DAMAGE BY BABOONS TO PINE PLANTATIONS IN SOUTH AFRICA,

with special reference to the ecology of three troops of baboons in the Western Cape.

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Thesis presented in fulfillment of the requirements for the degree of Master of Science at the University of Stellenbosch.

M. Sc. in Natuurbewaring

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January 1993.

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously, in entirety or in part, been submitted at any university for a degree.

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1 February 1993

Abstract.

Baboon density in the study area was lower than in other studies, probably as a result of removal programmes. Troops had seasonal differences in home range utilization. Home range increased in summer as troops exploited local crops, and permanent water points. All troops showed a preference for plantations, as they provided shelter, food and protection.

Data on feeding habits was collected by faecal analysis as baboons' fear had developed a fear of humans. Favoured foods were monocotyledonous and dicotyledonous plants, bulbs, seeds and cones. Xylem, phloem and cambium cells did not constitute a large proportion of the diet, nor was there any seasonal variation in occurrence. Dicots were selected in spring, pine cones in autumn (probably a selection for seeds not cones), insects in summer and bulbs in winter. The five favoured items were found throughout the year. Baboons have a few staple items which they supplement with seasonally available foods. Bark stripping is inherent in baboons, despite the low energetic value of bark tissues. It is not known why all troops in plantations do not strip. Pine seeds and grasses play an important role in the diet, and may attract baboons into the plantations.

Some mineral nutrients in the pine tree tissues varied seasonally. Levels in these tissues were comparable with levels in many plants consumed by baboons elsewhere. Zinc levels were higher in trees damaged by baboons than in other trees. Baboons may thus be selecting for zinc. This phenomenon, and the implications for managing baboon damage, needs further research.

37% of plantations in South Africa experienced baboon damage. This was not restricted to any particular area or species of pine. Less than 15% of the compartments on any station showed damage. On average, less than 25% of the trees within a particular compartment were damaged. Increase in damage within a plantation was isolated. No relationship was found between damage and environmental factors. Less than 2% of the total compartments in South Africa and less than 1% of the total area afforested show damage.
Baboon damage at Kluitjieskraal State Forest affected 6% of all

compartments. Less than 25% of the trees in these compartments were affected. Damage to the trees varied in severity. Patterns of damage were determined and were found to differ between areas within a plantation.

A precise estimate of financial losses on a national scale is not possible due to many complicated factors and the considerable lack of available data. An assessment of the severity of the damage is provided. Authorities must determine whether it is practical and economical to introduce control measures. Indications are that the losses in South Africa amount to less than R5 000 000 on present areas afforested.

Information on control programmes in the Western Cape is scarce, although control has been carried out in Forestry areas for many years. The effectiveness of electric fencing to decrease damage levels is discussed. It is imperative to understand the population dynamics of specific baboon populations to exercise effective control.

Bobbejaandigthede in die studiearea was laer as in ander studies, moontlik as gevolg van bobbejaanvewyderingsaksies. Troppe se tuisgebiedbenutting het seisonsveranderinge getoon. Tuisgebiede vergroot in die somer omdat troppe naby-gelee oeste en permanente waterbronne benut. Alle troppe het 'n voorkeur getoon vir plantasies omdat dit skuiling, voedsel en beskerming bied.

Data oor voedingsgewoontes is versamel deur misontleding omdat die bobbejane vrees teenoor mense geopenbaar het. Monocot, dicot, bolle, sade en dennekeëls is as voorkeurvoedsel verkies. Xileem, floeem en kambiumselle was van minder belang in die dieet en het geen seisonsvariasie getoon nie. Tweesaadlobbige plante is in die lente geselekteer, dennekeëls in die herfs (moontlik 'n seleksie van sade en nie keels), insekte in die sommer en bolle in die winter. Die vyf voorkeurvoedselitems het regdeur die jaar in die dieet voorgekom. Bobbejane benut 'n paar voedselitems waarmee hulle seisonsbeskikbare voedsel aanvul. Basstroping is inherent aan bobbejane ten spyte van die lae energievlak van basweefsel.

Dit is onbekend waarom net somige troppe bas in plantasies bas afstroop. Dennesade en grasse speel 'n belangrike rol in hul dieet en mag bobbejane na die plantasies lok.

Sommige mineralevlakke varieer seisonaal in die denneweefsel. Mineraalvlakke was vergelykbaar met vlakke in plante wat deur bobbejane in ander areas benut word. Bome wat deur bobbejane beskadig is het hoer sinkvlakke getoon as onbeskadigde bome. Bobbejane mag dus vir sink selekteer. Hierdie verskynsel, asook die implikasies met die bestuur van bobbejaanskade, verlang verdere studie.

37% van die plantatsies in Suid Afrika ondervind bobbejaanskade. Skade is nie beperk tot 'n geografiese gebied of dennespesie nie. Minder as 15% van die plantasiekompartemente by enige stasie het skade getoon. Gemiddeld 25% van die individuele bome in 'n kompartement was beskadig. Groter skade het in geïsoleerde gevalle voorgekom. Geen ooreenkoms is gevind tussen skade en omgewingsfaktore nie. Minder as 2% van die aantal plantasiekompartemente asook minder as 1% van die oppervlakte onder plantasies in Suid Afrika het skade ondervind.

Bobbejaanskade het in 6% van die kompartemente by Kluitjieskraal Staatsbos voorgekom. Minder as 25% van die bome was geaffekteer. Die mate van skade aan individuele bome het gevarieer. Die bepaling van skadepatrone het getoon dat skade varieer in die verskillende gebiede van 'n plantasie.

Die bepaling van akkurate finanssiele verliese op 'n nasionale skaal is onmoontlik as gevolg van gekompliseerende faktore en die aansienlike gebrek aan beskikbare data. 'n Skatting van die ernstigheidsgraad van skade is egter weergegee. Owerhede moet bepaal of dit prakties en ekonomies regverdigbaar is om beheermatreels toe te pas. Indikasies dui daaop dat skade in kommmersieel beboste areas in Siud Afrika minder as R5 000 000 beloop.

Data oor beheerprogramme in die Wes Kaap is skaars, alhoewel beheer reeds vir baie jare in bosbouareas toegepas word. Die effiktiefigheid van elektriesese heining as 'n beheermetode is maatreëls bespreek. Dit is gebiedend om die bevolkingsdinamika van spesifike bobbejaanpopulasies te verstaan voordat effektiewe beheer toegepas kan word.

Dedicated to my mother, aunt and husband.

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Acknowledgments.

There are a great number of people who have contributed towards this study in one or more ways. Firstly, I would like to thank the employees of the Department of Environment Affairs who gave of their time and energy to help me with information. Mr. Nic Engelbrecht, Mr. Francis Gerber (Kluitjieskraal State Forest), Mr. Notley (Bergplaas State Forest) and Mr. Ryno Visagie (La Motte State Forest) were of special help. Mr. Braam du Preez and Mr. Rynhard van Heerden of the Western Cape Forest Regional office in Cape Town also contributed greatly. Mr J. Rossouw and Mr G. Thornton of La Motte State Forest provided special assistance in accumulating data about the financial losses due to baboon damage. Mr. Tom Zeeman of the Chief Directorate of Nature and Environmental Conservation (Cape Provincial Administration) was based at the Waterval State Forest. He kindly provided accommodation while I worked in the Kluitjieskraal area.

Mr. Johan Breytenbach, of the Saasveld Forestry Research Institute, provided invaluable advice. Mr. Steve Whitehead and Mr. Mike Laws of the University of Natal also gave valuable guidance.

I further thank Mr. Dave Pepler and Dr. Bertie van Hensbergen, both of Stellenbosch University, for technical assistance and help with statistical analysis respectively.

I gratefully acknowledge the advice provided by my supervisors Dr van Hensbergen and Prof. R. C. Bigalke.

Mr Martin Scott of Vrolijkheid Nature Conservation Station translated the abstract into Afrikaans.

I am indebted to the assistance given by my family for their support, both physical and moral. I was frequently accompanied in the field by either my sisters Julie and Margaret, or my Aunt, and mother. All freely gave of their time. My husband Zane has accepted significant disruption to our family life and has been unfailingly supportive and interested in the study. Both he and my mother proof read the document. My mother-in-law helped with many household chores to enable me to work. Thanks must also go to all the baby sitters. Lastly, I would like to thank my son who has accepted major inconveniences in his little life in the interests of this study.

1. Introduction and Research Aims.

In the last century there has been a spectacular increase in the development of agricultural and forestry practices throughout Africa. This, according to Maples et al (1976), has led to marked changes in the distribution and ecological adaptation of the chacma baboon *Papio ursinus*. The expansion of these activities has seen the introduction of extensive additional water and food sources. This has increased the suitability of certain areas for baboons (Lloyd, 1981). Baboon populations occur frequently where human settlements are found (Stoltz and Keith, 1973). This inevitably leads to conflict between man and baboon. Such conflict may in turn lead to financial losses for the landowner.

Baboons are efficient omnivorous foragers. They utilize a very large range of food items. Most crops planted in proximity to their natural ranges have suffered (Smithers , 1983). The baboon is thus regarded as a problem animal.

A particular problem is highlighted in this study. This is the damage caused by baboons in pine plantations in many parts of South Africa (Bigalke and van Hensbergen, 1990). It is alleged that baboons may be responsible for losses exceeding several million Rand (Bigalke and van Hensbergen, 1990), as a result of decreased timber returns.

The aims of this study were

1. to investigate the ecology of baboons known to cause damage, with special reference to ranging and feeding behaviour;
2. to identify those factors that encourage baboons to utilize plantations for any reason;
3. to evaluate the role of food items provided by plantations in the baboons' diet;
4. to analyze tissues of pine trees consumed by baboons to determine whether any particular mineral elements are selected for;

5. to investigate and evaluate baboon damage experienced by the forestry industry;
6. to determine damage levels and patterns of damage on State Forests throughout South Africa by means of questionnaires;
7. to evaluate control options, with special reference to electric fencing, and the effect of control on the population dynamics of baboons.

2. The Baboon Problem: A Literature Review.

2.1 What is the problem?

Baboons in the Cape Province were, until recently, classified as vermin (Lloyd, 1981). Any landowner was thus entitled to destroy them as he saw fit. They are currently classified in the Cape Nature Conservation Ordinance (No. 109/1988) as a protected species, with an open hunting season (1 January to 31 December). In effect there is virtually no legislative protection for the baboon. The situation exists because of continuing conflict between landowner and baboon (Lloyd 1981; Maples et al, 1976; Strum, 1987). The response by land owners to the conflict is the same as it has been for three centuries. Individuals, and entire troops as far as this is possible, are destroyed.

Baboons have been reported as causing considerable damage to crops since the 1700's (Skead, 1980). Reference to damage in pine plantations dates back to the 1960's (Department of Forestry Annual Report No. 1969). Baboons enter pine plantations and climb the trees. Branches are subsequently broken and bark is stripped from the tree. This permits access to the layer of cells between the bark and the inner wood. This layer may then be eaten. Such behaviour is well documented, not only for the baboon, but for many other species of primate and other vertebrate (Section 2.6).

The baboon bites into the bark and proceeds to tear the bark from the tree. Fingers and teeth are used to scrape the layer of cells (the xylem, cambium and phloem, often referred to as "cambium" for convenience) from inside the bark and off the tree (van Schalkwyk, 1984; Giesen, 1985). The bark itself is not eaten. This is most likely due to a high tannin content (Beeson, 1985) and low nutritive value (Bigalke and van Hensbergen, 1990). The bark is left in strips below the tree on the ground (Giesen, 1985).

This damage causes a wound that may heal (Bigalke and van Hensbergen, 1990), but invariably results in damage to the wood. Timber retrieved from a tree after it has been damaged may be deformed, stained or have resin inclusions. This decreases the volume and quality of the timber (Droomer, 1985). Wounds are also susceptible to fungal infection (Swanepoel, 1989; pers. comm.). Trees may be ring barked, resulting in loss of the crown and even death of the tree (Bigalke and van Hensbergen, 1990). These authors state that damage occurring in the lower reaches of the stem leads to loss of the best grade of timber (namely the first and second logs). Damage to individual trees may be so great that whole stands may need to be clearfelled to minimize losses.

There are no accurate figures of areas damaged in South Africa, but estimates in 1980 were:

-Western Cape 450 ha,

-Tsitsikamma 200ha and

-Eastern Transvaal 300ha (Bigalke, 1980).

No reliable financial estimates of losses due to damage are available. Droomer (1985), however, calculated a loss of R4720/ha in areas damaged in a similar manner by the samango monkey (*Cercopithecus (mitis) albogularis*). Using this figure comparatively, baboons may be responsible for losses exceeding several million Rand (Bigalke and van Hensbergen 1990).

2.2 Origins of the bark stripping habit

The bark stripping habit is one that occurs frequently in undisturbed habitats, though not on the same scale as in pine plantations. Numerous literature sources refer to primate species eating bark of indigenous trees, eg. the chimpanzee (*Pan troglodytes*)(Nishida, 1976; Goodall, 1986); the gorilla (*Gorilla g beringei*)(Goodall, 1971); orang-utans (*Pongo pygmaeus*)(Rodman, 1977), the chacma baboon (Hall, 1963) and the samango monkey (von dem Bussche and van der Zee, 1981). This appears to be an "emergency" food when preferred fruits do not ripen (Nishida, 1976).

Baboons also eat the exudates from *Acacia xanthophloea* in Kenya (Altmann and Altmann, 1970; Hausfater and Bearce, 1976). The bark of *Strychnos* trees is eaten by baboons on Kariba Island (Hall, 1963). A. Wills (1987, pers. comm. in Bigalke and van Hensbergen,

1990) observed baboons stripping *Acacia karoo* in Zululand. Baboons are also recorded as stripping the bark off *Acacia albida* in the Namib Desert during periods of severe water shortage (Brain and Mauney, 1991). Midgley (1991) believes that baboons are responsible for the death of large numbers of tree euphorbias in the Eastern Cape. They appear to break off the tips of the branches and eat the inner core. Hamilton (1976) found similar behaviour with *Euphorbia avas-montana* in the Namib during food shortages, while Hediger (1951 in Hamilton, 1976) and Lock (1972) also observed baboons eating *Euphorbia candelabrum* in East Africa.

Utilization of parts of trees in their native habitats is thus a natural feature of baboon behaviour. Baboons also exploit many trees seasonally for fruit or seeds. The stripping of exotic softwoods is not an isolated phenomenon and occurs throughout Africa, notably in plantations in Malawi (Beeson, 1985). It is apparent that baboons do not consume the "cambium" tissues as a significant food source (Bigalke and van Hensbergen, 1990). Pine seeds produced in plantations do however act as an important food source (Giesen, 1985).

There are many theories as to what first caused baboons to start stripping pine trees.

1) It would seem that baboons are attracted into these areas by the seeds produced by the pine trees. The inner cells may have been discovered when a cone was pulled from the stem, tearing the bark away from the tree as well (van Schalkwyk, 1984).
2) Another common theory is that baboons may pull the bark away in search of insects. McMahon (1977) and Schlichte (1975, in Beeson, 1985) believe that samango monkeys strip the bark from the trees in indigenous forests to get to hidden insects.
3) Resin may act as an olfactory stimulus (Giesen, 1985), attracting baboons to the trees. A. Roscher (1987, pers. comm. in

Bigalke and van Hensbergen, 1990), states that damage at Kluitjieskraal State Forest in the Western Cape increases after pruning. The smell of resin is very strong at this time.

4) Pine plantations in the Western Cape are cooler in summer and warmer in winter than the exposed areas surrounding the plantations. In addition a ready source of food in the form of seeds creates an attractive site for baboons in terms of shelter and food (Bigalke and van Hensbergen, 1990).

5) It is widely believed that baboons may have begun to utilize the "cambium" tissues as a supplementary food source during times of shortage (Darwin, 1982; van Schalkwyk, 1984; Giesen, 1985). Bigalke and van Hensbergen (1990) refute this, claiming that the nutritive value of these tissues is too low to be of importance.

6) Beeson (1985) believes that food sources in the baboons' natural habitat could not, in the long term, sustain the same scale of damage as is recorded in pine plantations. He thus suggests that the super-abundance of identical food items acts as a superstimulus, leading to excessive stripping.

Plantations were first established in the Western Cape in the early part of this century. The first exotics were planted at Tokai State Forest in 1884 (Van Zyl, 1992; pers. comm.). The damage by baboons, however, was only recorded in 1967 (Giesen, 1985). Baboon damage was observed in Malawi in 1973 (Darwin, 1982). There has been rapid removal of natural vegetation for the expansion of plantations. Beeson (1987) proposes that this clearance may have triggered the bark stripping habit of blue monkeys (*Cercopithecus mitis*) in Malawi. He suggests that there may be a critical threshold in the proportion of exotic vegetation in the natural habitat for some mammals. Should this level be exceeded, raiding and damage may occur.

2.3 Extent of the problem

Bark stripping by baboons in commercial plantations has been recorded in Malawi (Darwin, 1982), South Africa (Bigalke and van Hensbergen, 1990), and some of the homelands eg. Lebowa (Bigalke and van Hensbergen, 1990; R. Venter, 1991; pers. comm.). Estimates of damaged areas in South Africa are given in Section 2.1. The financial loss due to poor or irretrievable timber is complicated by other factors such as decreased growth rate due to damage. This is obviously very difficult to calculate as factors such as seasonal rainfall, insect and hail damage etc, also affect growth rate (Engelbrecht, 1987; pers. comm.).

Also to be considered are the economic losses sustained when compartments have to be clearfelled and replanted. E. Uys, (1987; pers. comm. in Bigalke and van Hensbergen, 1990) calculated the cost of replanting areas at Bergplaas State Forest in the Southern Cape to be R550/ha. At Storms River State Forest, also in the Southern Cape, certain areas have been so badly damaged that they have been replanted twice. Replanting costs in this case were R1100/ha (Bigalke and van Hensbergen, 1990). As mentioned in Section 2.1, Droomer (1985) calculated the loss at clearfelling (of 30 year old trees damaged by samango monkeys) at R4720/ha.

It would appear that damage levels are escalating. Bigalke and van Hensbergen (1990) found a mean compound growth rate in damage of 27% per annum in seven consecutive years at Bergplaas State Forest. They also state that previously undamaged compartments at Kluitjieskraal State Forest are now showing signs of damage. In Malawi, a 25% increase in damage occurred from 1981 to 1982 (Darwin, 1982).

2.4 Similar damage by other mammals

Other primates responsible for stripping the bark from trees in commercial plantations in Africa are the samango monkey

(*Cercopithecus (mitis) albogularis*) in South Africa (von dem Bussche and van der Zee, 1985), the sykes monkey (*Cercopithecus mitis kolbi*) in Kenya (Omar and de Vos, 1970) and the blue monkey (*Cercopithecus mitis*) in Malawi (Beeson, 1985). Bark stripping may have started because of a temporary food shortage. The habit, however has not persisted as a feeding pattern due to the low nutritive value of the "cambium" tissues as a food item. The habit is more likely to persist because of an acquired taste for the sap (Beeson, 1987). This author proposes that the initiation of bark stripping coincided with large scale clearances of natural vegetation for plantations. This is supported by observations that only those groups closest to the plantations practice bark stripping. He further suggests that leaving areas of indigenous shrub adjacent to plantation areas, and not removing indigenous food sources within the plantations, may deter monkeys from stripping.

Katerere (1982) records incidence of eland (*Taurotragus oryx*) stripping the bark from pine trees in Zimbabwe. Beeson (1987) warns that although bark stripping by other vertebrates appears to be similar to that of primates, the behaviour may not have the same function and cause.

In Australia, plantations are damaged by rabbits, wallabies, rats and possums (McNally, 1955; Barnett et al, 1977). Barnett et al (1977) claim that rabbits can be excluded by fencing, but possums are a greater problem. McNally (1955) found that two species of possum (*Trichosurus caninus* and *T. vulpecula*), a wallaby (*Wallabia bicolor*) and the allied rat (*Rattus assimilis*) were responsible for damage. He attributed this to the availability of ground cover in the plantations, thus providing a suitable habitat. Availability of water and the close proximity of native vegetation is an additional attraction. Exotic trees are used as a food source during times of shortage. Removal of cover within the plantation should help to decrease damage levels (McNally, 1955).

The stripping of the bark of *Acacia koa* by *Rattus* spp. on the islands of Hawaii and Mau is very common (Scowcroft and Sakai, 1984). Rats only seem to strip young trees, and were not observed to ringbark the trees, as all other damaging vertebrates were reported to do.

Sullivan and Sullivan (1981) reported that snowshoe hares (*Lepus americanus*), red squirrels (*Tamiasciurus hudsonicus*) and porcupines (*Erethizon dorsatum*) remove bark from trees in North America. This damage is also attributed to the increased food and cover associated with plantations.

Grey squirrels (*Sciurus carolinensis*) strip the bark of beech and oak trees in Britain (Shorten, 1957). Stripping is attributed to a temporary food shortage resulting in an acquired taste for the sap. Shorten (1957) also found that squirrels were not able to obtain significant amounts of nutrients from the bark.

Hannson (1985) reports stripping damage by voles (*Microtus agrestis*) in North America. Damage is most common in trees six years and younger.

The xylem and phloem tissues are the cells that transport water and nutrients throughout the plant. Bark stripping to obtain these tissues (and the cambium) is a common phenomenon in vertebrates throughout the world. Stripping as a problem in commercial plantations is not unique to any area or taxon. Although the predicament is debated in detail in the literature, there does not appear to be a common basis for large scale damage, nor an efficient and cost effective way of decreasing damage levels.

2.5 Patterns in Baboon Damage

2.5.1 Season

Reports of damage levels escalating in a particular season vary, and are mostly contradictory. In the Southern Cape for example, damage is reported as increasing in the winter months (Best, 1983; van Schalkwyk, 1984; J. Koen, 1987; pers. comm. in Bigalke and van Hensbergen, 1990). The damage is ascribed to a food shortage during this time that forces baboons to look for an additional food source. Damage in the Western Cape would appear to increase during the spring (D. Pepler, 1987; pers. comm. in Bigalke and van Hensbergen, 1990) and summer months (A. Roscher, 1987; pers. comm. in Bigalke and van Hensbergen, 1990; James and Clough, 1989). Summer is the dry season and baboons may use the "cambium" tissues as an additional source of moisture. Botha (1988) found that small mammal damage to trees increased during periods of drought. Beeson (1987), however found that bark stripping by blue monkeys occurred during the rainy season. He felt that increased damage may be correlated with a higher quantity of sap flow during higher rainfall periods. Darwin (1982) also found baboon damage in Malawi to increase during the wet season. He attributed this to the sap rising in the trees prior to the rainy season growth flush. It would also seem that most damage occurs when least fruit is available.

Baboons move over larger areas in summer than in winter, and movements of a troop are greatly influenced by the availability of crops on nearby farms (Darwin, 1982). Increase in damage during winter months may occur because more time is spent within the plantation, closer to the sleeping sites and the natural vegetation.

2.5.2 Species affected

The species damaged in the Southern and Western Cape are *Pinus radiata* and *Pinus pinaster* (van Schalkwyk, 1984; Giesen, 1985). This is most likely a reflection of the fact that these are the two most widely planted species in these areas. In Malawi *Pinus taeda* is the most severely damaged species. Baboons may therefore prefer certain species of tree. Bigalke and van Hensbergen (1990), however, claim that all commercial species are liable to attack.

2.5.3 Area

Baboon damage does not occur uniformly throughout a plantation, or even within a compartment within the plantation. Damaged sections seem to be concentrated in areas inhabited by baboons, such as the mountainous slopes within some plantations (Seydack and Grewar, 1974). A further factor influencing the occurrence or severity of damage is the proximity to sleeping sites (Bigalke and van Hensbergen, 1990).

It is widely reported that damage within a compartment shows a distinct pattern. Damage is more severe at the edges than in the centre (Rossouw, 1977; Giesen, 1985). This is especially apparent on edges adjacent to indigenous vegetation (Rossouw, 1977; Barnett et al, 1977; Clark, 1980; von dem Bussche and van der Zee, 1985; Beeson, 1987; James and Clough, 1989). Even in a compartment with heavy damage throughout, there is still a trend towards clumping. This pattern reduces the effectiveness of selective thinning to decrease losses (van Schalkwyk, 1984).

2.5.4 Trees selected

Baboons tend to select the largest and best trees within the compartment. This was also observed for blue monkeys (Clark, 1980) and baboons (Anon, 1978) in Malawi. James and Clough (1989) found that baboons showed a significant preference for trees to which fertilizer had been applied. They related this to differences in growth rate between the two groups, rather than to the nutritive status of different trees. It was also observed that larger trees in both "fertilized" and "unfertilized" plots were selected. Sullivan and Sullivan (1981) found the same selection by red squirrels in Central British Columbia. They related the preference for larger (and therefore faster growing) trees to the greater quantity of vascular nutrients in the xylem, cambium and phloem.

2.5.5 Damage on the tree

Damage seldom occurs to a tree before it reaches the age of four years (Bigalke and van Hensbergen, 1990). The trees appear to reach a certain minimum size before stripping occurs. This minimum size can be reached earlier than four years, especially if fertilizer is applied to the trees (James and Clough, 1989). In the Western Cape, trees are no longer damaged once they are twenty years old (Seydack and Grewar, 1974; Rossouw, 1977). This can be attributed to the thickness of the bark (Bigalke and van Hensbergen, 1990). Bigalke (1990, in Bigalke and van Hensbergen, 1990) however, observed 40 year old trees in Lebowa that had recently been stripped.

