Total Aerial Count of Elephants, Giraffes, Roan Antelopes and other Wildlife Species and Ostrich in Waza National Park, Cameroon

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Counting Crew Waza February 2007 Total Aerial Elephant Count

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EXECUTIVE SUMMARY

The total aerial count of elephants for Waza National Park was conducted between 21st and 23rd February 2007. A Cessna 206 Stationair six-seater aircraft fitted with GPS was used in navigation, recording survey paths and waypoints. Total counts of elephants and other wildlife species were done and livestock numbers were estimated. A total of 496 elephants were counted in three different herds of 180 and 66 in the park along with a further 250 migrating towards Kalamaloue National Park. The herds in the park were aggregated around central part of the park along river. This represents a decrease of 77.5% compared to the sample count estimate of 1100 by Tchamba et al 1991. The total number of carcasses recorded was 7 giving a carcass ratio of 2.85%. This ratio is high and if used as a relative index of poaching levels then the situation in the Park could be a cause of concern, though the age of the carcasses (old & very old) needs to be kept in mind.

About 21,002 heads of livestock and over 50 farmlands and human settlement were estimated in the Park. This signifies a high level of human activities in the area and thus a high potential for loss of range for the elephants and illegal killing.

INTRODUCTION

Elephants in Cameroon occur in three distinct bio-geographical regions, with the Savannah elephants occurring in the northern Savannah ranges in the Sahelian and Sudanian regions and forest elephants in the Southern forested area (Tchamba *et al* 1997). In 1936, the northern savanna population was estimated at no more than 200 individuals, while the southern forested zone was thought to hold between 9,000 and 10, 000 elephants (Jeannin, 1936). Between the 1940s and the 1960s, populations in the northern savanna reportedly doubled and by 1971, increasing elephant numbers were already cause of concern as elephants were destroying Acacia tree woodland in Waza National Park (Corfield & Hamilton, 1971). Most of the increase was associated to the immigration into northern Cameroon from Chad, probably resulting from disturbances there such as the deforestation of the Manadelia Faunal Reserve (Fry, 1970).

Many attempts had earlier been done to estimate Waza National Park elephant population. Esser & Van Laveieren estimated 478 elephants in 1978; Eijs & Ekobo, 1988; Steehouwer & Kouahoe in 1969 estimated 750 elephants within the Park. An aerial sample count conducted in the Waza –Logone ecosystem in 1991 gave an estimate of 1,100 elephants (Tchamba & Elkam, 1995). Given the disparities in counting methods and the growing length of time since the last systematic survey in 1991, it was important to get an up to date population estimate.

Waza National Park is one of the Cameroon's MIKE (monitoring of illegal killing of elephant) sites and is believed to hold the largest elephant population in Northern Cameroon with high concentration of other large mammal, which makes Waza the focus of considerable conservation interest in Cameroon.

Information on elephant numbers and range is important for the effective conservation and management of Africa's elephants. The 2007 total aerial count of Waza National Park was therefore undertaken to determine the current baseline status of Waza's elephant population and map out the threats to this northern population and their distribution.

Objectives of the survey

The objectives of the survey were therefore as follows:

- Establish current elephant population size and distribution
- Determine number and distribution of elephant carcasses
- Setting a baseline for future change in the elephant population size and distribution
- Document distribution and numbers of other species such as Giraffes, roan antelopes and livestock
- Train Cameroon staff in the methods of aerial counting of elephants
- To map the incidences of human activities that may be threatening elephants through protected area encroachment

STUDY AREA

Waza national park (figure 1) is located near Lake Chad in the department of Logone and Chari, Northern Province of Cameroon and lies between 11º00'-11º30'N and 14º30'-14º75'E. It covers an area of approximately 170 000 ha with an average altitude of 300-320m, rising to 500m on the rocky outcrops around Waza village.

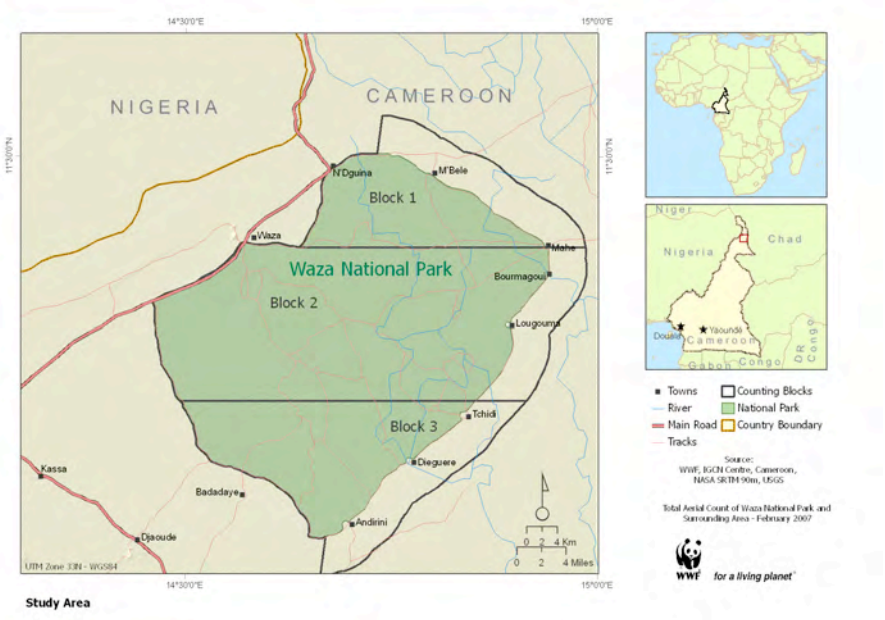

Figure 1 : Study Area, Waza National Park & the buffers

The park lies in the Chad depression in an area of low relief with no permanent rivers. Soils are mainly ferruginous tropical with various catenas, hydromorphic soils and vertisols.

