Distribution, habitat structure and troop size in Eastern Cape samango monkeys *Cercopithecus albogularis labiatus* (Primates: Cercopithecoidea)

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by

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GENERAL ABSTRACT

The samango monkey subspecies *Cercopithecus albogularis labiatus* is endemic to South Africa, and known to occur in Afromontane forests. There has been a major decline in this subspecies, exceeding 30% in some populations over the past 30 years, primarily as a result of the loss of suitable habitat. A second samango subspecies, *C. a. erythrarchus*, occurs near the northern border of South Africa, mainly in coastal lowland forest, and the distributions of the two subspecies do not overlap. *C. a. labiatus* was thought to be confined to Afromontane forests, but the study described here focused on *C. a. labiatus* populations that were recently identified in the Indian Ocean Belt forests near East London. I undertook to assess the distribution of *C. a. labiatus* in the Eastern Cape, to evaluate the habitat structures of the Afromontane and Indian Ocean coastal belt forests, and to understand the effect these habitats have on essential aspects of the socio-ecology of the *C. a. labiatus* populations. Distribution surveys were conducted in protected areas throughout the Eastern Cape, and samango monkeys were found to be present within forest patches in the Amatola Mountains, Eastern Cape dune forests and the Transkei coastal scarp forests. The sizes and composition of two troops were assessed: one troop in the Amatole forests and one in the Eastern Cape dune forests. The Amatola Mountain troop had a mean troop size of 28.8 ± 7. 8, while that the dune forest mean troop size was 29.1 ± 9.7. *C. a. labiatus* was found to be distributed in forest patches where the subspecies was previously thought to not be present. The structures of the different forests proved to have no significant effect on these fundamental aspects of socio-ecology within the subspecies.

Keywords: Biogeography, Cercopithecini, Indian Ocean coastal forest, Socio-ecology, Sykes' monkey, Troop composition

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“Uyehova ngumelusi wam andisweli lutho”

DECLARATION

The work described in this dissertation was carried out by me in the Department of Zoology & Entomology at the University of Fort Hare, Alice campus, the Amatola Mountain forests and different nature reserves managed by Eastern Cape Parks and Tourism Agency, between January 2013 and December 2015 under the supervision of Dr. Fabien G.S. Génin and Prof. Judith C. Masters. I declare that this is my own work, and all the results included were collected by me unless explicitly stated, in which case the source is identified. I have never submitted this thesis before for any degree or diploma at any tertiary institution.

I, Vusumzi Martins declare that the research reported in this dissertation, except otherwise stated, is my original work. This dissertation does not contain another person's data, pictures, graphs or other information, unless otherwise stated and referenced.

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CHAPTER ONE: GENERAL INTRODUCTION

1.1 Species as units of biodiversity conservation

In 1942 Ernst Mayr contended that the essential criterion defining a species centres on the occurrence of actual or potential interbreeding within a population, or between members of different populations. He believed that species are those populations possessing factors intrinsic to their members which will act to prevent interbreeding between the populations. Species-level taxonomy provides the basic reference system for biological diversity (Baum, 2009), and calling a particular group of organisms a species might be taken to mean that it is an evolutionary unit, a lineage or a morphologically distinct entity. Species are fundamental units of biodiversity, but they may be clearly defined as such only in a restricted zone of time and space and, consequently, species counts become less and less meaningful as larger and larger areas are covered (Mallet, 2007). Although taxonomists may reach agreement concerning specific cases, even this small measure of agreement is not always possible. Both ecological theory and conservation and biodiversity studies, however, need to recognise that species counts over large expanses of time and space represent only a sketchy measure of biodiversity, a measure which often owes more to taxonomic and metaphysical fashion than to science (Baum, 2000).

As subspecies are defined as a taxonomic rank subordinate to species (Inger, 1961), a species will be recognised as either having no subspecies at all or two or more, but never only one (Mayr, 1982). Inger (1961) used the term subspecies to designate geographical varieties, and this meaning has continued to be applied to subspecies in zoology. Darwin recognised subspecies as a stage in the speciation process and the beginning of a new species, while Mayr considered subspecies to be evidence of the adaptive response of a species to local climatic conditions (Mayr, 1961). I consider both Darwin’s and Mayr’s definitions to be useful in understanding subspecies, as subspecies represent the diversity of adaptations which various groups have acquired as they responded to selection in their local environments. In circumstances in which barriers are long-lasting, they can represent the first steps in speciation. Subspecies can also offer information concerning processes such as mating patterns and sexual selection, breeding behaviours, dispersal and gene flow, colonisation events and phenotypic plasticity (Haiman, 2012). Haiman (2012) also maintains that from the point of view of conservation, protecting subspecies ensures that a wide range of the genetic, morphological, and behavioural variation within a species is preserved. This leads to the preservation of the greatest possible adaptive potential for the species as a whole.

Taxonomists, biologists and conservationists need to work together to determine appropriate criteria for defining species and relating them to their respective subspecies, as both of these taxonomic ranks are important in the overall conservation of biodiversity. Without a shared definition of both species and subspecies, the conservation of biodiversity is impeded by miscommunication and confusion.

1.2 Defining species

As Nicholson (1872) wrote, no term is more difficult to define than species, and on no point are evolutionary biologists more divided than on what should be understood by this word. The species problem results from two conflicting motivations among biologists: (1) to categorise and identify organisms, a pre-requisite for any biological study, and (2) to understand the evolutionary processes which give rise to species and speciation, which probably constitutes the most persistent question in evolutionary science (Hey, 2001). My project was conducted under the auspices of the APIES research programme, which focuses on the role of ecology and climate change in speciation among African primates, and much of the group's research is informed by the Recognition Concept of species, which originated in South Africa (Paterson, 1985).

My aim in this study was to clarify the taxonomic and conservation status of the populations of samango monkeys found in the Eastern Cape. The subspecies *Cercopithecus abogularis labiatus* was previously held to be confined to the Afromontane region, to which essential aspects of its Specific-mate Recognition System (SMRS; Paterson, 1985) and socio-ecology should hence be adapted. It is both a cliché and a truism that animals usually mate with conspecifics. Mayr (1963) explained speciation according to the Biological Species Concept or BSC (also known as the Isolation Concept) as the evolution of reproductive isolation. The BSC defines species as groups of populations which normally do not exchange genes with other such populations, as a result of one or a combination of several reproductive isolating mechanisms (Dobzhansky, 1951). Alternatively, Paterson (1985) proposed that it is not isolating mechanisms which define a species, but rather a sub-set of mechanisms which enable conspecific mates to locate and recognise each other. In terms of his Recognition Concept or RC, Paterson (1985) maintained that post-mating isolating mechanisms are by-products of speciation. In all mobile sexual organisms the SMRS constitutes a major component of fertilisation. Primate SMRS characters have been documented by Masters (1993, 1998). The RC predicts that speciation occurs when the SMRS is no longer effective in a new environment and under different habitat conditions. A consequence of this hypothesis is that specific-mate recognition signals should be adapted to the physical conditions of the environment in which a species is usually to be found, or its preferred habitat. The best diagnostic characters of species will logically be specific-mate recognition signals, which are defined by the sensory channels used by a species and the propagation properties of their preferred habitats. I propose to investigate, in particular, the characteristics of the habitats in which the samango monkeys of the Eastern Cape are found.

1.3 Description and diversity of samango monkeys

Samango or 'blue' monkeys are medium-sized (4 - 8 kg), diurnal, arboreal primates. Their faces are almost naked and usually dark in colour, with blue being infrequent, and they have well-developed facial musculature (Lawlor, 1979). The South African samangos belong to the species *Cercopithecus albogularis* Wolf, 1899, which is part of the *C. nictitans* species group, also known as diademed monkeys because they have a prominent row of forward-pointing white hairs just above the brow line (Rudran, 1978). They have white cheek tufts, which are particularly well developed in males. Male samango monkeys are larger than females, with adult males weighing approximately 7 – 9 kg and females approximately 4 – 5 kg (Rudran, 1978). A group of *C. a. labiatus* animals is shown in Figure 1.1. Rudran (1978) also reported that *C. albogularis* has a dental formula of 2/2 1/1 3/3 2/2 = 32 (as in all Old World monkeys), with males possessing canines which are slightly larger than those of the females. Like most catarrhine monkeys, the nostrils are close together and face downward. As is the case with all guenons, *C. albogularis* has cheek pouches to carry food while foraging (Lawlor, 1979). The nail of each digit is flattened, and the pollex and hallux are opposable (Lawlor, 1979). The upper parts of the body are grey, while the limbs are darker (black) in appearance.

Although samangos are described as strictly arboreal, they do frequently descend to the ground to forage (Rudran, 1978); they are very active, gregarious, and noisy primates, and also very intelligent animals (Smithers, 2000). Lawes (1990) describes these monkeys as highly social: the animals live in troops with up to 35 members, although 13 – 21 is the norm, and one or more resident adult male(s) (Lawes, 200). The resident males are responsible for protecting the females and sub-adults from extra-troop males. Lawes (2000) observed that during the breeding season the number of males in a group can increase significantly, owing to the fact that non-resident or extra-troop males enter the troop and mate with the females.

Figure 1.1. Samango monkeys (*Cercopithecus albogularis labiatus*) in the Hogsback Afromontane forest (Photo: Vusumzi Martins)

Many nonhuman primates produce loud, species-typical calls (Mitani and Stunht, 1998), and samango monkeys are known to make acoustically distinct alarm calls to indicate different types of predators. Adult male blue monkeys produce two loud alarm calls, known as "hacks" and "pyows", in response to predators (Murphy et al., 2012). Pyows are high-pitched, loud, atonal calls, usually produced in response to the presence of terrestrial predators, while hacks are usually produced in response to aerial threats (Papworth et al., 2008). Figure 1.2 presents sonograms illustrating these calls. Estes (1991) describes samango monkeys as territorial and female bonded with a type-I loud call. Samango monkey males are territorial and they defend their mating rights against non-resident males who often intrude and try to mate with females belonging to the troop (Lawes, 1991). Lawes also states that adult males emit loud resonant "booms" produced through large laryngeal air sacs that develop at puberty. Samango monkey resident male boom calls can be heard unambiguously at large distances, and hence can serve a watchdog role to repel predators, competitors or unwanted intruders (Lawes et al., 2000). Figure 1.3 depicts a sonogram of a male boom. Samango monkey troops consist of allied female members that achieve group cohesion through social behaviour such as contact calls and grooming (Payne et al., 2003). Female samango monkeys keep contact by means of a series of grunts and "trills" (Payne et al., 2001).

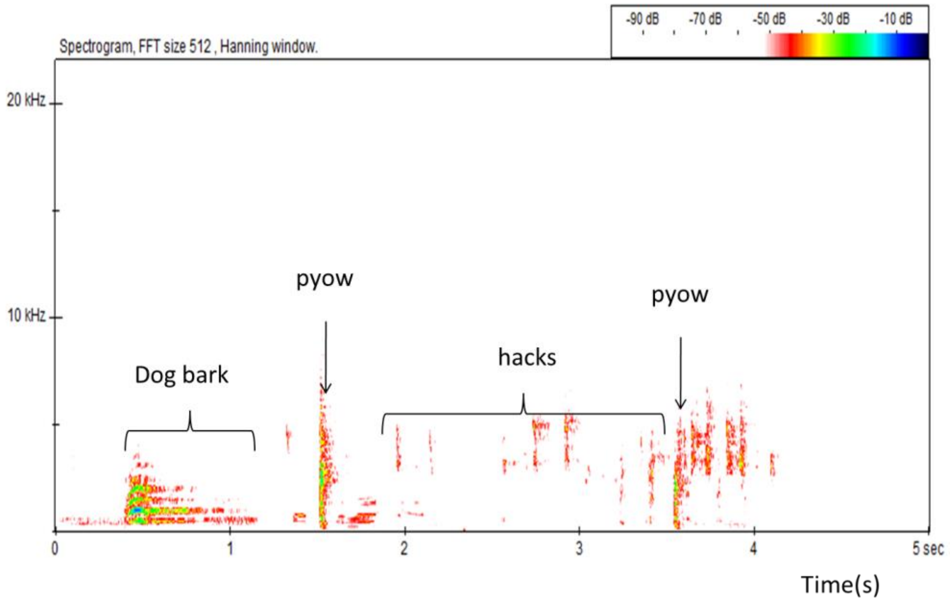

Figure1.2. Sonagrams created by BATSOUND software to illustrate "pyow" and "hack" calls uttered in response to a threat from a ground predator (dog).

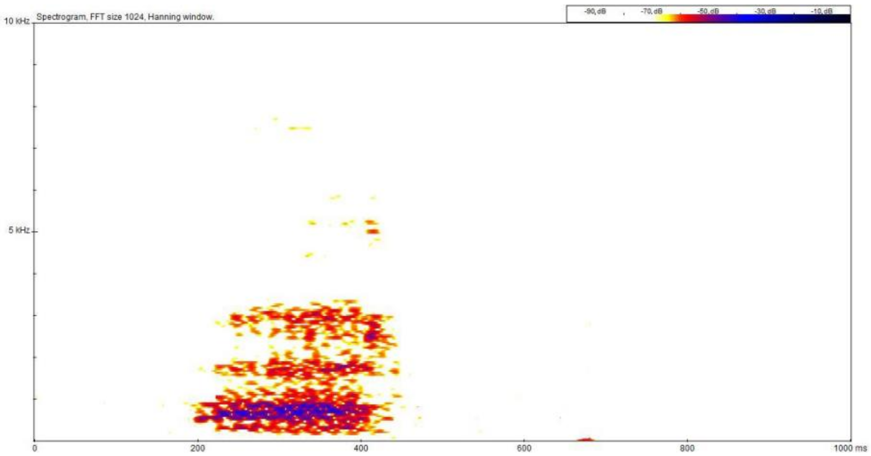

Figure1.3. Sonagram created by BATSOUND software illustrating the low-pitched "boom" uttered by resident samango males.

Lawes (1990) suggested that as samango monkeys are to be found at the southern limit of the range of *Cercopithecus albogularis*, the greater climatic seasonality at this latitude results in more predictable fruiting patterns, and hence it is no surprise that the diet of samango monkeys consists mainly of fruits, at least during the fruiting seasons. They also feed on flowers, leaves and arthropods, and, as they have been observed stripping bark, in some areas samango monkeys are considered to be pests in pine plantations (Smithers, 2000). However, pine trees are exotic imports to South Africa, and are unlikely to form part of the animals' preferred diet. The inclusion of pine bark is probably a consequence of the fact that the monkeys tend to be relatively unselective in their choice of food types and eat whatever foods are available, regardless of their energy content (Lawes, 1991). It has also been proposed that when the abundance of favoured or preferred foods is low, the diet of samango monkeys becomes more diverse (Twinomugisha et al., 2003). The seasonal availability of fruits, taken with both their variable nutrient content and the changing dietary needs of the animals, favours such dietary flexibility, as observed in many other frugivores (Stiles, 1989). Samango monkeys, like most fruit-eating forest guenons, are believed to play a role in the dispersal of the seeds of many plants, which attract them with the bright colours and succulent pulp of the fruits they produce (Kaplin et al., 1998).

Two subspecies of samangos, *Cercopithecus albogularis labiatus* (Fig. 1) and *C. a. erythrarchus*, are recognised within the southern African subregion (Lawes, 1990). Roberts (1951), Groves (2001, 2005) and Dalton *et al*. (2015) recognised a third samango subspecies in the Soutpansberg Mountains in South Africa, namely *C. a. schwarzi*, although the International Union for the Conservation of Nature assessment recognises only the two subspecies mentioned above, following Meester et al. (1986). Skinner and Chimimba (2005) describe *C. a. labiatus* as "showing an affinity for Afromontane forest, and *C. a. erythrarchus* for Indian Ocean coastal belt forest" (p. 228). Afromontane forests tend to be highly fragmented and several patches are under threat of deforestation. Habitat reduction and destruction has resulted in the decline of samango numbers in South Africa over the last 100 years, particularly in the case *C. a. labiatus*, which has hence been listed as endangered within the subregion and vulnerable globally in the IUCN Red Data Book (Lawes, 1992).

1.4 Taxonomy and conservation of South African samango monkeys

There has been a considerable amount of debate concerning the species identity of the South African samango monkeys: Lawes (1990, 1992) and Kingdon et al. (2008) refer to these populations as *Cercopithecus mitis*, while Meester et al. (1986) classified them as *C. albogularis*. Sineo (1990) conducted a preliminary karyological study comparing the karyotypes of three geographical populations of blue monkeys, and showed that, while their karyotypes were similar, they were not identical. *Cercopithecus mitis* shares a diploid number of 72 chromosomes with *C. albogularis* and *C. doggetti*, but the karyotypes of *C. mitis* and *C. albogularis* differ by several pericentric inversions i.e., by chromosomal rearrangements that involve the centromere. I therefore follow his recommendation, and refer to the South African populations as *C. albogularis.* Makhasi (2013) recently conducted a morphometric analysis of East African blue monkeys and samangos and suggested that they should be divided into two species, *Cercopithecus albogularis* in East Africa, and *C. labiatus* in South Africa. More information is needed to confirm the validity of this species distinction.

Taxonomic disputes have significant consequences for conservation because conservation initiatives generally target species rather than populations. Without a working classification of the organisms living in any given area, attempting to estimate the amount of biodiversity present is a futile endeavour, making informed decisions in the interests of conservation impossible. As conservation becomes increasingly politically and socially important, the work of taxonomists has consequences for not only the scientific community, but also for society as a whole. In spite of a distribution comprising various different forest habitats, *Cercopithecus albogularis* does not tolerate fragmentation or isolation as well as other, less widely distributed primate species (Lawes, 2004). Lawes (1992) believed that the continued survival of *C. albogularis* requires urgent conservation measures, such as the preservation of forest habitats and the management of existing populations. Lawes (2004) maintained that a flexible diet, particularly with respect to the consumption of foods low in nutritional value favoured by folivorous animals, is advantageous to this species group, as it limits the need for movement among the various fragmented areas of forest which comprise its habitat. Various different conservation strategies have been employed in the quest to save the remaining populations of samango monkeys in South Africa. The creation of corridors has been found to improve the wellbeing of samango monkey populations by Lawes and others.

1.5 Seed dispersal by samango monkeys

Most guenon monkeys are arboreal, omnivorous feeders which have evolved a variety of dental, oral and digestive, locomotor and sensory adaptations which enable them to exploit ripe and unripe fruits, soft and hard seeds, and protected and unprotected fruits (Lambert and Garber, 1998). During the eating of fruit, seeds may be masticated and consumed, dropped under the parent tree, spat out or swallowed and later defecated at some distance from the parent tree (Wrangham et al., 1994). Although certain primate taxa are reported to act principally as predators and to destroy large numbers of seeds, it is likely that most frugivorous primates act as both seed dispersers and seed predators for many tropical trees (Gautier-Hion et al., 1993). The ecological effects of seed dispersal can be defined in terms of the quantity of fruits and seeds removed from a parent tree, the phenological stage at which these food items are selected, the ways in which seeds are consumed and processed, and the manner in which a given species deposits seeds within its geographic range (Schupp, 1993).

According to Lambert and Garber (1998), *Cercopithecus* species are among the most important seed dispersers in the Afrotropical forests. *Cercopithecus* species, including samango monkeys (Lawes, 1991), are highly frugivorous wherever they occur, and they disperse large numbers of seeds, primarily through spitting them out, but also as a result of swallowing and defecating them (Linden et al., 2014). Compared with tropical forests, frugivorous primate diversity in South Africa's subtropical Afromontane, scarp and coastal forests is low, comprising the small-bodied, nocturnal greater bushbaby (*Otolemur crassicaudatus*) and the large-bodied, diurnal samango monkeys (*Cercopithecus albogularis labiatus* and *C. a. erythrarchus*) (Linden et al., 2014).

Linden et al. (2014) conducted a study of seed dispersal by samango monkeys in the Afromontane forest of South Africa and found that samangos dispersed 52% of the seeds which they consumed, through either defecation or spitting. Chapman (2005) reasoned that the contribution of samango monkeys to seed dispersal depends on a variety of factors which include: (1) the number of seeds dispersed away from the area beneath the parent tree, which is characterised by high density-dependent mortality; (2) the method of seed processing, i.e. whether the samango monkey defecates seeds or spits them out, and the germination potential of seeds processed in these various ways; (3) the suitability of the microsite where the seeds are deposited for germination and growth. Cercopithecines tend to retain digested foods in their intestines for long periods (Lambert, 2002), and this increases the chances of seeds being deposited some distance away from the parent plant, enhancing the potential for successful seed dispersal by samango monkeys, and their significance as providers of ecosystem services.

1.6 Sociality and communication in samango monkeys

Socio-ecological models maintain that social primates live in groups in response to the pressures imposed by predation and the threat of infanticide (Payne et al., 2003), which leads to both increased competition for limited resources and increased opportunities for co-operation. Chapman and Chapman (2000) classified the benefits of living in groups into two broad categories: the avoidance of predators and the defence of resources. Several studies have provided evidence to support the view that benefits derived from the warding off of predators constitute the principal motivators for the evolution of group living (Alexander, 1974; van Schaik, 1983). Living in a group decreases the probability of an individual falling prey to predators as a result of the dilution effect, whereby increased numbers reduce the risk of any single individual of being preyed upon (Coleman, 2013). By contrast, Creswell and Quinn (1994) held that the most important advantage of living in groups is the 'detection effect', in terms of which a larger group increases the number of vigilant individuals, which in turn increases the chances of spotting a predator. Through the detection effect, individuals are able to reduce the time each needs to spend being vigilant as a result of being able to rely on other members of the group, which may allow them to gain access to resources either in areas or at times which might otherwise have entailed too high a risk of predation (Hill and Lee, 1997). It is clear that primates, like other animals, have evolved ways to minimise the risk of predation.

