ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN RUMPED ELEPHANT-SHREW (*Rhynchocyon chrysopygus*) IN THE NORTHERN COASTAL FORESTS OF KENYA

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DECLARATION

I, Grace Wambui Ngaruiya declare that this thesis is my original work and to the best of my knowledge, has not been presented for a degree in any other university.

SIGNATURE .....

DATE 25th March 2009

This thesis has been submitted for examination with our approval as the university supervisors.

DR. E.M. MWANGI

SIGNATURE .....

DATE 25/03/2009

DR. N. GICHUKI

SIGNATURE .....

DATE 18 March 2009

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DEDICATION

This thesis is dedicated to:

My mother and sister

Martha Wanjiku Ngaruiya & T'evelyn Wanjiru Ngaruiya

For listening to my dreams and their support to make them come true

GOD BLESS YOU

ACKNOWLEDGMENTS

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Finally, I must thank God for opening up doors for me to reach this level, all glory to Him always.

ABSTRACT

This research was conducted from September 2007 to April 2008 on three ecological aspects of the golden-rumped elephant-shrew (GRES) in selected forests along north coast of Kenya.

Range of the golden-rumped elephant-shrew was first determined at sites further north from Arabuko-Sokoke forest (ASF) and its environs, to Boni and Dodori National Reserves through ground-truthing. Secondly, 6 m wide transects were used to assess relative densities and population in confirmed habitats of the species. Thirdly, questionnaire surveys were used to measure conservation attitudes of the indigenous people living adjacent to the forests towards GRES.

This research showed that the GRES is only found within the protected Arabuko-Sokoke and Gede National Monument forests. An unrecorded species of elephant-shrew was discovered at Boni and Dodori Reserves and is undergoing tests to determine classification.

Density results indicate a 9% decrease in total GRES number while specific trends in ASF show population estimate of GRES at *Cynometra* forest have increased by 12% and declined at *Brachystegia* forest by 21% and by 50% in the mixed forest. Estimated GRES population at Gede was an estimated 20 individuals.

An observation from the indigenous people showed lack of knowledge on endemic species within their area and lack of know-how on how to sustainably use resources

present in the area, and this is one main factor why destruction of the forests was still a problem.

Observations of forest quality in Gede show that proper fencing and monitoring of a forest can support existence of an endangered species even with destruction of the surroundings. Addition of a buffer zone can decrease frequency of poaching in the forest by providing an area for safe extraction of firewood and herbs by the indigenous people.

Education emphasizing on importance of conservation of resources especially endemic species is therefore important targeting all age groups for conservation to be effective over many generations.

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction of study animal

Elephant-shrews are an ancient group that only arose in Africa (Corbet and Hanks, 1968). Elephant-shrews are estimated to have begun living about 100 million years ago, with tenrecs and golden-moles, the aardvark, sea cows (manatees and dugongs), hyraxes, and elephants. These superficially very different species are part of an early placental radiation of African mammals, the Afrotheria, all more closely related to each other than to any other mammals (FONZ, 2007; Nicoll and Rathbun, 1990).

Afrotherians evolved and diversified in Africa, isolated for millions of years from all other mammals. Today only about 80 species of Afrotheria survive (one aardvark, two elephants, four sea cows, six hyraxes, 15 sengis, 21 golden-moles, and 30 tenrecs (FONZ, 2007; Nicoll and Rathbun, 1990). In Africa, the coastal genus *Rhynchocyon* is thought to have been isolated from the main central African population by the formation of the East African Highlands and Rift valley about 16 million years ago (Corbet and Hanks, 1968).

Elephant-shrews belong to the order of mammals called Macroscelidea. This name derives from the Greek and means long legs, while the elephant part of their common name is a reference to these small mammals' long, flexible noses (Figure 1).

Figure 1: Picture showing the common features of elephant-shrews.
These are (a) long, thin legs, (b) large eyes and (c) external ears and a (d) long flexible proboscis-like nose

The Macroscelidea contain 15 living species, which form a single family (Macroscelididae) and two subfamilies (Rhynchocyoninae and Macroscelidinae) (Figure 2) (FONZ, 2007; Kingdon, 1997). One subfamily includes large sized individuals in the genus *Rhynchocyon* which weigh approximately 408g to 600g, body length in the region of 28cm cm plus a tail length of 19 to 26.3 cm. The other sub-family includes small sized elephant-shrews in genera *Petrodromus, Macroscelides and Elephantulus* (Figure 2) ranging in weight approximately 155g to 220g, have body length of about 16.5 to 22cm and an average tail length of 16cm (Kingdon, 1997).

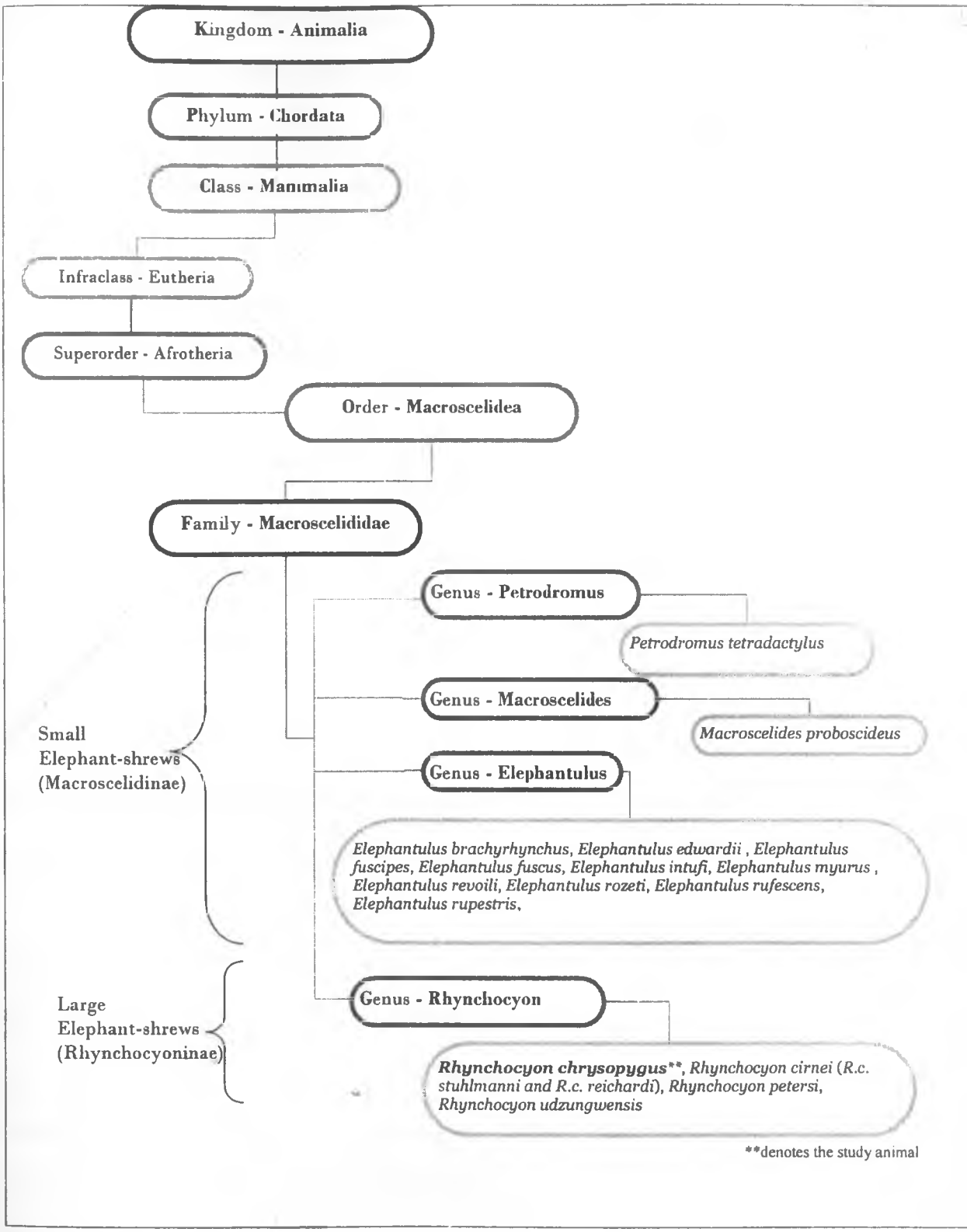

Figure 2: Classification of the elephant-shrews and scientific names of the species in each genus.

Elephant-shrews have a very distinct color scheme between the two sub-families:

- Large elephant-shrew wear richly colored coats (used to describe them in common names) while
- Small elephant-shrew possess drab, gray to brown fur.

The common name "sengi" is used in place of elephant-shrew by many biologists to disassociate the Macroscelidea from the true shrews in the order Soricidae, as they are both insectivorous in nature.

All sengis are born highly precocial in small litters (Rathbun, 1979; Neal, 1995) with long limb bones adapted for cursorial locomotion (Evans, 1942). They are insectivorous and use their long flexible nose to overturn leaf-litter in search of invertebrates including earthworms, millipedes, insects and spiders (Rathbun, 1979; FitzGibbon, 1995). Snakes, raptors, and carnivores are known predators of sengis.

Sengis have well-developed senses of sight, hearing, and smell. At the slightest unusual sound or sight, the sengi will usually freeze and cautiously sniff the air, if a predator is close then it will either walk away slowly slapping its tail loudly on the leaf litter or run away while crunching leaf litter loudly with its rear feet producing a characteristic "crunch crunch" sound as it flees (Rathbun, 1979). This unusual anti-predator behavior may imply that the sengi is aware of a predator or trying to exaggerate its size to scare the predator.

The International Union for Conservation of Nature and Natural Resources (IUCN) red list of threatened animals include three elephant-shrew species; *Elephantulus revoili*, *Rhynchocyon chrysopygus* and *R. petersi* (IUCN, 2006). The red list is a compiled inventory of species with global conservation concern.

In Kenya, only two species of large elephant-shrew have been recorded: black and rufous elephant-shrew (*R. petersi)* in the Southern coast forests and the endemic golden-rumped elephant-shrew (*R. chrysopygus)* in the Northern coast forests (Nicoll and Rathbun, 1990).

The golden-rumped elephant-shrew (GRES) in addition to being an IUCN Endangered species has recently been named an Evolutionarily Distinct and Globally Endangered (EDGE) species by the Zoological Society of London (ZSL). The ZSL has also funded research into GRES distribution and conservation status through their fellowship program.

The GRES has a long flexible snout and is distinguished from other large sengis by being of a dark amber color with black legs and feet, and a distinctive golden rump patch (Figure 3) (Rathbun, 1979). Adults normally weigh about 540 g, with body and tail lengths of an average of about 28.5 cm and 24.5 cm respectively (Kingdon, 1997).

Figure 3: Picture of a golden-rumped elephant-shrew showing the distinct golden color

GRES breeds throughout the year giving birth to a single young with an estimated gestation period of 42 days (Rathbun, 1979), therefore being able to produce 3 -4 offspring per year. They have few and infrequent pair-bond behaviors, little direct paternal investment and parental aggression towards maturing young (Rathbun, 1979). Adults probably live for 3-4 years once established on a territory.

There is no significant sexual dimorphism except for longer canines and thicker rump skin of the male (Rathbun, 1979). A monogamous pair defends a territory of approximately 1.7 ha (Rathbun, 1979) marked by scent produced by perianal, sternal, subcaudal or foot glands.

It is diurnal and sleeps in one of its several nests that it builds on the forest floor. Nests are usually well hidden beneath trees and shrubs. The nests comprise shallow oval depression (Figure 4) which the elephant-shrew excavates using long scraping sweeps of a forefoot (Rathbun, 1979). Dead leaves are then dragged and arranged into a layered lining by rapidly vibrating both front feet on the leaves' surface after which the rest of the nest is made by piling additional leaf litter on top of the nest. A finished nest (Figure 5) is usually 15 cm high and about 50cm in diameter showing importance of leaf litter to the sengi. The nest building is either done all at once or in sessions over 1-2 days (Rathbun, 1979).

Figure 4: Picture showing the first step in nest building by an elephant-shrew.
The clearing is the estimated diameter of the finished nest.

Figure 5: Top side view picture of a complete nest.
The white dotted line shows the slight rise of the nest from the ground.
Where marker pen shows the base and the tape shows the top of the nest.