The climate of the region is semi-arid, with a dry season extending from October to May. Rainfall is irregular, with an annual mean of 700mm. The mean annual temperature is 28ºC. December is the coolest month, with a mean monthly minimum temperature of 16ºC and a mean monthly maximum temperature of 33ºC. April, just before the first rains, has a mean monthly minimum temperature of 21ºC and a mean monthly maximum temperature of 45ºC.

The vegetation comprises open *combretaceous* shrub savanna with *Sclerocarya birrea* tree savanna, *Combretum* and *Terminalia* shrubs and stands of *Hyphaena thebaica*; *Anogeissus leiocarpus* woodland on sandy soil; *Lannea humilis* open grass savanna with short annual grasses, sparse trees and stands of *Mitragymna innermis* forming small islands around temporary waterholes; and *Acacia seyal* tree savanna on black clay soils which are saturated with water in the rainy season. The latter vegetation type is slowly spreading as the area gradually dries out. The Yaéré floodplains is populated with perennial grasses such as *Vetiveria nigitana, Oriza longistaminata, Echinocloa pyramidalis*, *E. stagnina* and some herbaceous legumes including *Sesbania pachycarpa*. Water continues to be one of the most serious problems for Waza. Recently, important dry season waterholes have been created and managed in the floodplain zone.

METHODOLOGY

Training of the crew
Because up to date information on wildlife population in the Waza National Park was scanty, the entire area was flown to determine large mammal species occurrence and distribution. The count was carried out in February 2007. The total aerial survey technique standards for the MIKE (monitoring of illegal killing of elephant) programme as detailed in Craig (2004) and as described in Omondi *et al* (2002) and Douglas-Hamilton (1997). This technique aimed to systematically cover the entire surface of the defined census zone and to record every species of animal being counted and its geographical location (Litoroh, 2002). Total aerial count relies heavily on the experience of both the pilot and the flight crews (Douglas-Hamilton et al., 1994; Litoroh, 1995). Therefore one day of training and test flights were undertaken for both the pilot and the counting crews.

Crew members' roles
The survey crew consisted of a pilot and his co-pilot; 1 FSO and 2 Rear Seat Observers (RSO). The role of each crew member is described following the protocol of Norton-Griffiths (1978) and improved upon by Douglas-Hamilton et al (1994) and Douglas-Hamilton (1996).
The pilot and Front Seat Observer (FSO) pre-plan each flight, decide on whether they will fly East-West or North-South transects. They also decide on the standard strip width separation to be used. Adjacent strips were 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 would circle around a group of elephants. Great care was taken, however, to resume the original strip at the spit at which it 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). The type of aircraft used largely determines speed; **130kph/80mph** is the most suitable speed for total aerial counts. Height was 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 was also responsible for guaranteeing that he 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 pilot's vantage point can prove particularly useful in drawing the observer's attention to the animals coming in the plane's flight path. The pilot and FSO decide on their start point and programme this into the GPS. The start point was 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 was 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 were left into the next block.

The FSO were responsible for the actual recording of data. The FSO, in consultation with the Rear Seat Observers and the pilot, adjust the strip widths as necessary. The flight lines were recorded onto the FSO's flight map including any deviations. This were compared later with the computer printout, but is always 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 was having 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 need to circle the group until a consistent figure is agreed upon.

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

Census zone and counting blocks

The census area included the entire National Park and a 5 km buffer and covered an area of 1,970 sq km. The area was divided into 3 discrete counting blocks, bordered by well-defined features such as roads, rivers, and the Park/Reserve boundary (Fig 1). Each crew was provided with flight maps of the block for the pilot and Front Seat Observer (FSO). Flight paths to cover each block were then selected by Pilot, FSO and GIS expert. Transects ran East-West, and were spaced at 1 km (Fig 2). The area of each block is shown in Table 1

Table 1: Area of each block surveyed

Block No.	Area in Km^2
Block 1	401
Block 2	1,031
Block 3	538

Data recording

The count employed the Global Positioning System (GPS) technique with ArcView software used for plotting species distribution maps. A Cessna 206 Stationair six-seater aircraft was used in the count. The aircraft had a GPS for use in navigation and recording survey paths. The animals recorded were elephants (**EL**) both live and dead, Giraffes (**GI**), (**HI**) Hippotrague; **(DA)** Damalisque ; **(LI)**-Lion; (**HY)-** Hyena; **(AU)** Autruche; (Ph) Phacoche`re; **(CB)** Cobe de Buffon; **(GZ)**Gazelle; **(IL)** Illegal Activity and cattle (**C**), sheep and goats (**SH**) distribution. **Cattle, goats** and **sheep** (**shoats**) herds were recorded as approximate estimates. The aim was 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.

Dead elephants were recorded in the following categories (Craig, 2005):

- **Carcass 1 (C1):** for **fresh** carcass (less than 1 month old), still has flesh giving the body a rounded appearance. Vultures probably present and ground still moist from body fluids.
- **Carcarss 2 (C2):** for **recent** carcass (more than 1 month old but less than one year old), the rot patch and skin still present. Skeleton not scattered.

- **Carcass 3 (C3):** for an **old** carcass (more than a year old), where only a skeleton is present with white bones visible. Vegetation regrown in rot patch.
- **Carcass 4 (C4)** 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 was equipped with a data entry sheet and a flight map. The FSO was responsible for the entry of all data onto these sheets. During the flight the FSO recorded, 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.
An UTM grid were super-imposed on each block map, so that transects could be flown on this grid with the help of GPS. The GPS record the exact flight pattern for the later reconstruction of the exact position of each observation. The GPS were also used to fly in parallel strips or 'flight lines', using the GPS to stay on track. In most cases East-West lines were chosen, which has the advantage of equal light for the observers on both sides.

All observations made were saved in the GPS (Garmin X12) by the Front Seat Observer (FSO) as waypoints with the geographical location referenced and were used in producing species distribution maps. The GPS was downloaded onto a computer at the end of each day's operation and the Front Seat Observer (FSO) and the crew did a summary table of each block. Any double counts were also worked out and eliminated during these sessions. The exercise started every morning at 7.30am and ended late in the evening. Breaks were taken during refuelling of the aircraft and at lunch.

