No of Ind	Density	%
Benin	W National Park	42	182	0.031	21.82
Benin	Goungoun Classified Forest	0	0	-	-
Benin	Djona Hunting Zone	4	7	0.006	0.84
Benin	Pendjari Hunting Zone	10	65	0.035	7.79
Benin	Konkombri Hunting Zone	1	2	0.008	0.24
Benin	Mékrou Hunting Zone	18	38	0.035	4.56
Benin	Pendjari National Park	20	158	0.056	18.94
Benin	Outside ecosystem boundaries	1	6		0.72
Burkina Faso	W National Park	12	37	0.015	4.44
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	5	37	0.030	4.44
Burkina Faso	Kourtiagou Hunting Zone	3	21	0.043	2.52
Burkina Faso	Koakrana Hunting Zone	1	2	0.008	0.24
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	2	8	0.012	0.96
Burkina Faso	Pama South Hunting Zone	25	193	0.321	23.14
Burkina Faso	Pama Central South Hunting Zone	3	6	0.011	0.72
Burkina Faso	Pama Central North Hunting Zone	1	7	0.008	0.84
Burkina Faso	Pama North Hunting Zone	1	3	0.004	0.36
Burkina Faso	Singou Game Ranch	2	4	0.002	0.48
Burkina Faso	Konkombouri Hunting Zone	2	8	0.012	0.96
Burkina Faso	Madjoari Enclave	0	0	-	-
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	2	19		2.28
Niger	W National Park	11	27	0.012	3.24
Niger	Tamou Total Faunal Reserve	0	0	-	-
Niger	Outside ecosystem boundaries	0	0		-
Togo	Oti-Mandori Faunal Reserve	1	4	0.003	0.48
Togo	Keran National Park	0	0	-	-
Total		167	834	0.027	100.00

Anubis baboon were observed 167 times, totaling 834 individuals. An average of 4.99 ± 5.36 (SE) individuals per group was calculated. The group size varied between 1 and 32 individuals (Map 24).

It is obvious that the aerial count gives only an incomplete picture of the real situation for this species. Given its small size and its cryptic colour, it is unlikely that all individuals were counted.

Patas Monkey

The results of the total aerial count are presented in Table 18

Table 18. Number of Observations, Individuals and Density of the Patas Monkey per Protected Area.

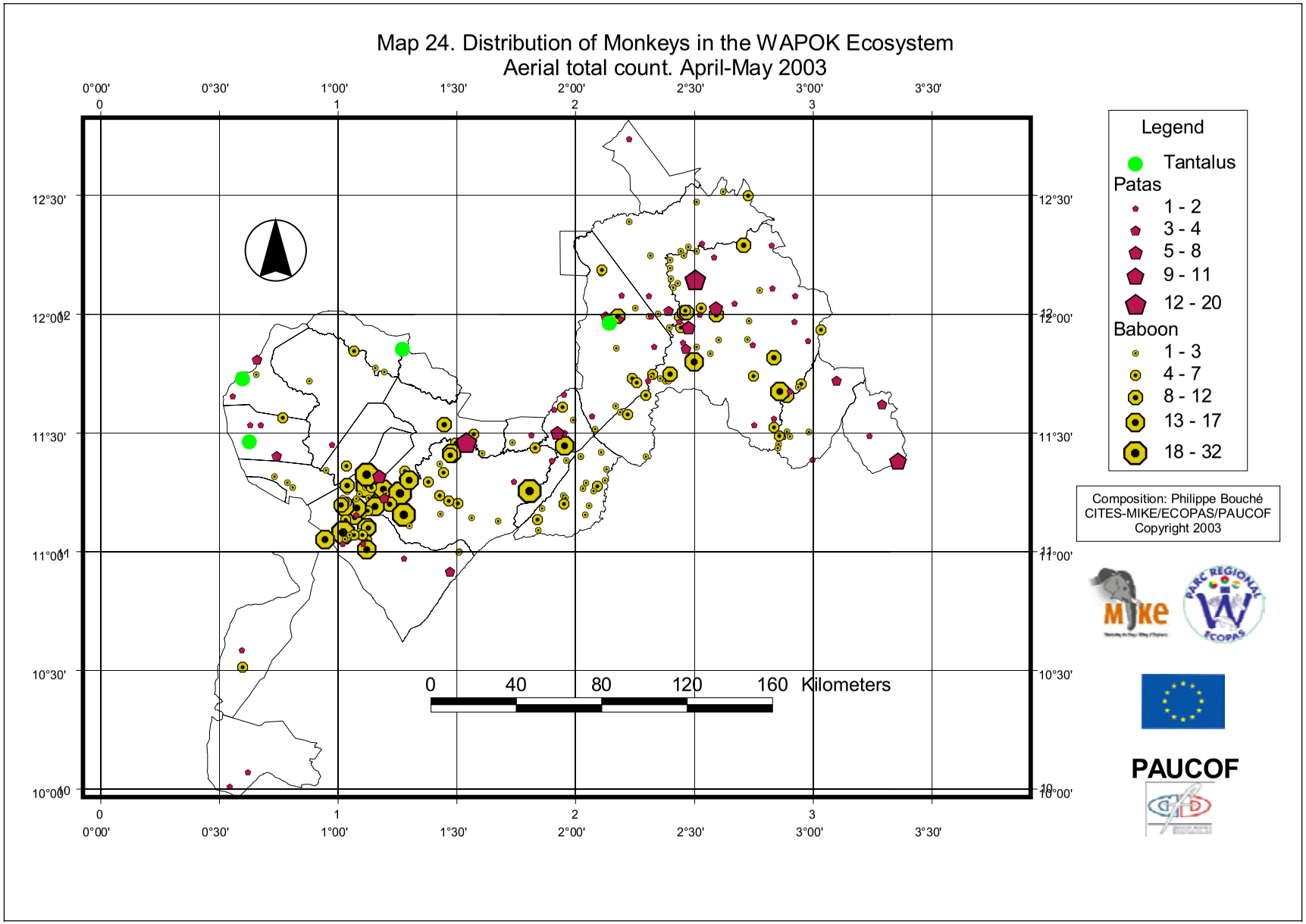
Country	Protected area	No of Obs	No of Ind	Density	%
Benin	W National Park	18	54	0.009	34.18
Benin	Goungoun Classified Forest	3	15	0.019	9.49
Benin	Djona Hunting Zone	1	3	0.002	1.90
Benin	Pendjari Hunting Zone	4	8	0.004	5.06
Benin	Konkombri Hunting Zone	0	0	-	-
Benin	Mékrou Hunting Zone	0	0	-	-
Benin	Pendjari National Park	3	6	0.002	3.80
Benin	Outside ecosystem boundaries	1	1		0.63
Burkina Faso	W National Park	6	11	0.005	6.96
Burkina Faso	Tapoa Djerma Hunting Zone	0	0	-	-
Burkina Faso	Arli National Park	1	19	0.016	12.03
Burkina Faso	Kourtiagou Hunting Zone	4	10	0.021	6.33
Burkina Faso	Koakrana Hunting Zone	1	2	0.008	1.27
Burkina Faso	Pagou-Tandougou Hunting Zone	0	0	-	-
Burkina Faso	Ougarou Hunting Zone	0	0	-	-
Burkina Faso	Pama South Hunting Zone	1	1	0.002	0.63
Burkina Faso	Pama Central South Hunting Zone	0	0	-	-
Burkina Faso	Pama Central North Hunting Zone	3	6	0.007	3.80
Burkina Faso	Pama North Hunting Zone	1	1	0.001	0.63
Burkina Faso	Singou Game Ranch	1	1	0.001	0.63
Burkina Faso	Konkombouri Hunting Zone	0	0	-	-
Burkina Faso	Madjoari Enclave	1	5	0.016	3.16
Burkina Faso	Pama Enclave	0	0	-	-
Burkina Faso	Outside ecosystem boundaries	1	4		2.53
Niger	W National Park	4	7	0.003	4.43
Niger	Tamou Total Faunal Reserve	1	1	0.001	0.63
Niger	Outside ecosystem boundaries	0	0		-
Togo	Oti-Mandori Faunal Reserve	1	1	0.001	0.63
Togo	Keran National Park	2	2	0.001	1.27
Total		58	158	0.005	100.00

Patas monkeys were observed 58 times, totaling 158 individuals. An average of 2.72 ± 3.73 (SE) individuals per group was calculated. The group size varied between 1 and 20 individuals (Map 24).

Once again, it is obvious that the aerial count gives only an incomplete picture of the real situation for this species. Given its small size and cryptic colouration, it is unlikely that all individuals were observed.

Four Tantalus monkeys were observed during the census.

The distribution map of observations made of monkeys is presented here for the record.


Map 24. Distribution of Monkeys in the WAPOK Ecosystem
Aerial total count. April-May 2003
0°00'
0°30'
1°00'
1°30'
2°00'
2°30'
3°00'
3°30'
12°30'
12°00'
11°30'
11°00'
10°30'
10°00'
0
40
80
120
160
Kilometers
Legend
Tantalus
Patas
1 - 2
3 - 4
5 - 8
9 - 11
12 - 20
Baboon
1 - 3
4 - 7
8 - 12
13 - 17
18 - 32
Composition: Philippe Bouché
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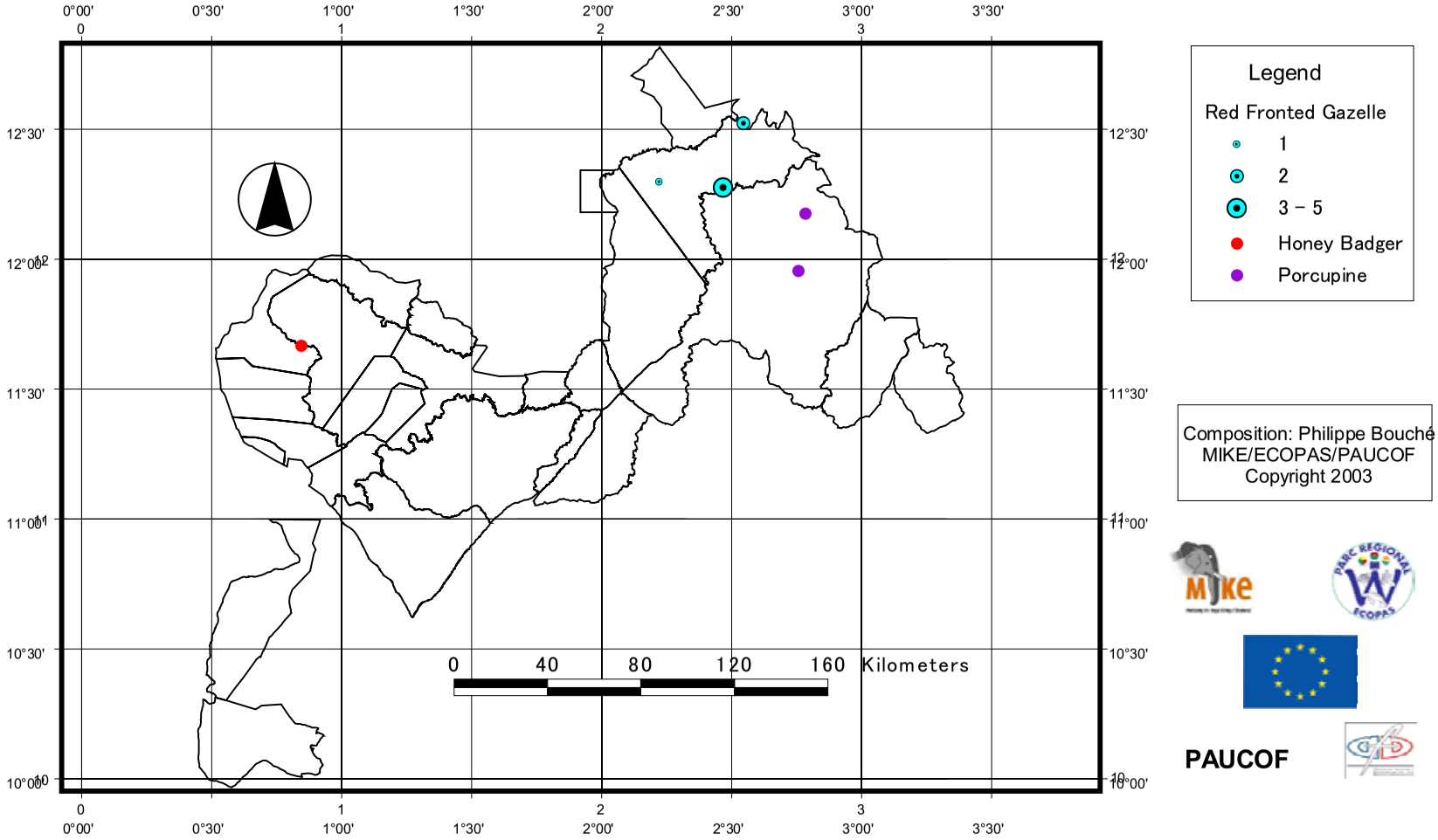
4.4.16. Other species

