Some ecological factors influencing the distribution and abundance of Patas monkeys (*Erythrocebus patas*) in Laikipia, Baringo, Uasin Gishu and Trans Nzoia Districts in Kenya.

By

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A thesis submitted to the Faculty of Science in partial fulfillment of requirements for a Master of Science degree in Zoology (Biology of Conservation)

University of Nairobi, 2002.

This thesis is dedicated to my mother, Esther Kaari Ngece, from whom I got the encouragement to read and achieve the best in education.

Abstract

A four-month survey of patas monkey (*Erythrocebus patas*) populations, carried out in Baringo, Uasin Gishu, Trans Nzoia and Laikipia districts of Kenya revealed that they have reduced in numbers drastically from the year 1970. This was attributed to the fact that no single population is found in protected areas, while intensive farming and vegetation clearance practices have been recorded in areas that used to accommodate these populations. Competition for land with humans has been a major factor, as humans and wild animals have killed both individuals in some of the populations. Human encroachment into the habitats was obvious, with much of the land being turned to farming, particularly in Laikipia and Uasin Gishu. This promoted human-wildlife conflict mainly in the agriculturally oriented farms. Just a handful of ranches with a policy of conservation still have groups of patas monkeys.

To determine the numbers and densities of patas monkey left in the study area, road counts, observation vigils, ground transects and questionnaires were used. Entire districts of Baringo, Uasin Gishu, Trans-Nzoia, Laikipia and a part of Nakuru were covered through driving, vigils and walking. Contrary to earlier reports that the patas were widely distributed, it was found that populations were limited to a few areas. Informants explained that most of these areas had patas up to the early and mid 1980's from when most of them disappeared. They suggest that

the cause for the disappearance was human wildlife conflict, drought and desertification, and migration to other potential areas. A total of 148 animals were counted distributed in-groups ranging from one (1) to twenty-two (22). Of these, most were found in Laikipia District while a few others were found in Baringo. Uasin Gishu, Trans-Nzoia and parts of Nakuru Districts which were covered did not yield any animals though earlier questionnaires revealed animals existed up to mid 1980's in each of these Districts.

A total of 3.064 people were interviewed in the research area, of which 78.8 % reported having never seen patas in their lifetime. Of the 21.2 % who had seen patas one time or another, 42 % were aged above 51 years. The sex ratio of patas was highly biased towards females for males, females, juveniles and infants respectively. The ratio was 12:54:38:31

Acknowledgements.

I convey my sincere gratitude's to Dr. Lynne Isbell (USA), Mr. Noel Rowe (USA), for assisting me in finishing the project. I also thank Dr. Jason Mwenda (Kenya) for his continuous advice during the study period. More thanks go to Dr. Warui Karanja and Dr. Gideon Nyamasyo for their constructive criticism and advice during the project and write-up period.

Mr. Bernard Musyoka, Mr. Peter Ayabei and Mr. James Mugambi and a host of other assistants helped me gather the data. I sincerely thank the entire provincial administration in the districts visited, the National Museums of Kenya staff and the Kenya Wildlife Services staff for their advice whenever I visited their areas.

Finally, I thank my wife Breta, my daughter, Yvonne and son, Kim for their support and patience during the entire period of my study.

The research was funded by the Primate Conservation, Inc (USA), and by grants from National Science Foundation (NSF) and National Geographic Society (NGS) to Dr. Lynne Isbell (University of California, Davis-USA). The Semi Arid Research & Development Project (Kenya) provided some of the maps used in the research. The Institute of Primate Research (Kenya) and the National Museums of Kenya provided the logistical support to the project.

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Chapter 1. INTRODUCTION

Conflict between non-human primates and farmers as human populations increase and natural habitats are encroached upon, degraded and destroyed is rapidly on the increase. At the same time, we are finding non-human primates to be vital components in the natural communities, excellent indicators of the condition of ecosystems, and important subjects for behavioral and ecological studies (Butynski and Mwangi, 1994).

Natural calamity, trade in species, poaching and habitat destruction have been ranked as the most ultimate threats to primate species density (Butynski, 1986). This has drastically contributed to the status of some of the primates being threatened. Habitat destruction is the most detrimental resulting to the modification of the environmental variables pertinent to the maintenance of the primate populations.

In Kenya, habitat destruction is rampant; leaving small scattered patches of bush in the once indigenous savanna lands. This has been due to land demands by the ever increasing human populations and the accompanying demand for fuel- charcoal, timber and others. Eley (1989) states that lands considered as marginal for agriculture are being turned into cultivation, or for ranching purposes thus reducing habitats available for the more arid-adapted primate species. Perhaps most affected by this is the patas monkey *(Erythrocebus patas)*.

Suitable patas monkey habitats have been reduced, threatening their survival (Hall, 1965). Habitat destruction has also led to the isolation of some species, consequently leading them vulnerable to natural catastrophes, however minor (Olson and Chism, 1981). By studying the social structure, diet, ranging patterns and other aspects related to primate ecology, we may predict the effects of habitat disturbance, trade and other natural calamities on them, thus contributing to their conservation (Chism and Rowell, 1988).

Unlike baboons (*Papio spp*) and vervets (*Cercopithecus aethiops*), the two other dry habitat species, patas monkeys live at low densities and appear now to be restricted in East Africa to habitats occurring in "black cotton" soils (Hall, 1965).

Until recently, patas monkey habitats have been restricted largely to pastoral uses because their aridity makes them not suitable for agriculture. Patas monkeys have been able to survive mainly in cattle ranches because the major food source, *Acacia drepanolobium*, is not disturbed, while they are able to utilize the water troughs/ dams and streams passing through the ranches for their water needs. Chism *et al.*, (1984) argues that as human population increases, more marginal lands are being converted to small-scale agriculture while the *Acacia drepanolobium* is being converted to charcoal; hence both water sources and food resources are depleted.

Today the distribution of patas monkeys in Kenya and their status may not be well defined by any authority, thus there is need for a survey (Struhsaker and Gartlan, 1970). This study aimed at establishing the first reliable estimates of Patas monkeys density and distribution and elucidating the ecological requirements of remaining populations with the ultimate goal of establishing procedures for their conservation.

1.1. Natural history of Patas monkeys.

1.1.1. Introduction- Taxonomy, Biology and Ecology of Patas monkeys.

Patas monkey belong to the family Cercopithecidae, genus *Erythrocebus*. The family Cercopithecidae includes other common savanna monkeys like the Syke's monkey (*Cercopithecus mitis*), the De Brazza monkey (*Cercopithecus neglectus*) as well as Vervets monkey (*Cercopithecus aethiops*), (Kingdon, 1971). It also includes other species such as the Mangabey (genus: *Cercocebus*) and Baboons (Genus: *Papio, Mandrillus* and *Theripithecus*). The genus *Macaca* also belongs to this family (Kingdon, 1971; Eley, 1989).

Plate 1. Picture of a patas monkey carrying a young one.

Plate 2. Picture of a baboon.

Picture adapted from: The Safari Companion: A Guide to Watching African Mammals Including Hoofed Mammals, Carnivores, and Primates Richard D Estes and Daniel Otte.

Plate 3. Picture of a vervet monkey.

Picture adapted from: The Safari Companion: A Guide to Watching African Mammals Including Hoofed Mammals, Carnivores, and Primates Richard D Estes and Daniel Otte.

Patas monkeys are described as guenons and mainly found in savanna grasslands. (Chism and Rowell, 1988). They exploit very short trees. Though classified as Cercopithecidae, their limbs are proportionately large compared to other members of the family, while they are more slightly built (Kingdon 1971; Chism and Rowell, 1988). Similar to baboons, they walk on fingers and not on flat hands (Napier and Napier, 1985), hence increasing the effective length of forelimbs further. They are able to run very fast and when attacked run to a tree or rock. When far from one source of refuge, they appear very nervous (Chism and Rowell, 1988) and occasionally stand bipedally to look for any source of danger.

They are very inconspicuous; their colour is similar to that of cryptic grassland antelopes. Patas monkeys move quietly and vocalize infrequently compared to other forest monkeys (Kingdon, 1971). Most probably, their cursorial build gives them the ability to cover long distances. The face of adults is marked with a white nose and white mustache surrounded by black and orange fur. These monkeys live in social groups and choose the company of other females, infants and juveniles whereas the adult males occupy peripheral positions (Chism and Rowell, 1986; Rowell, 1989).

Patas monkeys are omnivorous and eat flowers, seeds, grasses, insects, lizards, crayfish, fruits and sometimes mushrooms (Hall, 1965a). Small vertebrates also form a major part of their food (Chism and Rowell, 1988; Hall, 1965). One of the Acacia trees (*Acacia drepanolobium*) forms a major part of the diet (Chism and Rowell, 1986); hence this species will be found in savanna with this tree species. They also feed on prickly pear cactus (*Opuntia vulgaris*), which was introduced in East Africa as cattle fodder (Rowell, 1989). Struhsaker and Gartlan, 1970) determined that adult male patas monkeys are hunted and shot for pillaging crops, and occasionally killed by domestic dogs and captured for biomedical research.

Hall (1965a) states that the average group size of a patas monkeys troop ranges from 15 to 31 animals, usually one adult male per group. All adult male groups are up to 4 individuals. Patas monkeys attain sexual maturity at an age of 3 years in females while in adult male's, 4-4.5 years, table 1. The species is highly sexually dimorphic, with adult males being larger and more brightly colored and with a body mass almost twice the female (Bramblett.1976).

The dimorphism is likely due to intense competition among the adult males who must compete for assess to groups of females (Chism *et al*., 1984). Females have a gestation period of approximately 170 days (Rowell and Hartwell, 1978), (table 1).

1.2. Distribution

Kingdon (1971; 1974) describes patas monkeys as well distributed in Africa. He states that they are found in a belt across Africa south of the Sahara and north of the equatorial forests. They are found in Kenya mainly in Laikipia, Baringo and Turkana savanna lands (Hall, 1965). Percival (1928) claims to have sighted patas monkeys near Makindu, Kenya (37° E). He described the species to be extremely rare however. In East Africa, sightings have also been reported in northern Tanzania at about 2° S, 35° E (Tappen, 1960). Tappen (1960) however doubts this sighting since it is as far as 1905. Chism and Rowell (1986) sighted patas monkeys in Laikipia, Kenya. More recently, Isbell et al (1999).

Patas monkeys are also found in Senegal, Cameroon, Ghana and Ethiopia (Chism and Rowell, 1986; Galat-Luong, 1991). It is important to note that this species is found to be distributed in dry areas ranging from desert scrub, open savanna and woodland (Kingdon, 1971). Patas monkeys have also been sighted in Uganda by Hall (1965). In his study,Hall (1965) recorded 110 patas monkeys. He calculated their density to be 0.035 animals per square kilometer. In Kenya, Chism and Rowell (1988) compared two study groups who had a population density of about 1.2 animals per square kilometer. Their home range is among the highest ever recorded (Chism and Rowell, 1986).

1.3. Conservation status.

Though Kingdon (1971) describes patas monkeys to be abundant, this may no longer be the case. The International Union for Conservation of Nature and Natural Resources (IUCN, 1996) does not list patas monkeys to be threatened. However, many habitats have been lost through bush fires and charcoal burning (Chism and Rowell, 1986). It is possible that patas monkeys in East Africa have declined dramatically in the past 30 years.

1.4. Objectives of the study.

Data collected were as a result of a series of questionnaires, surveys and observations. Data were gathered in order to fulfill the following specific objectives:

- To document the distribution and status of patas monkeys in the research area and map out these locations.
- To identify ecological characteristics for habitats suitable for patas monkeys.
- To establish how habitat disturbance influences socio-ecological variables of patas monkeys e.g. feeding habits and home range.

1.5. Hypotheses of the study.

- Patas monkey population numbers have declined highly.
- Patas monkey habitats have seriously been encroached on and reduced.

Table 1. Life history parameters of patas monkeys.

Parameter	Data
Adult female body mass (Kg)	5.60 (a)
Adult male body mass (Kg)	10.00 (a)
Gestation period (days)	171.4 (b)
Number of offspring per litter	1 (d)
Weaning age (Months)	7 (c)
Length of Oestrus cycle (Days)	3.0 (b)
Age at first breeding for female (Years)	2.5 (c)
Age at sexual maturity for males (Years)	3 (c)
Maximum recorded lifespan (Years)	20.2 (a)
Inter-birth interval (Months)	11.8 (e)
Age at sexual maturity for adult males (Years)	4-4.5 (a)

Harvey *et al*.., 1987

Rowell and Hartwell, 1978

Chism *et al*.., 1984

Napier and Napier, 1985

Rowell and Richards, 1979

Chapter 2: THE STUDY AREAS.

2.1. Introduction

The primary requisite in the definition of the boundaries of this study was that the entire range where patas monkeys have been sighted in the last two decades should be encompassed. Southwood (1960) pointed out that the size of a terrestrial animal necessarily dictates many of its strategies, both of life history and of habitat exploitation. Though with shorter life spans (approximately 20 years), Patas monkeys require a lot of space to satisfy their spatial requirements in a semi-arid unpredictable environment such as Laikipia and Baringo (Chism *et al*., 1983).

I tried to cover districts of Baringo, Uasin Gishu, Trans-Nzoia and Laikipia, where patas monkeys had recently been sighted. Boundaries used to define the study were much dependent on the Kenya Government district boundary lines. I however exceeded or came close to the boundary lines depending on the prevailing factors like topography, accessibility of the area by road, the people and likelihood of patas monkeys ever been sighted in the area. This was determined by the type of vegetation in the area and the economic activity in the area.

The most conspicuous feature in the study area where patas monkeys were found was the presence of pastoral activity as well as a wide distribution of *Acacia drepanolobium*. Most of the study area was flat, apart from the Tugen hills, the Cherangani hills, Nandi hills and Mt. Elgon forest, which however did not have any patas monkeys present. In Cherangani hills, it was discovered that the density of human settlements precluded the existence of wildlife. In Uasin Gishu, it became impossible to conduct the surveys near the border with West Pokot District due to the prevailing insecurity in the area.

The border of Laikipia and Meru was totally under horticultural farming. Laikipia is on the leeward side of the Mt Kenya. The Aberdare Ranges, which were too wet, surround other parts of Laikipia and heavy agricultural activity is common. This is similar to most parts of Uasin Gishu and Trans-Nzoia. By disseminating a questionnaire about one kilometer towards the interior of agricultural settlements, I was able to determine the degree of farming and settlement i.e. whether heavily farmed and without settlement, or heavily farmed and with settlement, or heavily settled. Having established the degree of farming and settlement, the study and questionnaire process would be discontinued since it would be a waste of time.

Most of Laikipia was open grassland, with *Acacia drepanolobium* trees common. This is the same for most of Baringo and a small part of Uasin Gishu. *Acacia drepanolobium* was not present in Trans Nzoia, but was common in West Pokot and parts of Elgeyo Marakwet and Koibatek districts, which were however not surveyed due to insecurity. Most of the other survey area was plains land and a very low human population density at altitudes ranging between 4000 to 5000 ft. above sea level.