The important question, in this regard, is whether the threat of predation was the primary force which drove primates, such as samango monkeys, to evolve the social behaviour which resulted in their living in groups. Isbell (1994) concluded that this is a difficult question to answer, as there is insufficient direct evidence of predation affecting primates. This view has some validity, as primatologists tend to focus their studies on primates and not on their predators. Most researchers agree that the threat of predation is the key determinant of the evolution of group living (Hill and Lee, 1998), but they differ in the details of how this risk has affected group structures. Van Schaik and Horstermann (1994) concluded that predation pressure has had a major influence on the composition and sizes of groups of primates. When this pressure is great, males tend to constitute a larger percentage of the adult members of the group and they are likely to defend conspecifics (Anderson, 1986). Dunbar (1996) suggested that the sizes of groups of primates increase when the risk of predation is high and that the increase in the number of males may be simply a consequence of a larger group size (Hill and Lee, 1998). A study conducted by Hill and Lee (1998) concerning the influence of the risk of predation on the size of groups among cercopithecoid primates (the superfamily under which samango monkeys fall), found that predation risk has a significant influence on the size of groups, confirming the findings of Van Schaik and Horstermann (1994). Hill and Lee (1997) also found a positive relationship between predation risk and group structure, as they discovered that when the risk of predation was high, the numbers of male in a group were significantly higher than when the risk of predation was low.

Using an ecological modelling approach and a variety of primate species, Wrangham (1980) concluded that group living confers a greater advantage in defending resources than it does as a strategy for avoiding predators. Wrangham used the limited amount of information concerning primate social systems available in the late 1970s to propose that when foods were spatially clumped and of high quality, females would be philopatric and exhibit strong intergroup aggression because they were able to defend the food resources. In his model Wrangham (1980) suggested that being in a group improves access to resources compared with being alone, and that being in a group improves the ability of females to defend resources against other competitors, usually members of their own species, which they would not be able to do as well if they were alone with their infants. Females form the focus of the model because their reproductive success is more strongly affected by access to food than that of males (Isbell, 1991). Wrangham's theory is likely to be validated when food is relatively scarce and high in nutritional value; and when food patches are small enough to allow them to be defended, and large enough to support several individuals in the group (Isbel, 1991). As more primate studies were conducted, Wrangham's model was re-evaluated (Isbell and Young, 2002). Behavioural ecologists, such as Isbell (1991) and many others, have reviewed his theory and devised second generation theories, including those concerning the cost of living in groups (Janson and Goldsmith, 1995) and those postulating that the known behavioural expressions of competition between females are either weak or non-existent (Isbell, 1991), but all support the contention that living in groups has resulted from primates defending their resources.

Sociality in primates in general may have evolved for different reasons and at different times in the past. Both of the explanatory approaches discussed above may provide plausible explanations for the evolution of sociality among samango monkeys. In most of the areas of the Eastern Cape surveyed in this study, pressure from predators seems to be very low and, in some forest patches, non-existent, but nevertheless social behaviour is evident among the populations of *Cercopithecus albogularis labiatus*. If the subspecies evolved its social behaviour as a result of the pressure of predation, then it would be logical to predict that their natural predators must have been driven to extinction over the centuries. As matters stand at present, sociality in samango monkeys is easily explicable in terms of the defence of resources hypothesis, as in all of the forests surveyed in this study, multiple female-bonded troops have been observed occupying and feeding in the same patch of forest.

1.7 Research rationale and motivation

This study aims to characterise the distribution, population densities and activity patterns of several populations of samango monkeys, *Cercopithecus albogularis labiatus*, in the Eastern Cape. As has been reported under section 1.3, samango monkeys feed on a variety of food types. Accordingly, the distribution and availability of food may not be sufficient to characterise the preferred habitat of samango monkeys, and other types of resources may be involved in their selection of habitats. For example, the availability of the cliffs which are used as sleeping sites may limit the distribution of baboons. Studies of vervet monkeys have shown that safe areas also have a great influence on their use of space, as the animals are constrained by a “landscape of fear” (Laundré et al., 2010). An important difference between these species and samango monkeys is their ability to use open areas. Samangos seldom cross extensive areas of open space (Rudran, 1978). Consequently, they tend to have a patchy distribution, with exchanges among the various localised groups being rare. However, their distribution is unlikely to have been influenced by either the presence or the absence of predators.

Habitats are not shaped only by the availability of resources, but also by the inhabitants themselves. Plants and animals create habitats both for themselves and for other species. As has been mentioned above, samango monkeys, like most fruit-eating forest guenons, are likely to play a role in the dispersal of the seeds of the many plants which produce the fruits whose bright colours and succulent pulp attract them (Kaplin et al. 1998).

1.8 Research problem and research focus

The distribution patterns of extant forest-dwelling animals in southern Africa are generally assumed to be a consequence of vegetation adjustments following climatic changes during the Pleistocene (Lawes, 1990). Lawes (1990) suggested that the dispersal of samango monkeys into and within southern Africa could have followed two possible migration routes, as these routes relate directly to the timing and the development of the Afromontane and Indian Ocean coastal belt forests, respectively. The Afromontane forest is thought to be the more ancient of the two forests, and consequently, the more persistent forest type (White, 1981). The difference between the relative ages of the two major forest types suggests that the two South African samango subspecies represent different radiation events in the overall pattern of evolution of the *Cercopithecus albogularis* group in southern Africa (Lawes, 1990). According to Lawes (1990), the distributions of the two samango subspecies do not overlap and *C. a. labiatus* is confined to the Afromontane forests. In contradiction of this commonly held view, the subspecies *C. a. labiatus* has been identified recently in the Indian Ocean coastal belt forest near East London, where they were previously thought not to occur. Whether this is a recent range expansion owing to human pressure or a case of missing data is unknown at this point.

This study focuses on the differences between the forest structures of the Afromontane forest and Indian Ocean coastal belt forest in various parts of the Eastern Cape in South Africa, and the way in which they influence the socio-ecology of the samango monkeys that live in them, with specific emphasis on any differences in terms of their use of space and troop sizes and composition. In addition, as habitats and systems of communication are interrelated, forest structures may affect the propagation properties of vocal signals. For instance, samangos may avoid habitats in which the male booms do not resonate, or use smaller home ranges when the booms do not travel far, also limiting the sizes of the troops.

1.9 Research hypothesis and objectives

The Afromontane forest is characterised by diverse species of tall tropical and non-tropical trees (Wethered and Lawes, 2005) and tends to occur in patches, few of which cover areas greater than 1 – 2 km (Cowling, 1983). The canopy cover of the Afromontane forest is continuous, comprising mostly evergreen trees which can grow up to 20 m high (Hayward et al., 2005), and beneath it the vegetation is multi-layered (Wethered and Lawes, 2003).

If the flexible diet of samango monkeys makes it unlikely that suitable habitats are defined for them by the distribution of specific food resources, some other aspect of their interaction with the environment must be involved. I hypothesise that animals select a sensory habitat rather than a dietary one, in which they are capable of maintaining social bonds and structures through communication. Hence, the phenomenon known to animal behaviourists as "sensory drive" (Endler and Basolo, 1998) is the predominant factor in the selection of a habitat. The presence of conspecifics and the physical properties of the environment which influence the propagation of specific signals may constitute the first cue used by animals to judge the adequacy of a given environment as a suitable habitat. Consequently, it follows that the second hypothesis of this study is that the apparently different habitats used by the two South African samango subspecies are, in fact, very similar in terms of their sensory properties, although the animals may make use of different resources and experience very different climatic conditions.

Samango monkeys have been seen in the Indian Ocean coastal belt forest around East London. On the basis of visual observation, they are members of the *C. a. labiatus* subspecies, usually restricted to Afromontane regions, although this needs to be confirmed by genetic analyses. Since there is a great deal of difference in the habitat structures of the two forest types, how does the ecology of the coastal populations differ from that of the species found in the Afromontane forest? On the basis of this question, the research problem I developed for this investigation can be expressed as follows: "If the preferred habitat of *Cercopithecus albogularis labiatus* comprises patches of Afromontane forest between which it rarely moves, how well adapted are the populations that occur in forests of the Indian Ocean coastal forest belt?”

CHAPTER TWO: RESEARCH SITES AND METHODS

2.1 Habitat preference and distribution of samango monkeys in the Eastern Cape

An understanding of both the habitat requirements of a species and the factors which limit its distribution is essential if the species is to be conserved. Although many different views and opinions concerning the habitat requirements of the samango monkey subspecies in South Africa have been expressed, it is generally held that *Cercopithecus albogularis labiatus* prefers to occupy the denser Afromontane forests, while *C. a. erythrarchus* is to be found in coastal forests.

Variations in abiotic factors such as aspect, altitude and slope can have significant effects on the composition of plant assemblages in an area, often resulting in a variety of distinct types of habitat containing very different plant species (Rutherford et al., 2006). Variations of this sort have important consequences for the range and seasonality of available foods. Scarcities of food can result in reduced rates of fecundity, growth and survival for animals, and these effects have been observed in a number of primate species, including yellow baboons (*Papio cyanocephalus*) (Altmann et al., 1977), chacma baboons (*P. ursinus*) (Stone et al., 2013)), Japanese macaques (*Macaca fuscata*) (Hanya, 2004) and saddle-backed tamarins (*Saguinus fuscicollis*) (Goldizen et al., 1988). Consequently, all primate groups maintain home ranges which encompass a sufficiently large area to allow them to find adequate food to survive and reproduce (Mitani and Rodman, 1979). Many primate species have been observed varying their foraging distribution or ranging behaviour, depending upon the local availability of food, (Waser, 1977; Stanford, 1991; Zhang, 1995; Doran, 1997; Hanya, 2004; Volampeno et al., 2011). While the availability of food is always an important consideration for primates, other spatially variable resources may also affect their behaviour.

Several studies have reported that primates vary their ranges in order to gain access to spatially variable resources such as fresh water (De Gama-Blanchet and Fedigan, 2006; Ferrari and Hilario, 2012; Stone et al., 2013) and refuges from predators (Cowlishaw, 1997). Arboreal species may avoid areas where there is low tree cover or low canopy height, owing to a reduced supply of food or the increased risk of predation associated with more open areas (Salter et al., 1985; Bitty and McGraw, 2007). Primates need to consider both the benefits and the risks when choosing where to forage, and they may choose to avoid areas in which they perceive the risk of predation to be high, even though resources may be available to them there (Willems and Hill, 2009).

Among the factors which may affect the ranging behaviour and troop movements of wild primates, food is the best documented for a number of species (Gautier-Hion and Quris, 1981). Most studies conclude that habitat use is closely related to the availability of food; when food is scarce, both ranging patterns and the composition of the diet are modified. Forest structure also affects the penetrability of the surroundings and visibility (Bourlière, 1979), and can be expected to play an important role in determining the pattern of movements and the communication of primates, particularly with respect to morphological adaptations and defence strategies against predators. Waser and Brown (1986) maintained that the differences in the structure of vocalisations in the various primate species are likely to be attributable to the differences in the acoustic ecology of their respective habitats.

The distribution of samango monkeys in the Eastern Cape is determined by the presence of forest patches that suit the animals’ modes of feeding, locomotion and communication. Although the Eastern Cape has several different types of forests, samango monkeys are found only in certain patches, suggesting that these primates are selective in terms of the habitats which they prefer.

2.2 The study area

I investigated all of the nature reserves in the East London area and along the Wild Coast, including both coastal dune forests and patches of Afromotane forest, to establish the extent of the distribution of the samango monkeys in the Eastern Cape.

2.2.1 Characterisation of Eastern Cape coastal dune forests

According to Lawes et al. (2004), South Africa has two forest types, the Afromontane forests, which are also referred to as Afrotemperate forests, and the Indian Ocean coastal belt forests, with an intermediate coastal scarp forest, in terms of species composition and geography, situated between them. Although approximately 7% of South Africa's land surface is climatically suitable for the development of forests, forested areas constitute as little as 0.1 to 0.56% of it (Mucina and Rutherford, 2006). Most forests are fragmented and patches tend to be very small, less than 100 hectares, from personal observations. The removal of trees for timber and fuel, the over-exploitation of plants and animals for traditional medicines, and the clearing of forests for agriculture, housing, commercial plantations and mining, are the greatest threats to these forest patches (Lawes et al., 2004). The coastal dune forests fall within the Indian Ocean coastal belt biome (Rutherford et al., 2006); the Indian Ocean coastal belt formed relatively recently in geological terms, after the last glacial maximum (Lawes, 1990), which occurred approximately 23-18 000 years ago (Gasse, 2000).

The Eastern Cape coastal dune forest occupies a narrow strip along the Wild Coast of the former Transkei and the Indian Ocean seaboards between Port St. Johns and Cape St. Francis, to the west of Port Elizabeth (Mucina and Rutherford, 2006). This strip of forest is known to harbour many endemic species and is also responsible for the isolation of populations of rare or tropical species found at the southern limit of their distribution, such as the reticulated python, the spotted ground thrush and the barred owl. It has been estimated that the mammals and birds found within these forests make up over 5% of the taxa found in South Africa (Geldenhuys and MacDevette, 1989). Anthropogenic activities have severely affected the extent of the coastal dune forest (Eeley et al., 1999), such that the remaining patches are listed as vulnerable, and approximately 1% of them are protected (Mucina and Rutherford, 2006).

For the purpose of this study all the protected areas within the Eastern Cape coastal dune forests were surveyed, from the East London coast to the Wild Coast (see Figure 2.1). All these protected areas are under the management of the Eastern Cape Parks and Tourism Agency.

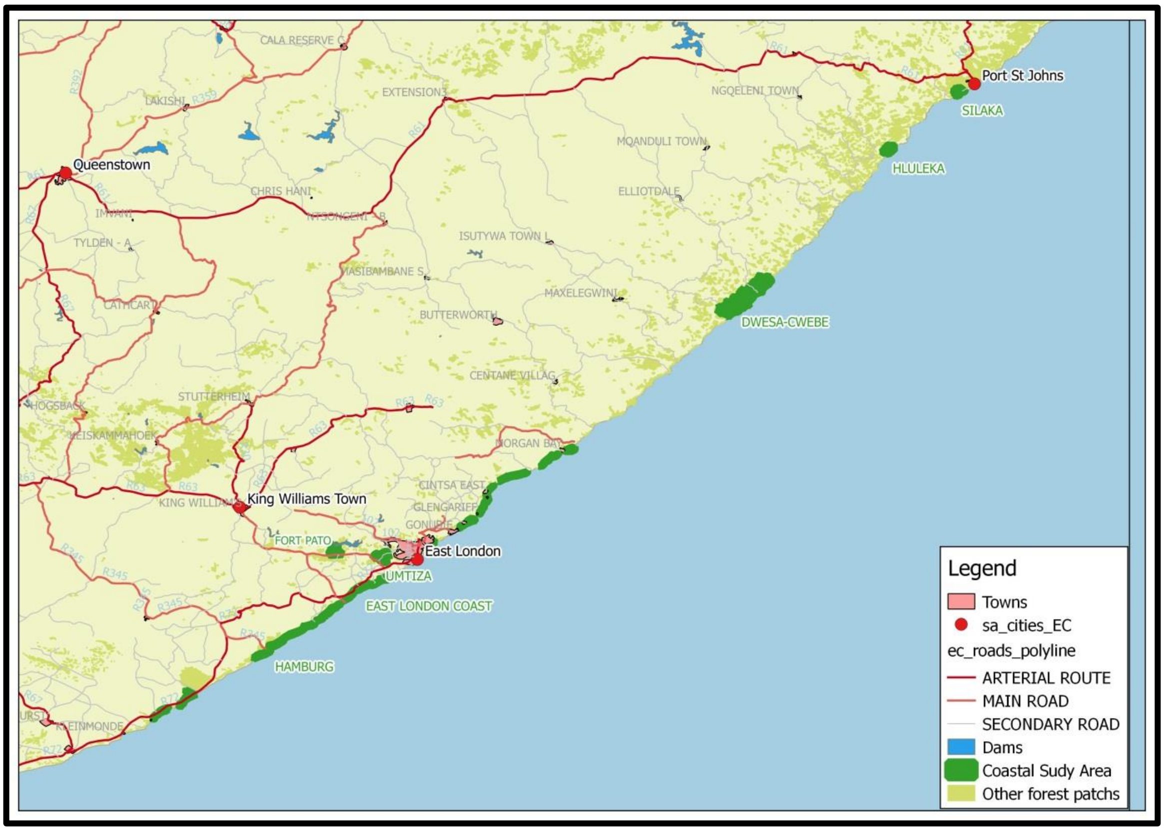

Figure 2.1: Map illustrating the Indian Ocean coastal belt forests surveyed.

East London Coast Nature Reserves (ELCNR)

According to the Eastern Cape Parks and Tourism Agency's strategic management plan (SMP, 2010), the East London Coast Nature Reserves (ELCNR) embrace five main vegetation types and the transitional coastal forest which occurs in the Umtiza and Fort Pato nature reserves. The canopy generally varies in height between 5 and 10 m in exposed areas but may grow to 20 m. In more protected areas, trees such as *Ptaeroxylon obliquum* (sneezewood), *Buxus macowanii* (Cape box) and *Harpephyllum caffrum* (African wild plum) are the common canopy-forming trees. The understorey is dominated by scrambling shrubs (Low and Rebelo, 1996).

The SMP (2010) of the ELCNR also describes valley thicket, or sub-tropical thicket, which occurs in the Fort Pato nature reserve and to a lesser extent in Umtiza nature reserve, as forming dense thickets of mainly woody shrubs and trees with a closed canopy up to 6 m in height. The third vegetation type in the ELCNR is the eastern thorn bushveld, or dry savanna, which usually occurs on the dry upland ridges above the valley thicket (Mucina and Rutherford, 2006).

While most of the mammal species which once were found locally have become extinct over the last century, many animals still occur in the ELCNR, including the threatened Afromontane samango monkey at Umtiza (ELCNR SMP, 2010). Rare fauna such as blue duiker (*Philantomba monticola*) and tree dassies (*Dendrohyrax aboreus*) are also found in these nature reserves. Cape parrots used to be seen at Umtiza, but from my own observations and those of my colleagues, they have not been seen for many years. The ELCNR nevertheless has a diversity of flora and fauna that is worthy of protection.

The Dwesa and Cwebe nature reserves

The strategic management plan of 2012 for the Dwesa-Cwebe nature reserves describes the environment of these reserves as complex, containing ecosystems which are considered rare and of great importance for conservation. The Dwesa nature reserve comprises roughly 80% indigenous coastal scarp forest and 20% Transkei coastal belt grassland or other vegetation types, while the ratio for the same vegetation types in Cwebe is considered to be roughly 50:50 (Mucina and Rutherford, 2006). These authors also explain that in general, indigenous forest covers the inland areas of the reserves, with a narrow strip of coastal grassland bordering the Indian Ocean, and dune and scrub forest – both of which are classified as sensitive vegetation types – also found close to the coast. The coastal forests are among the largest remaining indigenous forests on the Eastern Cape coast, and they have a unique floral composition.

In common with the rest of the Wild Coast region, populations of alien, invasive plants are increasing in the Dwesa and Cwebe nature reserves (Dwesa-Cwebe SMP, 2012). Invasive species known to occur are Mauritius thorn, lantana, inkberry, morning glory, bugweed, guava, black wattle, *Eucalyptus* spp., *Sesbania*, peanut butter cassia and jacaranda (Dwesa-Cwebe SMP, 2012).

After the reserves were fenced in the late 1970s, a range of large game species was introduced into the Dwesa and Cwebe nature reserves, including bulk grazers such as Cape buffalo, blesbok, Burchell’s zebra, red hartebeest, white rhinoceros and blue wildebeest (Dwesa-Cwebe SMP, 2012). Apart from Cape buffalo, most of these species probably did not occur naturally in the area in the past. Bushpig, grey duiker, bushbuck and blue duiker always occurred in the area and are still present (Dwesa-Cwebe SMP, 2012).

No information concerning samango monkeys was available for these reserves, and only a few people knew of their existence. This could be because samango monkeys are forest-dwelling primates and frequent areas in the reserves which are far from human habitation.

Hluleka nature reserve

According to the Hluleka nature reserve SMP of 2012, the reserve is located in the magisterial district of Ngqeleni in the Nyandeni Local Municipality, and lies approximately 87 km south-east of Mthatha by road and 45 km south-west of Port St. Johns along the coast. Mucina and Rutherford (2006) described the vegetation as scarp forest and coastal forest, which cover approximately 70% of the reserve, and thicket and Transkei coastal belt grassland, which cover the remainder. The forests appear to be in relatively good health, but they are invaded in places by alien vegetation, particularly in the riverine areas (Hluleka nature reserve SMP, 2012).

There are numerous large to medium-sized mammals in the reserve, including chacma baboons, blue wildebeest, bush buck, blesbok, black-backed jackal and bush pig (Hayward et al., 2005). A mammal survey conducted by the latter authors in the reserve showed that small mammals such as blue duiker, common duiker and large spotted genet, to name a few, are indigenous to the reserve. Both vervet monkeys and samango monkeys are present, and both are listed as indigenous to the area.

Silaka nature reserve

The strategic management plan of 2012 for Silaka nature reserve describes it as a small nature reserve of 340 ha, situated approximately 7 km south-west of Port St. Johns. According to Mucina and Rutherford (2006), the reserve is dominated by a relatively healthy coastal forest with small patches of alien species in riverine areas. Apart from the forest vegetation, thicket is the most common vegetation found in the reserve, and dune forest is not well represented, occupying less than 20 ha (Mucina and Rutherford, 2006).

