DEMOGRAPHIC STATUS OF THE MERU ELEPHANT POPULATION

Final Report to the Elephant Research Fund/KWS and Save the Elephants

By
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2003

SAVE THE ELEPHANTS

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Acknowledgements

I am most grateful to the sponsors of this project, European Union through the Elephant Research Trust Fund (ERTF-Kenya Wildlife Service) and the WWF(US) through Save the Elephants. This project was part of a larger project conducted by Save the Elephants, the Meru Elephant Monitoring Project, and I am grateful to STE for providing me with data on elephant movements. My supervisors, Dr. Richard Bagine and Omondi Patrick, Kenya Wildlife Service, and Dr. Iain Douglas-Hamilton and Dr. Juliet King, Save the Elephants, deserve special thanks for the various roles they played in the project. In particular, I am grateful to Dr. Juliet King for her support in the field and in writing up the project. Mark Jenkins, Senior Warden Meru/Kora National Parks and his team of dedicated personnel are highly appreciated for the logistical support and the enabling working environment they offered me. The following people are appreciated for assisting me in the project in one way or another: Barnard Lesowapir, Kimani Wainaina, Njoki Kibanya, Rose Mayienda, Elphas Bitok, Julius Muriuki, Moses (GIS-KWS). I am deeply grateful to authors whose work I have quoted to give a picture of the demographic status of Meru elephants as complete as possible.

This project would not have been possible without your support.
May God bless you all.

Abstract
The Meru elephant population suffered unequivocally from poaching in the 1970s and 1980s and declined up to a tenth of its size in this period. Results from aerial surveys and an individual elephant identification study conducted between 1990 - 1999 showed that the Meru elephant population did not register a significant increase in population size during the 1990s. It was under the foregoing that the Kenya Wildlife Service embarked on a translocation programme aimed at restocking the park. The Kenya Wildlife Service was concerned at the apparent insignificant growth of the population. The present study therefore aimed to investigate factors responsible for the lack of significant increase of the elephant population. Basic individual elephant identification technique was used to study the demographic status of the population. Post-release monitoring of 50 elephants translocated from Sweetwaters Game Reserve in July 2001was also conducted.

After the study begun, Meru National Park was listed as a site for Monitoring the Illegal Killing of elephants (MIKE) thus making it all the more important to examine the status of the population. A total of 406 different elephants were encountered in the one-year study (September 2001-September 2002). This included 14 translocated elephants, 11 from Sweetwaters and 3 from Lewa. The estimate however excludes 17 of the elephants translocated from Sweetwaters, which were observed from the air and another 22, which are believed to be within the park, as these were never encountered on the ground. The population exhibited a seasonal migration pattern to areas to the north and northwest of the park. Elephants may be vulnerable to potential threats during such movements due to the general insecurity in these areas. The demographic data collected in the present study show that the population remained static in the early 1990s but experienced a high rate of growth in the last few years. The increase in size of the population since the late 1990s was attributed to: 1) translocations of over 70 elephants into the park in recent years, 2) high calf recruitment since 1997 and 3) low adult mortality compared with early to mid 1990s. High calf recruitment and low adult mortality are possibly due to improved management and increased anti-poaching efforts since the late 1990s. The Meru elephant population has been growing since the late 1990s at rate of about 5%, an estimate that is consistent with results of recent aerial surveys and is the rate of growth of a stable elephant population.

1.0 Introduction

In the 1970s and 1980s, the numbers of the African elephant, *Loxodonta africana* (Blumebach) declined at an unprecedented rate from an estimated 1.3 million in 1979 to 600,000 in 1991(Douglas-Hamilton et al., 1992). This led in 1989, to a global consensus to up list the species to Appendix 1 and consequently ban international trade in ivory and other elephant products. By 1989, the major threat to the elephant was poaching and it was thus widely envisaged that the ivory ban, which came into force in 1990, would allow for recovery of affected populations.

Presently, elephant conservation is faced with many challenges. In many areas, a major threat to elephants is the increasing proximity and in most areas, actual encroachment of human settlement and activities into protected areas. The human population has continued to increase and thus exert great pressure on the limited natural resource base. Consequently, conservation areas that were once large and surrounded by adequate buffers have increasingly been fragmented and the wildlife populations within them compressed leading to overcrowding and habitat degradation. Competition for resources has led to intense human-elephant conflicts around protected areas. Thus the elephant, which once occurred in vast areas across Africa (Poole, 1996), now exists in small pockets surrounded by human settlement and activities.

Kenya Wildlife Service in collaboration with other interest groups uses several monitoring systems in order to understand the country's elephant populations with the objective of formulating plausible management strategies. Such monitoring systems include aerial and ground-based surveys. Registration of individual elephants in a population, in addition to providing accurate estimate of population size, gathers valuable demographic data on the population that may provide pointers critical for monitoring future population trends.

1.1 Historical Review of the Meru Elephant Population

Table 1 shows estimates of elephants in Meru National Park and where indicated (when census area is more than 844km², which is the approximate area of the park), including those in the adjacent areas since 1965. E. C. Goss carried out the first total count of elephants in the area in 1965 and found about 544 elephants inside the park (Douglas-Hamilton & Hillman, 1976).

Table 1: Estimates of Elephants numbers since 1965

Year	Estimate	Method of Estimate	Area Counted (km²)	Source
1965	554	Total	844	E.C Goss, Aerial Count
August 1976*	1328	Total	844	Douglas-Hamilton &Hillman 1976
October 1990	251	Total	3960	Douglas-Hamilton, 1990
July 1992	260	Total	3960	Litoroh 1992
November1997	360	Total Count	3960	Mwathe *et al*., 1997
June 1999	306	Total Count	3960	Kahumbu, P. *et al*., 1999
June 2002	413	Total Count	7540	Omondi *et al.*, 2002

*A sample count estimated 2122 elephants

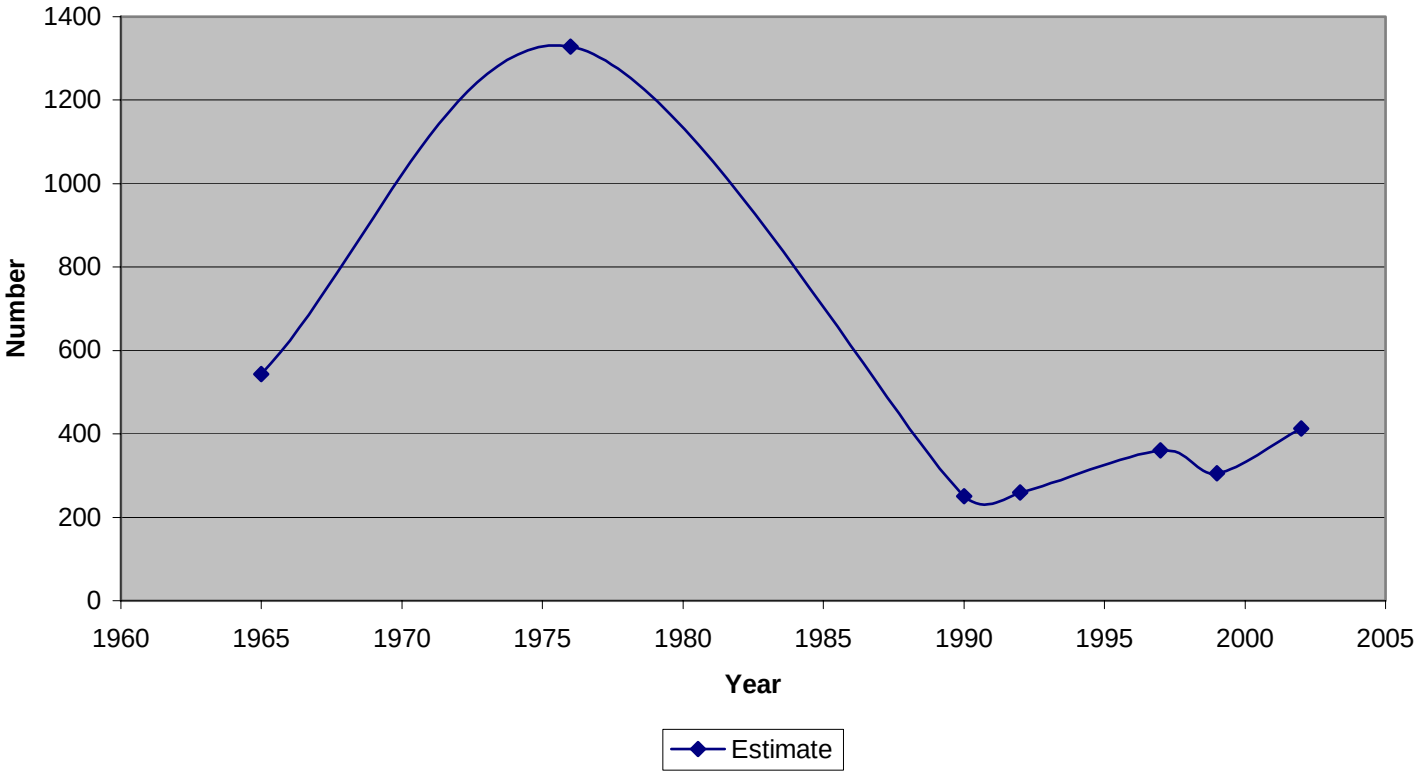
Douglas-Hamilton (1990) reported that it was during 1970s that the Meru National Park started experiencing the 'elephant problem', resulting in compression of elephants within the park consequently resulting in woodland destruction. Pressure from expanding agriculture by the Wameru on the west was intensifying in addition to illegal grazing in Bisanadi National Reserve and much of eastern Kora National Park. The illegal presence of pastoralist Somalis and Boranas provided a safe haven for poachers. Poaching levels increased horrendously between October 1973 to 1976 in the northern conservation area and southern parts of Meru National Park, again where gangs of poachers found sufficient camouflage among Tharaka farmers. The situation led to the concentration of elephants within Meru National Park (Douglas-Hamilton & Hillman, 1976; Poole *et al.*, 1992). The situation was however brought under relative control in 1975 through ranger training by the Kenya Army and provision of radio equipment to enhance communication. However, by 1976, poaching levels begun rising and caused major decline in elephant numbers. Total and sample aerial counts in August 1976 found 1,328 and 2,122 respectively (Douglas-Hamilton, 1976). The period from 1965 to 1976 is considered to be the period when the population experienced a rapid increase in elephant numbers. According to Poole et al. (1992) however, the increase could have been as a result of elephants moving into the park in escape of intense poaching in areas outside the park. Several sample counts done by Patrick Hamilton and KREMU (later DRSRS, now NEMA) during the 1980s showed that elephant numbers remained relatively stable during this period. There are however reports by the Senior Warden at the time that elephants were still being poached. There is little data on population trends and mortality reports between 1980-1990.

In 1990 when the next total count was carried out, a total of 251 elephants were found in the Park, which represented an 81% decline when compared with the results of the 1976 total count (Douglas-Hamilton, 1990). Elephants were seen in large groups close to the park headquarters, which Douglas-Hamilton (1990) attributed to protection the elephants received by being close to the park headquarters and which seemed to affect their distribution. Poaching affected the distribution of elephants in the park and outside it. In the first half of 1970s, elephants were mainly compressed within the park but by 1977-1980, Patrick Hamilton (Douglas-Hamilton, 1990) reported an exodus due to intense poaching inside the park. These movements of elephants in and out of the park could have affected results of sample counts during the time (Poole et al., 1992). In 1992, a total of 264 elephants were counted (Litoroh, 1992) and the distribution was no different from that reported by Douglas-Hamilton (1990). However, a group of 72 elephants was seen on the southern part of the park, which was thought to indicate improved security and possibly a relaxed state by the elephants. In the same year, an individual identification study indexed 227 elephants most of which occurred in large aggregations (Njumbi, 1993). Results of the ID study also showed that the population was lacking in young and old elephants as a result of selective elimination of adults by poachers and high infant mortality. The estimate was however thought to represent about 86% of the population at the time. A team of 5 Bristol University students who had worked together with Njumbi continued to monitor the population by gathering more IDs and updating existing ones between August 1993 to July 1994, and found a total of 260 elephants (Demmers and Bird, 1995).