In Laikipia some places were not surveyed due to overlap with similar research performed under the auspices of the Patas and Vervet Ecology (PAVE) project of Dr. Lynne Isbell, whose work has been highly cited in this project. This centered on the major ranches among them Segera, Mpala, Ol Pejeta, Ol Jogi, Laikipia and Sweetwaters.
This study covered Laikipia, Baringo, the Mt Elgon ecosystem, Cherangani and Elgeyo escarpments.

2.2. Laikipia District.

Laikipia is one of fourteen districts in the Rift Valley Province. The District lies east of the Rift Valley. It borders Samburu District to the north, Nyeri District to the south, Isiolo to the northeast, Meru to the southeast, Nyandarua to the southwest and Baringo and Nakuru Districts to the west. Rumuruti is the largest division covering 36% of the total area of the district. Nanyuki division is the second largest, covering 23% of the district. The smallest division, Ng'arua, covers 11 % of the district. Lamuria and Mukogodo cover 18% and 12% respectively (Ahn and Geiger, 1987).

The district lies on (00° 05" N / 36° 42" E) at an altitude of 1900 M (Ahn and Geiger, 1987). Elevations range from 1260 metres at the base of the Mukutan Gorge and 2600 metres in the highest hills (Ahn and Geiger, 1987).The district has various subsidiary valleys while some areas are covered by black cotton soils (Ahn and Geiger, 1987).

The altitude of the district vary between 1800 metres in the north, while the maximum height of 2600 metres is found around Marmanet Forest. The other areas of high altitude are Mukogodo and Loldaiga Hill to the east (Ahn and Geiger, 1987). Due to its leeward position, this area is comparatively dry and low and is mainly used for pastureland except for the mountain slopes and forest zones (Laikipia District Surveys Office, *pers comm*). The tributaries of Ewaso Nyiro River drain the level plateau of the district, which have their catchments in the slopes of the Aberdares and Mt. Kenya (Taiti, 1992). These tributaries include Nanyuki, Rongai, Burguret, Segera, Naromoru, Engare, Moyak, Ewaso Narok and Ngobit Rivers. The flow of these rivers indicates that the district slopes gently from the highlands in the south to the low lands in the north (Ahn and Geiger, 1987).

There are two major swamps in the district, which are virtually undeveloped. The first one is along Major Valley in Ol Pajeta Ranch locally known as Maruca Swamp (Laikipia District Surveys Office, *Pers com*) while the second is around Rumuruti Rural Centre locally called Ewaso Narok Swamp.

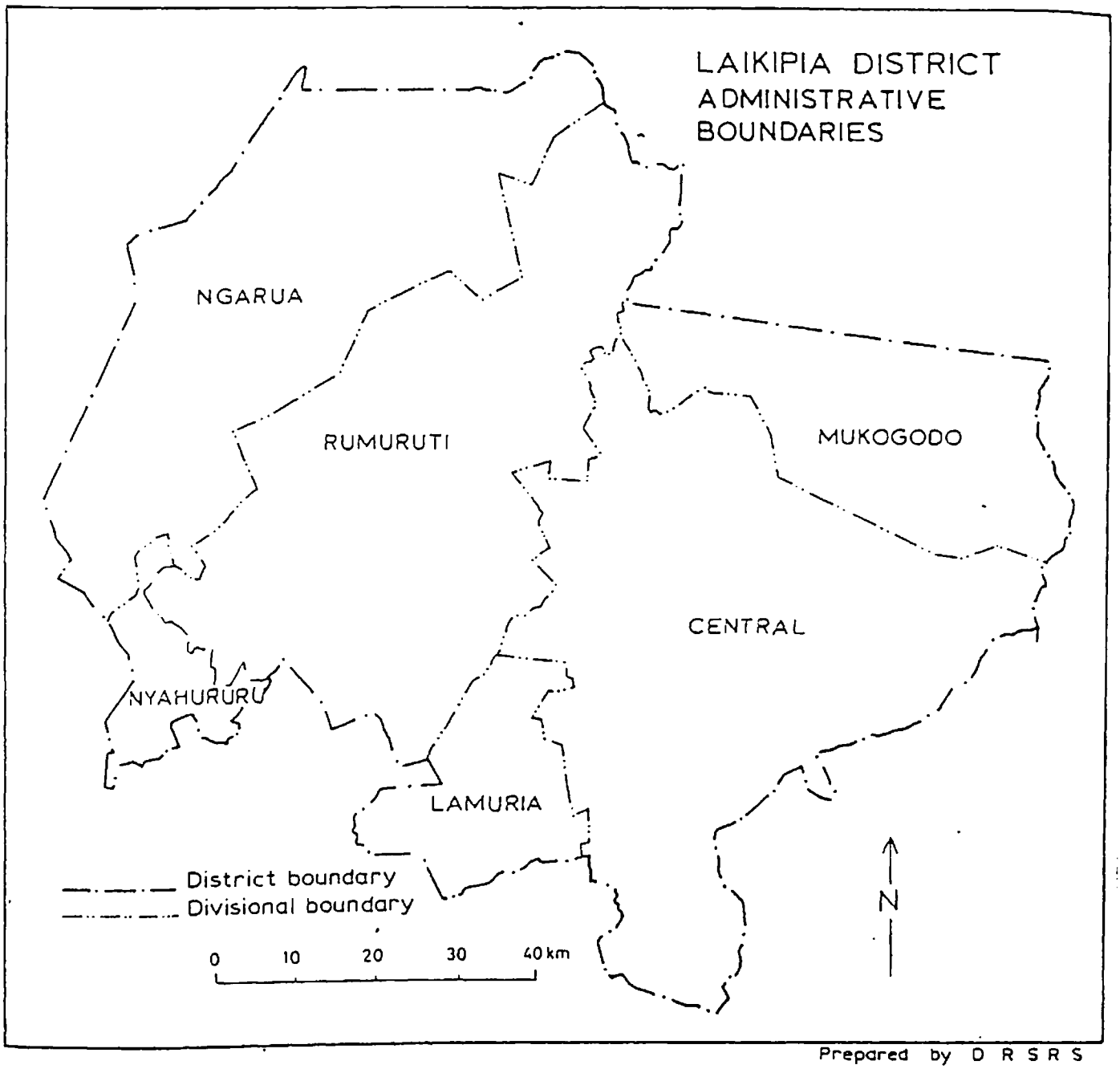
The swamps have some agricultural potential and may be one of the areas hosting patas monkeys due to water availability (Ahn and Geiger, 1987).

The distribution of surface water has much influence on the patas monkeys distribution. Patas monkeys are highly dependent on water and will hardly go for a day without drinking (Gathenya, 1992). He summarizes that Mukutan, and Ol Doinyo Sabuk and other seasonal streams, dams and boreholes are widely distributed in the district.

The soils in Laikipia support mainly grassland or bushed grassland with varying densities of two species of swollen thorn acacias (*A. drepanolobium* and *A. seyal* spp. Seyal) (Young *et al*., 1997). In fact, much of Laikipia is *Acacia drepanolobium* wooded grassland, covering 28% of the ecosystem (Taiti 1992). Another species *Tarconanthus camporatus* is widely distributed in Central and North West of the district, (Taiti, 1992).

Acacia drepanolobium is locally restricted to black cotton soils (Chism *et al*., 1983). All individuals produce stipular swellings and some of their stipular thorns are red when young and black when mature (Isbell, 1998). The thorns are white or pale grey when old (Young *et al*., 1997). There is also plenty of *A. seyal* variety *fistula*, which occurs in two forms: var. *fistula* occurs on black cotton soils and produces swollen stipular thorns that are white or grey when mature (Taiti, 1992). Var. *seyal* occurs on other soil types and does not produce swollen thorns (Taiti, 1992; Young *et al*., 1997).

Figure 1. Map of Laikipia District showing administrative boundaries.



2.3. Baringo District

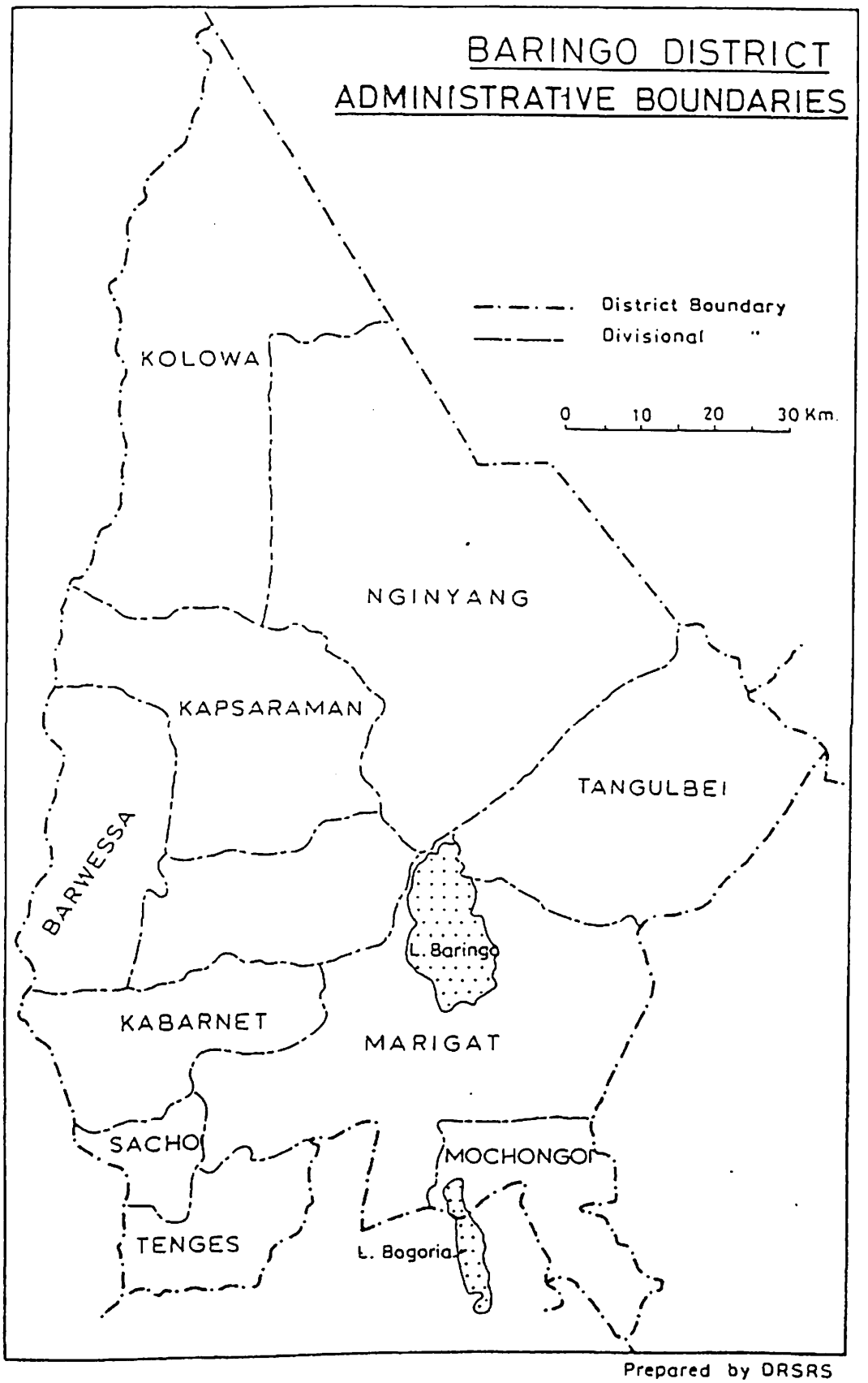
One of the prominent river valleys is the Kerio Valley. It is situated on the western part of the district and it is a fairly flat plain. In the eastern part of the district, near Lakes Baringo and Bogoria, is the Loboi Plain covered mainly by the lacustrine salt-impregnated silts and deposits (Ralph and Schmidt, 1996). The Tugen Hills form a conspicuous topographic feature in the district. The altitude varies from 300 metres to 1,000 metres above sea level (Ralph and Schmidt, 1996).

About 45% of Baringo District is either too steep i.e. (Tugen Hills) or too dry i.e. (eastern parts around Lake Baringo and north eastern parts i.e. Nginyang and Northern Kabartonjo) to support high human populations. Along valleys, alluvial soil deposits together with irrigation has made it possible for profitable agriculture to be practiced. The district has different agro-ecological zones necessitating different agricultural activities (Ralph and Schmidt, 1996).

Baringo District has a fairly reliable rainfall, experiencing two seasons: the long rains from the end of March to the beginning of July, and the short rains from the end of September to November. Rainfall varies from 1,000 to 1,500mm in the highlands to 600mm in the northeastern part of the district (Ralph and Schmidt, 1996).

The mean annual maximum temperature is between 25° C and 30° C in the south and central parts and 30° C in the north, rising occasionally to over 35° C (Ralph and Schmidt, 1996). The hottest months are from January to March with mean annual minimum temperature varying from 10° C to 18° C but can drop as low as 10° C particularly in the Tugen Hills (Hamilton and Perrot, 1979). Most of the places are covered by black cotton soils and chalk (Hamilton and Perrot, 1979).

Figure 3. Map of Baringo showing administrative boundaries.