Bark may be removed from anywhere between the base of the tree to the crown. Most damage however, appears to be concentrated where the bark has a maximum thickness of 5mm - usually 1/3 to 1/2 the height of the tree (Giesen, 1985). Because *P. pinaster* bark tends to be thicker, stripping occurs higher up the tree than in *P. radiata* (Giesen, 1985). *P. radiata* bark comes away from the tree more easily, resulting in longer mean strip lengths (Bigalke and van Hensbergen, 1990).

2.5.6 General

There does not appear to be any particular pattern to baboon damage, or for that matter, any mammal stripping damage, except that the largest trees are selected. The bark itself is not eaten, due most likely to the very high condensed tannin content (Beeson, 1985). Bigalke and van Hensbergen (1990) analyzed bark and xylem, cambium and phloem tissues of three species of *Pinus* for starch and sugars. The starch and sugar levels were much lower in the bark samples than in the soft tissues. The tissues of the cambium, xylem and phloem were however, also low in starch and sugar levels. 100g of fresh cambial tissue would yield only 0,2 MJ if completely digested. Such levels are too low to contribute greatly towards baboon nutrition. The theory therefore, that baboons strip to obtain energy seems unfounded. Beeson (1987) states that stripping is too rare to be regarded as a feeding behaviour for blue monkeys. The same would most likely apply to baboons although the slightly sweet and resinous taste of the xylem, cambium and phloem tissues may act as an enticement (Bigalke and van Hensbergen, 1990).

Baboons require drinking water and shade (Altmann and Altmann, 1970). Altmann and Altmann (1970) also found, as did Stoltz and Saayman (1970) that those areas of home range most frequently used were close to drinking water and sleeping sites. Plantations may act as sources of shelter, especially during hot dry months in the Western Cape (Bigalke and van Hensbergen, 1990). All these factors may account for the frequent presence of baboons in plantations and the stripping that is sometimes associated with their presence.

Not all baboons ranging in or near commercial plantations strip trees. Many troops utilize plantations for seeds and shelter without causing damage (Bigalke and van Hensbergen, 1990). At Wemmershoek plantation in the Western Cape, stripping damage does not occur. However, in the neighbouring plantation, La Motte Forest Station, stripping has been a problem for many years (Bigalke and van Hensbergen, 1990). Beeson (1985; 1987) claims that blue monkeys also do not invariably strip bark when in contact with plantations.

It would thus appear that bark stripping may be a learnt (socially transmitted) behaviour that becomes a local tradition in certain troops (Bigalke and van Hensbergen, 1990). Hall (op. cit. in Bigalke and van Hensbergen, 1990) found that some baboon feeding habits are acquired regionally due to a temporary requirement. These habits are then taught to successive generations. Bigalke and van Hensbergen (1990) state however, that dietary necessity is not the only reason different feeding habits develop in different troops. Cultural differences have also been recorded in different "groups" of primates.

2.6 Why is the baboon a problem animal?

"As agriculture expands and forests are utilized, primate habitats suffer. More and more, human and non-human primates come into direct contact and direct competition." (Strum, 1986). The above statement highlights the core of most "pest" situations, especially primate problem animals, and reflects the incidence of landowner-baboon "conflict" situations that have become prevalent in many areas of South Africa. Strum (1986) further claims that more conflict exists between humans and non-human primates than between any other two taxa. This is largely due to the extensive overlapping of their respective niches. She describes baboons as intelligent, manually dexterous and highly opportunistic. This means that their control is often costly, inefficient and ultimately ineffective. Baboons, besides being aggressive competitors, are very adaptable. This ability to adapt to an altered environment means that problem populations are able to survive, despite man's attempts to "control" them.

Strum (1987) describes a population of baboons (*Papio cynocephalus*) at Gilgil, Kenya, that began raiding crops as the surrounding free range areas were taken over for cultivation. She found baboon raiding behaviour did not occur if baboons had reasonable home range refuges in adjoining non-agricultural areas, and certain procedures (which were not described) were followed.

At the heart of the problem is the need for man and baboon to co-exist. If all problem troops are removed, new troops, subject to the same environmental conditions move in to fill the vacuum (MacDonald, 1980). This is thus no solution. It is necessary in such a situation to determine how real, and how significant losses to the landowner are. These losses need then to be related to the cost of any management activity that may be employed to decrease damage levels. Control need only be considered when damage is severe enough to warrant expenditure on control measures (Dolbeer, 1981).

Furthermore, in considering these issues, it must be remembered that man is part of the problem and must therefore be part of the solution (Strum, 1986; 1987).

2.7 Control Measures

Numerous different control methods have been recorded. Most techniques are aimed at reducing baboon population density in the hope that this will in turn decrease damage levels. The population density at which damage is reduced to acceptable levels has yet to be determined. Other methods are aimed at discouraging baboons from being attracted into an area.

2.7.1 Poisoning

Poisoning, e.g. strychnine and Telodrin, was found to be most effective in reducing population levels under certain circumstances (van Schalkwyk, 1984; Brand, 1989). This method however, is not commonly used as it is very unselective (Brand, 1989) and may have undesirable environmental effects (Bigalke and van Hensbergen, 1990).

2.7.2 Shooting

Shooting at baboons, and hunting them with dogs has been attempted (Sahlertz, 1988). Baboons however, learn very quickly and this method was found to be inefficient, time consuming and expensive.

2.7.3 Trap cages

The most commonly used method is that of trapping baboons in cages, and then shooting trapped individuals. Trap design is based on that of Fitzsimmons (1955). When traps are used in large numbers, after an adequate pre-baiting period, the method can be successful in reducing population numbers. Brand (1989) found that in nine baboon trapping operations in the Western Cape, an average of 18,5% of the troop remained. This method is thus not completely effective in removing the whole troop. Brand and Jordaan (1991), however, claim that it is possible to remove an entire troop. If the whole troop were to be removed, a vacuum would be created (MacDonald, 1980). This would soon be filled by neighbouring troops, which may or may not have the bark stripping habit. More than 1000 baboons have been removed from Bergplaas State Forest over a period of eight years (F. Notley, 1989; pers. comm.), and over 600 at Kluitjieskraal State Forest in six years (Engelbrecht, 1989; pers. comm.). Baboon population density remains high in these areas. No accurate records of trapping data or damage levels exist, yet it would not appear that damage levels have decreased as a result of extensive trapping operations (Bigalke and van Hensbergen, 1990).

2.7.4 Contraception

Contraception has been suggested as a means of reducing population levels. Oral contraception is not considered a practical option as such drugs are short term in action, and need to be given over a period of time. One method of administering the drug, which is non selective as regards sex and age, is in the food. Furthermore it would entail artificial feeding on a regular basis. Implanting the drug is difficult and costly.

2.7.5 Silvicultural methods

These techniques include planting species that are not preferred by the baboons (Giesen, 1985). This author suggests increasing the size of the compartment to reduce the edge effect. The boundary zone could be left unpruned. Viljoen (1983) proposes for samango monkeys that pruning be carried out high in the tree. Trees would then be more difficult to climb, and not as many branches would be broken.

2.7.6 Spraying/injecting trees

Trees can be injected or sprayed with substances to make them unpalatable (Bigalke in Sahlertz, 1988). Selenium has been positively tested on a small scale in the U.S.A. (Bigalke in Sahlertz, 1988). More research is needed on this topic. It may be difficult and expensive to mount such an operation on a large scale. Strum (1986) claims that taste aversion conditioning may hold promise as a management tool in control procedures.

2.7.7 Scaring of individuals

Attempts have been made to scare baboons from the plantations and from farmlands. This includes shooting (Bigalke and van Hensbergen, 1990), painting a member of the troop white to scare other members (Best, 1983) and playing calls of predators (Viljoen, 1983) and alarm calls of baboons (Strum, 1987). None of these methods is particularly effective, especially in the long term. Whitehead (1988; pers. comm.) suggests a programme of scaring baboons from the plantations for a period of years (a couple of generations) in order to "unlearn" the bark stripping habit. He claims that the cost of hiring someone to do this for the period will ultimately be cheaper than damage as the alternative.

2.7.8 Attacking sleeping sites

As damage tends to be concentrated around sleeping sites, it has been suggested that attacks be made on the sleeping sites (Sahlertz, 1988). This has not been undertaken, due to the terrain involved, the safety aspects and the lack of manpower.

2.7.9 Electric fencing

Electric fencing has been found to be successful at excluding baboons under certain circumstances (Viljoen, 1983). This needs to be tested further to determine how cost effective it would prove on a large scale.

2.8 Conclusion

In all cases it is necessary to determine whether the money saved by control methods is greater than that spent on the control. Cost effectiveness of different types of control should also be compared (Fig. 2.1) (Dolbeer, 1981). This means that adequate research must be done to determine damage levels and possible control options, before a decision is made.

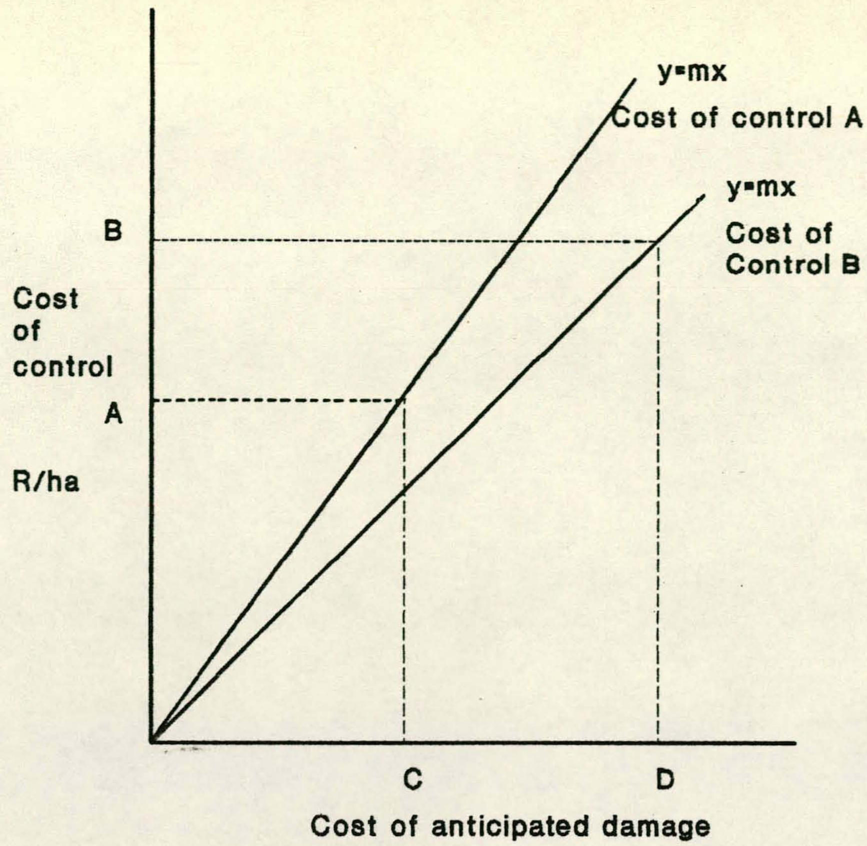


Fig. 2.1. Model of Cost-Benefit Equation. Damage must be greater than Rand C for option A to be employed, and greater than Rand D for option B to be employed. (Adapted from Dolbeer, 1981).

3. Baboon Ecology.

Baboons are mainly terrestrial primates. Their classification is as follows:

Family: CERCOPITHECIDAE
Subfamily: CERCOPHECINAE
Genus: *Papio*
Species: *anubis* - the olive baboon (West Kenya, Uganda)
cynocephalus - yellow baboon (East Kenya, Tanzania)
hamadryas - sacred/desert baboon (Egypt, Ethiopia)
papio - guinea (West Africa)
ursinus - chacma (Southern Africa) (Moss, 1975).

The above species, except for *P. hamadryas*, are regarded by some researchers as races of one species of savanna baboon (Moss, 1975). The genus, *Papio*, is found throughout Africa. Baboons are the most successful ground living primates next to man (Moss, 1975). They adapt to habitats ranging from forest (Rowell 1966) to savanna (De Vore and Hall, 1965), including Cape fynbos (Hall, 1961; Davidge 1976; 1978).

Troop size varies from 8 - 110 individuals, with a tendency to a group size of 30 - 50 (De Vore and Hall, 1965). These authors claim that food and habitat resources have a major determining influence on group size.

Baboons move in a defined home range which often overlaps with that of neighbouring troops. Core areas are the most heavily used and contain sleeping sites and permanent food and water resources. It is seldom that core areas are used by more than one troop at the same time (De Vore and Hall, 1965; Ewer, 1968). Baboons are very dependant on water, and their home range will contain at least one permanent water point (Moss, 1975). Baboons may cover 8 - 20km a day in search of food (De Vore and Hall, 1965). These authors claim in addition that the most important factors determining home range area are the size of the troop, concentration and distribution of food, and the proximity of neighbouring baboons.

Baboons eat almost anything, although they are mainly vegetarian. The most important facet of their diet according to De Vore and Hall (1965) is their ability to adapt to any environment and to utilize whatever food is available. Moss (1975) claims however, that baboons are selective feeders, choosing carefully from a wide variety of plants. Diet varies according to season and stages of plant development. Insects are a small, but important part of the diet, and where available, caterpillars and reptiles are eaten. At the Cape Point Nature Reserve in the Western Cape, baboons feed on marine crustaceans found on the shore and in rock pools (Hall, 1962).

Baboons occasionally take small mammals, eggs and fledglings, and small antelope. This habit is however very rare, and usually opportunistic (De Vore and Washburn, 1962; Moss, 1975; Strum, 1975). Food items such as grass, seeds and fruit are selected for when available.

There are two opposing views on baboon social structure. De Vore and Hall (1965) believe that the troop is dominated by a male hierarchical system, which defends the troop from predators. Strum (1987) on the other hand, claims that the troop is female dominated, with the young males leaving the troop to avoid inbreeding. New males enter the troop by becoming "friends" with females.

The baboon troop is a complex structure which displays intricate social organization. The baboon's greatest assets are its extreme adaptiveness, vigilance and the close structure of the troop socially (Moss, 1975). These have enabled the baboon to thrive despite persistent conflict with man.

4. Study area.

4.1 General

The Kluitjieskraal State Forest (33°25'S, 19°10'E) lies in the Western Cape region of South Africa (Fig. 4.1), approximately 100km north west of Cape Town. It is situated on the slopes of the Waterval Mountains, and in the basin between the Waterval and Elandskloof Mountains (Suurvlak Valley). The area afforested is 3254ha.

The towns of Wolseley and Tulbagh are close by. The mountain slopes have been planted with exotic softwood timber. The valley surrounding the towns is cultivated with vineyards, wheat, and to a limited extent, fruit orchards. The high mountainous areas are covered in mountain fynbos.

The Waterval River flows north-east through the Suurvlak Valley, over two waterfalls and later joins the Boontjies, and then the Little Berg Rivers. The Suurvlak area has been proposed as a reservoir and may thus be flooded at some stage in the future.

4.2 Physical Environment

4.2.1 Geology

The Waterval and Elandskloof Mountains form a block of resistant Table Mountain Group Sandstone (Fig. 4.2). This rises above the Malmesbury Group shales to the east and west, to an altitude of over 900m (Pike, 1967).

4.2.1 Climate

The climate of the area is basically Mediterranean, with hot dry summers, and wet, cool winters. The area receives an annual average rainfall of 700mm, with Kluitjieskraal State Forest recording an annual average of 637mm. Most of the rain falls during the winter months (May to August). Rainfall is probably

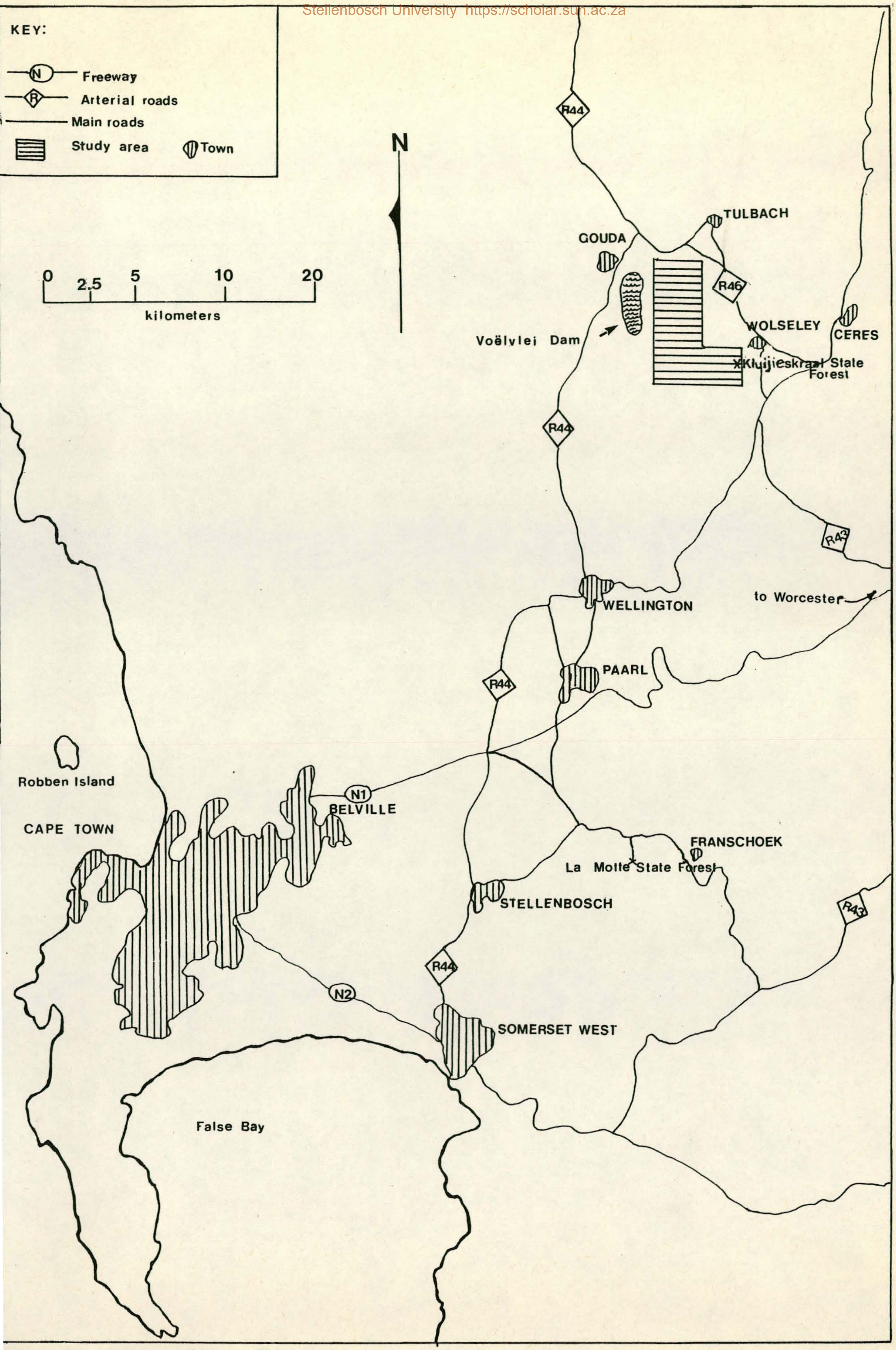


Fig. 4.1 Locality Plan

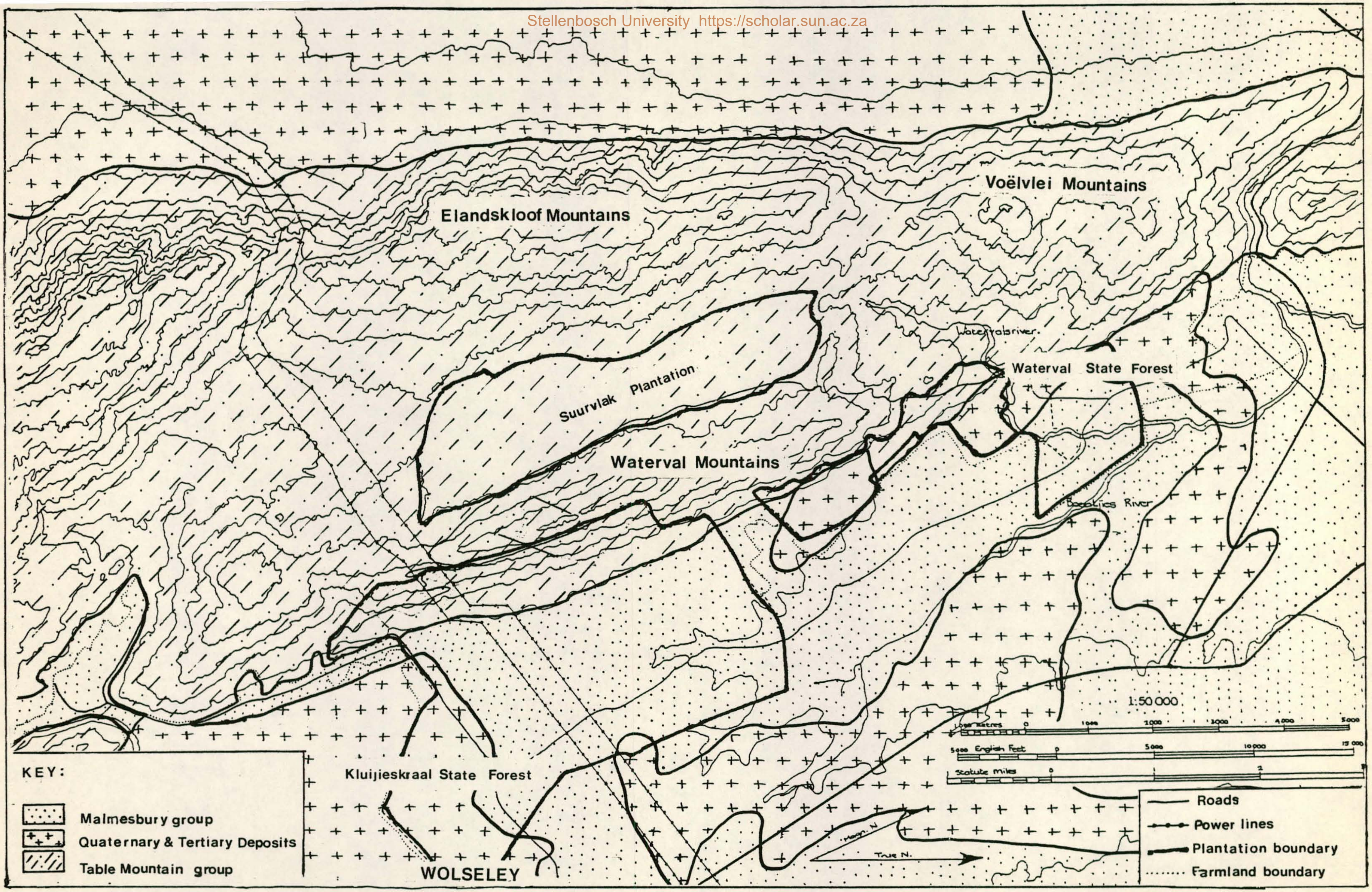


Fig. 4.2. Geology of study area.

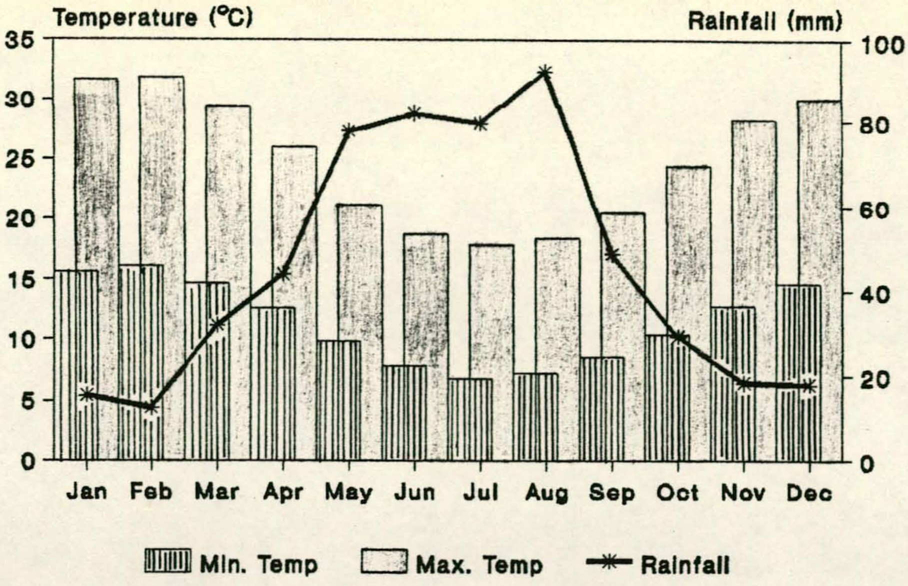


Fig. 4.3. Climatogram of the Kluitjieskraal study area.

orographically by the mountains and by interception of mist by the fine-leaved mountain fynbos (Snow, 1985). There is a significant difference between summer and winter months, in the flow rates of the numerous mountain streams that feed the Waterval River i.e. reduced flow rate in summer. This is due to the poorly developed soil profile (Bristow et al, 1985).

The maximum temperatures in summer vary between 25°C and 40°C, often accompanied by a strong south-easterly wind. In winter temperatures vary between 0°C and 20°C, with heavy rains and occasionally, snow. The climatogram (Fig. 4.3) was constructed from data collected by the Weather Bureau at Tulbagh.