Each individual uses a number of nests at any given time; Fitzgibbon calculated the number to be 6 nests per GRES (FitzGibbon and Rathbun, 1994). They maintain nests for months (3-4) and research has shown that they go back to unused nests after some time (Fitzgibbon, 1994).

Reasons why GRES needs many nests may include: discouragement to predators that search for prey in nests; time allowance for reduction in ecto-parasite load in nests; size allowance in female size during gestation; maximization of foraging time in new prey-rich sites and maintenance of freshness in nests by avoiding accumulation of decomposing leaves

A relationship between the GRES and birds has been observed by several avid birdwatchers. Where the birds follow foraging elephant-shrews and feed on flushed insects or forage on recent left-overs of the sengi. These include Fischer's Greenbul (*Phyllastrephus fischeri*), Forest Batis (*Batis mixta)*, Blue-mantled Crested Flycatcher (*Trochocercus cyanomelas*) and the Red Capped Robin-Chat (*Cossypha natalensis*) (Rathbun, 1979).

1.2 Literature Review

Information on the golden-rumped elephant-shrew ecology is found in publications from research done extensively at the Arabuko-Sokoke forest namely: social structure and ecology of elephant-shrews (Rathbun, 1979); action plan for elephant-shrew conservation (Nicoll and Rathbun, 1990); surveying *Rhynchocyon* elephant-shrews in tropical forest (FitzGibbon, 1994); distribution and abundance of the golden-rumped elephant-shrew in Kenyan coastal forests (FitzGibbon, 1995) and impact of commercial and subsistence practices on the Arabuko-Sokoke forest in Coastal Kenya, using an endemic mammal as an indicator species(Bauer, 2001).

The golden-rumped elephant-shrew has the most restricted range of all elephant-shrews only being reported from forests of the northern Kenya coast (Corbet, 1971). This species occurs in fragmented and small forest patches inland from Mombasa (on the north side of the Kombeni River near the Rabai Hills) (Corbet and Hanks, 1968; Rathbun, 1979). It is found in forest, dense woodland, and thicket habitats that support dense leaf litter on the ground and also occurs in some coastal scrub and degraded woodland habitats although at low densities (FitzGibbon, 1994).

Characteristics of a forest habitat that make it suitable for the sengi are (Bauer, 2001):

(i) High Litter availability - it provides material for the construction of nests and also determines prey availability (invertebrates)

(ii) High Canopy cover and percentage of shrub cover - it contributes to the amount of leaf litter available while also providing protection from predation from birds of prey.

(iii) Average tree diameter size – smaller sized trees may grow close together and hinder movement of the sengi in the undergrowth while large sized trees may lead to the opening up of the under-story and make detection by predators easy.

It has been shown from previous studies that the factors that lead to a decrease in GRES number is change in:-

- vegetation structure;
- degree of habitat modification and
- intensity of subsistence trapping (FitzGibbon, 1994, Bauer, 2001)

Figure 6 shows the approximated geographical distribution of the golden-rumped elephant-shrew in the north coastal forests of Kenya (Rathbun, 1979). The map also shows where my study sites were located relative to suggested range.

Confirmed sightings and studies have been carried out only in the Malindi area while unconfirmed sightings are further north of the Tana River.

The species is listed as endangered based on having an extent of occurrence less than 5,000 km^2 in severely fragmented habitat and continual decline in both habitat and species (IUCN 2006). The most important habitat for the species has been Arabuko-Sokoke Forest which supports 20,000 individuals (FitzGibbon, 1994).

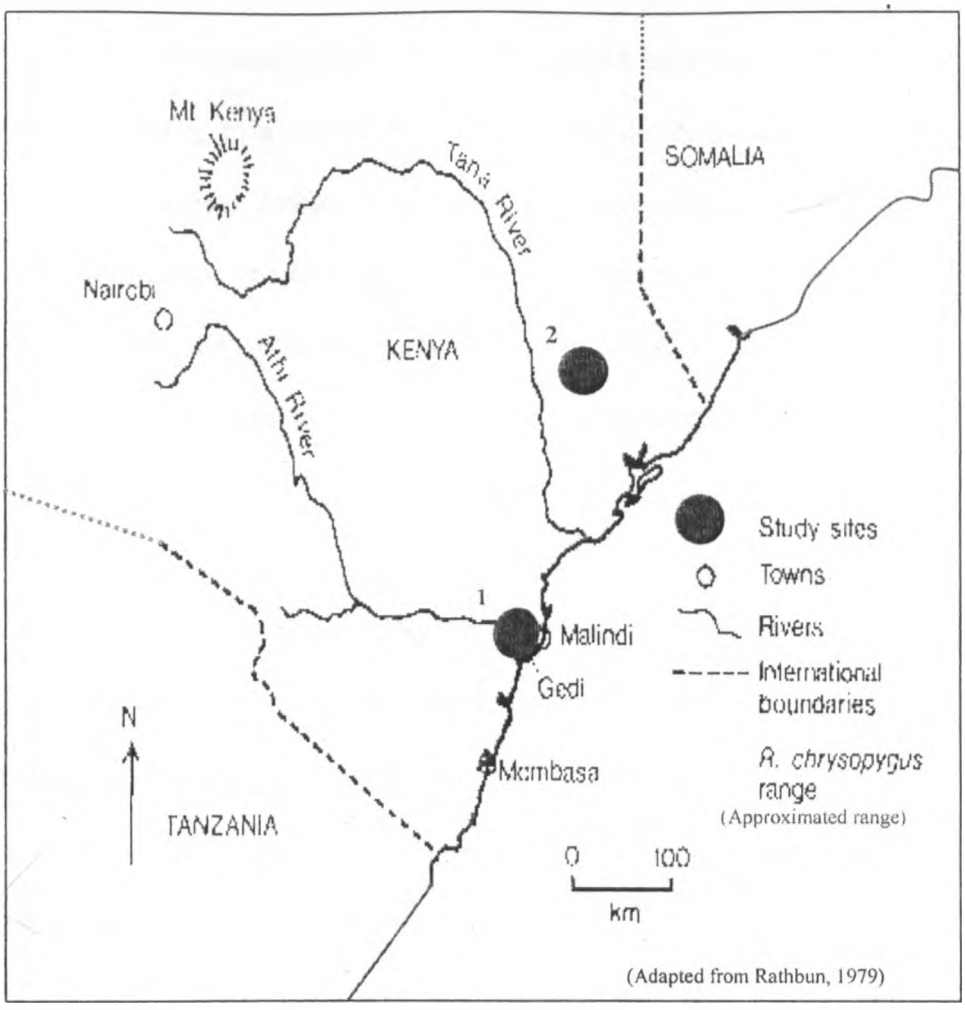

Figure 6: Map showing both approximated range and study sites on GRES in Kenya.
Where:
1- Arabuko-Sokoke and Gede ruins;
2- Boni and Dodori National Reserves

In addition the species was recorded in five out of 13 small sacred forests (Kayas) surveyed between Mombasa and the Arabuko-Sokoke forest to the north in the early 1990s (FitzGibbon, 1994).

Forest resources have been seriously depleted and modified by over-exploitation thus negatively affecting many wildlife species like GRES that depend on forest quality. Extreme poverty in the local communities results in heavy subsistence demands, especially for firewood and building materials, and illegal activities within the forest, such as poaching (of wood and animals). These

activities continually endanger the forest resources that have up to now helped to support local communities, leading to a vicious cycle of degradation all too often seen in tropical forests. Households living near forests regularly collect forest products (Mogaka, 1991), including firewood, construction materials, plants and bushmeat that are used mostly for subsistence purposes (ASFMT, 2002). Recent research done in 2006-2007 showed that bush meat trapping and illegal logging was still occurring in alarming proportions in ASF (Lutz and Newiadomsky, 2007), shown by decrease in wildlife populations.

Even though Arabuko-Sokoke and Gede Forest are some of the only remaining forests in coastal Kenya that can be said to be formally protected, degradation of ASF has been recorded in recent research (Lutz and Newiadomsky, 2007). This is because the sites are surrounded by farmlands without a buffer zone thus permitting the locals to access the forests for cheaper and easily available alternatives for survival.

Other GRES sites like Kayas, which used to be protected by cultural laws and traditions, have declined in quality of biodiversity because of the erosion of values associated with ancestral powers through introduction of formal education. Whereas concerns from the elders in the villages (Kayas) were respected, the present young generation places no value to the traditional laws.

In 1994, the population of the GRES was estimated at about 20,000 individuals at the Arabuko-Sokoke Forest, (FitzGibbon, 1994) showed that the GRES population at Gede Forest was likely to be decimated by stray dogs within the ruins. Seven years later the estimated GRES

population in Arabuko-Sokoke had decreased to about 14.000 individuals mainly through illegal intensive logging activities (Bauer, 2001). From 2000 no research has been done to check on the overall status of the endemic GRES till now.

1.3 Problem Statement

Population densities of *Rhynchocyon chrysopygus* in the Arabuko-Sokoke Forest decreased by c. 30% between 1993 and 2000 (Table 1) (FitzGibbon, 1994; Bauer, 2001), mainly due to habitat loss (Rathbun and Kyalo, 2000). Population trends in other areas are unknown but clearance of woodland and scrub in areas adjacent to the forests is thought be a likely factor in population declines (Rathbun, 1995; Rathbun and Kyalo, 2000; Bauer 2001).

Table 1: Previous studies on the golden-rumped elephant-shrew

YEAR OF SURVEY	RESEARCHER	GRES STATUS	MAIN FACTORS AFFECTING CONSERVATION
1979	Galen Rathbun	Confirmed recording of species in Kenya	
1992 & 1993	Clare FitzGibbon, Galen Rathbun	Estimated 20,000 individuals	Decline in forest cover, fragmented habitat, predation by dogs
2000	Cindy Bauer	Estimated 14,000 individuals	Intensive commercial logging in the forest

The large decline of GRES between 1993 (20,000) and 2000 (14,000) may be due to lack of proper security over forest resources and which was consequently solved by construction of an electric fence around the forest.

R. chrysopygus is given full, meaningful protection only within Gede Historical Monument (Gede Ruins) and Arabuko-Sokoke Forest in Malindi. But these sites are probably not large

enough to ensure the species' survival because the expanding human population requires more agricultural land. This is leading to practices that modify the forest habitat through logging practices and clearing for agricultural and urban development (Rathbun and Kyalo, 2000). Such activities focus more toward financial profit instead of conservation, making habitat destruction a major threat to this species.

Even though Arabuko-Sokoke Forest is jointly managed by more than 6 stakeholders, GRES population has been decreasing (Bauer, 2001) therefore there is need to determine present population of GRES and any threat processes impacting GRES to be able to formulate a proper conservation strategy that can be used in other elephant-shrew habitats.

Secondly, it was believed that the population of the GRES in the Gede Ruins had almost been finished by a pack of feral dogs that used to roam at night (FitzGibbon, 1994); but no population study had been done to prove effectiveness of the fence built in 1992/3.

Finally, there was ample reason to believe that the golden-rumped sengi occurs in the Boni Forest north of the Tana. This was based on a single sighting and interviews with residents of Milimani village in 1971 (Rathbun and Kyalo 2000). By assuming low human density in the area results in minimal impact on the forest biodiversity then sengi population (if present) should be high.

This study attempted to assess the present status and population size (presence, distribution and abundance) of the golden-rumped elephant-shrew in representative forests in the north coast of

Kenya. The information was needed to develop better conservation and management strategies for the GRES and its habitat.

1.4 Objectives

The main goal of the study was to find out the current status of the golden-rumped elephant-shrew in Kenya through the achievement of three minor objectives namely:

(i) To investigate the presence and if present, abundance of golden-rumped sengi in Boni and Dodori National Reserves

(ii) To establish present abundance of golden-rumped sengis in already surveyed forests of Arabuko-Sokoke forest and Gede ruins and compare population changes over time

(iii) To determine the social attitudes affecting conservation of the golden-rumped sengi and its habitat

1.5 Hypotheses

a) The golden-rumped sengi is found in the Boni and Dodori National Reserves

b) Population of sengi has not changed over time in Arabuko-Sokoke forest and Gede ruins.