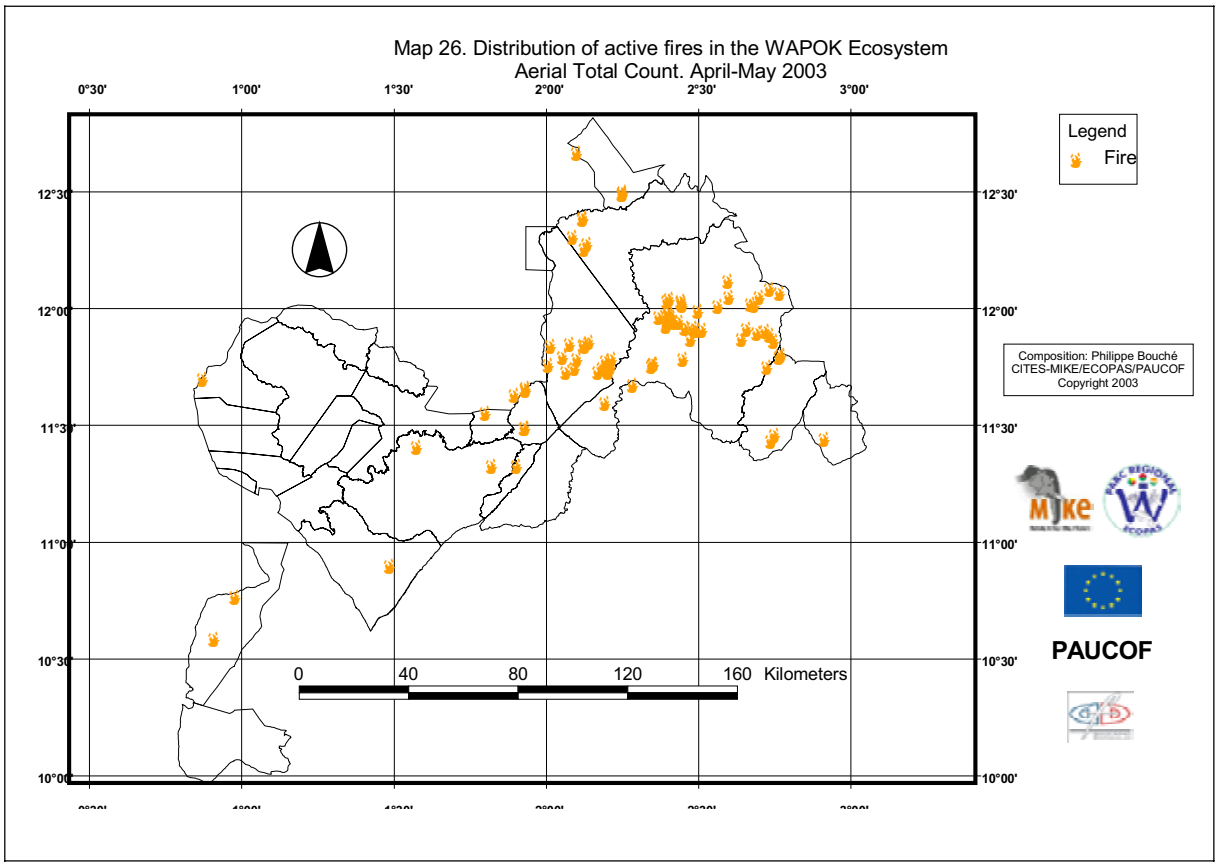
Other species observed such as the red-fronted gazelle (*Gazella rufifrons*), honey badger or ratel (*Mellivora capensis*) and porcupine (*Hystrix cristata*), are included here for the record (Map 25).

Map 25. Distribution of Red Fronted Gazelle, Honey Badger and Porcupine in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



4.4.17. Fires

The Map 26 presents the distribution of active fires at the time of the census. It is not possible to say whether the fire was man-made or natural. In any case, they were late burns since they occurred in April and May (Map 26).



4.4.18. Human activities and their impact

During the survey, several signs of human activity within and around the ecosystem were recorded.

Fields and villages.

The fields and villages encountered were recorded by the observers. All the data collected is presented in Map 27.

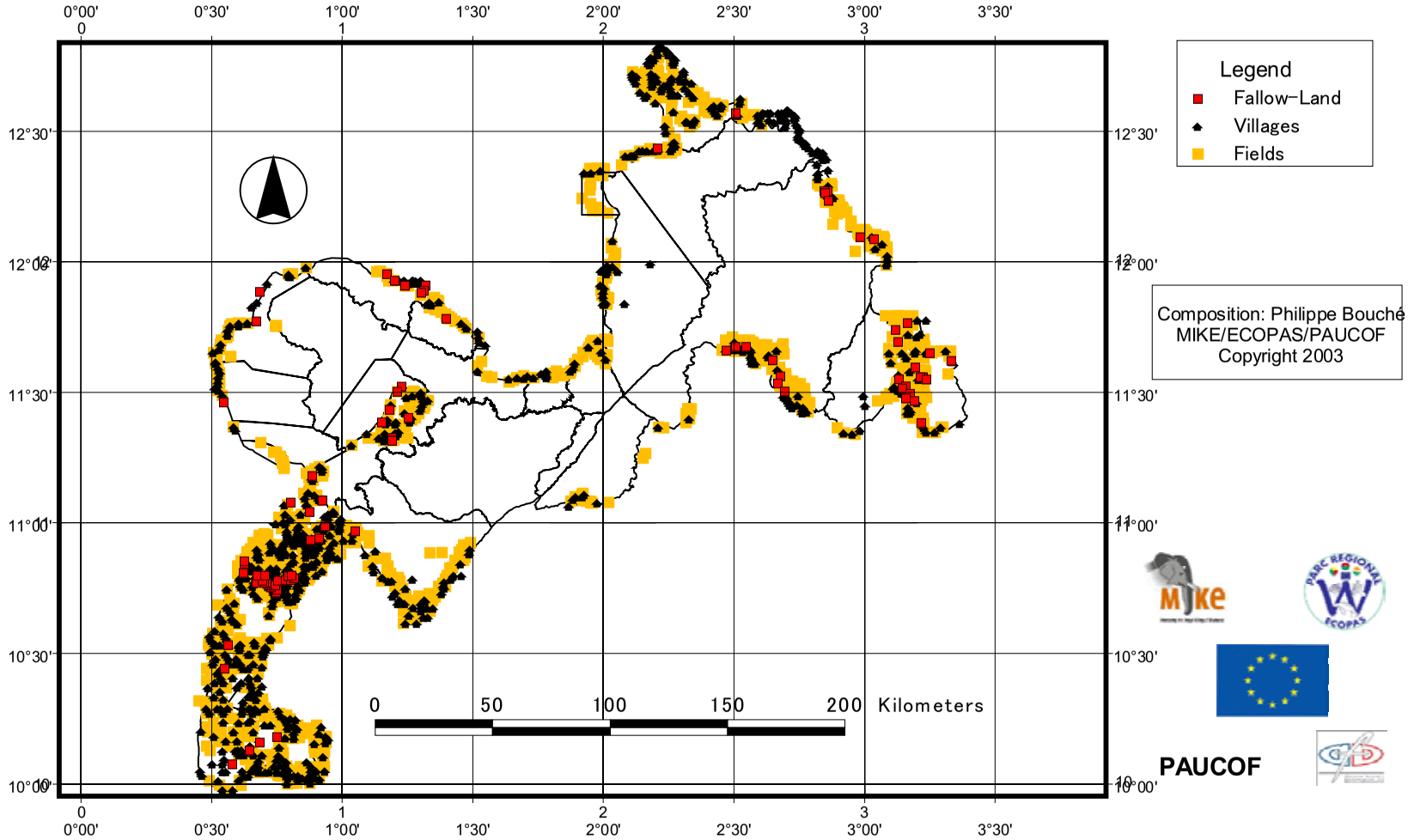
In general, fields and villages are distributed along the boundaries of the ecosystem. However, one can notice a serious encroachment of fields and villages inside the boundaries, in:

- the Goungoun CF;
- the North-East of the Djona;
- the Tamou FR;
- the Oti-Mandouri FR;
- the Kéran NP;
- the south of W Benin NP;
- and, to a lesser extent, in the Pendjari HZ.

It should be underlined that in the Madjoari agricultural enclave (Burkina Faso) it appears there is a trend to install fields and villages along the Madjoari-Tindangou road.

Picture 7. Village and Fields

Map 27. Distribution of Fallow-Land, Villages and Fields in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Domestic Animals

This operation was also an opportunity to assess the distribution of livestock (cattle, sheep, goats, camels, donkeys) within and around the ecosystem.

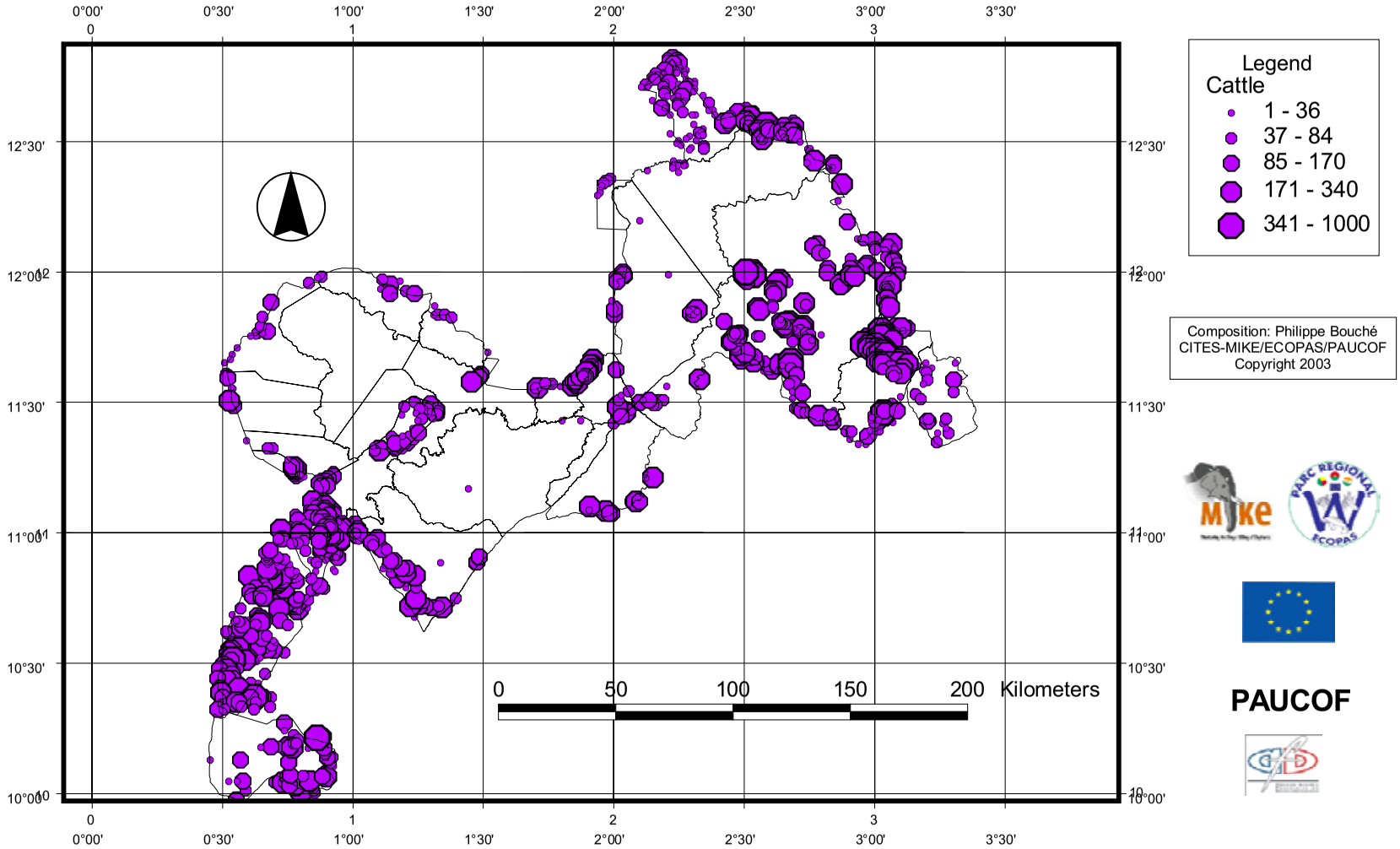
For cattle, the following table was established.

Table 19. Number of Observations, Individuals and Density of Cattle per Protected Area.