Results of total aerial count for Meru National Park and Bisanadi National Reserve obtained by Tuft University students provide estimates of 248 in 1995, 222 in 2000 and 350 in 2001, (Muriuki, 1995, 2000 & 2001). Though the estimates seem inconsistent, they hint on an increase in number of elephants in the area. However, the estimates are likely to be low because the counts were carried out only in Meru National Park and Bisanadi National Reserve. Thus, the population estimates may possibly not include other elephant groups using other parts of the Meru conservation area.

In November 1997, Mwathe and colleagues conducted a wet season count and found a total of 360 elephants in the Meru and Kora National Parks and Bisanadi and Mwingi National Reserves all covering an area of 3,984 km². No elephants were counted in Meru and Kora National Parks and Mwingi National Reserve, which revealed the role of rainfall on the distribution of elephants. However by June 1999, 306 elephants were counted, 56 of which were found in Meru (Kahumbu et al., 1999). The estimate was thought to have represented a 15% decline in elephant number since 1997. Human settlement and illegal grazing was found to have increased in Bisanadi, Kora and Mwingi. In the latest count, June 2002, 413 elephants were counted in the Meru ecosystem. The results of the count also indicate that there was an increase in the number of elephants using Meru National Park and a decrease in numbers of elephants outside the park. Summary of Meru elephant population estimates is shown in Fig. 1. In general there seemed to have been an increase in population size between 1965 and 1976 after which the population declined by up to 81% and remained relatively stable with no significant increase during the 1990s.

Figure 1: Meru Elephant Population Size Estimates since 1965



1.2 Translocation of Elephants to Meru

The management of elephant populations in Africa is faced with a vast array of challenges ranging from economic hardships to perennial civil wars in most range states. Poaching has continued unabated due to among other factors, available markets in Asia that tempt Africans already living in abject poverty and in war-torn areas which link up to form routes through which ivory leaves the continent. Insecurity in most range states in addition to increasing population has caused the compression of elephant populations in small habitats usually in fenced ranches, where elephant numbers have continued to grow. As human population continues to rise, the proximity of human settlements and activities to such areas increases and further isolates such areas leading to compression of wildlife populations in already relict habitats. Consequently, human-elephant conflicts intensify as the confined elephants seek pasture and water outside the ranches. On the other hand, other populations such as the Meru elephant population have remained more or less static.

Kenya Wildlife Service is adopting translocation as one of the solutions to the many challenges facing elephant conservation in the country such as human-elephant conflicts and habitat degradation in some areas and the need to restock areas that once accommodated large numbers of elephants. The KWS envisages elephant translocation to open up under-stocked areas to tourism and diversify the local economies in addition to safeguarding the welfare of elephants.

Translocation is a long process that requires a multidisciplinary approach for example to address veterinary, ecological and conservation education issues. Thus there is a critical need for pre-translocation and post release monitoring. WWF (1997) recognizes a number of major problems about translocation including cost, stress to elephants during transportation, security and elephants and people and the available space at the recipient site. Central to this is the welfare of the elephant, which all stakeholders in elephant conservation strive to achieve.

About 70 elephants have been translocated from Laikipia to Meru and Kora National Parks between 1998 and 2002, Table 2. However, prior to the successful July 2001 translocation of 50 elephants from Sweetwaters, emphasis was never given to pre-translocation monitoring and little is known about elephants that have been added to the Meru elephant population. Without demographic data such age and sex of translocated elephants, any contributions of such elephants to the Meru elephant population remain difficult to quantify. Also, without post-release monitoring it is impossible to determine the success of the translocation unless the fate of the translocated elephants over time is known.

Table 2: Past Elephant Translocations to Meru

Year	Donor	Number	Status, e.g. ID
1998	Lewa Downs	10 bulls	Unknown
2000	Lewa Downs	3	Unknown
2000	Sweetwaters Game Reserve	7, 6 bulls, 1 cow	Unknown*
2001, July	Sweetwaters Game Reserve	50	IDs known
2002, September	Lewa Downs	3 bulls	IDs known

***** Translocated elephants unknown except for one bull, B18, Lomuigo which is reported to have broke its ear during transport.

2.0 Aims and Objectives:

It was in light of the insignificant growth in size of the Meru elephant population during the 1990s that the present study was established.

The study aimed to investigate factors limiting population growth by gathering demographic data on the population through the use of individual recognition techniques. To establish whether the lack of increase in the population was due to the following factors either jointly or individually:

1. late maturity of females and low birth rate
2. low recruitment of calves into the population (i.e. high infant/calf mortality)
3. high adult mortality

The study also aimed to provide information on the demography, status and distribution of the Meru elephant population that would be useful to management, and through individual recognition techniques to establish the number of elephants using Meru National Park.

This study also aimed to provide information on the fate of 50 elephants, including family groups translocated to Meru in July 2001 through post-release monitoring.

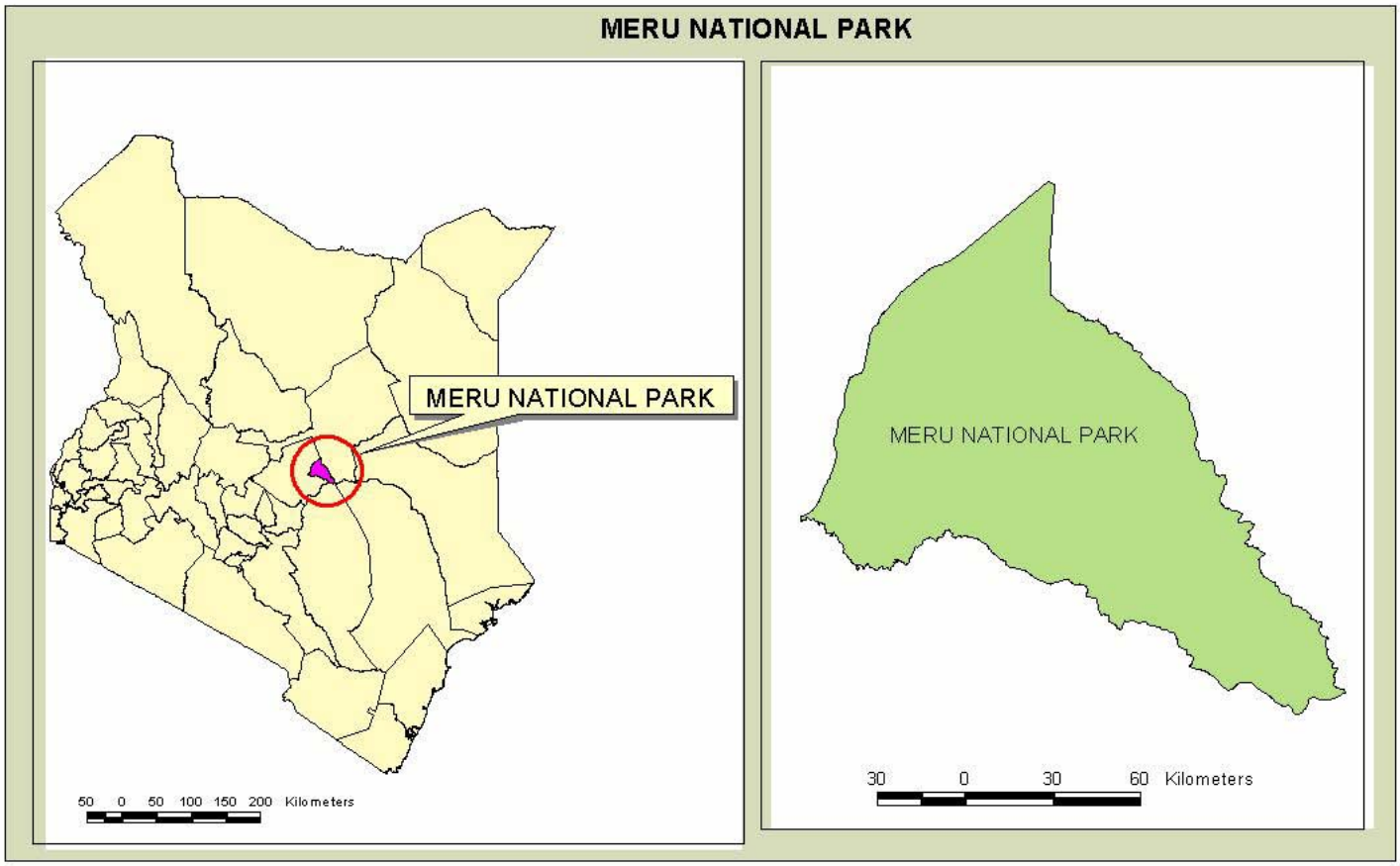
3.0 Material and Methods

This study was carried out between September 2001 and September 2002. Results from radio tracking of collared elephants carried out by Save the Elephants in collaboration with the Kenya Wildlife Service between June 2000 and September 2001 are also presented.

3.1 Study Area

Due to the workload and logistical constraints, the study was confined within the boundaries of Meru National Park.

Figure 2: Map of Meru National Park



Meru National Park, established under legal notice 4756 of 18/12/66, boundary plan number 204/37, is located in Eastern Province, 0° 20' and 0° 10' S, 38° 0', 38° 25' E and covers an area of 884 km², Figure 1. It has a marked altitudinal gradient measuring 330m at the Tana River on its southern boundary and 850m at the foot of the Nyambene Hills. Rainfall in the park occurs in two seasons. During the study period, the long rains were experienced during the months of October-December 2001and the short rains started in March through to May 2002. However, the park experienced differential precipitation with strips around the western boundary receiving most precipitation and remained green throughout the study period. The southern half of the park, which lies on the Equator, was mostly dry.

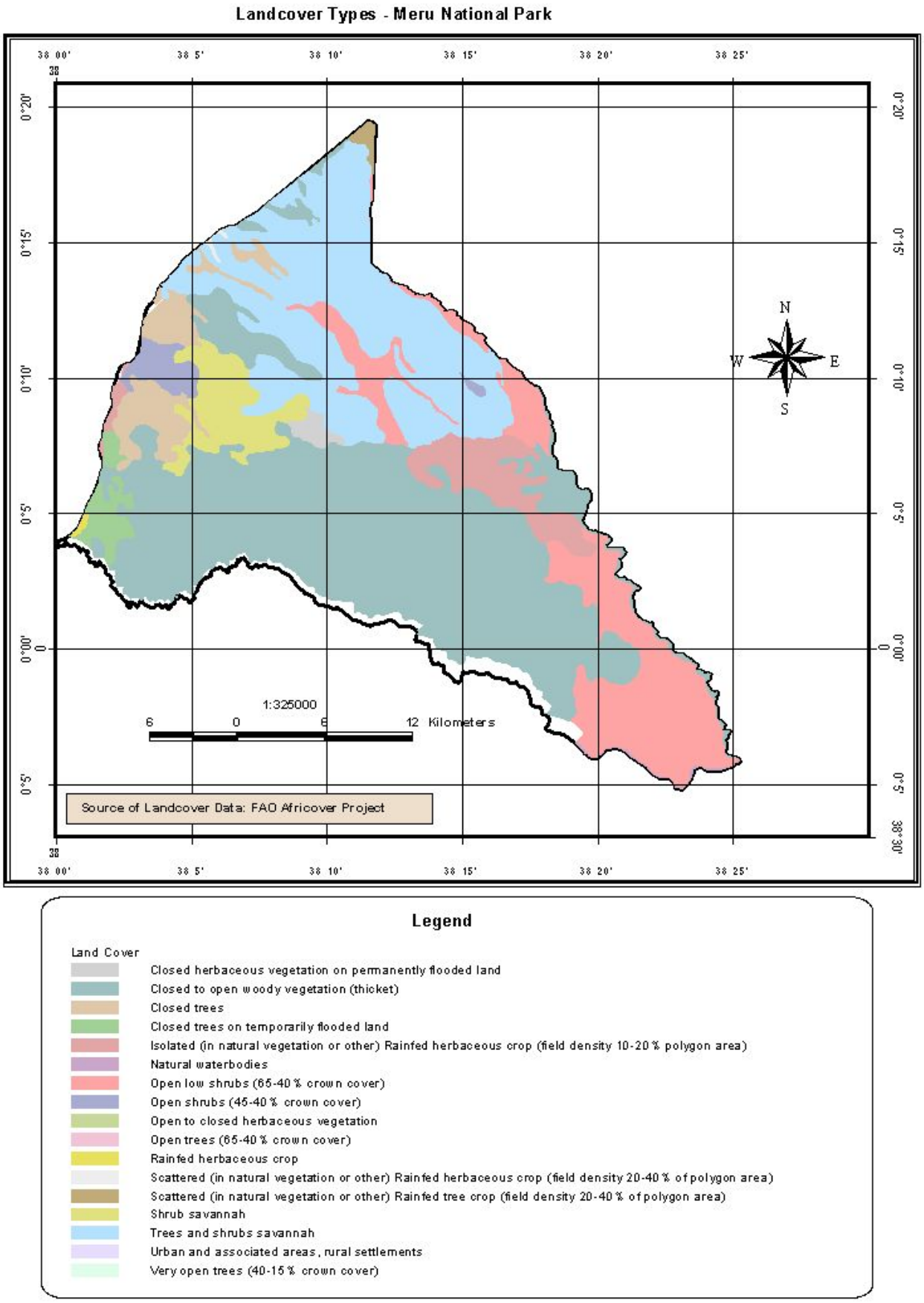
During the rainy months, most elephants moved out of the park to the north and northwestern parts of Bisanadi National Reserve.