***Way-points recording (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 should 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.

Making photographs

When herds of elephant number more than 25 they are to be photographed. The FSO coordinated closely with the pilot to assure the best possible alignment and order before they begin to count or

photograph the herd(s). The FSO 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 was 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. Therefore, it was necessary to make sure that all films are properly labeled. Films were numbered in advance. The individual film number was scratched into the emulsion on the film leader.
Generally, the best angle for photography is slightly oblique, but not too oblique as larger animals may obscure young ones.

Photographs should not be taken at anything under 1/500 sec or they will be blurred. Also it is important to make sure that the film speed is set at 400 ASA and to make certain that the focus is at infinity. It is often a good idea to tape it fast for the duration of the count. 50 or 55mm lens may use but a 105 or 135mm lens is often 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 were used for preliminary analysis by the co-ordinators.

A display table were 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.

Data Analysis

The densities known as numbers of direct sightings or signs per unit area (km^2) were calculated per block for each animal. Densities were also used for human activities. The regression analysis was carried out to test relationship between animal densities and the level of human activities. Regression analyses depend upon the assumptions of normality and homoscedasticity, with regard to the values of *Y*, the dependent variable. To evaluate the relative habitat preference for the survey period, the relative frequency of the species occurring in each vegetation type were calculated as the density of the species in the type compared to total density of the species in the park. Departure from a uniform distribution was tested using one-way ANOVA.

RESULTS

A total of five persons drawn from the WWFCPO, Yaounde; Waza National Park and two private pilots were successfully trained on the techniques of total aerial count of elephants and were involved in the exercise as either Pilot, GIS expert and rear seat observers. A total of 12:27 hrs was flown during the exercise, with a total count time of 11: 15 hrs giving a search rate of 175 km per hour. Fig 2 shows the flight patterns of the Cessna aircraft involved in the count and table 2 provides the flight summary details of the flight logs provided in Appendix 4.

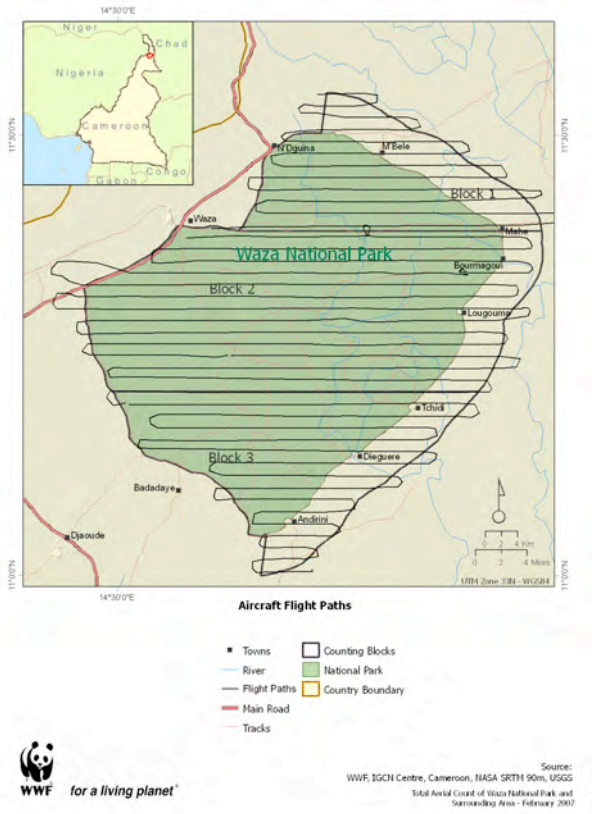

Figure 2: Flight patterns flown

Table 2: Flight summary (NB: Distance doesn't include ferrying distance to and from the blocks).

Date	Take off time	Block	Start Count	End Count	Landing time	Distance (km)
21-Feb	6:32	1	6:37	9:23	9:33	326
22-Feb	6:26	2	6:30	10:47	10:55	536
22-Feb	16:21	2	16:28	17:56	17:58	177
23-Feb	6:38	3	6:47	9:31	9:58	358

All species were counted in order to ascertain species diversity, distribution and status. Dead elephants were also counted and their distribution mapped.

Population number and density

A total of 09 wildlife species were counted, 85% of which was found in the central part (Block 2) of the Park. Table 3 provides the number and the density of each species counted across census blocks.

Table 3: Number and density of some large herbivores mammals' population in the Waza National Park

Species	number (Census blocks)				Density (Census blocks)			Density (census zone)
	Blocks				Blocks			
	1	2	3	Totals	1	2	3	Mean±SE (95% CL)
Elephant (EL)	180	66	0	**246**	0.449	0.048	0.000	0,166±0,142
Recent carcass (C2)	0	2	0	**2**	0.000	0.002	0.000	_
Old carcass (C3)	0	3	1	**4**	0.000	0.003	0.002	_
Very old carcass (C4)	0	1	0	**1**	0.000	0.001	0.000	_
Giraffe (GF)	99	458	47	**604**	0.247	0.444	0.087	0,26±0,103
Gazelle (GZ)	8	20	0	**28**	0.020	0.019	0.000	0,013±0,0065
Kob (KB)	100	1,462	0	**1,562**	0.249	1.418	0.000	0,56±0,44
Lion (LN)	2	3	0	**5**	0.005	0.003	0.000	0,0027±0,00145
Ostrich (OS)	0	6	3	**9**	0.000	0.006	0.006	0,004±0,002
Roan antelope (RA)	2	142	4	**148**	0.005	0.138	0.007	0,05±0,044
Topi (TP)	61	785	2	**848**	0.152	0.761	0.004	0,3±0,23
Warthog (WH)	13	7	1	**21**	0.032	0.007	0.002	0,014±0,0093