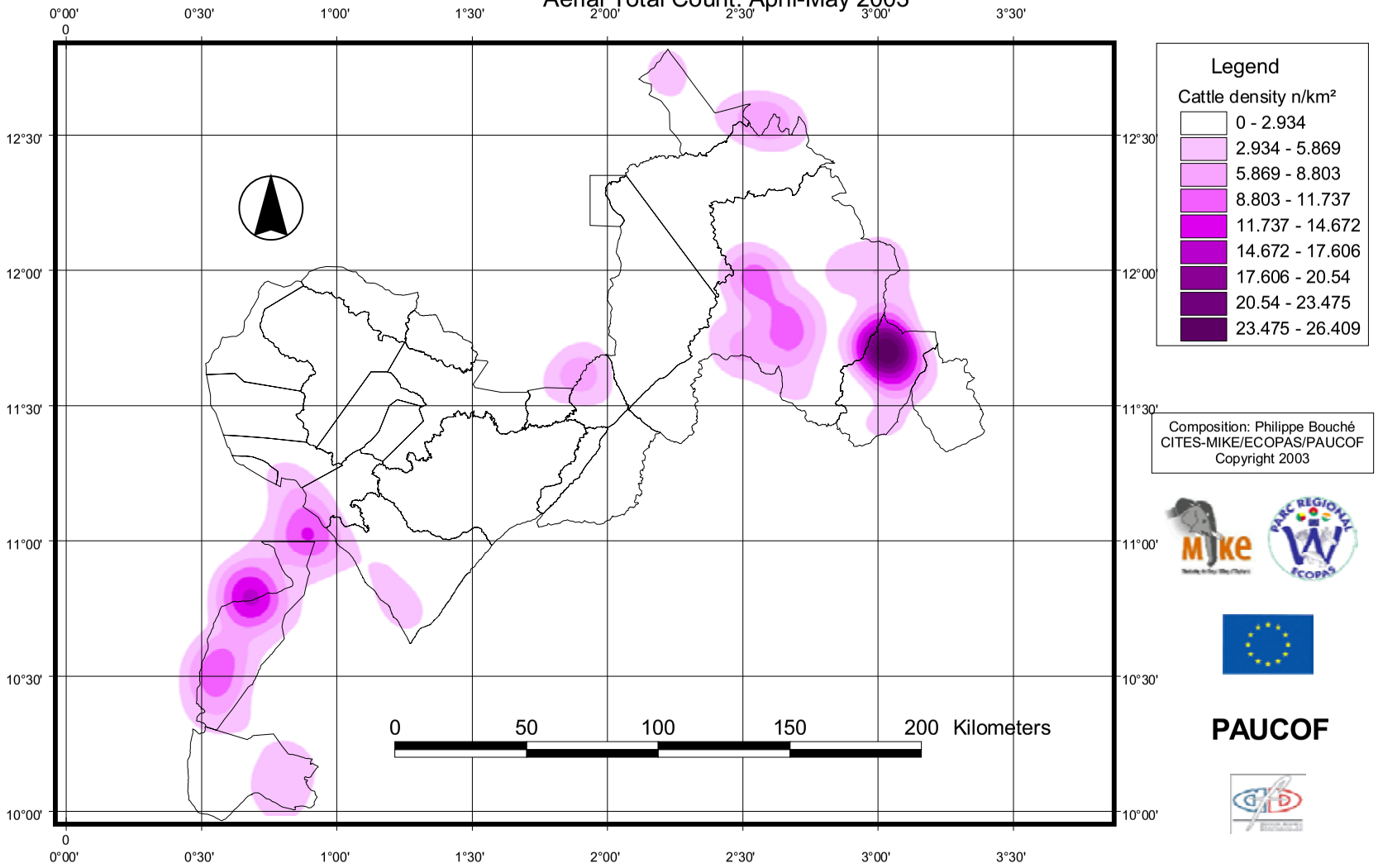
Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	172	19709	3.36	19.45
Benin	Goungoun Classified Forest	25	1054	1.31	1.04
Benin	Djona Hunting Zone	113	14974	12.31	14.78
Benin	Pendjari Hunting Zone	47	4305	2.31	4.25
Benin	Konkombri Hunting Zone	1	50	0.19	0.05
Benin	Mékrou Hunting Zone	10	924	0.85	0.91
Benin	Pendjari National Park	3	4	0.00	0.00
Burkina Faso	W National Park	7	504	0.21	0.50
Burkina Faso	Tapoa Djerma Hunting Zone	7	240	1.19	0.24
Burkina Faso	Arli National Park	7	800	0.65	0.79
Burkina Faso	Kourtiagou Hunting Zone	12	971	2.00	0.96
Burkina Faso	Koakrana Hunting Zone	4	365	1.38	0.36
Burkina Faso	Pagou-Tandougou Hunting Zone	3	90	0.22	0.09
Burkina Faso	Ougarou Hunting Zone	3	174	0.27	0.17
Burkina Faso	Pama South Hunting Zone	12	1010	1.68	1.00
Burkina Faso	Pama Central South Hunting Zone	8	632	1.20	0.62
Burkina Faso	Pama Central North Hunting Zone	2	25	0.03	0.02
Burkina Faso	Pama North Hunting Zone	7	195	0.24	0.19
Burkina Faso	Singou Game Ranch	0	0	-	-
Burkina Faso	Konkombouri Hunting Zone	1	13	0.02	0.01
Burkina Faso	Madjoari Enclave	41	2046	6.64	2.02
Burkina Faso	Pama Enclave	8	765	7.88	0.75
Niger	W National Park	18	408	0.18	0.40
Niger	Tamou Total Faunal Reserve	71	2498	3.17	2.47
Togo	Oti-Mandori Faunal Reserve	135	12152	8.19	11.99
Togo	Keran National Park	30	3025	2.16	2.99
Total		747	66933	2.14	66.06
	Outside ecosystem boundaries	424	34396		33.94
Grand total		1171	101329		100.00

It was noticed that cattle herds were recorded in practically all protected areas, except the Singou GR. However, the highest densities were observed in the Djona HZ, the Benin W NP, the Oti-Mandouri FR, the Keran NP, the Niger W NP and in the Tamou TFR; as well as along the western boarder of the Pendjari HZ (mainly limited to the Controlled Occupation Zone), in (maps 28 and 29).

Map 28. Distribution of Cattle in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Map 29. Distribution of Cattle Densities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



The distribution of domestic animals other than cattle is presented on Map 30.

Table 20 presents the information relative to sheep and goats ("shoats")

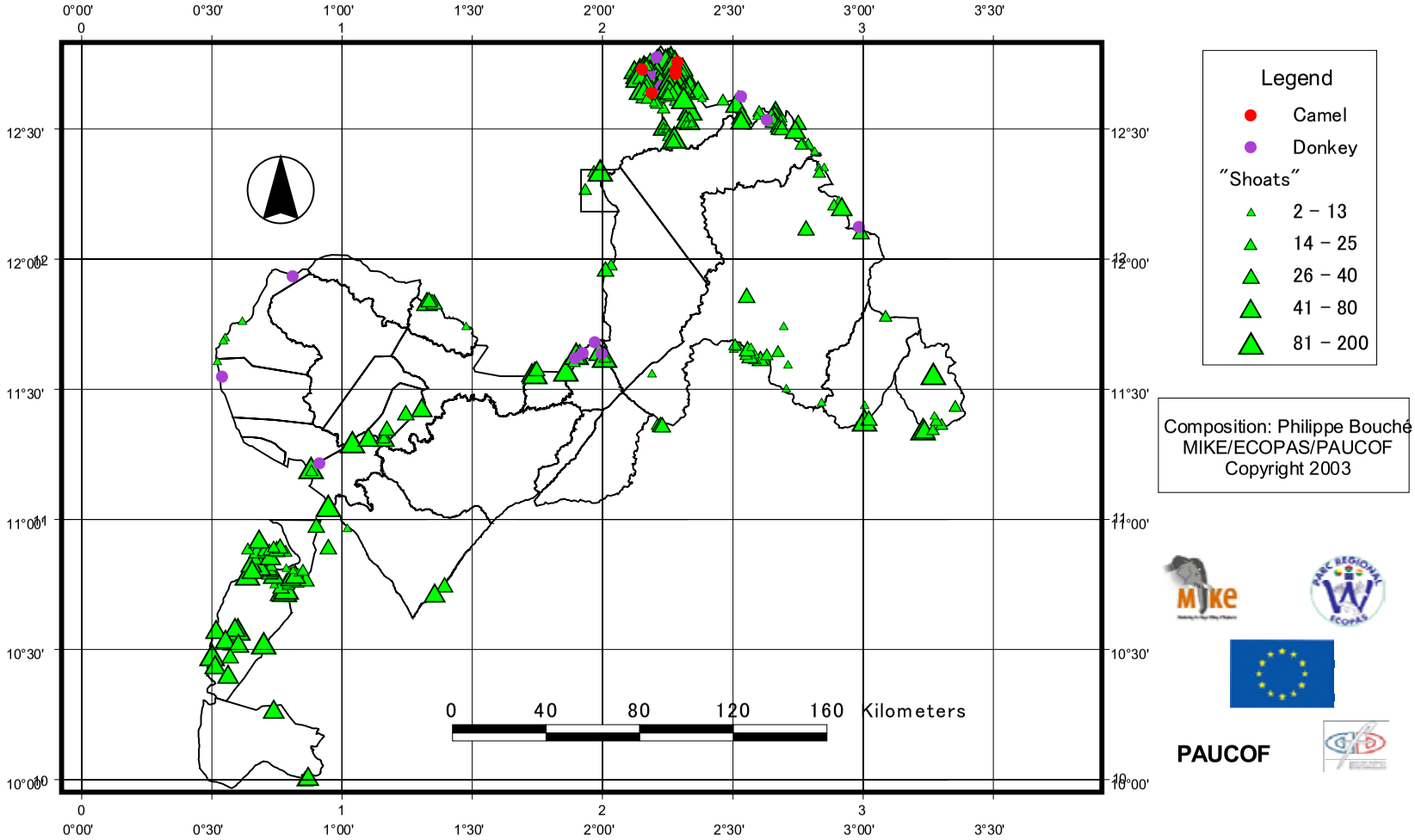
Table 20. Number of Observations, of Individuals and Densities of Sheep and Goat per Protected Area.

Country	Protected Area	No of Obs	No of Ind	Density	%
Benin	W National Park	19	393	0.07	3.43
Benin	Goungoun Classified Forest	7	236	0.29	2.06
Benin	Djona Hunting Zone	1	10	0.01	0.09
Benin	Pendjari Hunting Zone	2	90	0.05	0.79
Benin	Konkombri Hunting Zone	0	0	-	-
Benin	Mékrou Hunting Zone	0	0	-	-
Benin	Pendjari National Park	0	0	-	-
Burkina Faso	W National Park	0	0	-	-
Burkina Faso	Tapoa Djerma Hunting Zone	3	135	0.67	1.18
Burkina Faso	Arli National Park	1	50	0.04	0.44
Burkina Faso	Kourtiagou Hunting Zone	4	195	0.40	1.70
Burkina Faso	Koakrana Hunting Zone	0	0	-	-
Burkina Faso	Pagou-Tandougou Hunting Zone	1	40	0.10	0.35
Burkina Faso	Ougarou Hunting Zone	0	0	-	-
Burkina Faso	Pama South Hunting Zone	4	370	0.62	3.23
Burkina Faso	Pama Central South Hunting Zone	0	0	-	-
Burkina Faso	Pama Central North Hunting Zone	1	3	0.00	0.03
Burkina Faso	Pama North Hunting Zone	2	20	0.02	0.17
Burkina Faso	Singou Game Ranch	0	0	-	-
Burkina Faso	Konkombouri Hunting Zone	0	0	-	-
Burkina Faso	Madjoari Enclave	4	150	0.49	1.31
Burkina Faso	Pama Enclave	0	0	-	-
Niger	W National Park	2	90	0.04	0.79
Niger	Tamou Total Faunal Reserve	92	3688	4.67	32.23
Togo	Oti-Mandori Faunal Reserve	35	1164	0.78	10.17
Togo	Keran National Park	1	50	0.04	0.44
Total		179	6684	0.21	58.41
	Outside ecosystem boundaries	127	4760		41.59
Grand total		306	11444		100.00

Sheep and goats were observed at lower densities than cattle in the ecosystem. The largest concentrations were observed within and around the Oti-Mandouri CF and in the Tamou TFR.

For the record, the distribution of other livestock species is presented on Map 30.

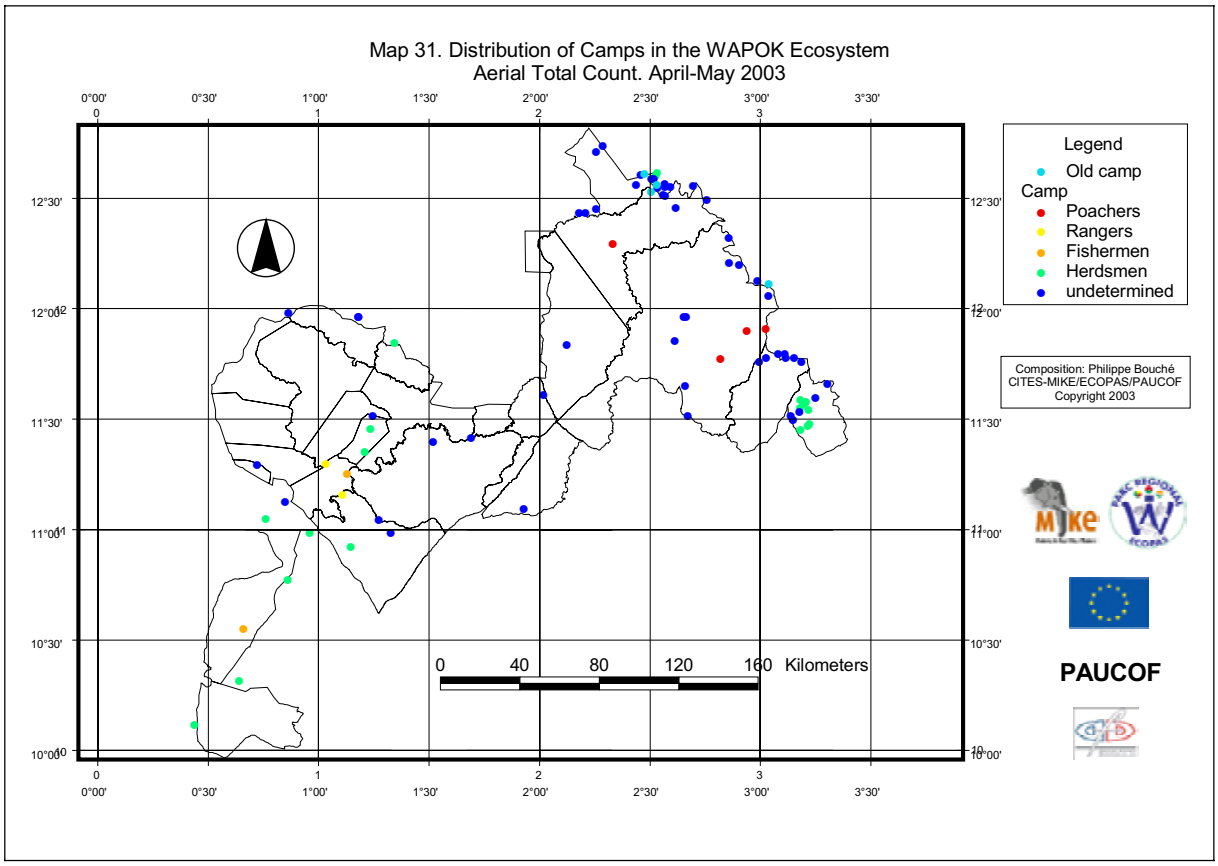
Map 30. Distribution of Camel, Donkey and "Shoats" in the WAPOK Ecosystem
Aerial Total Count. April-May 2003



Camps

Various types of camps were observed from the air.