The introduction of large mammals to the reserve has proved to be problematic, owing to the small area covered by the reserve (Silaka nature reserve SMP, 2012). There have been reports by the local people of sightings of leopards in and around the reserve, but these have not been confirmed. Extra-limital species such as the blue wildebeest and Burchell’s zebra were introduced, but have since been phased out (Silaka nature reserve SMP, 2012). Samango monkeys and vervet monkeys are indigenous, and may be observed in large troops throughout the reserve (Hayward et al., 2005).

2.2.2 Characterisation of Amatola mistbelt forest

The forests which occur in the high rainfall areas of the Eastern Cape from sea level to montane altitudes are all of the Afromontane type (White, 1981). According to Lubke (1986), in the Eastern Cape these Afromontane forests may be categorised into three distinct types, (1) the montane forests which form pockets of forest islands extending from the Drakensberg over a number of mountainous regions in the Eastern Cape, (2) the Amatola Mountains, the forests of which form some of the most species-rich forested areas in southern Africa, and (3) the Knysna forests.

Phillipson (1987) explained that the name Amatole Mountains has been applied to a vaguely-defined section of the Winterberg range, centred on the well-known Hogsback Ridges. In his study Phillipson (1987) described the Amatola Mountains as being a part of a long outlying spur of the high interior plateau of southern Africa. The spur extends south-east and then east from the Great Escarpment, gradually losing height and disappearing near the town of Stutterheim.

The vegetation of the Amatola Mountains consists predominately of plants with Afromontane affinities (White 1981), and many typical Afromontane species reach their southern limits in this region. According to the classification of vegetation by Acocks (1975), these mountains fall within an area of highland and Dohne sourveld. As a result of the high rainfall in the area, the Amatola Mountains are able to support well-developed high forests (Phillipson, 1987). White (1983) referred to these as floristically rich, containing both evergreen and deciduous species, with large specimens of *Podocarpus falcatus* (yellowwood) being particularly prominent. Anthropogenic activities have had a significant influence on the vegetation of the Amatola Mountains as forestry, residential and recreational developments have facilitated the introduction of exotic species in the area (Philipson, 1987).

The climate of the Amatola Mountains is temperate, characterised by high rainfall, cold winters and moderately warm summers in comparison with other parts of southern Africa (Story, 1952). From my own observations, fog and mist are common on the escarpment and south-facing mountain slopes. Figure 2.2. illustrates the Afromontane forest patches surveyed in this study.

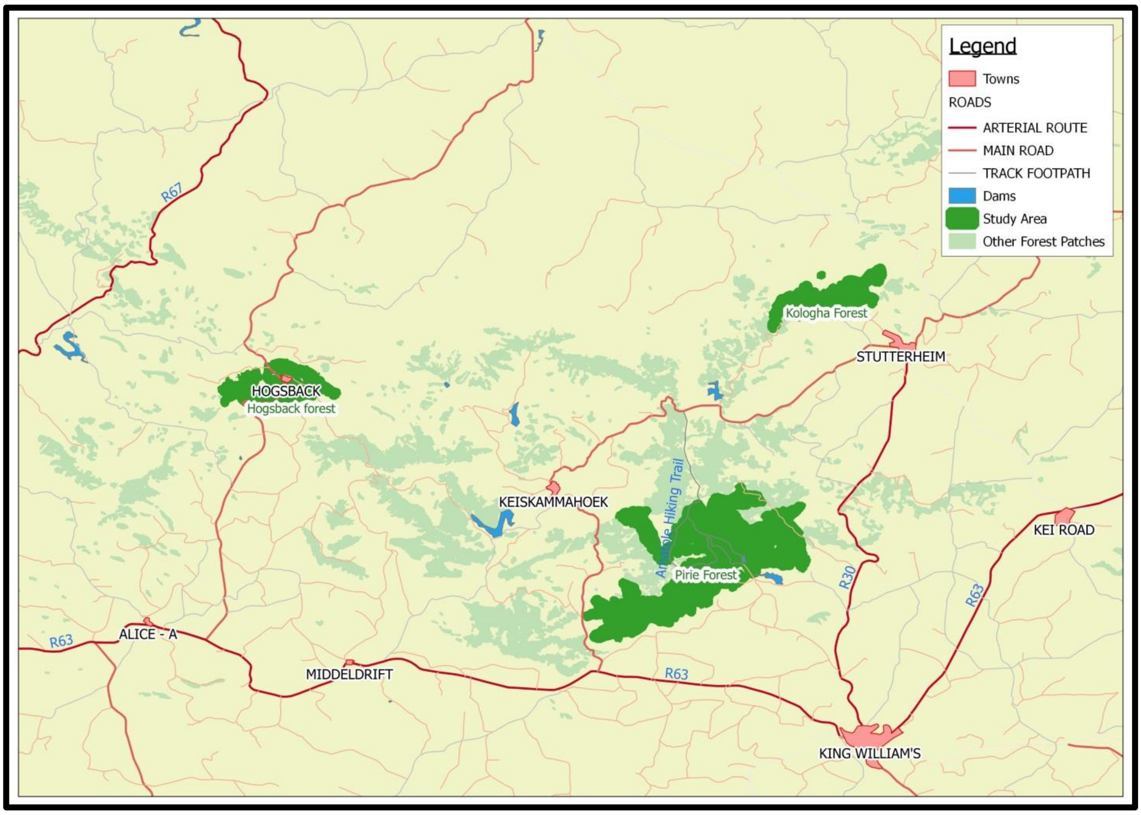

Figure 2.2: Map illustrating the Eastern Cape Afromontane forest surveyed

Pirie forest

Pirie forest occurs on the southern slopes of the Pirie Mountains in the Evelyn Valley sector, approximately 20 km north-west of King William’s Town in the Eastern Cape. Low and Rebelo (1996) described the Pirie forest as an Afromontane forest situated at an altitude of 580 m, which is based on mudstone, shale and sandstone and has 43 predominant species of trees.

Kologha forest

Kologha forest is located mainly along the south-facing foothills of the Kologha Mountains, an eastern extension of the Amatola Mountains near Stutterheim in the Eastern Cape (Skead, 1964). The slopes of this area are densely covered by ancient forests of yellowwoods (*Ptaeroxylon obliquum*), white stinkwoods (*Celtis africana*), Cape chestnuts (*Calodendrum capense*) and other indigenous trees (Phillipson, 1987). The vegetation in Kologha forest includes Afromontane forest and montane grassland. A subtropical climate prevails, with rainfall averaging 952 mm per annum, and mainly occurring in summer (Kopke, 1988).

Hogsback forest

Hogsback forest is located in the Amatola Mountains at the junction of several ecosystems, including a mist belt yellowwood (*Ptaeroxylon obliquum*) forest and alpine grasslands. The area is home to several endangered species, including the Cape parrot, the Afromontane samango monkey and the Amatola toad.

There is a limited amount of literature concerning the forest reserves that make up the Amatola forest, and consequently, not much is known about them. In formulating my study, I predicted that samango monkeys should be abundant in these forest reserves, as they form a part of the Amatola montane forests.

2.3 The groups of samango monkeys studied

For purposes of comparison one troop was selected in each of the two focal study areas, namely the Hogsback forest and the Umtiza nature reserve. Troop selection was based on regular observations and the presence of accessible footpaths in the forests. The troops were studied for periods of equal duration during the summer of 2014 – 2015.

As the troop studied in the Hogsback forest has its range in the yellowwood forest in and around the Swallowtail Country Estate, I referred to it as the Swallowtail troop. Its range consisted mainly of forest, with rocky cliffs where baboons were often present, and there were also a few human dwellings situated within it. The troop was observed feeding in the gardens of the residents, and hence the monkeys tend to be regarded as pests. The Swallowtail troop consisted of between 30 and 40 individuals, but the exact number was difficult to determine as the troop was scattered during its daily foraging activities. I observed the troop feeding on the leaves of yellowwood and black wattle trees and on the fruits of Belhambra trees, the latter two being alien species in South Africa. During the course of my observations, two adult males were present in the troop, usually accompanied by females with infants, juveniles and sub-adults. The troop was observed to have one sleeping site, in the plantation across the road from the Swallowtail Country Estate, which has tall pine trees, and is not far from where they foraged. During their daily foraging the troop occasionally encountered baboons. No violent encounters were recorded when the two primate species met. The monkeys in the Swallowtail troop were relatively habituated to the presence of human beings, which made counting this troop easier. A small bachelor troop consisting of 4 or 5 males was also observed in the area around the Swallowtail Country Estate.

In the coastal forests near East London, samango monkeys are present in two forest patches, in the Umtiza and Fort Pato nature reserves. The two forests are comprised mainly of transitional forest with tall sneezewood trees (*Ptaeroxylon obliquum*). The troop studied in Umtiza inhabits the area near the staff village where the reserve staff resides, and hence, for the purposes of this study, it is called the “staff village troop”. It consists of 35 to 45 individuals, but owing to the constant movement of the troop and the lack of proper footpaths, it was not possible to achieve an exact count. Each morning the troop was observed crossing the road from the adjacent forest in which they were assumed to rest. This forest has no trails and is very thick, and consequently, once the monkeys had entered the forest, it was very difficult to follow them. The troop was observed feeding mainly on the leaves of the sneezewood and bugweed *(Solanum mauritianum)* trees and the fruits of the poison star-apple tree (*Diospyros dichrophylla).* Compared with the Hogsback troop, the staff village troop foraged far from its assumed sleeping site and, as a result, the troop needed to travel a long distance to its preferred foraging area every day.

2.4 Field survey methods

A study of the distribution of wild primate populations typically involves a considerable investment of time and resources such as money, equipment, travel and labour. Accumulating data pertaining to the presence or absence of a primate species can help to establish the geographic range and the habitat requirements of a primate species (Singh et al., 1999). Data gathered for this purpose can also contribute towards species lists, biodiversity evaluations and the identification of suitable sites for further ecological or behavioural studies (McGraw, 1998). The presence of primates in an area may be detected from both direct and indirect evidence such as: (1) direct observation of live animals, (2) observation of signs left by the animals, (3) observation of animals captured or killed and (4) reports from local residents.

Both direct and indirect methods were used to survey the distribution of samango monkeys in the Eastern Cape, and population estimates were made concerning both the Swallowtail and the staff village troops.

2.4.1 Questionnaires, interviews and sighting reports

One of the simplest methods of determining species distributions and gaining a subjective estimate of animal abundance is to collect reports of sightings and general impressions from various people in the field (Gese, 2001). Questionnaires, interviews and sighting reports from hunters, rangers, tourists and field personnel have been used, with some success, to measure animal distributions (Nilsen et al., 2007). More in-depth questionnaires or interviews conducted with people who have intimate knowledge of the area and who spend considerable time in the field, such as field rangers and guides, may provide not only information concerning distribution, but also a general, subjective estimate of abundance (Gese, 2001).

Questionnaires are used in ecological research to test research hypotheses when information concerning the distribution of animals is required. According to White et al. (2005), the use of questionnaires can be crucial for gaining an understanding of primate behaviour and ecology. Significantly, questionnaire surveys have been used to determine the success of introduced species, to assess the degree of conflict between wildlife and human populations and to study the distribution patterns of various different species (Thorn et al., 2011). In order to assess the distribution and to estimate the abundance of the samango monkey subspecies *Cercopithecus albogularis labiatus* in the Eastern Cape of South Africa, I conducted questionnaire surveys.

I compiled a semi-open-ended questionnaire to administer to people living in and around the nature reserves and forest patches in the Eastern Cape. The questionnaire (see Appendix 1) consisted of four sections and a total of 115 interviews were conducted. In the first section respondents were asked to answer general questions concerning their socio-economic status and the depth of their knowledge of the reserve or the specific area in question. The purpose of the second section was to assess the knowledge of the respondents concerning samango monkeys and whether they had observed them in the area. The third section was designed for those respondents who had confirmed that samango monkeys were present in the area and focused mainly on the diversity and composition of the troops observed. The aim of the final section was to obtain insights into the difficulties encountered by samango monkeys within a specific area and how people tend to perceive the monkeys.

All of the questionnaires were administered in person, in the first language of the various respondents, to ensure the maximum completion of the questions and the best overall understanding of the phenomenon being studied (White et al., 2005). The answers were later translated by the interviewer into English, where necessary, in order to facilitate their interpretation and analysis. The data were collected between June 2014 and January 2015.

2.4.2 Direct counts

Direct counts involve the actual counting of the animals themselves, as opposed to counting signs (Giese, 2001). Counts include both dead animals, such as mortality samples or road kills and live animals, such as those which have either been sighted or trapped. Apart from helping to determine the distribution of the species in question, direct counts also provide biologists with an estimate of the densities of the species in a given area. According to Caughley (1977), counts may involve total counts of an area or a sector of the area with extrapolation to the whole area of concern. Stratification of sections according to different types of habitat or classes of land could serve to increase the validity, usefulness and precision of surveys (McDonald et al., 1998a). When it is possible for biologists to count animals directly, it may be done along transects, strips, in quadrats or within a defined area, in order to estimate population density or the size of groups (Gates, 1979).

The monitoring of primates is generally conducted using surveys, sweep census methods or linear transect methods (Struhsaker, 2002). The choice of methods will depend on the data required and the objectives of the study. More general methods, such as broad geographical surveys, yield useful information on large-scale patterns of species richness over a variety of habitats, but they lack the statistical rigour needed for the sensitive monitoring of long-term trends in either richness or abundance (Wilson et al., 1996).

For this study I employed line transect surveys to estimate the abundance of samango monkeys in the two focal areas of the study, namely the Hogsback state forest and the Umtiza nature reserve. Line transects constitute the method of choice for estimates of absolute density, and this approach is widely applied in studies, both of mammals in general and of primates in particular (Wilson et al., 1996). This method of direct observation is difficult to carry out, is costly in terms of both time and labour, and tends to underestimate animal densities (Beck-King et al., 1999). A single troop was selected in each of the focal study areas on the grounds of accessibility. Line transect surveys were conducted, and when a troop of samango monkeys was encountered during the survey, the date, time and GPS coordinates were recorded. Two methods of observation were used. The first involved focusing closely on the first animal spotted (focal-animal sampling): an estimate was made of its height in the tree it occupied and the following behaviours were recorded: foraging, resting, grooming and moving; the second consisted of a scan of the entire troop (scan sampling), in order to assess the total number of individuals and the numbers of males, females and juveniles. When the troop was observed feeding, samples of the food were collected and identified.

2.4.3 Presence of signs

Sightings of primate species allow direct confirmation of the presence of a species. However, in the absence of visual confirmation of the animals themselves, biologists may resort to surveys of animal signs to determine whether a species is present in a given area (Giese, 2001). If an animal cannot be observed directly, calls may be used to identify the species when visibility is poor and they may also be used to gain insights into the distribution of the species (Brockelman and Ali, 1987). Sign surveys have been used to determine the distribution of most primate species (Ross and Reeve, 2003). Blom et al. (2001) have listed several different methods of conducting sign surveys which have been used to evaluate primate distributions, including those making use of calls, fallen fruits and hair samples.

Sign surveys can serve a dual purpose. In their most rudimentary form they provide information about distributions (Giese, 2001), and through the standardisation of methodologies and the amount of effort put into conducting them, sign surveys may also be used as an index of abundance (Kohn et al., 1999). The number of signs produced by an individual animal can be affected by many factors, including its age or sex, the size of the home range, the type of habitat, the time of year and weather conditions. As a result, for relative abundance surveys physical signs alone cannot be used to estimate trends in the abundance of a particular species.

Indirect surveying methods, such as the presence of signs, do allow distribution and abundance to be estimated when the signs produced by the animals are more easily detected than the animals themselves, as a result of their living in concealing types of habitat at low densities, or of their tending to move away before they can be seen (Putman, 1984).

In order to assess the distribution of samango monkeys, I employed sign surveys as one technique to gain an indication of their presence or absence. The signs indicating the presence of samango monkeys included calls and half- consumed fruits and plants found on the ground.

2.4.4 Remote camera traps

The use of remote camera traps is a relatively new method for gaining insights into the distribution and abundance of a species (Foster and Harmsen, 2012). This method of surveying is becoming increasingly popular and has been used successfully to detect the presence of several animal species (Giese, 2001). These cameras can be set to be triggered by an animal tripping a line, or activated remotely by pressure-sensitive plates or motion or heat detectors (Ross and Reeve, 2003). While these camera traps are used mainly to detect the presence of animals, they could potentially be used to identify individuals if they have been tagged or are distinguishable, in terms of markings or mutilations, from others in the same group (Giese, 2001)

Giese (2001) maintained that remote camera traps have the added benefit of providing a permanent photographic record which is available for examination by other researchers. He also pointed out the disadvantages of remote camera traps, particularly in terms of affordability, as they are fairly expensive. For the purposes of this research I placed remote cameras in particular forest patches where people had confirmed the presence of the monkeys. Not all the forest patches were surveyed using remote camera traps, owing to the fact that only a few traps were available.

2.4.5 Assessment of troop size

Samango monkeys are very difficult to identify individually and troop sizes were estimated using scan sampling, a method which has proved useful in estimating the numbers and population structures of various primate species, including samango monkeys

(*Cercopithecus albolgularis),* vervet monkeys (*Chlorocebus aethiops*) and (*Cercocebus* atys) mangabeys (Lawes and Piper, 1992; Waser, 1975; Harrison, 1985).

Counts were made by either one or two observers (second observers were Lawandiso Pamla or Ayaka Peter), who were on foot and covered approximately 1 km each day. Each troop was counted for 5 days per month for 5 months and their locations were specified using a Global Positioning System (or GPS) recorder. Each troop was located early in the mornings in the immediate vicinity of their sleeping sites and counted as the monkeys departed to forage. This allowed us to obtain repeated, reliable counts of each troop, as they both crossed a small road in order to reach their preferred foraging areas in the respective forests. GPS coordinates were taken every 10 to15 min in order to estimate the home range of the troops.

2.5 Computer-based methods

2.5.1 Habitat mapping and modelling

Mapping of potential habitats, also referred to as the development of species distribution models or SDMs, has been widely used for the past two decades (Guisan and Thuiller, 2005). One of the most fascinating topics in evolutionary ecology is how plants and animals are distributed on the earth. As Guisan and Thuiller (2005) explained, most modelling approaches developed for predicting plant or animal distributions have their roots in quantifying species–environment relationships. Making use of correlations between distributions of species and climate seems to have constituted the earliest form of modelling, as may be seen in the work of Johnston (1924).

Species distribution models are empirical models relating field observations to environmental predictor variables based on statistically or theoretically derived response surfaces (Guisan and Zimmermann 2000). According to Guisan and Zimmermann (2000), the rise of new, powerful statistical techniques and GIS tools have seen a rapid growth of predictive habitat distribution models in ecology. These models are static and probabilistic in nature, as they statistically relate the geographical distribution of species or communities to their present environments (Guisan and Thuiller, 2005). A wide range of models has been developed to cover aspects as diverse as biogeography, conservation biology, climate change research and habitat or species management (Austin, 2002).

As I discussed in Chapter 1, the signal propagation qualities of the environment are likely to be very important in terms of habitat preferences. Animals select suitable sensory habitats, and the presence of conspecifics and the physical properties of the environment influencing the propagation of specific signals may be the first cue used by animals to judge the adequacy of a given environment for potential occupation. By mapping the potential habitats of samango monkeys, insights into how these primates select habitats and the extent of their distribution in the Eastern Cape can be gained.

2.5.2 Museum records

Though field surveys are very important, museum specimens provide a valuable historical record of the localities of organisms (Graham et al., 2004). Museums store and preserve animal specimens from different locations, sometimes with the GPS coordinates of the animal's collection locality. Museum specimens form the basis for research in evolution, speciation and distribution, and they also provide an important baseline for studies of conservation (Newbold, 2010). Accordingly, museum data can be of enormous value to conservation biologists and ecologists for studying past and present distributions and abundance of species.

When used judiciously, museum data can provide invaluable assistance to efforts to understand patterns in the distribution of species (Harmon et al., 2009). Museum records present us with records of the presence or absence of species. When the amount of time and money necessary for the conducting of surveys of the occurrence of species is taken into consideration, the wisdom of making use of records from museums becomes self-evident (Newbold, 2010, Graham et al., 2004). Museum records can also be used to identify areas which are important for species of concern for conservation, in order that their habitats may be protected (Newbold, 2010). Museum records have been used in many studies endeavouring to assess changes in distribution over time (Araujo and Guisan, 2006; Wintle et al., 2005). Conservation ecologists often use species richness to assess how important it is to protect an area because it is relatively easy to measure, although other criteria may be more informative (Kershaw et al., 1995; Margules and Pressey, 2000; Wilson et al., 2007). However, extensive gaps in our knowledge of the distribution of species mean that even species richness estimates may be unavailable for many areas (Newbold, 2010).

For this study I collected records from the Amathole Museum in King William's Town, which were used to assist in determining the distribution of samango monkeys in the Eastern Cape. Data pertaining to *Cercopithecus albogularis labiatus* from the Amathole Museum provided me with important information regarding the distribution of the subspecies, although some of the locations cited in the data have subsequently proved to be incorrect.

CHAPTER THREE: RESULTS OF FIELD SURVEYS

3.1 Distribution of samango monkeys in the Eastern Cape province

The distribution of *C. a. labiatus* was assessed in different forest patches in the Eastern Cape. Several methods were used to evaluate the presence or absence of *C. a labiatus* in these forest patches, including questionnaire interviews with different people who either lived or worked in and around these forest patches; and direct and indirect field observation methods to confirm the results obtained from the questionnaire interviews. In this chapter I present these results.

Direct field observations of samango monkeys were attempted in all of the 14 forest patches I surveyed, but observations of *C. a. labiatus* were possible in only 4 forest patches, hence indirect detection methods were employed in the other areas, including searching for signs left by samango monkeys and the use of remote camera traps. In this chapter I also present the results of troop size and composition estimates for two troops from the two distinct habitat types in which I have found *C. a. labiatus*: i.e. the Afromontane and coastal forests. The two troops were followed for 5 months each in their respective habitats.