CHAPTER TWO

STUDY AREA AND SAMPLING SITES

2.1 STUDY AREAS

Coastal forest was formally extensive along the Eastern African coast but has been destroyed in the heavily populated regions to provide wood for fuel, building, production of artifacts and furniture, and to make way for farmland and tourist developments. Remaining coastal forests exist as a series of small patches, isolated from each other mainly by agricultural land or degraded scrub habitat, but in some areas by savannah woodland (Hamilton, 1981).

The eastern Africa coastal forest extends from a lowland altitude of 500m near coast up to 1000m further inland. It is greatly influenced by the Indian Ocean climatic system having rainfall between 800 and 2000mm per year and temperatures of 25 to 35^0 C throughout the year. The effects of drainage, topography, altitude, geology, soil moisture content and distance inland all combine to determine sites able to support a coastal forest.

Although the Kenyan coast was once covered with largely continuous dry deciduous forest, it is currently greatly reduced and fragmented, the largest of which is Arabuko-Sokoke (Collar and Stuart, 1988) followed by the Boni and Dodori forests (Figure 7). The Witu forest is the smallest in size and is found near the Tana River. These forests are biodiversity hotspots (Myers et al, 2000) with both high species richness and endemism of flora and fauna.

The loss of tropical coastal forests in Kenya has been dramatic, and over the past couple of decades the country has experienced intense reduction of forest cover. Today, less than 2% of the total land in Kenya is covered by forests, an area that is below the internationally recommended minimum forest cover of 10 per cent.

Biological research in the coastal forests of Kenya has been concentrated in forests close to the coast such as Arabuko-Sokoke, Shimba Hills and the Kaya forests. For a long time the existing instability in neighboring Somalia has hindered research work in the Boni and Dodori areas.

Figure 7: Map showing location of study sites along the Kenyan Coast.

2.1.1 Arabuko-Sokoke Forest

The Arabuko-Sokoke Forest (ASF) covers approximately 420 km^2 in Kilifi and Malindi Districts of Coast Province, Kenya. It is a forest that is bordered by many small towns or villages (Figure 8) mainly inhabited by people from the Mijikenda groups.

It is one of the last remnant of indigenous forests in Kenya, the largest and most intact coastal forest in East Africa, and by far the largest remnant of the forests that once dominated East African coastal fringe.

The eastern part of the forest lies on a flat coastal plain at an altitude of c. 45 m above sea level. The land rises to a plateau of about 60–200 m in the central and western parts of the forest. The forest was originally declared as Crown Forest in 1932 and gazetted as a forest reserve in 1943. An additional section at Kararacha in the south east was added in 1968. Within the forest area about 43 km^2 was designated as a strict Nature Reserve in 1977. This was extended by 17 km^2 in 1979.

Management of the forest has been undertaken since 1993 by a team made up of:-

a) Four Kenyan government partners: the Kenya Forest Service (KFS), Kenya Wildlife Service (KWS), Kenya Forestry Research Institute (KEFRI) and National Museums of Kenya (NMK)
b) Local community represented by Forest Adjacent Dwellers Association (ASFADA),
c) Other organizations like Nature Kenya, Birdlife International and AROCHA Kenya as non-governmental organizations.

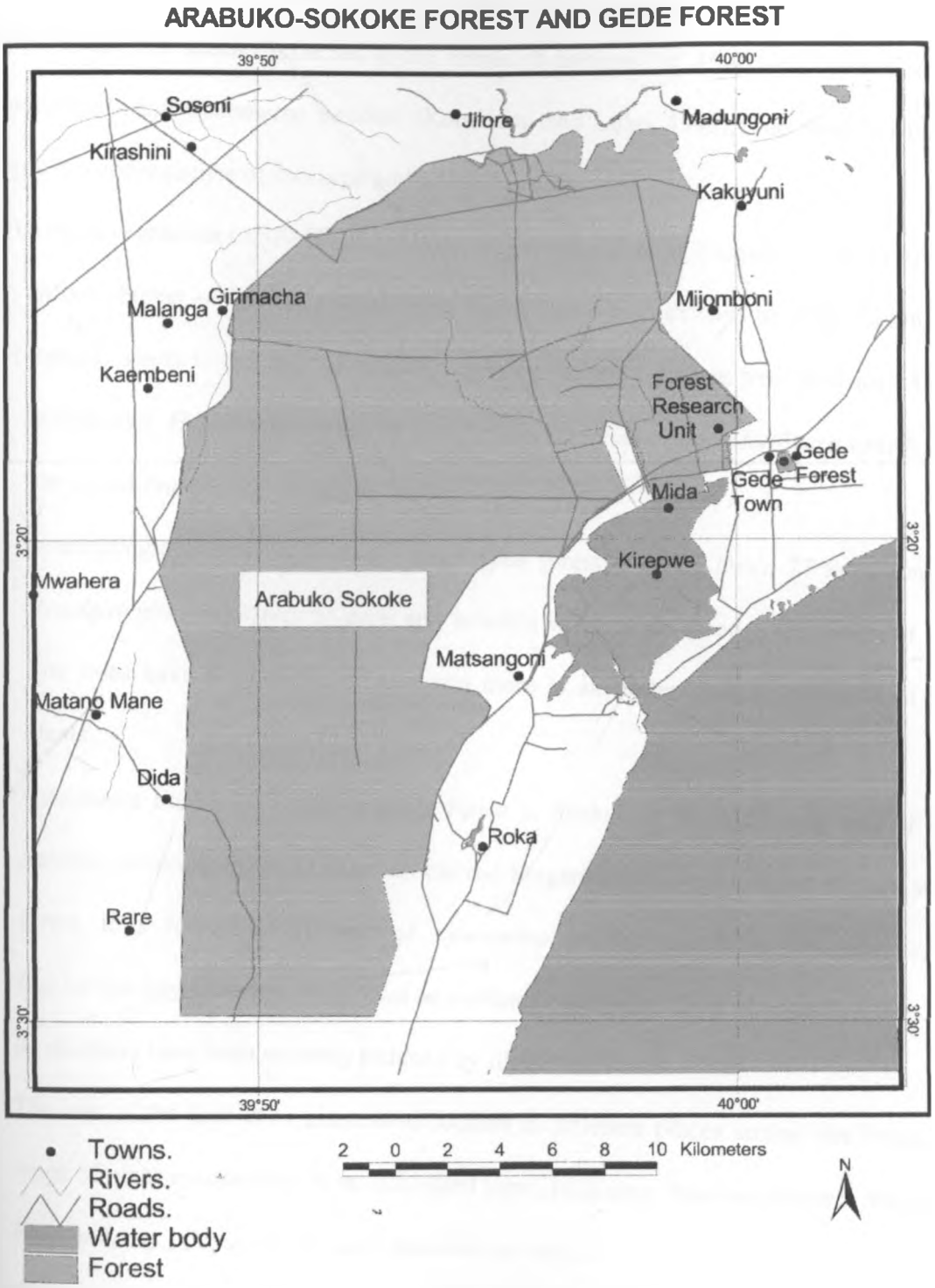

Figure 8: Map showing the general layout of the Arabuko-Sokoke and Gede environs.

The forest is broadly divided into four vegetation types, three of which are each dominated by indigenous tree species reflected in the names of portions i.e. *Afzelia quanzensis, Brachystegia spiciformis* and *Cynometra webberi* (Robertson and Luke, 1993). The variation in vegetation type is a consequence of soil type and rainfall patterns.

The main vegetation (ASFMT, 2002) types in Arabuko-Sokoke Forest are (Figure 9):-

a. Mixed Forest — This is a semi-dense forest type which extends to about 70 km^2 on wetter coastal sands in the east of Arabuko-Sokoke. It has a diverse tree flora including *Afzelia quanzensis*, *Hymenaea verrucosa, Combretum schumannii* and *Manilkara sansibarensis* and the cycad *Encephalartos hildebrandtii.*

b. *Brachystegia* Forest — This is a more open forest covering about 77 km^2, dominated by *Brachystegia spiciformis* on drier and infertile white sands through the centre of the forest. The trees have spreading canopies and there is an under-layer of grasses and flowering plants.

c. *Cynometra* Forest — This is a dense forest or thicket on the north-west side of Arabuko-Sokoke, covering about 235 km^2 on the red Magarini sands towards the western side of the forest. It is dominated by trees of *Cynometra webberi* and *Manilkara sulcata*, and the *Euphorbia candelabrum*. *Brachylaena huillensis* also used to be abundant in this zone, but its numbers have been severely reduced by illegal extraction.

d. The rest of the area is in plantations located in different places around the forest edge. A range of plant species have been cultivated there, including *Gmelina arborea*, *Araucaria* sp., *Eucalyptus* sp., *Casuarina* sp. and *Azadirachta indica.*

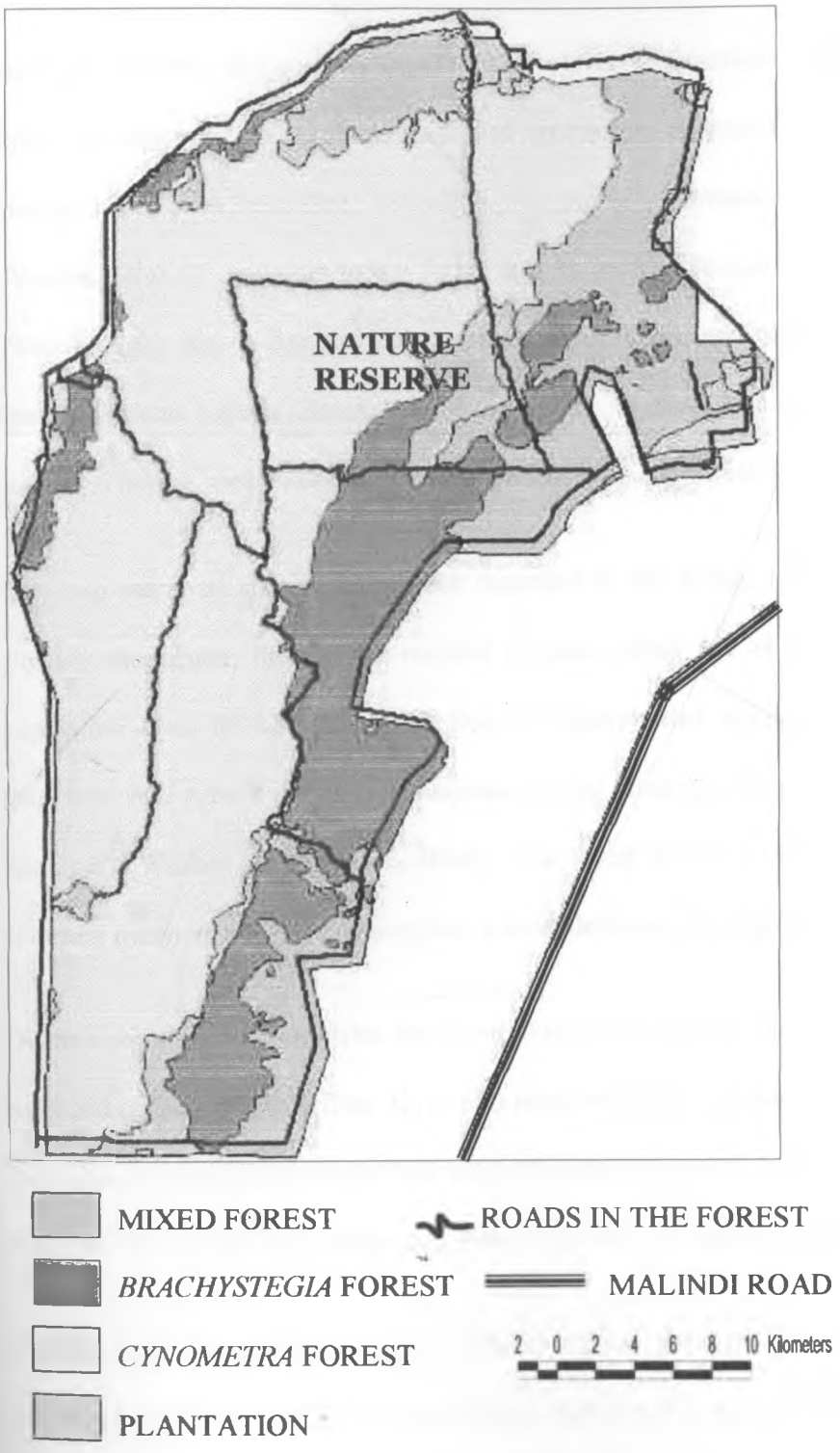

Figure 9: Map showing the Vegetation types and Distribution in Arabuko-Sokoke forest

The forest has rich biodiversity, including a concentration of endemic and endangered flora and fauna (20% of Kenya's bird species and about 30% of its butterflies have been recorded in this small part (0.07%) of Kenya (ASFMT, 2002)). It has been ranked as the second most important forest for conservation of threatened bird species in mainland Africa. More than 230 bird species have been recorded, including six globally threatened species: Clarke's Weaver (*Ploceus golandi)* (endemic to the forest and its immediate surroundings), Sokoke Scops Owl (*Otus ireneae*), Amani Sunbird (*Anthreptes pallidigaster*) and Sokoke Pipit (*Anthus sokokensis)*, Spotted Ground Thrush (*Zoothera guttata*) (a rare migrant) and East Coast Akalat (*Sheppardia gunningi*) (a rare species confined to East African coastal forests).