4.3 Biological Environment

4.3.1 Fauna

The study site comprises a mixture of fynbos and exotic softwood plantations. The fynbos does not support a high density of vertebrates (Bigalke, 1979). The low number of mammal species in the area can further be attributed to the monoculture habitat

Table 4.1: List of larger mammals and birds seen to occur on the study site.

Species name:	Common name:
Mammals	
Papio ursinus	Chacma baboon
Panthera pardus	Cape leopard
Cynictis penicillata	Yellow mongoose
Galerella pulverulenta	Small grey mongoose
Procavia capensis	Rock dassie
Sylvicapra grimmia	Duiker
Oreotragus oreotragus	Klipspringer
Pelea capreolus	Grey rhebok
Birds	
Accipiter rufiventris	Red-breasted sparrow hawk
Aquila verreauxi	Black eagle
Buteo rufofuscus	Jackal buzzard
Corvus albus	Pied crow
Elanus caeruleus	Black shouldered kite
Falco peregrinus	Peregrine falcon
Falco tinnunculus	Rock kestrel
Francolinus capensis	Cape francolin
Haliaeetus vocifer	Fish eagle

provided by the plantation. Those mammals and birds that were observed in the area during the course of this study are listed in Table 4.1. The river has a full complement of aquatic species (King, 1985 in Bristow et al, 1985).

4.3.2 Flora

The vegetation (Fig. 4.4) on the slopes of the Waterval and Elandskloof Mountains and extending down the Suurvlak Valley and gorge is Mesic Mountain fynbos or Macchia (Veld type No. 69, Acocks, 1975). Much of the natural vegetation has been replaced (2474 ha on the Voorberg slopes facing Wolseley and 780 ha in the Suurvlak Valley) by tree plantations. The remainder is relatively undisturbed, although subject to frequent wild fires. The Elandskloof Mountains have burnt twice in the last five years (Engelbrecht, 1987; pers. comm.). Many geophytic plants and grasses abound following a fire (Bigalke and van Hensbergen, 1990).

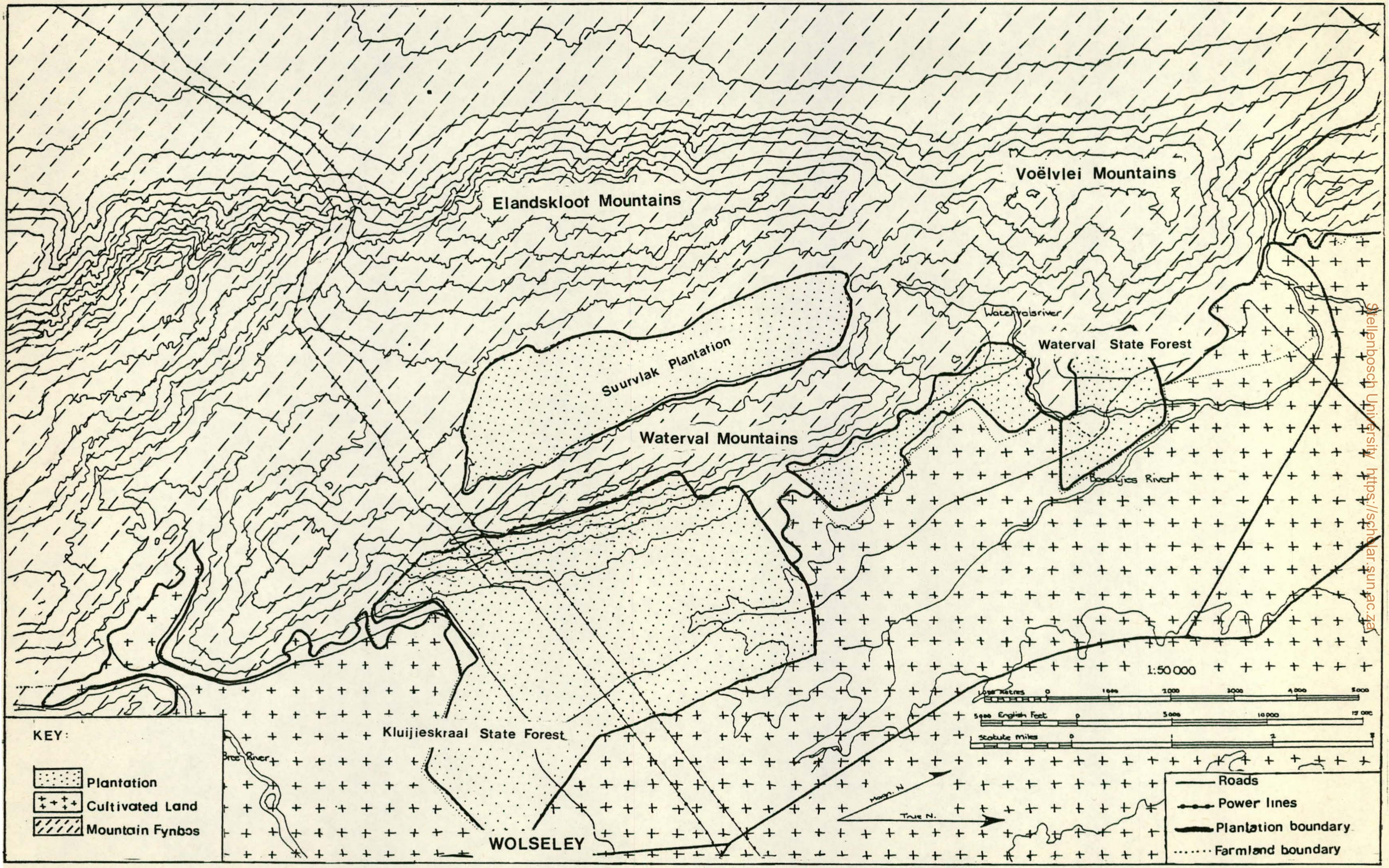


Fig. 4.4. Vegetation types of study area.

The indigenous vegetation should thus have a high proportion of attractive food items for baboons following a fire. Certain food types may however not survive if fire frequency is high, particularly the serotinous protea species.

Pinus pinaster has invaded some areas surrounding the plantations. *Acacia cyclops* and *Acacia mearnsii* found scattered within the plantations, are infesting mountain areas in close proximity to the planted areas. *Eucalyptus* spp. have also been planted at Waterval and Kluitjieskraal State Forests, but show less tendency to invade.

5. Methods

5.1 The Study

The study took place over a period of four years and five months. The details of the study are described in Fig. 5.1.

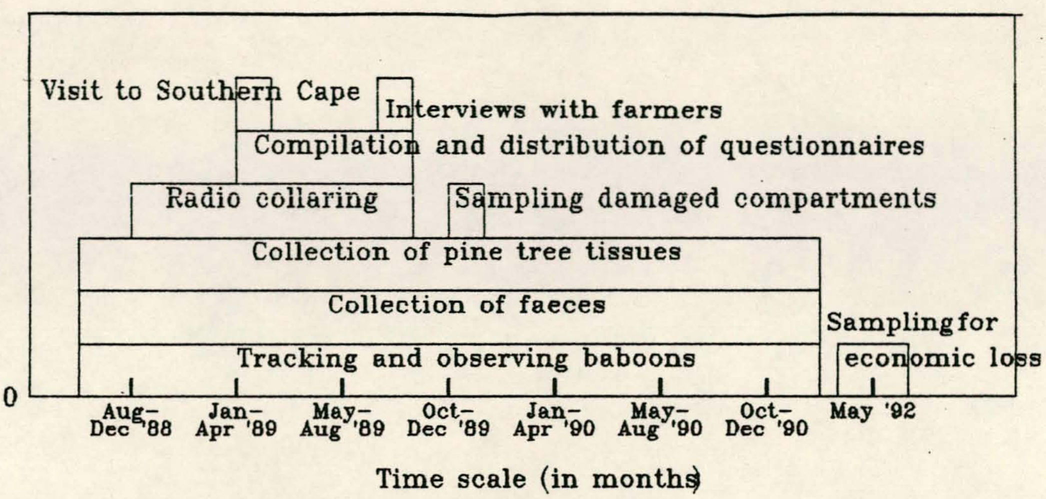


Fig. 5.1. Time scale of field work.

5.2 Methods

The methods for each section are described separately, under the title of the chapter discussing the topic, for ease of reference.

5.2.1 Ranging Behaviour.

Field work commenced in August 1988, and continued regularly until January 1990. During this time, on average three days a week, three weeks a month were spent at the study site.

Much field work centred around the location of baboon troops within the study area, and observing them as much as possible. Animals were located by means of radio-tracking and using visual and/or auditory cues. The observer would also lie in wait for baboons along routes where they commonly moved. During the study, four baboons were trapped in cages normally used by the Forestry officials. The animals were anaesthetized using a dart gun and a mixture of 75mg Ketalar (Ketamine) and 25mg Rompun. A radio-collar that had been prepared in the laboratory was then fitted to the baboon. The baboons were released from the cages after the anaesthetic had worn off.

Radio collars (Fig. 5.2) were made in the laboratory by Mr Dave Pepler (Dept. Nature Conservation, University of Stellenbosch). The material for the band is fused acrylic and nylon.

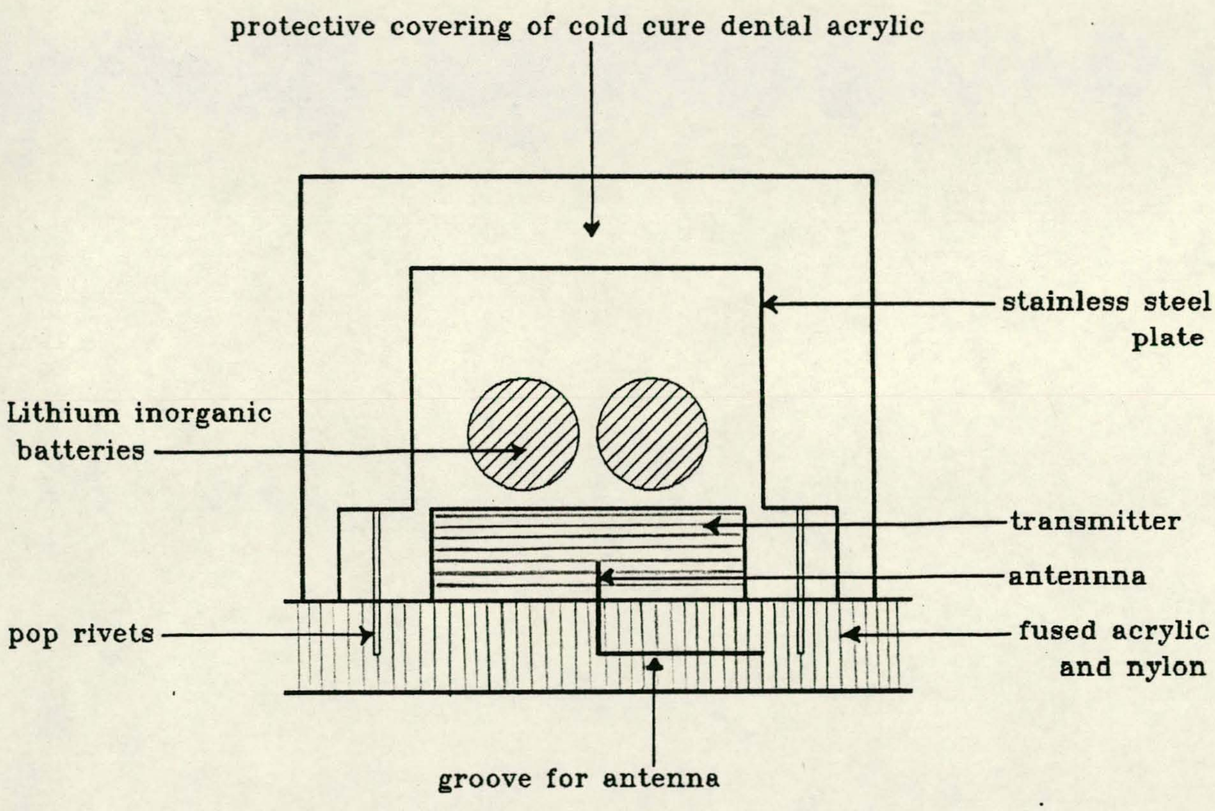


Fig. 5.2. Diagram of the radio collar used.

The transmitters, fitted with antennae, were bought from Mr van Urk of the Physics Department, University of Potchefstroom. Batteries were Tandan type TL2100 (19g) with a 2,0 Amp hour capacity, and a C size (52g) battery with a capacity of 5,2 Amp hours. Two batteries were used in each collar. The battery and transmitter were placed together on a steel plate and covered with dental acrylic, to ensure that they were water tight, and that the collar was "baboon proof". To save the batteries a switch was left exposed through the dental acrylic. The switch is cut to activate the collar. The aerial was screwed into a groove cut into the collar.

The receiver used was an Yaesu type. The two antennas used were a five element Yagi and a two element Yagi. Tracking began on entering the area, and continued on a regular basis from the vehicle. Set locations were used. Once a signal was received, an attempt was made to get as close to the individual as possible. This was usually attempted on foot within a certain range.

Readings were recorded as points on a 1:25 000 map, marked with a 1cm x 1cm grid. All observations and any vocalizations by the baboons (more than one and a half hours apart) were recorded. Any other records of baboon presence (eg. footprints and recent droppings), as well as sightings by forestry employees were recorded on a standard data sheet (Appendix A). Also included, where possible, were data regarding troop size and composition, type of vegetation and all food items that were observed to be eaten. These data were used to determine the utilization distribution of home range for each troop, using the Kernel Estimation method of Worton (1989). This method uses a random sample of locational observations of animals in their home range to estimate (nonparametrically) the utilization distribution of a group of animals, or individuals.

Questionnaires (Appendix B) were distributed to farmers on, or near whose land, baboon troops commonly ranged. Information received was related to baboon movements onto farmland, and the regularity and seasonality of such movements. The problems caused by baboons were also investigated.

5.2.2 Feeding Behaviour

Baboon feeding habits could not be systematically observed. As a result of the control operations, they were too wary of humans to allow the observer to come close enough to identify which plants were being consumed. It was thus not possible to collect observational data on feeding behaviour and patterns. Information concerning what the baboons in this study ate was thus accumulated almost entirely through faecal analysis. Faeces provide a readily available and easily collected source of information (Putman, 1984).

Faeces were collected from the study site on a regular basis for over a year. Plants that were seen to be eaten (or suspected of being eaten) were collected and stored in 98% alcohol. These served as a reference for identification. The date and location of collection were recorded. All food items seen to be eaten were also noted.

The faeces were taken to the laboratory, oven dried for 36 hours at 80°C and stored. Individual faeces were soaked in a solution of 25% hydrogen peroxide, 25% acetic acid and 50% distilled water for 48 hours to facilitate softening. The samples were then placed in a solution of water, 98% alcohol and a mild household detergent to speed the softening process. Samples were passed through a sieve (2,36mm mesh size) to separate the larger and more easily identified particles from the other matter. All particles large enough to be identified under a microscope were removed from the matter that had passed through the sieve. This was then added to the material in the sieve. Sampling was carried out according to a simplification of the Point Sampling method of Chamrad and Box (1964). Each sample was examined once only, as opposed to multiple times in the original method. One hundred points were sampled and identified under a 100x magnification (Appendix C). The number of times each item was identified in the sample was recorded as a percentage of the total. In total 63 samples were analyzed. The number of faecal samples collected per month varied between four and six.

An experiment was carried out at the Tygerberg Zoo, outside Stellenbosch in the Western Cape. Five baboons, born in captivity, were presented with a pine tree (*P. pinaster*, 7 years old). This tree (approximately 4m tall) was felled the same morning at the Jonkershoek State Forest. This was placed in a specially designed stand within the baboon cage. The baboons' response to the tree was then recorded.

5.2.3 Analysis of Pine Cambium, Phloem and Xylem Tissues

Monthly samples were taken from a compartment of *P. radiata*, aged 12 years. The outer layer of bark was removed over an area of 10cm by 25cm, by means of a small axe. Care was taken not to remove the layer of cells beneath the bark. If, however, this did happen, the layer was scraped off the bark and retained. The layer of cells between the bark and the inner layer of wood, consisting of the phloem and the cambium was then removed. This was done by cutting around the area with a sharp knife and then peeling the layer off. More than five grams of sample (wet weight) was required.

Samples were taken from three categories of trees

1. undamaged trees;
2. trees previously damaged by baboons;
3. trees from which a sample had been taken the previous month.

Four trees per category were used, i.e. a total of twelve samples per month. The samples were placed in separate labelled plastic bags and sealed and taken back to the laboratory. They were weighed and oven-dried for 36 hours at 80°C, and then weighed again. Samples were sent to Elsenburg Agricultural College near Stellenbosch for analysis of mineral nutrients.

5.2.4 Baboon Damage in South Africa

Questionnaires were designed (Appendix D) and sent to the 73 State Forests in South Africa, as well as to the private Forestry organizations SAPPI, MONDI and Natal Tanning Extract (NTE). 69

State and 36 private Forests returned the questionnaires (94.5%). Data was extracted from the returned questionnaires and in many instances, secondary questionnaires were sent out to clarify the replies.

Information obtained from the questionnaires was used to make an assessment of total damage levels in South Africa. The total area under commercial plantations, and the total number of compartments were used to calculate an average compartment size per region.

A/B = C; where A = total area afforested per region
B = total number compartments per region
C = average compartment size per region (1)

Regional classification was according to the Department of Forestry. Private Forests were grouped as one to facilitate ease of discussion. Private areas were kept separate from State land as total figures for this group were not obtained. The average number of compartments damaged per State Forest (or private forest station) was calculated using the given percentage of compartments damaged. The interval midpoint was taken as the mean percentage for each category i.e.

a = eg. 0-5% : mean = 2.5%
or 5-15%: mean = 10%; (2)

The mean percentage of compartments damaged was multiplied by the number of pine compartments on each forest station. This was taken to be the number of compartments damaged on each station.

i.e. a x B = D, a = mean percentage for each category (2)
B = total number of compartments on each station;
D = number of compartments damaged per station (3)

The number of compartments damaged was multiplied by the average area per compartment for each station.

C x D = E where C = compartment size per region (1)
D = number of compartments damaged per station (3)
E = average area damaged per station (4)

The totals for each station (Equation E) were added to give a figure for each region.

The data for the Northern Transvaal State Forests was excluded where necessary as only the questionnaire for the station with damage (Entabeni) was returned. It is not known if baboons occur on the other four State Forests in this region. Comparisons between damaged and undamaged areas in this region could not be undertaken.

5.2.5 Damage at Single Station Level

Damage in the Kluitjieskraal plantation was investigated by extracting data on number of compartments affected, and the extent of damage from official records (Western Cape Regional Office and Kluitjieskraal Office, Wolseley). In addition, ten compartments were sampled intensively by inspecting every tree in every fifth row. Presence or absence of damage, and the following characteristics were recorded on standard data sheets (Appendix E):

a) type
   - -1. <50% of the circumference of the bark removed in one area;
   - -2. >50% of the circumference of the bark removed in one area;
   - -3. ringbarked;
   - -4. crown dead;
   - -5. branches broken;
   - -6. healed damage, i.e. the tip was originally removed, but the tree survived by forming a fork with two secondary trunks;

b) aspect of damage;

c) height of damage in meters:
   - i. 0 - 0.5m
   - ii. 0.5 - 1.0m
   - iii. 1.0 - 1.5m
   - iv. 1.5 - 2.0m
   - v. 2.0 - 3.0m
   - vi. >3.0m;

d) age, i.e. recent or old damage;

e) whether damage was observed more than once on the tree.

Results were analyzed to determine whether any significant patterns of damage occurred.

5.2.6 Financial Implications of Bark Stripping

A compartment (D1) on the slopes of the Groot Drakenstein Mountains, at the La Motte State Forest in the Western Cape (see Map 4.1) was routinely felled in 1992. The species was *P. radiata*, aged 53 years, of good timber quality on a site of intermediate quality. One hundred consecutive trees were used in the study. Field work was done by the Dept. of Forestry, in the person of Guy Thornton. All trees were graded and measured for diameter and length in each class. A tree with baboon damage was graded twice. The first time it was treated as if there was no damage. The second time, measurements were made taking the damage into consideration, as is the practice with damaged trees. An example of the data sampling sheet is included (Appendix F). The volume of each tree represented by class A, B, C and D logs, and by pulp and poles, and the price (1992 prices) for each was calculated. Calculations for damaged trees were once again made twice - once disregarding damage, and the second time taking it into consideration.

The data gained from this exercise, and that from questionnaires about damage levels in South Africa, was used to calculate the total cost of damage. All stations were questioned about the percentage of damage in the five worst damaged compartments on each station. The interval midpoint was used to represent each damage class (Equation 2). The average number of trees per compartment was calculated from compartments sampled at Kluitjieskraaland used as a yardstick as such information was not readily availble. The number of trees in each damage class was calculated as follows:

$$F \times G = H \quad \text{where } F = \text{average number of trees per compartment}$$
$$G = \text{midpoint interval of each damage class}$$
$$H = \text{number of trees in each damage class} \qquad (5)$$

This figure was then multiplied by the total number of compartments in each damage class (calculated from questionnaires) to give the number of trees damaged.

$H \times I = J$ where H = number of trees in each damage class

I = number of compartments in each damage class

J = number of trees damaged (6)

$J \times Ry = Rb$ where J = number of trees damaged

y = average financial loss per tree in Rands

b = total financial loss per damage class (7)

The number of trees damaged was multiplied by the average loss per tree (Equation 7). Loss from each damage class was added and was taken to represent the financial loss as a result of baboon damage.

5.2.7 Control Options

Data on methods of control used on forest stations, and their

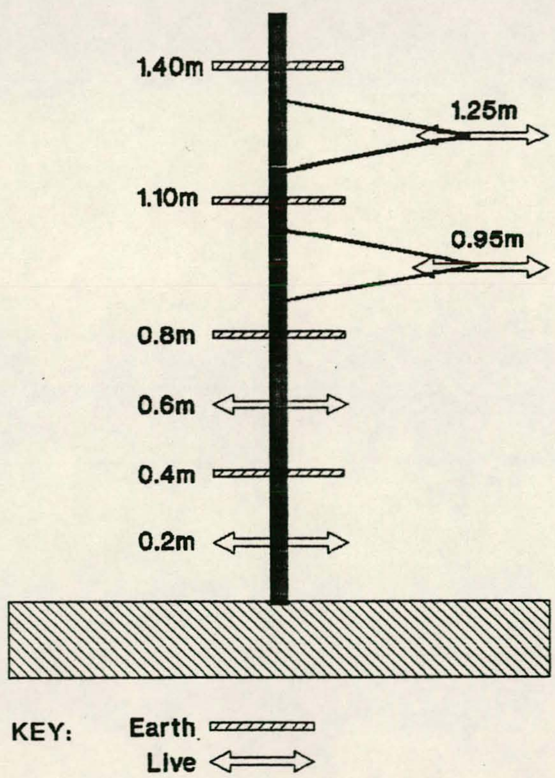


Fig. 5.3. Design of experimental electric fence.

effectiveness were collected by means of questionnaires (Appendix C). The effect of control on the present situation was also investigated. Other control options were considered. An experimental electric fence of 700m was erected. The structure (Fig. 5.3) was designed specifically to prevent baboons from entering the enclosed area. The fence was 1.4m high with eight strands, four being earth and four live wires. The top two live wires were offset to the fence (220mm). Standards were placed every 30m, with droppers every 10m. The area was baited with fruit inside and outside the fence to attract baboons into the area and entice them over the fence. The area was monitored thereafter to detect baboon entry into the enclosed area.

6. Ranging Behaviour.

6.1 Introduction

An animal spends most of its time in an area known to it, i.e. its home range. A home range contains sufficient food, water and shelter for specific needs, while allowing for social relationships with conspecifics, like mating, reproduction and care of the young (Burt, 1943; Ewer, 1973).

It is, however, of little relevance to use home range size and shape data as such. According to Bowen (1982), this may become an important biological parameter when coupled with ecological and behavioural information, such as patterns of usage seasonally or in different vegetation types.

Also of great interest is the distribution of movement within the home range. Altmann and Altmann (1970) state that this allows for an understanding of how animals utilize their habitat in order to survive. They claim that each area within the home range offers different resources eg. food, shelter, water and protection from predators. The distribution and intensity of use in each region can be related to the specific area and what it has to offer. This may include hazards to be expected which can explain much about troop behaviour and movements. Home range data collected over a period of years also allows for a perception of seasonal usage (Harding, 1976). This author claims spatial data of this type will help to establish whether home range area expands or contracts over time in response to such factors as population density, amount and type of food.

Home range size may differ in different areas, and this can be ascribed to the variations in resource distribution and availability. Macdonald (1980), for example, found that the territories of foxes are significantly larger in areas where food is less available.

Such information is of vital importance in understanding the utilization of plantations by baboons, and in determining the role of plantations in terms of the resources they offer to baboons.

6.2 Results

6.2.1 Troop size

There were three troops in the study area which habitually used the plantations and the surrounding areas. The three troops, Suurvlak (SV), Waterval (WV) and Voorberg (VB), used the plantations to a differing extent. The size and composition (as far as could be determined) of each troop is shown in Table 6.1.