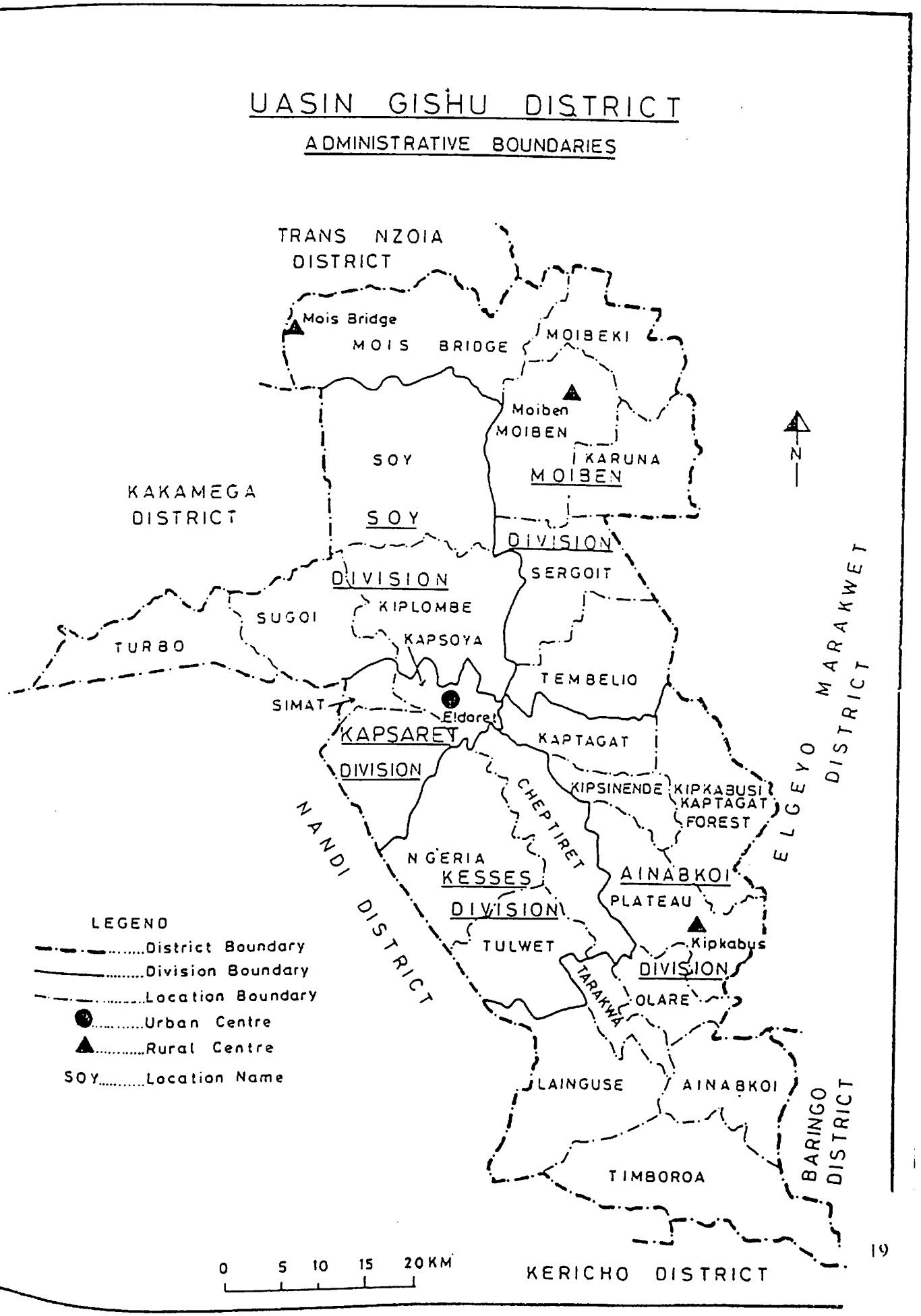
2.4. Uasin Gishu

Uasin Gishu extends from latitude 0° 20" north to 1° 30' north and from longitude 35° 0' east to 35° 45" east (Ralph and Schmidt, 1996). The district has an elongated and narrow shape and is wedged in between the large-scale farms of Uasin Gishu on the West and the Kerio River on the East (Hamilton and Perrot, 1979). The Kerio River, which flows from its source in the southern part of the district draining into Lake Turkana, forms the eastern boundary (Ralph and Schmidt, 1996; Hamilton and Perrot, 1979). The total area of the district is 3,053 sq. Km (Kiteme *et al.*, 1998). Kerio Valley is narrow, averaging 6.4 Km in width and running to about 150 Km long in a North-South direction (Ralph and Schmidt, 1996).

The main water divide runs along the escarpment. East of the divide is the Kerio catchment area, which drains into lake Turkana (Hamilton and Perrot, 1979). Soils are mainly loam with some patches of clay and black cotton (Ralph and Schmidt, 1996). Due to large differences in altitude there is great variation in rainfall figures in different parts of the district. While the central parts of the district receive most of the rain (1200mm-1700mm per year) (Ralph and Schmidt, 1996), the western pan receives 1000-1400mm and 800-1000mm in the eastern part (Ralph and Schmidt, 1996). This rainfall is of a bimodal nature with long rains occurring between the months of March to June with the peak period being the month of April and May (Hamilton and Perrot, 1979). Hamilton and Perrot (1979) reports that short rains occur during the months of June and December with peak period being September and November.

The pattern of this rainfall also varies from place to place. Whereas the southern part of the district (Chepkorio) receives most of its rain during the first period, the northwestern part of the district (Cherangani Forest) receives most of its rain during the second period (Hamilton and Perrot, 1979).

Figure 4. Map of Uasin Gishu district showing administrative boundaries.



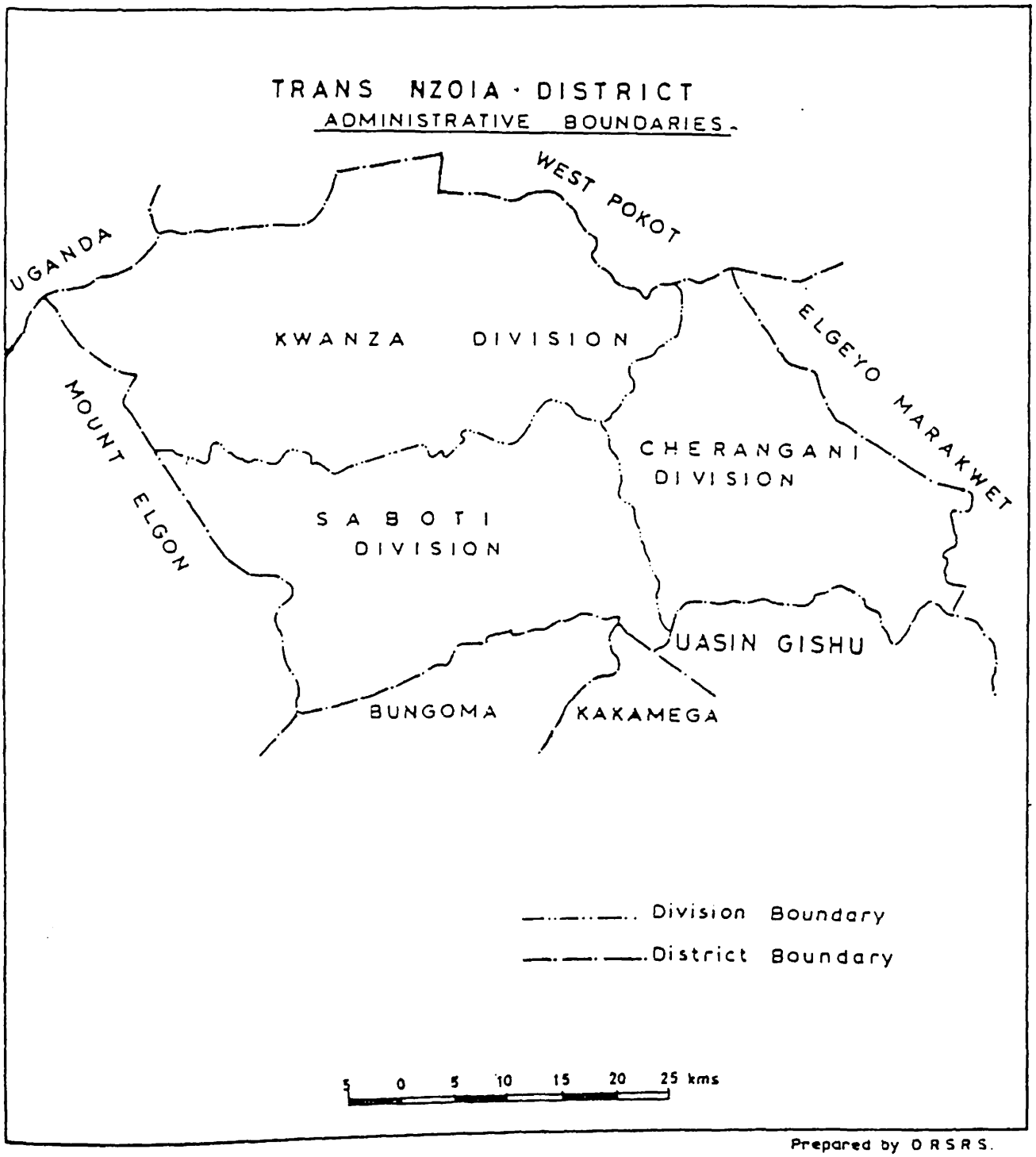
2.5. Trans Nzoia

Trans Nzoia borders Uganda, West Pokot, Uasin Gishu and other districts in western Kenya. Soils are mainly loamy with some clay patches. Most of the district is of very high agricultural potential, with pyrethrum, maize, tea and wheat covering most of the land. The Mt. Elgon forest (Hamilton and Perrot, 1979) covers other parts. The mean annual minimum temperature varies from 10° C to 18° C but can drop as low as 10 ° C in some parts of the district. (Hamilton and Perrot, 1979).

Eutric Nitosols covers most of the places. Soils on lava flows as well as solonchaks and Andosols are also common (Hamilton and Perrot, 1979). Rainfall distribution and pattern in the Trans Nzoia District is highly influenced by the altitude (Hamilton and Perrot, 1979). In the western and central parts of the district, around Mt. Elgon forest often referred to as the highland plateau. Where the altitude is high, the climate is characterized by high amounts of rain (Hamilton and Perrot, 1979). In eastern part of the district bordering Uasin Gishu where the altitude is low, the climate is characterized by relatively low rainfall (Hamilton and Perrot, 1979; Gichuki *et al.*, 1998).

Due to these large differences in altitude there is great variation in rainfall in different parts of the district (Central bureau of Statistics, 1994). The Mt. Elgon microclimate has highly influenced rainfall patterns in the district, with most parts receiving as high as 1700mm of rainfall per year. The area bordering Uasin Gishu and West Pokot receive a bit less rainfall, averaging at around 1200 mm annually (Hamilton and Perrot, 1979). Rainfall is distributed in two peaks.

Figure 5. Map of Trans Nzoia showing administrative boundaries.



Chapter 3. MATERIALS AND METHODS OF PATAS MONKEY SURVEY.

3.1. Introduction

In this thesis, the term community is used in a purely descriptive, rather than functional sense. The Patas monkeys community consists of different groups of populations of patas monkeys that are about equally abundant, ranging from one individual (lower limit of "countability") from the ground or from the car, to twenty-two individuals (upper limit).

Any other species of animal encountered in the study area was acknowledged and recorded but did not comprise the term "community", and hence is not considered in the thesis. Animals encountered include Hippopotamus, *Hippopotamus amphibius* found in Lake Kamnarock conservation area in Baringo, the Dikdik, *Madoqua kirkii*, which was abundant and ubiquitous in bushed and wooded country in most of the study area. Others were the Klipspringer, *Oreotragus oreotragus*, Thomson's gazelle, *Gazella thomsoni*, Topi, *Damaliscus lunatus* and Bushbuck, *Tragelaphus scriptus*.. These are summarized in appendix 1.

3.2. Methods of data collection

The main aim of this study was to estimate the current distribution of patas monkey. The bulk of the thesis revolves around the presentation and discussion of the results of a series of ground surveys and questionnaires. Each of the parameters being measured is presented differently.

3.3. Conventions in presentation.

Throughout this thesis a number of conventions are used in- order to try reduce the complexity both of the data themselves and of the numerous statistical tests that were performed on them. They are as follows:

- The study area is defined into 4 major regions i.e. Laikipia, Trans Nzoia, Baringo and Uasin Gishu.
- Where possible results are discussed as they are presented.

3.4. Patas monkey group census

Group censuses were carried out over 4 months, during the dry months. This was concentrated in rangelands located in the four study areas. The main objective was to determine the current population status of the patas monkeys. The census was not conducted in some regions thought to host patas monkeys due to insecurity and accessibility problems. Other areas were visited at least twice.

3.5. Methods

3.5.1. Questionnaires

One homestead within a village in each quadrant was visited. Each quadrant was five by five (5X5) Km2 in Baringo while Laikipia, Uasin Gishu and Trans-Nzoia was ten by ten (10X10) Km2. In each quadrant, one village was selected and ten (10) homesteads were visited. The vehicle distance recordings determined quadrants areas.

Pastoral families were mainly targeted and if the first three homesteads (or 10 adults, herdsmen, herdsboys or elders) were not able to identify Patas monkeys from the pictures (Patas, Baboon, Vervet) shown, then the entire village would be abandoned. A short questionnaire (appendix 2) would be administered in areas where there was a positive answer.

To ensure positive identification, those answering to questions were requested to describe (colour, mode of feeding, habitat, and behavior) and identify patas monkey using the local language (Eley 1989). Those I thought knew the patas monkeys were then shown pictures of patas, baboon and vervet. If they were still able to identify patas monkey between the three, I was then sure he/she knew patas monkey well.

3.5.2. Vigils

Other observations and censuses were held at water holes and sites mentioned by the villagers. Physical searches were made by a team of 2- 4 moving on a transect. If patas monkeys presence was determined using 8*30 mm binoculars, ground surveys were done until all the animals were counted. The task involved in censusing the individuals of a patas monkey group varied greatly with the terrain and vegetation cover if the group is moving. Patas monkeys vigil data form (appendix 3) was then prepared. Attempts were made severally to drive random transects into the bush. While driving the transects, both sides of the vehicle were searched for animals, which when sighted had a number of attributes recorded to describe them. The size of the group was recorded, distance of the group from observer as well as distance from nearest water source (Eley, 1989; Isbell *et al*., 1998). A number of methods of computing density were attempted, assuming that all animals in the transects run were seen and recorded and that the area was evenly searched. This was a technique used by Western (1984).

Daily timing for the vigils was timed from around 07:00 hours to about 18:00 hours. Approximately 3.5 months were spent on data collection. In each of the study areas, driving or walking or both were used to determine presence of patas monkeys. I managed to count all visible individuals before they ran away. This was done by eye or by use of binoculars. At no time did the animals run away before I could count them.

Chapter 4. DETAILED DEMOGRAPHY OF GROUPS.

4.1. Introduction

Important demography variables include group size, age-sex composition, rate of birth, maturation, migration and death (Dunber, 1987). Monitoring such variables is important in formulating appropriate conservation and management strategies. Krebs and Davies (1987) concluded that in an optimum group size there is a maximum range of individuals for any set of environmental conditions. Such a group would have a reproductive age comparatively higher than that of groups of other sizes in that environment. (Altmann and Altmann, 1970; Krebs and Davies, 1987). Once a group's size exceeds its food supply or any limiting resource, then the group may expand its home range or migrate (Downing, 1980). It's important to monitor not only overall population trends, but also sex and age ratios (Downing, 1980).

4.2. Methods.

Both the questionnaires and vigils (described above in chapter 3) were used to determined demographic numbers of patas monkeys. The study was concentrated in the dry season only due to the fact that it's the time patas monkeys move to the watering places. A wet season survey would have produced no or compromised results since patas monkeys stay in the bushes during wet season, for they can easily assess water from small pools collecting when it rains.

4.3. Results

Each of the four censuses yielded a separate population estimate and associated standard error for each species. The low sampling fraction led, on each occasion, to high between unit variance, so that the precision attached to the individual estimates was not great.

This was expected from the outset and the technique used to overcome this initial imprecision was to combine the estimates and take their mean, having first investigated within and between unit variation.

There was an assumption that repeatability is synonymous with credibility. According to Zar (1984) variance estimates are based purely on the distribution of the animals with respect to the sampling units. The high variance that would be associated with clumped distribution, while signifying a less repeatable estimate, doesn't justify the assumption that the estimate is intrinsically less credible. This matter was therefore pursued in great detail by analysis of variance: the data used being the mean unit density for each of the four censuses. A two-dimensional analysis was performed, the dimensions being the four censuses and the eight units. Results are represented in table 2.

From the table we can derive that distribution between units is highly significantly different for patas monkeys. This could be brought about by the localized absence of suitable habitat, by the termination of the species range (hence some of the units had not even a single animal sighted) or maybe by seasonal changes in the populations. The implications of this part of the analysis of variance are that the patas monkey population in Kenya has a discontinuous distribution, either permanently or seasonally. Estimates of the populations may be combined with absolute confidence, the interpretation non-significant results of the analysis being that the census boundaries was not significant. Seasonal changes in dispersion and visibility of the animals did not markedly affect their overall numbers, either. Since the survey was conducted only during the dry seasons when visibility was categorized as high, we assume most or all of the animals occurring in the study area were counted.