Vegetation in the park is in three broad types of *Acacia sp* occurring in much of the park from the northern parts extending well past the central area, the western region is dominated by *Combretum* and *Terminalia* woodland and to the south there is dense *Commiphora sp*. Riverine vegetation is mainly Doum and Raffia palms and *Lawsonia inermis*. Figure 3 shows vegetation cover types in the park.

There are 14 permanent rivers flowing in a west-easterly direction that drain into Tana River. Most of these rivers however dominate the northern half of the park. The southern parts are extremely dry with the seasonal Kyulu Sand River being the only source of water.

Intensifying irrigation farming on the western boundary is a concern as rivers such as Bwatherongi Mulika and Makutano are showing signs of decreasing volume. Drying up of these rivers will have serious effects on habitat use by most species, and ultimately ecosystem function.

Figure 3: Land Cover Types In Meru National Park



3.2 Individual Identification of Elephants

In light of the primary objective of the study, attempts were made to register as many elephants in the population as possible. Elephant encounters were based much of the time on opportunistic encounters along routes within designated blocks. On the southern area of the park, the routes did not allow for intensive searching of elephants as roads are quite far a part and the area is covered by dense *Commiphora* bush making off-road driving impossible. Observations were made from the vehicle and most often on foot as much of the study area was covered in dense vegetation. However, tracking elephants on foot was quite dangerous and one day, 14 November 2001, proved near fatal when an elephant attacked my assistant, Mr. Bernard Lesowapir. This incident did not however affect our effort to obtain as much data as possible. Additionally, the park pilot while carrying out routine aerial surveillance communicated the whereabouts of elephants, which enabled me to locate elephants

An amalgamation of basic individual elephant recognition techniques developed by Douglas-Hamilton (1972) and Moss (1988) were used in establishing an identification file for the elephant population. This involved the use of elephant 'fingerprints' found on their ears such as nicks, notches, holes and in some cases general ear shape. In addition, other features such as patches of dry tissues and/or warts on the body, nature of tusks and also but rarely tail hair density, physical disabilities and any other individual uniqueness provided facets for distinguishing one elephant from others. This formed a satisfactory basis for recognition of bulls and cows above age 10. However, calves below age 10 were recognized through their association with cows, which were presumed to be their mothers.

Registering individuals of the population and developing an individual identification file yielded data that was used to determine the demographic status of the population. During each sighting of elephant(s), date, time, GPS location (obtained using a GPS handset), group type, group count and count accuracy. In addition, Reaction Index, a subjective index that can be used as an indicator of nervousness of elephants in a population was noted at each encounter. It ranges from 1-3 where a reaction index of 1 is used in cases where a group remains calm when approached by researcher's vehicle and continues with activity; 2 where a group gets skittish, runs and then relaxes; 3 when a group completely flees. The index may be used in making inferences on habituation of Meru elephants to vehicles and observers, and possibly, threats facing a population, which can be gauged from elephant reaction in different parts of their range and in areas outside protected areas.

Age and sex of each elephant was noted. In the case of cow/calf groups, associations between cows and calves were keenly observed as a requisite for the determination of mother-calf attachment.

Photographs of the head, ear and tusk of elephants aged 10 years and above were taken. Photographs were taken using a Nikon digital camera and later downloaded onto the computer. Drawings of ears and nature of tusks were made for each elephant to augment the photos besides enhancing the researcher's memory of all catalogued individuals. In addition, brief descriptive notes on any other conspicuous features such as warts, scars etc were recorded on field notebooks. Such notes are very important for future monitoring as earmarks and tusks may greatly change over time and may hinder population recollection.

Each elephant was aged, coded and named using a system adapted from Moss and Poole (1983). In the case of cow/calf groups, a family name and code specific to each family was given to all families and each cow of reproductive age, 12 years and above (Laws, 1966; Douglas-Hamilton, 1972), was coded as guided by the family code, as well as given a name. For example the first family herd I catalogued is coded as AA, the oldest cow in the family is coded AA1, the second oldest, AA2 through to AA4, the total number of cows in family AA. Calves were coded as guided by their close association with cows presumed to be their mothers. For example a 2-year old female calf that closely associated with AA1 was coded as AA1.99F where 99 (1999) is the year of birth and F denotes sex of the calf. This type of cataloguing provides important baseline data for future monitoring, ensuring that each individual in the population has a unique ID. The present ID file was critically checked for double counts by comparing each individual ID with all the others.

Sex Determination

A combination of both physical and behavioral features was used in sexing elephants. Physical attributes used were adapted from Moss (1996). These include pronounced sexual dimorphism in body size (for adults), external genitals, side-view of head-shape, tusk size etc. Adult males tower over adult females who stand at approximately 270 cm at the shoulder height. Body size together with tusk size, which is generally robust in males, was used for sex determination particularly in closed habitats. External genitals are also used. Genital opening of males face forwards whereas that of females face directly downward. However, it is quite difficult to establish sex in young individuals. Poole (1986) noted that waiting until a young calf urinates enhances sex determination. Male calves show pseudo-erection after urinating and the conspicuously hanging penis makes it easy to distinguish a male from a female calf.

Female elephants exhibit close-knit associations with their female calves throughout their life span whereas males become independent and leave their natal groups at about the age of 12 and transfer from one group to another depending on their reproductive state. Thus, sub-adult males are usually seen alone or range at some distance from family units or groups they associate with (Poole, 1986).

Aging Elephants

Visual assessment was used for age estimation using a combination of characteristics such as size, emergence, length and circumference of tusks, and body shape and proportions (Moss, 1996). Derivation of the shoulder-height technique (Laws, 1966) was used in aging calves by visually assessing their shoulder-height in relation to that of their mother. Additionally, other morphometric features such as nature of tusks, nature of back-line, status of hollow of the eye and ear curvature (Moss, 1996) were used to ameliorate those based on visual assessment of shoulder-height for age determination especially for female elephants. These features however differ slightly from population to population and may result in some variations. All age estimates were continuously fine-tuned, and therefore good precision was achieved. Ages of calves under 10 years were estimated to ±1 year, those between 10-20 years, ±2 years; and ±5 years for individuals above age 20 years.

However, large age class boundaries were used in analysis to further minimize any errors that could have emerged from age estimation: Age classes were defined as 0-4.9 years; 5-9.9; 10-14.9; 15-19.9; 20-24.9; 25-34.9; 35-49.9 and 50+.

Recollection of Individuals

The ID file developed in this study was compared with that developed by Njumbi, Demmers and Bird in 1993 to find out how many of the elephants previously indexed could be positively recognized in the present study.

Mortality

Any elephant carcasses found during the course of this study were visited and attempts made to identify the individual. Additional data on mortality of the population were obtained from secondary sources, including reports from Senior Wardens and pilots of the park and radio messages. Elephant mortality data for the population have been summarized by Thouless et al., (2002) whose results are quoted here. This provided information on elephant mortality and poaching incidence during the study and the previous decade.

4.0 Results

4.1 Population Demography

4.1.1 Elephant Monitoring

On each field day, sighting time was recorded and hourly-sighting frequencies generated, Figure 4. Most sightings were made in the morning (0700-1200 hours) and again in the afternoon, between 1500–1700 hours. The few sightings between late morning and much of the afternoon was probably as a result of the high temperatures during the day when elephants sought shade in densely vegetated areas and were therefore difficult to observe.

Figure 5 shows the number of different individuals observed and total number of sightings of elephants for each month of the study. It appeared that rainfall had an effect on the number of sightings of elephants/groups encountered. Fewest elephants were encountered during October, November, December 2001 and May and June 2002 which were wet months, and the highest number of elephants were sighted in September 2001 and 2002, January, July and August 2002 which were dry months, Figure 5. During the wet months elephants moved out of the National Park towards the North and North-West.

No significant relationship was found between number of elephants sighted per month and number of days spent in the field per month, linear regression ($P = 0.520$, $R^2 = 8.1\%$).

Figure 4: Meru Elephant Monitoring: Hourly Sighting Trends

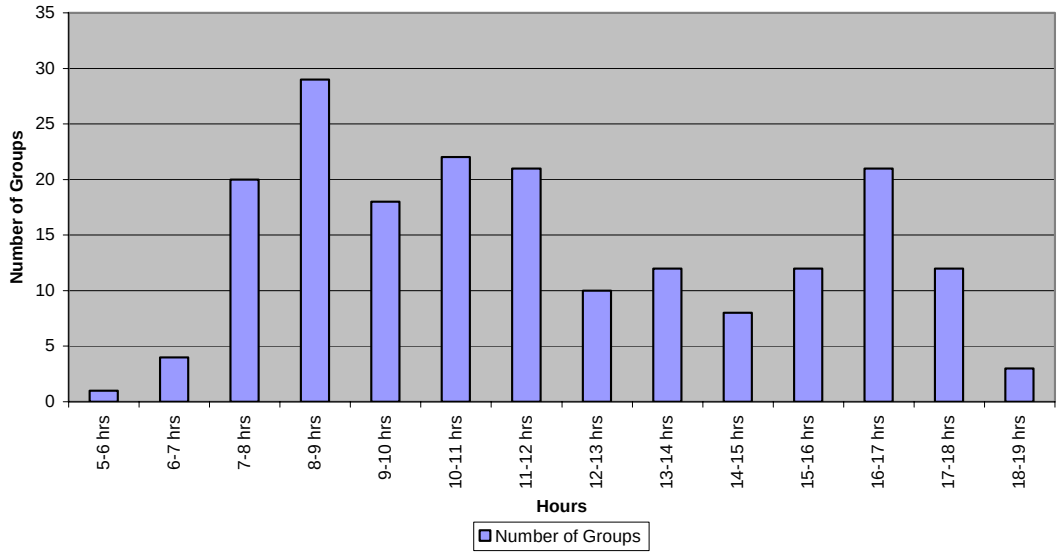
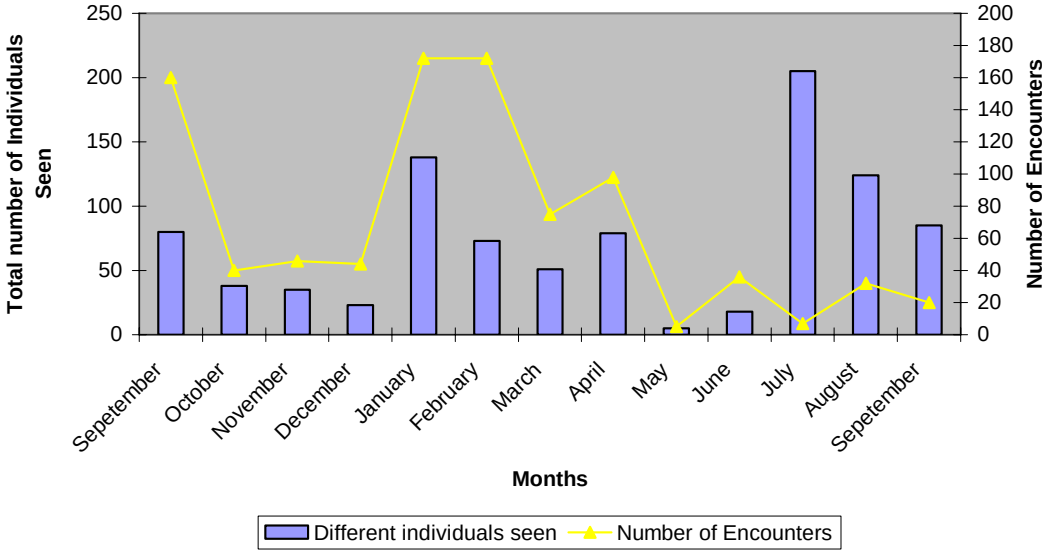