Elephants were clumped and only 2 herds were observed and the count recorded 246 elephants along with 604 Giraffes. 75.8% of these records were in the central part of the park (Block 2). It is worthy to mention that, with known elephant migration in the region during the dry season, a further recce survey conducted counted 250 elephants migrating in Kalamaloue National Park in one big aggregation. This sub-population together with the population counted in the park give a picture of 496 elephants that reside or migrate throughout Waza National Park. Seven (07) elephants carcass spread into different categories (Recent/Old/Very old) were found. This has direct implication of poaching, which might explain the absence of most species from along the boundaries to the interior. Illegal hunting of elephant is certainly most important along the park border towards the interior. Other species counted included Roan antelope, 148; Topi, 848; Kob, 1562; Lions, 5; Red Footed Gazelles, 28; Ostrich, 9; and Warthogs, 21. The animals' densities were calculated per unit area in each block surveyed and averaged across blocks. Observations show that the highest animals densities were found primarily in the kob population (0,56±0,44 animal/km²), secondarily in the topi population (0,3±0,23 animal/km²) and finally in the giraffe population (0,26±0,103 animal/km²). Elephant was the fourth abundant species with a mean density of 0,166±0,142 animal/km². There were generally very low species densities of less than 0,1 animal/km² in the remaining animals species' population per surveyed blocks (table 4). These were Gazelle, Lion, Ostrich, Roan antelope and Warthog.

Distribution

Elephants & Elephant Carcasses distribution

A total of 246 elephants were counted in the park and were aggregated into two large mixed groups of 180 and 66. Another herd of 250 individual in one big aggregation was spotted at 80 km outside the park during recce survey. This herd was migrating towards Kalamaloue National Park to the North.

Photo: A herd of 66 elephants sighted during the count

There was a notable scarcity of elephants in most part of the park particularly in block 3. The total number of elephant found would be the minimum estimate given the migratory behavior the animal at the beginning of the dry season. Therefore, it is probable that the true figure for the park is slightly more. Fig. 4 below represents elephant and carcass distribution within the study area.

The elephants spotted from the air were ranging within the confines of watering points within the central part of the park. Seven elephant carcasses were counted during the exercise. Most of the carcasses were sighted in areas where there were presence of livestock, farmland and human settlement (Fig 4).

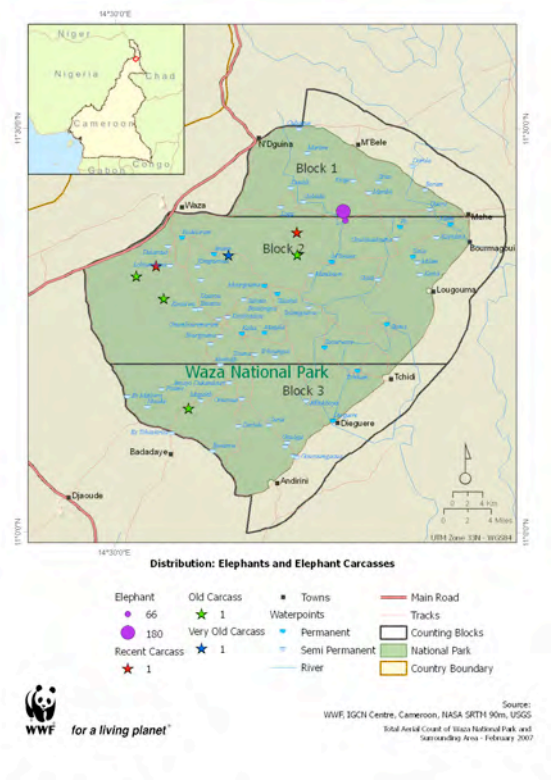

Figure 3: Elephant and Carcass distribution

Other large mammal distributions

The animal distributions plotted on a 1:100 000 map of the park, are shown in figure 3. All the species were not distributed evenly. Giraffes tend to occur in high number in the central portion of the park though they can be seen widespread in low number except in the eastern section. The Kobs are concentrated in high number in the central to the eastern part of the park. They tend to congregate in the grassland around settlement. The red fronted gazelle was recorded exclusively in the central portion of the study area particularly in the woodland zone to the west and the north and the grassland zone around settlement to the east. Topi and Roan antelope were restricted to central portion of the park. Lion and ostrich were very scarce as did warthog. Animals were in general very scanty in the southern portion of the census area. The highest densities of most species were found in the central towards the northeastern part of the park, animals becoming scanty in the south, southeast and western portion towards the periphery. This might be explained by the presence just across the boundary, of a number of villages.

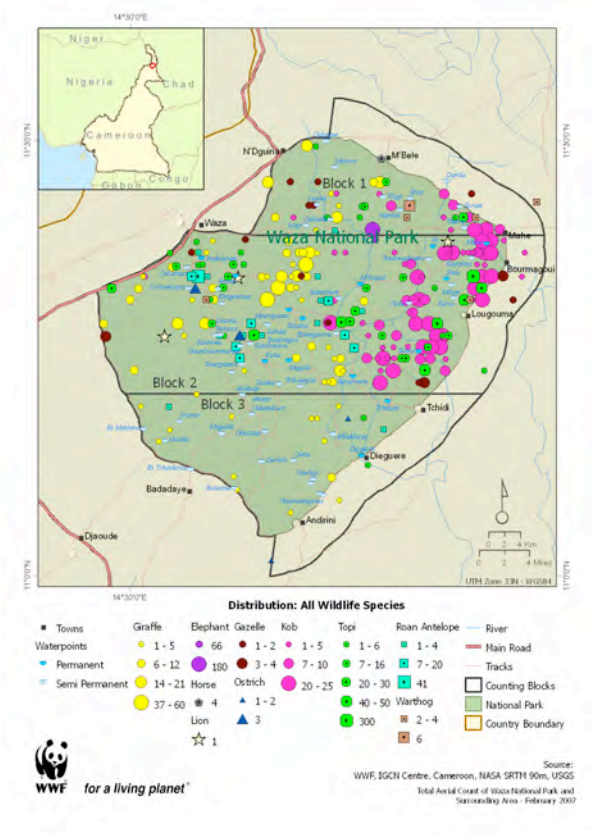

Figure 3: All species distribution

Species habitat association

Relative habitat preferences of the nine species, as derived from animal distributions plotted on a 1:100 000 vegetation map of the survey area, were established. Nearly all species exhibited a significant habitat preference (P<0,05). Elephants exhibited significant preference for *Acacia seyal* zone by and to a lesser extend the floodplain zone. Giraffe seems to be restricted primarily to *Acacia seyal* zone,