A total of 13 sightings occurred in two of the four study areas. In these 13 sightings, there were of 11 heterosexual groups and 2 were of lone adult males. Group size varied from 1 to 22 individuals.

Table 2. Table showing patas monkey distribution per district counted per sex and age.

District	Adult males	Female males	Juveniles	Infants	Unidentified	Total	Percentage
Baringo	6	24	11	9	2	52	35 %
Trans Nzoia	0	0	0	0	0	0	0 %
Uasin Gishu	0	0	0	0	0	0	0 %
Laikipia	6	30	27	23	10	96	65 %
Total	12	54	38	32	12	148	
Percentage	8 %	36 %	26 %	22 %	8 %		100 %

Adult males: n=4; μ=3; σ=3; V=1.01

Female males: n=4; μ=13.5; σ=13.7; V=1.01

Juveniles: n=4; μ=9.5; σ=11.05; V=1.16

Infants: n=4; μ=8; σ=9.4; V=1.18

Unidentified: n=4; μ=3; σ=4.1; V=1.37

Where σ = Standard deviation

- n= sample size
- μ= mean of a population
- v= coefficient of variation

These 13 sightings had a total of 148 patas monkeys (Table 2). Of these groups encountered ADC Mutara (1 and 2 combined due to the proximity of the groups) in Laikipia (31 patas monkeys: 20.9 % of animals counted), had the highest concentration in an area. The least concentration was in the Chemeron area in Baringo (5 patas monkeys: 3 % of animals counted).

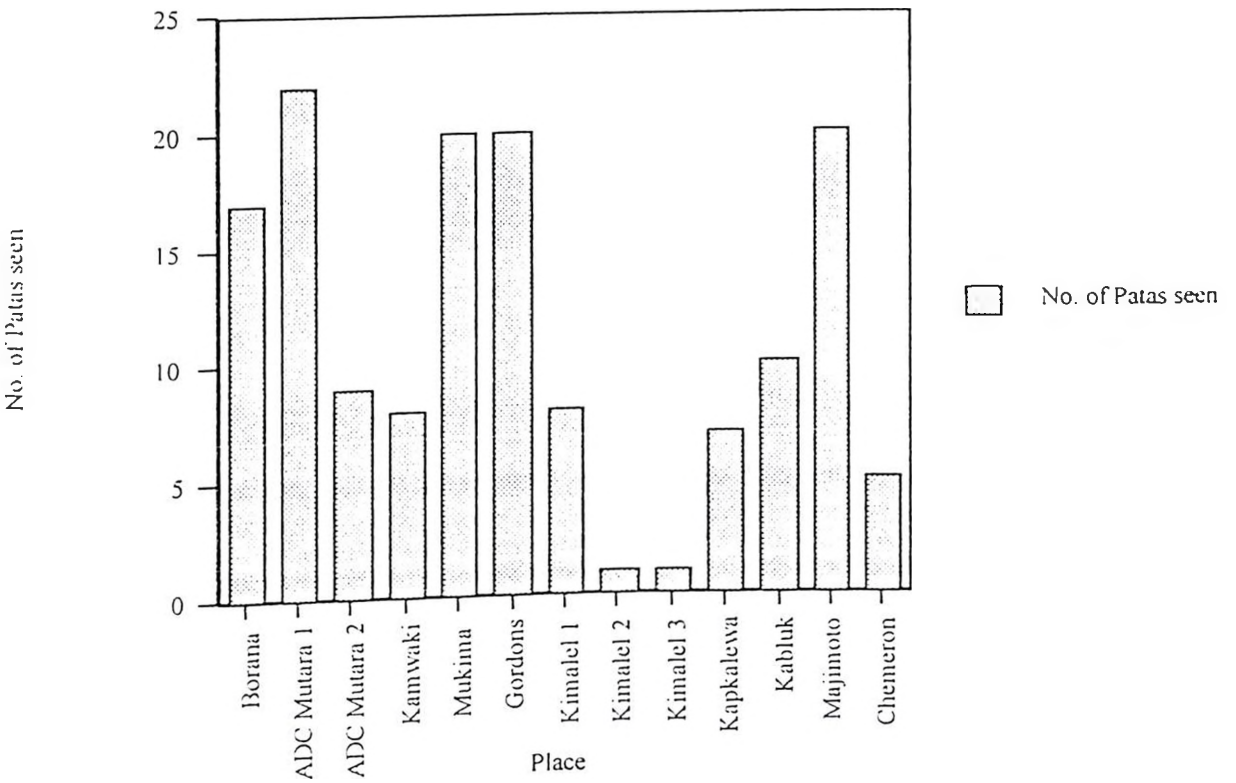
Baringo had more patas monkeys troops. (7 troops) but consisted fewer animals. 52 (35 % of animals counted). (Figure 6 and Table 2). This disintegration may be due to food resource distribution in various areas but in small quantities.

Animals were only seen in the two districts of Baringo and Laikipia (Table 2 and 3). In Uasin Gishu and Trans Nzoia, though respondents to questions indicated having seen patas monkeys, as recently as 2001, I was not able to come across any individuals. Most sightings are dated over two decades ago (Appendix 4, 5, 6 and 7). In Uasin Gishu, 39 % of those interviewed indicated having seen patas monkeys up to 1970, while none had seen the animals in 2001 (Figure 7). Of those having seen patas monkeys in Trans Nzoia, 21.7 % saw them up to 1970. (Figure 7).

As the study was carried out in the dry season, in both protected and outside protected areas, it was found that the few populations encountered were in non-inhabited areas and mainly flat *Acacia- commiphora* grasslands also found in areas of increased aridity.

Questionnaires (appendix 2) also produced some information which guided in the determination of areas where Patas monkeys were present (Figure 7). However, this was just a small fraction of the total interviewed. 3,064 individuals were interviewed, of whom; only 651(21.2 %) reported having seen patas monkeys in their lifetime. Of the 651 who saw patas monkeys, 204 (32 %) reported having not seen them after 1970 and 196 (30 %) between 1991 and 2000 (Figure 7). This represented only 7 % and 6.7 % respectively of the total individuals interviewed in the four districts.

Figure 6. Relative abundance of patas monkeys in the study area (determined by name of place sighted).



n=13; χ=11.4; σ=7.2; V=0.6

Where σ = Standard deviation

- n= sample size
- χ= mean of sample
- v= coefficient of variation

Of the questionnaire respondents, the bulk of them 327(50.2 %) saw between 1 and 5 patas monkeys. This represented 10.7 % of the total individuals interviewed. Most of the sightings were in Baringo:269 (41.3 %) (Figure 8) and 8.8 % of the total interviewees and 14.8 % of those interviewed in Baringo. This compares to 7 (1.5 %) in Uasin Gishu, 41 (6.9 %) in Trans Nzoia and 10 (4.9 %) in Laikipia. Very few people saw from 13 patas monkeys and above (24 individuals: 0.8 % of the total interviewees). (Figure 8 and Appendix 4.5, 6 and 7).

Of the respondents to the questionnaire from January 2001, 125 (42.7 %) were aged above 51. While efforts were made to question all age classes, at most times the men were able to identify patas monkeys positively. This may be due to the fact that they have lived a longer time and during their hey days (the 1950's to 1970's) Patas monkeys were more abundant. These are followed by the youth (21- 40) that might still be spending much of their time in the bush herding livestock. They are the group that is mobile today. These have a combined percentage of 37.9 % (111 individuals). (Table 4). In Baringo, respondents above the age of 51 represented 23.5 % while those between the age of 21 and 40 represented 48.2 %. Laikipia had 53.8 % above the age of 51, Uasin Gishu: 63.4 % and Trans Nzoia: 44 % (Table 4).

Table 3. Table showing patas monkey distribution in the study area according to sex and age

Group	Adult males	Adult females	Juveniles	Infants	Not identified	Total
LAIKIPIA DISTRICT						
Borana Ranch	1	5	5	4	2	17
ADC Mutara 1	1	8	7	6	0	22
ADC Mutara 2	1	3	2	2	0	9
Kamwaki Ranch	1	3	2	2	0	8
Mukima area	1	5	6	4	4	20
Gordons Ranch	1	6	4	5	4	20
BARINGO DISTRICT						
Kimalel G 1	0	4	2	2	0	8
Kimalel G 2	1	0	0	0	0	1
Kimalel G 3	1	0	0	0	0	1
Kapkalewa G	1	3	2	1	0	7
Kabluk G	1	5	2	2	0	10
Majimoto G	1	8	5	4	2	20
Chemeron G	1	4	0	0	0	5
Total	12	54	38	32	12	148

Figure 7. Patas monkey distribution up to 2001 (From Questionnaires)

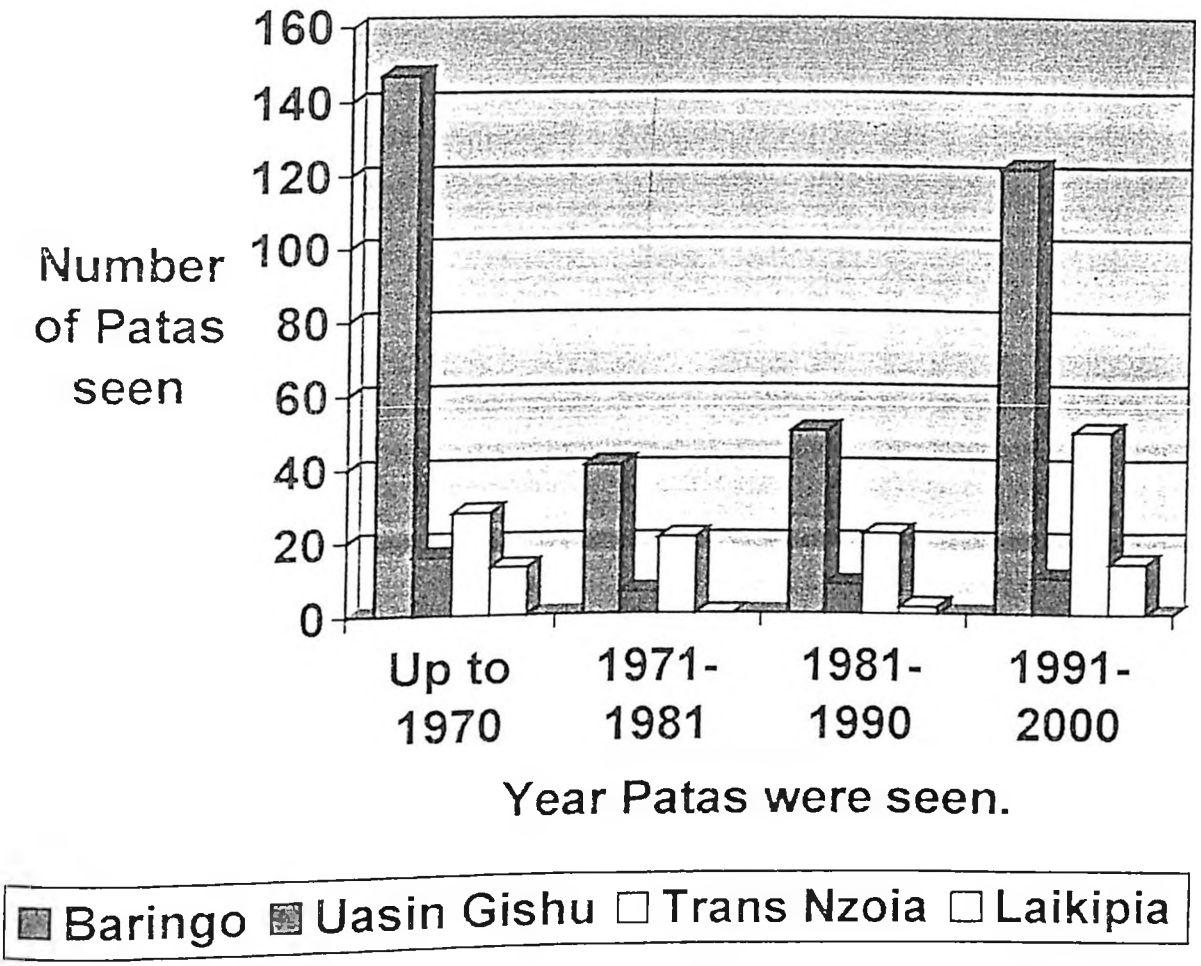


Figure 8. Comparison of Questionnaire respondents by District

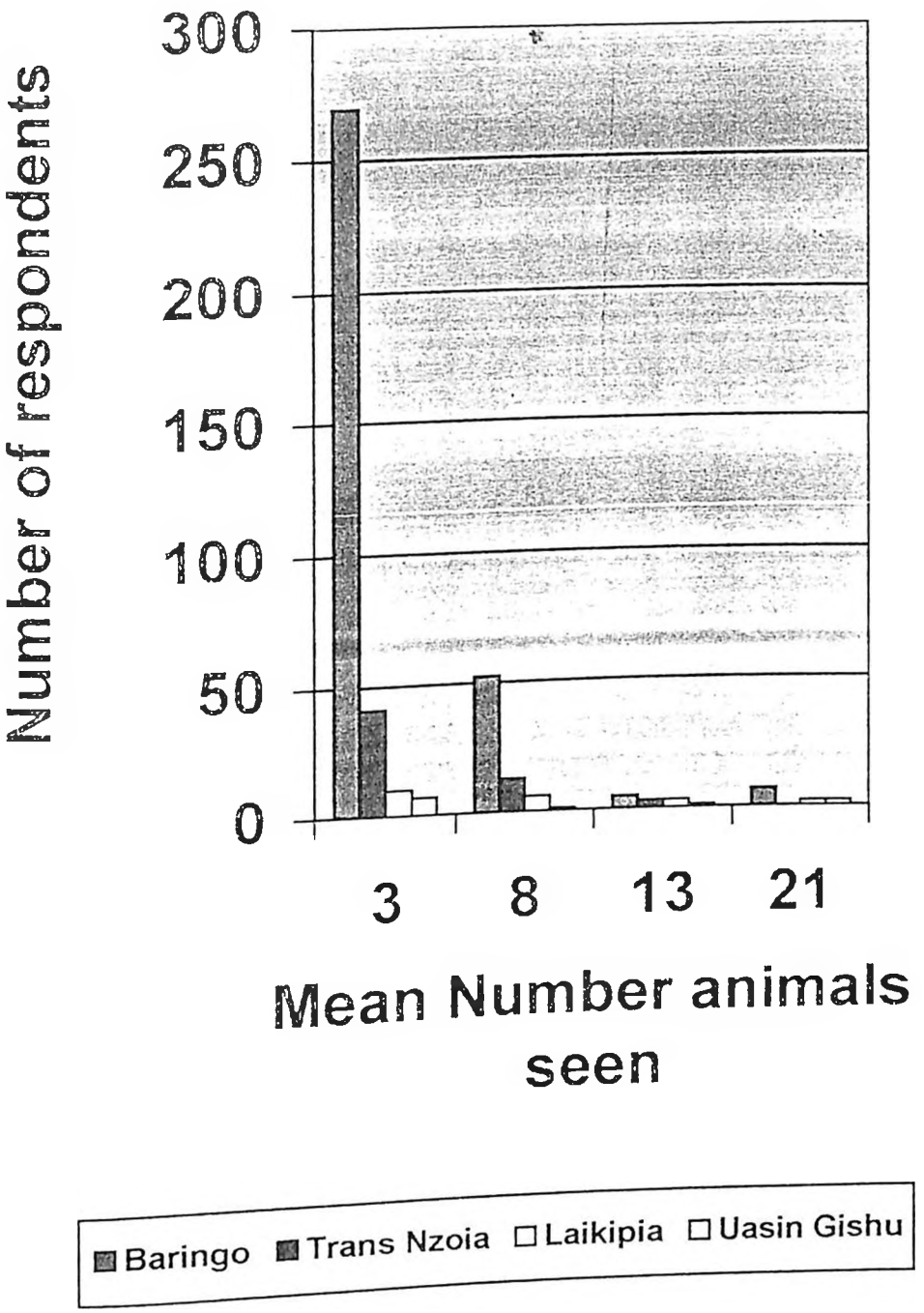


Table 4. Table showing the Age of respondents per district.