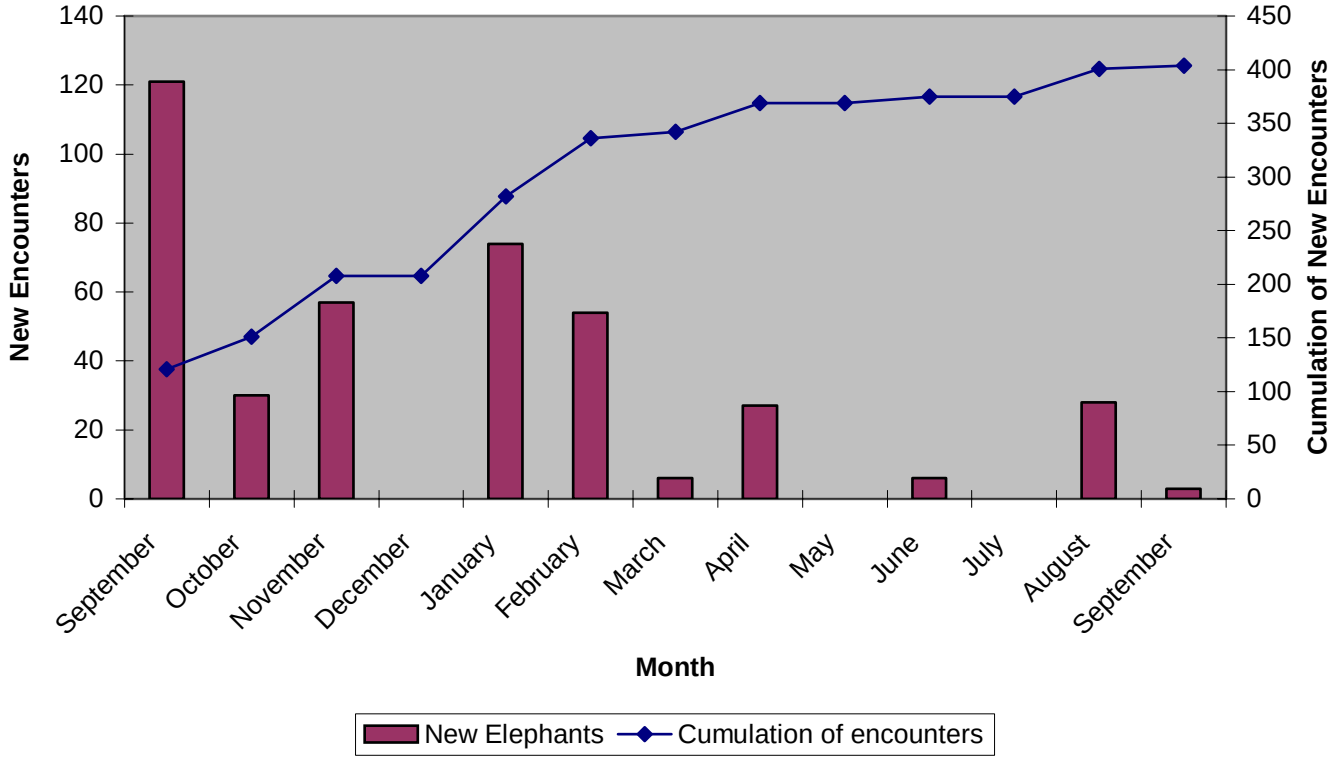
Figure 5: Monthly Elephant Monitoring Data



4.1.2 Population Size Estimate

Cumulations of 'new' elephants were used to estimate number of elephants that used Meru National Park during the study, Figure 6.

Figure 6 : Population Size Estimate from New Encounters



A total of 406 different elephants comprising 134 cows, 114 bulls and 158 calves were encountered during the study. The estimate however includes 69 elephants in 8 families which were encountered only once and therefore do not have good IDs and another 14 cows whose families were not established, Appendix 1. The graph in Figure 6 shows that after the first 6 months of the study, the number of new encounters was very low. Hence the population estimate after one year of approximately 400 individuals is likely to be an accurate estimate of the number of elephants utilizing Meru National Park. Some of these individuals were encountered only once hence good IDs were not obtained. However, drawings of ear patterns and nature of tusks were made for the adults in this category and therefore any over-estimate of population due to lack of good IDs which may cause double counts, is likely to small. The sex of 68 calves was not determined. More time is therefore needed to establish correct IDs of the least encountered individuals and to determine sex of the 68 calves and others being born into the population so as to get an accurate estimate of the population size.

In June 2002, a total aerial count of the greater Meru conservation area was conducted which found 413 elephants (Omondi et al., 2002). This figure is very similar to the 406 estimate derived from the individual ID study. In addition, 22 of the elephants translocated from Sweetwaters Game Reserve in July 2002, which are believed to be

within the park were neither encountered on the ground nor through aerial surveillance.

The 2002 survey also showed that there was an increase in number of elephants using Meru National Park and a decrease in numbers of elephants outside the park compared with previous years. Both the aerial survey result and population estimates from this study indicate that the Meru elephant population has increased over the last few years. However, some of the increase is due to the recent translocation of 73 elephants into Meru National Park (number elephants that have been translocated into Meru was shown in Table 2).

4.1.3 Age and Sex Structure of the Population

The age and sex structure of the population, Table 3, suggests a medium aged population, many young calves but few old individuals in the present than in the previous study. The high number of young calves suggests high recruitment and low infant mortality in recent years. The few number of males aged 20-35 years may imply that the low off take poaching discussed elsewhere in this report is biased against male elephants. Appendix 4 and 5 show ages of elephants in the Meru elephant population.

Table 3: Age and Sex Structure of the Population

Age Class	Total	Males	Females	Unknown	Sex ratio of aggregate ages M: F	Group of Population (%)
0-4.9	138	39	24	75		34
5-9.9	22	7	8	7		5
10-14.9	43	28	15			11
15-19.9	44	24	20		98:62 (1.5:1)	11
20-24.9	48	23	25			12
25-34.9	82	24	58			20
35-49.9	26	13	13			6
50+	3	2	1		62:97 (1:1.6)	1
Total	**406**	**160**	**164**	**82**		

Table 4: Age class of elephants in previous study and present study

Age class (years)	Previous study	Present study
0-4.9	55	138
5-9.9	34	22
10-14.9	53	43
15-19.9	36	44
20-24.9	43	48
25-34.9	30	82
35-49.9	7	26
50+	0	3

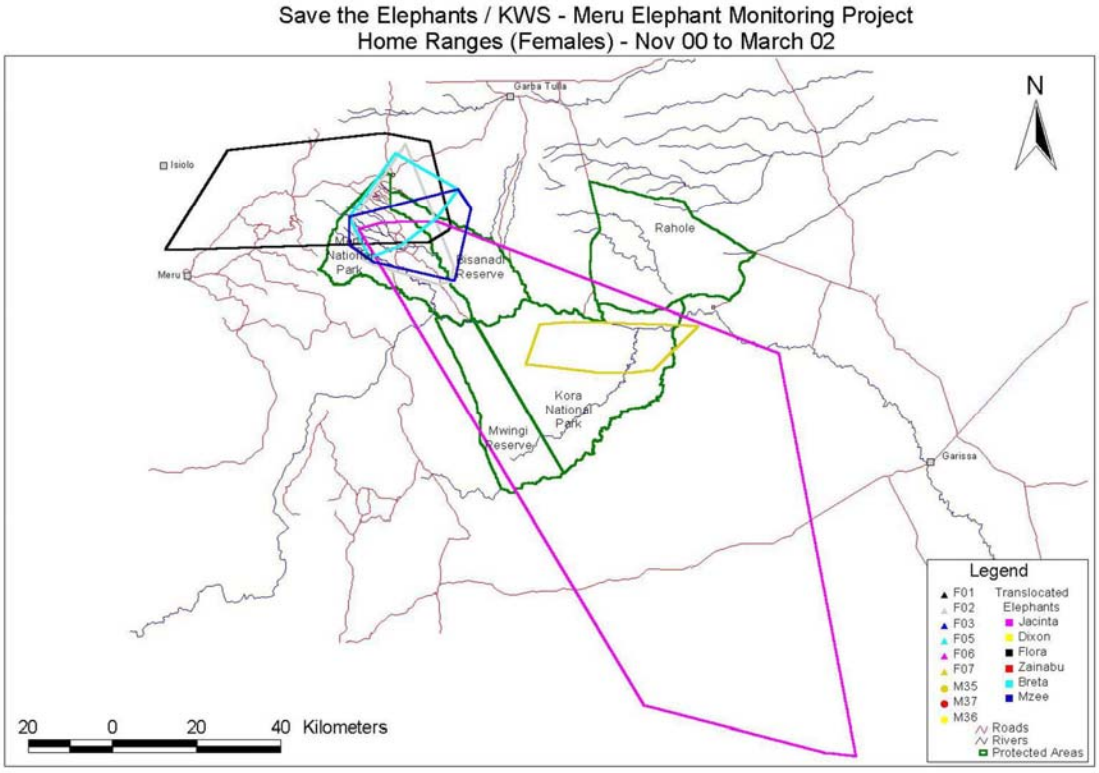
There is a marked difference in age structure between the previous study and the present study. In the early 1990s when the previous ID study was done, there were fewer old (those aged 25 years and above) individuals, which was attributed to first, selective elimination of older males and later, indiscriminate removal of adult individuals of both sexes. There are many more young calves (0-5 yrs) in the present population than in the early 1990s. In the present study, there are more 0-5 year olds and those aged 25+ years found in the population than was reported in the previous study.

4.1.4 Movements and Distribution of Meru Elephants

In June 2000, a detailed radio tracking study was established by Save the Elephants in collaboration with the Kenya Wildlife Service. 10 elephants, 6 females and 4 males, were collared and radio tracking is carried out by the KWS pilot to establish the whereabouts and extent of movements of the Meru elephants. The extent of movements and distribution of the Meru elephants is much greater than was previously thought and seasonal distribution patterns are becoming evident.

Tracking has shown that elephants in the population move as far north as Garba Tulla, north-west to Imenti Forest on the edge of Mt Kenya by passing around the northern tip of the Nyambene Hills, and one family has been located 120 km south-east of Garissa town (King, 2002). Minimum convex Polygon home ranges of the 6 females calculated from radio tracking data collected between November 2000-March 2002 has revealed that the Meru elephants have the widest variation in MCP home range size reported for a single population, Figure 8**.** The MCP of one female is the largest home range so far reported for savanna elephants (King et al., in preparation). These results have been quoted so as to provide a picture of the status of Meru elephants as complete as possible.