which is probably explained by the fact that *Acacia seyal* is its primarily food item. Red footed gazelle preferred the Floodplain zone and *Acacia seyal* zone and avoid the Woodland zone. Topi was mainly found in the floodplain zone and secondarily in the *Acacia seyal* zone. Woodland zone was the less preferred habitat for this species. Roan antelope was restricted in the Acacia seyal zone and the edge between this habitat type and the woodland zone while kob strongly avoid the Woodland and showed a clear preference for the Floodplain zone probably because of the dry season growth of perennial grass such as Vetiveria *nigritana*, which might be excellent grazing for this species. Warthog was concentrated in the Floodplain zone and occurs in isolated individual at the edge between woodland and *Acacia seyal* zone. Lion occurs indiscriminately between the Floodplain zone and the woodland zone while Ostrich was restricted in the *Acacia seyal* zone. It appears clearly that wildlife in the Waza ecosystem avoids the Woodland zone and exhibited strong preferences to the *Acacia seyal* and the Floodplain zone. The Woodland zone might be the less suitable habitat for most species.

Livestock and Other Human Activities

Quantitative observations on human activity noted a heavy concentration of livestock particularly cattle and shoats. Table 4 gives livestock and human settlements spotted during the count. Figure 4 shows positions locations of human incidences in the park and buffers.

Table 4: Livestock and Human Settlements densities

	Livestock and other human activities (5 Km buffers zone)				Densities (5 km buffers zone)		
	Block 1	**Block 2**	**Block 3**	**Totals**	**Block 1**	**Block 2**	**Block 3**
Illegal activity (IL)	0	0	5	**5**	0.000	0.000	0.009
Horse (HS)	4	0	0	**4**	0.010	0.000	0.000
Shoats (SH)	1,95	270	1,323	**3,543**	4.863	0.262	2.459
Settlement (ST)	10	8	14	**32**	0.025	0.008	0.026
Cattle (CT)	7,37	4,656	5,433	**17,459**	18.379	4.516	10.099
Fire (FI)	4	2	5	**11**	0.010	0.002	0.009
Farmland (FL)	0	6	13	**19**	0.000	0.006	0.024

Most of the east, southeast and northeast of the park is under heavy human pressure.

Nomadic pastoralists and their herds were seen mostly at the edge of the park. Locally there was destruction of grass cover as a result of frequent and accidental burning to improve dry season growth of forage for cattle. A total of 21.002 livestock was estimated within buffer zone abutting the conservation area easterly. The buffer zone abutting Block 1 had the highest number of livestock 44.38% of the total with a density of 18.099/km^2 and 4.863/km2 for cattle and shoats (goats & sheep) respectively, followed by the buffer zone abutting Block 3, 32.17% with densities of 10.099/km2 and 2.459/km2 for cattle and shoats respectively (Table 4, figure 4). The entire Park was surrounded by heavy human settlement with densities calculated at 0.025/km², 0.008/km² and 0.026/km² respectively in the zone abutting block 1, block 2 and block 3 easterly. Some isolated ffarmland on the park as well as bush fire was also observed.

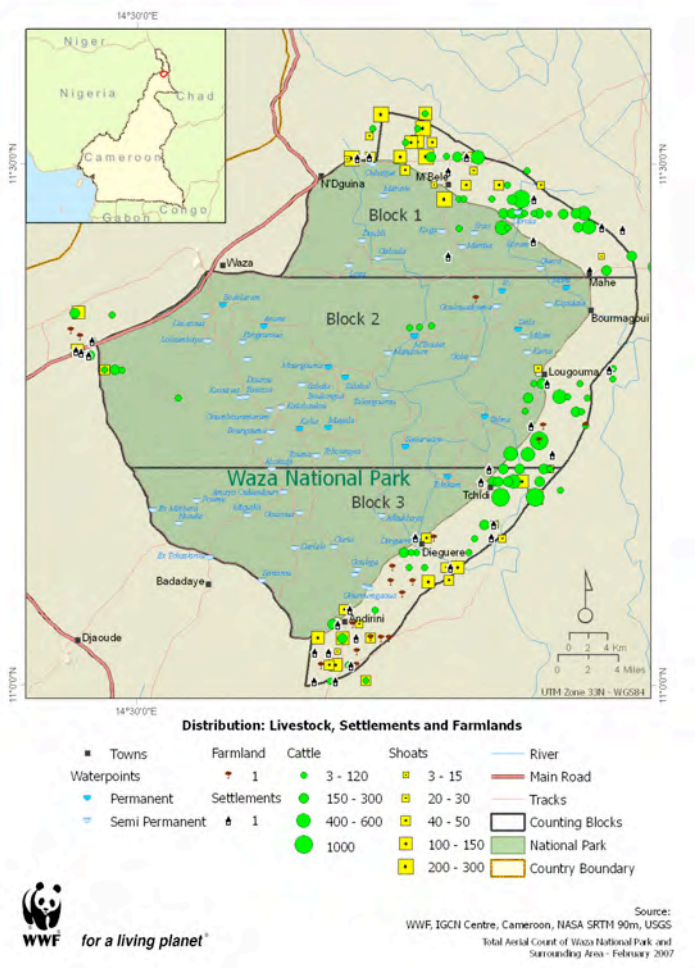

Figure 4: Distribution livestock, settlements, farmland and other human activities

When counts recorded on all large mammal species were pooled and averaged across surveyed blocks, the results indicated a weak relationship between the animals densities and human activities densities in the three blocks (r^2 = 0.29, F = 0.692929, P > 0.05,). The Durbin-Watson statistic test of the residuals confirms a lack of significant correlation between the two variables (P > 0.05). The fitted regression line is shown in figure 5. Therefore, animals' densities distributions were not influenced by human activities. However, pressures at the periphery of the park are high.