Age	Baringo	Laikipia	Trans-Nzoia	Uasin Gishu	Total	Percentage
<20	15	2	4	1	22	7.5 %
21- 30	13	4	26	3	46	15.7 %
31- 40	28	6	25	6	65	22.2 %
41- 50	9	6	15	5	35	11.9 %
>51	20	21	58	26	125	42.7 %
Total	85	39	128	41	293	

Nb: Age of respondents was recorded from the January census until May.

More men (250) than women (43) were able to identify patas monkeys positively. Men represented 85.3 % while women a mere 14.7 % of the total individuals interviewed (Table 5).

Table 5. Table showing results of the Questionnaire respondents by sex.

Sex	Baringo	Laikipia	Trans-Nzoia	Uasin-Gishu	Total	Percentage
Elderly Men	69	38	110	33	250	85.3 %
Elderly Women	16	1	18	8	43	14.7 %

4.4. Discussion

It can therefore be seen from the brief review that while there was a fair basis for comparative studies of numbers and densities, there was a considerable need to improve the information available on numbers.

4.4.1. Population Estimates

The distribution of the patas monkeys was shown to be non-uniform across the study area, the only real difference being that there were significantly more of them outside parks, while none was found inside any conservation area. Isbell *et al.* (1998a). Isbell and Pruetz (1998) and Chism and Rowell (1988) state that patas monkeys have very big home ranges, which provide enough food resources. This is due to the climate of their habitats, hence will require bigger space.

There were at least 13 groups living in the study area (Figure 6). Kingdon (1971) states that patas monkeys are well distributed in East Africa, North Africa all the way to West Africa. This study however suggests that this is no longer the case. It is likely that patas monkeys are undergoing local extinction. Local people maintain that most patas monkeys went away due to human pressures on the land but I, however could not determine to where these animals could have migrated.

Various researchers say that there has been a massive decline in the patas monkeys (Isbell (1998), Isbell and Pruetz (1998) and Chism and Rowell (1988). Chism *et al.* (1983) describes the presence of predators in patas monkeys land, and states that leopards contributed to their disappearance at night. In their research (Chism and Rowell, 1988) analyzed habitat types and reported that predators were sighted 96 times near patas monkeys groups.

They (Chism and Rowell, 1988) reported that 76 % of the sightings were of Black-backed Jackals (*Canis mesomelas*) which probably predated on young patas monkeys. Struhsaker and Gartlan, 1970 and Chism *et al.*, 1983 found that Jackals were encountered in margins of open acacia woodland, while cheetahs and wild dogs were encountered in dense acacia woodland. Chism and Rowell (1988) actually observed domestic dogs kill a patas monkey, and saw herdsboys and farmers chase them away with stones. I encountered dead patas, while questionnaire respondents confided in us chasing patas away or killing them.

Chapter 5. SEXING AND AGING OF THE PATAS MONKEYS.

5.1. Introduction

Aging and sexing animals require group habituation. Though hard to achieve fast on patas monkeys, other methods can be applied if the research is on a short time span. Habituation is very important when it comes to achieving a 100 % success in sexing and aging (Kummer, 1986).

Habituation of patas is the process of getting used to the animals, by them being able to tolerate your presence. This involves showing yourself, or visiting their home range, where the animals can see you and be able to understand that you are of no harm to them. In this way, the animals will not run away whenever they see you, and you can even approach them at least 2 metres away. Aging of patas can be achieved through daily visiting their home range, for you can be able to observe all characteristics of the animal. It can however be achieved though other means in a number of ways.

For the purposes of this study, all that was relevant was the approximate age (adult, juvenile, infant) and sex (adult male or not) of the animal, distance of animal from observer, distance of animal from water source (if any). Population size and group composition was studied to define age and sex based on the size scaling method (Eisenberg, 1981).

5.2. Methods

To determine where patas monkeys are, the methods described above (Questionnaires and Vigils) were applied. Once the animals were detected, acclimating was applied since we would not habituate wild patas monkeys so fast. This revolved around retreating but by going around the animal in a circular manner and avoiding looking at the animal directly as recommended by Kummer (1986), or by sitting down.

Visual contact was, however, maintained on a group for at least 4 hours mostly in the late morning and late afternoon when Patas monkeys were very active. Aging was based on visible external features like relative body size and coat color, reproductive organs (adult male) and nipples (Turnquist, 1983).

Determination of an individual's sex was based on visible and auditory features like canines, genitalia in adult males and vocalization. The number of individuals of each sex or age was determined by a basis of counts by the researchers, each independently (Turnquist, 1983).

5.3. Results.

Adult females dominated most of the groups with 90 % groups having adult males. The number of infants is significantly correlated with the number of adult females (Spearman rank correlation test, two tailed, $r_s = 0.76$, d.f= 10, $p<0.05$). Groups with infants have significantly more adult females per group than those without infants (Median test, $X^2=4.66$, d.f= 1, $P<0.05$). Eight (62 %) of the groups were located within 200 metres (Table 11) of water while others were further away. There was, however, no significant difference between number of adult males per group in groups near or far from farms (Median test, $X^2=0.90$, d.f=1, $P>0.05$). (Zar, 1984).

A total of 13 groups were seen in two of the four study areas. In these 13 groups, there were 11 heterosexual groups and 2 lone adult male sightings. Group size varied from 5 to 22 individuals. Overall composition of the population consisted of approximately 8 % adult males, 36 % adult females, 26 % juveniles and 22 % infants (Figure 6).

There is no much considerable difference in the proportions of juveniles and infants in all the groups encountered, (the analysis of variance showed this as not to be significant). Juveniles and Infants contribute 47.3 % of the total population encountered (Table 6).

Table 6. Table comparing between Juvenile and Infant numbers in Baringo and Laikipia Districts.

	Baringo	Laikipia	Total	No. Of sighting
Juveniles	11 (7.4%)	27 (18.2 %)	38 (25.7 %)	10
Infants	9 (6.5 %)	23 (15.5 %)	32 (21.6 %)	10
Total	20	50	70	
Percentage	13.5 %	33.8 %	47.3 %	
No. of sightings	8	12		

Of this, 25.7 % were juveniles while 21.6 % were infants. There was little variation in the juveniles and infants in Baringo (7 % and 6.5 % respectively), similar to Laikipia's (18.2 % and 15.5 %) proportions (Table 6).

In Baringo, there was little variation amongst the various troops encountered amongst the different ages and sexes. All groups had an adult male presence of 1.9 % (1 adult male per troop) of the 52 Patas monkeys encountered. Most of the groups had no variation in juvenile presence (3.8 % of 52). However, there was much variation in the adult female (5.8 % to 15.4 % of 52). (Table 7).

Laikipia shows some difference to that of Baringo. Adult males have 1 % of 96 individuals present in all the troops, while adult females varied from 3.1 % to 8.3 % of 96 individuals. Baringo, juveniles had a wider variation (2.1 % to 7.3 % of 96). Infants also had a variation (2.1 % to 6.3 % of 96). (Table 7). In both the districts, adult females and juveniles had the highest presence: Baringo (46 % and 21 %) and Laikipia (31.3 % and 28 %) respectively (Table 7 and 8).

Table 7. Mean group size of the seven Baringo Patas monkeys troops.

	Overall Mean	Kimalel G. 1	Kimalel G. 2	Kimalel G. 3	Kapkalewa G.	Kabluk G.	Majimoto G.	Chemeron G.	Total/ %
# Adult males	0.9	Nil	1	1	1	1	1	1	6 (11.5 %)
# Adult females	3.4	4	Nil	Nil	3	5	8	4	24 (46 %)
# Juveniles	1.6	2	Nil	Nil	2	2	5	Nil	11 (21 %)
# Infants	1.3	2	Nil	Nil	1	2	4	Nil	9 (17.5 %)
# Not identified	0.3	Nil	Nil	Nil	Nil	Nil	2	Nil	2 (3.8 %)
Total/ %	10	8 (15.4 %	1 (1.9 %)	1 (1.9 %)	7 (13.5%	10 (19.2%	20 (38.5%)	5 (9.6 %)	52 (100 %)

Adult male: n=7; μ=0.9; σ=0.3; V=0.4

Adult female: n=7; μ=3.4; σ=2.6; V=0.8

Juveniles: n=7; μ=1.6; σ=1.7; V=1.0

Infants: n=7; μ=1.3; σ=1.4; V=1.0

Unidentified: n=7; μ=0.3; σ=0.7; V=2.4

Where σ = Standard deviation

μ= mean of a population

v= coefficient of variation

n= sample size

Table 8. Mean group size of the six Laikipia Patas monkeys troops.

	Overall mean	Borana Ranch	ADC Mutara 1	ADC Mutara 2	Kamwaki Ranch	Mukima	Gordons ranch	Total/ %
# Adult males	1	1	1	1	1	1	1	6 (6.3%)
# Adult females	5	5	8	3	3	5	6	30 (31.3%)
# Juveniles	4.5	5	7	3	2	6	4	27 (28 %)
# Infants	3.7	4	6	2	2	4	5	23 (24%)
# Not identified	1.7	2	Nil	Nil	Nil	4	4	10 (10.4%)
Total/ %	10	17 (17.7%)	22 (22.9%)	9 (9.4%)	8 (8.3%)	20 (20.8%)	20 (20.8%)	96 (100 %)

Adult males: n=6; μ=1; σ=0; V=0

Adult females: n=6; μ=5; σ=1.7; V=0.3

Juveniles: n=6; μ=4.5; σ=1.7; V=0.4

Infants: n=6; μ=3.8; σ=1.5; V=0.4

Unidentified: n=6; μ=1.7; σ=1.7; V=1

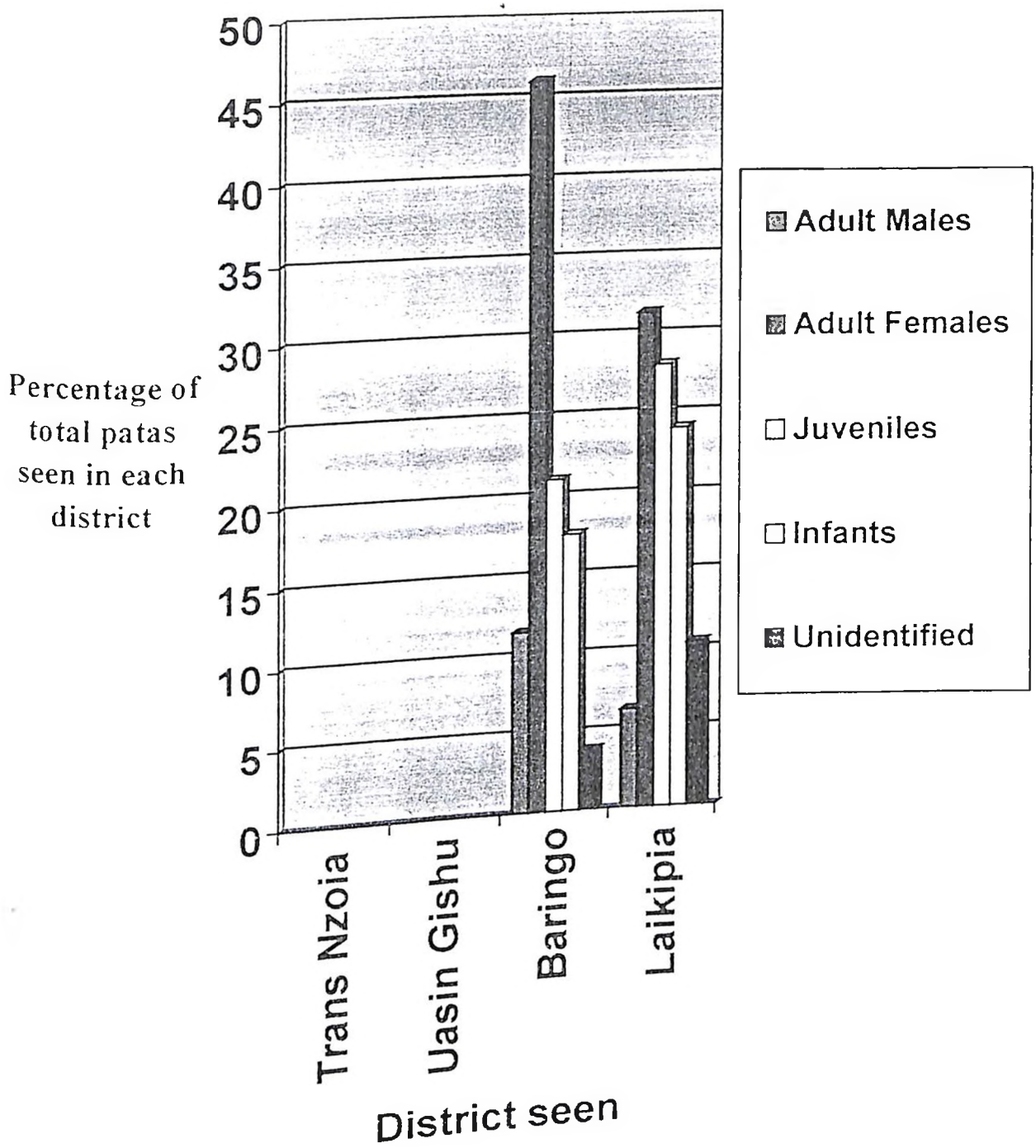
Where σ = Standard deviation

μ= mean of a population

v= coefficient of variation

n= sample size

Figure 9. Sex and age distribution of Patas monkeys.



5.4. Discussion

I estimated approximately 148 individual patas monkeys in this population distributed in 11 groups and 2 lone adult males with no overlapping home ranges. The size and demographic composition of the groups varied in time and space. Various intrinsic and environmental factors might have been the cause of this variation e.g. human activity, presence of food, species density and presence of predators. Both Baringo and Laikipia have the major sources of food to patas monkeys as will be seen below (*Acacia drepanolobium*). Absence of patas monkeys in Uasin Gishu and Trans Nzoia may be due to the extensive human activity. Climate, especially in most parts of Trans Nzoia could totally not allow patas monkeys presence.