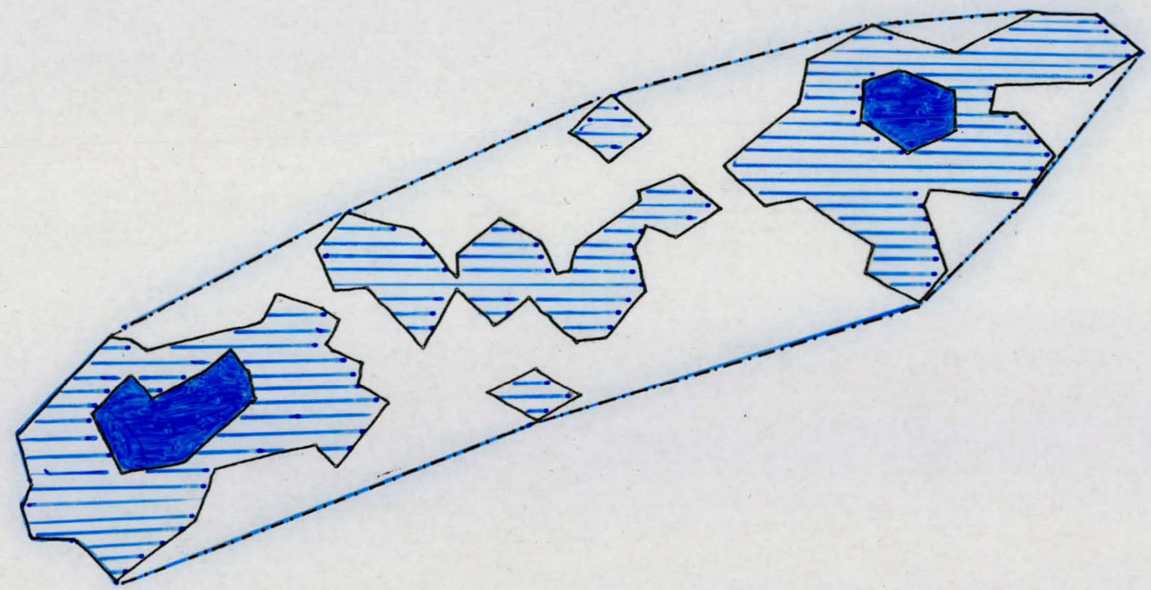
It was very difficult to obtain accurate or complete counts of size of troops and age classification of individuals in this area. As a result of the control programmes (trapping and shooting) carried out over the last 30 years, the baboons were extremely wary of humans, especially at close range. The terrain of the plantations and the rocky cliff faces also made it very difficult to observe the troop as a whole. There did not appear to be any change in group size during the period of this study.

Table 6.1. Troop size and composition.

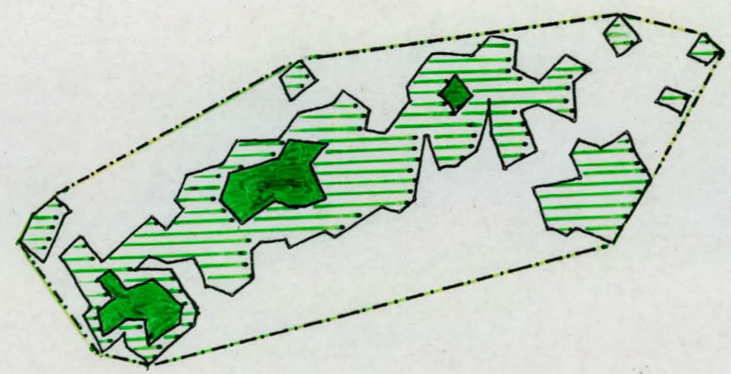
	Suurvlak	Waterval	Voorberg
Total	31?	21?	9
Adult male	4	4	1
Adult female	5	4	3
Adolescent	9	1	1
Juvenile	4	2	2
Infant	3	2	2

6.2.2 Home Range Size

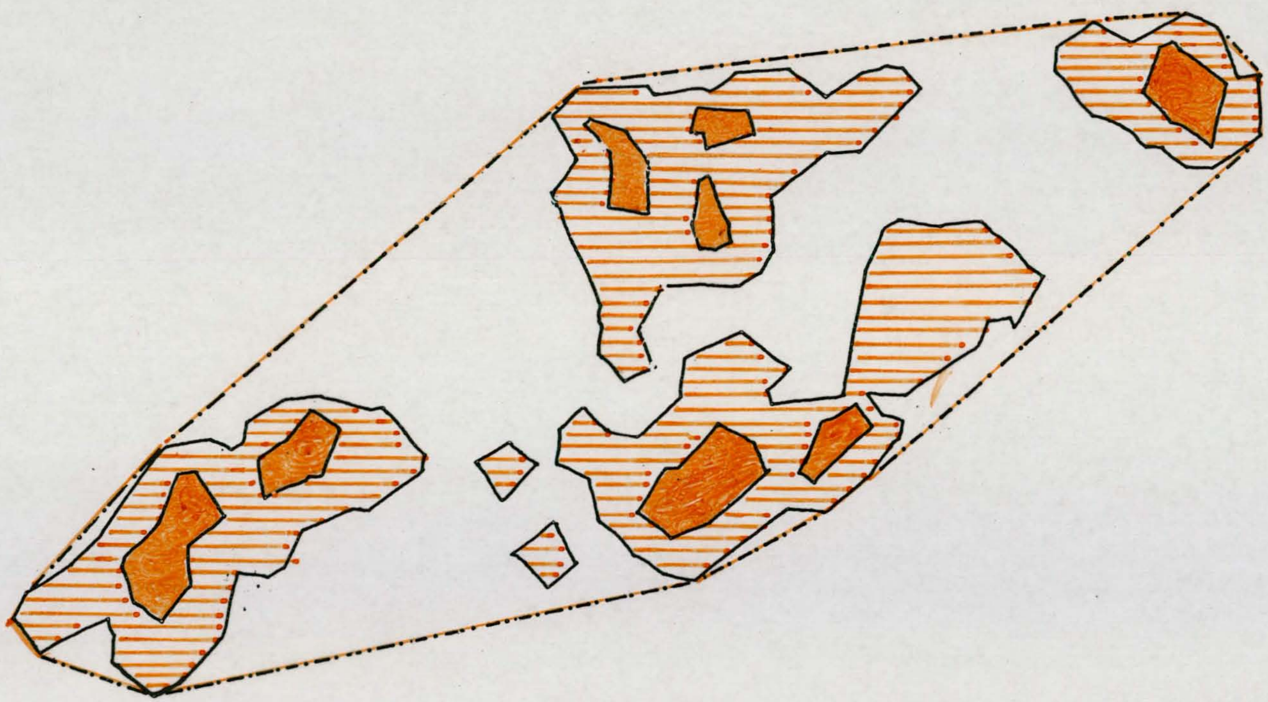
The size of the home range of each troop varied in total, as well as seasonally (Table 6.2). The largest troop, SV, ranged over the largest area ($22km^2$)(Fig. 6.1), while WV, the second largest troop, covered $13.2km^2$ in total. The smallest troop VB, used only $4.6km^2$.



Waterval troop



Voorberg troop



Suurvlak troop

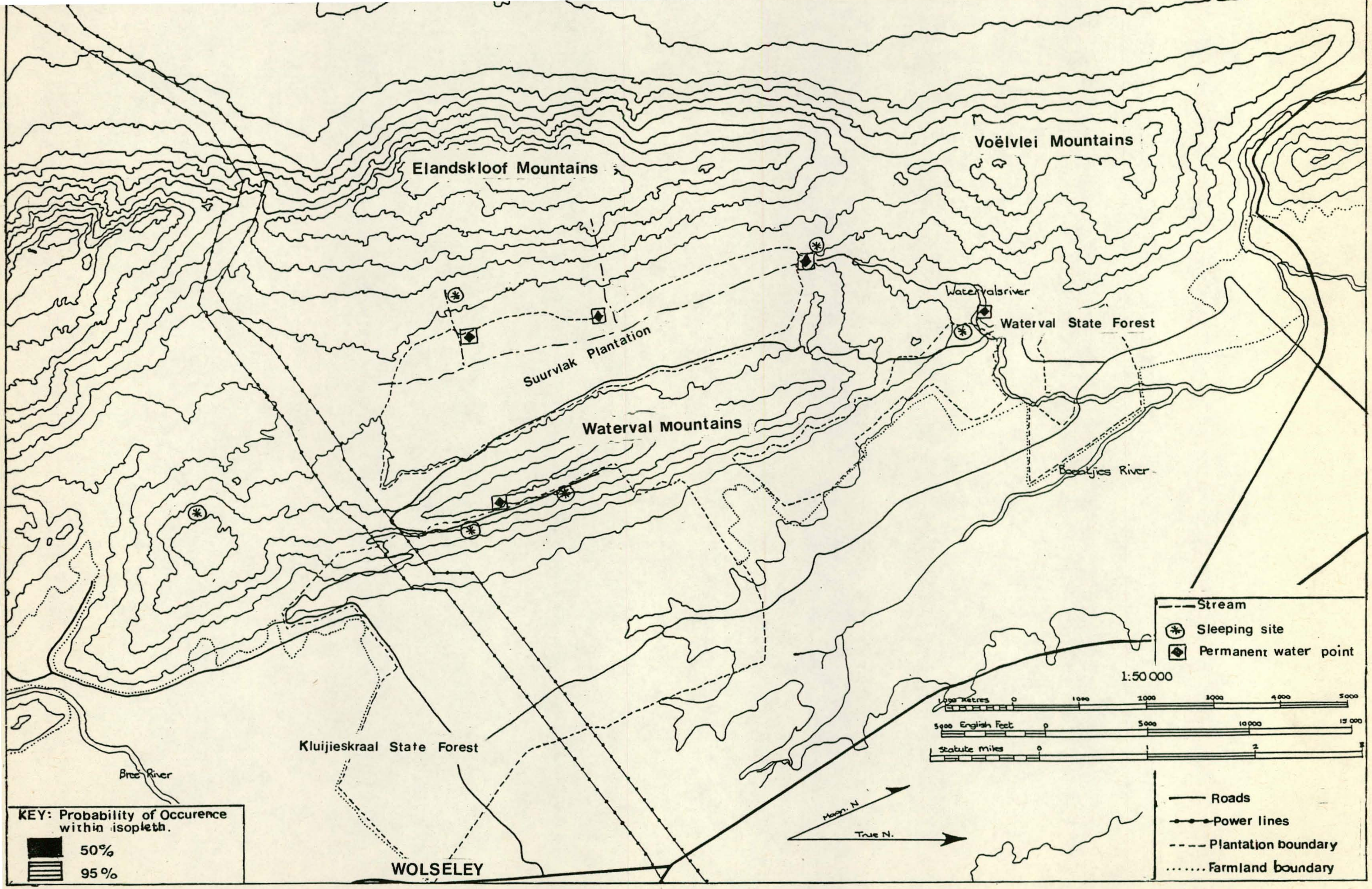


Fig. 6.1. Kernel Estimation of Home Range utilization.

Home range size thus increased with troop size. This corresponds with findings by Davidge (1978) and Stacey (1986) that group size correlates positively with home range size.

Table 6.2. Seasonal and total home range sizes.

	Suurvlak	Waterval	Voorberg
No. observations	129	108	199
Minimum troop size	30+	20+	9
Home range size	22km^2	13.2km^2	4.6km^2
Summer range	21km^2	10km^2	4.6km^2
Autumn range	5.8km^2	6.6km^2	1.7km^2
Winter range	5.8km^2	7.1km^2	1.7km^2
Spring range	7.1km^2	9.1km^2	3.5km^2
Density (no./km^2)	1.36	1.52	1.96
Mean density (no./km^2)		1.61 *	

* Mean density does not take overlap of home range into account.

6.2.3 Seasonality

All three troops moved over a wider range in spring and summer than in autumn and winter (Table 6.2). The former are the drier and warmer times of the year when many additional sources of food became available, eg. fruits such as grapes, apples and pears on the farmlands bordering the plantation and mountain catchment areas. This seasonal increase in home range area also coincided with the periodic drying up of many smaller streams and drinking pools. Permanent water sources are indicated in Fig. 6.1. All the most distant sources of water or food were well within a day's range (5 - 10km) of known sleeping sites. Troops thus seemed to move further in spring and summer months to obtain additional, seasonally available foods, and also to make use of permanent water sources.

6.2.4 Core Areas

Activity was not evenly distributed throughout the home range, but was concentrated in certain areas. Intensity of usage is illustrated in Fig. 6.1. (Probability of Occurrence of 95%).
It can thus be seen that SV used certain areas on the Voorberg and

near the farmlands particularly heavily. These areas were in close proximity to known sleeping sites and sources of permanent water. WV troop had two areas of concentrated use, i.e. around Waterval Forest station and on the Voorberg. Even the VB troop, which used its small range more evenly than the other troops did theirs, had areas of particularly heavy use.

Certain sections of the home range appeared to be used mainly as a passage by animals as they moved from one core area to another (possibly while exploiting a seasonal resource).

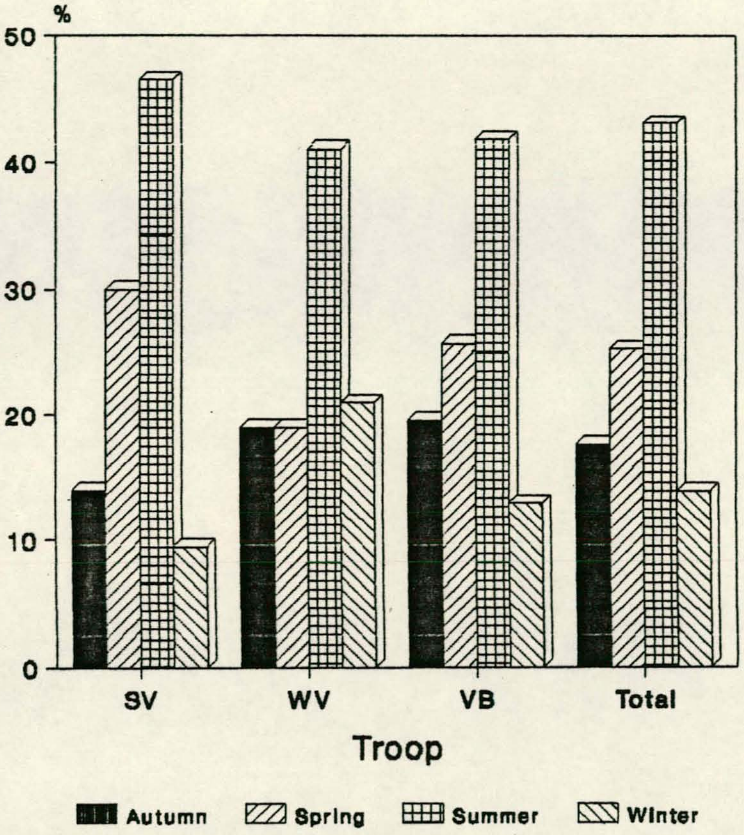


Fig. 6.2. Seasonal distribution of the observations of each troop (N=436).

6.2.5 Bias

Most observations on baboon activity were made in spring and summer (Fig. 6.2). Less field work was done in autumn, and especially winter, due to the very wet conditions and the poor roads. Many more observations were made on the VB troop than on the others (Table 6.2), due to the fact that its home range area was the smallest. Furthermore the troop was found predominantly in the vicinity of the main road which transected the study area. Two members of the troop were radio collared, as opposed to one each from the other troops.

SV and WV troops moved onto the Voorberg (southern part of the Waterval Mountain, above Kluitjieskraal Forestry Station) during this period and were more seen often in this area close to roads, than during summer and spring.

6.2.6 Use of Vegetation

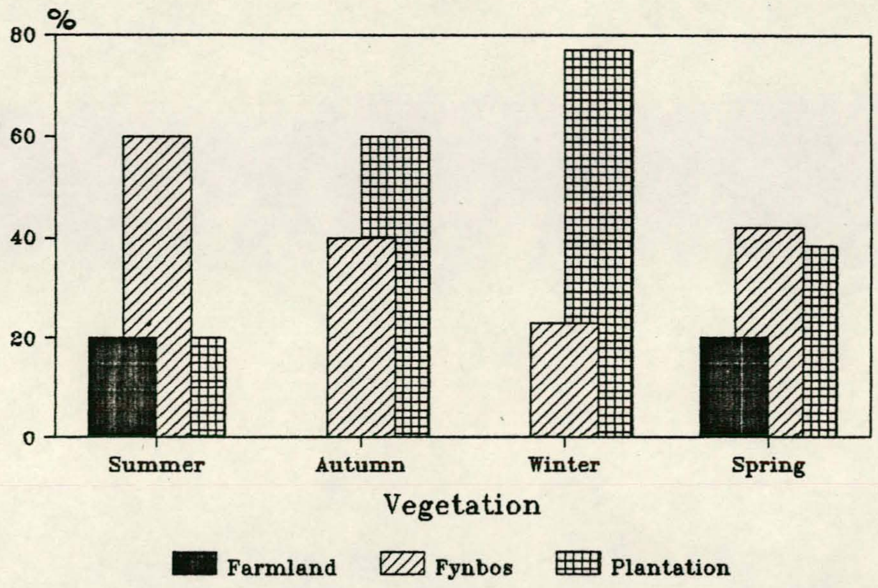


Fig. 6.3. Seasonal use of vegetation by the Suurvlak troop (N=129)

There were three vegetation types represented in the study area. The distribution of vegetation types in each troops' home range, as well as in the study site as a whole, was not equal. Mountain catchment area (fynbos) constituted approximately 57% ($60km^2$), plantation 35% ($36km^2$) and farmland 8% ($8km^2$) of the total study area (Fig 6.6). Usage, based on the number of observations in each vegetation type, differed seasonally and between troops.

The SV troop was found most often in fynbos in summer (60%). Usage of this vegetation type was lowest in autumn and winter, when most observations (over 60%) were made in the plantations (Fig. 6.3).

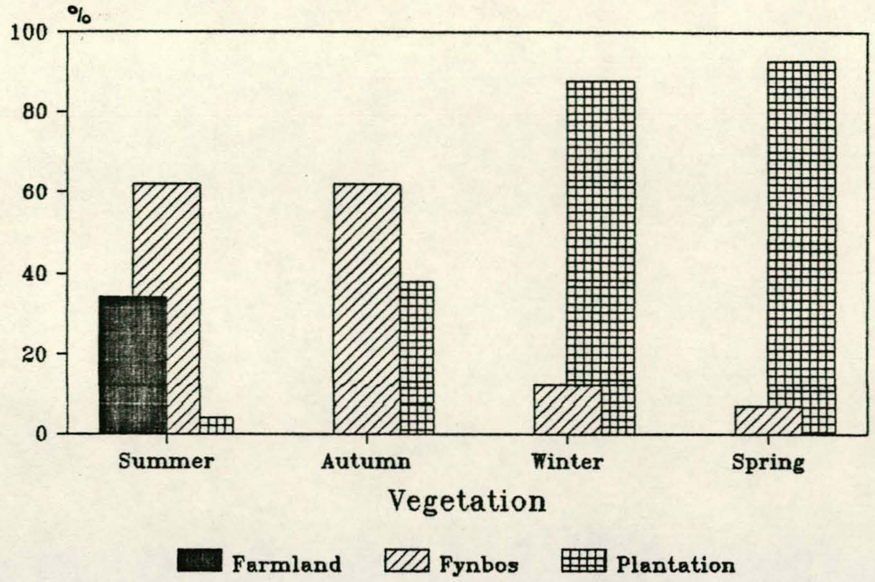


Fig. 6.4. Seasonal use of vegetation by the Waterval troop (N=108).

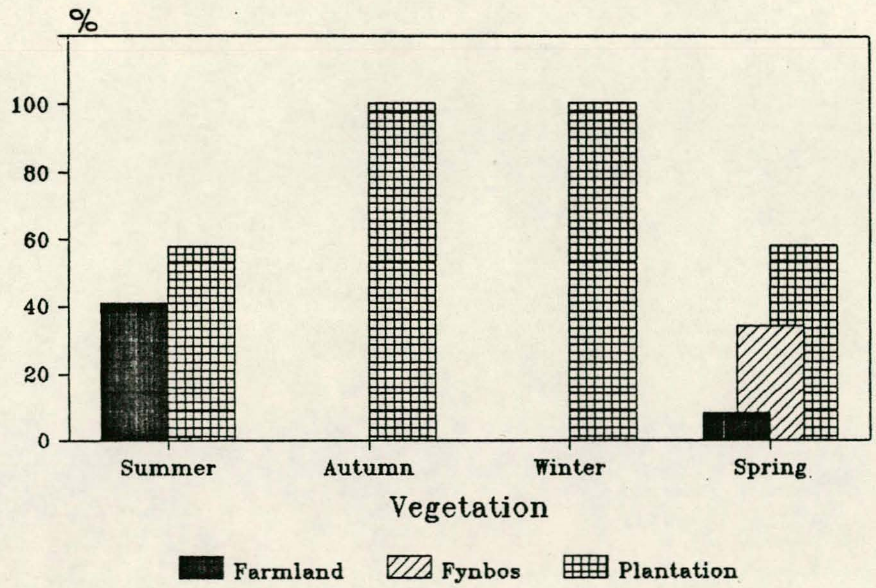


Fig. 6.5. Seasonal use of vegetation by the Voorberg troop (N=199)

The WV troop was observed more often in summer and autumn in fynbos (62% and 65% respectively) (Fig. 6.4). The fynbos was used less during spring and winter when 58% and 85% respectively of the observations were in the plantations. The fact that WV preferred the fynbos in autumn and the plantation in spring differed markedly from the SV troop.

The VB troop was always found in plantations, except for brief forays into fynbos and onto farmlands in spring and summer (Fig. 6.5). No troop was observed on the farmlands during autumn and winter.

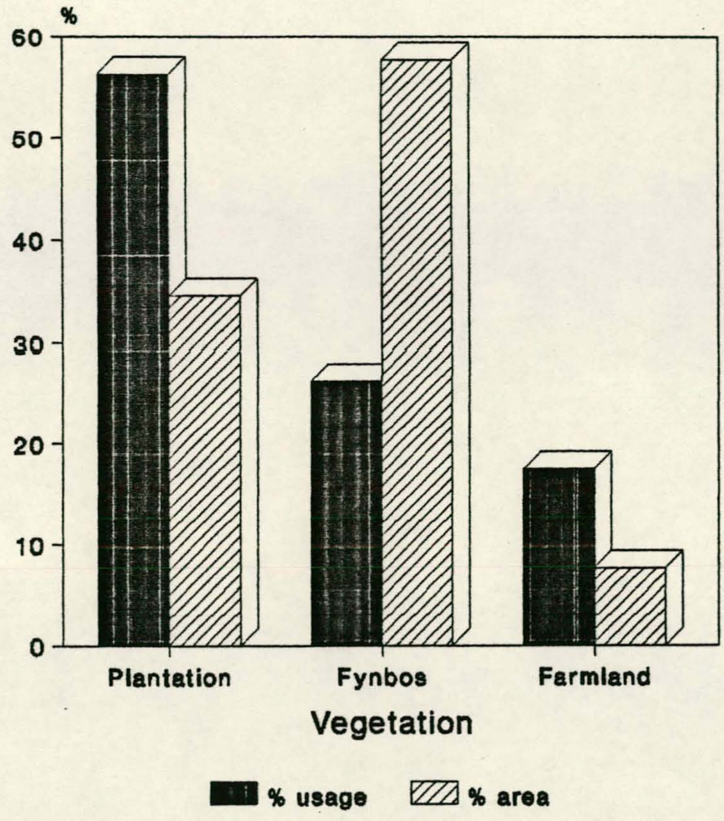


Fig. 6.6. Comparison between vegetation utilization by baboon troops and the percentage area represented by each vegetation type. H_0: Do troops select for a specific vegetation type? N = 436; Chi-squared = 205.117; DF = 2; $P<0.05$.

The amount of time spent in each vegetation type was disproportionate to the percentage of the total that each represented (Fig 6.6). The high value for chi-squared, and the very small significance level (Table 6.3), suggest that the troops did indeed select for plantations and farmland.

Table 6.3. Summary of number of observations, percentages and statistics concerning troop usage of vegetation in each season.

	Farmland	Fynbos	Pltn	Total	Chi-sq.	DF	Sign.
Autumn	0	17	60	77			
	0%	16%	24%	18%			
Spring	16	21	74	111			
	21%	20%	29%	26%			
Summer	61	64	62	187			
	79%	60%	25%	43%			
Winter	0	4	57	61			
	0%	4%	23%	14%			
Total	77	106	253	436	105.48	6	P=0.0001
	18%	24%	58%	100%			

More than 50% of all observations for all troops were in the plantation despite the fact that the area the plantation represented in the home ranges was less than 40% (Fig. 6.6). Fynbos comprised over 50% of the total area used by baboons, but the number of observations of baboons therein was less than 30%. Farmland was also heavily used, despite the small area it represented. Almost 20% of the observations were on farmland, while the vegetation type represented less than 10% of the total study area. Plantations were selected for in autumn and winter and farmlands in summer. The greater number of observations in spring and summer in the fynbos may be the result of the baboons moving from plantation to farmland through the fynbos.

Intensity of usage differed seasonally and between the different troops (Fig. 6.7). All troops followed the same pattern of usage for plantation and farmland in that there were more observations in these vegetation types than would be expected from the area represented in each troops' home range. SV and WV troops used fynbos less than would be expected considering the availability of the vegetation type in their home ranges. Fynbos was limited in VB's range, yet it was used less than would be expected if all vegetation types were being evenly utilized. The same pattern was displayed by all troops in showing a distinct preference for alien habitats. The degree to which the vegetation types were used however, varied amongst the troops.