Figure 7: **Home ranges of Female Elephants from Tracking Data of November 2000 – March 2002**

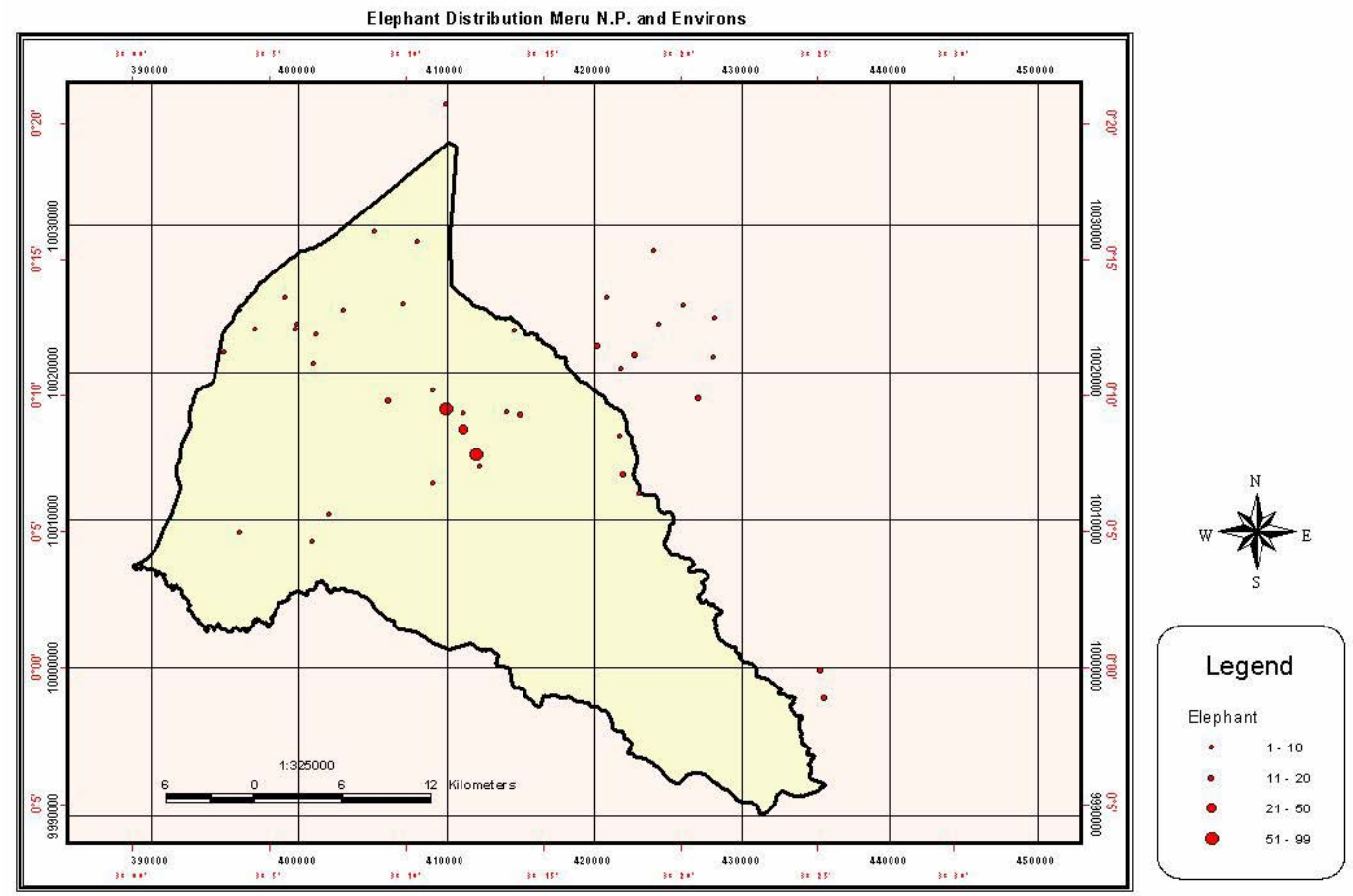


Distribution of the Meru elephants obtained during the June 2002 total aerial count is shown in Figure 9. Many groups of about 10 elephants were found out of the park on the eastern side where they are vulnerable to poachers due to the presence of heavily armed pastoralists.

The Meru elephants appear to show a wet season dispersal pattern, moving outside the protected areas during the rainy months (Mid October 2001 through to mid January 2002 and from March to May 2002). Most elephants moved out of the park to northwestern Bisanadi and to the north of the park to an area known as the Northern Dispersal Area. These movements began about two weeks before the start of the rains. When the elephants returned to the park, they entered from northeastern boundary around Golo Plains and Dik Dikd Nyeupe. On their return to the park, most groups aggregated into large herds.

Most sightings of elephants were made in the central and northern part of the park. Few sighting of elephants were made in the thick *Commiphora sp* areas in the southern part of the park. Few signs of elephant activity (old dung heaps, signs of elephants browsing and foot prints) were seen in this area.

Figure 8: Distribution of Elephants in the Meru Ecosystem, June 2002 Total Aerial Count Results (Courtesy of Elephant Programme, KWS)



The timing of fruiting by *Acacia tortilis* in July-August 2002 was observed to greatly affect habitat use patterns by most elephants in the population. Most elephants concentrated their activities under *A. tortilis* trees to eat fallen seedpods. During August-early September 2002, elephants were mostly observed in the riverine habitats rich in *A.. tortilis* especially along the Mtundu and Bwatherongi rivers and south of Mulika River.

It was observed that during the wet season, elephants moved away from the southern parts of the park rich in easily waterlogged clay soil to more dry and raised areas to the northeast and north of the park.

4.1.5 Seasonal Herd Dynamics

Group type encounters among the four groups, all bull, lone bull, cow-calf and mixed throughout the study period were not significantly different ($F_{3, 48} = 0.92$, n=266, P = 0.438,), although there was a high difference in the number of monthly encounters among the groups (CV = 94%). Elephant group sizes were compiled for each month throughout the study period. Bull average group size was found to be 1.9 (range = 1 to 9) and that of cow groups (cow-calf and mixed groups) was 17 (range = 2 to >100). Average group size during dry months was compared with that during rainy months. During dry months (June, July, August, September 2001 and September 2002), the average group size was 2.2 (range, 1 to 9) for bull groups and 21.3 for cow groups (range = 3 to >100) and that during rainy months (November and December 2001 and March, April and May 2002) was 1.6 for bull groups (range = 1 to 6) and 13.64 (range = 2 to >100) for cow groups.

Group sizes of families did not remain constant during the dry months. However, bull tended to aggregate into relatively large groups especially around swamps along Mkutano River and Muiruri Swamp. Bull group sizes during dry months were highly significantly different from those during wet months, t-test (t, = 2.74, d.f. =113, n dry months = 68, n wet months = 47, P = 0.007). Although this observation is consistent with reports by other workers (e.g. Douglas-Hamilton, 1972; Moss & Poole, 1983), social integration between bulls and cow groups was not significantly different between the dry and wet months, t-test (t = -0.89, d.f. = 38, n dry months = 14, n wet = 26, P = 0.379). During the short dry period from mid January to mid March 2002, groups remained more or less aggregated and family boundaries were not clear. In the longer dry period that extended from June through to September 2002, many of the large cow groups that had aggregated during the rainy months broke up into groups consisting of about 1to 3 families, but continued to constantly re-unite, and mean cow-calf group size during the dry months was not significantly different from that reported for the wet months, t-test (t = -1.53, d.f. = 72, n dry months = 53, n wet months =21, P = 0.131). During the rainy months, elephants especially cows and calves were found even in much larger groups whereas bulls were mostly found alone. This finding is not much different from the population group dynamics reported by the previous study, when it was attributed to general insecurity in the park and neighboring areas. It is possible that the elephants continue to experience insecurity especially during the seasonal movements, when most elephants range in areas outside the park.

4.1.6 Behaviour- Wildness/Tameness of Meru Elephants

Elephants in Meru were observed to be generally nervous. Reaction index for 145 out of 262 elephant sightings showed that Index 1 was the modal index for all the group types, lone bull groups were the least nervous whereas mixed groups were observed to be mostly nervous (All bull groups: Index 1=26; Index 2=8; Index 3=4;n=38; Lone bull group: Index 1=29; Index 2=7; Index 3=0; n=35; Cow-calf groups: Index 1=18; Index 2=6; Index 3=2; n=26; Mixed group: Index 1=19; Index 2=18; Index 3=9; n=46). During the first months of the study, most elephants encountered either reacted aggressively or fled in the presence of the researchers and vehicle. After a period of habituation, some lone bulls and family groups tolerated the presence of researchers and vehicle, Photo 4.

However, after the rains and as elephants returned to the park, most elephants even those considered calm, were observed to react aggressively. This may suggest insecurity in areas the elephants traverse in the course of their wet season movements during which they likely encounter people.

Photo 1: Researcher less than 10 metres from Kuseren, one of the most friendly bulls in Meru National. *Photo by Bernard Lesowapir*

4.2 Factors Affecting Population Growth of Meru Elephants

Results from aerial surveys conducted during 1990s showed that the Meru elephant population remained relatively stable and did not show a significant growth in numbers. However, between 1999 to 2002 results from total aerial counts showed that the population increased by about 35% (107 individuals) in three years, or an annual growth rate of 12%. Much of this increase is due to translocations of 60 elephants into the population during this period. When this factor is removed, the mean annual growth rate implied by the census is 5% in the period 1999-2002.

4.2.1 Mean Age at First Conception and Mean Calving Interval

Late maturity of females (determined from mean age at first conception) and low birth rate (mean calving interval) are possible factors that may limit population growth and were therefore determined from association data between cows and calves. 134 females of breeding age were indexed out of which 66 cow/calf associations were established. The following analysis is based on only a sub-set of the population, since associations between cows and calves was only established for a limited number of females. Only 24 of the associations were those in which more than one calf was associating with one cow giving a mean calving interval of 2.75 ± 0.335 years (n=24; SE=0.162, range = 2 to 4 years). It must however be stated that errors in determination of calving interval through association based maternity may arise as a result of allomothering which has been reported in the African elephant (Lee, 1987), and may be high especially in a population with a history of disturbance such as the Meru population.

Age at first conception was not calculated as most of the cows with calves for which associations were deduced were above age 20 and thus could not provide a reliable estimate.

More association data are needed, through close observation of family groups, in order to carry out these analyses and state with confidence the age at first conception and mean calving interval for the population as a whole.

4.2.2 Recruitment

High infant mortality and low recruitment of calves into the population was examined for calves less than 10 years of age, i.e. for the period 1993-2001. Data for 2002 are not included as the study was completed before the end of the year and therefore is likely to under-estimate the number of calves recruited in 2002. However, 10 calves were born between January to September 2002.

Ages of calves aged less than 10 years were used to establish the level of recruitment for each year in the previous decade. These results are shown in Figure 9. The graph shows that recruitment in the mid 1990s, 1994-1996 was low (i.e. there are few calves in the population aged 6-9 years, and recruitment of calves into the population since 1997 has increased. In particular there has been high recruitment since 1999.

Figure 10: Recruitment since 1993 as derived from Ages of Calves

There was low recruitment in the first half of 1990s when disturbance to the population through poaching was high. It is possible therefore that there was high infant mortality during this time. The high infant mortality during this time and in addition to the fact that the population was disturbed is likely to have contributed to low growth in size of the population. Since the 1999, security in the park and surrounding areas has improved and the population is less disturbed. This has coincided with a higher rate of recruitment of calves into the population in recent years.

4.2.3 Mortality

Table 4 shows known elephant mortality from 1990 to 1999. In the period between 1990-1995, elephant mortality was high, more than 80% of which was due to poaching. From 1996-1998, there was no pilot stationed in Meru and the decrease in reported mortality during this time is likely to be as a result of reduced surveillance rather than an actual decrease in mortality (Thouless et al., 2002). The increase in reported poaching in 1999 may be due to a combination of an actual increase in poaching together with increased surveillance as a resident aircraft returned to Meru in 1999.

Monitoring of elephant mortality in Meru National Park and the larger conservation area is difficult because of a number of reasons. The dense habitats that cover much of the area reduce visibility thus make it difficult to locate carcasses either through ground or aerial search. As with other elephant populations that disperse over a wide area the reported elephant mortality will be much lower than actual mortality since the possibility of finding carcasses in remote areas where there is little or no patrolling is low. The rate of carcass decay was also found to be high perhaps due to high density of scavengers. Photo 1 shows a half a month old carcass whose bones are already visible especially on the skull and much of skin already gone. Photo 3 shows a one-year-old carcass, which may be difficult to see from the air and may be easily

classified as old and therefore obscure the estimate of carcass ratio. It is possible therefore that the continued poaching during the 1990s and in particular in mid 1990s was sufficient to negatively impact population growth.
The age and sex structure of the population, Table 3, also suggests that the population continued to suffer from poaching during the 1990s since few mature adults (over 35 years) of either sex are found in the population as mature adult males and females were targeted by poachers.