In Baringo and Laikipia overall adult sex ratio is skewed, the adult females to adult males ratio being 54:12. There may be a high adult male death rate. There was some evidence of some dead adult males (2), which had probably been killed by man or dogs. In addition, more males are forced to become solitary because of the social structure of the species. Solitary adult males were, however, very hard to detect.

The number of juveniles and infants combined per group is positively correlated with the number of adult females per group (Spearman rank correlation test, two tailed, r_s=0.62, d.f= 10, P<0.005). This shows that the total number of potential breeding adults per group is the determinant of the absolute potential growth of the group. Composition of a group also affects the potential for an increase in population size.

The patas monkey's population in Baringo district shows a high variation in the male, female, juvenile and infant ratios as compared to Laikipia. Comparing the male: female ratios in the two districts, it is evident that Baringo does not present a healthy population (11.5 %: 46 %) (6.3 %: 31.3 %) to Laikipia (6.3 %: 31.3 %). The same may be said for the male: infant ratios. While Baringo has a ratio of males: infants (11.5 %: 17.5 %), Laikipia has (6.3 %: 24 %). There is a very high variation between females in Baringo (46 %) compared to that of Laikipia (31.3 %). It seems in Baringo reproduction is not directly proportional to the number of females and that the population is not healthy.

Chapter 6. VEGETATION AS A SOURCE OF PATAS MONKEY FOOD.

6.1. Introduction

In any population of herbivores, vegetation very much determines the distribution and abundance of the species. Presence of food species for the animal means the animal, if other factors remain constant, will find a home in this location (Young *et al.*, 1997).

Food distribution and abundance have wide ranging effects on animals, including the foraging behavior of individuals and the quality of competitive relationships within and between groups (Isbell, 1998). Southwood (1960) argues that food distribution is considered in the context of a dichotomy between food that is clumped into patches in which food density is greater than the surrounding area and food that is evenly distributed.

In a study conducted in Laikipia, Isbell (1998) estimated food distribution separately for each plant species according to the number of individuals that are able to feed together. It was determined that the amount of food available in an ecosystem determines how far an animal moves each day (Isbell, 1998). Patas monkeys will move less if there is much food (water included) and move more if food is not easy to find (Olson, 1983). Chism and Rowell (1988) determined that patas monkeys prefer *Acacia drepanolobium* or *Acacia seyal* woodlands in a study carried out in Laikipia. Hence it was important to determine whether this was true for other parts patas monkeys were present.

6.2. Methods

Vegetation study was only done in Baringo district since Laikipia had been studied (Chism and Rowell, 1988; Isbell *et al.*, 1998a). A ground transect was done whenever patas monkeys were encountered. The distance covered in each transect was approximately one kilometer long by 2 meters wide, determined by pacing along a straight line and marked with pieces of wood. Samples of plants we would not identify were collected and preserved for identification by an expert.

6.3. Results

Five of the Seven Baringo groups (71 %) were seen in areas with a high percentage of *Acacia drepanolobium* and *Acacia seyal* trees. Vegetation recorded in the area is listed below, (Table 9).

6.4. Discussion

From the results above, it's evident that Patas monkeys have a wide range of potential food sources from different habitats. Research on food items of patas monkeys in Laikipia (Isbell, 1998) shows other food items including ants and other arthropods, vertebrates, roots and mushrooms. The kind of plant distribution in the study area shows possible foods of the animals in the area, though detectability was the problem. In some of the areas where *A. drepanolobium*, the major food source for patas monkeys in Laikipia (Isbell *et al.*, 1998a; Chism and Rowell, 1988) occur, swollen thorns were opened showing either patas monkeys or baboons ate them at some time or another. Further verbal enquiries in the areas revealed that baboons had never been present.

Table 9. Vegetation encountered in the process of survey of patas monkeys

Plant species	Type	Ecology	Food item taken/ colour
Acokanthera schimperi	Evergreen shrub/ tree	Dry-land, thickets and grasslands	Fruit is yellow to purple
Berchemia discolar	Deciduous tree	Dry woodland	Fruit and seed- yellow
Carissa edulis	Evergreen shrub	Bush and forest edges	Fruits- seed/ yellow to black
Combretum molle	Deciduous tree	Wooded grassland/ bush-land	Gum
Euclea divinorum	Evergreen tree	Woodland and dry bush-land	Fruits- Purple to black
Ficus thoningii	Deciduous tree	Open grassland/ river-line	Fruits/ Purple-red-yellow
Rhus natalensis	Tree or bush	Wooded savanna	Fruit. Red
Strychnos henningsii	Shrubby tree	Dry areas/ river line	Fruit. Freshly- Orange purple
Tamarindus indica	Shrubby tree	Semi arid areas/ wooded grassland	Fruit. Pale brown
Teclea nobilis	Evergreen tree	Highland forest/ bush land savanna	Fruit red and smooth

Table 9 cont'd

Vangueria madagascarensis	Shrub tree	Scrub/ forest margins	Fruit. Green
Acacia drepanolobium	Shrubby tree	Dry areas/ bush land savanna	Gum, thorns, pods (both opened and not opened), flowers. Cream
Acacia xanthophloea	Evergreen tree	River line savanna	Gum. Yellow bark
Acacia seyal	Shrub tree	Semi arid areas	Gum, flowers, thorns. Purple to black. Flowers yellow
Commelina species	Evergreen shrubby tree	Semi arid areas/ wooded grassland	Flowers, leaves, fruit. Pale brown. Flowers blue
Lipia javanica	Shrubby tree	Dry area	Fruits. Blackish to brown
Opuntia vulgaris	Evergreen tree	Dry areas	Leaves

Chapter 7. SOIL SAMPLING

7.1. Introduction

Soils are very important components of an ecosystem. They determine the kind of plants that the ecosystem will support, hence the type of animals. *Acacia drepanolobium* has been shown to be the major source of food for Patas monkeys in Laikipia (Isbell, 1998) and the main soil supporting it is black cotton soil. Hence there was a need to determine if this was consistent in other areas where Patas monkeys are still found.

7.2. Methods and Results.

Locations where patas monkeys were first seen were noted before the animals could move away. When all the other information (sex, age, ratio, vegetation) was determined, and the Patas monkeys had left the area, five spots ten metres apart were identified in each location. Using a sharp metal knife (panga) a hole, 1 meter deep was dug and soil collected from each. Five samples were collected in each location and stored separately. The soil was then stored in an airtight plastic bag, labeled according to the location. These were numbered 1 to 5.

Similar recordings were made in the Patas monkey vigil data sheet. The soil bags were stored in a carton and were then sent over to the University of Nairobi soil labs in Kabete at the end of the field research for analysis. The analysis only had an aim of determining the soil type.

It was determined that 6 out of 7 (86 %) of the sightings had black cotton soils. 43 % were in areas dominated by rocks, while 14 % had sandy soils. One group (14 %) occurred near a flood plain hence presence of clay soils.

Table 10. Summary of the soil types found in Baringo patas monkeys area.

Group	Soils
Kimalel 1	Black cotton mixed with clay soil.
Kimalel 2	Black cotton.
Kmalel 3	Black cotton mixed with red soil.
Kapkalewa	Black cotton in a rocky environment.
Kabluk	Black cotton
Majimoto	Rocky environment with sandy soil.
Chemeron	Black cotton in a rocky environment.

7.3. Discussion and conclusion.

Acacia drepanolobium has been proven to thrive well in areas of black cotton soils. Being the major food source for the patas monkeys *Acacia drepanolobium* is abundant, and distribution of the patas monkeys may be widespread. Soils are a major determining factor of patas monkeys distribution, since they support the major food sources utilized by them. The relationship between black cotton nutrients and presence of *Acacia drepanolobium* has not been determined. During the survey, *Acacia drepanolobium* was seen in Kitale and Mt Elgon area, but no Patas monkeys were seen or recorded. Most of the sightings of patas monkeys were on black cotton soils.

Chapter 8. GENERAL DISCUSSION

Results show a very interesting status of patas monkeys in Kenya. While only a small area was covered, the above results show that patas monkeys numbers are declining drastically. Kingdon (1974) describes the occurrence of patas monkeys in most of Eastern, Northern, Central and West Africa. Patas monkeys are not listed in the red data book of IUCN as vulnerable or endangered. There is need to review this information in the red book since this and other research suggests otherwise (Chism *et al.* 1984).

Out of four study areas, which had been reported by Kingdon (1974) to host numerous populations of patas monkeys, only two had small populations. And in these two areas, only 148 animals were encountered. Prior research in these areas shows that there is a drastic decline in patas monkeys. An example is on the Mutara 1 and Mutara 2 groups. Chism and Rowell (1988) reported studying 41 and 74 patas monkeys respectively. This study has, however, found two groups of 22 and 9, which if true are the same groups studied by Chism and Rowell (1988) would represent a decline by 19 and 65 individuals respectively.

It was impossible to determine whether the patas monkeys migrated, died of natural death, or were killed by predators. Chism and Rowell (1988) report that domestic dogs were seen hunting patas monkeys. On the other hand, Chism *et al.*, (1983) report that Patas monkeys preferred to give birth during the day to reduce the risk of predation on their young. The group Isbell has been studying in Laikipia for about a decade has been reduced to just over 10 animals from approximately above 40 individuals (Isbell, unpublished data). Though the decline, bones of patas monkeys were never found, and therefore we could not be sure of the predation aspect.

This study tried to find the numbers as well as the problems causing the numbers to decline so fast. All in all this study was never conceived as infinite in scope, nor as one that would provide irrefutable answers. The intention was to provide a broad ecological description of the numbers and geographical distribution of the Patas monkeys populations in Kenya. That description was to serve as a baseline for a long-term evaluation of population status in relation to environmental change. The original desire has so far proved fruitful

8.2. Data analysis

The bulky part of the analysis of the thesis was multiple regression analysis of the distribution strategies of the animal. The most important questions surrounding the results of those analyses are:

1. Was the analytical technique an appropriate one?
2. Why was there so much residual variation?

Multivariate techniques of analysis and prediction are the subject of an almost endless round of criticism and defense in the ecological literature. For example, Aldredge and Ratti (1986) provide an extensive review of the potential of multivariate analysis in vegetation classification studies, while Zar (1984) considers that multiple regression models should only be applied when rather detailed data are available at a starting point. However if the technique is restricted to the aiding of intuition, rather than the formulation of predation models, it may, if used with care yield valid results (Karanja, pers. com).

The question of residual variation falls in the first instance back into the court of the data collection. Had it not been necessary to amalgamate the counts, the precision of the relationship between the animals and the variations in the habitat could have been improved. So too could the precision of the techniques have been increased, had we been able to improve the spatial resolution. The arguments for and against doing both of these things have already been aired.

It is desirable in wildlife survey operations from which habitat utilization inferences are to be drawn (Western, 1984) to record animal activity as an index of whether or not an animal was actively utilizing the habitat in which it was recorded. Since the vehicle movement disturbed the majority of animals recorded in this census operation, no such activity description could be applied.

It is on these four accounts, if not others as well, that the significance correlations could never be found that together explained more than 32 % of the variance of the data. While all the correlation presented above were significant, their coefficients of determination, being low, meant that the results were of low predictive value. This in turn is likely to be most attributable to the high residual variation. It is for this reason that the data are not used for predictive purposes. That in turn is why no attempt has been made to investigate the functional interactions between the species of the community. The broad geographical approach to the problems of patas monkeys in the study area precluded such a detailed examination.

8.2. The influence of climate on the density and distribution of patas monkeys in Laikipia, Baringo, Uasin Gishu and Trans Nzoia.

There is a gradient of climatic severity across the study area. This gradient is shown by the different climatic conditions between Trans Nzoia and Uasin Gishu on one hand and Baringo and Laikipia on the other hand. This provides a clear framework for the examination of the role of climate in determining animal numbers and distribution.

If climate affects patas monkeys, it may do so directly or indirectly in the study area. The effects range from the heat load impinging on the animal (expressed in this study as aridity) to diurnal micro-climatic fluctuation.

These may be moderated in their intensity by the availability of shade (expressed as tree canopy and shrub cover). The indirect effects of climate focus on rainfall, as it mediates the productivity of the herbivores' food supply. Between the two, there lies a third effect, that would act on both, and that is a component of predictability. The structure of the whole community can change according to the differential responses of the separate species to these three components.

There exist already several demonstrations of the effects of climatic gradients on the species diversity of vertebrate communities. Martin and Bateson (1993) have reviewed bird community literature from the mountains of western North America and have shown that species diversity decreases with a negative exponential curve. As the temperature range increases, the standard deviation of the mean temperature in the breeding month increases, the standard deviation of the mean temperature in the breeding month increases; and with the reciprocal of actual evapo-transpiration.

Direct dependence on climate by patas monkeys is shown by its availability in areas with some water availability. Indirect effects of climate are expressed largely through the influence of rainfall on the primary productivity of the area, which in turn may be shown to determine the carrying capacity.

8.3. Distribution of dry season water and its influence on Patas monkeys availability.

It can be said that one of the best predictors of distribution was distance to water. It was evident that at least each encountered group was at a proximity to some water source. It can be seen from the table that there is a high concentration of most of the groups in areas near water sources. A total of seven (7) groups representing 68 % of the total encountered animals were found less than 500 metres from water sources.

The patas monkeys distribution therefore shows that majority of the patas monkeys are to be found within 1 kilometer of permanent water sources during the dry seasons.

8.4. The activities of the human population affecting Patas monkeys distribution.

In most of the study area, areas considered to be patas monkeys land were in one way or another interfered on by man and his activities. Hence this human interference has capacity to depress the patas monkeys population in two general ways.

One is by competing with patas monkeys either directly for space or indirectly for resources that are used by their domestic stock or by themselves. The second form of potential limitation is direct exploitation of the animals, which currently takes the form of illegal hunting. This section reviews some of the information gathered during the study which show that forces of depression of patas monkeys numbers are currently dominant over those for promotion, and are likely to become more so.

8.5. Pressures for land

Competition for space between people and patas monkeys was a common phenomenon in the study area. Hence patas monkeys have been compressed in a small area, where not much human activity is found. That means patas monkeys have been denied assess to land that they formerly occupied, and continue to be forced to occupy less and less space.

Man may attribute this to the quest for more farmland and grazing land; while others are being converted to big ranches for wheat and flower farming. This is an example of Laikipia, where most of the district is already sub-divided into ranches. This is however different to what occurs in Baringo, where not much of the land is ranch-land, but communal grazing areas. Some of these areas have however been under intense pressure from charcoal burners (plate 4).

Table 11: Summary of distance from water source for encountered groups.

Distance from water	0 to 0.5 km	0.6 to 1 km	1.1 to 1.5 km	1.6 to 2 km	2.1 to 2.5 km
Number of animals	101	10	28	9	Nil
Number of Groups	7	1	2	3	Nil

Plate 4. Photograph of an area cleared for Charcoal burning. The picture was taken in Laikipia. Trees in the background are *Acacia drepanolobium.*

In other districts, most of the land is occupied by agricultural activities. Higher densities of human settlement are major causes in the disappearance of patas monkeys ecosystems, hence patas populations have diminished.