3.1.1 Questionnaires

Questionnaire interviews were conducted with people I encountered in and around the surveyed forest patches. The interviews were carried out by one or two interviewers, in the respondents' preferred language (English or Xhosa). When the interview was conducted in Xhosa it was later translated into English. In total, 115 interviews were conducted in the 14 surveyed forest patches. The respondents varied from reserve employees (reserve managers, nature conservators and field rangers), scientists who worked in the area, and local community members.

Of the 115 respondents, 82% were males and 18% were females (see Table 3.1). The majority of respondents had some level of education: 43 (37%) had secondary education, 39 (34%) had at least a primary education and 30 (26%) had a tertiary education in the form of a university degree or a diploma. Only 3 (3%) of the respondents had no education at all (Table 3.1). As shown in Table 3.2, only 9 (8%) of the questionnaire interviews were conducted in isiXhosa as the respondents could only speak isiXhosa. The remainder (92%) were conducted in English, as most of the respondents understood and could respond in English even if it was not their first language. The average age of the respondents was 47 (± 14.66) years (range: 21-79).

All 30 of the respondents with a tertiary education could differentiate between a samango monkey and a vervet monkey without being shown pictures. While only 20 of the respondents with a secondary education had to be shown pictures, the rest knew what a samango monkeys were. All 39 of the respondents with a primary education needed to be shown pictures of the two primate species in order for them to confirm samango monkey absence or presence (Appendix 2 and 3). All 3 of the respondents with no education were elderly males who knew the respective forests very well and knew the difference between Inkawu (vervet monkey) and Intsimango (samango monkey). I viewed the interview data as having a high level of reliability, as all the respondents knew what a samango monkey was.

Information obtained from the 115 questionnaire interviews conducted throughout the Eastern Cape confirmed the presence of samango monkeys in eight out of 14 nature reserves (see Table 3.2): five were comprised of coastal forest, while three consisted of Afromontane forest.

Table 3.1: Summary of the demographics of the respondents interviewed

Demographics of responder		Number	%
Gender:			
	Males	94	81.7%
	Females	21	18.3%
Language:			
	English	91	92.2%
	Xhosa	9	7.8%
Education:			
	None	3	2.6%
	Primary School	39	33.9%
	High School	43	37.4%
	Tertiary Education	30	26.1%
Age:			47(±14.66)

Table 3.2: Presence and absence of samango monkeys in surveyed forest patches and nature reserves

Forest Name	Forest Area	Forest Type	Present/Absent
Hamburg nature reserve	East London coast	Coastal forest	Absent
Kidd’s Beach nature reserve	East London coast	Coastal forest	Absent
Umtiza nature reserve	East London coast	Transitional coastal forest	Present
Fort Pato nature reserve	East London coast	Transitional coastal forest	Present
Kei Mouth nature reserve	East London coast	Coastal forest	Absent
Cape Morgan nature reserve	East London coast	Coastal forest	Absent
Morgan’s Bay nature reserve	East London coast	Coastal forest	Absent
Double Mouth nature reserve	East London coast	Coastal forest	Absent
Pirie forest	Amatole Mountains	Afromontane	Present
Hogsback forest	Amatole Mountains	Afromontane	Present
Kologha forest	Amatole Mountains	Afromontane	Present
Dwesa-Cwebe nature reserve	Wild Coast	Indigenous coastal scarp forest	Present
Silaka nature reserve	Wild Coast	Indigenous coastal scarp forest	Present

In the coastal forests in and around East London, *C. a. labiatus* was present in only two forest patches, while the taxon was present in all three of the forest patches surveyed on the Wild Coast, in the north-east of the Eastern Cape. In the forests which lie along the Amatola Mountains, Afromontane samango monkeys were found in abundance in the Hogsback, Pirie and Kologha forests.

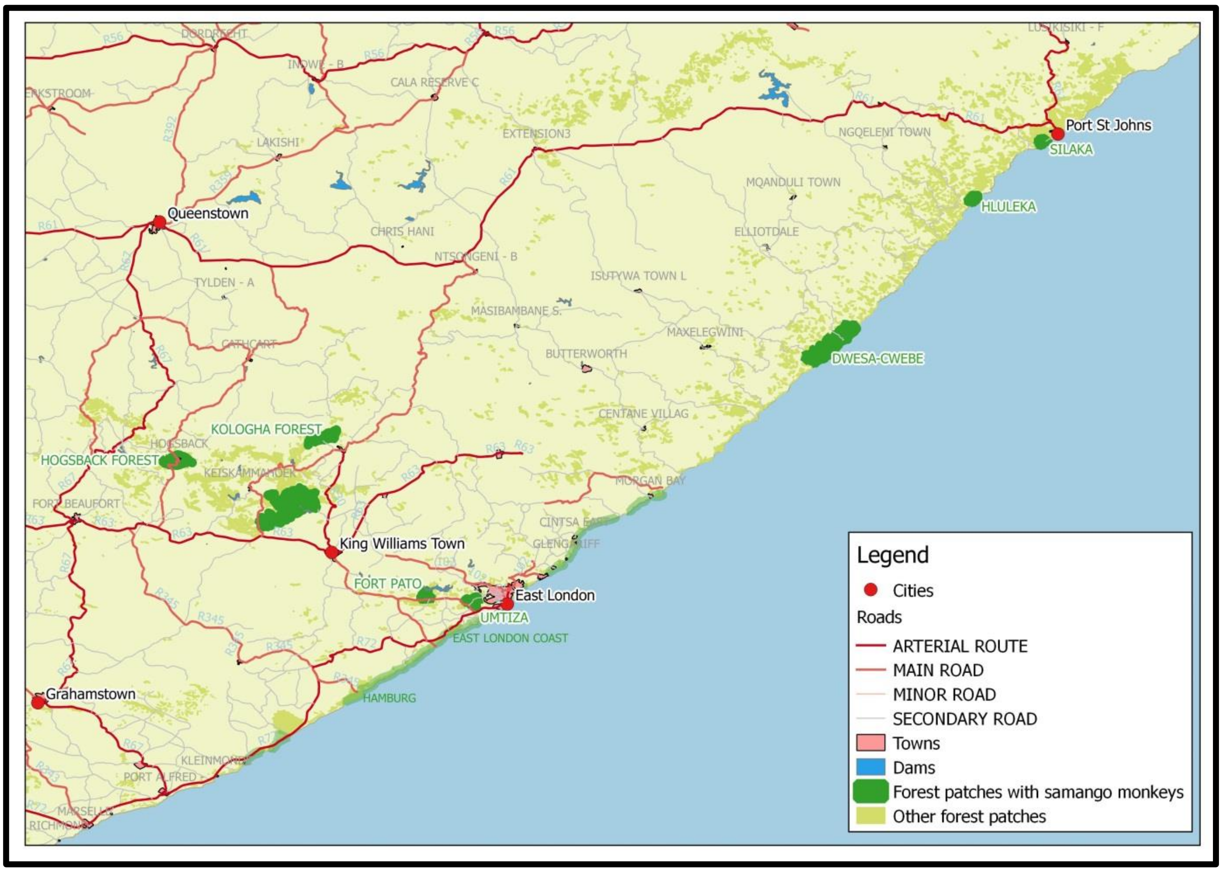

Figure 3.1: Map illustrating forest patches where questionnaire interviews and reported sightings confirmed the presence of *Cercopithecus albogularis labiatus*.

3.1.2 Direct observations

In order to validate the data obtained from the questionnaire interviews, it was necessary to conduct field surveys to confirm the presence of samango monkeys directly. My field surveys were carried out in all of the forest patches where questionnaire interviews had been conducted, including those where the absence of *Cercopithecus albogularis labiatus* had been reported (Figure 3.2).

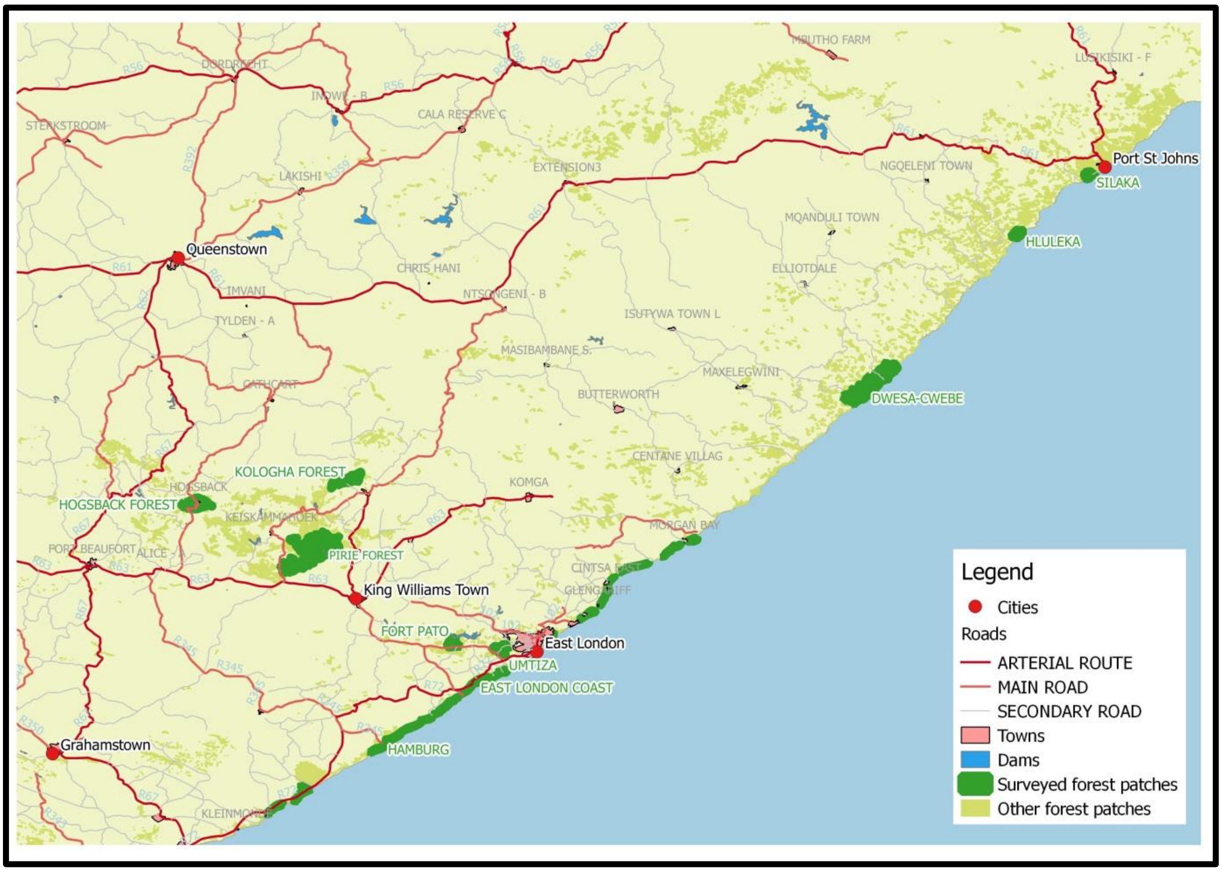

Figure 3.2: Map illustrating all of the forest patches surveyed in the Eastern Cape

Figure 3.2 illustrates the forest patches surveyed throughout the Eastern Cape. A series of 1 km line transect surveys were conducted in all forest patches. Visual observations were possible at the Umtiza and Fort Pato nature reserves and in the Hogsback and Kologha forests. In Umtiza nature reserve 4 troops were observed, all which comprised 20 or more individuals. Three troops were observed at Fort Pato nature reserve. Owing to the small size of the reserve, the troops foraged close to each other and at times two troops spent time feeding in the same area. In the Afromontane forests, visual observations of samango monkeys were possible in Hogsback and Kologha forests. An estimation of the exact number of troops was not possible in these forests, as there were many troops present. A recent assessment of troops in the Hogsback forest in and around the village estimated a minimum of 15 troops (Guzzo and Baldi, personal observations).

3.1.3 Presence of signs

In some of the forest patches surveyed it was not possible to make visual observations of the samango monkeys, although the results of the questionnaire interviews revealed that the animals were known to be present there. This made it imperative to look for field signs left by the monkeys in these forest patches. Figure 3.3 below shows the forest patches where field signs confirming the presence of Afromontane samango monkeys *Cercopithecus albogularis labiatus* were found.

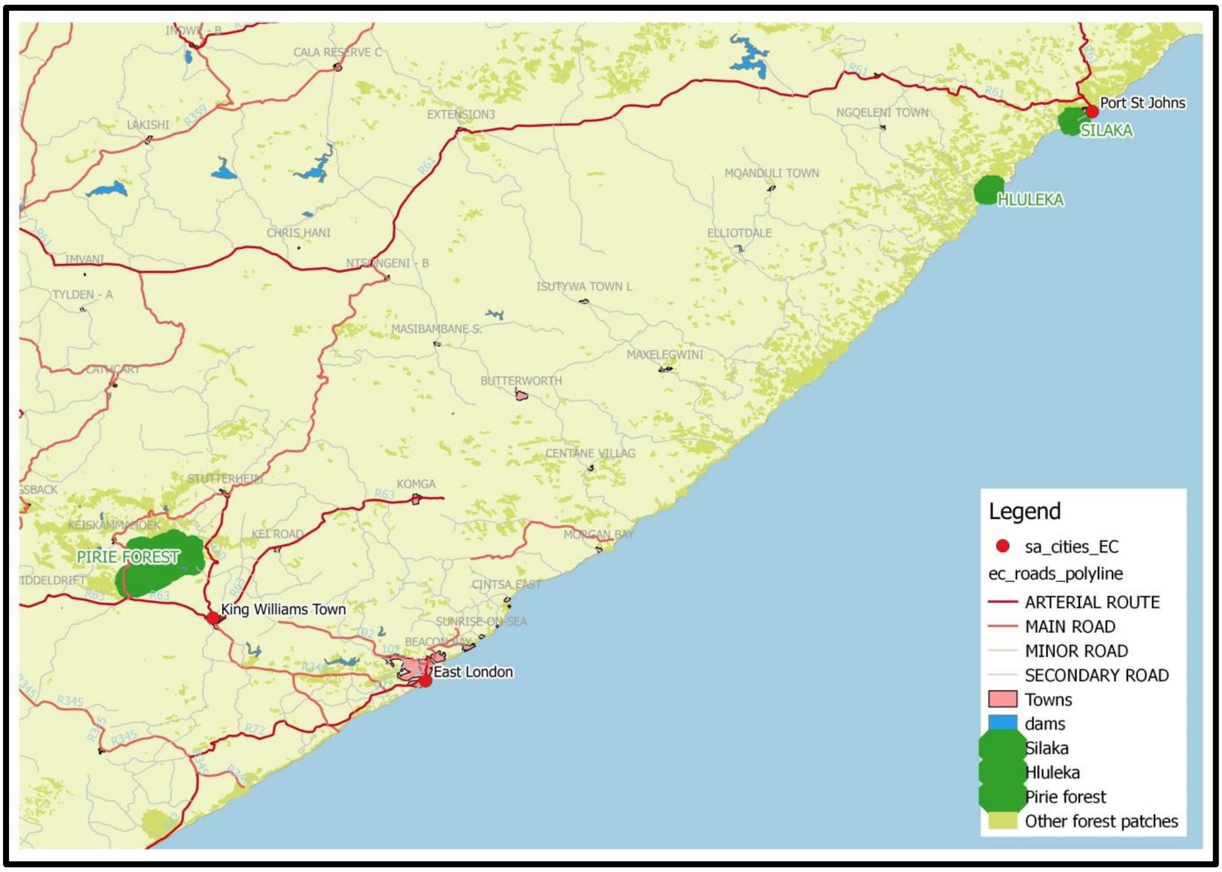

Figure 3.3: Map illustrating the forest patches where surveys for field signs were conducted.

Surveys for field signs were conducted in three forest patches, namely the Silaka and Hluleka nature reserves on the Wild Coast and the Pirie forest in the Amatola Mountain forests. Sign surveys were conducted for 1-2 days per forest patch. In all three of the forest patches samango monkey vocalizations were clearly heard, confirming their presence in these forest patches. The dominant calls heard throughout the forest patches were the contact calls produced by the females, referred to as “grunts” or “trills”, and used to locate other members of the troop. Occasionally alarm calls were given by the females when they observed me or the field assistants. These were series of “pyows” and “hacks”. The male vocalizations where not heard in the two forest patches that lie on the Wild Coast, although in the Pirie forest these “boom” calls were heard both the times I surveyed this forest patch.

In Hluleka nature reserve signs included fallen half-eaten fruits, although this sign alone cannot confirm the presence of samango monkeys as vervet monkeys are also present in the reserve and could be responsible for the fallen fruits.

3.1.4 Remote camera traps

In those forest patches where direct observations of samango monkeys were not possible and field signs indicating their presence could not be found, use was made of remote camera traps to confirm the potential presence of samango monkeys.

The Dwesa-Cwebe nature reserve, illustrated in Figure 3.4, was the only forest patch in which use was made of remote camera traps, as visual observations of monkeys were not possible and no signs of monkey presence were found. The camera traps confirmed the presence of samango monkeys in the reserve photographically. Two camera traps placed in different locations revealed that there were at least two troops on the Dwesa side of the reserve, although exact numbers of troops were not possible because of the limited number of camera traps.

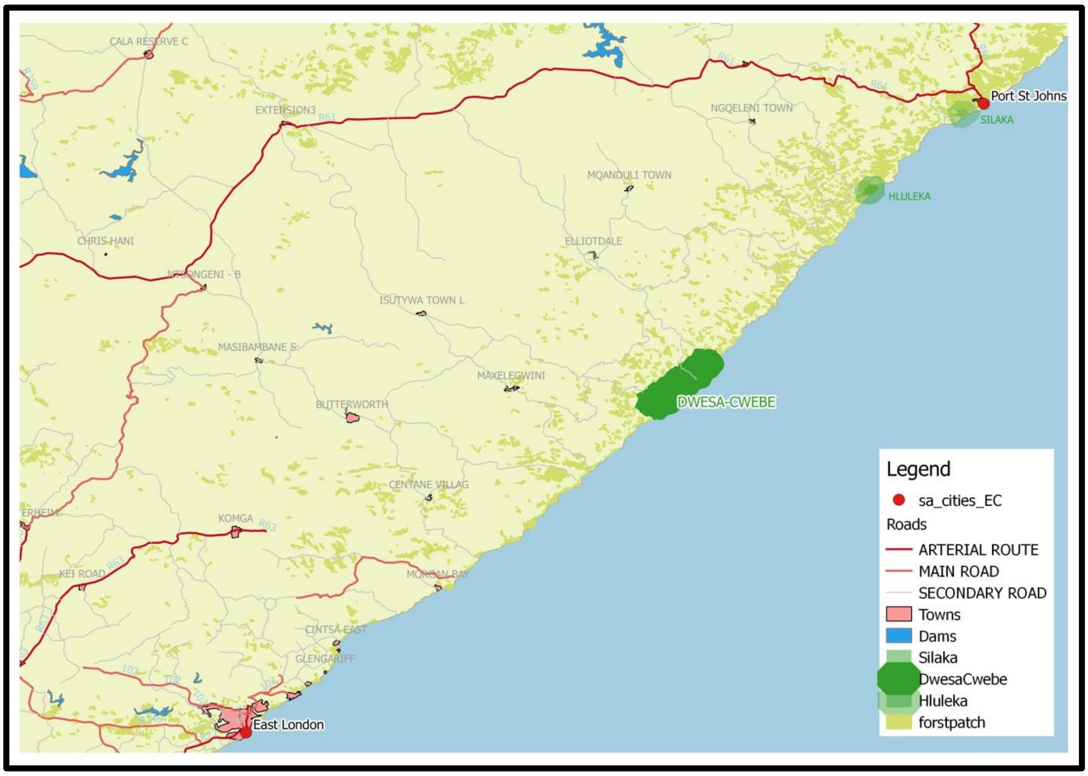

Figure 3.4. Map illustrating the Dwesa-Cwebe nature reserve, in which remote camera traps deployed

3.1.5 Overall distribution of samango monkeys in the Eastern Cape

Figure 3.5 shows all the forest patches surveyed in the Eastern Cape. Combining all of the evidence from the diverse methods employed, the samango monkey subspecies *Cercopithecus abogularis labiatus* was shown to be present in the Umtiza and Fort Pato nature reserves in the East London coastal forests, in the Dwesa-Cwebe, Silaka and Hluleka nature reserves on the Wild Coast, and in the Hogsback, Pirie and Kologha Amatola Mountain forests.