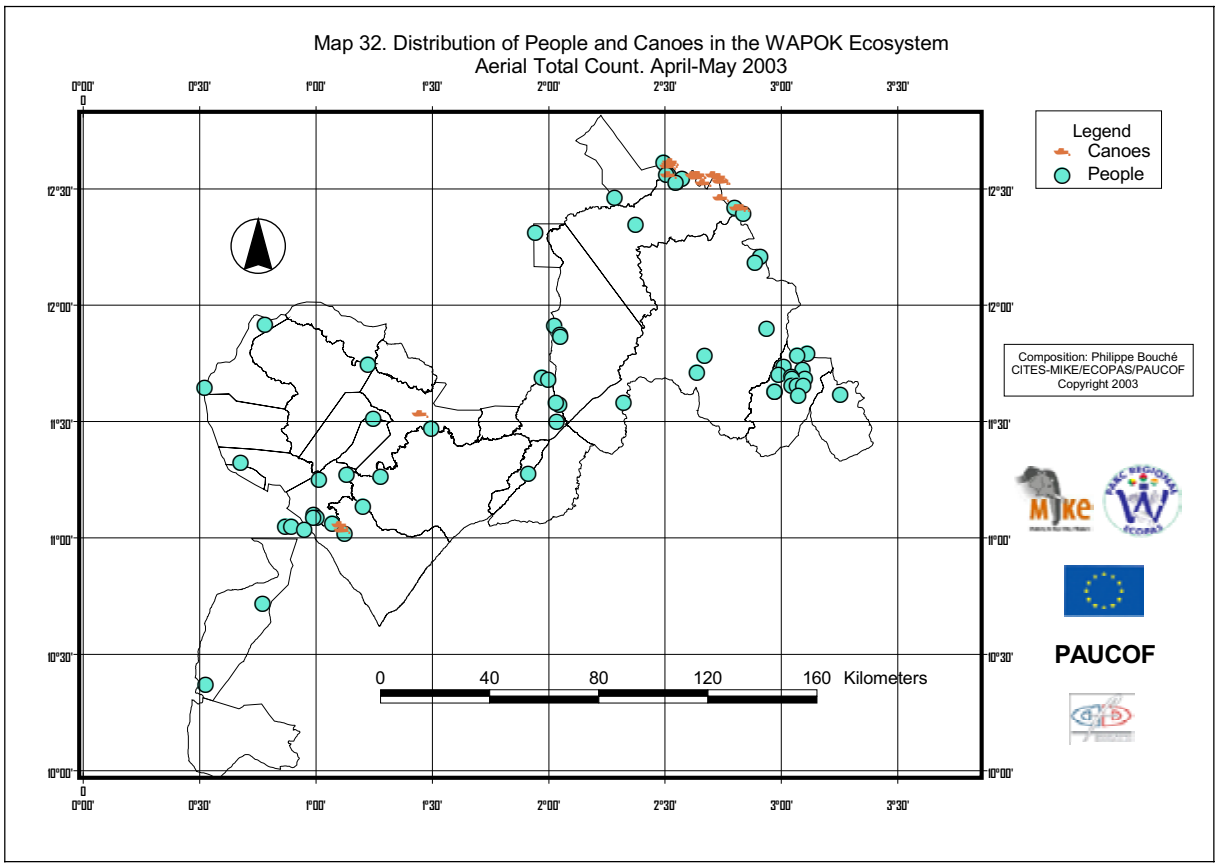
Their position on Map 31 is presented here for the record. It is worth noting that confirmed poachers' camps were seen in the W NP (Benin and Niger sectors) and in the Pendjari NP and HZ.



People and Canoes

The following map shows the position of people and canoes recorded by the observers.

People were observed in the whole ecosystem; due to lack of additional information we present Map 32 for the record.



5. SPATIAL ANALYSES

From the information collected, it is possible to carry out some analyses of the spatial distribution of wildlife with regard to the presence of surface water and human activities.

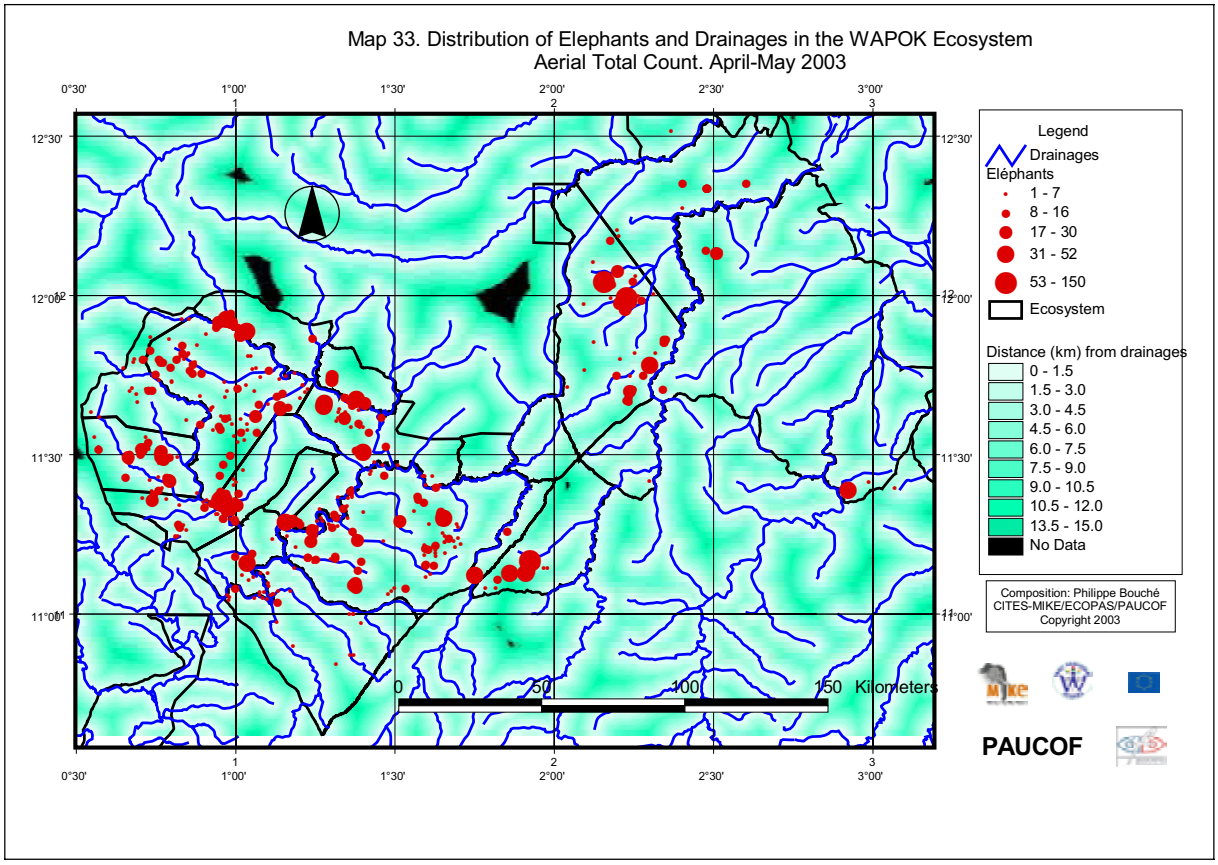
The following analyses concern only elephant and buffalo (species for which the data are the most reliable), which generally have a high need for water and which are generally sensitive to human activities and to poaching in particular.

5.1. Water

The presence of surface water is an important factor of animal distribution; as is the case for elephant and buffalo.

5.1.1. Elephant

Map 33 illustrates the elephant distribution with regard to surface water, as represented by rivers and seasonal drainages supposedly containing water during the survey period (hot dry season after the first rains).



Map 33 and Figure 4 illustrate elephant distribution with regard to water. In general, we notice an obvious decrease of numbers and herds as one goes further away from drainage lines. This fact is certainly true for the dry hot season period at which this operation was carried out.

On a sample of 4,557 individuals (99.2% of the total number), 89.4% of the herds and 91.3% of individuals were observed less than 6 km away from the nearest

drainage line. Only 0.008% of herds and 0.006% of individuals were observed more than 10 km away from the nearest drainage.

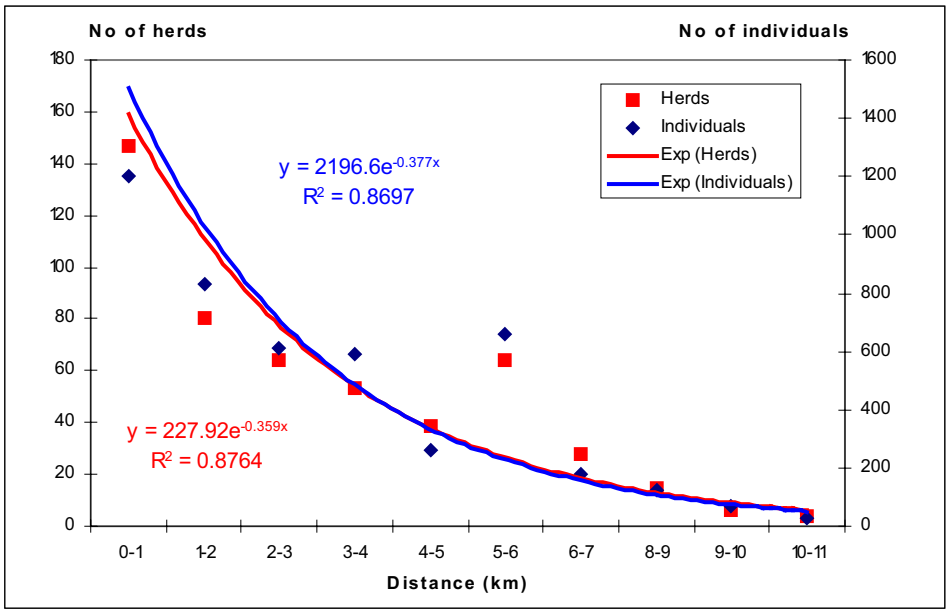
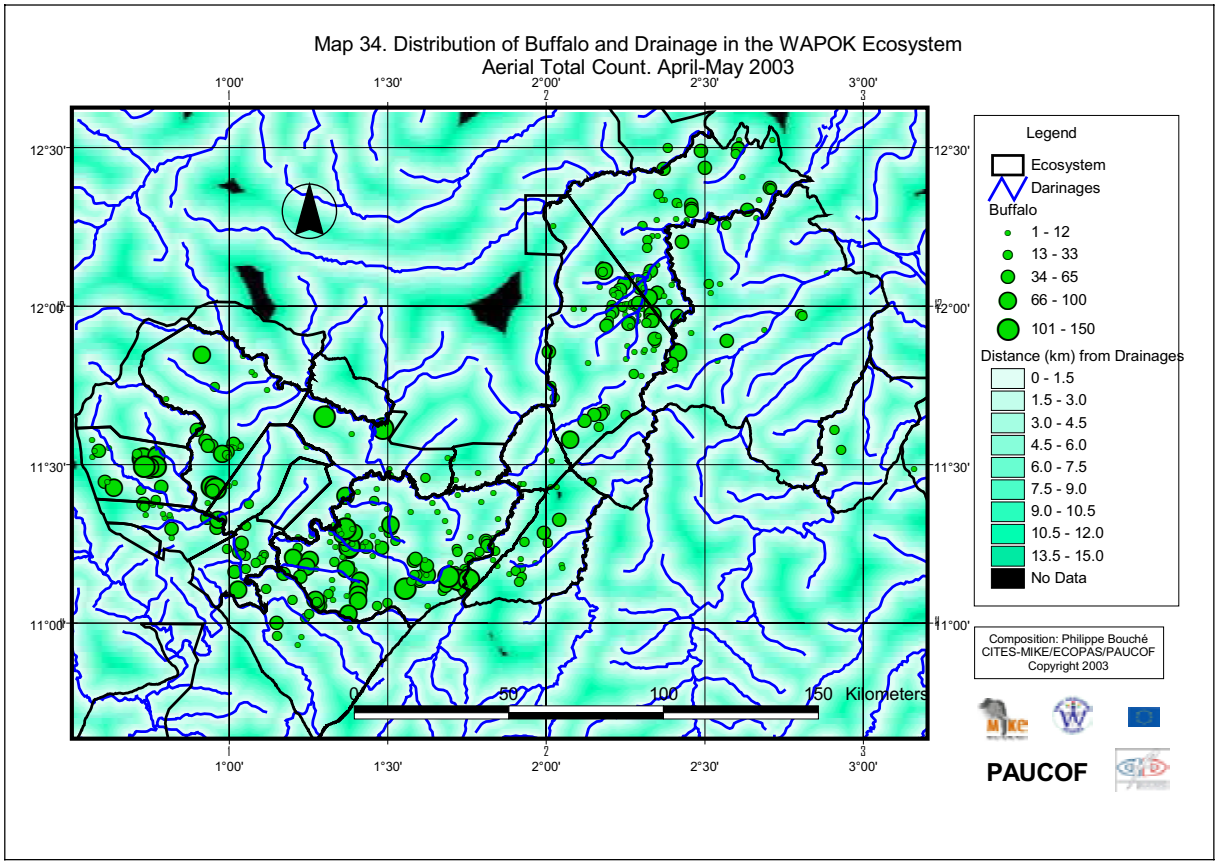


Figure 4. Number of Elephants and Herds Observed According to the Distance (km) from Drainage Lines

This distribution is logical for this species, whose water needs are high; however, the surface water factor is not the only one which plays a role in the distribution of this species, because even if some water points had dried up in this period of the year, elephants are not distributed in the same way along all the water-courses (Map 33).