It can be seen from the maps that Uasin Gishu and Trans Nzoia are mainly farmland. On the other hand, weather conditions in these areas actually do not allow for patas monkeys occupation.

In both Baringo and Laikipia, a further form of human activity was mapped, that of felling trees for charcoal burning (plate 4). The extent of this, both in the form of smoking and disused but recognizable charcoal clumps can be seen in photographs attached. In Laikipia, the main trees targeted for charcoal was *Acacia drepanolobium* a major food source for Patas monkeys (plate 5 and 6). This was common in areas near Endana where a large potion of *A. drepanolobium* said to have hosted a group of patas monkeys had been totally cleared a converted to charcoal during a recent drought (Musyoka, *pers com*). Other areas are near Timau, with most of the land being converted to horticultural land.

Questionnaires revealed that patas monkeys existed in this area up to the late 1970s when most of these farms were started. Whilst the study has shown the spatial distribution of charcoal exploitation, there is still no information at all on its effects on woodland dynamics, or on the effect the canopy cover may be having on patas monkeys in both Baringo and Laikipia.

Plate 5. Photograph of Drying *Acacia drepanolobium* trees in Laikipia

Plate 6. Photograph of an *Acacia drepanolobium* bushland in Baringo.

8.6. Pressures on the Animals

The current major form of destructive exploitation of patas monkeys in the study area is hunting, not for food or trophy, but due to their effect on crops. No attempt was however made to quantify this, but seven times, dead corpses of patas monkeys were encountered, whereas some respondents to questionnaires actually confided in us as having killed or witnessed killing of Patas monkeys (table 12). No attempt was made to collect the corpses since we did not have materials and techniques to do so.

Since no other study has tried to quantify the numbers of patas monkeys, it is not possible to determine whether mortality is increasing or decreasing, or whether there is recruitment to the population or not. But a comparison between the infants and juveniles on one-hand and adult males and adult females on another hand shows there could be a rapid population decline. Basing arguments on published data from previous patas researchers (Chism and Rowell, 1986; Fedigan, 1992; Isbell, 1998, Isbell *et al*., 1998a; Hall, 1965), while also considering the fact that Kingdon, (1974), Kingdon, (1971) and IUCN, (2000) state patas are abundant, we can conclude that populations are declining.

Table 2 above shows that out of the total population of 148 animals counted, 12 were adult males, 54 adult females, 38 juveniles and 32 infants. Both adult males and adult females have a combined total of 66, while the juveniles and infants total to 70. Considering that every group has an average of 1 male, we can say that infant and juvenile numbers ought to be more to qualify the population to be healthy.

Table 12. Summary of dead Patas monkeys encountered and questionnaire response to Patas monkeys killed. All in numbers.

District	Trans Nzoia	Uasin Gishu	Baringo	Laikipia
Encountered dead by survey team	Nil	Nil	5	2
Questionnaire respondents for Killed	9	5	29	1

8.7. Outlook for the future

These few quantitative data on the patas monkeys and reviews of land use picture of competition and exploitation show that patas monkeys numbers are rapidly being depressed. Human population increase can be expected only to aggravate this situation over the coming years, particularly in Doldol division and Rumuruti division of Laikipia districts and Kamnarock, Kaboskei and Nginyang areas of Baringo District.

The bleak outlook does not mean that all is lost for the patas monkeys. Continued monitoring of patas monkeys densities, patas monkeys mortality and human settlement densities is vital. If the estimates fall outside the standard errors of the present ones, the data for each can be converted to rates-of-change. These in turn can be used in multiple regression analysis to test the relative contributions of compression and human exploitation to the changes in the patas monkey population.

8.8. Why conservation areas should be created in the two districts where Patas monkeys were encountered.

Despite the small numbers of patas monkeys found in Kenya today, no conservation efforts have been applied. patas monkeys are now largely restricted to black cotton soils in Kenya, and occur mainly in pastoral areas. Apart from Lake Bogoria National Park and Lake Baringo National Reserve, there is no other conservation area in the patas monkeys range. There are however no patas monkeys populations in Lake Bogoria or Lake Baringo, this placing patas monkeys a suitable candidate for being locally extinct if cattle ranches no longer tolerate them and the current trends elsewhere are not reversed.

There is therefore a dire need for creating some conservation areas in both the two districts, which will be left unutilized and this means patas monkeys, can be conserved in them. This is only possible in areas where vegetation and soils, which provide patas monkey with food are found. This has been totally supported in this thesis, which has broadly dealt with the problem.

8.9. Recommendations

To manage the current downtrend in patas monkeys populations a number of issues should be put into consideration.

- Herdsmen should be discouraged against use of dogs to chase away patas whenever they encounter them as they graze livestock.
- Conservation areas should be set aside for the sake of patas monkeys populations. Some areas in Nginyang, Kimalel and Tangulbey in Baringo district would provide suitable candidates for patas monkeys conservation land. Climate in these areas is ideal for patas monkeys whereas most of the vegetation here has been found to support Patas monkeys populations. The same areas do not have high populations and are not suitable for ranching due to soil and rainfall factors.
- Authorities should consider a translocation plan for patas monkeys from areas where they are at risk or pose problems to man (Chemeron, Majimoto areas of Baringo) to places such as Lake Kamnarock Conservation Area and Lake Bogoria National Reserve, both having climatic conditions suitable for patas monkeys. For Laikipia, if conditions remain as they are (ownership of large ranches to individuals), patas may survive since a favorable environment is provided by them.
- More research is needed on patas monkeys distribution and ecology since not much has been done on this side to date.
- People living in habitats considered to be patas monkeys range should be advised on the economic potential of patas monkey, that is tourism and scientific research. They should be encouraged to set up ecotourism sites in their areas and engage in patas monkey tracking.

- A patas monkeys-monitoring programme should be initiated to focus mainly on their distribution and status in the areas set aside for them. More research in other areas not covered by my survey is highly recommended.

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Chapter 10. Appendices

10.1. Appendix 1. Animals encountered in the study area.

Animal	*Scientific name*	Where found	Type of ecosystem
Topi	*Damaliscus lunatus*	Baringo	Bushed grassland
Hippopotamus	*Hippopotamus amphibius*	L. Kamnarock Baringo	Grassland
Dikdik	*Madoqua kirkii*	Laikipia, Baringo	Bushed, wooded country
Klipspringer	*Oreotragus oreotragus*	Baringo, Laikipia	Grassland
Elephant	*Loxondanta africana (Blumenbachi)*	Laikipia	Bushed grassland
Bushbuck	*Tragelaphus scriptus*	Laikipia, Baringo	Bushed grassland
Baboon	*Papio anubis*	Uasin Gishu, Laikipia, Baringo, Trans Nzoia	Common in all ecosystems
Zebra	*Equus burchelli (Gray)*	Baringo	Bushed grassland
Giraffe	*Giraffa camelopardalis (L.)*	Baringo, Laikipia	Bushed, wooded grassland
Warthog	*Phacochoerus Aethiopicus (Pallas)*	Baringo, Laikipia, Trans Nzoia	Grassland, forest
Impala	*Aepyceros melampus (Lichtenstein)*	Laikipia, Baringo	Bushed grassland
Ostrich	*Struthio camelus (L.)*	Baringo, Uasin Gishu, Laikipia	Bushed grassland

Appendix I cont'd

Lion	*Felis leo*	Laikipia	Grassland
Leopard	*Panthera pardus*	Laikipia	Bushed grassland
Black backed Jackal	*Canis mesomelas*	Baringo, Laikipia	Grassland
Spotted Hyena	*Crocuta crocuta*	Laikipia	Grassland
Domestic dog	*Canis familiaris*	Baringo, Laikipia, Uasin Gishu, Trans Nzoia	Forest, Bushland, Grassland
Leopard	*Panthera pardus*	Laikipia	Bush land
Cheetah	*Acinonyx jubatus*	Laikipia, Baringo	Bushed grassland
Caracal	*Felis caracal*	Laikipia	Grassland
Common Jackal	*Canis aureus*	Laikipia	Grassland

10.2. Appendix 2- Questionnaire

Name of Village_____ _____

Road from_____ To _____

Sex _____ Approx. age _____

Where have you seen Patas monkeys and when?

Where _____ Location _____

Time of year _____ Time of day _____

How many individuals did you see? Adult males _____

Adult females _____

Female with Babies _____

Juvenile _____

Single animal _____

For how long were they present in this location (YR)? _____

Do you know any areas Patas monkeys used to be but no longer present? _____

Why do you think they disappeared? _____

How many sources of water do you know of around the area? _____

What kinds are they, e.g. Water troughs, permanent streams, taps?

_____

Have you seen Patas monkeys drinking at any of these water sources? _____

_____

If so which ones and where are they located? _____

_____

_____ Up to 1970. _____

10.3. Appendix 3. PATAS MONKEY CENSUS VIGIL DATA SHEET

Observer _____

Date (Day, Mon/ Yr) _____

Water source nearby _____

On black cotton soil _____

Air temperature _____

Time at start of vigil _____

Time at end of vigil _____

Group composition

Number of adult males _____

Number of adult females _____

Female with babies _____

Number of juveniles _____

Number of un-identified _____

Distance of 1 st Patas monkeys seen from observer (m)

_____

Distance of 1 st Patas monkey seen from source of water (m)

_____

Quality of counting

All counted with confidence

Most counted

Half or fewer counted

Very few counted _____

Behavior of animal to observer

Well habituated

Slightly nervous but continue to approach water

Obviously nervous and avoid water but don't leave area

Run away when observers detected. _____

Other comments _____

10.4. Appendix 4. Summary of Questionnaire response- BARINGO

TOTAL INTERVIEWEES= 1810

Questions	Responses	Number of People	Percentage of Total Interviewed
Have you seen patas monkeys?	YES	442	24.4
	NO	1368	75.6
When did you see patas monkeys	Up to 1970	147	8.1
	1971- 1980	41	2.3
	1981- 1990	50	2.8
	1991-2000	122	6.7
	2001	3	0.2
How many did you see	1-5	269	14.8
	6-10	52	2.9
	11-15	5	0.3
	16-20	11	0.6
	>21	7	0.4
	Many	89	4.9
Water source nearby?	YES	372	20.5
	NO	70	3.9
Do you know areas where patas monkeys used to be but no longer?	YES	162	8.9
	NO	280	15.5
Why do you think they disappeared?	Deforestation	52	2.9
	Drought	58	3.2
	Lack of water	31	1.7
	Lack of food	54	3.0
	Settlement/ farming	90	5.0
	Chased by man/ killed	29	1.6
	Migration	18	1.0
	Didn't know	131	7.2

10.5. Appendix 5. Summary of questionnaires- Uasin Gishu

Total Interviewed= 461

Questions	Responses	Number of people	Percentage of total interviewed
Have you seen patas monkeys?	YES	41	8.9
	NO	420	91.1
When did you see patas monkeys	Up to 1970	16	3.5
	1971- 1980	6	1.3
	1981- 1990	8	1.7
	1991-2000	10	2.2
	2001	0	0
How many did you see	1-5	7	1.5
	6-10	1	0.2
	11-15	1	0.2
	16-20	0	0
	>21	2	0.5
	Many	30	6.5
Is there any water source nearby?	YES	40	8.7
	NO	1	0.2
Do you know areas where patas monkeys used to be but no longer?	YES	29	6.3
	NO	12	2.6
Why do you think they disappeared?	Deforestation	5	1.1
	Drought	0	0
	Lack of water	0	0
	Lack of food	0	0
	Human settlement/ farming	25	5.4
	Chased by man/ killed	5	1.1
	Migration	0	0
	Didn't know	13	2.8

10.6. Appendix 6. Summary of Questionnaires- TRANS-NZOIA

Total Interviewed= 591

Questions	Responses	Number of people	Percentage of total interviewed
Have you seen patas monkeys?	YES	129	21.8
	NO	462	78.2
When did you see patas monkeys	Up to 1970	28	4.7
	1971- 1980	21	3.5
	1981- 1990	22	3.7
	1991-2000	50	8.4
	2001	6	1.0
How many did you see	1-5	41	6.9
	6-10	13	2.2
	11-15	3	0.5
	16-20	0	0
	>21	0	0
	Many	67	11.3
Is there any water source nearby?	YES	125	21.1
	NO	4	0.7
Do you know areas where patas monkeys used to be but no longer?	YES	48	7.9
	NO	81	13.9
Why do you think they disappeared?	Deforestation	0	0
	Drought	0	0
	Lack of water	1	0.2
	Lack of food	2	0.3
	Human settlement/ farming	45	7.6
	Chased by man/ killed	9	1.5
	Migration	0	0
	Didn't know	79	13.4

10.7. Appendix 7. Summary of Questionnaire- LAIKIPIA

Total Interviewed= 202

Questions	Responses	Number of People	Percentage of Total Interviewed
Have you seen patas monkeys?	YES	39	19.3
	NO	163	80.7
When did you see patas monkeys	Up to 1970	13	6.4
	1971- 1980	0	0
	1981- 1990	2	1
	1991-2000	14	6.9
	2001	10	4.9
How many did you see	1-5	10	4.9
	6-10	6	3.0
	11-15	3	1.5
	16-20	2	1.0
	>21	2	1.0
	Many	16	7.9
Is there any water source nearby?	YES	36	17.8
	NO	3	1.5
Do you know areas where patas monkeys used to be but no longer?	YES	4	2.0
	NO	35	17.3
Why do you think they disappeared?	Deforestation	2	1.0
	Drought	1	0.5
	Lack of water	0	0
	Lack of food	0	0
	Human settlement/ farming	4	2.0
	Chased by man/ killed	1	0.5
	Migration	0	0
	Didn't know	31	15.3