Table 5: Reported Elephant Mortality in Meru since 1990-May 2002, (Thouless, et al., 2002)

Year	Total Reported Mortality	Number of Elephants Poached
1990	14	13
1991	2	1
1992	6	3
1993	14	13
1994	26	21
1995	18	18
1996	11	7
1997	12	4
1998	6	4
1999	21	12
2000	11	5
2001	15	7
Jan.-May 2002	7	4

Note: It must be mentioned that these data include reports of elephant deaths in the larger Meru Conservation Area.

Seven elephant deaths were reported during the study. Three of the carcasses were examined. One case, a bull aged 35-40 years was poached though tusks were later recovered after a suspect was arrested. The second case was of a young bull, 10-15 years. There were arrow wounds and it was thought that these were the cause of death. The tusks were already chopped out by the time the carcass was found. Given the age of the elephant, and the part of the park on which the incident occurred, southwestern side, death could have been as a result of conflict, a possible crop raid, during which the elephant sustained injuries. Death of the third elephant, also a young bull aged 10-15, was from natural causes. The elephant was first reported to have swollen limb. It was darted and treated, but due to complications had to be darted again two days later, it was later found dead, Photo 2.
The continuing background level of poaching, although it appears to have decreased over the last 3 years, may have an impact on the demographic status by selectively targeting mature adults.

Photo 2: Half-month old carcass. Photo by *Patrick Ogola*, 1 March 2001

Photo 3: Researcher inspecting elephant carcass area to ascertain cause of death. *Photo by Bernard Lesowapir*

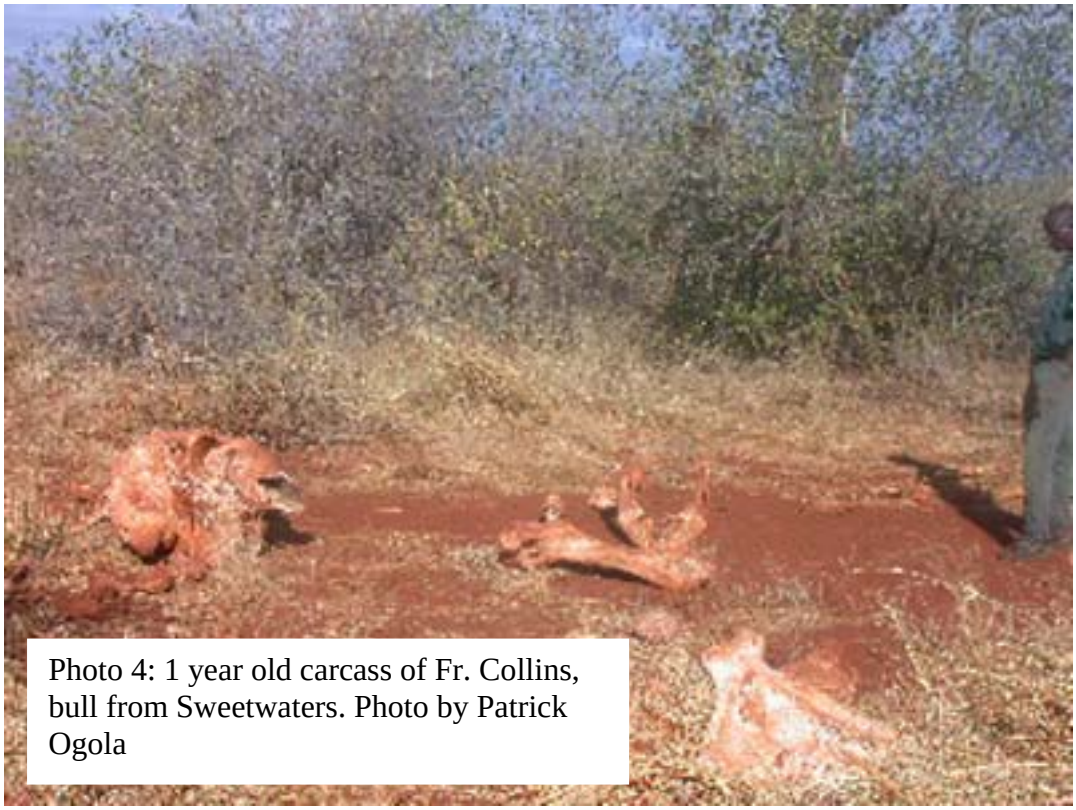


Photo 4: 1 year old carcass of Fr. Collins, bull from Sweetwaters. Photo by Patrick Ogola

The wide distribution of the carcass locations within the conservation area and the high possibility that other deaths could have gone unreported remains cause for concern.

4.2.4 Population Recollection

A comparison of the ID file developed during this study was made with that developed by Njumbi, Demmers and Bird (1992-1994), in an attempt to establish the number of the elephants indexed in the previous study that were still in the population. It was hoped that this information would give insight into the survivorship of different age classes among the elephants that were indexed.

However, re-identifying individuals using IDs developed in the previous study proved more difficult than was expected as it appeared that most elephant identification marks such as ear and tusk characteristics and features had changed over the period between the two studies.

Only 42 elephants (about 22% of elephants indexed in the previous study) were re-identified. However, 3 IDs of the reconciled elephants are not certain, Appendix 2. The original age classes of reconciled individuals is shown in Table 6.

The difficulty in using individual identification techniques after a long period to monitor trends in demographic status in studying elephant population reinforces the need for continuous monitoring and updating of individual Ids.

Table 6: Age Classes of Reconciled Elephants

Age Class, Years (previous study)	Males	Females	Total
0-4.9	0	0	0
5-9.9	4	0	4
10-14.9	4	6	10
15-19.9	1	5	6
20-24.9	3	6	9
25-34.9	5	4	9
35-49.9	1	3	4
Total	18	24	42

Using dates when elephants are encountered, it is possible to distinguish between resident elephants, for which Meru National Park forms a major part of their range, and elephants that only occasionally visit the park at specific times of the year.

Most elephants in the population moved out of the park during the rainy season (October-December 2001 and March-May 2002). However, the encounter of 3 families and 9 bulls for the first time in July-August 2002, suggest that non-resident elephants use the park at certain times of the year, but spend much of their time in other areas. It is possible that the extensive movements of most elephants in the population may have contributed to the low number of reconciled elephants.

4.3 Post Release Monitoring of Translocated Elephants

Table 7 shows the list and ID elephants translocated to Meru National Park in July 2001 and whether they were observed either from the ground or by the pilot, or a radio signal from their collar received after release

Family	Size	Individuals	Sex/age	Status (Presence)
Jacinta's	5	Jacinta*	Ff-32	Signal and seen from air
		Joyce	f-24-26	Not reported
		Jane	f-22-24	Not reported
		C96	m	Not reported
		C95	m	Not reported
Zainabu's	4	Zainabu*	f-40-45	Signal and seen from air
		C00	m	Not reported
		C98	m	Not reported
		C95	m	Not reported
Flora's	5	Flora*	f-35-40	Signal and seen from air
		C98	m	Not reported
		Fiona	f-25-30	Not reported
		C00	m	Not reported
		C96	m	Not reported
Helida's	5	Helida	f-30-35	Seen from Air
		C00	m	Seen from Air
		C98	m	Seen from Air
		C93	m	Seen from Air
		C86	m	Seen from Air
Risper's	5	Risper	f-30-35	Not reported
		C00	m	Observed from ground
		C92	f	Not reported
		Rosana	f-16-18	Observed from ground
		C00	m	Observed from ground
Yvonne's	4	Yvonne	f-28	Observed from the air
		C00	f	Observed from the air
		C96	m	Observed from the air
		C92	m	Observed from the air
Caren's	6	Caren	f-40-45	Observed from the air
		C98	f	Observed from the air
		Carol	f-25-28	Observed from the air
		C98	m	Observed from the air
		Brenda	f-24-28	Not reported
		C01	f	Not reported
		Belta*	f-26	Signal and observed from ground
		C00	f	Not reported
		C95	f	Not reported
Alice's	7	Alice	f-40-45	Observed from ground
		Rose	f-12-14	Observed from ground
		C94	f	Observed from ground
		C98	f	Observed from ground

		C98	m	Observed from ground
Bulls				
Mzee*	42 years			Sigal received 10 days after release, not reported since
Koskei	44 years			Not reported
Mr. V	44			Not reported
Albert	16 years			Not reported
Maina	24 years			Not reported
Dixon*	24 years			Observed ground and air and signal regularly received
Maurice	12 years			Not reported
Mwangi	16 years			Not reported

Note: * shows elephant with collar

The ID file I developed during 5 months of intensive pre-translocation monitoring of the 50 elephants translocated from Sweetwaters Rhino Sanctuary in July 2001 was used for post-release monitoring.

10 of the translocated were observed from the ground, 16 from the air (by pilot and researcher) and five of the radio-collared individuals routinely monitored by the park pilot.

Observations made on the translocated elephants suggested the elephants tended to confine their activities in dense habitats and were observed to use a small area of the park. Immediately after release, most of the elephants moved to the south and southwest parts of the park and have continued to confine their activities there. One bull, Mzee, headed east into Bisanadi immediately after release, then moved south crossing the Tana River into Kora and continuing southeast across Garissa road, he was last located 10 days after release (King 2002). Two collared cows, Zainabu and Flora, in a group of 5 each joined within a month after release and moved south into northern part of Kora National Park from where signals from their collars have continuously been received during aerial tracking by the KWS pilot.

Radio tracking data of the collared translocated elephants are shown in figures 11&12and show restricted habitat-use habit by the elephants.