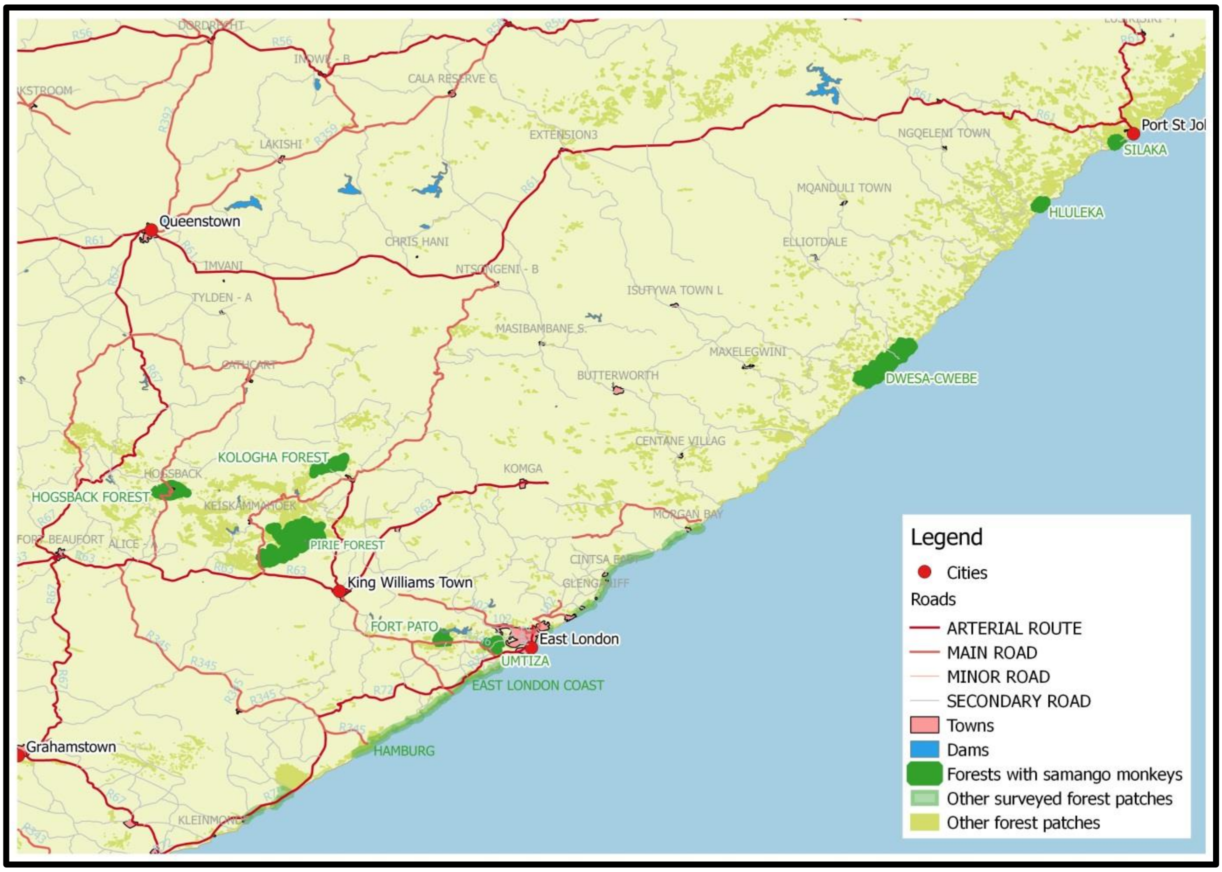

Figure 3.5. Map illustrating the distribution of *Cercopithecus abogularis labiatus* in the Eastern Cape

3.2 Troop sizes and compositions of Eastern Cape samango monkeys

As *C. a. labiatus* was found to be present in both Afromontane and coastal forest habitats, I undertook to investigate whether the troop sizes and structures in the two habitat types were noticeably different. One troop was selected from each habitat type for close observation: one troop from Hogsback forest (Swallowtail troop) in the Afromontane habitat, and one troop from Umtiza nature reserve (staff village troop) in the coastal habitat. Each troop was followed for 5 days a month for 5 months (October 2014-March 2015).

Details of the average sizes and compositions of the two troops monitored over the 5-month period are presented in Table 3.3. Two adult males were observed in the Swallowtail troop, which is a rare occurrence among samango monkeys, as males usually disperse to join bachelor troops. The females associated with the males always followed them, while the juveniles stayed close to the females. The Swallowtail troop had a mean size of 28.8 ± 9.8 individuals, with juveniles and sub-adults constituting the greater part of this number. The staff village troop had a single resident male and the group was observed to have more mature females than the Swallowtail troop. In both troops juveniles made up the largest cohort; 11.5 ± 3.8 in the case of the Swallowtail troop and 12.2 ± 4.4 in the staff village troop, owing to the fact that samango monkeys give birth during the summer and all the data pertaining to troop sizes were collected during this period.

Table 3.3: Mean troop composition of the Swallowtail and staff village troops (n ± SD)

	Swallowtail troop	**Staff village troop**
Total troop	28.8 ± 7.8	29.1 ± 9.7
Adults	4.5 ± 3.5	6.3 ± 3.3
Sub-adults	9.1 ± 3.6	11.6 ± 3.5
Females	6.9 ± 3.3	8.1 ± 4.3
Juveniles	11.5 ±3.9	12.2 ± 4.5

The data on troop sizes are illustrated graphically in Figure 3.6. The mean sizes of both troops varied over the 5-month period during which data were collected. In the case of the Swallowtail troop, November represented a peak in the mean troop size (30.7 ± 8.25). The monthly mean sizes of the staff village troop proved to be relatively constant for November and January, with a mean size of 29.2 ± 9.5 and 28.6 ± 9.6 respectively, with a peak in March of 33.5 ± 3.25. The monthly mean sizes for both troops were similar, including fewer than 35 individuals.

The number of days of observation was greatly affected by the weather (see Table 3.4). In October 2014 and March 2015 the full 10 days allocated to the study were available for collecting data owing to favourable weather conditions. During November, January and February it was not possible to collect data on some days, because of harsh weather conditions. In some cases audiovisual contact with the troops was lost. Over the five months of collecting data, 44 days were devoted to data collection, with a total of 1099 scan samples being conducted.

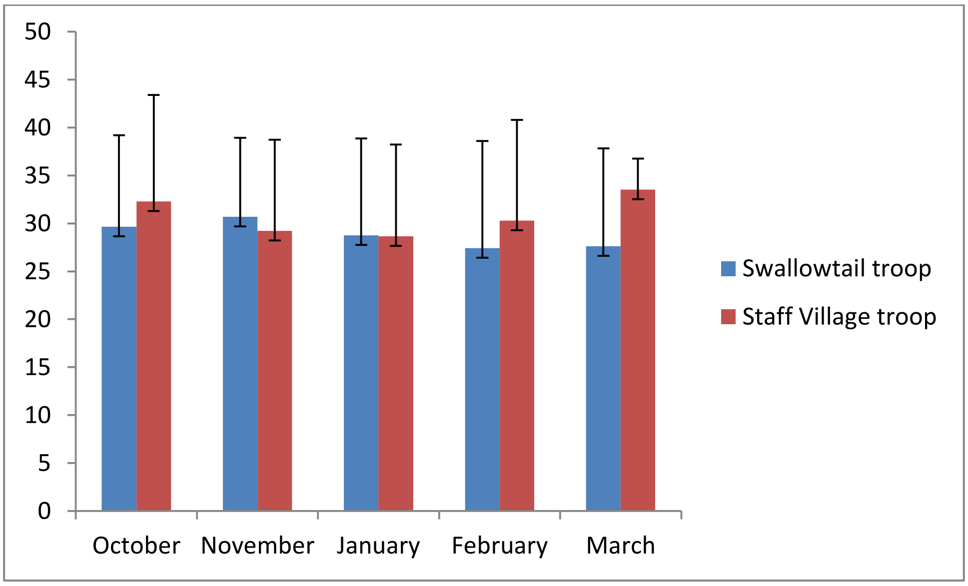

Figure 3.6: Monthly mean troop sizes of Swallowtail and staff village troops

Table 3.4: Number of observation days and scans per troop

Month	Total number of days of observation	STT days of observation	SVT days of observation	STT No. of scans	SVT No. of scans
October	10	5	5	178	104
November	9	4	5	125	95
January	8	.4	4	86	94
February	7	3	4	65	111
March	10	5	5	158	120

3.3 Summary of field survey data

Results from the questionnaire interviews and field observations conducted in the 14 forest patches in the Eastern Cape show that the distribution the samango monkey subspecies *Cercopithecus albogularis labiatus* extends from the Afromontane forests, specifically the Amatola montane forests in and around Stutterheim, Hogsback and King Williams Town, down to the coast to include two coastal forest patches near East London (Umtiza and Fort Pato nature reserves), and north-east along the Wild Coast. From these results *C. a. labiatus* is clearly able to tolerate both Afromontane and coastal forest habitats.

To assess how the ecology of *C. a. labiatus* might differ in the two habitat types, troop size and composition estimates were made, focusing on one troop in each habitat type. Similarities in troop sizes and composition suggest that *C. a. labiatus* not only can survive, but thrives, in both Afromontane and coastal habitats.

CHAPTER FOUR: RESULTS OBTAINED FROM COMPUTER-BASED METHODS FOR ASSESSING THE DISTRIBUTION OF SAMANGO MONKEYS

4.1 General introduction

Predicting the distribution of threatened and endangered species from data pertaining to their preferred habitats is a useful procedure. Fielding and Bell (1997) reported that the habitat-association approach to ecology has been used for a variety of purposes, including conservation and ecological management. The approach has been particularly useful for the development of predictive models for estimating population sizes and geographical ranges (Austin, 2002), and for identifying the potential impacts of future environmental changes. In recent years many geographical mapping applications have been developed which offer exciting new possibilities for understanding the distribution of biological diversity (Peterson, 2001).

Geographic information systems, or GIS, make it possible to map species-richness and endemism, to prioritise areas for conservation based on principles such as complementarity, which are quantitative procedures for identifying biodiversity priority areas, and to assess the completeness of existing networks of protected areas (Peterson et al., 2000). Austin (2002) further confirmed the usefulness of statistical and computer-based methods, often in conjunction with GIS and remote sensing. Generalised linear models (GLM) and generalised additive models (GAM) using logarithmic regression and presence-absence survey data are becoming increasingly popular as the statistical models to be used in research of this sort (Scott et al., 2002). In the majority of cases, the purpose of statistical modelling is to predict the distribution of species (Guisan and Zimmermann, 2000), while detecting functional relationships between species and the environment and testing ecological theory tend to be secondary considerations (Austin, 2002).

MacArthur (1972) defined the fundamental ecological niche of a species as a multidimensional ecological space related to its adaptations, and a crucial determinant of its distribution. Peterson (2001) pointed out that Hutchinson (1959) identified the valuable distinction between the fundamental niche, which is a range of theoretical possibilities, and the realised niche, which is the extent to which the fundamental niche is actually filled as a result of interactions with other species, such as direct competitors. Although it is true that only the realised niche is observable in nature, by examining species across their entire geographical distributions their adaptive potential may be observed against varied community backgrounds, and consequently, a model of a fundamental ecological niche can be assembled (Peterson et al., 2001). In this chapter I describe how I made use of computer databases to estimate the distribution of *Cercopithecus albogularis* in the Eastern Cape.

4.2 Museum records

In spite of inherent limitations, data obtained from museums may be very useful for the conservation of biodiversity. For the purpose of this study, information held by the Amathole Museum was used to investigate the distribution of *Cercopithecus albogularis labiatus* in the Eastern Cape. The museum has a total of 52 specimens of *C. a. labiatus* from various localities in the Eastern Cape in its collection (see Table 4.1). Each specimen (ideally) is accompanied by a data tag that records details of the collector, the date and locality of collection, and sometimes body measurements of the live or freshly killed animals. I used the locality data associated with the specimens to explore the distribution of samango monkeys in the Eastern Cape.

Table 4.1: Amathole Museum records of *Cercopithecus albogularis labiatus*

Specimen	Nature	District collected	Reference point
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Body mount	King Williams Town	Pirie forest
C. a. labiatus	Body mount	King Williams Town	Pirie forest
C. a. labiatus	Body mount	King Williams Town	Pirie forest
C. a. labiatus	Body mount	King Williams Town	Pirie forest
C. a. labiatus	Body mount	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	East London	Fort Pato
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin only	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest

C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	Zwelitsha	Mount Coke
C. a. labiatus	Skin and skull	Zwelitsha	Mount Coke
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	Victoria East	Hogsback
C. a. labiatus	Skin and skull	East London	Umtiza
C. a. labiatus	Skin and skull	East London	Umtiza
C. a. labiatus	Skin only	Fort Beaufort	Katberg forest
C. a. labiatus	Skin only	East London	Umtiza
C. a. labiatus	Skin and skull	King Williams Town	Pirie forest
C. a. labiatus	Skin and skull	Stutterheim	Kologha forest
C. a. labiatus	Skin and skull	Peddie	Peddie
C. a. labiatus	Skin and skull	East London	Fort Pato

C. a. labiatus	Skull only	Cathcart	Happy valley
C. a. labiatus	Skull only	Victoria east	Hogsback

Figure 4.1 shows the distribution of *Cercopithecus albogularis labiatus* according to the data obtained from the Amathole Museum. Most of the specimens had been collected from the Pirie, Hogsback and Kologha forests in the Amatola Mountains, while a few had been collected in the Fort Pato and Umtiza nature reserves in the East London coastal forests. No specimens had been collected in the other forest patches where samango monkeys have been found to be present, showing a degree of locality bias in the data.

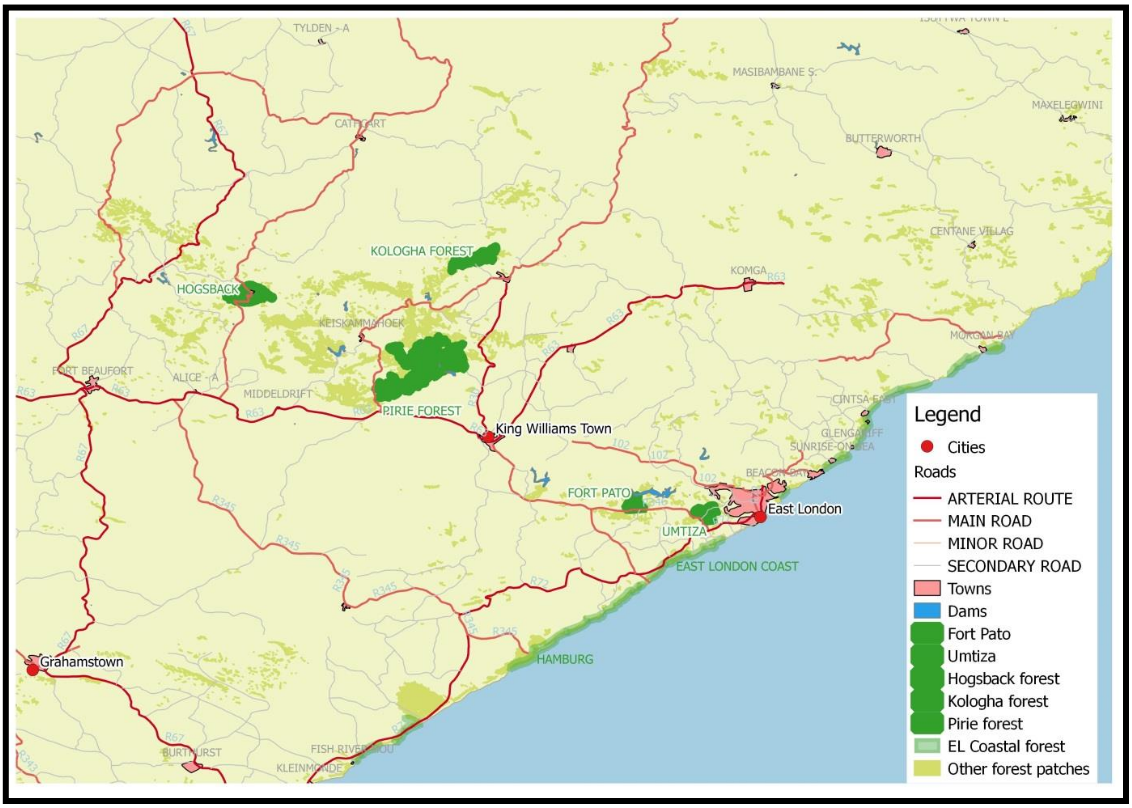

Figure 4.1: Map illustrating the forest patches where samango monkeys are present according to data obtained from the Amathole Museum

Data collected during the field surveys demonstrated that samango monkeys were present in more forest patches in the Eastern Cape than were evident from an examination of the records of the Amathole Museum. The specimens in the museum were collected mostly along the Amatola Mountains, with some specimens collected in the East London coastal forests (Umtiza and Fort Pato nature reserves). The museum also had specimens from localities where samango monkeys were not found during my field surveys, including the Katberg forest, Peddie, Mount Coke and Happy Valley between Cathcart and Hogsback. All these localities either have no forest or very small forest patches, unable to support viable populations of Afromontane samangos, and hence represent areas of local extinction.

4.3 Habitat mapping and spatial distribution of forests in South Africa

The forests of South Africa are highly fragmented and are considered one of the most vulnerable of the country's vegetation types. Extending from the Cape Peninsula eastwards through the Outeniqua and Tsitsikamma Mountains of the southern Cape, indigenous forests have a discontinuous distribution through the midlands of the Eastern Cape and KwaZulu-Natal. Northwards, forests are distributed along the Drakensberg Mountains of KwaZulu-Natal, the eastern Free State, Mpumalanga and into the Limpopo Province, where the northern-most forests are located in the Soutpansberg Mountains. The temperate inland forests are generally small, patchy in distribution and located on the south to south-eastern aspects of mountain ranges. Lowland forests extend along the coast from Port Elizabeth in the Eastern Cape through KwaZulu-Natal to Mozambique. These forests of the subtropical coastal zone have a discontinuous distribution in the south, but are fairly continuous in northern KwaZulu-Natal. Lowland forests are usually associated with specific topographic features such as coastal dunes, rivers, ravines and wetland areas.

Southern Africa’s diverse topography and its extension over a wide range of latitudes have generated highly variable climatic conditions across the region, both now and throughout its Cenozoic history. These factors have resulted in a diversity of southern African vegetation types. Forests typically occur in the moist areas of the country, but specialised forest types are also found fringing rivers or within protected kloofs within some arid areas. In spite of the small spatial extent of the forest biome (less than 0.3 – 2.5% of the land surface according to Rutherford and Westfall, 1994, but 0.56% according to the calculations of Low and Rebelo 1996), the forest is extensively utilised and provides highly valued resources both for humans and for biodiversity.

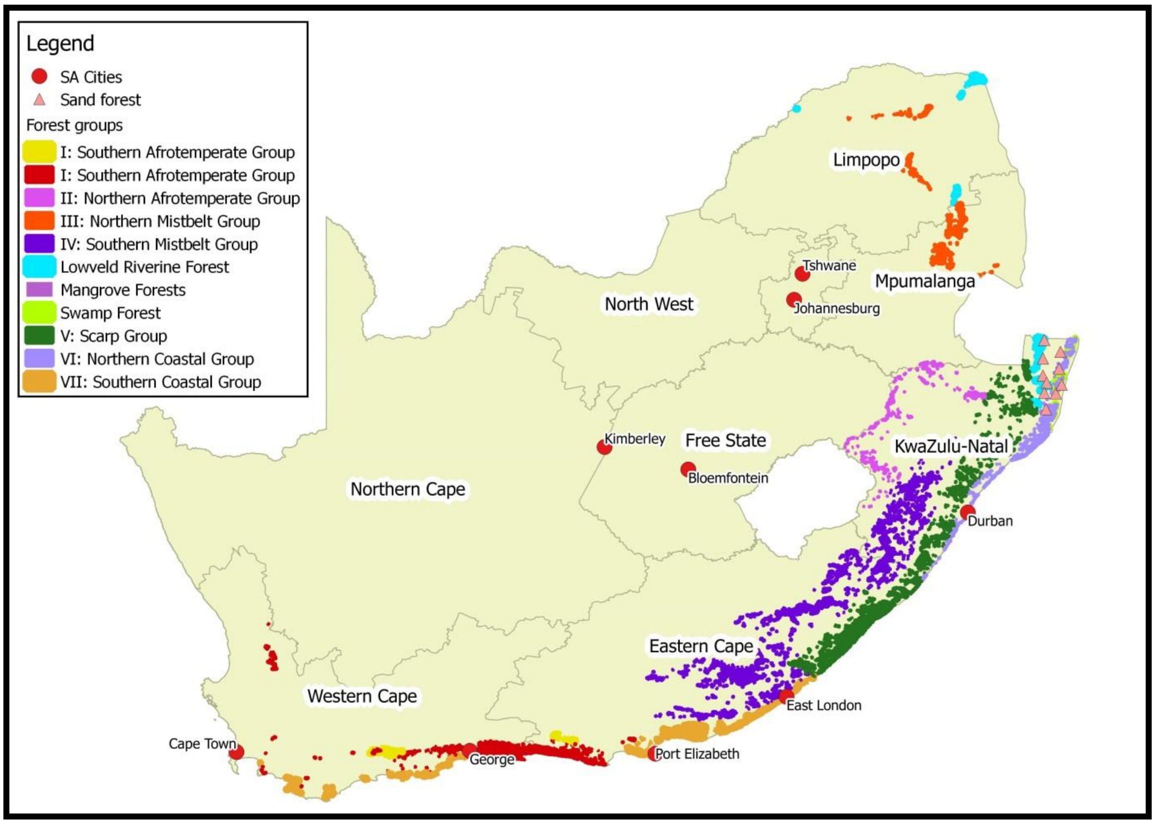

Figure 4.2: Map illustrating the distribution of indigenous forests in South Africa (from Mucina and Rutherford, 2006)

Figure 4.2 illustrates the distribution of South Africa’s indigenous forests, some of which are highly suitable for samango monkeys. Mucina and Rutherford (2006) recognised 12 indigenous forest groups in South Africa, most of them distributed between the Eastern Cape and KwaZulu-Natal. As I discussed previously, the distribution of arboreal primates is primarily influenced by: (1) forest structure, (2) climatic conditions, (3) temperature, and (4) forest patch size. As samango monkeys are primarily forest dwelling primates, one might predict that *C. a. labiatus* should occur in most if not all the forest patches of suitable size and diversity that occur within the Eastern Cape. In this chapter I used mapping techniques to estimate the distribution of samango monkeys not only in the Eastern Cape, but also within South Africa.