Picture 8. Herd of Elephants along a River Bed

5.1.2. Buffalo



Map 34: buffalo are obviously concentrated along drainage lines (supposedly representing the presence of water). This is highlighted in Figure 5, the curves representing individuals and groups of buffalo digress progressively as we move away from drainage lines; as can be seen on Map 34.

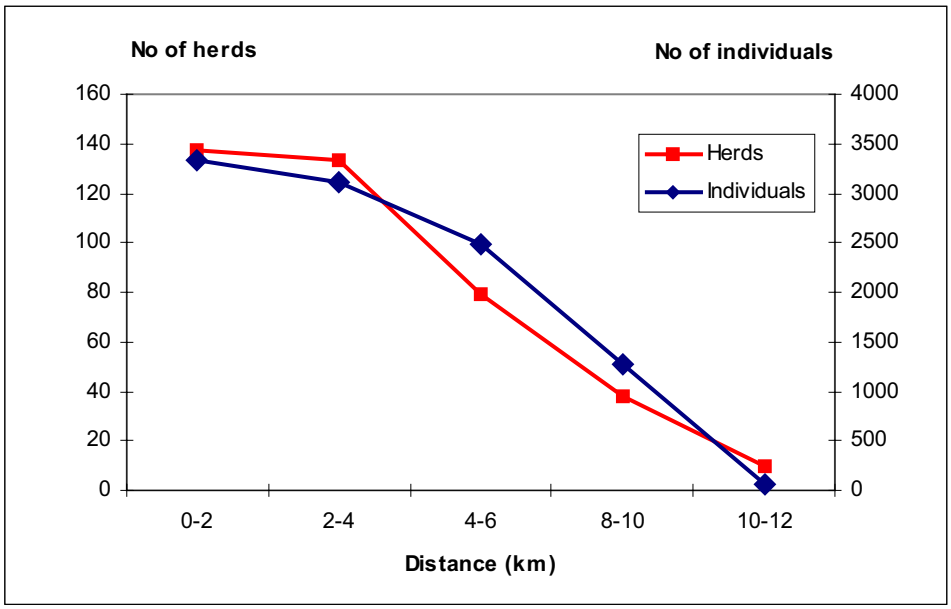


Figure 5. Number of Buffalo Individuals and Herds Observed According to the Distance (km) from Drainage Lines.

On a sample of 397 groups and 10,260 individuals (that represent 97.16% of the total number), 87.9% of individuals and 87.1% of groups were observed in a radius of 6 km around the drainages. Only 2.5% of groups and 0.5% of individuals were observed in a radius higher than 10 km.

It can be observed that even if the distribution of buffalo is larger than that of elephant, the surface water solely doesn't justify the distribution evident on Map 34 (as for the case of elephant). The distribution is not homogenous along all the water-courses. The explanation must certainly related to the season (water, new grass, etc.) but the animal distribution must also be influenced by the presence of human activities like poaching, fires, cattle distribution, agriculture etc. …

Picture 9. Buffaloes and Hartebeests

5.2. Impact of human activities on the distribution of wildlife

5.2.1. Elephant

Based on observations made during this survey, Map 35 presents the probability of finding elephants in the ecosystem at the time of the census. Each concentric circle corresponds to the probability expressed in % of finding elephants.

Two distinct sets are presented on the map. One covers approximately the east of the Burkina Faso W NP, the south of the Niger W NP in and along the Mékrou. The other one covers at the west of the ecosystem, that is the NP and the HZ of the Pendjari, the complex of Arli, Pama, Singou and related protected areas.

The highest probabilities (25 to 95%) are located mainly along the Singou and Pendjari rivers as well as along the Mékrou River.

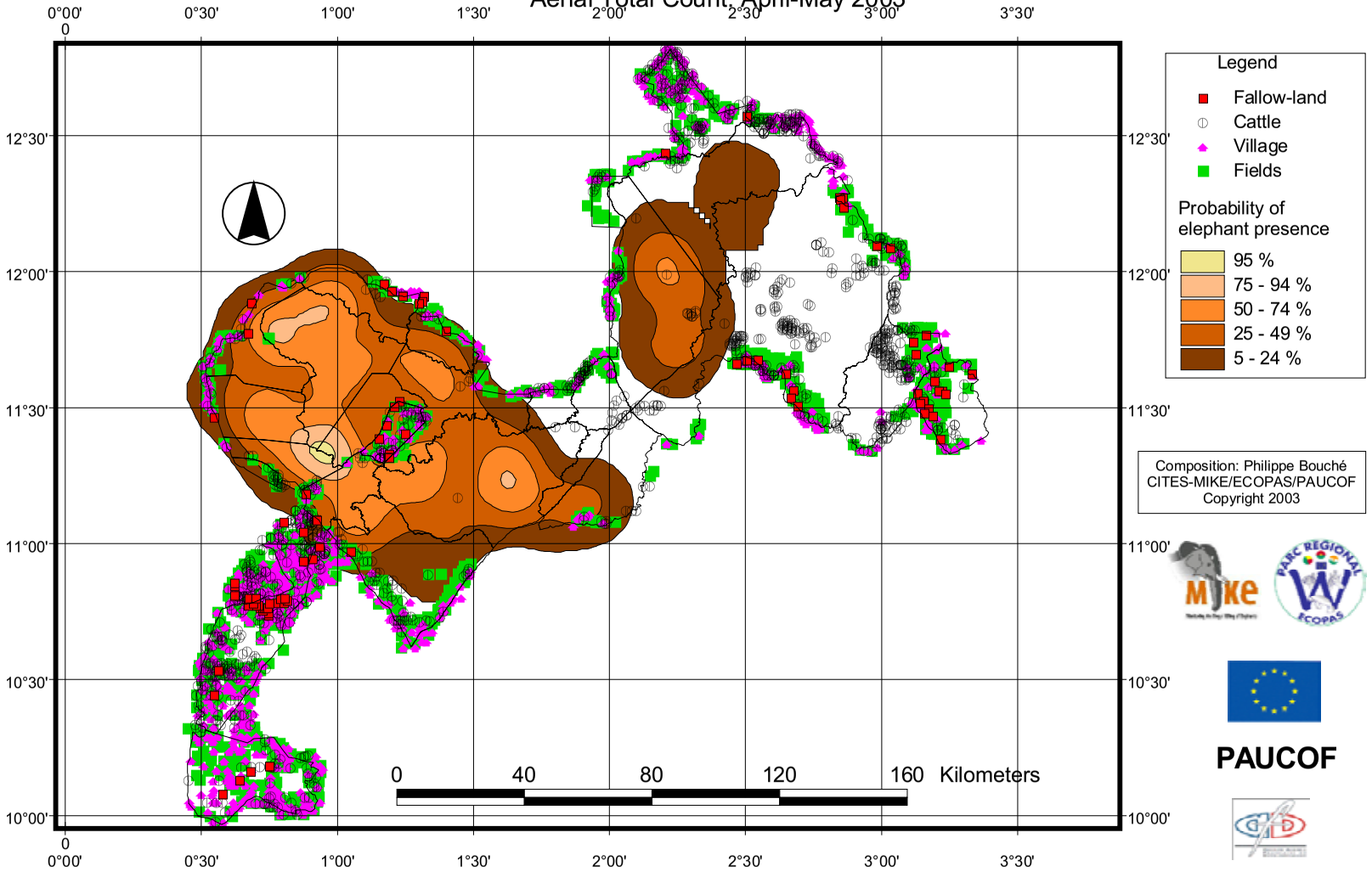
It is evident that the epicenter with the highest probability (that represents a probability at 95%) is located along Singou river in the south of Konkombouri HZ and Pama Central South HZ. It should be emphasized that this epicenter is not far from an inhabited area (Madjoari enclave). The existence of the epicenter can only be explained by two indissociable factors:

- the presence of water in the Singou river; this factor solely cannot explain this distribution since there is certainly more water in this period of the year in the Pendjari river;
- the tranquility of these localities for this species, due certainly to the concessionaires' efforts to protect their areas.

The fact that two distinct sets are evident doesn't mean that the herds in the east and west of the ecosystem have no contact. The two sets reflect the distribution observed according to the specific conditions of the moment where the census was conducted. If the census had been carried out two months earlier or later, the diagrams would no doubt have had different shapes.

Once more, one should consider that the census offers only a picture of the distribution at a specific moment. One should consider the ecosystem as a dynamic system and not as a fixed one. An area which seems to host few animals at a time "*t*" can see its numbers increase sharply some weeks or months later, depending on weather, management and/or human pressure changes in the course of the year.

Map 35. Spatial Analysis of Elephant vs Human Activities in the WAPOK Ecosystem
Aerial Total Count, April-May 2003



Elephant vs Agriculture

The graph in Figure 6 shows that the further one goes from cultivated areas the more the number of individuals (*r=0.9176*) and herds (*r=0.9925*) increases.

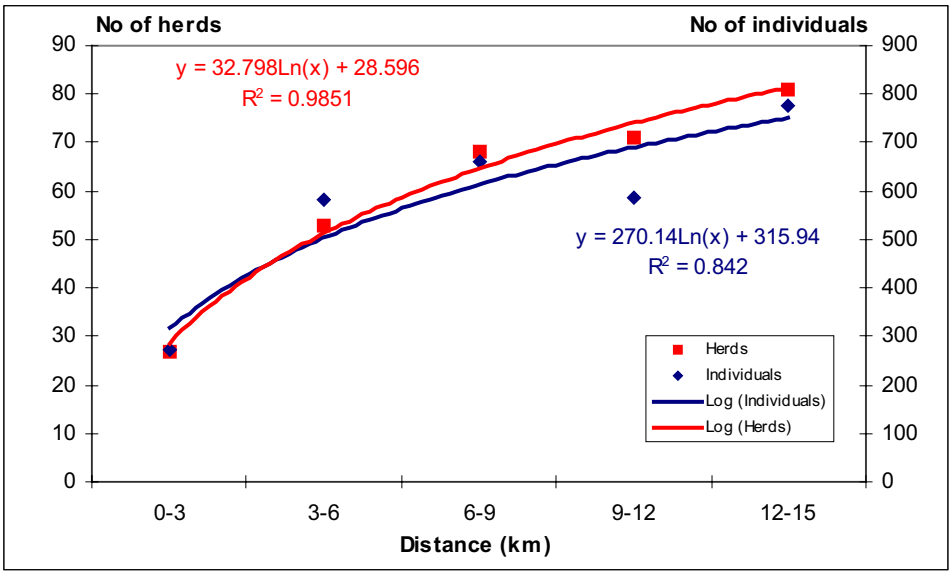


Figure 6. Distance (km) Separating the Elephant Herds and Individuals from the Cultivated Areas

On a 15 km distance, 2,873 individuals (that represent 62.5% of the population) were observed. Of this total, 70.3% of individuals and 73.3 % of herds were more than 6 km away from the first fields. Only 9% of the individuals and 9.4% of the herds were observed less than 3 km from the first fields.

Elephant vs Human Habitation

The graph in Figure 7 shows that the further one goes from human habitation the more the number of individuals (*r=0.8828*) and herds (*r=0.9801*) increases.

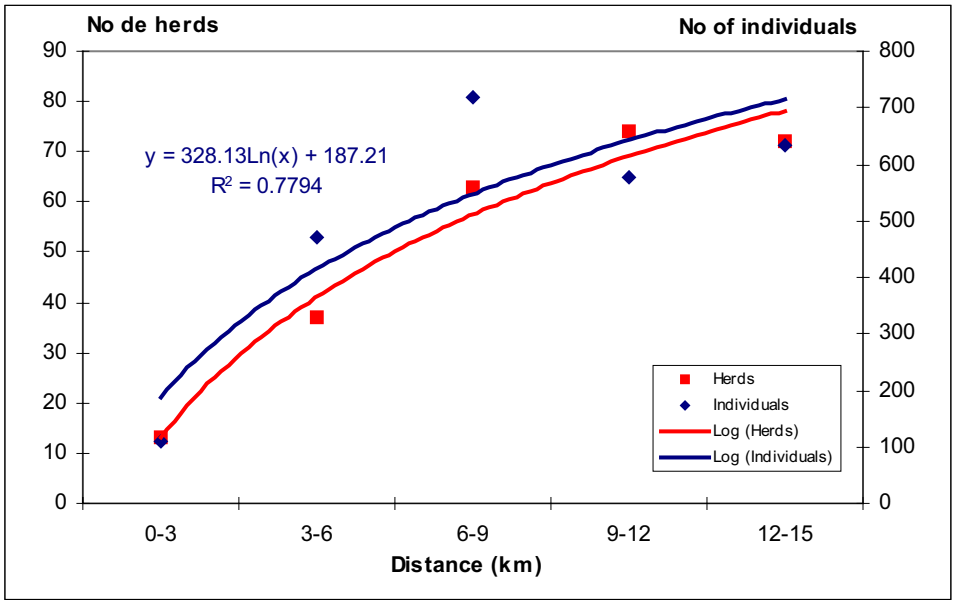


Figure 7. Distance (km) Separating the Elephant Herds and Individuals from Human Habitation

On an 15 km radius from villages, 259 herds were observed representing 2,507 individuals, or 54,6% of the total population. Also 76.8% of individuals and 80.7% of herds were observed more than 6 km away from the nearest villages.