Figure 10: Movements of Collared Translocated Elephants October 2001

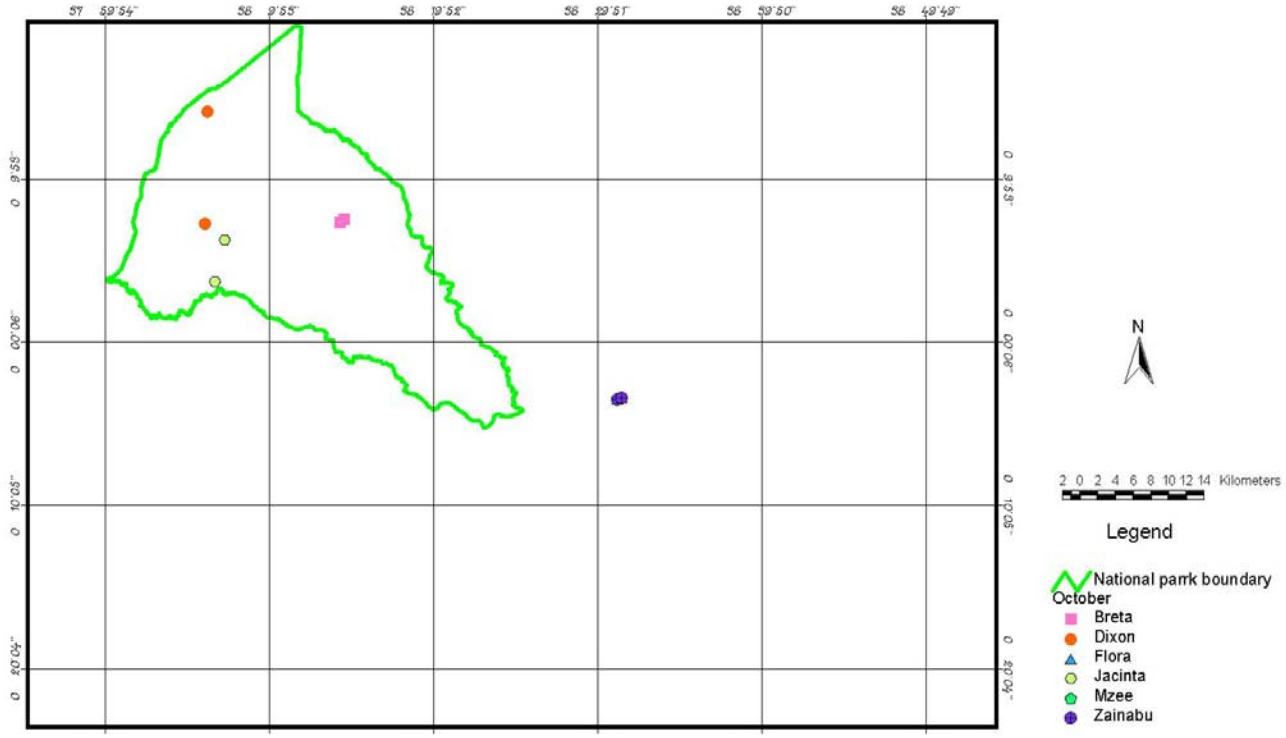
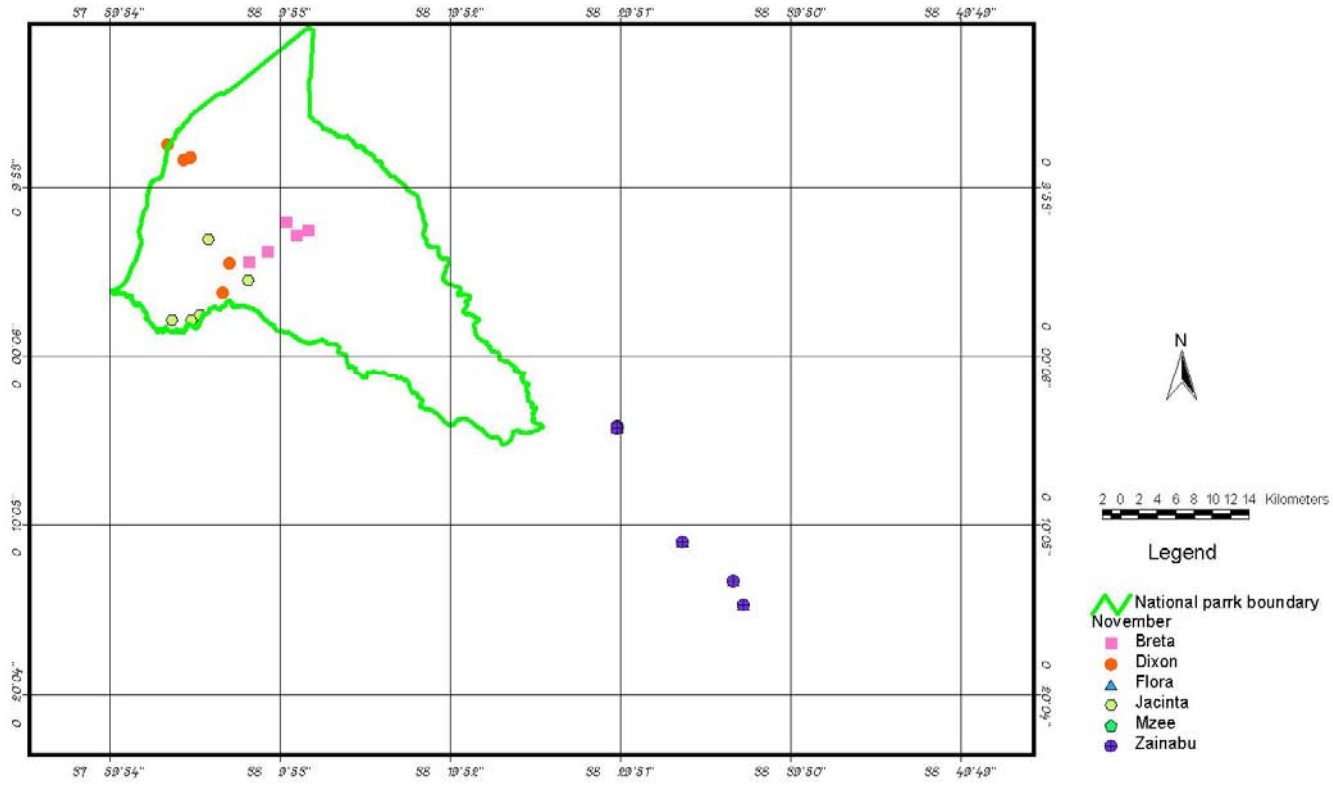


Figure 11: Movements of Collared Translocated Elephantsin November 2001



Two families, one with a collared female (part of Belinda's and Alice's families) and part of Risper's family, and one collared bull named Dixon (Code BT79) were encountered on the ground. The family with a collared female, Alice's family was encountered for the first time in April 2002 and was observed to be quite nervous. However, in the second sighting September 2002, the family was relaxed and was observed to feed well and most members were of fair body condition (determined by method of Riney, 1955 &1957). The second family was part of Risper's family (translocated as 5 members). Only three members, a cow, Rosana and two calves one belonging to her and the other to Risper were encountered. Risper, the martriach and another female sub-adult were not encountered. The elephants were observed to casually feed and the body condition was fair. However, the lumbar depression of Rosana was prominent giving the backbone a protruding appearance. The physical body condition of Helida's, Caren's and Yvonne's families which were observed from the air could not be properly ascertained.

Most of the transolcated elephants were observed to show limited use of available habitat, confining their activities in more closed areas of the park. This made it difficult to determine levels of integration with 'native' elephants. However, one bull, Dixon that was encountered quite often was seen to interact with native elephants and even joined a group of about 40 elephants to Imenti Forest, (Mark Jenkinns *pers comm*.).
However, most of the translocated elephants remained in the park as 'native' individuals moved out of the park.

Ground based monitoring of the translocated elephants was difficult due to among other things the dense habitat and the nervousness of the elephants. However, the fact that some of the translocated elephants had collars made it possible to at least collect qualitative data. Families in which no member was collared were never encountered on the ground. I only managed to observe two of the families, Helida's, and Yvonne's together from the air on 19 November 2001.
This makes it very important to collar at least one member in each family in future translocations.

5.0 Discussion

5.1 Population Demography and Population Estimates

A total of 406 elephants were encountered during this study, 83 of which were encountered only once and do not have good IDs. The total figure is however likely to be an under estimate of the number of elephants that utilize Meru National Park since not all elephants known to use the park (through radio-tracking and aerial monitoring) were encountered during this study. Although the number of new encounters of elephants after one year was very low, figure 6, this figure under estimates the total population size of Meru elephants for a number of reasons. Firstly the population is an open one with a wide range and expansive seasonal movements. While my study concentrated within the confines of Meru National Park and northwestern Bisanadi National Reserve, it is known from radio-tracking data and through aerial surveillance that the elephant's range extends as far north as Garba Tulla and Lower Imenti Forest to the west and to the outskirts of Garissa to the south. Furthermore, elephants known to use the park, through radio tracking and ID file of translocated elephants were not encountered during ground-based monitoring yet radio signals were regularly received from those with collars. Secondly, the estimate does not include overall group size but only report on the exact number of individuals indexed or those in the case of calves, closely associating with cows. In addition, 22 of the elephants, which were translocated from Sweetwaters in July 2002 and are believed to be within the park were neither encountered on the ground nor through aerial surveillance. The estimate thus only gives the number of elephants that were encountered and catalogued in Meru National Park between September 2001 and September 2002.

Population estimates from aerial counts and individual identification studies during the 1990s ranged from 251 in 1990 to 360 in 1997 and showed that the number of elephants within the Meru Ecosystem remained relatively stable with no consistent trend in numbers over time. However, recent total aerial count results showed that the population has increased from an estimated 306 in 1999 to 413 in 2002. The estimate obtained from the current ID study indicates a population of over 400 elephants utilizing Meru National Park, which corroborates the finding of the 2002 total count. The estimates of number of elephants using the Meru Ecosystem obtained from aerial total counts suggest that the population experienced an average, annual growth rate of 2% (taking into account 10 elephants translocated in 1998 into the population, Table 2) during the period between 1990 to 1999; and a growth rate of about 5% between 1999 and 2002. This is the accepted growth rate for stable elephant populations (Calef, 1988, Douglas-Hamilton, pers comm.). It must however be mentioned that the 2% growth rate during this period does not consider results of the 1997 aerial count, due to the fact that it was carried out in November (wet month, unlike other counts which are usually done in June which is a dry month). Thus, the aerial count results suggest that the population increased at a higher rate between 1999-2002 than between 1990-1999. Estimates obtained from ID studies however show that the population has been experiencing an annual increase of about 4%, from 1994-2002, (227 in the previous study and 299 (406 less 83 individuals without good IDs, 11 and 3 of the translocated elephants from Sweetwaters in July 2001 and Lewa in 2002 encountered from the ground). The 4% growth rate is however, in-part due to 20 elephants translocated into the population between 1998 and 2000, Table 2, which if taken into account (299 less 20), the average annual growth rate obtained from results of the two ID studies is 2.86%.

Results of the present study also suggest that much of the increase in elephant numbers was experienced between 1997-2002 than between 1993-1996, Fig. 10. There was an increased recruitment of calves into the population since 1997 together with a high number of 25+ year old adults in the current population compared with the previous ID study conducted in 1992-1994. This suggests that adult mortality has decreased over the last 5 years, which coincides with reports that poaching, although continuing at low levels has reduced since the mid 1990s. It is possible that the continued low take of adults and disturbance of the population due to poaching up to the mid 1990s was sufficient to limit population growth through both adult mortality and low calf recruitment in the first half the 1990s.

Compared with the previous ID study in 1992-4, the current population has a high number of young calves (0-4.9 years) implying a high calf recruitment rate. The age and sex structure of the population suggests that so many female elephants joined the active reproduction pool, which in this population was found to be between 10-35 years. This may explain the high fecundity during the 1997-2002.

Group size dynamics over the study period show that most elephants in the population occurred generally in large groups during the wet and dry months. Such aggregation behaviour may be attributed to security pressure especially among elephants that leave the park during the rainy months.

Too few elephants were re-identified from the previous ID study (1992-4) to make any conclusive inferences on the survivorship of specific groups/families.

The translocation of 73 elephants to Meru in the last few years has contributed to the population increase seen in the recent aerial surveys and also during this study. However, this accounts for only a part of the increase, the remainder of which is attributable to a natural increase in the resident population due to a lower adult mortality and higher calf recruitment in recent years.

5.2 Post-release Monitoring of Translocated Elephants

Post-release monitoring of translocated elephants through ground observation was of limited success due to the nervous nature of the elephants after translocation and their tendency to limit their range to thick bush where they could not be observed. This has reinforced the necessity for collaring of target individuals in family groups and adult bulls in future translocations. Of the 50 elephants translocated in July 2001, 29 have been observed either from the ground, air or through radio tracking. The whereabouts of the other 21 elephants is not known, although 1 male left the area immediately after release heading southeast and signals from its collar have not been received since. All of the collared females have remained within the Meru Conservation Area. One of the 8 translocated families remained discrete after translocation whereas others united. Pilot reports obtained during aerial surveillance showed that Jacinta's family remained discrete after release and restricted its habitat-use on the extreme western part of the park. Alice's and Belinda's families joined and continued to range together south of the park headquarters but moved slightly to the northeast during the rainy months. Caren's, Helida's and Yvonne's families were located from the air within Meru. Zainabu's and Flora's families of 10 united soon after release and moved toward Bisanadi and then south into Kora. One of the bulls, Dixon mixed with

individuals of the Meru population and in December 2002 joined a group of about 40 elephants that moved to the west up to Imenti forest before returning to the park (Jenkinns *pers. comm*.).

It is however interesting to note that one (Osama) of the three bulls translocated from Lewa in September 2002, returned to Lewa and had to be killed, (Douglas-Hamilton, pers comm..). A similar attempt by Mzee, a bull translocated from Sweetwaters Game Reserve to return to its site of origin show it move south of the park until signals from its collar could not be received and has not be sighted nor its whereabouts known. The foregoing in addition to the fact that only one of the 6 bulls translocated from Sweetwaters to the park and who are thought to be alive was observed, makes it apparent that the reconsider the benefits of translocating bulls.