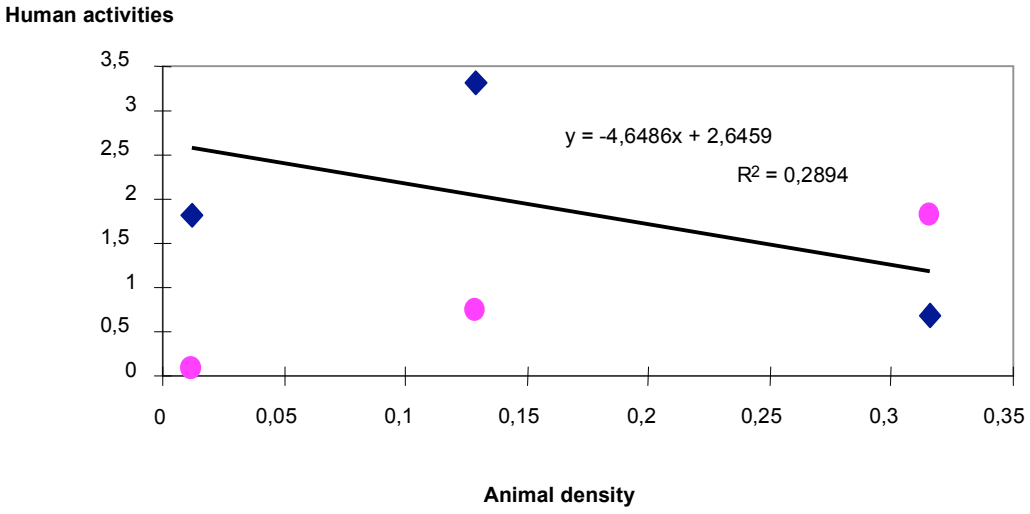

Figure 4: Fitted regression line of pooled animal and human activities' densities

DISCUSSION, CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

This count puts Waza elephant population at 246 elephants sighted inside the park giving a density of 0.166 elephant/km². Although the count was done just at the end of wet season, the visibility was good enough, and the crew could spot even a red-footed gazelle from the air. This figure therefore represents the currently found in the park during the surveyed period. Using Tchamba & Elkam (1995) estimate of 1,170 this represent a decline of 79%, which is quite high and suggests this population is declining at an alarming rate. It should be noted however that the two counts used different census methods, aerial sample for the 1991 count (Tchamba & Elkan, 1995) and aerial total during this count. It is very probable that the 1991 sample count was an over estimate given the aggregation groupings of the West African elephant population. Although the population comprises of mixed group of young, sub-adults and adults a detailed study should be initiated to establish the sex, age, and social structure of this population.

Tchamba (1993) hypothesized that there are three elephant sub-populations in Waza Park. The first sub-population resides in the northern part of the park and migrates to Kalamaloue National Park at the beginning of the dry season (December-January). They return at the beginning of the wet season (May-June). The second sub-population resides year-round inside Waza Park. The third sub-population uses the central and southern part of the park and spills out to the south of the park at the onset of rains (June-July). Indeed a recce survey conducted at the end of this survey counted 250 elephants migrating towards Kalamaloue National Park in one a big aggregation. The consideration of this number then put the total Waza ecosystem population at 496 individuals and this will still represent 44.2% decline compared to the 1991 survey. Future censuses should therefore include Kalamaloue and environs particularly if they are to be done during the dry season. The migratory behavior of Waza elephants is therefore a factor, which have affected the accuracy of the present census. It is alleged that elephants are subjected to severe poaching during migrations. It is possible that the population that is known to undertake short-term migration towards the Nigeria territory was missed. And, if this was the case the total population estimates for Waza elephant would be lower than expected.

From the survey there was evidence of rapid habitat loss from encroachment into the elephant range. The high densities of livestock/km² inside at the periphery of the park along side numerous human settlements, farmlands and illegal activities indicate a rapid habitat loss that need to be addressed immediately by the Government. The shrinkage of the elephant habitats must be arrested by securing the boundaries of the current known elephant range and by evicting illegal settlers from the range. Human activities such as farming, logging, and even hunting that has led to the loss of the habitat and disturbs elephants must be immediately prevented.

From the survey, it is also evident that the on-going human activities might make Waza an "ecological island" (Fig 4) and elephants movement may be curtailed in future. These elephants move in large aggregation, which could be a sign of their harassment and insecurity. An immediate attempt should be made to stop all illegal activities within the park and buffers. The boundaries of the protected elephant habitats should be clearly demarcated and secured to prevent further encroachment.

Seven elephant carcasses (recent/old/very old) were recorded during the census giving a carcass ratio of 2.85%. Poaching could therefore be one of the factors that have contributed to the decline of the Waza population. A programme to estimate age structures and sex ratios should be initiated to

understand this dynamics and also establish the level of illegal killing by elephants. Although MIKE has been operational in this site since 2003, no organised patrolling goes on in Waza, and very little resources have been set aside by the Government for elephant patrols and protection. There is poor record of illegal killing in the site and with the general lack of security patrols, the future of these elephants is bleak especially if encroachment and other illegal activity continues to flourish in the Park. More resources should be set aside for wildlife protection in this Park. Intensive air and ground patrols should be carried continuously to monitor the elephant status and ensure the survival of this population.

Although Acacia seyal zone had high number of species counted, population sizes of giraffe (Giraffa camelopardalis), roan antelope (*Hippotraginus equines*), Kob (*Kobus kob*) and topi (*Damaliscus korrigu*), Red footed gazelle (*Gazelle rufrifrons*) and Ostrich (*Struthio camelus*) showed a significant decline from the 1991 estimate by Tchamba and Elkan (1995). This decline could be attributed to the level of pressure by livestock and the illegal activities witnessed during the census. Elephants and other animal of the park require immediate protection if they are to survive. Presently, this could be achieved by making use of the existing community guards and the few (5) game guards allocated for the protection of the conservation area of about 1700 km². Unfortunately the lack of motivation and equipment prevent efficiency. The possibility to reinforce park surveillance team with army force during field patrols should be considered. Information on elephant movement is important for their conservation and management. While modern techniques for monitoring elephant movement is cost-prohibitive, conservation body such as WWF-CCPO could assist in carrying out long-term monitoring of elephant movement along Cameroon-Tchad border as well as possible movement along Cameroon-Nigeria frontier. Concerted efforts have to be made by the relevant government of these countries concerning a joint survey, as a long-term approach to managing this elephant population.