Only 4.4% of individuals and 5% of herds were observed at less than 3 km from human habitation.

Elephant vs Cattle

As the distance separating elephant from cattle increases, the more herds (*r=0.8905*) and the more individuals (*r=0.9699*) we observe (Figure 8).

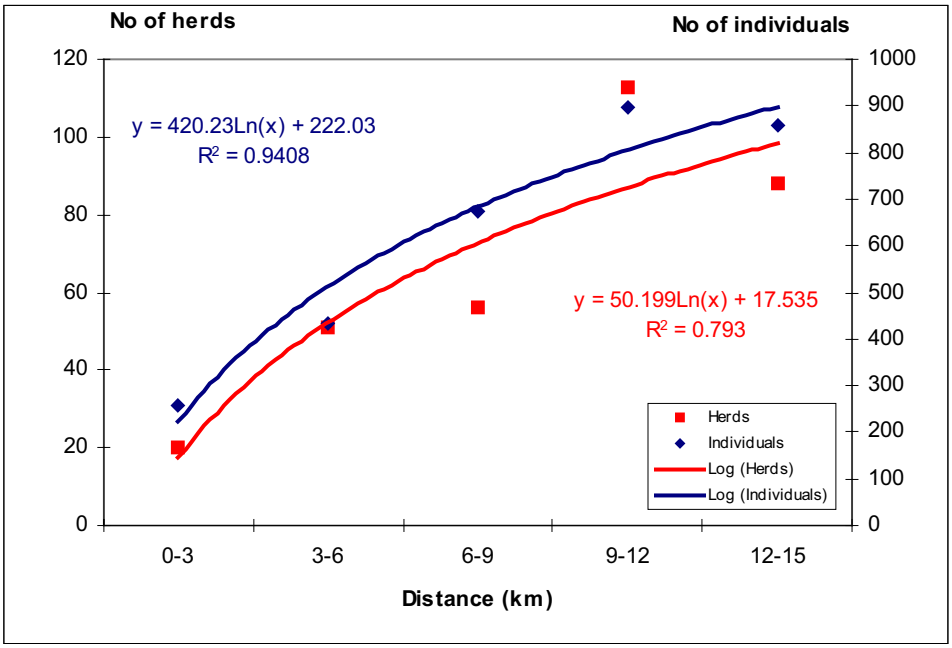


Figure 8. Distance (km) Separating the Elephant Herds and Individuals from Cattle

Of 328 herds representing 3,122 individuals (67.97% of the total population), 77.9% of individuals and 78.4% of herds were observed more than 6 km away from the nearest cattle herd; only 6% of the groups representing 8.2% of the individuals have been observed less than 3 km from a cattle herd.

In all the cases observed in the graphs (figures 6 to 8), the number of elephants individuals and herds increases with the distance which separates them from the most important human factors: villages (R^2=0,78), fields (R^2=0,84) and cattle (R^2=0,94). At the time of this census, the first activities of field preparation had already started.

Comparing to a χ^2 theoretical distribution, the elephant distribution towards villages, fields and cattle is significantly different :

$$\chi^2 = 173{,}28749 \text{ *** } (P \leq 0{,}001, 10 \text{ dl})$$

These analyses (Map 35 and figures 6 to 8 and χ^2 result) demonstrate the global lack of tranquility for elephant with respect to human beings and their most important activities that are observable from the air (agriculture, livestock, human encroachment).

5.2.2. Buffalo

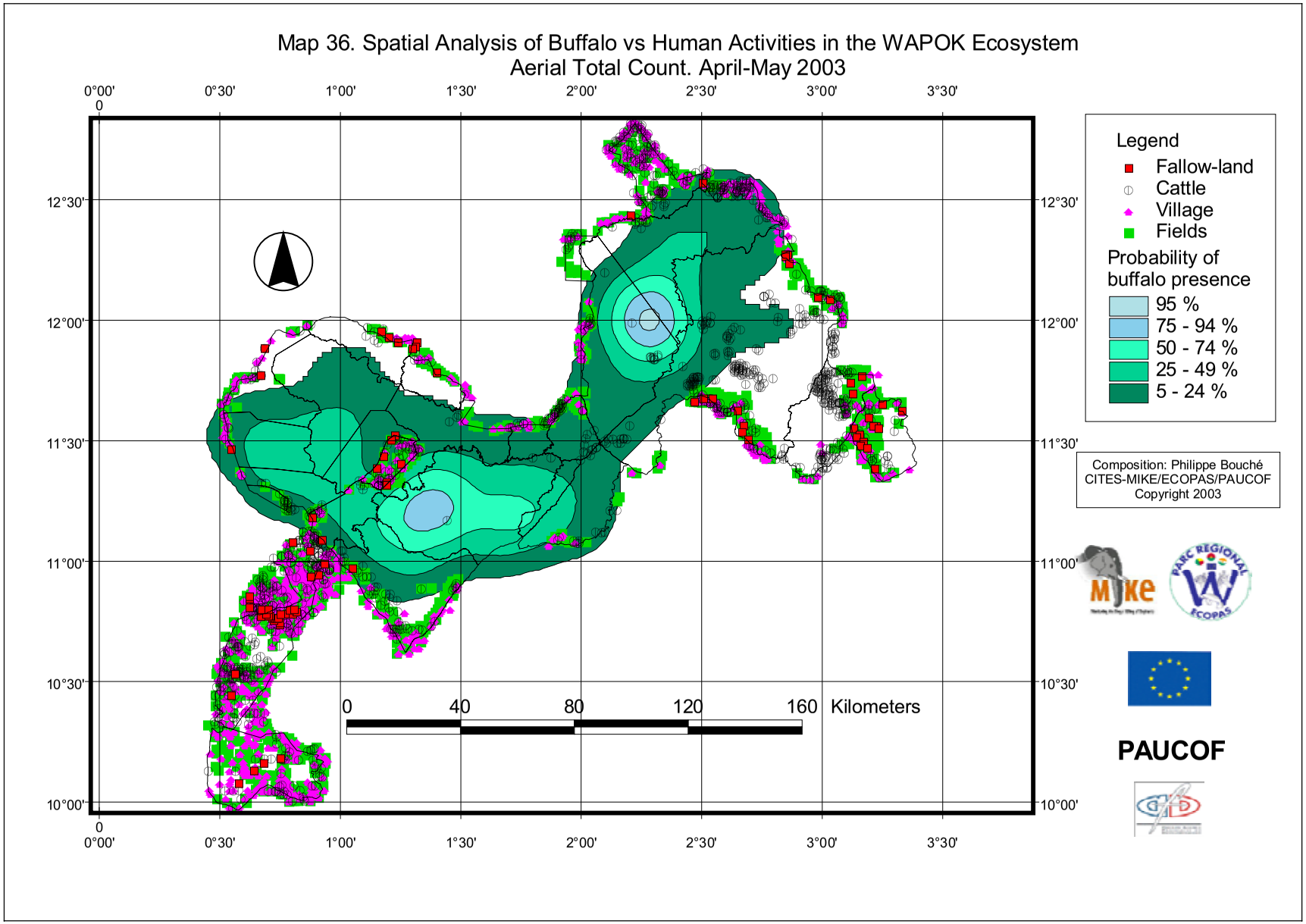
The same type of analysis was done with the data provided for buffalo.

Map 36 represents, on the basis of the observation made, the probability to find buffalo in the ecosystem at the period at which the survey was done. Each concentric circle corresponding to the probability expressed in % to find buffalo.

Map 36 shows a continuum from the banks of the Mékrou in the east of the to Pama-Pendjari complex located in the west of the ecosystem, with two epicenters in evidence:

- the most important (probability to 95%) at the east of the Burkina W NP and in the south of the Niger W NP;
- The Pendjari NP.

Once more, one should consider that the census offers only a picture of the distribution at a specific moment. One should consider the ecosystem as dynamic rather than fixed.


Map 36. Spatial Analysis of Buffalo vs Human Activities in the WAPOK Ecosystem
Aerial Total Count. April-May 2003
0°00'
0°30'
1°00'
1°30'
2°00'
2°30'
3°00'
3°30'
12°30'
12°00'
11°30'
11°00'
10°30'
10°00'
0
40
80
120
160
Kilometers
Legend
Fallow-land
Cattle
Village
Fields
Probability of buffalo presence
95 %
75 - 94 %
50 - 74 %
25 - 49 %
5 - 24 %
Composition: Philippe Bouché
CITES-MIKE/ECOPAS/PAUCOF
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PAUCOF

Buffalo vs Agriculture

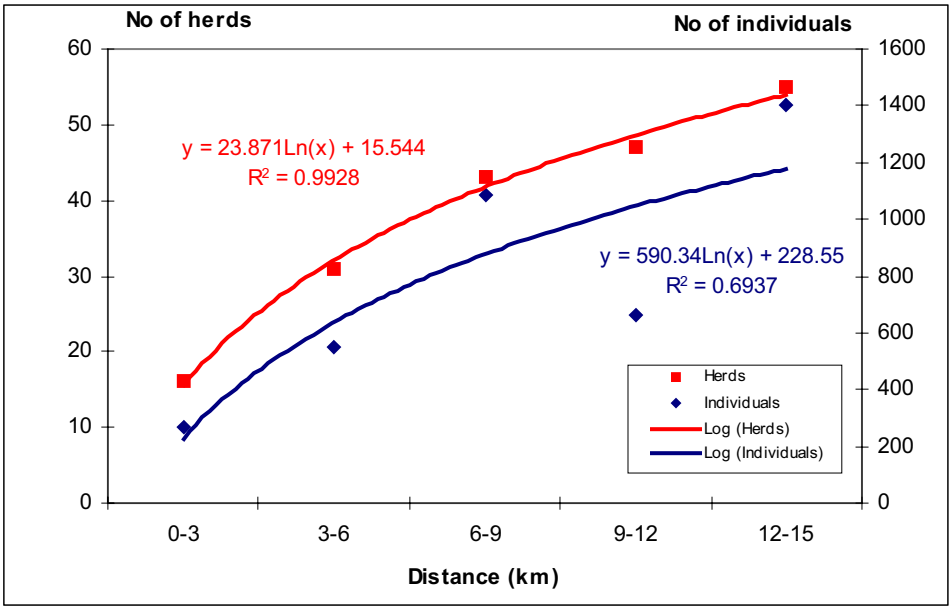

Figure 9. Distance (km) Separating Buffalo Herds and Individuals from Cultivated Areas

Figure 9 shows that the further one goes from fields the more the number of individuals (*r=0.8328*) and herds (*r=0.9963*) increases.

In a 15 km radius, 192 herds were counted representing 3,969 individuals, (37.6% of the population). Of this total, 75.5% of groups representing 79.5% of individuals were recorded more than 6 km away from the nearest fields.

Only 8.3% of groups representing 6.8% of individuals were observed less than 3 km away from the fields.

Buffalo vs Human Habitation

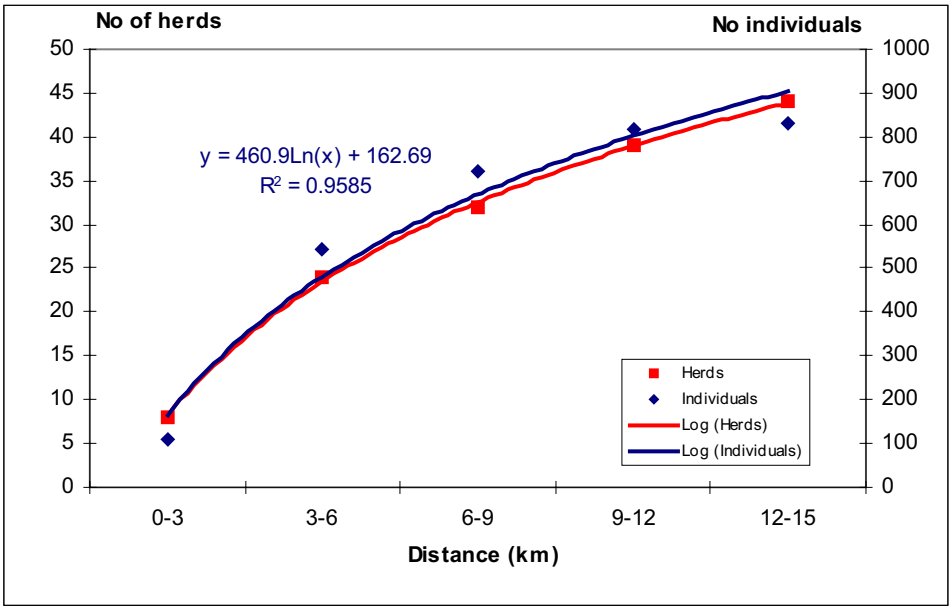

Figure 10. Distance (km) Separating Buffalo Herds and Individuals from Human Habitation

The graph in Figure 10 shows that the further one goes from villages the more the number of buffalo individuals (*r=0.9790*) and herds (*r=0.9996*) increases.