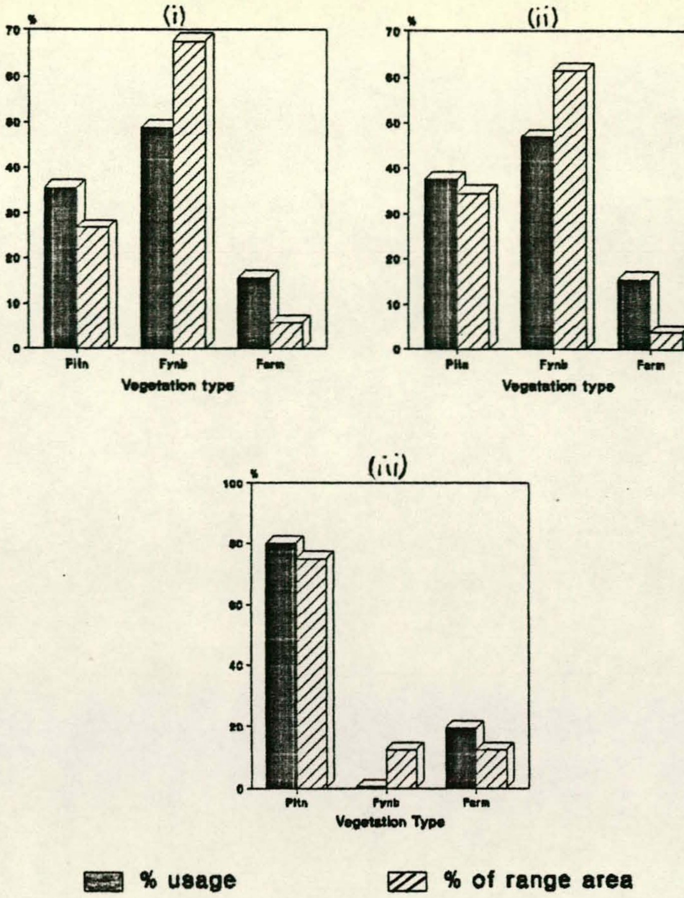


Fig. 6.7. Vegetation utilization compared to percentage habitat in each troop's range: H_0 - does a troop select a particular vegetation?
i)SV -N=129; X =39.3832; DF=2; P<0.001;
ii)WV -N=108; X =60.3911; DF=2; P<0.001;
iii)VB -N=199; X =34.5181; DF=2; P<0.001.

Although more observations were made for SV and WV troops in fynbos throughout the year (Fig. 6.8), it was clear that plantations were selected (in terms of the area represented in each home range) as a vegetation type in all seasons, except summer (Fig. 6.9). Utilization of the three vegetation types in summer by all three troops was even. Farmlands were selected for in summer and to a lesser extent spring, and selected against in autumn and winter.

6.2.7 Overlap of troops

Troop ranging areas and even core areas overlapped (Table 6.4 and

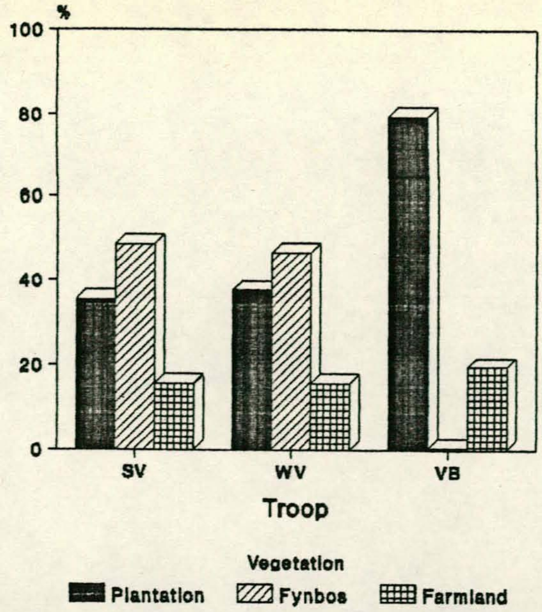


Fig. 6.8. Use of each vegetation type in total by each troop (by means of percentage of observations).

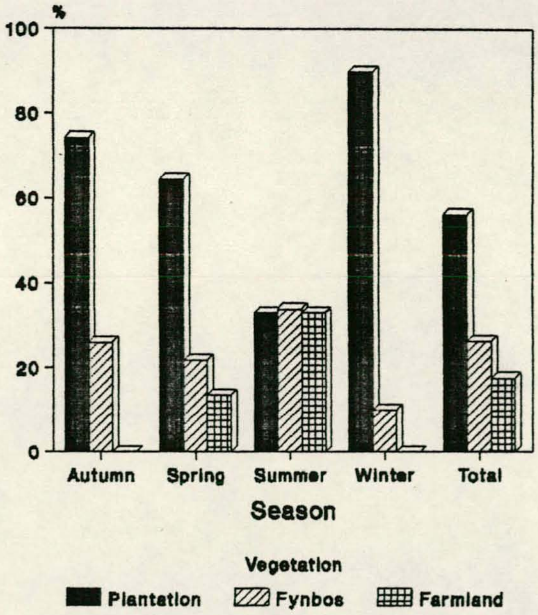


Fig. 6.9. Use of vegetation in each season by all three troops.

Fig. 6.1.) but the areas of overlap were not large. When core areas did overlap, they were not used by the same troop at the same time and most often, not in the same season. The home range of the VB troop showed the most overlap with the other troops' ranges (probably due to the small size of this range, and the fact that

it was situated around an area that appeared to be desirable to all troops).

In winter, WV troop moved onto the Voorberg and displaced the VB troop, which moved further south. The northern core area on the Voorberg was thus utilized first by the VB troop in summer and spring, and then by the WV troop in winter. The SV troop used this area throughout the year, and most heavily in winter, though not at the same time of day as the WV and VB troops.

Table 6.4. Overlap between home ranges of the troops.

	Suurvlak	Waterval	Voorberg
Suurvlak	*	4km^2	3km^2
% overlap on SV range		12%	9%
Waterval	4km^2	*	2km^2
% overlap on WV range	15%		8%
Voorberg	3km^2	2km^2	*
% overlap on VB range	65%	44%	
All troops	2km^2		
% total overlap	3% of total area used by all troops		

6.3 Discussion

6.3.1 General

Different methods of analyzing data give different results. Home range estimates may thus be regarded as indicators of utilization within an area. It is important to consider which methods were used when comparing results of different studies (McNab, 1963; Mace et al, 1983), as methods may have a great influence on the results.

Included in tabular form is a summary of the data in the literature concerning home range size and usage in different studies in Africa as a comparison to results from this study (Tables 6.5 & 6.6).

Table 6.5. Summary of literature concerning baboon home ranges in Africa.

Author	Location	Troop size	Density No./km^2	Home range size (km^2)	Mean daily range (km)
-Hall	A W. Cape,	C=53	2.4	34	
(1963)	R.S.A.	N=20			4.64
		S=26		10	
	A D'berg,		1.7		
	R.S.A.				
	S.W.A.	27			4.8
	S.Rhodesia	46			
-De Vore	A W. Cape,	C=80	2.3	33.67	
and	R.S.A.	N=20		9.06	
Hall		S=35		14.76	
(1965)	B Nairobi,	MR=12	1.8	5.18	4.8
	Kenya	LT=17		23.83	
		PP=24		18.13	
		AR=28		7.77	
		SR=28		40.14	
		SV=40		24.86	
		KV=77		30.3	
		HP=87		35.75	
-Rowell	B Uganda	V=58	10.5	3.88	1.6-2.4
(1966)	(forest)	S=32		5.38	
-Stoltz	B Transvaal,	RB=60	3.7	23.31	6.4-10.5
and	R.S.A.	W=77		12.95	
Saayman		KMW=40		15.54	
(1970)					
-Altmann	C Amboseli,	106	6.3	16.73	5.5-5.9
and	Kenya				
Altmann					
(1970)					
-Aldrich-	B Ethiopia	87	20.2	4.3	5.58
Blake					
et al					
(1971)					
-Nagel	B Ethiopia		5.6		
(1973)					
-Stoltz	A Transvaal,	40	5.2	18	
and Keith	R.S.A.				
(1973)					
-Harding	B Kenya	71	10.3?	20	5.1
(1976)					
-Hamilton	A Namib,	L=35	5.3	9.41	
et al	S.W.A.	M=33		4.02	
(1976)		U=20			
	A Botswana	A=108	24	4.7	
		B=128			
		G1=109		6.5	
		G2=39		2.1	
		H=71		4.8	
		I=95			
		W=7			

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Author	Location	Troop size	Density No./km^2	Home range	Mean daily range
Davidge (1978)	A W. Cape, R.S.A.	O=85	2.5	37	7.9
-Stacey (1986)	C Kenya	L=8 H=31 A=44	1.7	12.6 15.9 19.6	

In column 3: letters refer to different troops studied.

Table 6.6. Summary of characteristics of home ranges.

Author	Seasonal differences	Core areas used	Important determinants of home range size
-Hall (1963) A	area larger in winter as food less concentrated	1/3 of area used most	food water sleeping sites
-De Vore & Hall (1965) A;B		several core areas	troop size concentration of food
-Rowell (1966) B		spent 60% of time in core	
-Stoltz & Saayman (1970) B	shift home range for specific food eg. maize	several core areas	water and food sleeping sites population density troop size neighbouring troop
-Altmann & Altmann (1970) C	range larger in winter as troop not restricted by permanent water	core areas contain all essential resources	water sleeping sites food availability
-Harding (1976) B	troop moved more in warm months after certain foods	troop spent 75% of its time in <25% of the area	sleeping sites primarily NB water and food
-Hamilton et al (1976) A	range larger after summer rains	core areas changed as water needed	sparse water and food determines range size
-Rasmussen C (1979)		core areas used less intensively as whole range used	sleeping sites most NB
-Davidge A (1978)	range larger in summer due to food on nearby farms	core area of 0.45km	home range increases with troop size

(Table 6.5 and 6.6)
In column 1 and 2: A=*P. ursinus* B=*P. anubis* C=*P. cynocephalus*

6.3.2 Density

Density of baboons in the present study area was lower than that recorded for many troops in other study areas, including similar fynbos environments. Hall (1963) recorded a density of 2.4 baboons per kilometer^2, and Davidge (1978) 2,5 per kilometer^2 in coastal fynbos at Cape Point Nature Reserve in the Western Cape. Bigalke and van Hensbergen (1990) found the density of baboons at Kluitjieskraal to be 3.26/km^2 compared to this study figure of 1.61/km^2. The reason for the difference for the same populations may be that the figures for Bigalke and van Hensbergen were based on a computer model prior to control. The low figures in this study may thus be a reflection of control programmes by Forestry officials in this area prior to this study.

6.3.3 Seasonality

Core areas for troops in this study tended to differ seasonally. Harding (1976) and Altmann and Altmann (1970) also found that usage shifted seasonally according to the availability of preferred foods. Home range size in this study increased in summer which is the dry period, and is also the time in which highly attractive food sources are offered on distant fruit farmlands. This indicates that the baboons may have expanded their ranging areas in response to environmental factors. Davidge (1978) also found home range increased in dry periods, while Hamilton et al (1976) and Harding (1976) amongst others, found home range enlarged after rains were plentiful and animals were not restricted to certain areas. It thus seems that there are no definite rules, and that baboons adapt to the prevailing conditions.

6.3.4 Bias

The fact that there were very few roads traversing the study site may bias the results as information concerning movements of troops close to the road was easier to collect. The few observations made in areas far from the roads consisted mainly of radio tracking records. Visibility was bad in many parts of the study site, the terrain was often difficult and sometimes impossible to traverse on foot. Baboon troops were very wary of the observer and furthermore were well camouflaged in plantations, fynbos and on cliff faces, due to their grey-black colouring. The thick bed of pine needles on the ground in plantations deadened the sound of approaching baboons, unless they were vocalizing at the time. All these factors made observing the baboons difficult and may have biased the results.

Observations were not necessarily evenly distributed throughout the day. Although baboons were first located by means of radio-tracking, one tended concentrate on areas where baboons had been recently. These difficulties were also experienced by Rowell (1966). When discussing seasonality of troop activity and range use, these factors must be taken into account to prevent bias. Conclusions drawn from such data should be regarded as indicative rather than absolute.

6.3.5 Significance of plantations as part of the home range

Of great interest, especially when relating baboon ranging behaviour to the damage that occurs in commercial plantations, is why the animals spend so much time in the plantations. This needs to be considered in terms of what the plantation has to offer.

In the present study the area surrounding the plantation was bordered on one side by farmland and on the other by mountain catchment area (Fig. 4.4). The farmland acted as a rich source of easily accessible food in spring and summer, although the hazards associated with acquiring it were great (antagonistic farmers!). This food source was however, highly seasonal in availability and thus only influenced summer and spring ranging behaviour. In some instances plantations acted as an easy route from the distant areas of the home range to the farmland.

The mountain catchment area consisted of mountain fynbos, which is a nutrient-poor vegetation type (Bigalke, 1979). The surrounding mountains have been subjected to at least three fires in the last ten years (Engelbrecht, 1987; pers. comm.). They thus offered little in terms of shelter or shade, though the vegetation in early stages of post-fire succession was likely to be a good source of geophytes and grasses (Bigalke and van Hensbergen, 1990). Baboons are very dependent on shade and water (Altmann and Altmann, 1970). Temperatures in the study area can reach up to 40°C in summer, while winters are very wet and cold, with snow falling on the mountains at times. During summer strong south easterly winds blow for much of the time. The plantations may thus offer much in terms of shelter under such conditions.

Loots (1991) recorded an incidence of predation by black eagles on young baboons on an exposed cliff face. Plantations would also afford some form of protection against predators.

Baboons were found almost exclusively in the plantations in autumn and winter (wet and cold months). Although the plantations were used heavily in spring, the fynbos and farmlands were favoured more than in winter and autumn. In summer, usage was spread evenly throughout the habitats. Thus as a vegetation type, plantations were used more heavily than any other throughout the year. This supports the theory of the advantages offered to baboons by plantations in terms of shelter. It must be borne in mind however, that data was easier to collect in the plantation due the accessibility afforded by the road network.

The troops in this area have been shot at for decades in an attempt to discourage them from entering plantations. However, as noted from experience, baboons can be very difficult to see within the plantations, and the trees therefore offer a further form of protection.

Baboons are known to be opportunistic feeders (Hall, 1963) and have been recorded utilizing tissues from trees in natural habitats (Hall, 1963; Altmann and Altmann, 1970). Stripping bark from pine trees and eating the tissues found beneath the bark is therefore an extension of their natural feeding patterns. This is despite the fact that this food source cannot play an important dietary role due to the low nutritive value (Bigalke et al, 1981). There are many other sources of food to be found within the plantation, including a large and steady supply of pine seeds, mushrooms, grass, insects and the seeds of *Acacia cyclops* and *Acacia mearnsii*. The burning of firebreaks around the plantation on a regular basis encourages the growth of grasses and geophytes in this band. This food resource may act as an additional attractant to the plantations and surroundings.

It may thus be that baboons find the plantations pleasant surroundings that offer enough in terms of sleeping sites, water, food and shelter to support them for at least a certain proportion of the time. In the case of this study, baboons most certainly found food, water and sleeping sites within the plantations and at least one troop was supported almost entirely within this habitat.

6.4 Conclusion

The density of baboon troops in this area was lower than in other studies, most likely as a result of continued removal programmes over decades. All troops had seasonal differences in home range utilization. Home range size increased in summer as troops exploited seasonal crops on nearby farms, and permanent water points. All troops showed a distinct preference for the plantation as a vegetation type. The plantation appeared to hold many advantages for baboons in terms of shelter, food and protection.

7. Feeding Behaviour.

7.1 Introduction

Feeding behaviour can be explained as a compromise between obtaining essential nutrients and avoiding harmful substances (Chivers 1986). Because primates select for a diet rich in protein and carbohydrates and low in fibre (and tannins and alkaloids), they have a varied diet and select plants and parts of plants carefully.

It is thus very important to look at what, how and especially why, an animal eats what it does to determine how it reacts to its environment. This is particularly relevant when attempting to understand the habits and ecology of a problem animal.

Baboons are described as generalist or opportunistic feeders by most authors. An animal can be described as a generalist feeder if it

1. eats a wide range and variety of food types;
2. has a wide range of feeding behaviours;
3. can extract energy from food easily in a number of ways (Schoener, 1971).

An animal has to decide what food to eat, in which areas to feed, how much time to spend in each area, how best to get to those areas and how long to spend getting there (Pyke et al, 1977). The decisions made by the animal affect the size and patterns of its home range. It is thus easy to see that feeding behaviour affects movements in and out of the plantations, as well as how much time is spent within the plantations.

7.2 Results

7.2.1 Species seen to be eaten

A list of foods that were seen to be eaten is given in Table 7.1. These food items are typical of those eaten opportunistically, whenever they became available. No indication of the amounts eaten is given. A list of plants found in the study area and described as being eaten by baboons in other studies is given in Appendix G.

Table 7.1. Food items observed to be eaten.

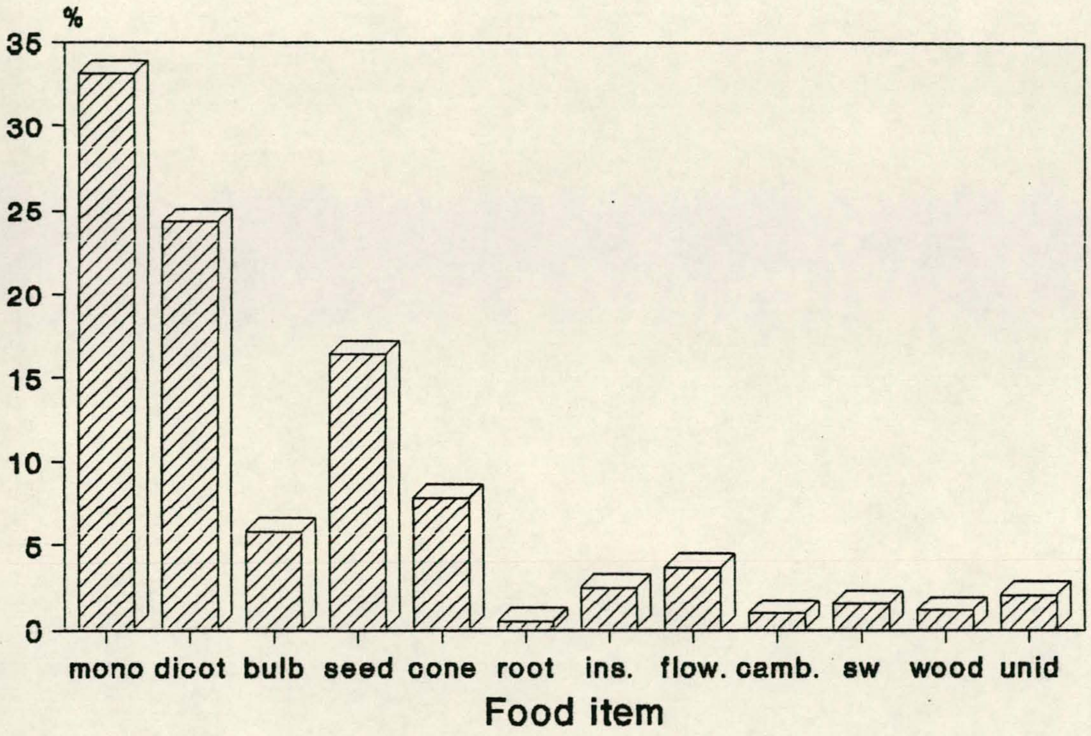
Plant	Part eaten
Pinus pinaster, P. radiata	cones/seeds
	cambium and phloem
Acacia cyclops	seeds
Acacia melanoxylon	bark/cambium/phloem
Oxalis spp.	flower and leaves
Aloe spp.	leaves
Mushroom	whole plant
Apples	fruit
Pears	fruit
Grapes	fruit
Pumpkin	fruit

Table 7.2. Percentage occurence of food items in scats (n = 63 scats).

	% summer	% autumn	% winter	% spring	% total
Insect	5.39	1.15	1.71	1.28	2.52
Monocotyledon - unid	10.44	13.00	18.43	14.78	13.98
Grass	15.28	9.54	13.93	9.56	12.16
Grass seed	1.72	3.15	1.50	0.00	1.48
Bulb	7.17	1.69	8.29	5.28	5.75
Restio spp.	6.39	2.92	1.79	9.89	5.65
Erica spp.	0.00	0.00	3.50	9.72	3.56
Leucospermum spp.	0.89	0.46	0.00	0.00	0.35
Protea repens	2.11	0.00	0.93	3.44	1.79
Protea nitida	0.50	0.00	0.29	0.00	0.21
Protea flower	1.28	0.00	3.64	1.72	1.67
Protea seed	0.00	0.00	0.21	0.00	0.05
Dicotyledon - unid.	18.94	13.77	18.36	20.50	18.19
Pinus spp. cone	4.78	20.46	5.21	4.00	7.89
Pinus spp. seed	10.78	20.08	11.93	11.11	13.05
Pinus spp. needle	1.83	2.31	1.36	0.17	1.35
Pinus spp. cambium	1.28	0.62	0.71	1.17	0.98
Pinus spp. flower	3.33	0.00	1.29	2.56	1.97
Pinus spp. seed wing	1.22	2.62	0.86	1.72	1.57
Pinus spp. bark	0.00	0.69	0.07	0.00	0.16
Pinus spp. wood	0.44	1.38	0.07	0.44	0.56
Total pine	23.67	48.15	21.5	21.17	27.53
Acacia seed	2.22	2.77	2.57	0.28	1.86
Acacia leaf	0.61	0.00	0.00	0.00	0.17
Acacia flower	0.00	0.31	0.14	0.00	0.10
Acacia bark	0.17	1.31	0.50	0.00	0.43
Root fibre	0.72	0.00	0.14	0.78	0.46
Unidentified	2.50	1.77	2.57	1.61	2.11

7.2.2 Occurrence of food items in faeces

A summary of the seasonal results of the faecal analysis is given in Table 7.2. To facilitate the establishment of trends in data, food items were clumped into twelve groups. This allowed the data to be more easily managed and displayed. The total percentage of each food item encountered in the faeces for all troops over all seasons was recorded and is presented in Figure 7.1.



KEY:
ins = insect; camb = xylem, cambium & phloem;
flow = flower; sw = pine seed wing.

Fig. 7.1. Total percentages of occurrence of the twelve main food items as determined by faecal analysis.

The five most important food items were monocotyledonous plants, dicotyledonous plants, seeds, cones and bulbs. Of the three food items that occurred more than 10% in each sample, monocots were found to be significantly more common than the others (Table 7.3).

Table 7.3. Statistical result of Chi-squared test to determine if monocotyledonous plants are selected for .
H_0: Do monocotyledonous plants occur significantly more often than dicots and seeds in faecal samples?

Chi-squared	Degrees of Freedom	Significance
7.15184	2	0.0279896

Number of samples = 63; $P<0.05$.

The monocot grouping included grass, *Restio* spp. and pine needles. Grass has been found to be the most important food item wherever it occurs in bulk (De Vore and Hall, 1965; Moss, 1975). It was also found to be important at Kluitjieskraal, and was eaten throughout the year. At Cape Point Nature Reserve in the Cape Peninsula, Davidge (1978) determined that grasses were only eaten in the winter and spring months. In the present study, pine needles were also observed in the faeces, but irregularly.

Included in the dicot class were *Erica* spp., *Leucospermum* spp., *Protea repens*, *Protea nitida* (waboom) and *Acacia* spp. leaves. Other dicotyledonous particles were not identified further, but encompass many fynbos species as well as the fruits eaten on farms.

All seeds, including those of grass, protea, pine and acacia, were classified as a single group, as they represented a major food item. Pine seeds were the favoured resource at the study site. This is probably due to the large quantity available and their level of utilization.

The presence of pine cone in the faeces is probably a reflection of the reliance of baboons on pine seeds as a food item. The cone itself is woody and is therefore not as easily digestible as other foods, hence the large proportion in the faeces. The pine seedwing is classed separately as it falls in no other grouping. It is not felt, however, that it is a selected food item, but is rather a by-product of eating pine seeds. Wright (1991) reported that baboons removed a substantial number of *Leucadendron bureolum* seeds at Cape Point Nature Reserve. He attributed the dispersal of these seeds to areas of young vegetation to omnivory by baboons.

Flowers (*Protea, Pinus* and *Acacia* spp.) were eaten when available - mostly in spring and summer. Hall (1962) recorded baboons eating the flowers of *Leucospermum conocapum* and *Protea lepidocarpodendron*. In this study, the infloresences of both *P. repens* and *P. nitida* were frequently seen scattered on the ground near the parent shrub. Remains were found in the baboon faeces.

Root fibres were not commonly observed in the faeces. This may be due to the fact that the fibres are often very small and are thus difficult to observe and/or identify, or they may be easily digested.

Wood particles were found in the faeces in small amounts. Their presence must also be attributed to their relative indigestibility, rather than a selection for wood as a source of food.

Xylem, cambium and phloem cells are included separately under the classification of cambium because of the interest of this particular item to the study. It was not found to be common in the faeces. Its low occurrence may be attributed to the ease with which the tissues are digested. Cambial samples of pine trees from the Northern Transvaal have also been found to have a low nutritive value (Bigalke et al, 1981). The total calorific content was approximately 0.2MJ/g (Bigalke and van Hensbergen, 1990) compared with a calorific content of 1.859MJ/g for grass samples collected in May (Davidge, 1978). It is thus reasonable to suppose that baboons would not select for these tissues. In fact Gieson (1985) determined that in many cases the baboons did not even eat the tissues when stripping the pine trees.