Fifty-two mammal species have been recorded in the forest, including three taxa which are globally threatened: the Golden-rumped elephant-shrew (of which 90% of the known global population lives in the forest); the Sokoke Bushy-tailed mongoose (*Bdeogale crassicaunda omnivore)* and Ader's duiker (*Cephalphus adersi)* (also spotted at Dodori National Reserve and Zanzibar) (Wacher and Andanje, 2004). The forest is also a refuge for some of Kenya's less common mammal species and supports a herd elephants (*Loxodonta africana*).

Diverse populations of reptiles and invertebrates are present; the latter include more than 250 recorded species of butterflies. Over 600 recorded plant species, including 50 that are globally or nationally rare. These high proportions of endemic species, some known only from Arabuko-Sokoke Forest, make the forest a key part of the East African Coastal Forests Endemic Area.

Certain birds e.g. Tiny Greenbul (*Phyllastrephus debilis)*, East Coast Akalat (*Sheppardia gunningi)*, and Forest Batis (*Batis mixta)* are only found in the Mixed Forest (Bliss, 1999).

Within the areas of *Brachystegia* woodland there are a number of seasonal pools that are a focal point for tourists because of the great number of water birds as well as blue, purple, pink and white water lilies (Bliss, 1999).

The *Cynometra* portion is home to the Sokoke Scops Owl (*Otus ireneae).* Mammals include Elephant (*Loxodonta africana*), Caracal (*Felis caracal),* Civet (*Civettictis civetta),* Genet (*Genetta tigrina),* suni (*Neotragus moschatus*), dik dik (*Madoqua kirkii)* and bush duiker (*Sylvicapra grimmia).* It also has an excellent viewing point formed by a natural cliff (Nyari), which gives unrivalled vistas out over the forest (Bliss, 1999).

2.1.2 Gede National Monument Forest

This site is three kilometers from Arabuko-Sokoke forest and is approximately 44ha in size though the forest accounts of only 35 ha, with a general geographic position of $03^{0}18'S$, $40^{0}01'E$ in Malindi District, Coast Province,.

It was gazetted in 1972 as a National Monument of on old Arab-African town that was abandoned in the 17th century and is managed by the National Museums of Kenya as an Archaeological site.

The name Gede is a Galla word meaning precious. The ruined walls and buildings overgrown with trees make the place a major tourist attraction. Over the ruins on the shallow coral rocks/soil has grown a distinct lowland semi-deciduous forest that is multistratal.

The forest is entirely fenced to reduce disturbance and poaching and is traversed by paths that wind between the excavated buildings. The forest is presently surrounded by farmland unlike in the early 1980's when there used to be corridors to other forest patches in the Malindi-Watamu area in. There is a 5 ha section that was once degraded land but was restored and is slowly regenerating as forest after a restoration project.

The vegetation in Gede forest is similar to the mixed forest portion at Arabuko-Sokoke forest. Although Gede vegetation is well conserved because it is completely fenced thus preventing any disturbance in the habitat unlike in the mixed forest. It has various species of trees with heights from 15m to 25m dominated by *Combretum schumannii, , Adansonia digitata, Ficus bussei and Tamarindus indica.* The dominant trees and bushes in the understory are *Lecaniodiscus fraxinifolius, Fagara chalybea, Grewia* spp. and *Monanthotaxis fornicate (*Faden and Faden, 1972). In areas where the sunlight penetrates the canopy, *Kyllinga cartilaginea,* a sedge and *Panicum deustrum,* a grass are common. At least 50 indigenous tree species occur

including *Gyrocarpus Americana, Sterculia appendiculata and Phaulopsis gediensis* has been described from the forest (Robertson and Luke, 1993). The forest floor is covered by year round, continuous carpet of dead leaf litter.

There is a community based organization (CBO) initiative based at Gede known as "Kipepeo" which was funded by United States Agency International Development (USAID) to help economically improve lives of people living adjacent to Arabuko-Sokoke forest. It promotes various income generating projects like butterfly farming and bee keeping among the people and even has a few beehives in a small part of the forest.

It is an Important Bird Area (IBA) an important site for the globally threatened Spotted Ground Thrush and as many as 110 bird species may be present between March and October each year (Bennun 1985), 42 forest dependent species have been recorded including the restricted range Fischer's Turaco *(Tauraco fischeri)* which is a resident.

The mammals commonly spotted in the forest include: suni (*Neotragus moschatus*), sykes monkeys (*Cercopithecus albogularis*), red bellied squirrel (*Funisciurus palliatus*), and the golden-rumped elephant-shrew (*Rhychocyon chrysopygus*).

The forest has diverse species of reptiles and amphibians like the monitor lizards (*Varanus sp*), frogs (Anura), Leopard tortoises (*Geochelone pardalis*) and snakes like the green mamba (*Dendroaspis sp*), black mamba (*Dendroaspis polylepis*), puff adder (*Bitis arietans*) and pythons (Pythonidae).

2.1.3 Boni and Dodori National Reserves

These two national reserves are located on the south-eastern part of Kenya near the Indian Ocean (Figure 10). The area is sparsely populated and has been high security risk zone due to its proximity to the Somalia border.

General climate of the area is hot and humid to sub-humid throughout the year. Rainfall is bimodal with peaks in April-June and in November -December. The average annual rainfall varies between 700 – 1,000 mm per annum in the northern parts (Boni) to considerably less in the southern, more arid areas adjoining Tana River District, and along the coastal strip (Dodori), which tends to be in a slight rainshadow.

Temperatures are generally high, ranging from 20°C to 29°C with December and April being the hottest months. The area has a mean relative humidity of 75% (DRSRS, 1990).

Both of these areas have eight vegetation types, which are characteristic of semi-arid zone vegetation. These include: wooded grassland; grassy bushland; woodland; bushed woodland; bushland; wooded riverine and seasonal and permanent swamps (DRSRS, 1990). Dodori reserve has a rich mangrove forest since some parts come into contact with the Indian Ocean especially on the Dodori Creek which pours water into the ocean.

Boni forest is an area of 1339 Km^2 which is gazetted and managed by the Kenya Wildlife Service (KWS) as a National Reserve. The whole area covers a quarter of Ijara District, stretching all the way to the Eastern part of Lamu District and the Western section of Badaade district of Somalia (Gwynne and Smith, 1974, Kuchar and Mwendwa, 1982; DRSRS, 1990).

It is a coastal forest with tree species rarely found in other forests (DRSRS 1990) with 5 threatened plant species (*Dalbergia vacciniifolia, Canthium kilifiense, Canthium pseudoverticillatum, Mkilua fragrans, Synsepalum subverticillatum).*

Several wildlife species are there including the Vervet monkey (*Cercopithecus aethiops)* Sykes monkey (*C. mitis)*, Yellow baboon (*Papio cynocephalus)*, giraffes (*Giraffa camelopardalis)*, buffaloes (*Syncerus caffer),* Oribi (*Ourebia ourebi*) and the endangered Hirola (*Beatragus hunteri)* with a rich record of bird species.

Research had proposed that it may have two threatened animal species (African elephant *Loxodonta Africana* and the Golden-rumped elephant-shrew *Rhynchocyon chrysopygus)* (Wacher and Andanje, 2004).

Dodori ecosystem is a reserve of 877 km^2 in Kiunga Division gazetted in June 1976. It is separated from Boni reserve by a road that goes from Hindi town till Kiunga town (Figure 10). The Dodori river, coastal forest, grassland, dune and lake system form an area of rich biodiversity and catchment protection for river and coastal ecosystems, particularly the coastal mangrove forests which are fundamental to the sustainability of the fish and mangrove pole resources in the area (Gwynne and Smith 1974, Kuchar and Mwendwa, 1982; DRSRS, 1990).

Dodori forest has 2 threatened animal species namely the African elephant and the Aders' duiker (*Cephalophus adersi*) (Wacher and Andanje, 2004). The discovery of Aders' duiker in dense thickets in the north-eastern part of the reserve added further importance to biodiversity conservation of the area. It is a rare antelope with limited known range. According to IUCN it is threatened by habitat clearance and hunting and the population trend is downward. It is classified as Endangered in the IUCN red list system (IUCN, 2006).

The intervening area forms a continuum in the ecosystem of the two game reserves, with a length of about 74 km. Notable physical features are the Mundane range (comprising of fossil sand dunes) rising to 330 m above sea level in the north, and the Dodori River which floods in the rainy season and discharges its load into the Dodori Creek (DRSRS, 1990).

Majority of the people inhabiting the area between the two reserves are called Awer or Boni. The Boni word is a derogatory term used by the Somali neighbors to mean people of a lower caste system thus not usually used. They live in villages i.e. Baragoni, Milimani, Basuba, Mangai, Mararani and Sankuli found along the road. Each village population is dynamic and could have between 50- 200 people as the Awer move regularly from village to village.
They are forest dwellers subsisting on hunting local wildlife and gathering native crops like "Nchili" and "Mkarabaka" which are palm-like trees found in the forest. Their total population was estimated at about 2000 people in the 1999 census (FARM-AFRICA, 2004). They practice farming but to a small scale because the crops are usually destroyed by wild animals like baboons, elephants and buffaloes.

These two areas are poorly known since they are far off the main roads and hence very little research has been carried out due to transport and security problems.

CHAPTER THREE

MATERIALS AND METHODS

This study on elephant-shrews of north coastal forests of Kenya was carried out from September 2007 to April 2008.

3.1 Presence of elephant-shrews in Boni-Dodori National Reserves

A questionnaire was administered to 6 representatives from each of the 4 main villages along the main road near the reserves namely Milimani, Basuba, Mangai and Mararani. The low number was because most adults go to farms and forest during the day and also very few people speak and understand Swahili thus the chief was translating to the Awer language for easy communication. This was done for each person separately in their homes.

Several clear color photographs of small mammals including R. *chrysopygus* and some foreign species that do NOT occur in the area, including distinctive mongooses, duikers and cats were used together with the questionnaire. Compiled color pictures of elephant-shrews of Africa were also presented to the residents so as to determine whether or not a different species was present in the area. The pictures were used to confirm accurately the presence (if any) of elephant-shrews and more specifically the golden-rumped elephant-shrew.

The questionnaire sought to find out: presence of elephant-shrew; local name of elephant-shrew; what it feeds on; any knowledge on its biology (reproductive and behavior); if there is any taboo associated with it and also if it is hunted for food or is a pest.

Further confirmation was done using transects to check the presence of nests in the forest patches near the villages and among woody grasslands. Nests were searched within transects of

6 meters width located in areas with high litter cover and large canopy cover. These were two main habitat characteristics associated with supporting elephant-shrews in coastal forests.

The final method for confirmation was the live capture of a specimen for identification purposes from the area. This was to be done using fishing nets and snares set near identified nests.

In Arabuko-Sokoke and Gede Forests

The same questionnaire was administered to residents living adjacent to Arabuko-Sokoke and Gede forests. However, there was emphasis on GRES presence since it was confirmed to exist in the area.

All sites for conducting the interviews in the three study sites were selected according on the basis of:

- Proximity of the road-side villages to the forest given that GRES being a forest dwelling mammal is only seen near forested areas.
- Distance from the forest to the homesteads, especially in Boni area where villages are >20km apart and study sites were in a rural setting far from towns.

3.2 Relative abundance of golden-rumped elephant-shrew

Abundance was calculated using distance sampling method which allows the estimation of density of biological populations.