In a 15 km radius from human habitation, 147 herds were counted representing 3,020 individuals, (35.34% of the population). Of this total, 78.2% of groups representing 78.4% of all individuals were recorded more than 6 km from the nearest villages.

Only 5.4% of the groups representing 3.6% of all individuals were observed less than 3 km from the villages.

Buffalo vs Cattle

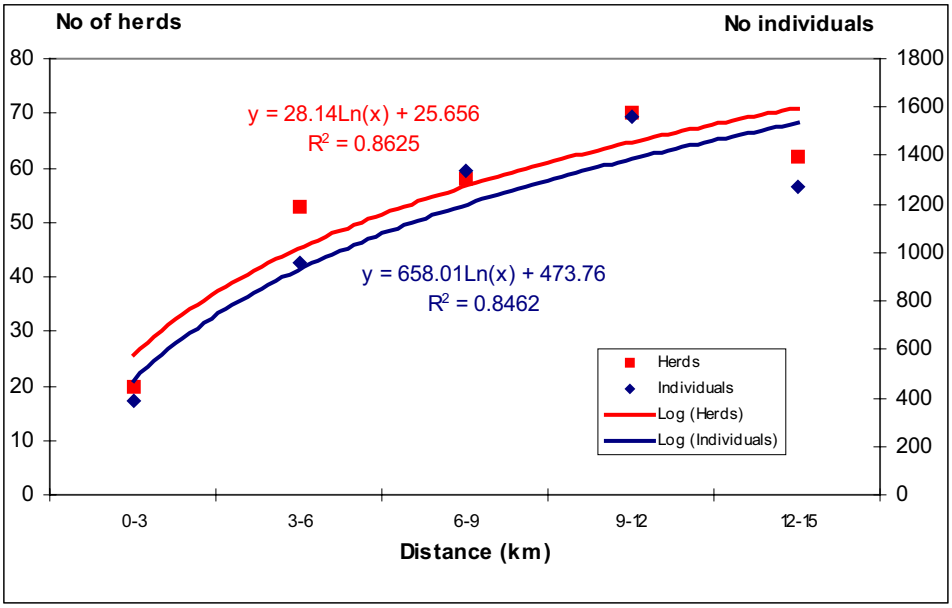

Figure 11. Distance (km) Separating Buffalo Herds and Individuals from Cattle

The more the distance separating buffalo from cattle increases, the more buffalo herds (*r=0.9287*) and individuals (*r=0.9199*) one observes (Figure 11).

In a 15 km radius, 263 herds were counted representing 5,519 individuals (52.3% of the population). Of this total, 72.2% of groups representing 75.6% of individuals were recorded more than 6 km from the nearest villages.

Only 7.6% of groups representing 7% of individuals were observed less than 3 km away from the villages.

The main human activities around and within the ecosystem have also an impact on the distribution of buffalo, given that in all graphs the number of buffalo and buffalo herds increases with the distance which separates them from the main human activities: in the increasing order of foci of permanent human presence: 1) cultivation (R^2=0,69); 2) cattle (R^2=0,84); and 3) human habitation (R^2=0,96).

Comparing to a χ^2 theoretical distribution, the buffalo distribution towards human habitation, fields and cattle is significantly different :

χ^2= 563,71272 *** (*P≤ 0,001*, 10 dl)

These analysis (Map 36, figures 9 to 11, and the χ^2 test result) demonstrate the global lack of tranquility for buffalo with respect to human beings and their most important activities that are observable from the air (agriculture, livestock, human encroachment).

It is also possible that, in the areas with high density of cattle (Djona, Oti-Mandouri), cattle compete for food and water with buffalo during some periods of the year and the latter could be obliged to avoid the pastures and space occupied by cattle. A phenomenon exists in West Africa that lead wildlife to avoid areas used by cattle except in some particular situations (Blake & al. 2003). Insufficient information exists to permit further discussion on the issue.

6. DISCUSSION

It would be tempting to establish a comparison with the results obtained during this census with those obtained during previous surveys. However, it should be remembered that this operation was the first to cover the whole ecosystem that there is no previous comparable information.

Overall ecosystem-wide, we were able to note some heterogeneity in census efforts (Poché 1974 ; Bousquet, 1982a,b; Delvingt, 1987; Green, 1979, 1988 ; Marchand & al, 1993 ; Bélemsobgo & al 1993 ; Barry & al., 1998 ; Chardonnet & al., 1999 ; Sinsin & al. 2000, 2001, 2002 ; Rouamba & al. 2002 a,b,c; Bélemsobgo & al, 2002 ; Bouché & al 2000). However only some areas were frequently counted, while others were never surveyed at all. It is also worth noting some heterogeneity in the methods used, in the climatic period and the regularity of the surveys. For all previous counts there was no Inter-State co-ordination, except during the aerial survey conducted in one area of the ecosystem (being the « W » NP in 2002; Rouamba & al. 2002 c).

This being the case, with no better knowledge of ecosystem dynamics, it would be best to refrain from comparing and attempting to establish population trends, which would undoubtably provide inexact and simplistic results.

If it is considered that one can or should attempt to compare population figures for specific areas with those obtained by previous counts, the reader should be cautioned by the fact that such attempts can only provide very rough information as they don't take into account animal movements and fluxes within the ecosystem, especially for the more migratory large-sized species such as elephant, buffalo, roan, or topi.

A valid comparison can only be carried out if we have knowledge of the ecosystem-wide population figures and dynamics. The information available is still largely insufficient to make valid comparisons.

This survey represents a baseline for the future. The next aerial total count of the whole WAPOK ecosystem, will provide information for a valid comparison of the numbers and possibly trends of large-sized species.

7. RECOMMENDATIONS

In order to improve knowledge of the ecosystem, the following recommendations should be pursued :

1. The ecosystem aerial total count should be repeated on a bi-annual or tri-annual basis. It is not necessary to do it every year, as an evaluation of population numbers every 2 or 3 years is sufficient to determine trends.

2. The total aerial count should be conducted in February: such was our first objective, although the count was postponed for reasons beyond our control.

3. Further studies need to be undertaken of species less-common such as waterbuck, Western topi, and red-fronted gazelle whose status is critical in the ecosystem, as well as the carnivores whose status is unknown.

4. The influence of human factors that play a negative role on wildlife distribution in the ecosystem should be monitored, with special attention paid to illegal encroachment and cattle distribution.

5. Ecological monitoring needs to be strengthened for the whole ecosystem and, therefore, Inter-State cooperation needs to be strengthened as well.

6. The Countries participating in the management of this ecosystem must request that all census reports include all raw data in appendices clearly describing the procedure and calculations, a copy of the report on CD ROM. This is essential both for maintaining scientific honesty, as well as standard and integrity relative to the participating financial partners and wildlife managers.

7. Foot counts should be encouraged for small-sized species.

8. During the next surveys, the capacity building of participant observers' teams should be pursued.

9. MIKE reports from each site must be transmitted on a regular basis and MIKE carcass forms should be diffused to all conservation stakeholders in order to sustain the ecological monitoring process throughout the ecosystem.

8. CONCLUSIONS

The aerial total count of 2003 aimed at laying the foundation for a basic understanding of the WAPOK Ecosystem, the largest savannah ecosystem and certainly one of the richest wildlife ecosystems in West Africa. Because of this richness and due to its size it joins the ranks of the most important wildlife ecosystems of Africa.

This ecosystem is of a particular interest for the MIKE Programme because it hosts the largest savannah elephant population in West Africa.

The count demonstrates that this single ecosystem hosts a definite number of elephant – according to the criteria of the African Elephant Database – which is almost the same that known for the entire West African region until now (Blanc & al 2003) and twice that known for the entire West African region in 1998 (Barnes & al 1999).

The study has shown that the presence of surface water plays an important role in the distribution of wildlife in this ecosystem. Managing this factor is therefore vital.

As demonstrated, elephant and buffalo populations at this site are significant, but the distribution of human activities (fields, villages) significantly influences the distribution of wildlife; elephant and buffalo in particular. It seems obvious that wildlife avoids all areas occupied by people and their livestock.

Certain figures produced by this report, due to their numerical importance, surprised many field specialists involved for a long time in West African wildlife conservation. This is symptomatic of the fact that the current knowledge of the WAPOK ecosystem is generally poor. The full integration and enhanced cooperation of the various stakeholders of wildlife management being undertaken by Governments, concessionaires, projects, NGOs, surrounding communities and scientists is certainly indispensable to bridge the gap.

This aerial census paved the way for ecosystem monitoring which should be sustain from sub-regional projects. As a matter of fact, it is only from knowledge acquired by studies of the ecosystem that it will be possible to efficiently and effectively conserve this heritage in the long-term. Due to its ecosystemic and sub-regional vision, the ECOPAS Project is in a good position to play a particularly important role.

The CITES-MIKE Programme hopes to repeat this operation in 2 or 3 years with support from partners who assisted it this year : ECOPAS and PAUCOF Projects, and other partners interested in pursuing monitoring efforts.

Regular monitoring cannot be complete without (among other activities), regular transmission of MIKE reports containing the necessary indicators of not only elephant populations but also of many other species. Systematic use of reports on carcasses in areas of the ecosystem other than the MIKE sites could be proven extremely profitable for relevant authorities in participating countries.

9. REFERENCES

BARNES, R.F.W., CRAIG, G.C., DUBLIN, H.T., OVERTON, G., SIMONS, W., AND THOULESS, C.R. 1999. African Elephant Database 1998. *Occasional Paper of the IUCN Species Survival Commission No. 22. IUCN. Gland, Switzerland. 249 p.*

BARRY I., CHARDONNET B. 1998. Recensement aérien de la faune de l'Unité de Conservation d'Arly. Résultats et commentaires. *Ministère de l'Environnement et de l'Eau. Burkina Faso. 24 p.*

BELEMSOBGO U., DOAMBA B. & DRABO A. 1993. Estimation de la densité de grands mammifères dans la Réserve Partielle de Faune de Pama. *Ministère de l'Environnement et du Tourisme 50p.*

BLAKE S., BOUCHÉ PH., RASMUSSEN H., ORLANDO A., DOUGLAS-HAMILTON I. 2003 The last Sahelian Elephants. Ranging behavior, population status and recent history of the desert Elephants of Mali. *Save The Elephants.49pp.*

BLANC J.J., THOULESS C. R., HART J.A., DUBLIN H.T., DOUGLAS-HAMILTON I., CRAIG C.G. AND BARNES R.F.W. 2003. African Elephant Status Report 2002. An update from the African Elephant Database. *Occasional Paper of the IUCN Species Survival Commission No. 29. IUCN. Gland, Switzerland. 301 p.*

BOUCHÉ PH. 2001. Méthodologie et techniques de recensement des grands mammifères en Afrique. *Institut Vétérinaire Tropical. Université de Liège. 182pp.*

BOUCHÉ PH. 2002. Elephant survey of Mole National Park. Ghana. March 2002. Report of the aerial survey. *Wildlife Division. CITES-MIKE 52pp*.

BOUCHÉ PH., HEYMANS J.-C., LUNGREN C. G., OUEDRAOGO L. K. 2000 Recensement des animaux sauvages dans les concessions de faune de l'Est. *Ministère de l'Environnement et de l'Eau. Burkina Faso. UICN 2000. 96 p + annexe.*

BOUCHÉ PH., LUNGREN C. G., OUEDRAOGO L. K. 2002. Statut et tendances des effectifs d'éléphants dans les aires protégées de l'Est du Burkina Faso. *Pachyderm 32, 49-54.*

BOUSQUET B. & SZANIAWSKI A. 1981. Résultats des inventaires aériens des grands mammifères dans la région « Pendjari Mekrou ». *Bénin et Haute-Volta, FAO FO : DP/UPV/78/008 DP/BEN/77/011; Document de terrain N°4. Version non officielle*

BOUSQUET B.1982A. Inventaire des ressources en faune sauvage et étude économique sur son utilisation en zone rurale. Résultats des inventaires aériens de la faune. *Haute Volta, FAO FO : DP/UPV/78/008 ; Document de terrain N°6 Rome.*

BOUSQUET B.1982B. Inventaire des ressources en faune sauvage et étude économique sur son utilisation en zone rurale. Diversité de la faune et évaluation numérique et économique des populations de grands mammifères. *Haute Volta, FAO FO : DP/UPV/78/008 ; Document de terrain N°8 Rome.*

CHARDONNET B., ROUAMBA P., BARRY I., OUEDRAOGO A. & NACOULMA P. 1999 Suivi écologique aérien des aires classées des bassins de l'Arly et du Singou. *Ministère de l'Environnement et de l'Eau. Burkina Faso. 124 p.*

CRAIG C. G. 2002 Aerial survey standard for the MIKE project.29 pp.

DELVINGT W.1987. Programme d'aménagement des Parcs Nationaux et de protection de l'environnement. Rapport sur l'Evolution des populations de grands mammifères dans le Parc National et la Zone cynégétique de la Pendjari. *Ministère du Développement Rural et de l'Action Coopérative. République Populaire du Bénin. 23p.*

DOUGLAS-HAMILTON I. 1996. Comptage des éléphants par l'air. Comptages totaux. 31-41. *in Kangwana K. (ed.) (1996)* L'étude des éléphants*. Série des manuels techniques AWF n° 7. African Wildlife Foundation. Nairobi.190 p.*

FRAME G. LUNGREN C., HERBISON FRAME L., LUNGREN R. 1991. Estimation de la population des grands mammifères au Parc National du W Burkina Faso. *ADEFA. Ministère de l'Environnement et du Tourisme. Burkina Faso. 22p*

GREEN A.1979. Density estimates of the larger mammals of Arli National Park, Upper Volta. *Mammalia 43 (1), 59-70*.