5.3 Human-Wildlife Conflicts

Meru National Park experiences an all-year human-wildlife conflict from invasion on the eastern and northern parts of the park by heavily armed Somali and Borana pastoralists during the dry months, and crop raids by elephants, buffalos and baboons in addition to trespass activities of honey and game hunters in the south. These conflict situations predispose the elephants to poaching.

There were 3 human deaths from elephants and 3 serious injuries sustained from buffalo attacks. Areas of frequent human-wildlife conflicts included much of the farmland on the western boundary of the park where there are rampant crop raids by elephants, buffalos and baboons. Areas to the southwest (around Ura Gate and Kambi ya Teziwa) and northwest (Murera, Kinna and Rapus villages) also experience livestock depredation by lions, leopards and hyenas.

During the rainy season when elephants migrate out of the park, areas around Kinna settlement experienced elephant problems (limited human activities due to large groups of elephants). Crop raiding by elephants was reported on several occasions and the sites of raids and the surrounding areas visited by the researcher in an attempt to obtain IDs of crop raiding elephants. A group of 11 elephants broke into the Kinna Village, which is completely electrically fenced in February 2002. The problem elephants were identified before they were driven out of the area by the park administration and the fence repaired, Photo 5. On 19 May 2002, a group of about 12 elephants moved from lower Imenti forest through Njiiru and Mbeu bushes in what was thought to be an attempt to reach Meru National Park, but were unable to reach the park due to dense settlement. Most crops destroyed were not as a result of eating but trampling by the elephants Photo 6. Dung heaps found on the destroyed farms contained Irish potatoes and oranges, which suggests that the elephants came from regions around Mt. Kenya and Meru Town. Local people in Miomboni claimed that the elephants retraced their steps to Mulika and entered Mbeu and Njiiru bushes and back to lower Imenti forest. During the same month (May 2002), numerous crop raids were reported. Most affected were farms close to Ura Gate on the western boundary of the park.

During the dry months of June to mid October, heavily armed Somali and Borana pastoralists drove in their herds of cattle and occupied much of Kora National Park, and Bisanadi and Mwingi National Reserves. Around this period, large and rarely encountered bulls were seen to move from southern part of Meru National Park to the

north. This movement could possibly have been as a result of heavy livestock presence much of Mwingi National Reserve. KWS used two light aircrafts and a helicopter to drive the livestock out of the protected areas.

Illegal human presence and activities by subsistence hunters and honey gatherers were found particularly to the southwest parts of the park, which neighbor areas inhabited by the Tharaka people. Human foot prints, fire points, harvested hives, missed target arrows, old clothes, sleeping groves etc, were observed and reported to the park administration.

In order to alleviate human-wildlife conflict, fencing of Meru National Park began in 1985 when a physical fence covering a distance of 25km was erected between Kindani and Kinna Community. The fence was put in place to prevent movements of wildlife outside the park and thus mitigate crop raiding on the western border of the park which is occupied by Tharaka, Igembe and Meru farmers. Borana communities around the park particularly on the northern part are also protected by electric enclosures within which they have their settlements and small agricultural plots on which they grow maize, vegetables and weaning fodder for their livestock. The enclosed villages are Kinna and Rapso measuring 18km^2 and 9km^2 respectively.

In 2002, when instances of human-wildlife conflicts were observed to intensify, an electric fencing project was commenced to cover much of the affected areas on the western side. Presently, a 54km electric fence has been put in place and includes the section covered by the physical fence. Another phase is expected to cover much of the western boundary extending to the Tana.

Short term consequences of the electric fencing project were observed to be tendency by farmers to extend their farmland so close to the fence line leaving no buffer on the outside, and crop raiding mammals shifting their crop raiding trails to the unfenced southern portion of the western boundary.

Areas of the park that were not regularly patrolled by KWS were visited and any information on unusual observations such as encroachment of illegal herders and hunters into the park reported to park administration. Also visited were all reported were cases of sickness and carcasses, of buffalos, rhinos and giraffes besides those of elephants and reports made to the park Senior Warden. Information on monitoring of sickness and possible cause of death of the animals guided the park administration on the seriousness of a situation and whether to involve the KWS veterinary unit or not.

Photo 6: Community wardens, rangers and casuals repairing a fence at Kinna Village. *Photo by Patrick Ogola*

Photo 7: Community Warden and his officers assess damage caused by elephants at Miomboni. *Photo by Patrick Ogola*

Conclusions

1. The population of elephants using Meru Conservation Area remained static during the 1990s, demographic data has shown that this is in-part due to adult mortality and low calf recruitment most likely as a result of poaching and continued disturbance of the population into the mid 1990s.

2. Evidence from a recent aerial survey (2002, 413 elephants) and the current study (406 elephants) has shown that the population has increased in recent years. This increase is attributed to the following factors:
    a) Translocation of over 70 elephants to Meru between 1998 and 2002.
    b) Good management and improved anti-poaching operations in the late 1990s which has resulted in:
        - Increased recruitment of calves into the population after 1997; a higher number of young calves (0-5years) were found in the present population compared with the previous study in 1992-1994.
        - Lower adult mortality in recent years; fewer elephants were reported as poached in 2000-2002 compared with the mid 1990s; an increase in 25+ year old elephants are found in the current population compared with the previous study in 1992-1994.

3. Most elephants using Meru National Park migrate to areas outside the park during the rainy seasons. Radio-tracking and observation from the current study have shown that areas outside the park especially to the north and northwest are important for management of the population.

4. The population is increasing despite the low level poaching that continues in the population

5. Elephant conservation in the Meru Conservation Area faces an all-year-round challenge due to their extensive movements, which predispose them to serious potential threats, invasion by heavily armed Somali and Borana pastoralists and human-elephant conflict in areas of agricultural cultivation on the western boundary.

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Appendix 1: Elephants for which no photos were taken

Family ID	ID Code	Name	Est. Yr of Birth	Sex
CAS	CA1 30-35	Chichi	1965-70	F
	CA1.98M	_	1998	M
	CA2 25-30	Chidi	1970-75	F
	CA2.99F	_	1999	F
	CA3 20-25	Chinue	1975-80	F
	CA3.99M	_	1999	M
	CA4 20-25		1975-80	F
	CA4.01F	_	2001	F
	CA4.01F	_	1998	F
DAS	DA1 15-20	Dwarf mother	1975-80	F
	DA1.99M		1999	M
GAS	GA1 25-30		1970-75	F
	GA1.98		1998	Not determined
	GA2 20-25		1975-80	F
	GA2.99M		1999	M
LAS	LA1 30-35	Laida	1965-70	F
	LA2 20-25	Lala	1975-80	F
	LA3 15-20	Lamia	1980-85	F
	LA4 20-25	Lamiaran	1975-80	F
	LA4.01	_	2001	Not determined
MAS	MA1 30-35		1965-70	F
	MA1.00		2000	Not determined
	MA2 15-20		1980-85	F
	MA2.97F	_	1997	F
	MA3 10-15		1985-90	F
	MA4 15-20		1980-85	F
	MA5 25-30		1970-75	F
	MA6 25-30		1970-75	F
	C98		1998	Not determined
NAS	NA1 35-40		1960-65	F
	NA2 15-20		1980-85	F
	NA3 10-15		1985-90	F
	C97/8M		1997	M
	C99/00		2000	Not determined
VAS	VA1 25-30		19970-75	F
	VA1.01		2001	Not determined
	VA1.99		1999	Not determined
	VA1.96F		1996	F
	VA2 15-20		1980-85	F
	VA3 10-15		1985-90	F

	VA3.01		2001	Not determined
	VA4 20-25		1975-80	F
	C94/5F		1994/5	F
ZAS	ZA1 25-30		1970-75	F
	ZA2 25-30		1970-75	F
	C02		2002	Not determined
	C97		1997	Not determined
	C97		1997	Not determined
	C96		1996	Not determined
	C93		1993	Not determined
**A3	**A3 25-30		1970-75	F
**A4	**A4 20-25		1975-80	F
**A5	**A5 25-30		1970-75	F
**A6	**A6 20-25	May beeRA5	1975-80	F
**A7	**A7 30-35		1965-70	F
	**A7.01		2001	Not determined
	**A7.99?		1999	Not determined
**A8	**A8 25-30		1970-75	F
**A9	**A9 25-30		1970-75	F
**A10	**A10 15-20		1980-85	F
**A11	**A11 25-30		1970-75	F
**A12	**A12 35-40		1960-65	F
**A13	**A13 30-35		1965-70	F
**A14	**A14 30-35		1965-70	F
**A15	**A15 25-30		1970-75	F
	**A15.02		20002	Not determined
**A16	**A16 30-35		1965-70	Not determined
	**A16.00M		2000	M

Appendix 2: List of Reconciled Individuals between Njumbi's (1992/3) and present ID Files

	Present study			Demmers and Bird (1993-4)		
	ID/Name	Sex	Age (years)	ID/Sex	Age (years)	Notes
1	IA1	F	35-40	Jackie	20-25	Positive
2	BA3 Bella	F	30-35	Laila	20-25	Positive
3	BA1Barbara	F	35-40	Leah	20-25	Positive
4	OA1 Oria	F	40-45	Calypso	35-40	Positive
5	OA4 Otilia	F	15-20	Toothypeg	10-15 years	Positive
6	RA1	F	35-40	Imogen	30-35	Positive
7	WA2	F	40-45	Kali	35-40	Positive
8	Anastasia	F	20-25	Mahali	15-20	Positive
9	YA1	F	25-30	Christy	15-20	Positive
10	YA2	F	20-25	S4.18*	10-15 yrs	Positive
11	YA3	F	20-25	B11.9 (1986)*	15-20 yrs	Positive
12	Fina (FA2)	F	25-30	Felists	20-25	Positive
13	Irene (IA3)	F	25-30	Karen	20-25	Positive
14	Isioma (IA4)	F	20-25	Katrin	10-15 years	Positive
15	RA3	F	30-35	Ingrid	10-15 years	Positive
16	FA1	F	35-40	S9.13*	30-35	Positive
17	FA3	F	25-30	B16.28*	25-30	Positive
18	UA2	F	25-30	S3.18* Edith	10-15 yrs	Positive
19	AB1	F	30-35	P4.18* Geof	20-25	Positive
20	JA1 Julia	F	20-25	P932.9*	10-15 yrs	Positive
21	JA4 Julieta	F	25-30	B9.19;28B14.30*	15-20 yrs	Positive
22	PA3	F	30-35	Crassulacea	25-30	Positive
23	BB1	F	40-45	B9.32* Belinda	35-40	Positive
24	Helena	F	25-30	P931.5;.6;.14*	15-20	Positive
25	Shadrack**	M	30-35	S3.31 (1273)*	20-25	Not clear
26	Lamparan	M	25-30	P6.10,.28;.23*	10-15 yrs	Positive
27	Bernard (B7)	M	40-45	Sinbad	25-30	Positive
28	Adams (B1)	M	20-25	Trouble	10-15 years	Positive
29	Lampash (B8)	M	15-20	Oliver	5-10 years	Not clear
30	Hamilton (B36)	M	45+	Mr.T	40-45	Positive
31	Alex (B37)	M	30-35	Bwana K.	20-25	Positive
32	Francis(B38)	M	15-20	No name	5-10 years	Positive
33	Galileo (B40)	M	45+	Dave	25-30	Positive
34	B62	M	15-20	Dingwall	5-10 years	Positive
35	B42 Ngangao	M	35-40	Broubaha	30-35	Positive
36	B15	M	35-40	Buge	20-25	Positive
37	Gary	M	35-40	Koehler	30-35	Positive
38	Smith	M	20-25	Johana	10-15Years	Positive
39	Meshack	M	25-30	Nico	15-20	Not clear
40	Leafy	M	15-20	B12.11;.10* Imara	5-10 years	Positive
41	Leseketet	M	35-40	B4.4;.14;.15;.18* Jacob	30-35	Positive
42	Graham	M	20-25	B4.28*	10-15 yrs	Positive