Insect remains were found in the faeces, but infrequently, and it is concluded that insects do not form a major part of the diet.

7.2.3 Seasonal variations

The seasonal variation of the occurrence of the five most common food items in the faeces are given in Fig. 7.2. In summer monocot and dicot plants formed a major part of the diet. Fruit crops on

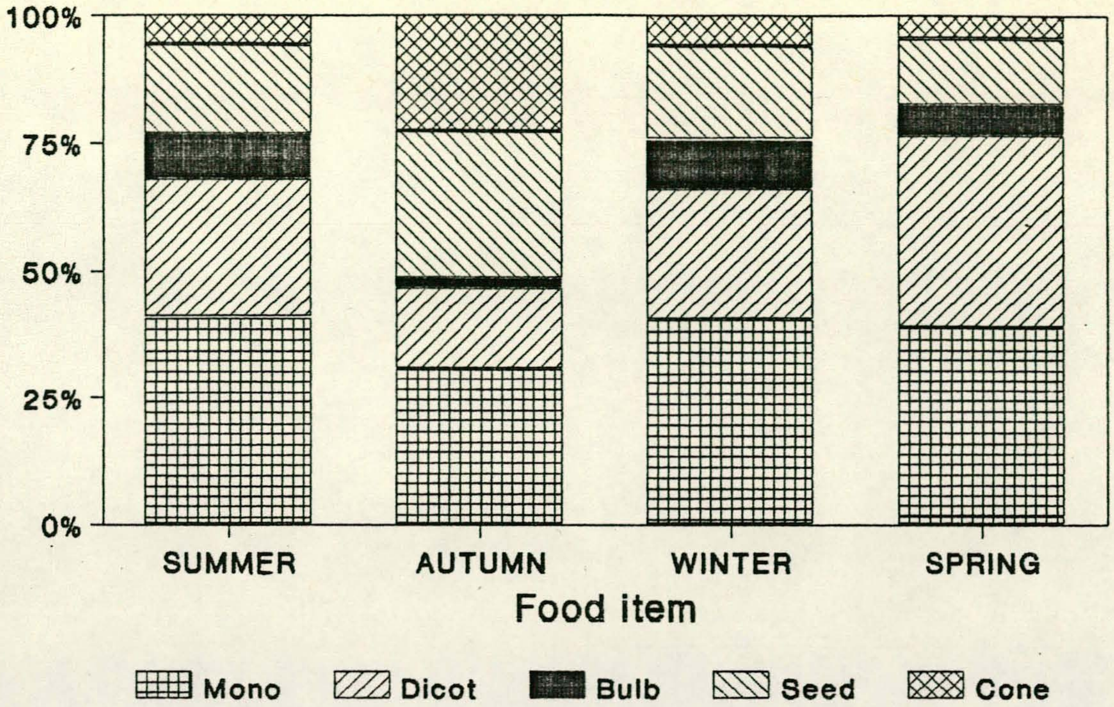


Fig. 7.2. The occurrence in the faeces of the five major food items during each season.

the farmlands offered a nutritious food source, which baboons utilized during summer and spring (Chapter 6). This may be why the proportion dicot in the faeces is higher during this season.

Seeds and cone (related to seeds) made a substantial contribution to the diet in autumn. The winter pattern was similar to that of summer, though dicots were not as prominent (no crops). Spring samples showed an increase in dicot presence. This may also be associated with the new spring growth of many fynbos species, for example many *Erica* spp.

Statistical tests (ANOVA) were performed to determine if any of the seasonal differences were statistically significant (Table 7.4). Significance was found for four items - dicot, pine cone, insect and bulbs. The proportion of dicot in the faeces was significantly higher in spring than at any other time of the year, due most likely, as stated earlier, to the presence of crops on neighbouring farms and the new protein-rich growth of spring. Pine cones were most common in autumn samples. This is attributed to the increased production of pine seeds at this time. This sudden increase in seed levels may be due to the seed production of *P. pinaster* at this time (Poynton, 1984). *P. radiata* produces seed throughout the year.

Table 7.4. Results of ANOVA on arcsin transformation on percentage of each food item as deduced from faecal analysis.

Food item	F-ratio	DF	Significance
Mono	2.422	62	0.0748
Dicot	4.972	62	0.0038 *
Bulb	3.583	62	0.0189 *
Grass	2.396	62	0.0772
Root	50.943	62	0.4258
Insect	6.639	62	0.0060 *
Seed	1.012	62	0.3940
Unid	0.714	62	0.5474
Pine seed	1.873	62	0.1441
Pine needle	1.740	62	0.1686
Pine flower	0.817	62	0.4899
Pine cone	6.080	62	0.0011 *
Pine cambium	0.438	62	0.7266
Acacia seed	1.504	62	0.2228
Acacia	1.980	66	0.1268

Number of samples = 63; $*P<0.05$.

Insect consumption increased in summer. Moolman and Breytenbach (1976) found a similar increase in summer during analysis of stomach contents of the chacma baboon in the Transvaal. The increase was attributed to the elevated levels of insects at this time of year.

The higher proportion of bulbs in the diet in winter may be as a result of the increased time spent in the plantations in winter. The baboons would thus have more time to spend digging for bulbs which act as a nutritious source of food at a time when there may be a shortage of other favoured foods.

It is of interest from the point of view of baboons as problem animals in plantations that there is no significant seasonal difference in xylem, cambium and phloem remains in the faeces.

Results were also examined in terms of presence and absence (rather than proportion) in the faeces on a monthly basis (Fig. 7.3). The major food items were found in the diet throughout the year. Root fibres were only found in samples for four of the twelve months, while all other items were found at least two thirds of all the months.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mono	●	●	●	●	●	●	●	●	●	●	●	●
Dicot	●	●	●	●	●	●	●	●	●	●	●	●
Bulb	●	●	●	●	●	●	●	●	●	●	●	●
Seed	●	●	●	●	●	●	●	●	●	●	●	●
Cone	●	●	●	●	●	●	●	●	●	●	●	●
Root		●				●			●			●
Insect	●	●	●	●		●	●	●	●	●	●	●
Flower	●	●			●	●	●	●	●	●		●
Camb	●	●	●	●	●	●	●	●	●	●	●	●
Unid	●	●	●	●	●	●	●		●		●	
Wood	●	●	●	●	●		●		●	●	●	
Seed wing	●	●	●	●	●	●					●	●

Fig. 7.3. Presence of major food classes in the faeces for each month of the year.

7.2.4 Use of indigenous and alien food types

Table 7.5. Percentage of occurrence of alien and indigenous food types in faeces during each season, and in total.

	summer	autumn	winter	spring	total
Indigenous vegetation	70.83%	45.69%	72.71%	76.94%	67.81%
Plantation vegetation	26.67%	52.54%	24.71%	21.44%	30.08%

Totals do not add up to 100 as unidentified particles were not included.

Remains of vegetation indigenous to the area in which the baboons moved was most common in the faeces ((67.81%) (Table 7.5). The fact that this occurred, while baboons spent as much time as they did in plantations, reflected the number of indigenous food types that also occurred within the plantations. Examples of these were *Protea* spp. found growing along roads in plantations, as well as many species of bulbous flowers. A higher percentage of alien foods were found in the faeces in autumn, due to the increased consumption of pine seeds at this time. Grass, although found occurring naturally in fynbos, was sparse and the bulk of the grass eaten was most likely consumed in the plantations.

7.2.5 Feeding behaviour

On the 25 April 1989 a seven year old *P. pinaster* was presented to baboons born in captivity and fed on a basic diet of dog pellets. The reaction of the baboons to this tree was observed to see if and how stripping was carried out.

The captive group consisted of one adult male, one adult female carrying a female infant on her stomach, one adolescent female and one male juvenile.

Baboons began to pull the needles off the tree and eat them. They sat at all levels of the cage fence to get to the tree, but showed no interest in the small cones. After ten minutes the baboons became more active. The juvenile showed the most interest, sitting on the branches in the tree and eating needles. He then tried to break branches off by swinging on them. Next he began biting the underside of the branches. Within fifteen minutes of seeing the tree, he had begun to strip the bark from the branches. He bit into the bark with his teeth, then pulled strips off, using either hands or teeth. The exposed area was then licked. The layer of cells between the bark and the wood (the xylem, cambium and phloem cells) were eaten. Within half an hour (15 minutes after the juvenile male) the adult male began stripping the tree as well. The adolescent female appeared the least interested in stripping, but continued eating pine needles. The individuals stripping the tree chewed the cambium and phloem off the inside of the bark before dropping it to the ground. The infant bit the parts of the tree she could reach. Cones were also eaten. After thirty five minutes the juvenile began to lose interest. The adult male also stopped stripping, returning for five minutes of stripping after a rest of fifteen minutes. Neither the adult female nor the adolescent female were observed to strip, although they both picked up bits of bark from the ground, from which they pulled the cambium. The adolescent did not even try to eat the bark once, as the others were observed to do. The juvenile male stripped higher up than the adult male (presumably due to his lighter weight). The tree was ringbarked so that no bark was left up to the first 1/4 of its height (at the first whorl of branches). All the needles growing on the trunk were eaten, as were all the small cones. After an hour the baboons began to eat biscuits and drink water and groom, returning to the tree for short intervals to strip and eat needles. The male was observed to smell the female's muzzle each time she ate something, after which he would pick an object from the ground, sniff it and eat it. After an hour and a half, the pattern was still continued although periods at the tree were becoming shorter and further apart.

Although the behaviour of the baboons in this situation cannot be regarded as normal due the captive environment, it is an indication that stripping is a "normal" behaviour pattern (see Chapter 2). The fact that the juvenile male started to strip the tree supports Cambefort (1981) who claims that juveniles discover new foods.

7.3 Discussion

Analysis of faeces gives some idea of the selection of food items and the quantity of each consumed. It does not necessarily always give an entirely accurate picture (Putman, 1984). Not all particles passing through the digestive system are easy to identify since some particles are non-translucent and others tend to agglutinate. Furthermore some tissues, such as those of mushrooms and bulbs, are far easier to digest than for example, wood or bark.

Some food tissues persist longer in the gut than others, thus possibly placing incorrect emphasis on these food types. Few remains of the easily digested food items pass out in the faeces, conceivably allowing items of major dietary importance to be ignored in studies such as this one. In many cases it was impossible to identify the species eaten from the remains. Classification of remains is for this reason very broad.

There is a possibility that the smell of resin may attract baboons into plantations. Resin has a slightly sweet taste which may be one of the factors enticing baboons to strip pine trees. Resin would however, be totally digested and no remains would be found in the faeces.

It is relatively easy to overlook significant food items. Norton et al (1987) for example, found a one year study to be inaccurate. The results from baboon faecal analysis are therefore treated as indicators of a broad feeding pattern displayed by baboons in and around plantations in the Western Cape.

Many studies have detailed specific foods eaten by baboons in different areas (Hall, 1962, 1963 and 1968; Rowell, 1966; Altmann and Altmann, 1970; Davidge, 1977; Hamilton et al, 1978; Post, 1982; Hamilton, 1986; Rhine et al, 1986; Norton et al, 1987). These studies, supported by findings from the present study, all point to the fact that baboons are mostly vegetarian (some troops to a greater degree than others). Insects, sometimes reptiles (Hall, 1962), and occasionally marine crustaceans (Hall, 1962) are typical of the animal matter consumed. Small mammals are taken when the opportunity arises (Dart, 1963; De Vore and Washburn, 1963; Harding, 1976; Rhine et al, 1986; Strum, 1986). The importance of non-vegetable matter in the diet appears to depend on the availability of such food items and may vary seasonally, as well as in different areas (De Vore and Hall, 1965). Baboons at Kluitjieskraal have a low intake of insects. Protein requirements may be provided by the utilization of pine seeds.

In savanna regions and grasslands, grass appears to be the most important part of a baboon's diet, while the acacia tree is the second most important plant (De Vore and Hall, 1965; Moss, 1975). In the fynbos similar food types are ingested but the pattern appears to differ slightly as regards the relative importance of each item in the diet.

Norton et al (1987) describe the baboon as an eclectic feeder that optimizes its diet by selecting from a large variety of available foods in a variable environment. This feeding pattern allows for a balanced diet. When foods that are usually heavily selected for are unavailable, those foods that are normally not used may be substituted. The findings in this study are supported by Post (1982), who found that a small number of food types accounted for the bulk of feeding time, and significantly determined home range patterns. These food items were eaten throughout the year. Seasonal changes in abundance of foods reflected a greater day-to-day than overall variability (Post, 1982). Baboons thus act as opportunistic feeders, over and above their normal feeding pattern, utilizing periods of peak production of rarer food items when available (Hamilton et al, 1978; Post, 1982). A general theory is that a more diverse diet can be expected when food is least available (Pyke et al, 1977; Hamilton et al, 1978; Krebs, 1978).

Post et al (1980) expands the above to include the following idea. Baboons are most selective for plants experiencing peak production during favourable periods, thereby allowing for adequate supplies of less variable foods when the general availability of food items decreases.

Baboons select not only the species to feed on, but also different parts of the plant, and different stages in its growth (Rowell, 1966; Altmann and Altmann, 1970; Moss, 1975; Hamilton et al, 1978). Thus in the case of a favoured food item, grass, the young blades and shoots are eaten when green and growing. During the dry periods, the rhizome (rich source of moisture and nutrients) and the base of the blades are eaten. Seeds are selected during the dry season when they are available (Rowell, 1966; Altmann and

Altmann, 1970; Moss, 1975). High protein levels are found in each of these parts of the plant at the time the baboons eat them (Moss, 1975). They thus appear to select the most nutritious part of each plant available in the environment in each season. Baboons at Kluitjieskraal also exploit this strategy. Ericas, for example, are favoured during spring growth. Crops on farms are also selected during the summer and spring season.

Selection from a wide range of plant species at various stages of development thus permits a higher protein intake than expected. Baboons living in forests ate the protein rich seeds of plants such as *Parkia* and *Acacia*, while fruits were eaten while still green (Rowell, 1966). This is the stage when protein levels are highest and the cellulose and alkaloid levels are lowest (Hamilton et al, 1978).

Seeds and particularly pine seeds, as a favoured part of the diet at Kluitjieskraal, satisfy the protein requirements of baboons. *Pinus* spp. seeds are not very common at Cape Point, yet when available, Davidge (1977) found that baboons selected them and ate them in quantity. Davidge (1976; 1977) and Hall (1962) found that baboons in the Western Cape utilize seeds of the exotic *Acacia* heavily. Acacia seeds were not in themselves a major food item at Kluitjieskraal, since exotic *Acacia* spp. are rare compared with the Western Cape. Davidge (1977) found that the seeds of *A. cyclops* had a relatively high fresh weight nutritive value, with a protein content of 24,7%, a lipid content of 10.4% and a calorific value of 1.951MJ/g. No similar information could be found about pine seeds, but it is assumed they have a similar high calorific value.

The manner in which baboons communicate information about new food items, or potentially harmful substances is uncertain. Hamilton (1986) observed muzzle sniffing behaviour to be associated with the adoption of a new food. Cambefort (1981) found that juvenile baboons discovered new foods and that transmission of the information was instantaneous. This was supported in the experiment at Tygerberg Zoo when the juvenile male was the first to start stripping. Cambefort (1981) also substantiated, as did

Fairbanks (1975), that observational learning of palatability is not sufficient to teach pigtail macaques and spider monkeys, who learn by personal experience. Jouventin et al (1976) and Fletemeyer (1978) however, found observational learning by baboons to be highly effective. It is thus not certain how new feeding habits, especially problem ones such as bark stripping and crop raiding are communicated.

Norton et al (1987) reported on a five year study of yellow baboons in Tanzania. It was established that one or two year studies on feeding behaviour are incomplete and can be misleading as variation in foods eaten between years can be very great. The broad feeding pattern however, was found to be repeated each year. It is important that this be borne in mind when assessing the results of this study, and that the data be used to indicate trends in feeding behaviour.

It thus appears that baboons at Kluitjieskraal follow the basic feeding strategy described in the literature. A broad base of foods is eaten throughout the year, with seasonal opportunistic feeding as items become abundant.

7.4 Conclusions

Data on feeding habits could only be collected by faecal analysis due to the baboons' fear of humans. Not all material passed out in the faeces was easy to identify, due to disintegration after passing through the digestive process. Also, some items appear to be more digestible than others. Foods were grouped into twelve categories for ease of handling. Favoured categories were monocotyledonous and dicotyledonous plants, bulbs, seeds and cones.

Xylem, phloem and cambium cells were not found to constitute a particularly large proportion of the diet, nor was there any significant seasonal variation in their occurrence. Dicots were selected for in spring, pine cones in autumn (although this is most likely a selection for seeds rather than cones), insects in summer and bulbs in winter. The five most favoured items were found in samples from each month of the year. Baboons appear to have a few staple items that sustain them throughout the year. These they supplement with other foods that become available seasonally. The habit of bark stripping is one that appears to be inherent in baboons. It is not known however, why only some troops found within plantations practice this habit on a wide scale, and why they should do so, considering the low energetic value of the bark tissues. Pine seeds and grasses appear to play a large role in the diet, and thus probably act as strong attractants as they are both found within the plantation.

8. Analysis of pine bark tissues.

8.1 Introduction

The problem caused by baboons in pine plantations is essentially the destruction of certain parts of the bark and bark tissues. The bark is composed of several layers of tissues. Innermost is the cambium which forms the xylem to the interior (wood cells), and the phloem to the exterior (bark cells). As new phloem cells are formed, the older cells are pushed outward and form the periderm, which protects the inner cell layers. The periderm isolates the outer cells from moisture and nutrients. These cells die off, forming the thick scaly bark. This is an ongoing cycle of outer cells being sloughed off and new layers forming (Scharfetter, 1982).

Moisture and minerals are taken up by the roots and transported to the leaves for photosynthesis by the xylem, while the products of photosynthesis are transported from the leaves by the phloem (Zimmermann, 1961).

Damage to these cells can thus have a major impact on the growth of the tree, depending on the severity of damage. The tree produces gum or resin at the site of the wound to prevent loss of moisture (Smith and Montgomery, 1959). This can result in a resin inclusion in the wood (Section 2.1), while the resin itself may act as an attractant to the baboons (Gieson, 1985).

The tissues eaten by the baboons were analyzed to determine if any particular element was selected. It is already known that the carbohydrate and sugar levels in these tissues are very low, and that they do not supply an adequate level of energy to act as a food source (Section 2.5.6) (Bigalke et al 1981). The mineral status of the tissues, however, is not known. The aim was thus to analyze the tissues for moisture, Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sodium (Na), Copper (Cu), Zinc (Zn), Manganese (Mn), Iron (Fe) and Boron (B).

8.2 Results

The results of analysis are presented in Table 8.1. An ANOVA (Table 8.2) was performed on the data to determine if significant differences existed between the levels of nutrients each month, and between the three types of sample taken each month.

Table 8.1. Levels of moisture and nutrients in different damage classes of trees, and different months.

		% moist	% N	% P	% K	% Ca	% Mg	% Na	ppm Cu	ppm Zn	ppm Mn	ppm Fe	ppm B
Feb	bdam	63.56	0.24	0.03	0.78	0.42	0.20	0.02	1.81	20.53	71.70	28.60	14.93
	ddam	63.19	0.25	0.03	0.79	0.34	0.18	0.02	1.93	15.93	49.00	36.80	15.65
	Undam	62.97	0.25	0.03	0.82	0.35	0.18	0.02	1.83	17.83	69.63	78.28	13.53
Mar	bdam	60.23	0.23	0.03	0.78	0.47	0.18	0.02	1.89	17.63	74.30	24.15	14.48
	ddam	59.33	0.23	0.03	0.73	0.46	0.20	0.02	1.57	18.68	74.93	33.13	13.60
	Undam	59.25	0.22	0.03	0.83	0.47	0.18	0.02	1.92	19.58	73.28	26.08	14.05
Apr	bdam	64.73	0.25	0.03	0.74	0.46	0.17	0.02	1.77	20.43	74.15	21.53	13.45
	ddam	65.99	0.24	0.03	0.73	0.45	0.19	0.02	1.73	22.13	146.88	28.45	14.60
	Undam	63.30	0.23	0.03	0.76	0.47	0.17	0.02	1.60	20.60	62.40	20.35	13.23
May	bdam	52.76	0.27	0.03	0.70	0.60	0.17	0.01	1.84	26.43	183.43	29.98	14.50
	ddam	58.00	0.25	0.03	0.78	0.58	0.17	0.02	1.81	22.30	77.50	27.33	13.68
	Undam	63.26	0.27	0.03	0.70	0.45	0.30	0.02	1.77	22.53	88.48	81.60	13.80
Jul	bdam	61.54	0.27	0.04	0.66	0.49	0.18	0.01	1.78	28.35	74.95	50.15	14.80
	ddam	60.33	0.29	0.03	0.67	0.46	0.18	0.02	1.96	21.78	77.68	41.98	16.03
	Undam	60.01	0.23	0.03	0.65	0.44	0.19	0.02	1.81	19.65	75.10	31.98	15.25
Aug	bdam	62.51	0.24	0.03	0.69	0.68	0.20	0.01	1.95	34.10	79.65	42.15	17.10
	ddam	64.93	0.25	0.03	0.60	0.45	0.18	0.01	1.76	17.87	71.37	42.93	14.13
	Undam	59.01	0.24	0.03	0.48	0.69	0.17	0.01	1.83	21.60	101.53	61.68	14.70
Sep	bdam	66.05	0.25	0.03	0.53	0.25	0.13	0.13	0.93	22.03	56.80	12.95	14.63
	ddam	63.57	0.25	0.03	0.62	0.32	0.15	0.08	1.16	19.08	64.23	27.68	14.30
	Undam	66.45	0.26	0.03	0.55	0.29	0.14	0.14	1.57	16.93	56.23	18.53	13.73
Oct	bdam	66.37	0.29	0.03	0.76	0.40	0.21	0.01	1.50	15.85	61.95	27.75	15.43
	ddam	62.47	0.24	0.03	0.60	0.47	0.20	0.01	1.40	17.40	66.20	29.00	12.68
	Undam	63.69	0.29	0.03	0.65	0.46	0.21	0.01	1.60	17.50	96.60	31.00	13.83
Nov	bdam	66.11	0.26	0.03	0.77	0.28	0.18	0.03	1.66	18.05	41.58	20.95	13.23
	ddam	63.27	0.24	0.03	0.71	0.33	0.21	0.03	2.06	14.00	81.67	30.80	14.13
	Undam	64.12	0.25	0.03	0.80	0.26	0.20	0.03	5.34	15.28	54.68	33.78	13.00
Dec	bdam	66.66	0.35	0.05	0.91	0.36	0.20	0.02	2.02	20.98	62.18	167.7	15.18
	ddam	64.85	0.25	0.04	0.82	0.34	0.22	0.02	2.01	19.75	56.40	26.63	15.10
	Undam	66.84	0.23	0.03	0.79	0.28	0.21	0.01	1.58	16.10	47.88	26.65	14.43

bdam - tree damaged by baboon; ddam - tree damaged experimentally; Undam - undamaged tree.

8.2.1 Moisture

Moisture levels (Fig. 8.1) varied between 50% and 70%. Levels peaked significantly from September to December.

8.2.2 Nitrogen

Nitrogen figures were multiplied by 6.25, to calculate the crude protein levels (MacDonald and Greenhalgh, 1969). There was no significant difference in uptake between any category of damage or in any particular month (Fig. 8.2).

Table 8.2. Results of ANOVA to determine if levels of moisture and nutrients differed monthly, and in different categories of damaged trees.

		F-ratio	Degrees of freedom	Significance
Moisture	date	6.806	9	0 *
	type	0.21	2	0.8109
Nitrogen	date	1.439	9	0.1843
	type	1.499	2	0.229
Phosphorous	date	2.599	9	0.0105 *
	type	2.02	2	0.1388
Potassium	date	11.14	9	0 *
	type	1.176	2	0.3133
Calcium	date	12.35	9	0 *
	type	0.738	2	0.4813
Magnesium	date	1.39	9	0.2051
	type	0.512	2	0.6009
Sodium	date	62.051	9	0 *
	type	2.687	2	0.7737
Copper	date	1.406	9	0.1981
	type	0.838	2	0.4359
Zinc	date	5.695	9	0 *
	type	1.766	2	0.0004 *
Manganese	date	4300.026	9	0.0007 *
	type	310.7393	2	0.7687
Iron	date	0.94	9	0.4949
	type	0.365	2	0.6956
Boron	date	2.715	9	0.0078 *
	type	0.299	2	0.516

* P>0.05 - statistically significant.

8.2.3 Inorganic elements

Potassium increased significantly in summer (Table 8.2), Calcium in August, Sodium in September, Phosphorous in summer (Fig. 8.3) and Boron in late winter (Fig. 8.4). No other monthly or damage category differences were significant for the elements Magnesium, Copper (Fig. 8.4) or Iron (Fig. 8.5).

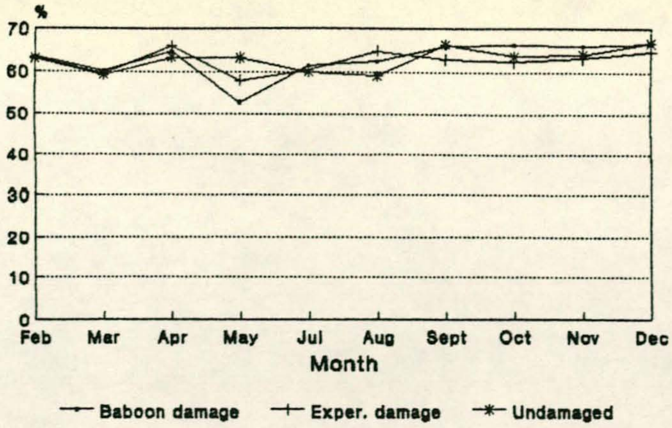


Fig. 8.1. Moisture levels in pine tree tissues each month.