There is an urgent need to set up a special elephant conservation program for Waza Conservation Area to conform to the strategy for the conservation of West African Elephants. The conservation program should address encroachment, establishing efficient protection systems, stopping illegal killing and managing the cross-border elephant sub-population that moves between Waza and Chad and Nigeria. The strategy should also ensure:

- Adequate park protection and surveillance for the elephants.
- Securing the buffers of Waza National Park by promoting compatible land use practices within the dispersal areas. Such an action should develop strategies that would maximise benefits from elephants to the local communities through eco tourism project. A team of Park managers, community opinion leaders should for example visit Kenya where such venture has led to efficient elephant management.
- Recruit, train, equip and motivate anti-poaching and other illegal activities patrol teams to make them efficient.
- Establish village or community game guards to control poaching and other illegal activities
- Establish intelligence networks to combat poaching and investigate the linkage between domestic ivory trade and illegal killing.
- Undertake intensive research into the bio-diversity of the park, to establish the impact of encroachment.

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We appreciate the efforts and dedication shown by Captain Robert Peerson, Co-pilot Ray Kapteyn for adapting to the requirements of total count flying and flew tirelessly to ensure that all blocks were covered within schedule.

We would also like to thank the Rear Seat Observers comprising of Saleh Adan, Warden Waza National Park and Lambert Bene Bene for their endurance in the air and being good spotters. To the team drivers, Waza National Park Security staff without whom the count would not have been smooth we applaud your dedication. Finally, to all those who participated in anyway and have not been mentioned, we thank you for your contribution to make the Waza count a success.

Appendix 1: Data Sheet

WAZA NATIONAL PARK & SURROUNDING AREA - TOTAL ELEPHANT COUNT - 2007 **SHEET NO.**

Pilot							**Block No.**	
Front Seat Observer								
Rear Seat Observer(left)							**Date**	
Rear Seat Observer(right)								
Take off		**Start count**			**Stop count**		**Land**	
Way Point	Dist.	L/R	Species	Estimate	Film# & Frames	End Frame	Photo-count	Comments (Transects,etc)

Appendix 2: List and Addresses of Participants

PARTICIPANTS

Name	Institution	Position	Telephone	Address	Email
Patrick Omondi	Kenya Wildlife Service	Principal Scientist		P.O. Box 363-0517, Nairobi	pomondi@yahoo.com
Saleh Adan	Waza National Park	Warden	502-4037		
Dr. Martin Tchamba	WWF Cameroun	Director	770-5412		mtchamba@wwfcarpo.org
Robert Peerson	SIL	Pilot	750-0219		
Ray Kapteyn	SIL	Pilot			
Tiawoun Sylvain	WWF Cameroun	Research Assistant	961-8048		
Lambert Bene	WWF Cameroun	Project Officer	748-1642		lbene@wwfcarpo.org
Rose Mayienda	African Wildlife Foundation	GIS Expert		P.O. Box 56484-00200, Nairobi	rmayienda@yahoo.com
Ntsa Tene Louis Paul	CRTV	Cameraman	772-2011		
Shifu Ngalla	CRTV	Journalist	576-7969		

Appendix 3: Total Elephant Aerial Count February 2007

WAZA NATIONAL PARK TOTAL AERIAL COUNT - FEBRUARY 2007

Pilot:	Robert Peterson	**Aircraft:**	N123TTM	**Take Off Time:**	6:32 AM
Front Seat Observer	Patrick Omondi	**Date:**	21st February 2007	**Start Count:**	6:37 AM
Rear Seat Observer (Left)	Bene Lambert	**Block:**	1	**Stop Count:**	9:23 AM
Rear Seat Observer (Right)	Saleh Adah			**Landing Time:**	9:33 AM

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
4								5											
5															2				
6						1													
7						1													
8												4							
9												20							
10												25							
11												7							
12																	1		
13				200															
14				500															
15				200															
16																5			
17																			3
18												7							
19																		27	
20																		2	
21												2							
22																			2
23																	1		
24																		5	
25								15											
26																		2	

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
27												1							
28								9											
29									1										
30									1										
31								4											
32																		2	
33																		7	
34												9							
35																			6
36												10							
37																	1		
38																			2
39																	1		
40																	1		
41				500															
42				200															
43									2										
44												8							
45				50															
46				500															
47				100															
48												5							
49												2							
50								4											
51								16											
52									2										
53									2										
54								7											
55								21											
56																		14	
57				300															
58				200															
59				200															
60				40															
61				15															

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
62				300															
63				50															
64				300															
65				300															
66				600															
67																	1		
68				1,000															
69				200															
70				100															
71				45															
72				50															
73																200			
74						1													
75						1													
76																15			
77										4									
78																40			
79																50			
80				40															
81																20			
82				30															
83																25			
84																	1		
85																50			
86																		2	
87								18											
88																15			
89																200			
90																	1		
91																50	1		
92																100			
93																300			
94				250															
95				50															
96				200															

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
97																50	1		
98				500															
99																50			
100																150			
101																100			
102				100															
103																30			
104				50															
105				100															
106																200			
107				100												100			
108																200			
110													2						

WAZA NATIONAL PARK TOTAL AERIAL COUNT - FEBRUARY 2007																			
Pilot:					Ray Kapteyn		**Aircraft:**	N123TTM			**Take Off Time:**	6:26 AM							
Front Seat Observer					Patrick Omondi		**Date:**	22nd February 2007			**Start Count:**	6:30 AM							
Rear Seat Observer (Left)					Bene Lambert		**Block:**	2			**Stop Count:**	10:47 AM							
Rear Seat Observer (Right)					Saleh Adah						**Landing Time:**	10:55 AM							