Meester et al. (1986), Lawes (1990) and Skinner and Chimimba (2005) all recognised two samango subspecies within South Africa (*C. a. erythrarchus* and *C. a. labiatus*), whereas Roberts (1951) and Groves (2001, 2005) added a third: *C. a. schwarzi.* These three putative subspecies occur within four provinces in the country: (1) Eastern Cape; (2) KwaZulu-Natal; (3) Mpumalanga, and (4) Limpopo. In the Eastern Cape *C. a. labiatus* is present within the Amatola mistbelt forests, the dune forests, the Transkei coastal scarp forests, and the Pondoland scarp forests which extend into KwaZulu-Natal. *C. a. erythrarchus* is distributed throughout the KwaZulu-Natal coastal and mistbelt forests, as well as the mistbelt forests of Mpumalanga and Limpopo. *C. a. schwarzi* is reputed to be found in Mpumalanga near Pilgrim’s Rest (Groves, 2001), although other authors (e.g. Dalton et al., 2015) identified the samangos in this province as *C. a. erythrarchus*. Dalton and her colleagues believed *C. a. schwarzi* to be restricted to the Limpopo Province.

All of the samango monkey populations found in South Africa occur in fragmented forest patches and are subjected to strong anthropogenic pressure as most of the forest patches are surrounded by human activities.

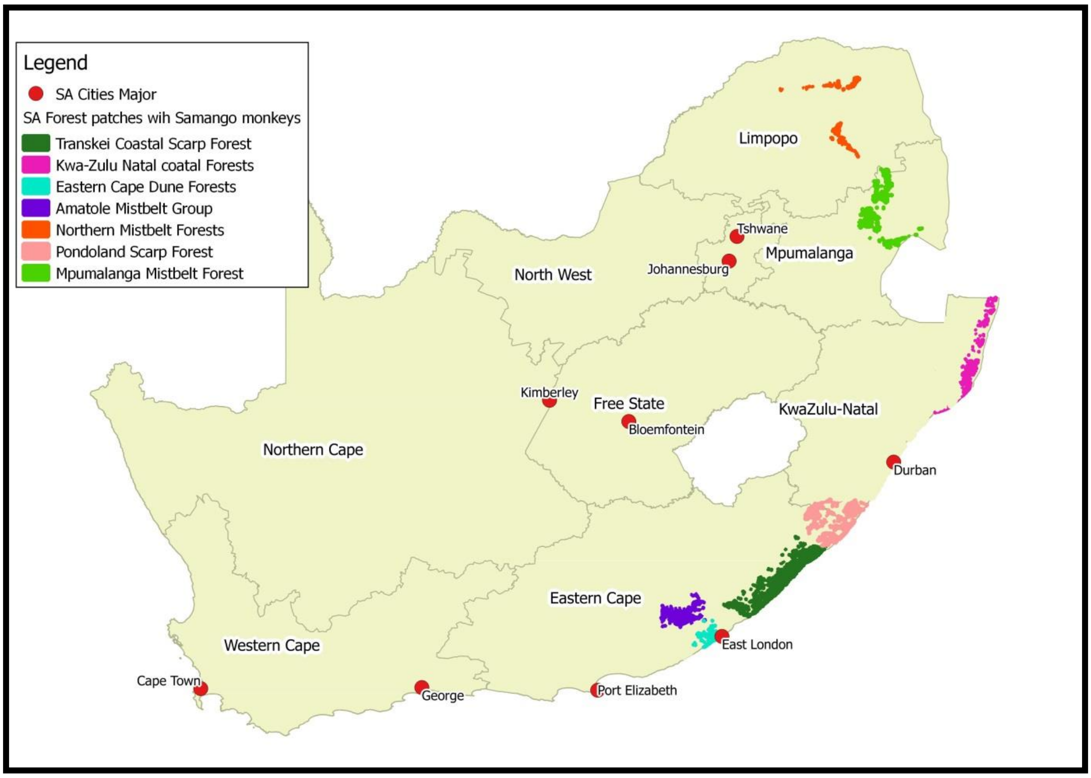

Figure 4.3: Map illustrating forest patches where samango monkeys are present

Figure 4.3 illustrates the distribution of samango monkeys in South Africa. The distribution of the various samango monkey subspecies is limited to only seven forest complexes (nine if sand forest and gallery forest). All of these forests are highly fragmented, restricting the movement of samango monkeys between forest patches.

4.3.1 Amatola mistbelt forest

The Amatola mistbelt forests are relatively large, species rich, middle altitude forests centred in the Amatola Mountains (Figure 4.4). The largest complex includes the Amatola escarpment forests, approximately 35 000 ha in extent and situated between 500 and 1600 m altitude in the Amatola Mountains. This forest patch includes Stutterheim, Hogsback and King Williams Town. Outlier forests occur towards the Kei River, and Boschberg near Somerset East.

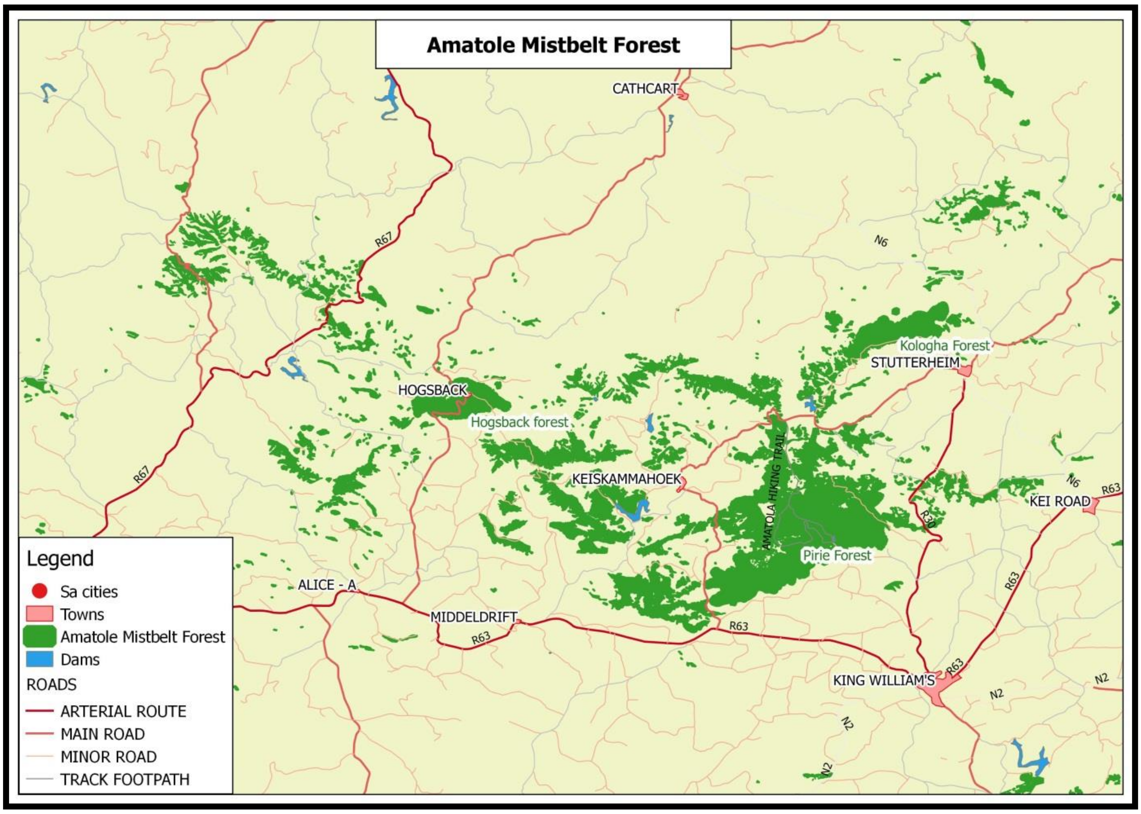

Figure 4.4: Map illustrating the distribution of Eastern Cape Amatola mistbelt forests

The vegetation structure of the Amatola mistbelt forests is typically multi-layered, comprising emergent trees and a tall, relatively open to closed upper canopy made up of a mixture of evergreen, semi-deciduous and deciduous trees, and a dense understory with a well-developed herb layer. These relatively species-rich forests experience a mixture of large and small canopy gap-disturbance driven regeneration dynamics.

The Amatola mistbelt forests extend from the dry, lower southern slopes (~500 m), across a succession of scarp terraces up to about 1400 m, including broad intermontane valleys. Mudstones, shales and sandstones of the Balfour formation with dolerite intrusions underlie most of the Amatola mistbelt forests. Soil depth varies according to the depth of superficial dolerite sheets in places. The soils have a high proportion of coarse silt and clay.

The forests are characterised by a temperate climate with an annual rainfall of approximately 800-1800 mm (Table 4.2). Temperature and rainfall are seasonal, although the Amatola region receives both summer and winter rainfall, with a winter rainfall average of 400 mm. Heavy mists are characteristic in spring and summer, and there is occasional winter snow.

Table 4.2: Climatic conditions prevailing in the Amatola mistbelt forest

	Rainfall (mm)	**Coldest temperature (°C)**	**Hottest temperature (°C)**	**Mean temperature (°C)**
Minimum	350	1	24	14
Maximum	1500	10	29	19

The Amatola mistbelt forests are strongly similar in terms of woody species to the Transkei mountain forests (eastern mistbelt forests), and share more than 40% similarity with forests along the East London coast (Eastern Cape dune forests). The Amatola mistbelt forests share phytogeographically important species such as *Cassipourea flanaganii* (Cape onionwood), *Englerodaphne pilosa* (Sliky fibre bush) and *Trimeria trinervis* (Small leaved wild mulberry) with the Transkei coastal valley forests. The distribution of *Cercopithecus albogularis labiatus* across this range of altitudes is hence made possible by similarities in the species composition of the forest types.

4.3.2 Eastern Cape dune forest

The Eastern Cape dune forest is a subtropical low-stature, dense canopy forest on old, stabilised dunes fringing the coast, usually dominated by *Mimusops caffra* (coastal red milkwood), *Sideroxylon inerme* (white milkwood) and *Dovyalis rotundifolia* (dune sour berry). It is endemic to the province, and found in small pockets from the Transkei Wild Coast in the north to Alexandria in the south. The canopy is generally 10 to 20 m in height, although it decreases along an east-west gradient, reaching 5 m near Alexandria. The species diversity of the canopy stratum is relatively low, with only eleven species recorded by Burns (1986). The tree and shrub species diversity in the Eastern Cape dune forests is lower than in the dune forests of KwaZulu-Natal.

The forests occur typically at altitudes from 5 to 70 m in sheltered positions, and are best developed in inter-dune valleys. The windward slopes of the dunes are covered by floristically similar vegetation called “dune thicket” which is typically of low stature, pruned by steady on-shore winds and salt spray carried inland. Schulze (1965) described the climate of this area as temperate to warm and humid with a summer rainy season. Strong winds blow from the east in summer, while the direction is reversed in winter. Seaward slopes are more moderate than landward slopes because of the ameliorating effect of the sea: landward slopes are both hotter during the day and colder at night. Within the dune communities, temperature contributes to the establishment of floristic gradients on the dune profiles.

Figure 4.5 shows the distribution of the Eastern Cape dune forests from Alexandria to the Wild Coast. Along this extent, Umtiza and Fort Pato nature reserves were the only two forest patches where samango monkeys (subspecies *C. a. labiatus*) were present.

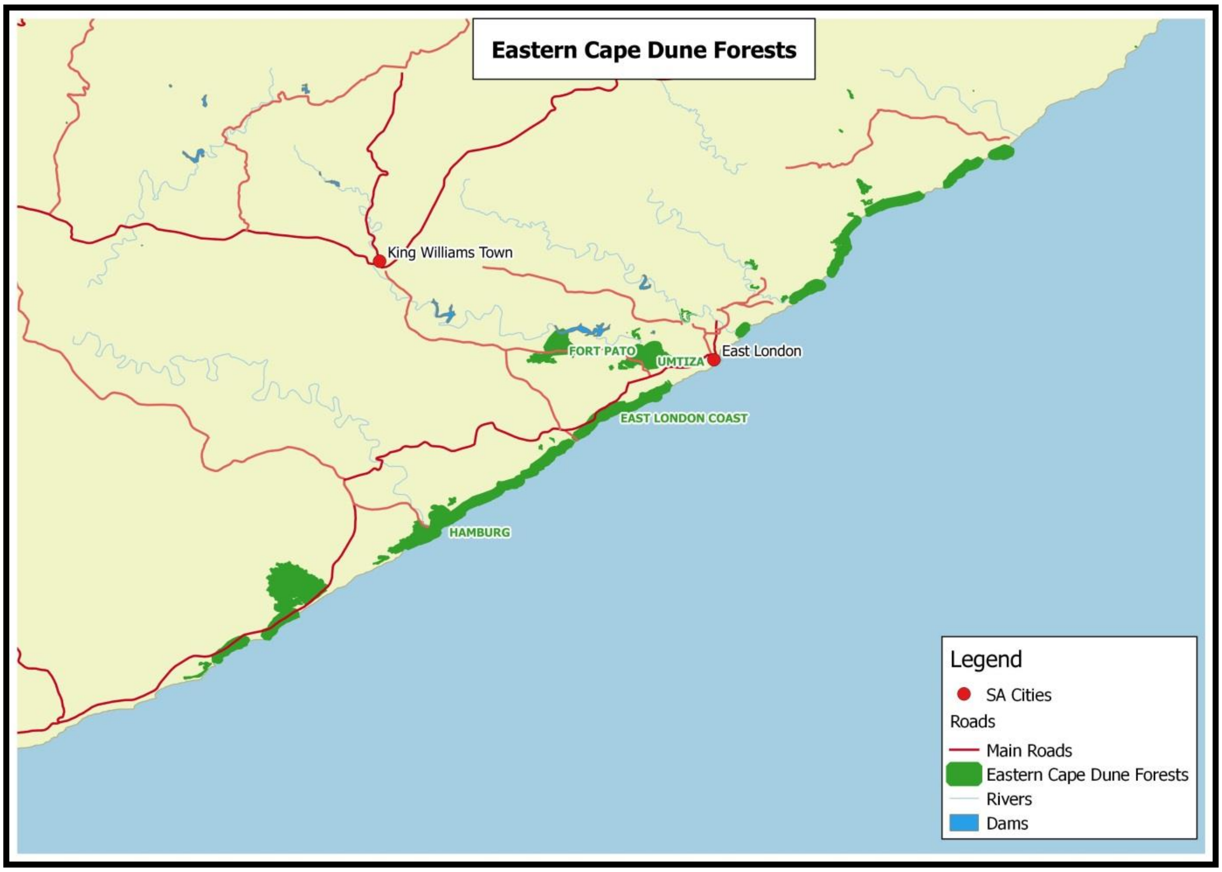

Figure 4.5: Map illustrating the distribution of the Eastern Cape dune forests

4.3.3 Transkei coastal scarp forests

These coastal scarp forests comprise low and medium crowned (9 – 25 m) species-rich forests with a poorly developed ground layer. *Milettia grandis* (umzimbeet), *M. sutherlandii* (Giant umzimbeet), *Buxus macrowanii* (Cape box), *Bauhinia natalensis* (Natal bauhinia) and the local *Umtiza listeriana* are typical constituents of the canopy. Forests of this type are found on sloping coastal platforms as well as on the steep scarps in deeply incised valleys at altitudes between 0 and 800 m. Their proximity to the coast helps to moderate the climate (Table 4.3).

Table 4.3: Climatic conditions characterising the Transkei coastal scarp forests

	Rainfall (mm)	Coldest temperature (°C)	Hottest temperature (°C)	Mean temperature (°C)
Minimum	630	7	25	17
Maximum	1200	11	27	20

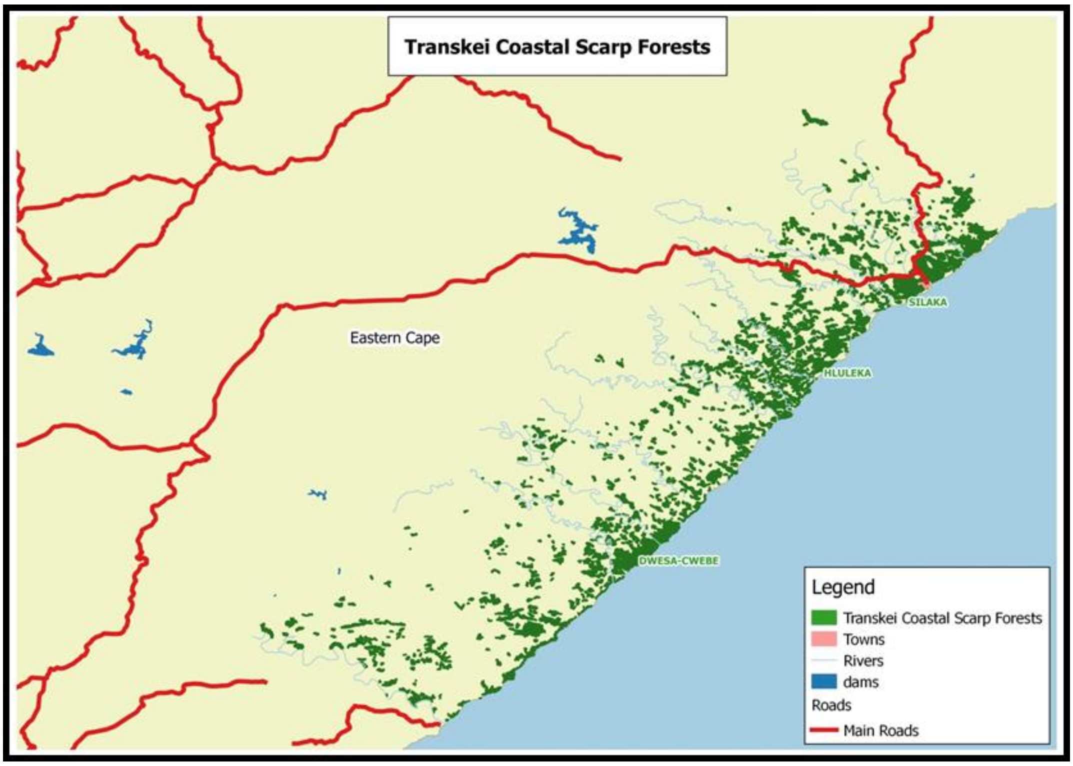

Figure 4.6: Map illustrating the distribution of the Eastern Cape Transkei coastal scarp forests

Figure 4.6 illustrates the Transkei coastal scarp forest distribution. These forests show similarities with the Pondoland scarp forests to the north. Among these forests, *C. a. labiatus* was present in Dwesa-Cwebe, Huleka and Silaka nature reserves.

4.3.4 Pondoland scarp forest

This is a tall (15 – 25 m high) species-rich forest found on the Msikaba Formation sandstones of the coastal scarp ridge in the north-eastern Transkei and southernmost KwaZulu-Natal. It is structurally diverse with a poorly developed herb layer. Wooded steep slopes of gorges with many endemic species are characteristic features of this forest type. They occur on south-facing slopes of the coastal scarp ridge, on sandstone outcrops of the region known as Pondoland in the north-eastern Transkei, from the complex of forests at and immediately north of Port St Johns, extending as far north as Oribi Gorge in southern KwaZulu-Natal. The distribution of these forests coincides with the Pondoland centre of endemism identified by Van Wyk and Smith (2001). The altitudinal distribution of the forest ranges from sea level to 600 m, close to the coast. The climate is renowned for strong its north-easterly winds and is less seasonal, cooler and less moist than the eastern scarp forests to the north (Table 4.4).

Table 4.4: Climatic conditions characterising the Pondoland scarp forest

	Rainfall (mm)	Coldest temperature (°C)	Hottest temperature (°C)	Mean temperature (°C)
Minimum	660	8	24	18
Maximum	1200	12	28	20

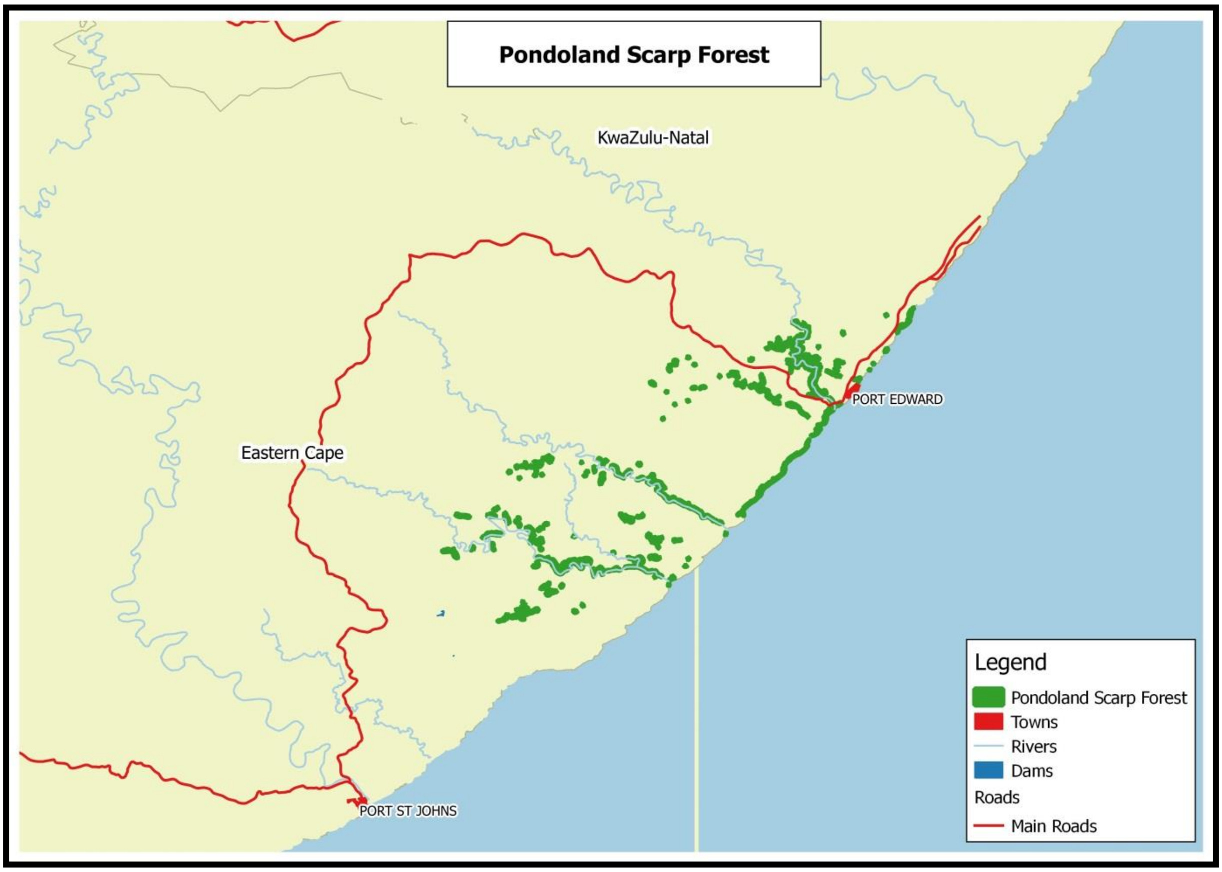

Figure 4.7. Map illustrating the distribution of the Pondoland scarp forests

Figure 4.7 shows that the Pondoland scarp forests are comprised of fragmented small patches, distributed chiefly within the Eastern Cape but extending also into southern KwaZulu-Natal. The Pondoland scarp forests share similar biological affinities with the Transkei coastal forests where samango monkeys (subspecies *C. a. labiatus*) occur.