GREEN A.1988. Elephants of the Pendjari-Singou-Mékrou region. West Africa. *Mammalia 52 (4), 557-565.*

KINGDON J. 1997. The Kingdon field guide to African mammals. *Academic Press. Harcourt Brace & Company Publishers. San Diego, London, Boston, New-York, Sydney, Tokyo, Toronto. 465 pp.*

MARCHAND F., LACROIX F., PASQUET H., SEBOGO L. LAMARQUE F. 1993. Projet :« Sauvegarde des Eléphants du Burkina Faso ». Rapport Final. *Ministère de l'Environnement et du Tourisme Burkina Faso, Ministère de la Coopération, République Française.*

NORTON-GRIFFITHS M. 1978.Counting animals. *2nd edition. Handbook no 1. African Wildlife Foundation. Nairobi. 139 p.*

OMONDI P., BITOK E., ONESMAS KAHINDI, MAYIENDA R. 2002A. Total Aerial Count of Elephants in Laikipia/Samburu Ecosystem. *KWS, CITES-MIKE, EU, STE, NEMA, Laikipia Wildlife Forum. 36p.*

OMONDI P., KING J., BITOK E. & GEDDES C. 2002B. Total Aerial Count of Elephants and Buffalo in Tsavo/Mkomazi Ecosystem. *KWS, CITES-MIKE, 23p.*

PENNYCUICK C. J. & WESTERN D. 1972.An investigation of some source of bias in aerial transect sampling of large mammal populations. *E. Afr. Wildl. J. 10 (1), 175-191.*

POCHÉ R. M. 1974. Ecology of the African elephant (*Loxodonta a. africana*) in Niger, West Africa. *Mammalia, 38(4), 567-580.*

ROTH H.H. & DOUGLAS-HAMILTON I 1991. Distribution and status of elephants in West Africa. *Mammalia, 55(4), 489-527*.

ROUAMBA P., HIEN B, OUEDRAOGO A., NACOULMA P. & JULIA R. 2002A. Recensement aérien de la faune sauvage du bassin de l'Arly. *Ministère de l'Environnement et du Cadre de Vie. Burkina Faso. 73p.*

ROUAMBA P. & HIEN B. 2002B. Recensement aérien de la faune sauvage dans la Réserve de la Biosphère de la Pendjari. *Ministère du Développement Rural, CENAGREF. Bénin. 48p*.

ROUAMBA P. & HIEN B. 2002C. Recensement aérien de la faune sauvage dans l'Ecosystème le Parc transfrontalier du « W ». *République du Bénin, Burkina Faso, République du Niger Programme Régional Parc – W (ECOPAS) ; FED 69p.*

SINSIN B. 2000. Dénombrement de la faune dans la Réserve de la Biosphère de la Pendjari. Avril 2000. *PCGPN. CENAGREF, GTZ, 55 p.*

SINSIN B. 2001. Dénombrement de la faune dans la Réserve de la Biosphère de la Pendjari Avril 2001. *PCGPN. CENAGREF, GTZ, 40 p, 13p, 6p.*

SINSIN B. 2002. Dénombrement de la faune dans la Réserve de la Biosphère de la Pendjari Avril 2002. *PCGPN. CENAGREF, GTZ, 40 p, 13p, 6p.*

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ANNEX 2. ABBREVIATIONS

AED: African Elephant Database

AFD : French Development Agency

CF : Classified Forest

ECOPAS : Ecosystème Protégés d'Afrique Sahélienne (Sahelian African Protected Ecosystems)

FR : Faunal Reserve

FSO : Front Seat Observer

GIS: Geographical Information System

GPS: Global Positioning System

GR : Game-ranch

GTZ: German Cooperation

HZ : Hunting Zone

MIKE: Monitoring the Illegal Killing of Elephants.

NP: National Park

PAUCOF : Projet d'Appui aux Unités de Conservation de Faune (Wildlife Conservation Unit Support Programme)

RSO : Rear Seat Observer

SE: Standard Error

UTM : Universal Transverse Mercator : Système de projection géographique Mercator

WAPOK: « W »-Arli-Pendjari-Oti-Mandouri-Keran Wildlife Ecosystem

ANNEX 3. BRIEFING NOTES FOR WEST AFRICA ELEPHANT COUNT – 2003

Objectives

To establish the status of the West African Savannah elephant populations as part of MIKE's implementation Programme in the region.

Counting Methods

The ecosystem has been divided up into discrete counting blocks, usually bordered by well-defined features such as roads, rivers, escarpment edges, mountains or the Park boundary. Each crew will be allocated one or more blocks to be counted each day and will be provided with fight maps of the blocks.

Elephants & dead elephants and Buffaloes will be counted. All other species will be estimated. **Cattle, goats** and **sheep** (**shoats**) herds will be recorded as approximate estimates. The aim is to fly parallel lines across each block, to scan the entire surface and to record the accurate position and number of each group of animals.

A UTM grid has been super-imposed on each block map, so that transects can be flown on this grid with the help of Trimble GPS.

The GPS will also record the exact flight pattern for the later reconstruction of the exact position of each observation.

The GPS will be used to fly in parallel strips or 'flight lines', using the GPS to stay on track. In most cases East-West lines should be chosen, which has the advantage of equal light for the observers on both sides.

Pilots Role

The pilot should be familiar with using a GPS to fly a grid pattern before beginning the count. Training and practice will be provided on the first day on how to use the GPS.

The pilot and FSO must pre-plan each flight, decide on whether they will fly East-West or North-South transects. It is a good idea also to decide on the standard strip width separation to be used (this should be discussed with co-ordinators). Adjacent strips should be no further apart than the distance at which the observers can spot the animals in question. Suggested intervals are **1 km** or less for the riverine or dense areas, spreading out to **1.5** to **2 km** in the more open areas, or in the larger blocks.

When herds on the far side of a strip need to be counted or photographed the basic flying pattern may be interrupted temporarily. Normally, the aircraft and crew will circle around a group of elephants.

Great care must be taken, however, to resume the original strip at the spit at which is was broken off (refer to ground features before leaving the strip and use the GPS to reorient yourself when rejoining to check that you are on line).

Speed is largely determined by the type of aircraft used, **130kph/80mph** is the most suitable speed for total aerial counts.

Height should be adapted to prevailing conditions (visibility, vegetation type etc.). A suitable mean height is **200-400 feet**. Flying higher increases the tendency to do wider strips, which should be avoided. Changes in ground level altitude should be observed and taken into account.

The pilot is also responsible for guaranteeing that he or she flies a **2-3km overlap** into the adjacent block on each block boundary. The pilot should participate in the counting only in so far as he can comfortably do so. In many cases, the pilots vantage point can prove particularly useful in drawing the observers attention to the animals coming in the plane's flight path.

Sharing responsibilities

The pilot and Front Seat Observer (FSO) must also decide on their start point and programme this into the GPS. The start point should be about 2km outside the block on the first flight line, so that the pilot has some time to line up on his correct line. The first transect should be at least 1 km outside the block in order to give a margin of overlap, and when turning at the end of each transect a similar overlap should be left into the next block.

Observers Role

The FSO will be responsible for the actual recording of data. The FSO will, in consultation with the RSOs and the pilot, adjust the strip widths as necessary. The flight lines should be recorded onto the FSO's flight map including any deviations. This will be compared later with the computer print-out, but is needed in case of any computer failure. The FSO must be certain that the pilot is flying a satisfactory overlap into adjacent blocks. The FSO will have primary responsibility for the recording and mapping of all data as described below.

The RSOs are responsible for observing on his or her side of the plane and for helping out when other observers are estimating large herds. When an animal is spotted they will call out clearly and loudly to the pilot and FSO indicating the species, side of aircraft, and the number of individuals counted (for example: 'Elephant, right, twelve). Very often if there is any doubt as to the exact number the pilot will need to circle the group until a consistent figure is agreed upon.

RSOs must alert the pilot when it will be necessary to photograph a herd that is too large to simply count (all herds over 25). See below for instructions on photography. The RSOs are responsible for calling out herd estimates on all herds that are photographed.

RSOs should make every effort not to call out their data at the same time as their fellow RSO is calling out his/hers. They must commit their information to memory and call it out to the FSO at the earliest possible opportunity or when requested by the FSO.

Recording animal numbers, species and photographic data in the plane:

The animals recorded will be elephants (**E**) both live and dead, buffalo (**B**), rhinos (**RH**) and cattle (**C**), sheep and goats (**SH**) distribution. Dead elephants will be recorded in the following categories:

- **F** for **fresh** carcass (less than three weeks old), where there is still flesh beneath the skin giving the body a rounded appearance and a pool of body fluids is still moist on the ground. Vultures may be present.
- **R** for **recent** carcass (more than three weeks old but less than one year old), the skin and bones are mostly in place, an open rot patch is present around the body from the decomposition fluids which have killed the surrounding vegetation.
- **O** for an **old** carcass (more than a year old), where only a skeleton is present with white bones visible, vegetation will have started to re-grow and the rot patch has disappeared. Skin may still be present.
- **VO** for a **very old** carcass (up to ten years old), where the bones are grey and cracked and widely scattered so the carcass does not stand out as a distinct entity. Difficult to spot from the air.

Each FSO will be equipped with a data entry sheet and a flight map. The FSO will be responsible for the entry of all data onto these sheets. During the flight the FSO will record, serially as a GPS way-point (or time reading), each individual group of each species on the data sheet along with the herd count or estimate and any photographs taken.

Recording the way-points (or time readings)

The pilot will record the actual way-point (or time point) on the GPS for later computer downloading. A briefing and demonstration of GPS handling will be made.

Correspondingly, the FSO will plot each group (according to its GPS way-point number (or time reading) on the data sheet) on the flight map. The FSO will not record the number of individuals per group onto the flight map. This will be done on clean maps later.

Group sizes are important for later analysis. Therefore, the FSO will plot each discrete group including single animals (NO LUMPING) in its approximate location. The pilot can assist the FSO to determine the plane's exact location at any given time. Make sure adjacent groups do not get mixed up by encircling more than one group on the flight map. Where groups are concentrated, they may be most clearly recorded on the flight map outside the actual block boundaries with an arrow to show the approximate location. When numerous herds are gathered in close proximity it may be easiest for the pilot to fly high and together with the FSO and RSOs work out a plan for the order of counting the different herds before coming low again to count

each herd in the order agreed upon. If a waypoint has more than one observation the FSO must make sure the same waypoint number is written down for each observation.

Photographs

When herds of buffalo or elephant number more than 25 they are to be photographed. The FSO must coordinate closely with the pilot to assure the best possible alignment and order before they begin to count or photograph the herd(s). The FSO will then record the group number onto the flight map and the **group number, species, film number** and **number of frames taken** and an **estimate of herd size** onto the data sheet.

It is imperative that an estimate be made in the unlikely event that the films are destroyed of the camera is malfunctioning. A blank should be shot into the lens cap or the photographers hand in between different herds of between different series of shots of one herd to allow for accurate herd separation in the final photographic analysis. Make sure that all your films are properly labelled. Films will be numbered in advance. The individual film number will be scratched into the emulsion on the film leader – check to make sure this has been done.

Generally, the best angle for photography is slightly oblique, but not too oblique as larger animals may obscure young ones. Buffalo herds are particularly difficult to photograph properly. When bunched up or lying down, buffalo must be 'buzzed' to get them up and moving before the photograph is taken. Do not take pictures for too high up as it defeats the purpose when the animals are too small to count on the pictures.

Photographs should not be taken at anything under 1/500 sec or they will be blurred. Also make sure your film speed is set at 400 ASA. Make certain your focus is at infinity. It is often a good idea to tape it fast for the duration of the count. You may use a 50 or 55mm lens but a 105 or 135mm lens is preferable.

Finalising Data

Clear and legible recording is not always possible while flying. Therefore, after each day's flying the **FSO should set aside an hour or so for finalizing the day's data collection**. The original data sheets and flight maps must be tidied up so that they are legible by anyone attempting to read them. After cleaning up the original flight data, the FSO must then clean up the map.

The ground crew at the end of the day's flying will download the GPS, and a map of the flight path together with the waypoints will be printed out. The FSO must then check this map, and write down the actual number of each species recorded as well as dead elephants at each waypoint (using species code and number or estimated number of individuals). At this stage any **double counts of herds should be removed** through discussion with the pilot, RSOs and co-ordinators. This cleaned and checked map will be used for preliminary analysis by the co-ordinators.

A display table will be filled in at the end of each day by the ground crew showing the total number of each species counted in each block, together with start and stop flight times.

Key for species codes to be used:
(codes relevant to this count are in **bold**)

B	**Buffalo**
BN	Baboon
BEF	Bat Eared Fox
C	**Cattle**
CH	Cheetah
CM	Camel
CR	Crocodile
DD	Dik Dik
DK	Duiker
DN	Donkey
E	**Elephant**
ED	Eland
F	**Fresh Carcass**
G	Giraffe
GG	Grants Gazelle
GK	Greater Kudu
GN	Gerenuk
HP	Hippo
HY	Hyena
IM	Impala
LN	Lion
LK	Lesser Kudu
O	**Old Carcass**
OS	Ostrich
OX	Oryx
R	**Recent Carcass**
RH	**Rhino**
SH	**Shoats**
VO	**Very Old Carcass**
WB	Waterbuck
WH	Warthog
Z	Zebra
ZG	Grevy Zebra
BB	Bushbuck
JK	Jackal

Make sure a distinction between carcass types is given, i.e:

- Recent
- Fresh
- Old
- Very Old