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
1																		2	
2								2											
3									1										
4								7											
5																			
6					66														
7					180														
8																			
9																			
10													1						
11																			
12												11							
13												20							
14												50							
15												3							
16												300							
17												200							
18												4							
19												12							
20												25							
21												7							
22												3							
23												3							
24												1							
25												2							
26												11							

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
27												4							
28												11							
29																			
30																			
31							1												
32												1							
33																			
34												2							
35												1							
36	1																		
37								3											
38								21											
39								6											
40								8											
41								7											
42																		1	
43								4											
44															1				
45								1											
46									1										
47																		2	
48								7											
49																		11	
50						1													
51																		5	
52																		2	
53																		14	
54																		5	
55								1											
56								37											
57												5							
58												10							
59												4							
60												1							
61												2							

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
62									4										
63												11							
64												23							
65																		300	
66												100							
67								2											
68																			
70												30							
71												3							
72												12							
73												36							
74																		9	
75												30							
76				30															
77				17															
78				3															
79		1																	
80															1				
81								6											
82									1										
83								21											
84								2											
85								20											
86								5											
87								6											
88			1																
89													1						
90																		16	
92															2				
93															41				
94															7				
95												2							
96								4											
97				100															
98																100			

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
99				200															
100							1												
101							1												
102				100													1		
103																		20	
104								9											
105	1																		
106																			
107														3					
108								8											
109								2										12	
110								46											
111								7											
112								3											
113																			
114																		10	
115																			
116																			
117																		1	
118												20							
119																		50	
120									1										
121												15							
122												2							
123																			4
124																		40	
126												26							
127												8							
128												12							
129												6							
130												10							
131												30							
132												50							
133								6											
134																			

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
135												1							
136												1			7				
137															4				
138								1											
139								60											
140								10											
141																		3	
142																			3
143								2											
144		1																	
145								12											
146				200													1		
147																	1		
148																100	1		
149				100												50			
150				200															
151				100															
152																		30	
153												2			2				
154												4							
155												7							
156																20			
157																	1		
158				120															
159				100															
160				4															
161																	1		
162				200															
163				100															
164																		40	
165												12							
166												17							
167												10							
169												3							
170																		25	

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
171																		40	
172												12							
173									1										
174															1				
175															9				
176																		13	
177								20											
178		1																	
179								14											
180								11											
181									4										
182				14									1						
183								4											
184															1				
185																		6	
186														3					
187															1				
188																		40	
189												1							
190															4				
191						1													
192															9				
193												1							
194												5						8	
195												7							
196												22							
197												23						2	
198									2									10	
199				200															
200				500															
201				15															
202				40															
203				100															
204				250															
205				20															

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
206												11							
207												11							
208																		8	
209												18							
210												1							
211												4							
212												2							
213															12				
214								5											
215								6											
216															20				

WAZA NATIONAL PARK TOTAL AERIAL COUNT - FEBRUARY 2007																		
Pilot:					Ray Kapteyn		**Aircraft:**	N123TTM			**Take Off Time:**	4:21 PM						
Front Seat Observer					Patrick Omondi		**Date:**	22nd February 2007			**Start Count:**	4:28 PM						
Rear Seat Observer (Left)					Bene Lambert		**Block:**	2			**Stop Count:**	5:56 PM						
Rear Seat Observer (Right)					Saleh Adah						**Landing Time:**	5:58 PM						

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
1															20				
2								7											
3								4											
4								10											
5												6							
6												1							
7												14							
8												3							
9												1							
10																		7	
11																		10	
12												10							
13												9							
14												1							
15				13													1		
16							1												
17				30			1												
18																		3	
19				1,000			1												
20												10							
21																		40	
22												40							
23												16							
24												5							
25								1											

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
26								14											
27								2											
28								7											
29								3											
30								4											
31								10											
32												12							
33									2										
34									3										
35												40							
36				500															
37				400															
38																	1		
39						1													
40				20												30			
41				200															
42						1													
43						1													1
44				300															
45				160															
46						1											1		
47								3											

WAZA NATIONAL PARK TOTAL AERIAL COUNT - FEBRUARY 2007

Pilot:	Ray Kapteyn	**Aircraft:**	N123TTM	**Take Off Time:**	6:38 AM
Front Seat Observer	Patrick Omondi	**Date:**	23rd February 2007	**Start Count:**	6:47 AM
Rear Seat Observer (Left)	Bene Lambert	**Block:**	3	**Stop Count:**	9:31 AM
Rear Seat Observer (Right)	Saleh Adah			**Landing Time:**	9:58 AM

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
1								5											
2															1				
3						1													
4								2											
5																	1		
6				200															
7				150															
8				260															
9				500															
10																100			
11																			
12				150															
13				100															
14				1,000												200			
15																			
16																			
17				1,000												100			
18																		1	
19														2					
20								4											
21								3											
22								2											
23								3											
24															3				
25																			
26				50												20	1		
27				200															
28								5											

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
29		1																	
30								3											
31																	1		
32																40			
33							1												
34				100															
35																	1		
36																30			
37				50															
38																			
39																		1	
40				50															
41				16															
42				150															
43								3											
44																			
45								6											
46							1												
47				100															
48				50															
49																40			
50																	1		
51																110			
52																50			
53																100			
54							1												
55							1												
56								3											
57											4								
58								3			1								
59							1												
60				27															
61																	1		
62																40			
63								2											

Waypoint	C2	C3	C4	CT	EL	FI	FL	GF	GZ	HS	IL	KB	LN	OS	RA	SH	ST	TP	WH
65				200															
66																	1		
67							1												
68																20			
69							1												
70							1												
71							1									40			
72																	1		
73				200												100			
74																100			
75																	1		
76																	1		
77																3			
78							1												
79							1												
80																	1		
81				50															
82																100			
83																50			
84							1												
85														1					
86																	1		
87				50															
88							1										1		
89				100												50			