4.3.5 Northern KwaZulu-Natal mistbelt forest

Northern KwaZulu-Natal mistbelt forests occur along the lower Drakensberg escarpment between Van Rheenen's Pass (near Harrismith) and Piet Retief, as well as in southern Mpumalanga and northern KwaZulu-Natal (Vryheid region) (Figure 4.8). These forests are usually dominated by tall trees including the yellowwood species *Podocarpus latifolius* (Broad leaved yellowwood), *P. falcatus* (Outeniqua yellowwood), *Dombeya burgessiae* (pink wild pear) as well as the low-growing *Xymalos monospora* (lemon wood), *Greyia sutherlandii* (Natal bottlebrush), *Canthium mundianum* (rock alder), *Acacia caffra* (common hooked thorn). Co-occurrence of species such as *Acacia caffra, Barleria obtuse* (bush violet), *Celtis africana* (white stinkwood), *Cephalanthus natalensis* (strawberry bush), *Clematis oweniae* (bridal wreath), *Dais cotinifolia* (pompom tree), *Dalbergia obovate* (climbing flat bean), *Diospyros lycioides* (star apple), *Dombeya burgerssiae* (pink wild pear), *Erythrina latissimi* (broad leaved coral tree), *Greyia radlkoferi* (woolly bottlebrush), *G. sutherlandii* (Natal bottlebrush), *Heteromorpha trifoliate* (parsley tree), *Leucosidea sericea* (ildwood), *Myrsine Africana* (African boxwood), *Oxyacanthus speciosus gerrardii* (wild loquats), and *Sparmannia ricinocarpa* (Cape stock rose) is a typical floristic feature of this forest type forming a dense, diverse and stratified canopy.

The forests form widely scattered archipelagos of isolated patches along the low Drakensberg escarpment, straddling the borders between the Free State, southern Mpumalanga and KwaZulu-Natal. A group of forests in northern KwaZulu-Natal in the surroundings of Vryheid (Eckhardt *et al.*1997, the Qudeni Forest and high elevation parts of the extensive Ngome Forest are grouped with this forest type. Its extension into Swaziland has not been confirmed so far, but is possible. The climatic conditions that typify these forest patches are recorded in Table 4.5.

Table 4.5: Climatic conditions prevailing in the northern KwaZulu-Natal mistbelt forests

	Rainfall (mm)	Coldest temperature (°C)	Hottest temperature (°C)	Mean temperature (°C)
Minimum	620	1	24	13
Maximum	1100	6	30	17

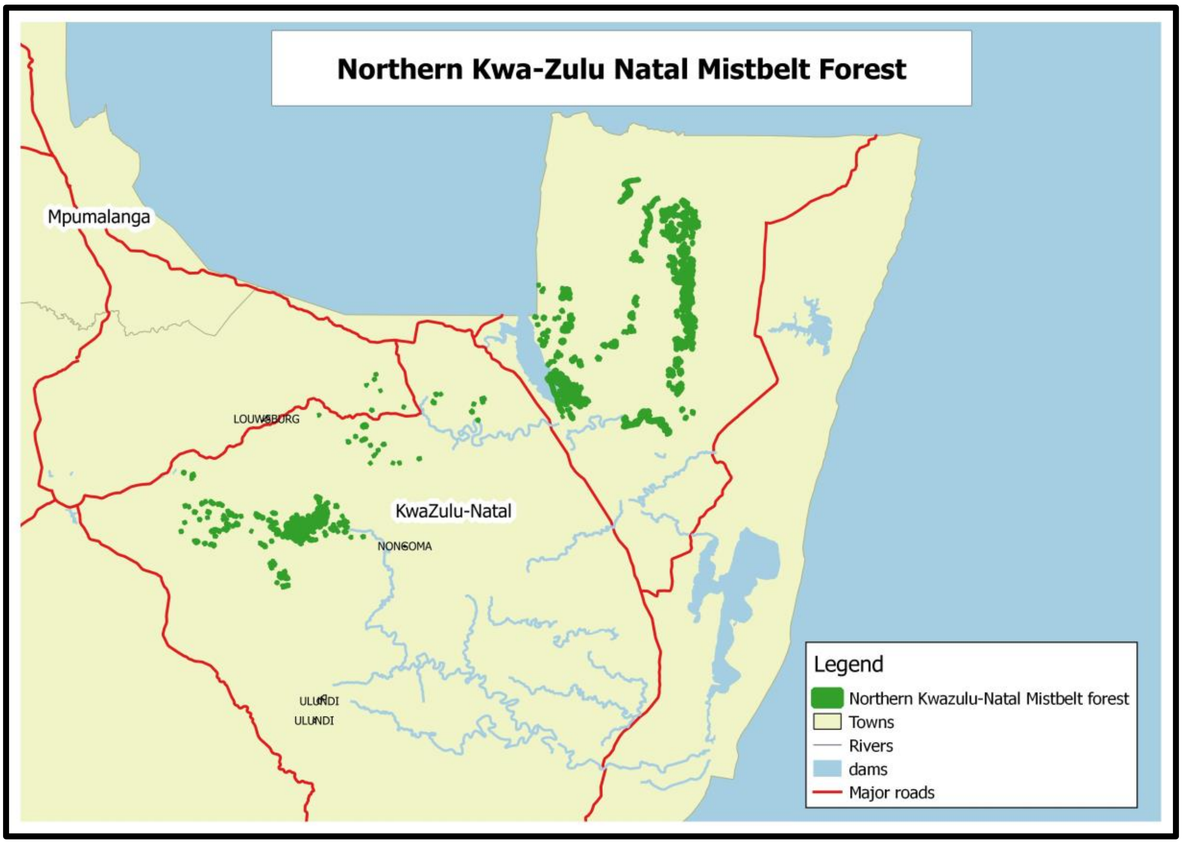

Figure 4.8: Map illustrating the northern KwaZulu-Natal mistbelt forests

4.3.6 KwaZulu-Natal coastal forests

These are medium to tall, species-rich forests closely associated with the flat to rolling topography of the coastal lowlands of KwaZulu-Natal in the form of small-sized patches. They occur in the immediate hinterland of the coastal dunes or on the free-draining deep sands of the Maputaland coastal plain, and their distribution is illustrated in Figure 4.9. Many tropical species reach their most southerly distribution in this region. Typical tree species dominating the canopy and sub-canopy layers include *Albizia adianthifolia* (flat crown albizia), *Dyospyros inhacaensis* (acorn jackal-berry), *Drypetes argute* (water iron plum), *D. natalensis* (Natal drypetes), *Englerophytum natalense* (Natal milk plum), *Protorhus longifolia* (purple currant), *Teclea gerradii* (Zulu cherry orange) and *Manilkara concolor* (Zulu milkberry). Subtropical shrubs and climbing plants are common, contributing to a dense understory. These forests extend along the KwaZulu-Natal coast, from southern KZN to beyond the Mozambique border. They are low-altitude vegetation types, occurring below a height of 100 m on the coastal plains or on low slopes in the undulating landscape. They are supported by sandy substrates, and experience relatively low levels of rainfall (400 – 700 mm) and hot, humid conditions. The warm coastal influence ensures that temperatures are never low, even in winter (Table 4.6). Plant communities have a strong tropical nature, elements of which extend along the Indian Ocean seaboard as far north as Tanzania. All patches of this forest type are imbedded within a narrow strip of so-called Indian Ocean coastal belt forest, which penetrates up to 30 km inland in the north but is limited to 3 – 4 km from the coast in the south.

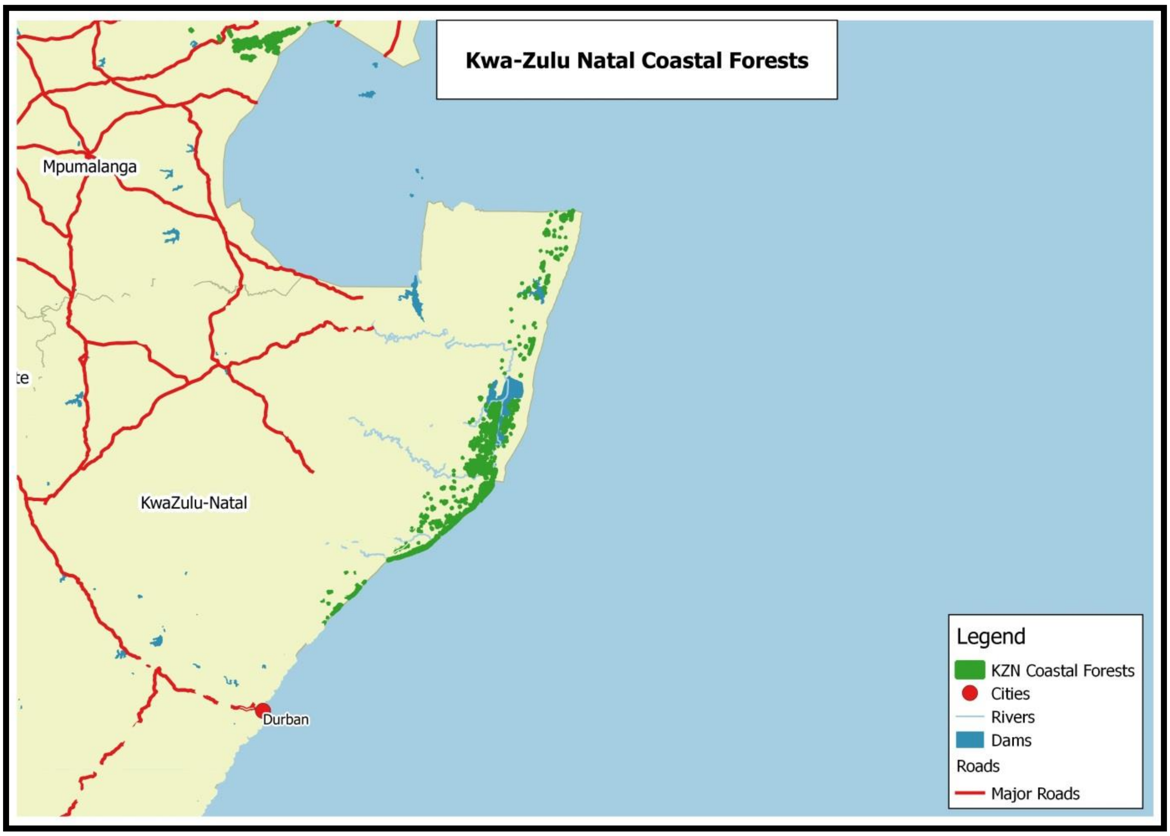

Figure 4.9: Map illustrating the distribution of KwaZulu-Natal coastal forests

Table 4.6: Climatic conditions prevailing in the KwaZulu-Natal coastal forests

	Rainfall (mm)	Coldest temperature (°C)	Hottest temperature (°C)	Mean temperature (°C)
Minimum	500	10	29	21
Maximum	1000	14	31	22

These forests are particularly important to my study because they are inhabited by the samango monkey subspecies *Cercopithecus albogularis erythrarchus*. Floristic analyses led Mucina and Rutherford (2006) to propose interchanges between the coastal forests and the KZN dune forests, as well as the Lowveld riverine forests, indicating the likelihood of the expansion of *C. a. erythrarchus* into these areas.

4.3.7 Mpumalanga mistbelt forests

These are tall, mixed evergreen Afrotemperate forests occurring primarily on east and south-east facing slopes and moist sheltered kloofs along the north-south trending Mpumalanga escarpment, as well as semi-deciduous forests on the lower slopes towards the Lowveld (Figure 4.10). The area has steep climatic gradients with an annual precipitation of 900 – 2000 mm (Table 4.7). The climate is seasonal, with summer rainfall and a high intensity of thunderstorms. Mist occurs frequently on the upper scarp and the plateau. Mean temperatures vary between 12 and 21°C in the higher scarp, and 16 and 25°C towards the Lowveld (Table 4.7).

The Mpumalanga mistbelt occurs at high altitude, between 900 and 1800 m and is characterised by many waterfalls, such as Bridal Veil, Horseshoe and lesser-known falls such as those in Wonderkloof forest. The forests in the northern section are relatively large and continuous along the escarpment north of Graskop, but smaller and rather fragmented to the south. They were previously surrounded by grassland on the plateaux and upper slopes, and savanna lower down near the Lowveld, but most of this vegetation has been replaced by alien pine and *Eucalyptus* plantations. The tree species of the Mpumalanga mistbelt forest occupy an intermediate and crucial position in the temperate to subtropical gradient.

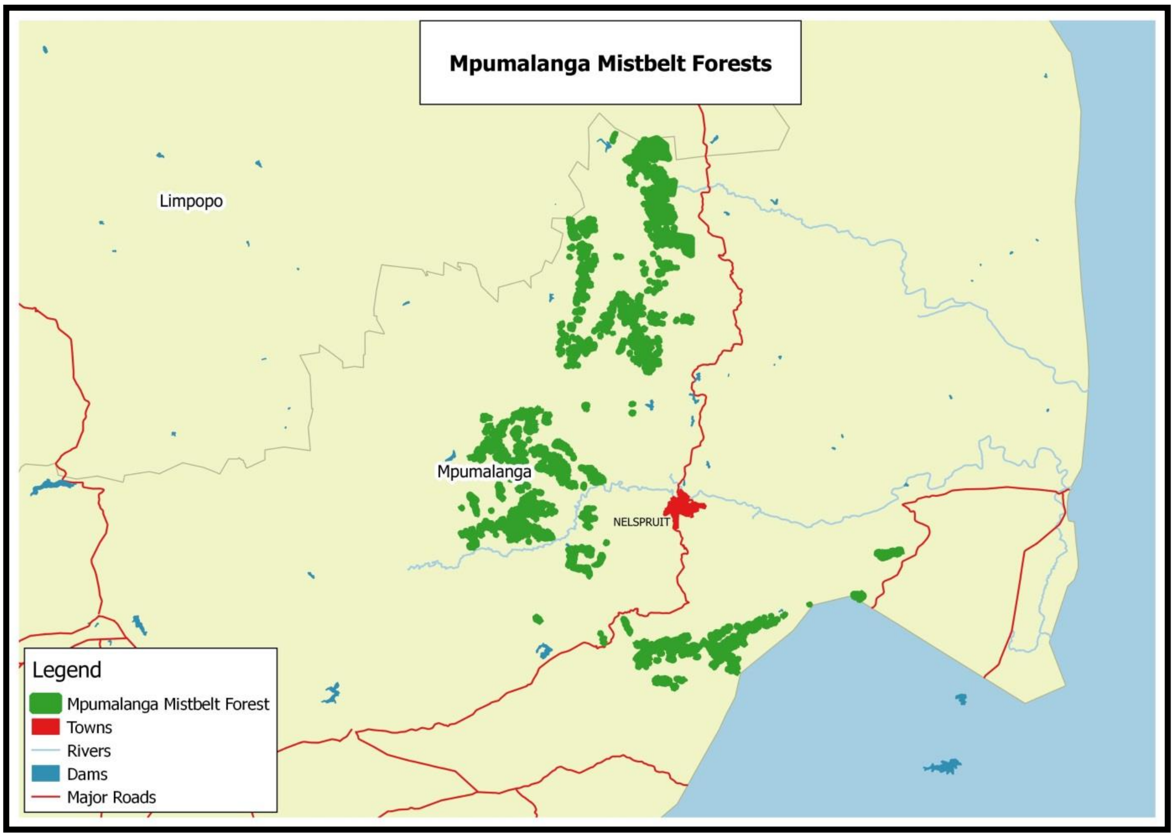

Figure 4.10: Map illustrating the distribution of the Mpumalanga mistbelt forests

Table 4.7: Climatic conditions characteristic of the Mpumalanga mistbelt forests

	Rainfall	**Coldest temperature**	**Hottest temperature**	**Mean temperature**
Minimum	500	3	24	15
Maximum	1500	10	30	20

The Mpumalanga mistbelt forests are home to samango monkeys of the subspecies *C. a. erythrarchus*.

4.3.8 Northern mistbelt forests

Northern mistbelt forests are small to large forests and forest complexes growing along the Soutpansberg Mountains and north-eastern escarpment in the Limpopo Province. Two ecological subtypes were identified by Mucina and Rutherford (2006): (1) moist evergreen forest in the mistbelt at higher altitudes, with a closed canopy and moist interior dominated by *Xymalos monospora* (Lemonwood) and a variably dense understory of ferns, grasses and shrubs; (2) semi-deciduous forest in various structural and floristic combinations. The latter include scrub forest, often regrowth forest in former woodland or grassland or on the lower slopes, with a low canopy dominated by *Acacia ataxacantha* (Flamethorn) among other woodland tree species, and a grassy understory; and riverine forest found in the lower-lying areas and at the higher reaches of the main river systems, with a canopy of variable height dominated by *Bridelia micrantha* (Mitseeri) and *Albizia adianthifolia* (Flat-crown albizia) and a mixed understory. Figure 4.11 shows the distribution of these forests.

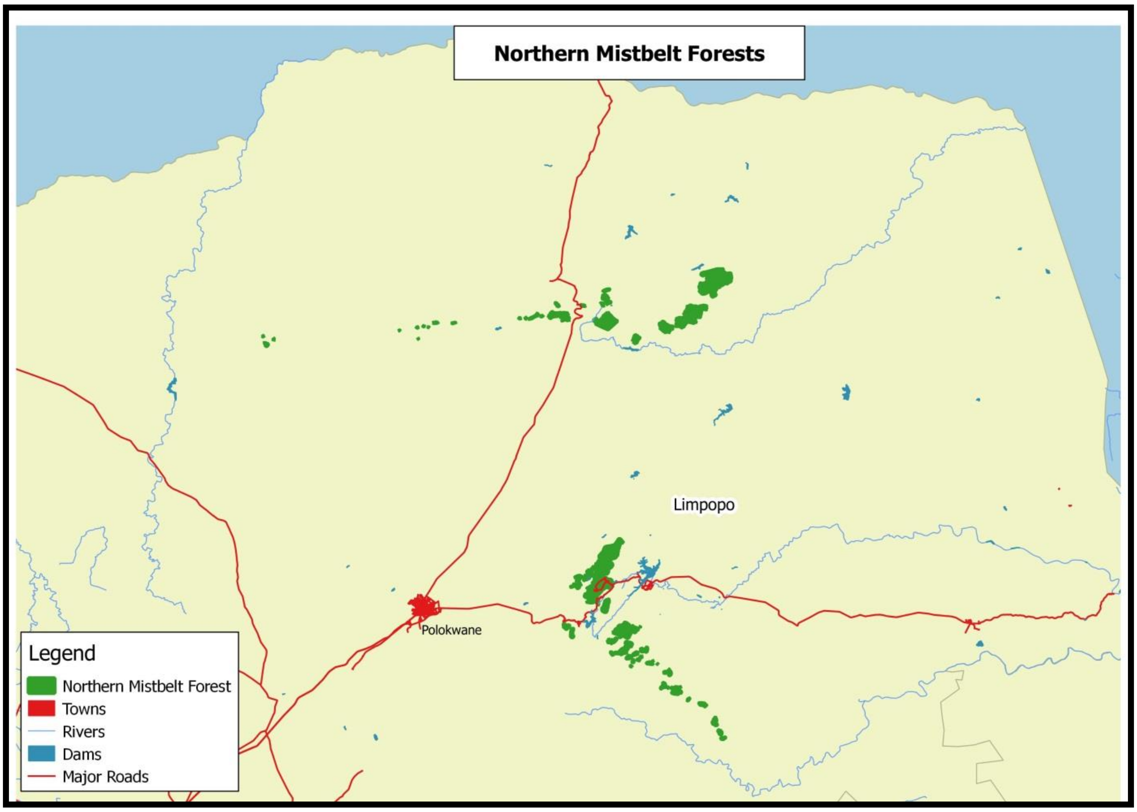

Figure 4.11: Map illustrating the northern mistbelt forests in Limpopo Province

The mistbelt forests occur on the undulating plateaux or below cliffs, in narrow gullies and open valleys at altitudes between 700 m and 1800 m. The semi-deciduous riverine forests occur along the banks and lower slopes of the streams. The northern mistbelt forests occupy a climatic gradient from the cool escarpment and upper montane plateaux to the warm Lowveld. Most of the annual precipitation, which varies from a mean of 1800 mm at higher altitudes to a mean of 600 mm lower down, occurs during the summer months from November to April. Above 1050 m altitude mist is frequent, and forest plants rely on ‘fog drip’ for moisture. Temperatures range from below 0°C in winter to above 30°C in summer and increases from higher altitudes to the foothills (Table 4. 8).