In Arabuko-Sokoke forest, transects were placed in three study sites namely *Cynometra, Brachystegia* and Mixed forests. While transects were located randomly in the fourth study site within the enclosed small Gede forest.

Transect length was affected by nature of vegetation i.e. *Cynometra* is mostly made up of thickets which resulted in shorter transects while *Brachystegia* is open spaced which resulted in

longer transect lengths. However, the data collected was standardized by a correction factor applied to nest results from all three sites.

An observer walked along the transect line recording the:-

- Occurrence of golden-rumped elephant-shrew nests (N) within 3 m on both sides.
- Perpendicular distance (Y) from transect to the centre of each nest sighted
- Distance of the nest along transect (X) recorded to the nearest 0.5m (Figure 10).

Each transect was checked twice, from start point to end point, to ensure that virtually all noticeable nests are found.

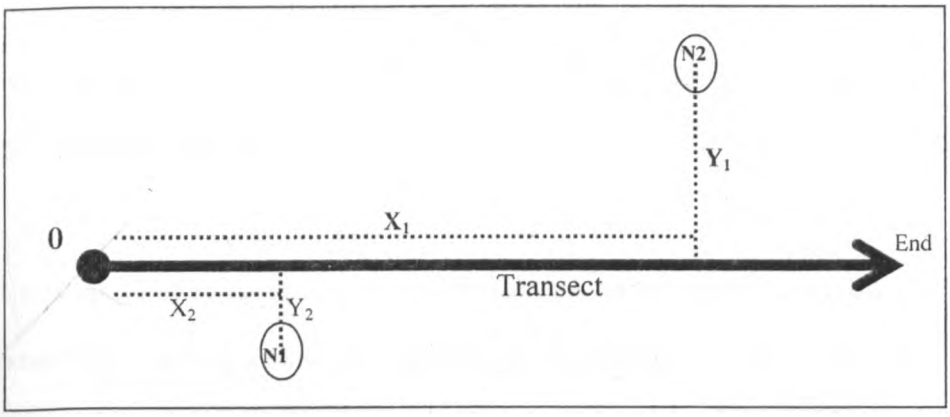

Figure 10: Illustration of the line transects.

Opportunistic random nest surveys were also used to estimate GRES seen or heard to confirm GRES presence in each forest study site.

3.3 Community attitudes and conservation status of species

This process was integrated with survey of elephant-shrews in villages that border study site forests.

In Boni/Dodori areas, this was done as a discussion session in the villages after administration of questionnaires. Since the GRES was not a confirmed species in the area, the discussion focused on elephant-shrews in general, species diversity and habitat conservation issues. For the

people to speak without fear, the chief and headman were the main translators (Swahili to Boni language) in the sessions.

In Arabuko-Sokoke and Gede areas, the interviewer sought to know from homesteads if the residents were familiar with the status of GRES, whether it was hunted and how their activities in the forest could affect conservation efforts. This was done with help of a guide who translated Swahili into Giriama language for ease of communication.

Other issues covered included: the involvement of the government through the wildlife and forestry ministries in dissemination of conservation information; role of culture and tradition in species and habitat conservation.

A total of 49 persons were interviewed from the three forest sites (Table 5).

Table 2: Data showing number and type of people interviewed in the three study sites

FACTOR		ASF	GEDE	BODO
GENDER	MALE	13	8	21
	FEMALE	5	4	3
AGE	YOUNG (15-25 years)	4	6	1
	ADULT (26-48 years)	5	0	14
	OLD (49-85 years)	9	6	9

The respondents were classified in the different groups to find if there was a different attitude concerning the sengi or conservation among sex and/or age.

3.4 Data Analysis

I. Determination of presence of elephant-shrews in Boni and Dodori habitats

The answers obtained from the questionnaire session were scrutinized to find out areas where elephant-shrews were stated to occur. These were also analyzed against results from nest surveys and areas were selected where probability of finding elephant-shrews were high. Fishing nets were set up in selected sites during the day as transect work was carried out.

The captured specimen is undergoing further analysis to establish whether it is a new *Rhynchocyon* species and to find any differences from the two already recorded elephant-shrews in Kenya. The analysis includes DNA tests, Skull comparisons and morphological measurements done by the National Museums of Kenya with help from Natural History Museum (UK) and Chicago Field Museum (USA).

II. Determination of the relative abundance of golden-rumped sengi

The critical data collected is the distance from a randomly placed line to objects of interest. Nest abundance has been found to correlate linearly with elephant-shrew density (FitzGibbon and Rathbun 1994). The nests have also been found to be randomly distributed through out sites (Bauer, 2001), therefore even though a large proportion of the nests may go undetected, as detectability usually decreases with increasing distance from the random line, the method allows accurate estimates of density.

Many ecologists have used the abundance of nests as a powerful yet practical way for estimating density of populations. Various researchers have used GRES nests to provide indirect estimates of GRES abundance since nests are relatively easy to detect (FitzGibbon and Rathbun 1994).

The number of nests obtained from transects were converted into GRES density numbers using DISTANCE 5.0 program to produce relative densities of sengi in the study forests. Distance is a Windows-based computer package that allows users to analyze distance sampling surveys of wildlife populations.

The technique uses the formula

$$D = \frac{N}{A} = \frac{E(n) \cdot f(0)}{2L}$$

Where D is density, N is number of objects in the specified habitat; A is the habitat area, E(n) are the distances from transect line of detected objects, f (0) is the probability density function of distances from the line evaluated at zero distance and L is total line length.

The underlying theory is the concept of detection function g (y), which is the probability of detecting an object given that it is at distance y from random mid-line.

The calculated densities for each study site were then divided by correction factor (0.49), to account for the multiple nest use by the sengi (Fitzgibbon and Rathbun, 1994). This was done to obtain the nest abundance indices (nests per 100m).

The values of nests per 100m from the two main sites (ASF and Gede) were analyzed using ANOVA to find out if the mean nest indices differed significantly.

This was also done in Arabuko-Sokoke to find out if there was any significant difference among the three vegetation types (*Brachystegia, Cynometra* and mixed forest).

The densities were then converted into population estimates by multiplying with forest areas used in previous studies for standardization of results.

III. Determination of community attitudes towards the species

The questionnaire was pre-coded to facilitate data analysis and to reduce time needed in data entry. The averaging and comparison tests were performed using *Statistical Package for Social Scientists (SPSS) program for windows*.

The information from the discussion sessions was summarized and the main points used to compare attitudes between the Awer and Giriama people. It was also used to prepare the recommendations and conclusions. As it was crucial in identifying factors that influence successful conservation of the golden-rumped sengi and its habitat.

CHAPTER FOUR

RESULTS

4.1 Presence of elephant-shrews in Boni-Dodori National Reserves

Eighteen interviewed persons along the road between the Boni National Reserve and the North part of Dodori Reserve (Milimani, Basuba, Mararani and Mangai villages) stated that they had never seen the golden-rumped elephant shrew but there was a similar but different colored creature in the forest.

While people from Dodori area near the Indian Ocean did not know the type of animal in question as they did not know of any rat-like animal with a long nose. This was confirmed when we did transects and did not come across nests of an elephant-shrew.

The villages where the elephant-shrew species was thought to be high after analysis of the answers from questionnaires were Milimani, Basuba and Mangai.

Traps made of fishing nets were set up for 6 consecutive days in Boni and Dodori forests but with no success. The nets were set in the morning and removed in the evening to avoid trapping other small mammals in the forest. A leg snare set near the village at Mangai on the Dodori forest side was able to capture one species of elephant-shrew. The captured animal confirmed that a different species/subspecies and not the golden-rumped elephant-shrew inhabited the area. Preliminary results showed that the specimen is in the Genus *Rhynchocyon* with a high possibility of being a new species unique to the Boni-Dodori area.

Twenty six transects were established in the forest patches measuring a total of 3,520 m and all yielded 48 shrew nests. After analysis, the estimated population of Boni-Dodori elephant-shrew species was about 520 individuals scattered within the forest patches.

4.2 Relative abundance of golden-rumped elephant-shrew in confirmed forests

A total of 66 transects measuring 7,663 m were surveyed from the two forests (Table 3).

Table 3: Summary of results obtained from transects in Arabuko-Sokoke and Gede forests.

FACTOR		GEDE	MF	BRY	CYN
Nest Distance from Transects	0 -1 M	15	18	15	7
	1.5 - 2 M	8	21	7	4
	2.5 - 3 M	36	22	7	14
TOTAL NESTS NO.		59	61	29	25
NUMBER OF TRANSECTS		21	15	15	15
TOTAL TRANSECT LENGTH (m)		2164	2184	1332	875

Arabuko-Sokoke forest still had the highest number of GRES estimated to be 12,750 while Gede forest had more than 20 individuals. The overall mean nest abundance (nests per 100m) for ASF was 0.67 while that for Gede was 0.82 (Table 4).

Table 4: Analysis results of nests per 100m at Arabuko Sokoke and Gede forest,

FOREST	MEAN NUMBER OF NESTS ± SE	FOREST AREA km^2
Arabuko-Sokoke	0.67 ± 0.08	38,200
Gede	0.82 ± 0.14	0.44

Gede and ASF have almost the same characteristics having high tree species diversity, deep litter and large canopy cover associated with high GRES population (Bauer, 2001). Also, Gede had the smallest area but with the highest nest index unlike *Cynometra* which had the largest area. *Brachystegia* had the lowest nest index of 0.45 (Figure 11).

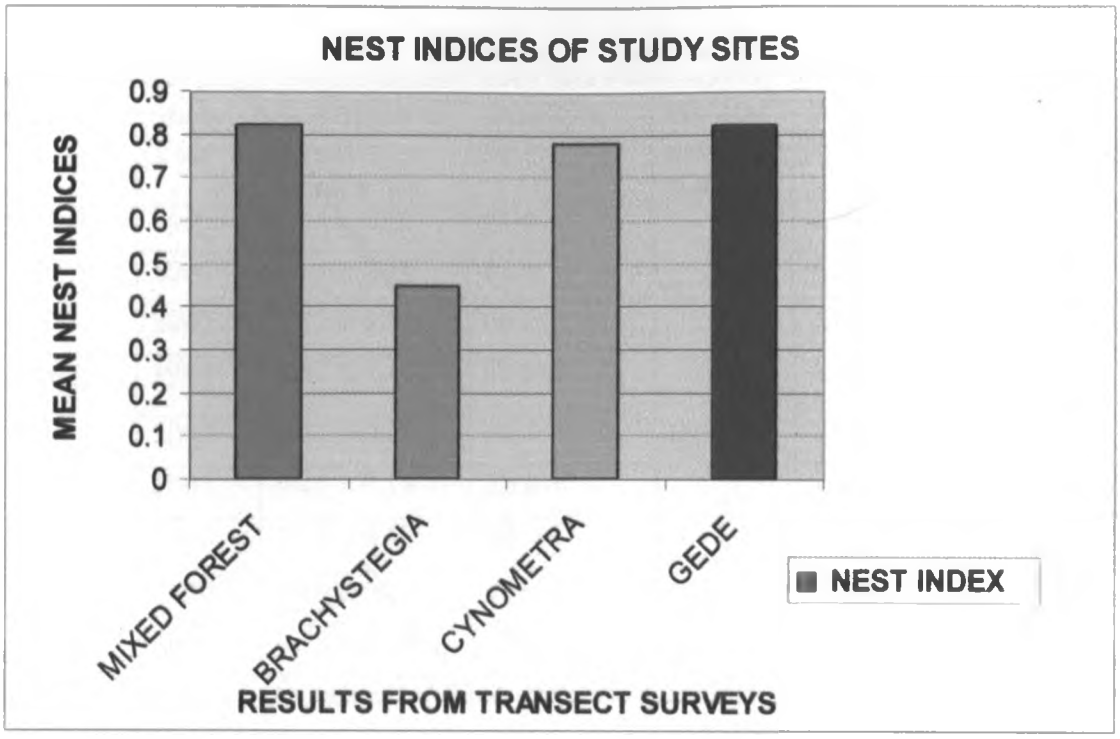

Figure 11: Graph showing nest indices in forest habitats.

In Arabuko-Sokoke forest, there was a significant difference ($F_{2, 42} = 6.095$, $p<0.05$*) in GRES mean nest abundance among the three vegetation types.