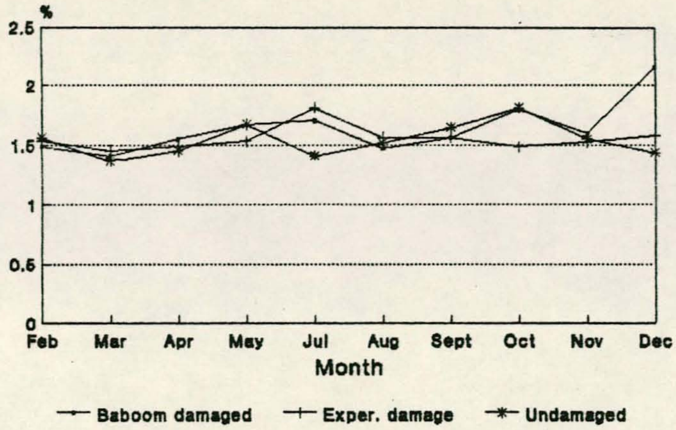


Fig. 8.2. Protein levels in pine tree tissues each month.

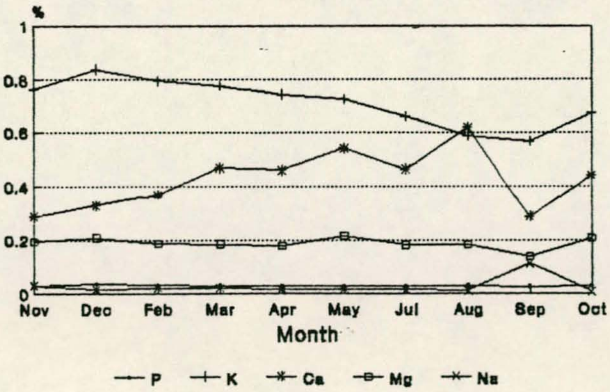


Fig. 8.3. Levels of Phosphorous, Potassium, Calcium, Magnesium and Sodium in pine tree tissues each month.

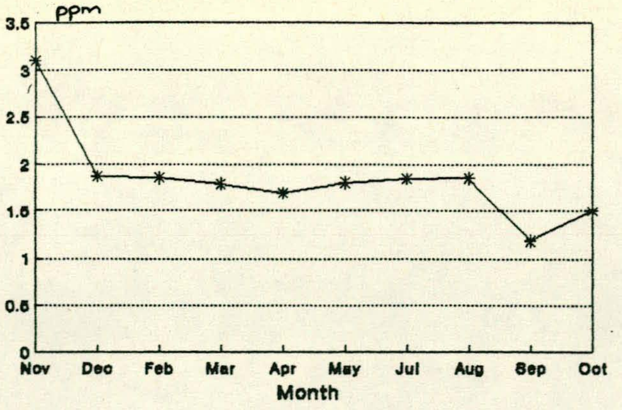


Fig. 8.4. Levels of Copper in pine tree tissues each month.

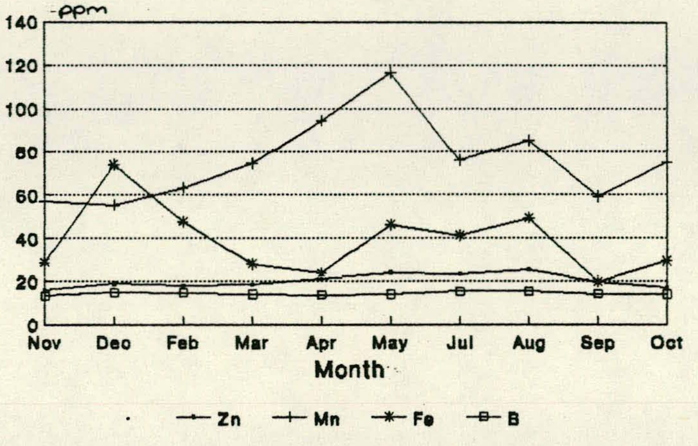


Fig. 8.5. Levels of Zinc, Manganese, Iron and Boron in pine tree tissues each month.

Zinc levels increased in late autumn and winter and Manganese in May (Fig. 8.5).

The only significant difference between damage categories was for Zinc (Table 8.2), where levels were significantly higher in those trees damaged by baboons (Fig. 8.6).

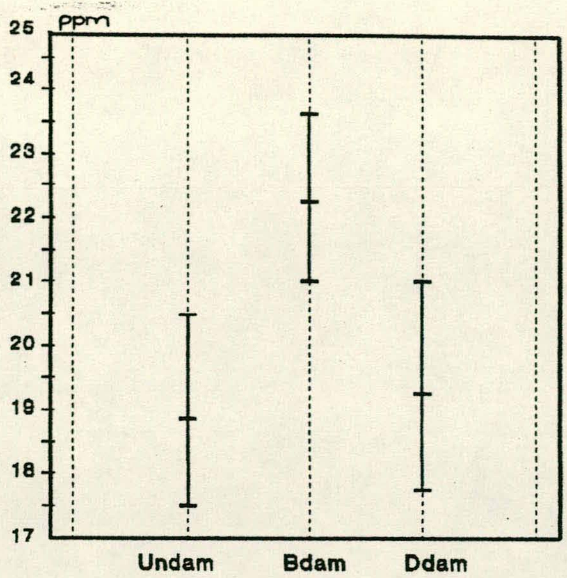


Fig. 8.6. 95% Confidence intervals for zinc, showing that zinc levels are higher in trees damaged by baboons than in other trees tested (results of ANOVA).

8.3 Discussion

8.3.1 Nutrients in Fynbos soil

The soil at Kluitjieskraal is typical of schlerophyllous shrublands (Bristow et al, 1985) which is strongly leached and nutrient poor (Stace et al, 1968; Specht, 1972). These oligotrophic soils have a notoriously low availability of P, N, Sulphur and possibly Cu, Zn and Mo (Day, 1983). Although low nutrient soils are characteristic of the fynbos, the nutrient levels may vary considerably depending on the availability of the nutrient, rather than the total quantity in the soil. This is determined by the presence of nutrient complexes in the soil and in soil solution (Day, 1983). The low levels of nutrients in the soils are reflected in the plants and this affects the nutrient levels assimilated by the animals that feed on them (Louw, 1969).

Fynbos soils have a low pH of approximately 5.7 (Day, 1983). The pH of the soil has a direct effect on the nutrient supply in that certain mineral elements are more available at different pH (Larcher, 1980). Plants growing in acidic soils are often subject to too many Al, Fe and Mn ions, while Ca^{2+}, Mg^{2+}, K^{+} and PO^{2-} are depleted, or in a form which is difficult to take up (Larcher, 1980).

8.3.2 Moisture

The peak in moisture levels coincides with spring growth, following the winter rains. It is postulated that if transport cells are damaged during the growth period, the tree may experience decreased growth due to the increased loss of moisture and photosynthates. This is also the time when certain sources claim that damage increases in the Western Cape (Section 2.5.1).

A number of food items that were consumed by baboons in Kenya were tested for moisture and various elements (Altmann et al, 1987). The moisture content of pine tissues was of similar levels to two of the plants tested (Table 8.3). Bark tissues may thus act as an important source of moisture during dry periods.

8.3.3 Protein

The nitrogen levels were similar to those of the plants studied by Altmann et al (1987). The levels in *Acacia tortilis* seeds (generally a high protein food source) were lower than that of pine tissues. This can be attributed to the age of the seed as protein levels increase with age. The N levels in mature or dry seeds of the same species of seed was 3.33 (Altmann et al, 1987). N levels in pine tissues, although not very high, are thus comparable to levels in many other plants commonly consumed by baboons.

8.3.4 Micro- and macro-elements

Most mineral nutrients (except N and P) are regulated by geochemical release, where water is a limiting factor (Day, 1983).

Low pH also has a limiting factor on the availability of most nutrients. The availability of nutrients is thus theoretically limited during summer and early autumn due to decreased water levels at this time in the Western Cape (Day, 1983).

Table 8.3. Moisture and mineral nutrients from this study and one by Altmann et al (1987) in Kenya.

	Pine tissues	Salvadora persica	Acacia tortilis	Sporobolus cordofa
% Moisture	62.83	72.1	69.9	11.7
% N	1.58	1.3	1.17	1.9
% P	0.03	0.12	0.1	0.4
% K	0.71	0.84	0.37	1.38
% Ca	0.43	1.45	0.15	1.27
% Mg	0.19	0.26	0.1	0.69
% Na	0.03	0.03	0.01	0.9
ppm Cu	1.58	2.5	2.4	10.7
ppm Zn - mean	20.06	4.8	5.6	18.1
- bdam	22.44			
- ddam & Undam	17.84			
ppm Mn	75.68	26.2	6.2	216
ppm Fe	38.73	48.4	11.5	40.5
ppm B	14.38	28.9	6.8	37

The levels of Ca, Zn and Mn in pine trees all decrease significantly during this period. This may thus be a reflection of the decreased availability in the soil. Levels of Na increased in spring, most likely due to elevated availability in the soil nutrient pool. K levels increased in summer. As this is inexplicable in terms of the above, the availability of K must be regulated by other factors. Levels of other mineral nutrients in pine tissues showed no significant differences.

Zn was the only element that differed significantly in the different categories of trees sampled. The trees damaged by baboons contained significantly higher levels of Zn than the other trees. It would thus appear that baboons may select trees with higher Zn levels.

This trace element is an essential micronutrient for all forms of life. Bryce-Smith (1989) claims that "zinc appears to have a greater variety of biochemical functions - catalytic, regulatory (inhibitory), structural - than any other trace element". Zn deficiency results in decreased growth and food intake, thickening and keratinization of the tongue (parakeratosis), decreased immune efficiency and reproductive ability, loss of hair and listlessness (Hansard, 1983).

It was previously assumed that vegetation on zinc deficient soils, such as the fynbos soils, contained enough zinc to meet the needs of the animals depending on this vegetation (Smith, 1990; pers. comm.). Smith (1990, pers. comm.) states that this can no longer be assumed. He further claims that too much fibre in the diet can decrease the absorption of Zn.

Zinc is freely available in animal tissues, but less so in plant tissues and especially seeds as zinc complexes with phytate, making it difficult to absorb (Robbins, 1983). It would thus appear that baboons, as largely herbivorous animals, with a high intake of seeds, are subject to low levels of zinc in their diet.

The zinc levels in pine trees are relatively high compared with the plants analyzed by Altmann et al (1987) (Table 8.3). This is especially so if the zinc levels of the trees damaged by baboons are compared with the findings from other studies.

There are thus strong indications that baboons may select trees that have high levels of zinc to preclude the potential of a zinc deficiency. This raises a number of important questions. Do baboons damage pine trees to obtain zinc? How do they select for trees high in zinc? Further research should be focused on this. If baboons do indeed select trees to obtain addition zinc, the possibility of using licks to overcome a zinc shortage must be investigated as this may result in decreased damage levels.

8.4 Conclusion

Many of the mineral nutrients in the pine tree tissues varied seasonally. This could be explained in terms of the nutrient availability in the soil. Nutrient levels in pine tree tissues were comparable with the levels in many plants consumed by baboons in other areas. The levels of zinc were significantly higher in trees damaged by baboons than in other trees of the same species. It would thus appear that baboons may be selecting for zinc in pine trees. This phenomenon, and the implications for managing baboon damage, needs further research.

9. Damage Levels throughout South Africa.

9.1 Introduction

Information on baboon damage throughout South Africa is rather limited, as mentioned in Chapter 2. Existing records are in Annual Reports of the Department of Forestry and Environmental Conservation (1969 - 1980) and of the Department of Water Affairs, Forestry and Environmental Conservation (1980 - 1986) in annual reports submitted by each State Forest to the Department. These data are not complete or detailed, and damage is often not

Table 9.1. Percentage damage to compartments at Kluitjieskraal State Forest as estimated by Department of Forestry officials.

Compartment	Damage	Compartment	Damage
K'kraal		Waterval	
E7a	*	H5	<10%
E7b	30%	H6	<10%
F10	0.2%	H11	10-50%
F12	60%	H13	10-50%
G7	4%	H15	<10%
G12	70%	H16	10-50%
H11	15.9%	H17	<10%
H13	*	H18	10-50%
I12	75%	H22a	>50%
J10	50%	H23	>50%
J11	62%	H24	<10%
K10	<10%	H25a	<10%
L10	1.5%	H25b	>50%
L11	22.5%	J4	<10%
L12	25.8%	J6	<10%
M10	75%	J16	10-50%
N10	11%		
T11a	1.8%		
U10	2%		
V10	32%		
W11a	18%		
W11b	14%		
W13	30%		
Z7a	*		
Z7b	<10%		
Z8b	<10%		
Z9	<10%		
Z11	*		
Z24a	10%		
Z24b	10%		

* - compartments with damage but no estimate figure.

recorded. Information concerning damage extracted from Annual Reports is summarized in Tables 9.1 and 9.2. Also included are estimates of damage by other animals, to give some idea of baboon damage in relation to total biotic damage to plantations.

Table 9.2. Records of baboon damage in State Forests (from Annual Reports submitted to the Departments of Forestry and Environmental Conservation, and Water Affairs, Forestry and Environmental Conservation - published and unpublished).

Year	Region/ station	Area damaged (ha)	Actual Loss	1991 value	Other damage	Area damaged (ha)	Actual loss	1991 value
1977	La Motte	300						
	K'kraal	80						
	Tsitsi.	200						
	E. Tvl	300						
1978	E. Tvl	16	R487	R7252				
	N. Tvl	41	R200	R2978				
1979	E. Tvl	14.3	R987	R13580				
	N. Tvl				monkey	36	R3600	R49532
1980	W. Cape	430	R5000	R63105				
	N. Tvl				monkey	20.8	R452	R5705
1981	N. Tvl				monkey	20	R4000	R45876
					antelope	156.6	R13600	R155978
	S. Tvl				rats	145	R2460	R28214
					small buck	217	R2213	R25381
1983	W. Cape	220	R20000	R183980				
	S. Cape	400			aphid	1899.5	R1000000	R9199000
					buck	-	R4000	R36796
	Tsitsi.				rats	22.2	R5200	R47835
					mice	400	R642	R5906
	Natal				buck	50	R1700	R15638
					rats	8.5	R850	R7819
	S. Tvl	0.25	R1125	R10348	rats	172	R3448	R31718
					buck	82	R984	R9052
1984	W. Cape	20	R4000	R32328				
	S. Cape	?	R2400	R19396	rats	10.5	R2680	R21660
	E. Cape				rats	48.5	R1500	R12123
	S. Tvl				rats; mice	200	R120000	R969840
	E. Tvl				bushbuck	299.2	R275825	R2229217
					rats	8	R600	R4849
	N. Tvl				monkeys	36.7	?	
1985	W. Cape	714.7	R10651	R73704				
	S. Cape	10	?					
	N. Tvl				monkey	714.7	R10651	R73705
Total		2746.25	R44850	R406674		4547.2	R1454405	R12975844

* La Motte and Kluitjieskraal (K'kraal) State Forests are in the Western Cape. The 1991 values were calculated using the average inflation figures for each year obtained from the Dept. of Statistics in Cape Town.

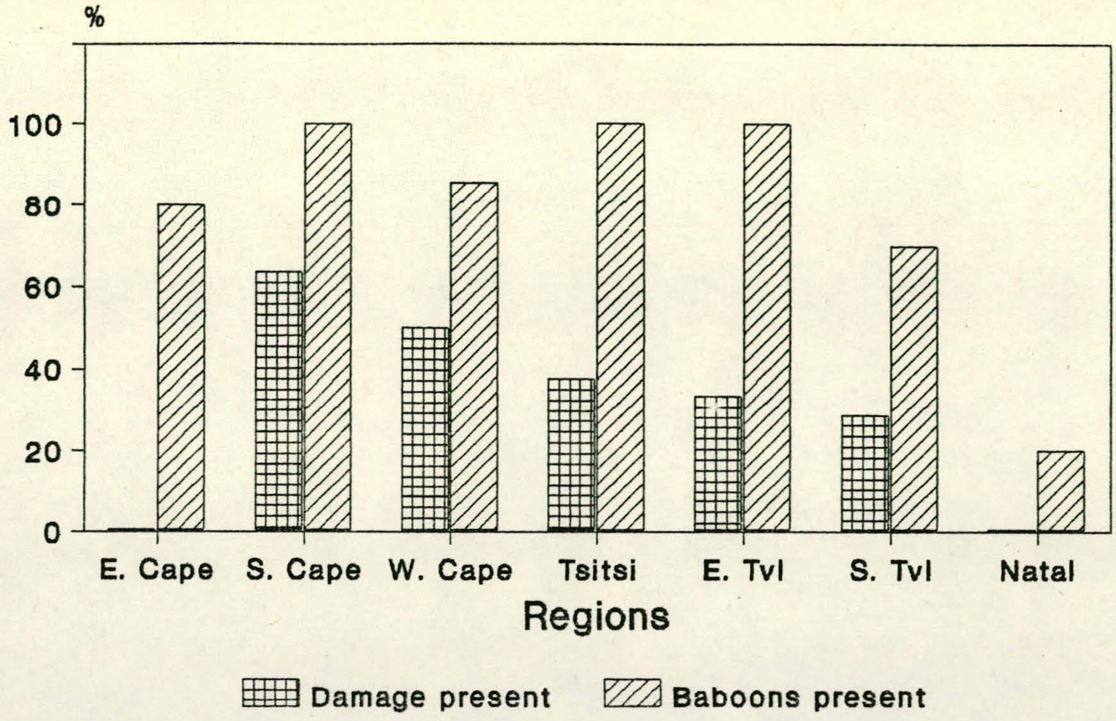


Fig. 9.1. The percentage of stations recording:
i) presence of baboons
ii) presence of damage (as a percentage of stations with baboons).

The aim of this chapter is to give an indication of the magnitude of the problem in South Africa, and to ascertain if any patterns in damage occur in the country.

9.2 Results and Discussion

9.2.1 Presence of damage

Of the 70 State Forests in South Africa, 54 stations reported the presence of baboons in and around the plantations - 77% (Fig. 9.1). Of these 54 stations, 20 reported damage (37%; or 26% of the original 73 forests).

25 private stations returned the questionnaires. 11 stations did not record the presence of baboons. 28.6% (4 stations) of the 14

stations with baboons experienced damage.

The number of stations with damage was significantly related to the number with baboons (Table 9.3). The existence of baboons with the bark-stripping habit is thus not an isolated occurrence, but rather a scattered phenomenon. Differences between the Cape, Transvaal and Natal regions, as regards the existence of damage were however not found to be significant. Damage was found throughout the country, but tended to occur in localized areas. Large scale damage within plantations was not a feature of any particular region, but rather a widespread occurrence.

9.2.2 Age of damage

Figure 9.2 shows the percentage of stations reporting various time periods when damage first became apparent. Most was observed during the last five years. The accuracy of this information is suspect.

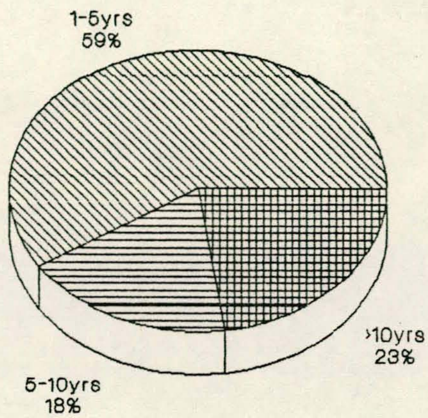


Fig. 9.2. Percentage of stations recording when damage was first noticed at various time intervals.

Table 9.3. Chi-sqaured test to determine significant differences between stations with damage and stations with baboons, and between species damaged.

	Chi-squared	Degrees Freedom	Significance
No. stations with damage in relation to no. with baboons +	21.5111	1	3.51787E-6 *
Spp. damaged +	6.88824	5	0.229056

+ Nul hypotheses: i)the relationship between stations with baboons and those with damage is not significant
ii)no species of pine is especially damaged

* P<0.05

Damage has been recorded in many areas since the 1960's. The questionnaire returned from Stormsriver State Forest (Tsitsikamma) noted damage as occurring only in the last five years, while Best (1989, pers. comm.) states that it has been evident for the last twenty years. Some of the information returned is thus known to be incorrect.

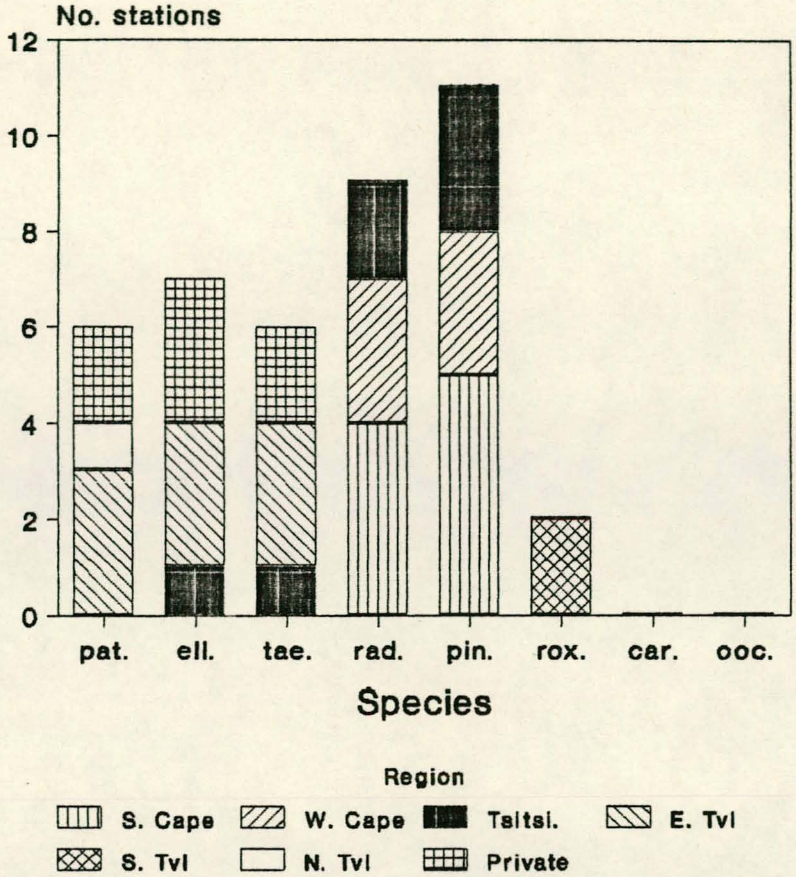


Fig. 9.3. Distribution of damage to different species of pine in the different regions.

9.2.3 Species damaged

No species of *Pinus* was found to be subject to significantly more damage than any other (Table 9.3). *P. radiata* and *P. pinaster* were damaged more than other species (Fig. 9.3). These two species however, are the most commonly planted in the Cape (Bigalke and van Hensbergen, 1990), where a large proportion of stations experience damage.

Most of the private stations that returned questionnaires, were situated in the Transvaal. *P. patula, P. elliotii* and *P. taeda* appeared to be the species that are most damaged in the north of South Africa where they are also more commonly planted. No regions reported damage to *P. oocarpa* or *P. careabea*, but in the Eastern Transvaal at Wilgeboom State Forest, *P. kesiya* was found to show signs of damage. Several species of *Eucalyptus* were also stripped, namely:

E. grandis (Tweefontein, Eastern Transvaal),
E. cloezia (Entabeni, Northern Transvaal) and
E. traxino (Kalmoesfontein, Sappi).

Stripping of *Acacia melanoxylon*, growing within the plantation at Kluitjieskraal, was also observed in this study. Thus damage appears to be a reflection of which species are planted in an area, rather than a selection by baboons for a particular species.

9.2.4 Levels of damage

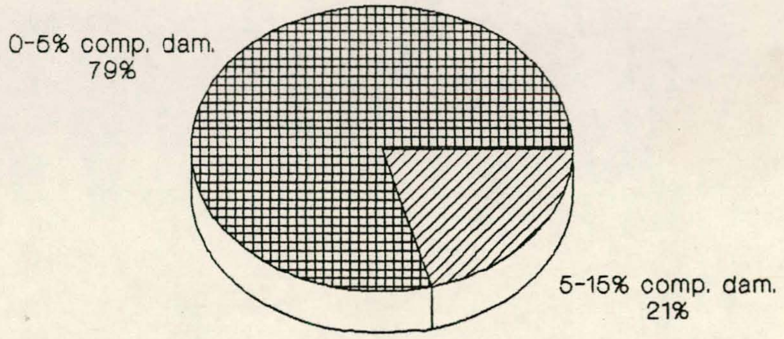


Fig. 9.4. The percentage of state forests showing the percentage of compartments damaged on each station.

Of particular importance is the extent to which damage occurs. Each station with damage was asked to evaluate the percentage of compartments damaged (Fig. 9.4), and the percentage of damage within the five most severely damaged compartments on each station (Fig. 9.5). A significantly greater number of stations found that 0-5% of the compartments showed damage.