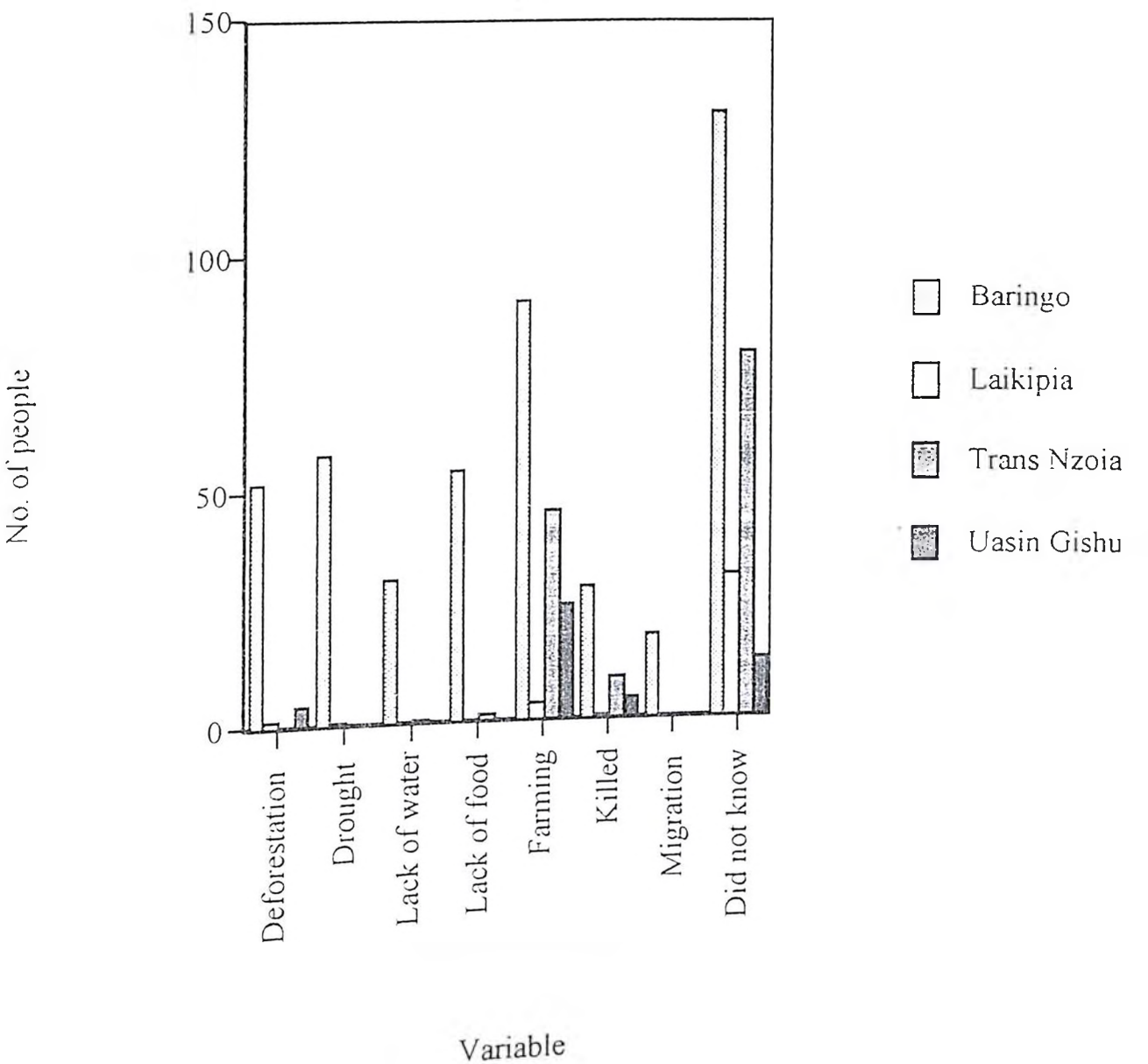
10.8. Appendix 8. Summary of the Laikipia District Patas monkeys census

	Borana Ranch	ADC Mutara 1	ADC Mutara 2	Kamwaki Ranch	Gordons ranch	Mukima area	Tota l
Name of Water source	Borana Dam	Mutara Dam	Nil	Kamwaki Dam	Water trough	Mukima River	
Soils type	Black Cotton	Black Cotton	Black cotton	Black cotton	Black cotton	Black cotton	
# Adults males	1	1	1	1	1	1	6
# Adult female	5	8	3	3	6	5	30
# Juveniles	5	7	3	2	4	6	27
# Infants	4	6	2	2	5	4	22
# Unidentified	2	Nil	Nil	Nil	4	4	10
Distance from observer (Metres)	150	30	100	200	200	100	
Distance from Water (Metres)	20	200	Nil	200	100	300	
Animal Behaviour	Very Nervous	Ran away when seen	Very nervous	Ran away when seen	Ran away when seen	Ran away when seen	
Total	17	22	9	8	20	20	96

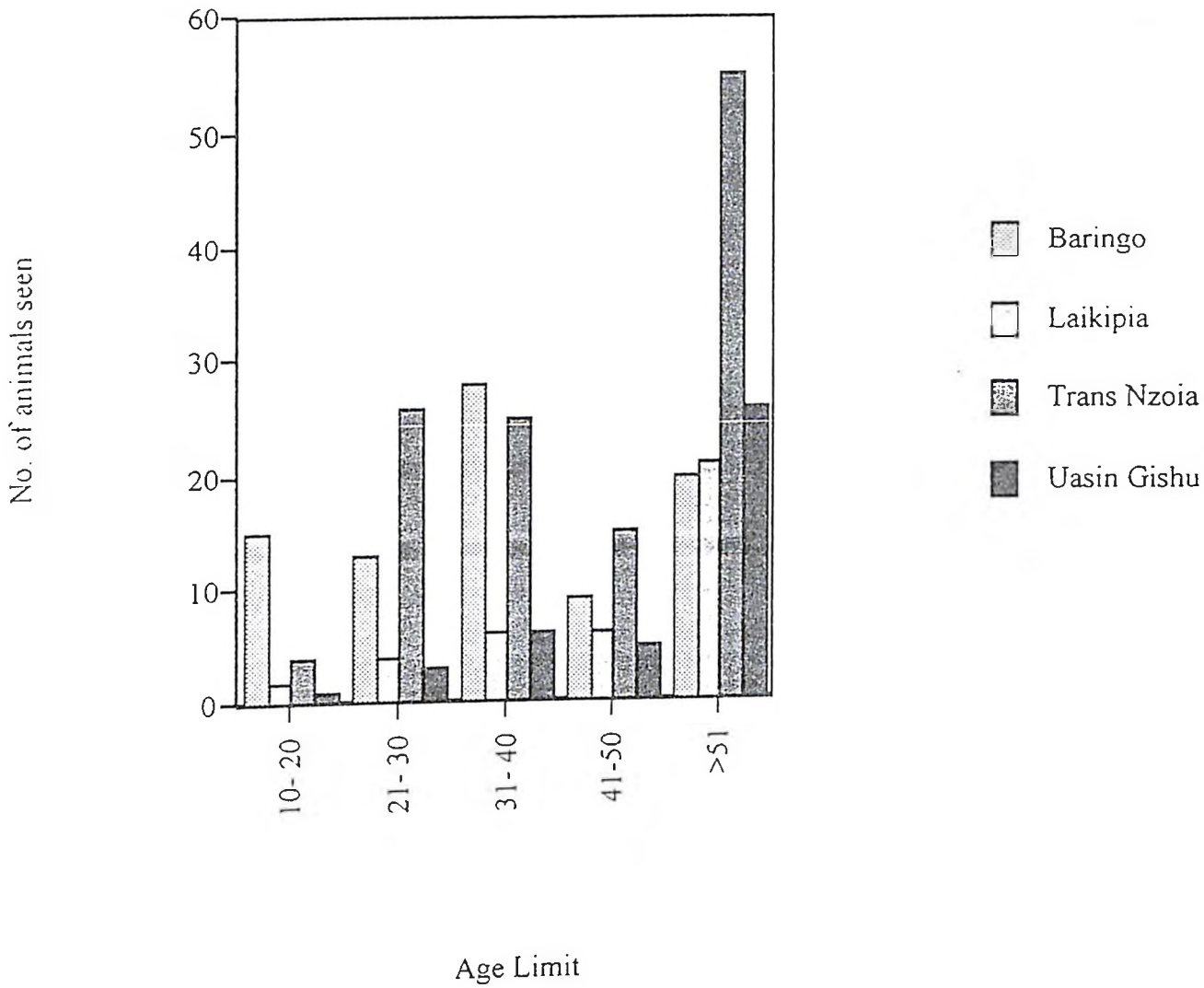
10.9. Appendix 9. Summary of the Baringo District Patas monkey Census

	Kimalel G. 1	Kimalel G.2	Kimalel G. 3	Kapkalewa G.	Chemeron G.	Kabluk G.	Majimoto G.	Total
Name of Water source	Nginyang Dam	Kinyach Dam	Kinyach Dam	Kerio River	Chemeron Dam	Yeptos River	Majimoto River	
Soils type	Black cotton/ Clay	Black Cotton	Black Cotton/ Red	Black Cotton/ Rocky	Rocky/ Black Cotton	Black Cotton	Rocky/ Sandy	
# Adults males	Nil	1	1	1	1	1	1	6
# Adult female	4	Nil	Nil	3	4	5	8	24
# Juveniles	2	Nil	Nil	2	Nil	2	5	11
# Infants	2	Nil	Nil	1	Nil	2	4	9
# Unidentified	Nil	Nil	Nil	Nil	Nil	Nil	2	2
Distance from observer (Metres)	600	1200	1500	200	1000	150-200	800	
Distance from Water (Metres)	1500	1900	1900	2000	500	1000	1200	
Animal Behaviour	Ran away	Very Nervous	Very Nervous	Ran away	slightly nervous	Ran away	Ran away	
Total	8	1	1	7	5	10	20	52

10.10. Appendix 10: Summary of variables causing patas monkeys disappearance.



10.11. Appendix 11. Figure of respondents to questionnaires by age



10.12. Appendix 12. Pictures taken in the study area depicting various problems facing Patas monkeys. Farming in what was *Acacia drepanolobium* plantation in Baringo District, Kenya.

Appendix 10:13 Summary of questionnaire respondents in the entire study area.

Baringo District					
Location	Up to 1970	1971-1980	1981-1990	1991-2000	2001
Kapturo	Present	Present	Present	Present	Present
Kaboskei	Present	Present	Present	Present	Present
Ngorora	Present	Present	Present	Present	Present
Kiboino	Present	Present	0	0	0
Bekibon	Present	Present	Present	Present	0
Elgeyo	Present	Present	Present	Present	Present
Endao	Present	Present	Present	0	0
Kimalel	Present	Present	Present	Present	Present
Kimorok	Present	Present	Present	Present	Present
Tanglubei	Present	Present	Present	Present	0
Nginyang	Present	Present	Present	Present	0
Marigat	Present	Present	0	0	0
Mochongoi	Present	Present	Present	Present	0
Barketut	Present	0	0	0	0
Kamnarock	Present	Present	0	0	0
Ochii	Present	0	0	0	0
Kapropita	Present	0	0	0	0
Tenges	Present	Present	0	0	0
Muskut	Present	Present	Present	Present	0
Sacho	Present	Present	Present	Present	0
Kamorus	Present	Present	0	0	0
Timboiwo	Present	Present	Present	Present	0
Emmom	Present	Present	Present	Present	0
Keiyo	Present	Present	Present	Present	Present
Marigat	Present	Present	Present	Present	0
Bartum	Present	Present	Present	Present	0
Sabor	Present	Present	Present	Present	0
Kimorok	Present	Present	Present	Present	Present
Yatoi	Present	Present	Present	Present	0
Kiserian	Present	Present	Present	Present	Present
Kositei	Present	Present	Present	Present	0
Loyamorok	Present	Present	Present	Present	0
Silale	Present	Present	Present	Present	0
Kolowa	Present	Present	0	0	0
Ravine	Present	Present	Present	Present	0
Wamba	Present	Present	0	0	0
Chepkisin	Present	Present	0	0	0
Bartabwa	Present	0	0	0	0
Ossen	1938	0	0	0	0
Lawan	Present	Present	Present	Present	0
Kinyach	Present	Present	Present	Present	0

Yatya	Present	Present	Present	0	0
Moloi	1950	0	0	0	0
Erralel	Present	Present	Present	Present	0
Bartolimo	1952	0	0	0	0
Kapkata	Present	Present	0	0	0
Kabtebereme	Present	Present	Present	Present	0
Ngorra	Present	Present	Present	0	0
Teberewo	1940	0	0	0	0
Kapkuikui	Present	Present	Present	Present	0
Koibos	Present	Present	Present	Present	Present
Kimose	Present	Present	Present	Present	0
Radat	Present	Present	Present	Present	0
Kerecho	Present	Present	Present	Present	0
Kimondis	Present	Present	Present	Present	0
Yatta	Present	Present	Present	Present	0
Salawa	1960	0	0	0	0
L. Baringo	Present	Present	Present	Present	0
Kiporkoi	Present	Present	Present	Present	Present
Guigui	Present	Present	Present	Present	0
Kabartonjo	1960	0	0	0	0
Emsea	Present	Present	Present	Present	Present
Kapalgany	1940	0	0	0	0
Kapyemit	1955	0	0	0	0
Kapultier	1968	0	0	0	0
Kaptum	1967	0	0	0	0
Baraweza	Present	Present	Present	Present	Present
Tambach	Present	Present	Present	Present	0
Ome	Present	Present	Present	0	0
Kabluk	1950	0	0	0	0
Majimoto	Present	Present	Present	Present	Present
Kapturwo	Present	Present	Present	0	0
Noregon	Present	Present	Present	Present	0
Koriema	Present	Present	Present	Present	0
Bargoi	1933	0	0	0	0
Soi	1967	0	0	0	0
Emsen	1942	0	0	0	0
Kibargor	Present	Present	Present	Present	Present
Soy	Present	Present	Present	0	0
Chemoibon	Present	Present	Present	Present	0
Sandai	Present	Present	Present	0	0
Seremwo	1942	0	0	0	0
Bartolimo	Present	Present	Present	Present	0
Poi	Present	Present	Present	Present	0
Kapkalewa	Present	Present	Present	Present	Present
Bartabwa	1963	0	0	0	0
Sibilo	Present	Present	Present	Present	0
Tot	Present	Present	Present	Present	0
Cheblil	Present	Present	Present	Present	0

Laikipia District					
Rumuruti	Present	Present	Present	Present	Present
Gatundia	Present	Present	Present	Present	0
Ol Arabel	1963	0	0	0	0
Mukutan	Present	Present	Present	Present	0
Sandai	Present	Present	Present	0	0
Marmanet	Present	Present	0	0	0
Kinamba	Present	Present	0	0	0
Ol Ngarua	Present	Present	0	0	0
Ol Moran	Present	Present	Present	Present	Present
Sipili	Present	Present	Present	Present	0
Solio	Present	Present	Present	Present	Present
Segera	Present	Present	Present	Present	Present
Sirima	Present	Present	Present	Present	Present
Thome	Present	Present	Present	Present	0
Kiamariga	Present	Present	Present	Present	0
Timau	Present	Present	0	0	0
Sirimon	Present	Present	0	0	0
Iingwesi	Present	Present	0	0	0
Sosian	Present	Present	Present	Present	Present
Mwenje	Present	Present	Present	0	0
Maundu-ni-meri	Present	Present	Present	Present	0
Kurikuri	Present	Present	0	0	0
Doldol	Present	Present	0	0	0
Ethii	Present	Present	0	0	0
Muramati	Present	Present	0	0	0
Endana	Present	Present	Present	Present	Present
Uasin Gishu District					
Kaptarakwa	Present	0	0	0	0
Kipkabus	Present	0	0	0	0
Tinderet	Present	0	0	0	0
Kaptagat	Present	0	0	0	0
Kaiboi	Present	0	0	0	0
Moiben	Present	0	0	0	0
Trans Nzoia District					
Kiminini	1940	0	0	0	0
Mt. Elgon	0	0	0	0	0
Tinderet	1930	0	0	0	0
Serewa	Present	0	0	0	0
Cherangani	Present	Present	0	0	0
Katsungur	Present	Present	0	0	0
Chepkotet	Present	Present	Present	0	0
Endebes	1950	0	0	0	0
Kinyarkwat	Present	0	0	0	0
Chepkobeh	Present	Present	0	0	0