Table 5 and figure 12 below show the approximated change in GRES population over time at Arabuko-Sokoke forest. FitzGibbon carried out a baseline survey of GRES density in 1993, which was then followed by Bauer in 2000 while analyzing effects of logging on GRES densities (FitzGibbon, 1994; Bauer, 2001).

Table 5: Comparison of golden-rumped elephant-shrew data within Arabuko-Sokoke forest[1]

Forest Type	Study Year	Nest/100m of transect Mean ± SE	Density ± SE	Habitat area Km^2	Population size ± SE	% Change
Mixed Forest	1993	1.54 ± 0.22	75 ± 11	52	3,900 ± 572	
	2000	1.68 ± 0.30	82 ± 15		4,264 ± 780	9.33
	2007	0.82 ± 0.16	40 ± 3		2,080 ± 156	-51.21
Brachystegia forest	1993	0.47 ± 0.10	23 ± 5	67	1,541 ± 335	
	2000	0.57 ± 0.27	28 ± 13		1,876 ± 871	21.74
	2007	0.45 ± 0.14	22 ± 3		1,474 ± 201	-21.42
Cynometra forest	1993	1.39 ± 0.17	68 ± 8	242	16,456 ± 1936	
	2000	0.69 ± 0.24	34 ± 12		8,228 ± 2904	-50.0
	2007	0.78 ± 0.18	38 ± 4		9,196 ± 968	11.76

The population estimates at *Cynometra* forest showed that it had the highest number of 9,196 individuals; mixed forest had a higher number (2,080 individuals) than *Brachystegia* forest with 1,464 individuals.

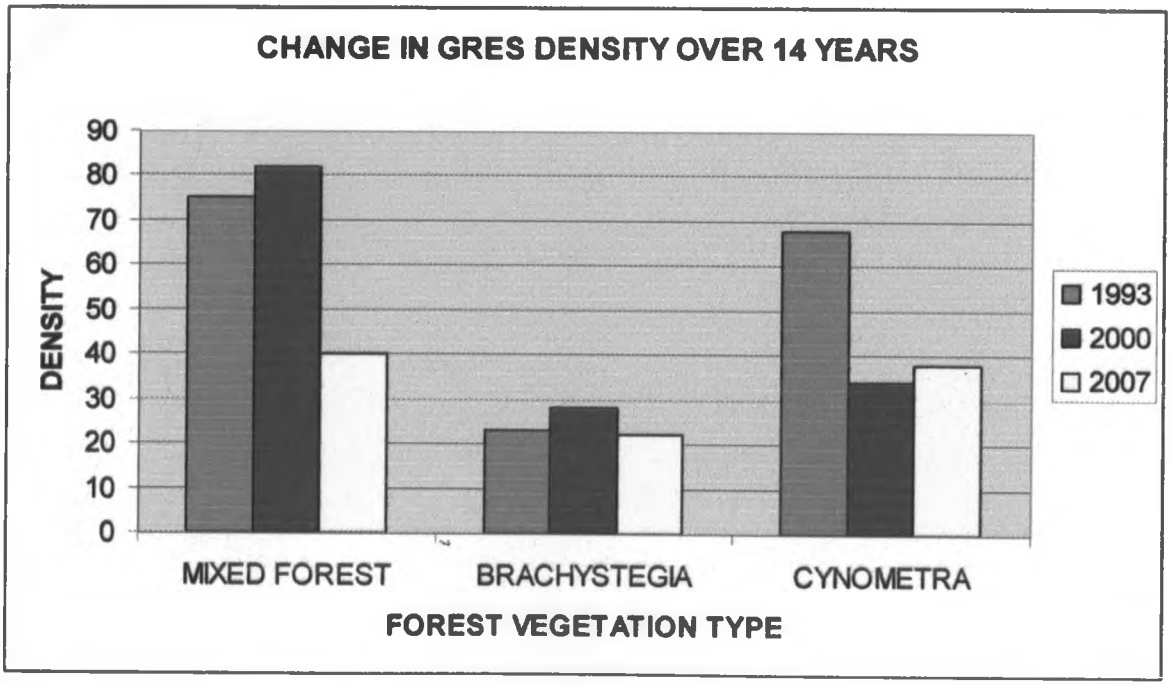

Figure 12: Graph showing GRES density changes over 14 years

[1] 1993 and 2000 data adapted from FitzGibbon (1994) and Bauer (2001).

From the graph above, GRES densities in the *Cynometra* portion had declined dramatically (50%) in the survey done by Bauer (2001) mainly due to illegal timber extraction, while results from my study the GRES had increased by 11 per cent in the portion.

The GRES density in the *Brachystegia* had decreased by 21 per cent which was the same margin it had increased in the 2000 study.

An alarming decrease of 51 per cent of GRES density was found in the mixed forest and which previously had increased by an estimated nine per cent in 2000.

4.3 Community attitudes and conservation status of species

The information used in the study was obtained from the questionnaire that was administered in the homesteads adjacent the forest. From the results it seemed that difference in sengi attitude was only present between the Giriama and the Awer/Boni people i.e. geographical. While within each the community they share an almost similar mind-set.

The Malindi (Giriama) people commonly refer to the large elephant-shrew as 'Fugu' a word from fusion of both Swahili and Giriama languages, while the Boni people refer to it as 'Ilalu' in their Awer language.

Results obtained from the questionnaire according to issues addressed:

a) **Frequency of forest visits in search of firewood, herbs and for bush-meat** (Figure13)

Most of the people interviewed from Arabuko-Sokoke and Gede forests were small scale farmers depending on the forest for few resources like firewood, herbs and butterfly pupae. Their visit to the forest was monitored by the forest officials through patrols even though there were cases of poaching of bush meat and timber reported.

However, the Awer people depend heavily on forest resources like honey, firewood, wild vegetables and fruits, bush meat and construction material for survival. Thus had a higher overall frequency of visiting the forest which is not monitored at all as there is no forest office and the reserve is not fenced.

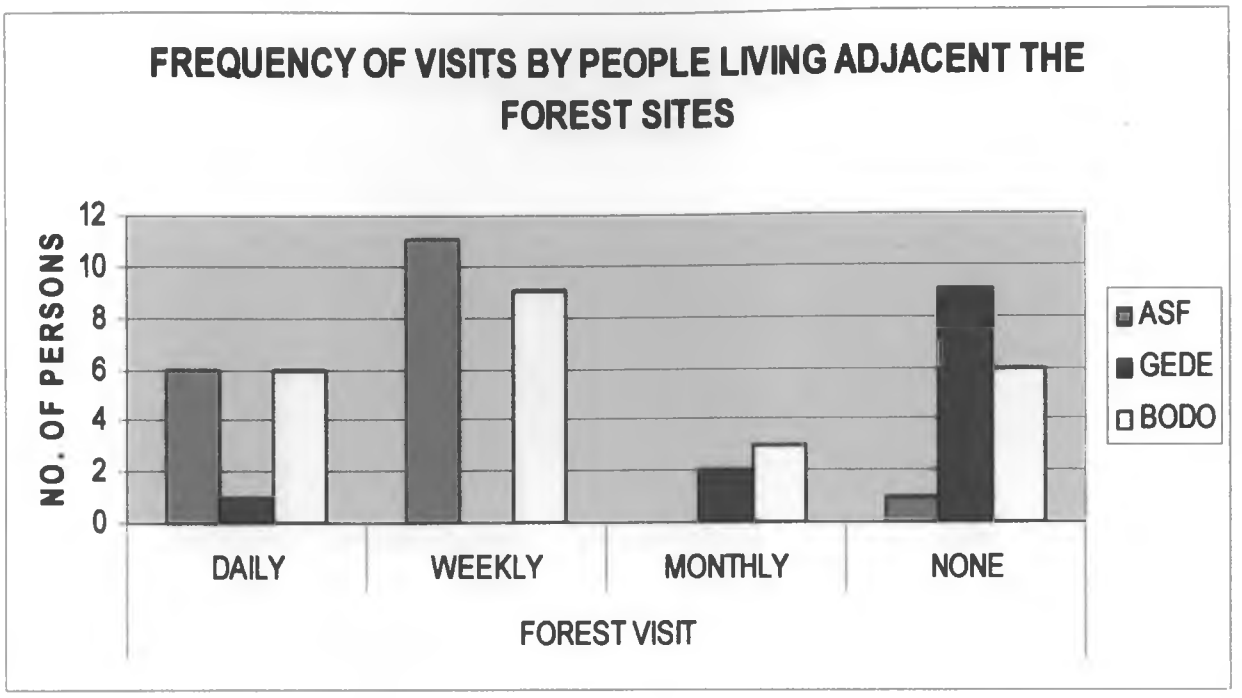

Figure 13: Graph showing number of persons who visit the forests at different periods. Where BODO represents Boni-Dodori National Reserves.

b) Presence and frequency of elephant-shrew in terms of personal sighting (Figure14)

Almost all persons from Arabuko-Sokoke and Gede areas stated that the GRES was a common animal and they did not have a problem with it since it did not spoil their crops.

People from Boni area stated that they seen elephant-shrews and it was common animal in the thicker forest patches. Though they did not have any idea that it was an insectivore and stayed in leaf nests on the forest floor.

A few people in Dodori area had never seen an elephant-shrew but this was because they lived near Indian Ocean and there was no thick bush nearby.

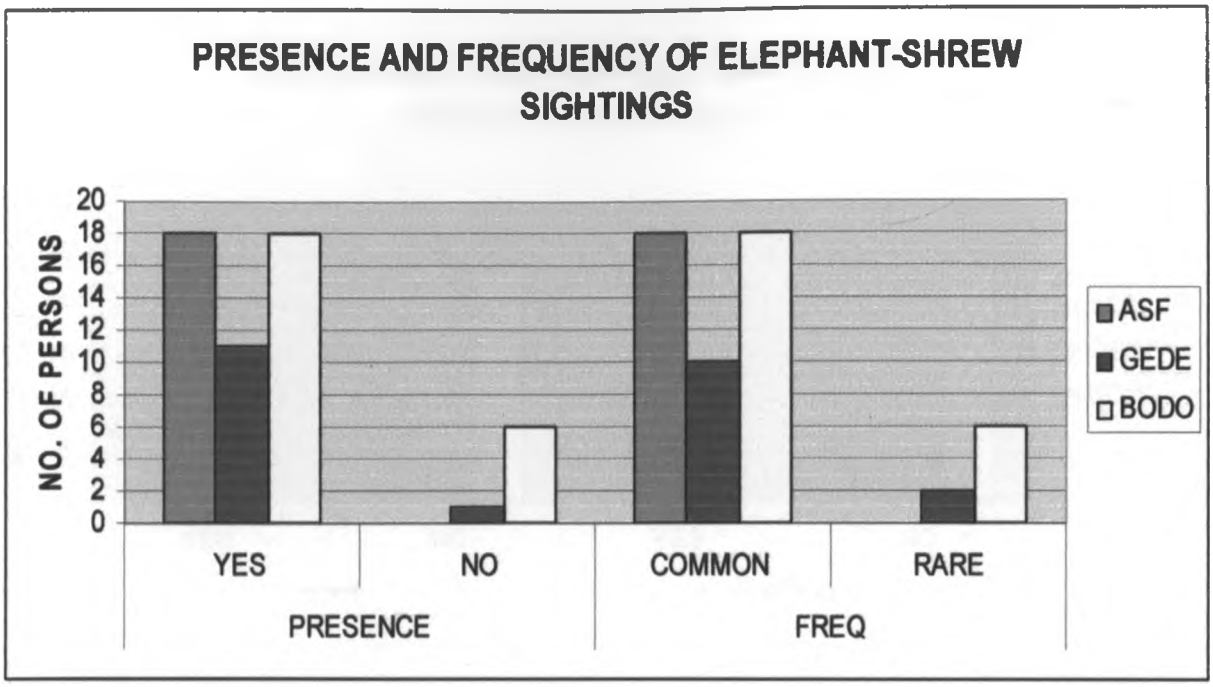

Figure 14: Graph showing presence and frequency of elephant-shrews. Where BODO represents Boni-Dodori National Reserves.

c) If the elephant-shrew is hunted and or used as a food item (Figure15)

There was a general fear among the interviewees in Arabuko-Sokoke and Gede area about being punished if they answered in the affirmative but there was a general consensus that the GRES is used as a food item occasionally. The locals did not have a specific snare/trap for capturing the GRES.