Table 4.8: Climatic conditions in the northern mistbelt forests

	Rainfall (mm)	Coldest temperature (°C)	Hottest temperature (°C)	Mean temperature (°C)
Minimum	460	4	26	17
Maximum	1500	9	29	20

Northern mistbelt forests have both Afrotemperate and Afrotropical elements, with a strong woodland component in the semi-deciduous forests. These forests share 43% of the woody species and 47% of the herbaceous species with the southern Cape Afrotemperate forests. There is also considerable sharing of species between the semi-deciduous forests and the Licuati Sand Forests. Dalton et al. (2015) distinguished *Cercopithecus albogularis schwarzi* in terms of genetic distances, which they proposed is restricted to the northern mistbelt forests.

4.4 Summary of results

Museum records collected from the Amathole Museum in the Eastern Cape were largely congruent with my observations of the presence of samango monkeys in different forest patches around the Eastern Cape, although they also indicated some areas of local extinction: Katberg, Peddie, Mount Coke and Happy Valley between Cathcart and Hogsback, which once hosted sufficient forest to maintain samango monkey populations, no longer do so. Hence, there is cause for concern concerning the long term survival of *Cercopithecus albogularis labiatus* in the province.

Table 4.9 presents a synthesis of all the forest patches where samango monkeys are present in South Africa. These forest patches possess very similar average annual temperatures and rainfall. The KwaZulu-Natal coastal forests show the lowest average annual rainfall and the highest average annual temperature. Similarities in climate conditions among these forests reveal major aspects of the realised niche of these monkeys.

Table 4.9: Table showing all the forest patches where samango monkeys are present along with average rainfall and temperature

Forest patch	**Average rainfall (mm)**	**Average temperature (°C)**	**Subspecies**
Amatole mistbelt forests	925	17	*C. a. labiatus*
Eastern Cape dune forests	894	16	*C. a. labiatus*
Transkei Coastal Scarp Forests	915	19	*C. a. labiatus*
Pondoland scarp Forest	930	19	*C. a. labiatus*
Northern mistbelt forests	980	19	*C. a. schwarzi*
Mpumalanga Mistbelt Forests	1000	18	*C. a. erythrachus*
KwaZulu-Natal mistbelt forests	860	15	*C. a. erythrachus*
Kwa-Zulu Natal Coastal Forests	750	21	*C. a. erythrachus*

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Distribution of *Cercopithecus albogularis labiatus* in the Eastern Cape

In this study I assessed the distribution of the samango monkey subspecies *Cercopithecus albogularis labiatus* along the Indian Ocean coastal belt forests and in the Afromontane forests of the Eastern Cape. Surveys were conducted for 10 months between 2014 and 2015 in the various forest patches which lie within these two vegetation types. The southern distribution of *C. a. labiatus* was previously reported as extending as far as the Kologha forest of the Amatola Mountains (Mucina and Rutherford, 2006). My observations of this subspecies in the coastal forests near East London refute this contention, and made it imperative to conduct an investigation into the actual distribution of the subspecies in the Eastern Cape region. *C. a. labiatus* is generally viewed as an Afromontane inhabitant (Meester *et al.,* 1986; Lawes, 1990), with *C. a. erythrachus* representing the species in the Indian Ocean coastal forests of KwaZulu-Natal. My observations, however, confirm that the subspecies present in the coastal forests of the Eastern Cape is *C. a. labiatus*. In order to assess the true range of this taxon, I employed various research methods, including questionnaires, field surveys and data sourced from museum collections.

In total, 115 questionnaires were administered to people who either lived in the vicinity of the forest patches or who had comprehensive knowledge of the area and its fauna. The questionnaire surveys conducted in the coastal forests near East London revealed that samango monkeys were present in only two forest patches, namely the Umtiza and Fort Pato nature reserves. The respondents to all questionnaires conducted along the Wild Coast confirmed the presence of *C. a. labiatus* in three nature reserves, Dwesa-Cwebe, Hluleka and Silaka. Questionnaires were also administered in areas along the Amatola Mountains, and these confirmed the presence of *C. a. labiatus* in the Kologha, Pirie and Hogsback forests. If the Kologha forest is considered as the eastern limit of the Amatola Mountain forests, with Pirie being the southern limit and the Hogsback forest in the middle, it appears that samango monkeys make use of the whole of the Amatola mountain range.

After the questionnaire surveys had been completed, it was necessary to confirm that the data collected in these surveys was indeed correct, and I assessed the validity of the questionnaire data by carrying out my own field surveys. These entailed direct observations along linear transects and observing signs left by the samango monkeys, and were conducted in nature reserves and forest reserves throughout the Eastern Cape. The results of my field surveys were entirely congruent with the results of the questionnaire surveys: *C. a. labiatus* is indeed present in the Umtiza and Fort Pato nature reserves in and around East London, and in the Dwesa-Cwebe, Huleka and Silaka nature reserves on the Wild Coast. The field surveys conducted in the forests of the Amatola Mountains also confirmed the presence of the subspecies in these forests.

Data on collection localities was further obtained from the Amathole Museum, as it has the second largest collection of mammals in South Africa (i.e. the G. S. Shortridge collection), and specialises in the fauna of the Eastern Cape. Although the locality data were not always detailed or completely accurate, they confirmed the presence of *C. a. labiatus* in the same forest patches as the questionnaire and field surveys had indicated, providing the final confirmation concerning the distribution of these forest-dwelling primates in the Eastern Cape. They also indicated areas where samango monkeys had become locally extinct.

However, there does seem to be an elephant in the room in the form of the question regarding why samango monkeys are restricted to these forest patches in the Eastern Cape. There are two possible answers to this question: the first involves the fragmentation and isolation of forests as a result of anthropogenic activities in historical time; and the second invokes the southward radiation and isolation of samango monkeys in geological time because of natural climatic shifts. A cursory glance at the southern African landscape makes it abundantly clear that human activities have resulted in the destruction of thousands of hectares of forest in southern Africa during the past five or six decades, causing fragmentation of forest patches, which are immediately surrounded by human settlements likely to provide a hostile environment for monkeys. Forests represent the smallest biome in South Africa, covering approximately 0.1% of the surface area of the country, and most of the country's forest is made up of small, isolated patches. As samango monkeys tend to be very selective in terms of their preferred habitats, the fragmentation of forests has resulted in their becoming confined to these small, isolated patches with movement between them either limited or prohibited. For this reason the present distribution of Eastern Cape samango monkeys could be attributable largely to forest destruction and fragmentation and the absence of corridors to connect the small patches of forest which remain. The other possible reason concerns an ancient southward migration of samango monkeys which was subsequently disrupted. As the geographical distribution of *Cercopithecus albogularis* ranges from central and eastern to southern Africa, its current distribution is believed to have involved a southward migration from the tropics along the forests that clothed the shoulders of the Great African Rift Valley. During the Pleistocene epoch (1.8 million to 10,000 years BP) the climate oscillated between glacial and interglacial conditions approximately every 100,000 years (Hamilton, 1981). During the interglacial periods, the forests would have expanded, and the animals would have extended their ranges accordingly. During the glacial periods, when water was locked up in ice sheets at the poles, the climate was dry and forests retreated, fragmenting previously continuous distributions. The Afromontane forest is thought to be the more ancient than the Indian Ocean forests, which leads me to conclude that in the Eastern Cape, *C. a. labiatus* radiated south from the Afromontane forests of the Amatola Mountains, reaching the coastal forests of present-day East London after the last glacial maximum.

However, this conclusion does not explain why *C. a. labiatus* did not radiate further south still, into the Knysna and Tsitsikamma forests to the south-west of East London. These forests are very similar to the Afromontane mistbelt forests in their composition (e.g. the presence of yellowwoods, *Podocarpus* spp.), where *C. a. labiatus* is found in abundance, but the Knysna-Tsitsikamma forests are lowland temperate forests which owe their existence to a very narrow coastal belt and an escarpment which brings abundant rainfall. The so-called ‘Bedford Gap’, or *smaldeel,* is a strip in this region which tends to be relatively wet during winter and dry during summer, which are the opposite conditions to those in areas in which *C. a. labiatus* occurs. Hence their absence from the southern forests may be a result of these climatic differences and the vegetation of this area.

5.2 Troop size and composition of Eastern Cape samango monkeys

As linear transects constitute the most efficient method for surveying most forest species, I used 1 km line transects to count samango monkeys in the two areas studied. The monkeys were followed for 5 days per month for 5 months in both areas and counts were made every 10 to 15 minutes. The number of observations and counts varied from month to month. For the two troops I recorded and counted all the adults, sub-adults, females, and juveniles which I observed. Samango monkeys bear their offspring during the summer season and, owing to this fact, the number of juveniles observed during the 5 month period was high (11.5 ± 3.9 for the Swallowtail troop and 12.2 ± 4.5 for the staff village troop).

During the period in which data were collected in Hogsback, two males were observed in the Swallowtail troop, which is relatively rare among samango monkeys. When more than one adult male is present in a single troop, one of them is the usually the resident male, while the younger male is a satellite who tends to maintain a distance from the resident male, mating in secret if and when the opportunity arises. A mean number of 6.9 ± 3.3 (± SD) adult females was observed in this troop, and interactions among these females were relatively frequent although most of the social activities involved females and their young. No form of aggression was observed among the adult females during the period in which the troop was followed, and those instances of aggression which were observed occurred among or between sub-adults. After juveniles, sub-adults formed the largest cohort in the Swallowtail troop, with an average of 9.1 ± 3.6 sub-adults observed during this period. The sub-adults were less vigilant than the adults and spent more time on the ground. Although this troop rarely raided the vegetable gardens of the local people, when raids did occur, they were carried out by the sub-adults. A mean number of 28.8 ± 7.8 (± SD) was determined for the Swallowtail troop, with juveniles being the predominant age class, having a mean number of 11.5 ± 3.9 (± SD).

The structure of the staff village troop was very similar to that of the Swallowtail troop, with the number of juveniles being higher than any other age class. An average of 12.2 ± 4.5 (± SD) juveniles was observed in the staff village troop. The average size of the staff village troop was also similar [at 29.1 ± 9.7 (± SD)] over the period of observation. A single resident male was observed in this troop; he was very vigilant and was seen every day during the count. The staff village troop was less habituated to a human presence than the Swallowtail troop, possibly because this troop rarely encountered people at close distances, and the troop became very vocal when I moved too close, with the resident male constantly exhibiting dominance displays towards the females and the young. As in the Swallowtail troop, the adult females were closely associated with one another and were always close to the male, while the younger sub-adults tended to maintain a measure of distance.

The dynamics of the two troops were found to be similar in most respects, and although the Swallowtail troop had two males, it was very clear which of the two was dominant. He was very wary of my presence and clearly exhibited dominance over the younger male. During my observations of the staff village troop, two fatalities occurred, both of which were traffic-related, involving young members of the troop. While moving from the resting site to the preferred foraging area, the staff village troop has to cross a busy road and as a consequence, this troop is vulnerable to death and injuries at this point of intersection between their habitat and that of their human counterparts.

5.3 Habitat preferences of Eastern Cape samango monkeys

In the Eastern Cape *Cercopithecus albogularis labiatus* was observed in the Amatola mistbelt forests, the Eastern Cape dune forests and the Transkei coastal scarp forests. According to the available literature (von Maltitz et al., 2003), this subspecies is also present in the scarp forests of Pondoland, to the north of the Transkei coastal forests. All four of these forests share some common characteristics. Although previous studies regarded *C. a. labiatus* as an Afromontane forest inhabitant, the results of this study confirm that *C. a. labiatus* is capable of surviving and thriving in the coastal forests of the Eastern Cape. Hence, the explanation for the absence of overlap between the "Afromontane" *C. a. labiatus* and the lowland coastal *C. a. erythrarchus* is not related to either the presence of *Podocarpus* forest or the altitude.

The montane forests occupied by the Eastern Cape samangos can be divided into two subtypes. The forests of the Amatola escarpment are relatively large, species-rich, middle altitude forests, the vegetation of which is dominated largely by a mixture of evergreen and semi-deciduous species. The second subtype comprises the Albany scarp forests, which are scattered, very small forest patches along the lower west-east quartzitic ridges found between the Zuurberg Mountains and the surroundings of Grahamstown. *Cercopithecus albogularis labiatus* inhabits the Amatola escarpment forests, which cover approximately 3500 ha between the altitudes of 500 and 1600 m, at high population densities. The escarpment forests have a moderate climate with seasonal rainfall, most of which falls in summer. The structure of these forests, their climatic and temperature regimes clearly suit the samango subspecies.

The Amatola forests have a history of anthropogenically-driven destruction and disruption through the harvesting of timber for furniture, poles, wagons and railway sleepers. These activities have constituted the main source of disturbance in the structure of the forests and have placed the survival of many forest-dwelling mammals, including *C. a. labiatus*, at risk. An assessment done by von Maltitz et al. (2003) showed greater than 40% of the tree species were shared between the Amatola forests and those along the East London coast, where *Cercopithecus albogularis labiatus* was found to be present.

Cercopihecus albogularis labiatus is also found in the subtropical low-lying, densely canopied forests which lie along the East London coast, known as the Eastern Cape dune forests as they are endemic to the province. They occur in small pockets as far north as the Transkei Wild Coast, although samango monkeys were found only in the forests further inland in this area, namely those of the Umtiza and Fort Pato nature reserves. As is the case for the Amatola forests, a moderate climate with a summer rainy season prevails in the dune forests of the Eastern Cape. The height of the canopies of the dune forests varies between 10 and 20 m, with trees such as *Ptaeroxylon obliquum* (sneezewood), *Buxus macowanii* (Cape box) and *Harpephyllum caffrum* (African wild plum) being the common canopy-forming trees. Both the Amatola forests and the dune forests of the Eastern Cape have these tree species in common and *C. a. labiatus* has been observed feeding on the African wild plum in both habitats, allowing me to conclude that the similarities in both the forest structure and the tree species found in these two indigenous forest types make them suitable habitats for *C. a. labiatus*.

The data obtained from the questionnaires and the camera traps revealed that the samango money subspecies *C. a. labiatus* is also present in the coastal scarp forests of the Transkei. These forests are medium to high, with heights ranging between 15 and 20 m, and they are comprised of three distinct strata, with a well-developed seedling and sapling stratum and a poorly-developed herb layer. Unlike the two previously mentioned forests where *C. a. labiatus* has been observed, beneath the canopies of the Transkei coastal scarp forests the vegetation is relatively open and the trees are mainly single-stemmed. Windthrow, resulting from the combination of strong coastal winds and shallow soil, constitutes the primary source of disturbance in these forests. Fire is also a serious hazard. Although the population densities of *C. a. labiatus* in these forests are unknown, the data collected in this study shows the presence of the subspecies in the Silaka nature reserve in the north, in the Hluleka nature reserve in the middle, and in the Dwesa-Cwebe nature reserve in the south. These findings suggest granted that *C. a. labiatus* is distributed throughout the coastal scarp forests of the Transkei. However, it needs also to be considered that these forests are highly fragmented and that the three largest patches of forest fall within protected areas.

From the results of my investigation into the distribution of *Cercopithecus albogularis labiatus* I can make an informed estimate of the habitat preferences of Eastern Cape samango monkeys. All of the forest habitats in which the subspecies is known to occur are relatively large, species-rich forests, the predominant vegetation of which is made up of tall, canopy-forming tree species. Through observation I concluded that the availability of specific types of foods was not an important factor driving habitat preference, as *C. a. labiatus* was observed feeding on whatever was available in each of the forests, including alien species. This indicates that *C. a. labiatus* is a generalist and opportunistic forager, and explanations for habitat selection must be sought elsewhere, e.g. predator avoidance. For samango monkeys in the Eastern Cape, birds of prey, such as crowned eagles (*Stephanoaetus coronatus*), are the chief predators. However, during the course of this study I did not observe any instances of predation, although this does not necessarily imply that habitat preference is not influenced by predator avoidance. Habitat selection may also be related to the potential of the environment for transmitting or propagating communication signals faithfully to maintain social structures and relationships, but this is a hypothesis that remains to be tested in future research.

5.4 Historical biogeography of the Afromontane and coastal forests in the Eastern Cape

The history of southern African forests has been largely influenced by frequent and radical changes in the climate during the Pleistocene (Lawes, 1990). These radical climatic changes brought about shifts in the vegetation of southern Africa. The hyperthermal periods were characterised by southward shifts in the rainfall belts, accompanied by a rise in temperature and a change in summer rainfall patterns. These conditions favoured the spread of Afromontane forests and range extension by *Cercopithecus albogularis*. Prior to the last glacial maximum the Afromontane forests within southern Africa occupied a much greater area than they do today, and the forests extended from the Eastern Cape to eastern Mpumalanga. Studies conducted by Acocks (1975) and other researchers show that the forest patches on the mountains of the Eastern Cape are isolated, even under conditions of high rainfall. Most authors agree that the Afromontane forest increased in area during the interglacial periods, although some maintain that the Afromontane forests are as extensive now as they were at any time during the Pleistocene (which again suggests corridors of thick riverine forest, i.e. gallery forest: note that worldwide, gallery forests are always the first to be removed by people).

It is widely held that the glacial maxima, which were characterised by very cool and dry conditions, led to the elimination of some forests. During this period forest patches retreated to refugia in protected mountain valleys. As the present Afromontane forests of the Eastern Cape occur in mountain valleys and are situated close to the coast at low altitudes, these forests would not have been badly affected during the last glacial maximum, although their past distributions may have been much more extensive. The refugia of the Eastern Cape Afromontane forests suggest that they are very old forests, which survived the last glacial maximum.

The Indian Ocean coastal belt forests have developed relatively recently, and are believed to have been formed after the Last Glacial Maximum (Lawes, 1990). Sand dunes were formed from deposits left by the regression of the Indian Ocean at the end of the last glacial period, 8,000 to 10,000 years ago, and subsequently, climatic forces, such as strong winds and aridity, shaped the dunes into their present-day parabolic shape. The strong, high pressure easterly winds which characterised the glacial summer (Heydorn and Tinley, 1980), would have extended the associated inshore upwelling phenomenon from the southern coast up the east coast to the tropics, and strengthened the Agulhas Return Current activity (Tinley, 1985). Together these phenomena lowered the surface water temperature of the south-eastern channels and must have bought dry summer conditions to this coastal sector, as cold inshore surface waters inhibit rain.

The development of the Eastern Cape coastal forests was thus a post-glacial event, resulting from the formation of dunes which closed the mouths of rivers along the Eastern Cape coast (Heydorn and Tinley, 1980). It appears that only the Kei River was sufficiently large to maintain an exit to the sea. The presence of *Cercopithecus albogularis labiatus* in these forests shows that there must have been corridors which this samango subspecies used to move from the Afromontane forests to the newly-formed forests of the Indian Ocean coastal belt along the coast of the Eastern Cape.

5.5 Habitat conditions and conservation implications of the study

This study has shown that in the Eastern Cape *Cercopithecus albogularis labiatus* inhabits various different forest habitats, including the Afromontane forests along the

Amatola Mountains, the Eastern Cape dune forests on the coast around East London and the coastal scarp forests of the Transkei. All of these forests are characterised by tall canopy-forming trees and have a moderate subtropical climate, which favours this samango subspecies. *C. a. labiatus* does not occur further south in the Knysna and Tsitsikamma forests, either for reasons of historical biogeography (i.e. there was no appropriate habitat corridor in the past) or for reasons of habitat preference. Nevertheless, the taxon is clearly able to thrive in a wide array of forest habitats, which differ in terms of structure and species composition to varying degrees.

As all of the forests surveyed in this study were in protected areas, the extent of the disturbances to which the samango populations were exposed was limited, and I do not have a measure of the ability of this taxon to tolerate habitat degradation. Its probable absence from areas outside of reserves indicates that this tolerance is unlikely to be high. *C. a. labiatus* is the only forest-dwelling primate found in the Eastern Cape, and it is imperative that more conservation strategies are implemented in order to ensure the survival of the subspecies. As anthropogenic activities have proved to be detrimental to the survival of many forest species, the conservation of forests in the province and in the country needs to become an urgent priority.

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Appendix A

Semi-open questionnaire compiled for people in and around nature reserves and forest patches along the Eastern Cape Coast, where samango monkeys are found.

ADVENTURE PROVINCE
Eastern Cape
PARKS & TOURISM AGENCY

IN LUMINE TUO VIDEBIMUS LUMEN
University of Fort Hare
Together in Excellence

AFRICAN PRIMATE INITIATIVE FOR ECOLOGY AND SPECIATION

Section A: Personal Details of respondent

Name:				
Date of birth:				
Gender:				
Race:				
First Language:				
Contact details:				
Date:				
Level of education:	None	Primary School level	High school level	Tertiary education specify:
GPS Coordinates:				
Reserve employee	Yes		No	
Lives in the reserves	Yes			No

How often do you go into the forest?	

<u>Section B:</u> Questions on the Distribution and Abundance of Samango monkeys

Do you know what a samango monkey is?	
Can you differentiate between a vervet and a samango monkey?	
Are there samango monkeys in this forest/ reserve?	
How often do you see the samangos?	
When last did you see the samangos?	
How many troops do you think there are?	
How many animals do you think there are in a troop?	
How many males in each troop?	
How many females in each troop?	
How many infants in each troop?	
When you see samangos where do you see them?	
What colour is the fur coat of the monkeys you see?	
Have you observed a red tint on the rump of the monkeys?	

How often do you encounter road kill?	
Are they killed by people?	
Are samangos known as a problem to people?	
How far does the distribution extend in the area?	
Do you think samango monkeys should be conserved/protected?	

Appendix B

Samango Monkey

Vervet monkey