There were several factors influencing this issue namely: not seen as an appetizing food item because it smelled like raw fish; makes a tasteless dish after it was cooked and locals thought it fed on faeces. Thus, it was not a favored food species for people.

People in Boni/Dodori area did not hunt nor eat elephant-shrew as part of the rules in religion of Islam. This is because Islam forbids the eating of non-hooved animals and also abundance of large sized ungulates in the area deflects hunting pressure from the elephant-shrew.

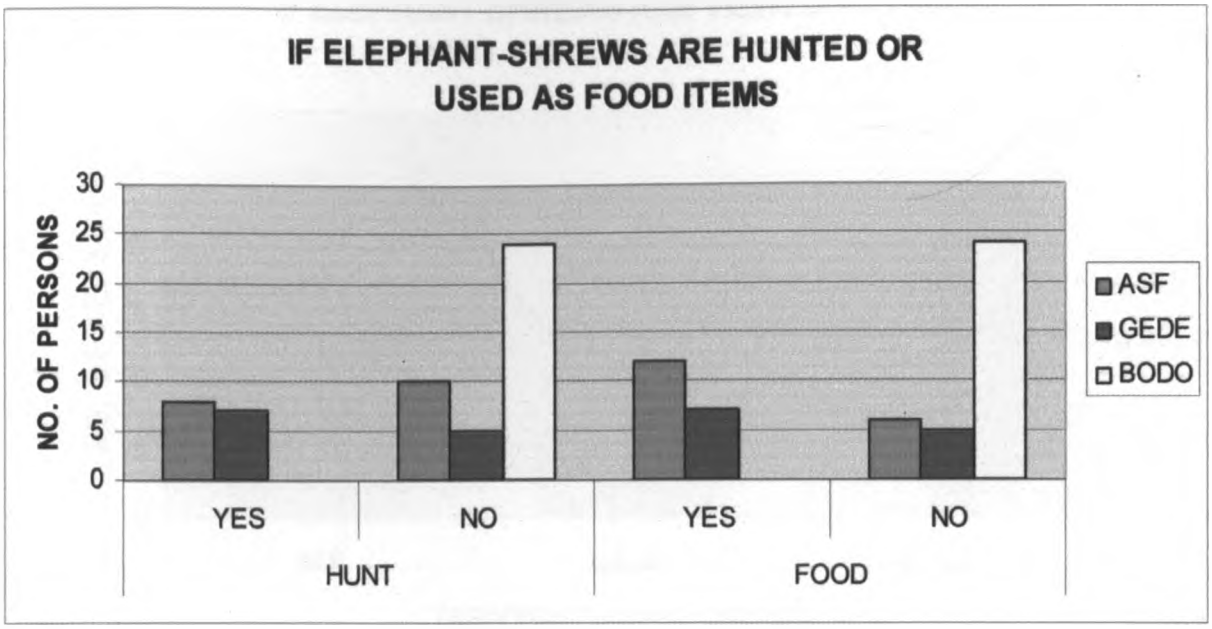

Figure 15: Graph showing number of persons who hunt and use the elephant-shrew as food. Where BODO represents Boni-Dodori National Reserves.

d) If it is used in traditional medicine and witchcraft purposes or viewed as a taboo (Figure 16)

In Arabuko-Sokoke and Gede areas, older persons stated that GRES had been used in the past by wizards to impose curses on persons according to their clients' wishes using the tail and the fur. The effects of the curse included forgetfulness and slow thinking. Pregnant women were forbidden to eat the animal as the effects would be carried down to the unborn baby.

While in Boni area, the people stated that the elephant-shrew was not used in any form of traditional medicine or viewed as a taboo. They just consider it as a wild animal.

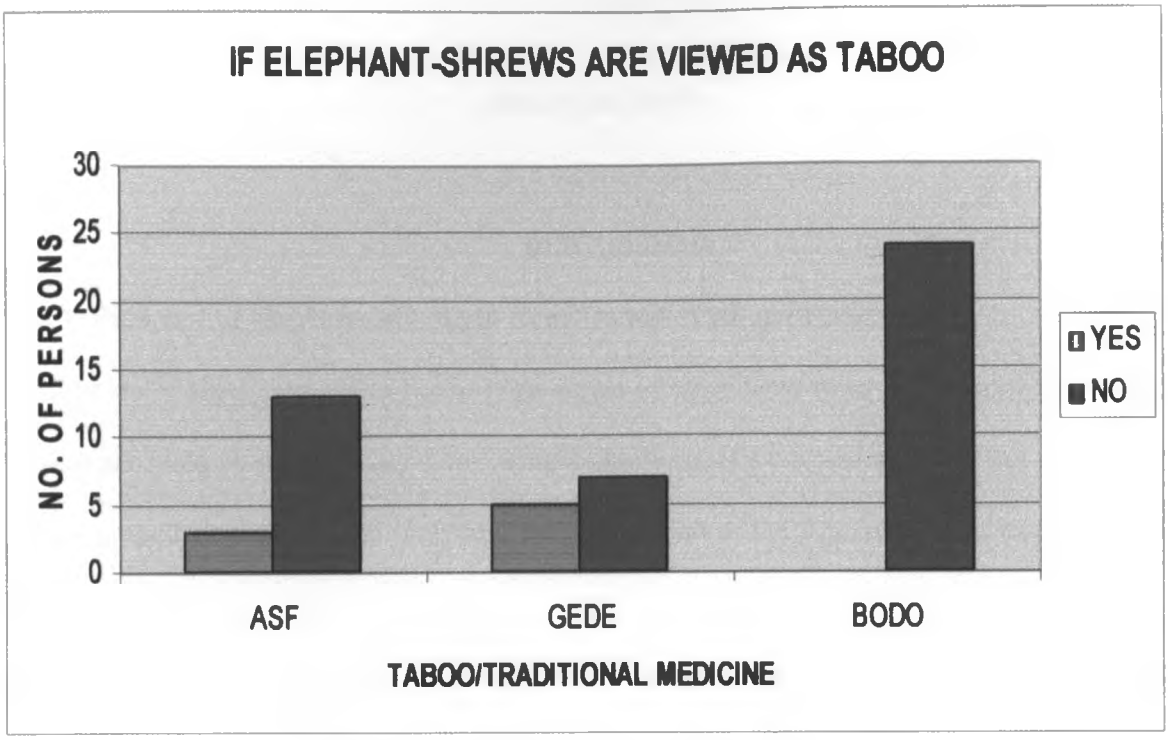

Figure 16: Graph showing number of persons who view the elephant-shrew as part of taboo. Where BODO represents Boni-Dodori National Reserves.

Results from the hunting, eating of the elephant-shrew and taboo questions showed a distinct difference in attitude between the Giriama people from Malindi and Awer people from Boni. Where in Malindi the elephant-shrew was eaten if found and was also considered a jinx while the Awer did not have basic knowledge or myth associated with the species.

CHAPTER FIVE

DISCUSSION

5.1 Presence of elephant-shrews in Boni-Dodori National Reserves

The first study objective was to confirm existence of elephant-shrews in the Boni-Dodori area, this was achieved by the capture of an elephant-shrew species but which turned out not to be the golden-rumped elephant-shrew. This resulted in rejection of the first hypothesis as GRES is not present in the area.

The seemingly small population in Boni/Dodori area could be due to the fact that only a small portion of the National Reserves supports sengi existence. Habitat attributes that favor sengi existence like litter cover, depth and canopy cover are only consistent with dense forest cover. Boni total forested area consists only 13.8km^2 from total area of 1,339km^2 (Mwangi *et al.*, 2007). The rest of the area is bushy grassland which does not support sengi survival. This was the same case in Dodori area.

Another factor which could affect the habitat quality was the constant bush fires started by the Awer to control Tse tse flies and reduce undergrowth for security purposes. These fires reduce the vegetation that protects the sengi from predators while foraging thus reducing suitable habitat resulting in low population of the sengi.

5.2 Golden-rumped elephant-shrew trends

The second study objective was to establish abundance and trend of golden-rumped elephant-shrew in confirmed areas of existence. The overall trend from the results is that GRES population is still decreasing from the North coastal forests of Kenya. The second hypothesis was hence rejected as GRES population and density had changed within the last 7 years (Table 5). This was critical now that the GRES has been confirmed only to inhabit Arabuko-Sokoke and the nearby environs.

The population estimate of ASF was approximately 12,750 individuals, where *Cynometra* forest had the highest number of individuals due to its large size while mixed forest being the smallest habitat had a higher density due to highly favorable habitat characteristics than *Brachystegia* forest. GRES at *Cynometra* forest had increased by 12%, while reducing at *Brachystegia* forest by 21% and 50% respectively in the Mixed forest portion (Figure 12).This was an overall 9% decrease from surveys done in 2000 (Bauer, 2001).

The decline could be attributed to continual change in forest qualities with increase in disturbance by loggers and poachers whose numbers have increased resulting in the reduction of other wildlife species. What used to be done for subsistence purposes has been converted for commercial purposes whereby the poachers trap many animals for sale to villages and cut trees for timber for sale to building contractors. Presence of an electric fence around Arabuko-Sokoke forest had been a positive factor in maintaining forest quality thus the high number of GRES. This has helped reduce human-wildlife contact though it is still being affected by poaching of

both wildlife (Lutz and Newiadomsky, 2007) and timber as people still pass under it and enter the forest.

Cynometra which is the largest part (235 km^2) of the forest was most affected by carvers for a long time because of illegal cutting of *Brachylaena huillensis* tree (muhuhu) used for high quality curios, resistant to insect infestation and weathering (Kyalo 1997). This together with natural regeneration had caused the forest portion to become too dense due to immature trees growing too close together, which are not attractive to the loggers. The recent increase of GRES population in the habitat could be because mature *Brachylaena huillensis* tree density had reduced hence poaching of the tree had gone down reducing disturbance of the habitat and thus promoting increase of sengi population.

GRES population decreased in mixed forest by more that 50%, which is the smallest portion of the forest but is richest in terms of biodiversity. This could be an indication that habitat disturbance by illegal loggers had moved from the *Cynometra* section to mixed forest portion in search of mature hardwood trees for carving and timber production. This portion still has the best habitat requirements for GRES existence according to previous work by Rathbun and Bauer but with a gradual decrease in density then more security needs to be put up to ensure that the GRES still continue to inhabit the mixed forest.

There had been a decrease with time of GRES population in the open *Brachystegia* habitat which had the least litter depth crucial for prey availability and nest construction material.

Estimated population at Gede is of more than 20 individuals which is a sustainable population in the small area. The forest has been kept intact by the fence protecting the trees from illegal logging by the people living in surrounding farms. This was a positive sign that implementation of proper conservation strategies results in maintenance of GRES habitat and which should be applied in ASF to protect the GRES from becoming extinct. A noted negative factor that may affect the population is a lone dog from the neighboring farms but is chased by guards once spotted.

5.3 Influence of community attitude on conservation of GRES

The third study objective was to determine social attitudes on elephant-shrews and conservation of people living adjacent to the forest sites.

Lack of knowledge about the endemism of GRES and elephant-shrews in all study sites was clearly brought out in the questionnaires where the people did not know that the elephant-shrews is only found in their area and that it was a potential source of tourist attraction. This showed a gap in the conservation strategy implemented by stakeholders To the indigenous people, it was just another animal found everywhere and not special at all. This was a sign that they have no idea on importance of their resources and the concerned stakeholders have not gone out to disseminate proper information to help the locals understand why they needed to conserve their resources.

In ASF, people indicated that rampant corruption in the management of the forest resources was the cause of decline in forest quality and they felt that people from neighboring areas were responsible for illegal logging. Also, population and poverty increase had placed pressure on the forest resources making people willing to poach so as to get a cheap meal once in a while. A positive aspect was that that they did not find GRES a nuisance therefore its survival was guaranteed if the habitat was maintained. FitzGibbon did a study that showed that subsistence hunting of the GRES could not affect its density as it could be able to recover by producing 3-4 times a year (FitzGibbon *et al*, 1995). The myth associated with GRES (jinx) also has contributed to its conservation by people avoiding capturing it.

People in Boni/Dodori area stated that neglect by the government especially the wildlife and forest departments was a major factor in determining future of the habitat. They have managed to conserve the forest and its biodiversity over time but stated that pressure from commercial timber companies was affecting the integrity of trees especially mature trees that produce high quality timber.

5.4 CONCLUSION

Presence of sengi in areas like Boni and Dodori National Reserves which are still intact, with low human population emphasizes the need to have proper conservation measures implemented so as to protect biodiversity from destruction.

From the study GRES population is still decreasing and there is a need to take its conservation seriously to make sure the negative trend is reversed before the species becomes extinct. A decrease in species like the GRES that is not targeted by poachers but is affected by change in forest characteristics goes to show that forest quality is important in the survival of many species, hence a serious step needs to be taken to avoid extinction through proper management of the forest.

The existence of GRES in unlikely parts of the forest like *Brachystegia* which was not seen as a suitable habitat shows that the GRES is adapting in places where there are fewer disturbances.

The relationship between the forest officials and locals can be improved to ensure proper dissemination of conservation knowledge by participating in fun activities that bring them together e.g. marathons, walks, retreats e.t.c. to facilitate open discussion on PFM (Participatory Forest Management) and also raise funds for beneficial projects. This is being done in various areas like the Lewa Marathon, Rhino Charge.

5.5 RECOMMENDATIONS

Habitat conservation efforts should be coupled with ecotourism efforts to improve the living conditions for local people.

My recommendations fall under three main points, namely:

a) **Ensuring proper management of forests**

- To document all research carried out in the forests and ensure implementation of recommendations.
- Buffer zones should be created around the forests since GRES usually forage outside the forest fence. These zones will reduce negative impacts of man in the actual forest. The degraded parts of the forest should be reforested with indigenous tree species.

b) **Wider dissemination of knowledge**

- Teaching all school children regularly about the important resources found in their area and how conserving the resources will benefit them in years to come. This is being tried out in small scale by AROCHA in selected schools whereby they have modified the English set book to include lessons about species, habitats and conservation of Malindi as part of the curriculum. This should be done on a large scale especially supported by the Ministry of Education to make conservation area specific in all parts of Kenya.
- Review training given to the guides and tour operators to include endemic animals and their conservation so as to teach their clients (tourists) about the animals and hence increase the awareness of the GRES.

c) **Increased economic empowerment of the locals**

- To initiate small scale projects in villages or community groups e.g. poultry keeping, rabbit or guinea pig rearing, fish keeping and mushroom growing. This will serve as a source of protein and also employ the youth involved in poaching. Briquette making will provide income, employment and environmentally safe energy as an alternative to firewood.

By developing and implementing strategies where efforts and conservation knowledge are integrated with increased economic empowerment of the local people then the overall biological diversity will be better protected in the ecosystems.

Finally, there is need to conduct a research on the status of black and rufous elephant-shrew in Shimba Hills Reserve to promote a wider conservation strategy aimed at increasing awareness of the need to conserve forests not for large mammals like elephants only but also as a habitat for small mammals.

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Appendix 1: List of recorded Elephant-shrews in the world

The common names and the scientific names in the respective genera

Family Macroscelididae

1. Genus *Elephantulus*
   - Short-snouted Elephant-shrew, *Elephantulus brachyrhynchus*
   - Cape Elephant-shrew, *Elephantulus edwardii*
   - Dusky-footed Elephant-shrew, *Elephantulus fuscipes*
   - Dusky Elephant-shrew, *Elephantulus fuscus*
   - Bushveld Elephant-shrew, *Elephantulus intufi*
   - Eastern Rock Elephant-shrew, *Elephantulus myurus*
   - Somali Elephant-shrew, *Elephantulus revoili*
   - North African Elephant-shrew, *Elephantulus rozeti*
   - Rufous Elephant-shrew, *Elephantulus rufescens*
   - Western Rock Elephant-shrew, *Elephantulus rupestris*

2. Genus *Macroscelides*
   - Short-eared Elephant-shrew, *Macroscelides proboscideus*

3. Genus *Petrodromus*
   - Four-toed Elephant-shrew, *Petrodromus tetradactylus* (one sub-species is threatened)

4. Genus *Rhynchocyon*
   - Golden-rumped Elephant-shrew, *Rhynchocyon chrysopygus* (vulnerable/endangered)
   - Checkered Elephant-shrew, *Rhynchocyon cirnei* (two sub-species threatened: *R.c. stuhlmanni and R.c. reichardi*)
   - Black and Rufous Elephant-shrew, *Rhynchocyon petersi* (rare)
   - Grey-faced Sengi , *Rhynchocyon udzungwensis* (discovered in Tanzania in 2007)

Appendix 2: Questionnaire used in the preliminary base-line study

ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN-RUMPED ELEPHANT-SHREW (*Rhynchocyon chrysopygus*) IN THE NORTHERN COASTAL FORESTS OF KENYA

NAME: GRACE W. NGARUIYA (MSc. Biology of Conservation, University of Nairobi)

QUESTIONNEIR FOR VILLAGE INTERVIEWS

PARTICIPANT'S AREA: ..... DATE: .....

GPS READING: ..... PARTICIPANT NAME: .....

AGE: ..... GENDER: .....

How often do you go into the forest? Daily ☐ Weekly ☐ Monthly ☐

Is the sengi present in the forest area? YES ☐ NO ☐

Is the sengi hunted? YES ☐ NO ☐

Is the sengi used as food? YES ☐ NO ☐

Is the sengi used as medicine? YES ☐ NO ☐

How often do you see the sengi? Common ☐ Rare ☐ Periodically ☐

What do you do when in the forest? Hunt ☐ Collect fruits & vegetables ☐

How do you capture the GRES sengi? Trap ☐ manual capture ☐

How many traps do you set? 1-5 ☐ 5-10 ☐ 10-15 ☐

How many sengis do you capture per trapping? 1-5 ☐ 5- 10 ☐ 10-15 ☐

Local names for the different shrews:

4-toed sengi ..... GRES sengi .....

Do you have any skins?

What sort of habitat is it found in?

Where in the forest?

View on community based conservation projects concerning the forest

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Other comments concerning the sengi or forest

Notes:

Appendix 3: Detailed questionnaire used in the study

ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN-RUMPED ELEPHANT-SHREW (*Rhynchocyon chrysopygus*) IN THE NORTHERN COASTAL FORESTS OF KENYA

NAME: GRACE W. NGARUIYA (MSC. BIOLOGY OF CONSERVATION, UNIVERSITY OF NAIROBI)

QUESTIONNAIRE FOR VILLAGE INTERVIEWS

DOCUMENT RECORDS

NAME OF QUESTIONNAIRE ADMINISTRATOR _____ DATE _____

SITE/ VILLAGE OF INTERVIEW _____ GPS LOCATION _____

QUESTIONNAIRE NO. _____

RESPONDENT CHARACTERISTICS

NAME _____ AGE _____ GENDER _____

OCCUPATION _____ PLACE OF RESIDENCE _____ PERIOD _____

KNOWLEDGE OF GOLDEN-RUMPED ELEPHANT-SHREW

LOCAL NAMES _____ HABITAT _____

FOOD _____ BREEDING _____

NESTS (EVER SEEN) YES ☐ NO ☐ DESRIBE _____

YOUNG (EVER SEEN) YES ☐ NO ☐ DESCRIBE _____

SOCIAL BEHAVIOUR _____

ESTIMATES OF ABUNDANCE OF SENGI

HOW OFTEN DO YOU GO INTO THE FOREST? DAILY ☐ WEEKLY ☐ MONTHLY ☐

HAVE YOU SEEN THE SENGI? YES ☐ NO ☐

HOW OFTEN DO YOU SEE THE SENGI COMMON ☐ RARE ☐ PERIODICALLY ☐

HOW MANY HAVE YOU SEEN TOGETHER? _____

WHEN ARE SENGI MOST FREQUENTLY SEEN? MORNING ☐ NOON ☐ EVENING ☐

ESTIMATE NUMBER OF NESTS SEEN IN VISITS TO FOREST _____

HAVE YOU SEEN DEAD SENGI? YES ☐ NO ☐ HOW MANY _____ WHEN _____

UTILIZATION OF THE SENGI

WHAT DO YOU DO WHEN IN FOREST? HUNT ☐ FIREWOOD ☐ VEGETABLES & HERBS ☐

DO YOU HUNT THE SENGI? YES ☐ NO ☐

HOW DO YOU CAPTURE THE GRES SENGI? TRAPS ☐ MANUAL CAPTURE ☐

HOW MANY TRAPS DO YOU SET? 1-5 ☐ 5-10 ☐ 10-15 ☐

HOW MANY SENGIS DO YOU CAPTURE PER TRAPPING? 1-5 ☐ 5- 10 ☐ 10-15 ☐

IS THE SENGI USED AS FOOD? YES ☐ NO ☐

IS THE SENGI USED AS MEDICINE? YES ☐ NO ☐

CULTURAL VIEW OF THE SENGI

MYTHS AND TRADITIONAL STORIES ON THE SENGI

DO YOU KEEP ANY SKINS FROM CAPTURED SENGI?

OTHER COMMENTS CONCERNING THE SENGI OR FOREST NOTES:

Appendix 4: Data sheet used for recording any visual encounter with GRES during transect surveys

ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN-RUMPED ELEPHANT-SHREW (Rhynchocyon chrysopygus) IN THE NORTHERN COASTAL FORESTS OF KENYA

NAME: GRACE W. NGARUIYA (MSc. Biology of Conservation, University of Nairobi)

FIELD DATA SHEET FOR VISUAL ENCOUNTER SURVEY OF GOLDEN-RUMPED ELEPHANT SHREW

NO.	FOREST	DATE	TIME	GPS READING	HABITAT	QUAL.	OBSERVER	NOTES
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

DEFINATIONS:

FOREST: BONI – **Bo**, DODORI – **Do**, ARABUKO-SOKOKE – **Asf**, GEDE - **Gd**
HABITAT: TRUE FOREST – **Tf**, SCRUB – **Sc**, DEGRADED WOODLAND - **Dw**
QUAL: QUALITY OF SIGHTING: VISUAL – **V**, NEST – **N**, SOUND – **S**, FEEDING – **F**
OBSERVER: G.NGARUIYA – **Gn**, GUIDE – **Gu**

NOTES: YES – **Y**, NO – **N** (at the bottom of the page)

NOTES

Appendix 5: Data sheet for recording nests encountered during the transect survey

ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN-RUMPED ELEPHANT-SHREW (Rhynchocyon chrysopygus) IN THE NORTHERN COASTAL FORESTS OF KENYA

NAME: GRACE W. NGARUIYA (MSc. Biology of Conservation, University of Nairobi)

FIELD DATA SHEET FOR NEST SURVEY

TRANSECT NUMBER .....
LOCATION .....
TRANSECT LENGTH .....
WEEK NUMBER .....

NEST NO.	FORM	GPS READING	DISTANCE ALONG TRANSECT	DISTANCE FROM TRANSECT	PHOTOS TAKEN	NOTES
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

DEFINATIONS:

FORM: IN USE – **IU**, NOT IN USE - **NIU**
NOTES: YES – **Y**, NO – **N** (at the bottom of the page)

NOTES

Appendix 6: Data sheet for recording the morphological measurements of captured Elephant-shrew species

ASSESSMENT OF THE RANGE AND POPULATION OF GOLDEN-RUMPED ELEPHANT-SHREW (Rhynchocyon chrysopygus) IN THE NORTHERN COASTAL FORESTS OF KENYA

NAME: GRACE W. NGARUIYA (MSc. Biology of Conservation, University of Nairobi)

FIELD DATA SHEET FOR CAPTURED GOLDEN-RUMPED ELEPHANT SHREW

NO.	FOREST	GPS READING	PHOTOS TAKEN	HABITAT

Specimen sheet ref:			Field sheet ref:		
Collector:			Date:	Time:	
Collecting site:			Altitude:		
Latitude:	Longitude:		Elevation:		
Sex:	Age:		Pregnant/Lactating:		
Color/Markings:			Wounds:		
Measurements					
HB	TL	TV	E	HF	W
Material Preserved			Medium:		
Whole specimen:		Tail tip:	Skin:		

Notes:

Where: HB- head and body length, TL- total length, TV- tail vertebrae, E- Ear , HF- hind foot, W- Body mass in grams

FOREST: ARABUKO-SOKOKE – **Asf,** GEDE – **Gd,** BONI – **Bo**, DODORI – **Do**
HABITAT: TRUE FOREST – **Tf,** SCRUB – **Sc**, DEGRADED WOODLAND - **Dw**