On five stations, 5-15% of the compartments were damaged. No station had more than 15% of the compartments damaged. Damage in 120 compartments on 24 stations was noted. Of these stations, five gave data for only one compartment. Whether this is because damage

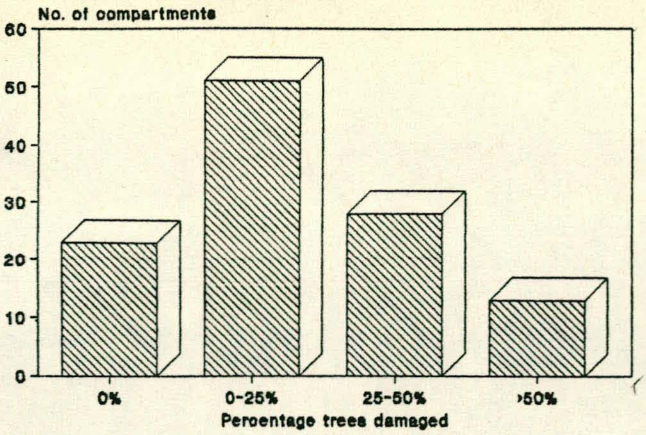


Fig. 9.5. Percentage of damage in the five worst damaged compartments on each forest station.

was only found in one compartment or not is uncertain. More compartments had damage in the 0-25% category. This amounted to over 50% of the compartments.

9.2.5 Increase in damage

An attempt to determine if damage levels are increasing proved inconclusive. Eleven stations found that an increasing number of compartments, as well as the number of trees within the compartments showed signs of damage, whereas twelve stations found no increase (Table 9.4). There was no obvious difference between regions as to the increase in damage. It would thus appear that although localized areas may show signs of increase, this is not a trend throughout South Africa and the situation is more-or-less static.

Table 9.4. All stations with damage were asked whether damage was increasing. The response is noted belown.

Region	1		2	
	yes	no	yes	no
S.Cape	2	4	2	4
W.Cape	3	0	3	0
Tsitsi	2	1	2	1
E.Tvl	3	2	3	2
S.Tvl	0	2	0	2
N.Tvl	0	1	0	1
Private	1	2	1	2
Total	11	12	11	12

KEY:

1. increase in the number of compartments being damaged;
2. increase in the number of trees within a compartment showing damage.

9.2.6 Patterns in damage

Each station was asked if, in the forester's experience, damage was related to any of the following factors

1. a particular food source;
2. a particular season;
3. presence of sleeping sites;
4. a particular soil type;
5. temperature (eg. heat that may drive baboons to search for shelter in the plantation);
6. presence of known drinking sites;
7. a prevailing wind;
8. a particular silvicultural practice (eg. pruning).

Most stations found no relationship between damage and any of the above factors (Table 9.5), except for season. Many of the stations did not know whether there was any affect of such factors on the incidence, and/or the increase or decrease of stripping.

Table 9.5. Response of each forest station to the query about the relationship between damage and the stated factors.

	Yes	No	?
Food source	3	12	7
Season	12	10	1
Sleeping site	8	12	3
Soil	2	17	4
Temperature	1	19	3
Water points	6	15	6
Wind	0	20	3
Silvicultural practices	2	18	3

Those stations that did find a positive correlation between the occurrence of damage and a food resource, related it to a food shortage that forced baboons into the plantations in search of an alternative food source. Seven stations found that in winter, damage increased as there were no crops on neighbouring farms at this time. Entabeni State Forest, however, related the presence, rather than absence, of crops on neighbouring farms positively to damage, as it was felt that the crops attracted the baboons into the area.

Many stations found no relationship between damage and favoured drinking sites or prevailing silvicultural practices. Two stations did however find that damage increased after work of any kind in the plantation as baboons were immediately attracted into this area. This observation was supported by A. Roscher (1987, pers. comm.) and P. van Zyl (1991, pers. comm.). Eight stations also found a correlation between areas of concentrated stripping and sleeping sites, although this number was not significant. Damage at Kluitjieskraal was found to be closely related to sleeping sites and the presence of crops on neighbouring farms (Chapters 2 & 7), both of which attracted baboons into the plantation.

Table 9.6. The number and percentages of compartments and areas damaged by baboons in the different forestry regions of Soth Africa.

Region	Total Area (ha)	Total no. comp.	No. comp. Damaged	Area (ha) damaged
E. Cape	8491	675	0	0
S. Cape	37568	3294	116	1325.57
W. Cape	16433	1987	84	547.82
Tsitsi.	32167	2549	86	1057.59
E. Tvl	50708	3288	46	766.48
S. Tvl	51959	2979	21	364.1
N. Tvl	5624	420	11	147.3
Natal	17558	1524	0	0
Zululand	35048	1451	0	0
State total	255556	18167	364	4208.86
Private	242984	4521	14	614.25
TOTAL	498540	22688	378	4823.11
% comp. damaged:	State	2%		
	Total	1.67%		
% area damaged:	State	1.65%		
	Total	0.97%		

9.2.7 Damage situation in South Africa

The most important factor at this point is to give some indication of the area damaged. Using data obtained from questionnaires it was found that 2% of the total number of compartments on State Forests were damaged. The total number damaged for private and State Forests was 1.67% (Table 9.6). The figures for the Northern Transvaal were excluded due to incomplete data.

9.2.8 Summary

A summary of damage patterns on a national level is as follows:

1. a large number of stations with baboons display damage;
2. damage is a relatively new phenomenon (this is questioned as most other information disputes this);
3. no particular species of pine is selected for;
4. the majority of compartments on each plantation show less than 25% damage;
5. few stations have more than 0-5% of the total compartments showing damage;
6. no patterns relating damage to environmental and other factors appear to exist;
7. total damage is 1.65% of the total State Forest land, and less than 1% of all afforested land.

9.3 Conclusion

Very little data is available concerning baboon damage in South Africa. A significant number of plantations experienced baboon damage. This was not restricted to any particular area, and no specific species of pine was selected for. No more than 15% of the compartments on any station showed signs of damage. Less than 25% of the trees within a compartment were damaged on average, although figures were greater than 50% in individual cases. Increase in damage within a plantation appears to be isolated. No significant relationship was found between damage and any particular environmental factor. Less than 2% of the total compartments in South Africa show damage, and less than 1% of the total area afforested has been damaged.

10. Damage at a Single Station Level.

10.1 Introduction

In this chapter the incidence and degree of baboon damage at the Kluitjieskraal State Forest is discussed. This is of relevance as it gives an indication of patterns of damage within a compartment at a single station level. Sampling also reveals the extent of damage to a single tree. Such sampling furthermore demonstrates the situation on a single station at one particular time. No other information concerning damage of this nature is available.

Estimates of damage at Kluitjieskraal from Forestry officials are compared with those derived from sampling operations to allow for a comparison of such estimates elsewhere. These estimates are somewhat confusing as no sampling was undertaken to determine these figures (van Heerden, 1989; pers. comm.). Furthermore, estimates were made in different years for different compartments, so that there is no clear indication of the situation at any particular time.

10.2 Results and Discussion

10.2.1 Distribution of damage

Damage at Kluitjieskraal was found to be concentrated in compartments bordering mountainous areas of indigenous vegetation (Elandskloof and Waterval Mountains) and cliff regions with suitable sleeping sites on the Voorberg. Although baboon troops have been observed moving through the plantations in the compartments above Knolvlei, no damage has been recorded in these areas with the exception of compartment G7 (Fig. 10.1). Baboons thus strip trees in those compartments that border on areas of natural vegetation. Pine cones form a major source of food (Chapter 7), and the baboons are thus attracted into the plantations to utilize this resource. It is also postulated that the plantations serve as shelter from the climatic extremes of summer and winter for the baboons in an otherwise exposed habitat

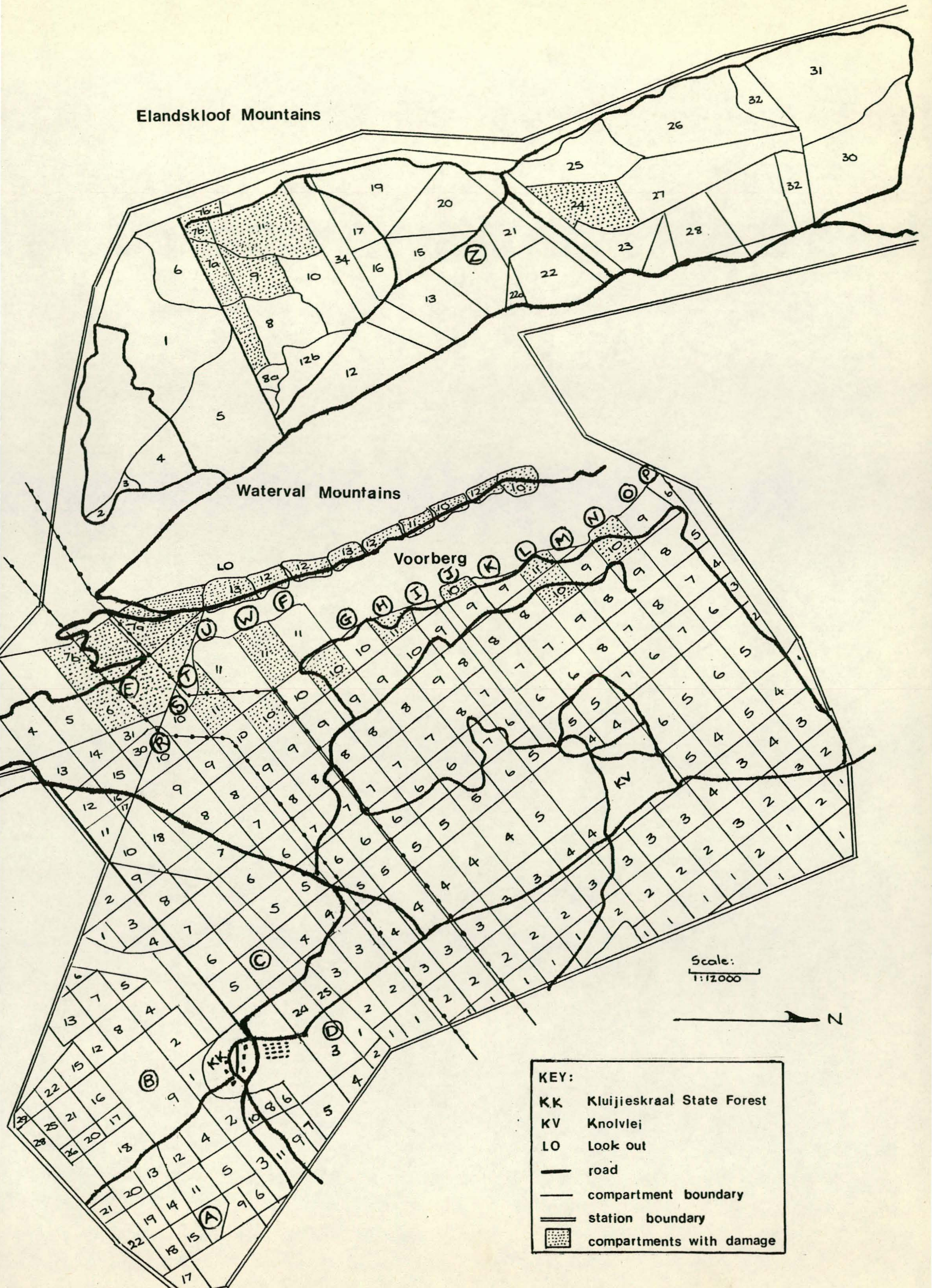


Fig 10.1 Compartment map

Table 10.1. Number and percentages of trees damaged in the ten compartments sampled at Kluitjieskraal State Forest.

Compartment	Species *Pinus*...	Age yrs	Site	Total trees	Trees sampled	Number damaged	% trees damaged
E7a	*radiata*	29	VB	1440	288	44	15.3
F12	*radiata*	28	VB	1235	247	53	21.5
G12	*radiata*	29	VB	755	155	48	31.0
H13	*radiata*	29	VB	790	158	73	46.0
H12	*radiata*	29	VB	605	121	65	53.4
W13	rad & pin	13	VB	1690	338	59	17.5
Z7a	*radiata*	12	SV	2300	460	100	23.9
Z7b	*pinaster*	6	SV	4290	858	248	28.9
Z8	*radiata*	19	SV	2340	468	66	14.1
Z9	*radiata*	12	SV	3450	690	121	18.5
Totals	Voorberg			4845	969	282	29.1
	Suurvlak			14070	2814	594	21.1
	Total			18915	3783	876	23.2

KEY: pin=*pinaster*; rad=*radiata*; VB=Voorberg; SV=Suurvlak

Table 10.2. The number of trees sampled in each compartment at Kluitjieskraal as regards total damage, type, height, age and aspect of damage.

Compartment		e7a	f12	g12	h13	h12	w13	z7a	z7b	z8	z9	VB	SV	TOTAL
Trees damaged		44	53	48	72	65	59	100	248	66	121	282	594	876
% damaged		15	21	31	46	54	17	22	29	14	18	29	21	23
More than 1* !		23	35	16	30	61	16	19	43	54	30	165	162	327
Type of dam. +	1	18	24	42	67	26	30	65	56	34	99	177	284	461
	2	6	11	2	3	35	7	14	6	20	15	57	62	119
	3	0	0	1	0	0	2	2	5	0	0	1	9	10
	4	5	3	0	0	0	12	10	65	11	5	8	103	111
	5	0	0	1	0	0	1	3	74	0	1	1	79	80
	6	15	15	2	2	4	7	6	42	1	1	38	57	95
Height of dam.	<0.5	2	6	0	2	6	2	26	23	5	34	16	90	106
(m)	0.5-1.0	4	0	3	2	3	1	3	19	10	4	12	37	49
	1.0-1.5	1	0	0	0	1	1	11	57	5	22	2	96	98
	1.5-2.0	0	0	3	0	0	2	2	69	0	8	3	81	84
	2.0-3.0	12	3	3	9	4	10	29	76	6	18	31	139	170
	>3.0	25	44	39	59	51	43	29	4	40	35	218	151	369
Aspect of dam.	No asp.	20	18	3	2	4	21	18	112	12	6	47	169	216
	E	3	3	3	7	10	5	17	31	7	14	26	74	100
	SE	1	0	2	2	6	7	7	21	0	9	11	44	55
	S	9	2	3	11	2	6	11	13	9	19	27	58	85
	SW	1	1	7	4	6	1	6	8	2	11	19	28	47
	W	3	5	5	14	2	3	5	10	6	14	29	38	67
	NW	1	7	11	9	9	5	7	10	0	15	37	37	74
	N	6	7	13	14	15	6	12	27	26	25	55	96	151
	NE	0	10	1	9	11	5	17	16	4	8	31	50	81
New damage		5	1	0	0	0	2	0	22	5	0	6	29	35
Old damage		39	52	48	72	65	57	100	226	61	121	276	565	841

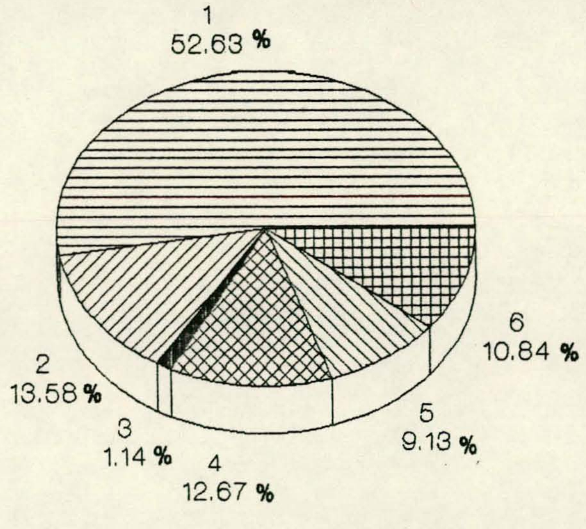
KEY: ! = Tree damaged more than once; + - see key for Fig. 10.2

(Chapter 6). Compartment Z24a and Z24b surround the permanent river flowing through the Suurvlak, where baboons were frequently observed to drink.

Table 10.3. Results of Chi-squared test to determine significant differences in damage as regards type, height, age and aspect, at Kluitjieskraal State Frest.

	Chi-squared	Degrees of Freedom	Significance P>0.05
Type	867.342	5	0.00000 *
Height	462.068	5	0.00000 *
Age	741.598	1	0.00000 *
Damage more than once	56.2603	1	6.35048E-14*
Aspect (without n/a)	88.9212	7	2.22045E-16*

A cosine trend was fitted to aspect data, but it was found that results were not regularly directional. A binomial distribution was fitted to data for trees damaged more than once, but there were insufficient degrees of freedom to conduct the Chi-squared test.
* P<0.05



KEY:
1 -<50% of circumference of bark removed;
2 ->50% of circumference of bark removed;
3 -ringbarked;
4 -crown dead;
5 -branches broken;
6 -tip removed, but tree survived.

Fig. 10.2. Percentage and number of trees in each different category of damage.

10.2.2 Total damage

The results of sampling in ten compartments are presented in Table 10.1 and Table 10.2. The percentage of trees damaged ranged from 14% - 53%, with a mean of 23.6%. This figure, however, does not reveal the extent of the damage to individual trees.

10.2.3 Type of damage

Class 1 damage - less than 50% of the cicumference of the bark in one area of the trunk removed (Fig. 10.2) - was significantly more frequent than other forms (Table 10.3). The results of this type of damage are that the quality of the timber is reduced and some of the logs are irretrievable. The tree also experiences decreased growth rates. However, apart from broken branches, this is the least serious form of damage, and thus does not represent as great a financial loss as would ringbarking and loss of crown.
Ringbarking and loss of crown could be regarded as the same category of damage as ringbarking leads to loss of crown. Loss of crown however, does not necessarily result in death of the tree, whereas ringbarking does. These groupings are thus kept separate. Damage resulting in death of trees could not be established over a long term as such trees are removed during prescribed thinnings.

Ringbarking of trees is not that common. This may however be a reflection of the fact that ringbarked trees die or are removed, and would thus no longer be present in the compartment. Other forms of damage occured at a similar level (i.e. between 9% and 14%).

10.2.4 Orientation of damage on the tree

Significantly more trees showed damage on the northern sides than on any other side (Table 10.3; Fig. 10.3). South easterly winds predominated throughout summer (Engelbrecht, 1987; pers. comm.) at the study site. A baboon stripping the bark on the northerly side of the tree would thus be sheltered from a strong south easterly wind. This theory is supported by accounts which suggest that most damage appeared to take place at Kluitjieskraal during summer (Rocher, 1987; pers. comm.). Orientation of damage could not be recorded for trees that had been ringbarked, or on which the crown of the tree was dead. When damage covered a large area on the tree (such as in the case of damage category 2), the centre of the damaged area was taken as the point of orientation of damage.

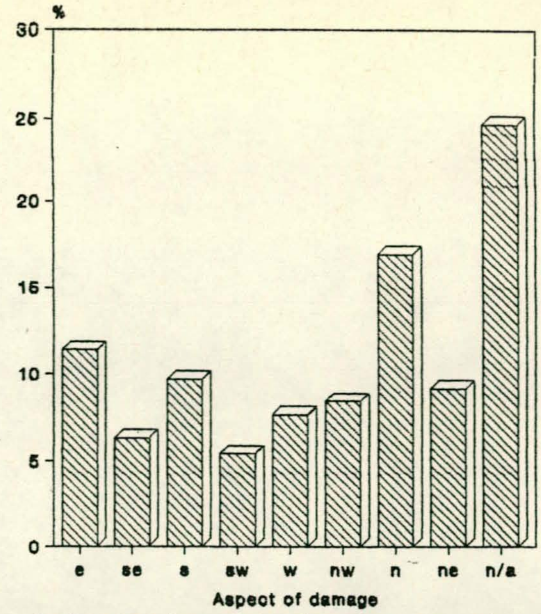


Fig. 10.3. Orientation of damage on the trunk of the tree.
n/a = damage has no direction

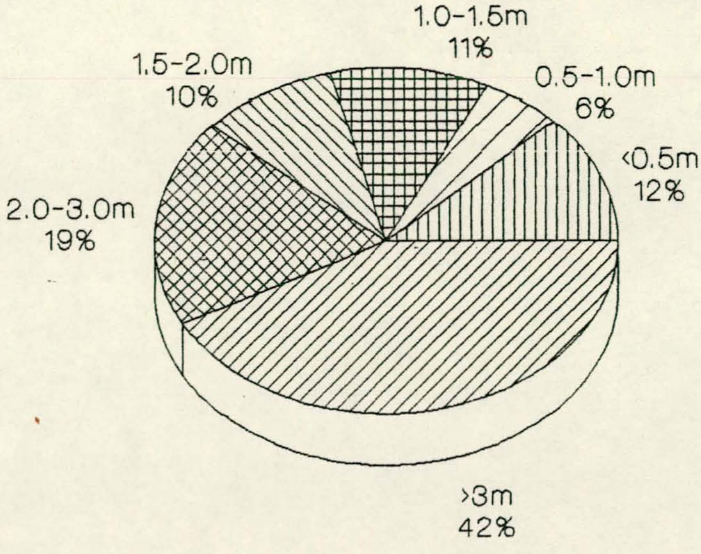


Fig. 10.4. Height of damage on the trunk of the tree.

10.2.5 Height of damage

Occurrence of damage in terms of height on the tree is shown in Fig. 10.4. Damage above three metres was found to be significantly more frequent than lower down (Table 10.3). Most damage was old (Fig. 10.5). Wounds were more common high on the tree and may be explained by the fact that the lower and older wounds heal with time and become less visible. Trees from the sample with the exception of one compartment (Table 10.1) were all over the age of 13 years, with five being nearly 30 years old.

10.2.6 Age of damage

Less than 5% of all trees damaged showed signs of recent damage. It is interesting that very little damage was fresh, since, as noted in 10.2.4 damage is believed to increase in summer. Sampling was undertaken in November and December and unless stripping increased after this period, it would seem that damage levels at this time were not particularly high.

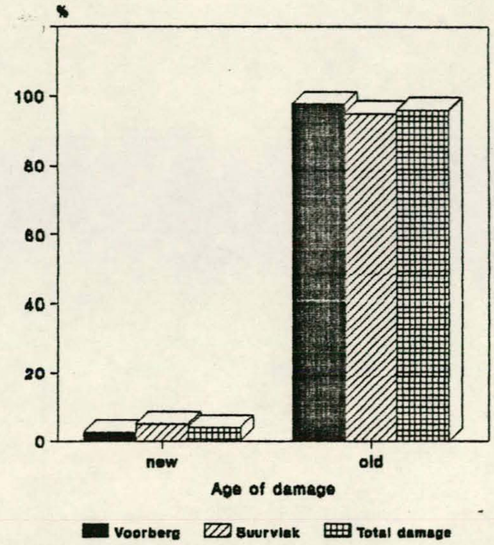


Fig. 10.5. Age of damage on the trees on the Suurvlak and the Voorberg and in total.

10.2.7 Difference in damage between two areas

Damage occurred in two distinct areas within the plantation i.e. the Voorberg and Suurvlak (Fig. 10.1), representing two different types of terrain. The Voorberg was an exposed, steep mountainside with many cliffs. The Suurvlak plantation lay on a level plateau situated between two mountain ranges. The area was more sheltered with a river flowing through the centre. Timber from Suurvlak tended to be of a better quality than that from the Voorberg (du

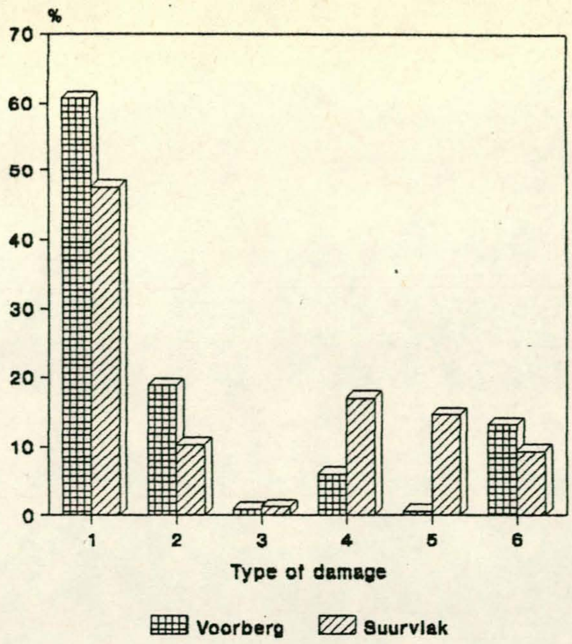


Fig. 10.6. Differences in the type of damage on the tree on the Suurvlak and Voorberg.

Table 10.4. Results of Chi-squared test to determine significant differences between the Suurvlak and the Voorberg in terms of type, age, height and aspect of damage.

Damage		Chi-squared	Degrees of freedom	Significance
Age	new	0.985135	1	0.320934
	old	0.0378505	1	0.845744
Aspect	E	4.02952	1	0.0447106*
	SE	0.220459	1	0.63869
	S	8.24742E-5	1	0.992754
	SW	0.0615751	1	0.804024
	W	0.506633	1	0.4766
	NW	2.19648	1	0.138326
	N	0.0329781	1	0.855898
	NE	0.243551	1	0.621653
	n/a	1.25207	1	0.26633158
Height	<0.5m	0.082875	1	0.77348
	0.5-1.0m	2.47781	1	0.115463
	1.0-1.5m	13.1635	1	2.8547E-4*
	1.5-2.0m	6.06069	1	0.0138224*
	2.0-3.0m	45.5529	1	1.485E-11*
	>3.0m	63.439	1	1.665E-15*
Type	1	1.61553	1	0.203716
	2	2.48039	1	0.115273
	3	1.6000	1	0.205103
	4	5.42393	1	0.0198626
	5	12.8933	1	3.29767E-4*
	6	0.65703	1	0.41761

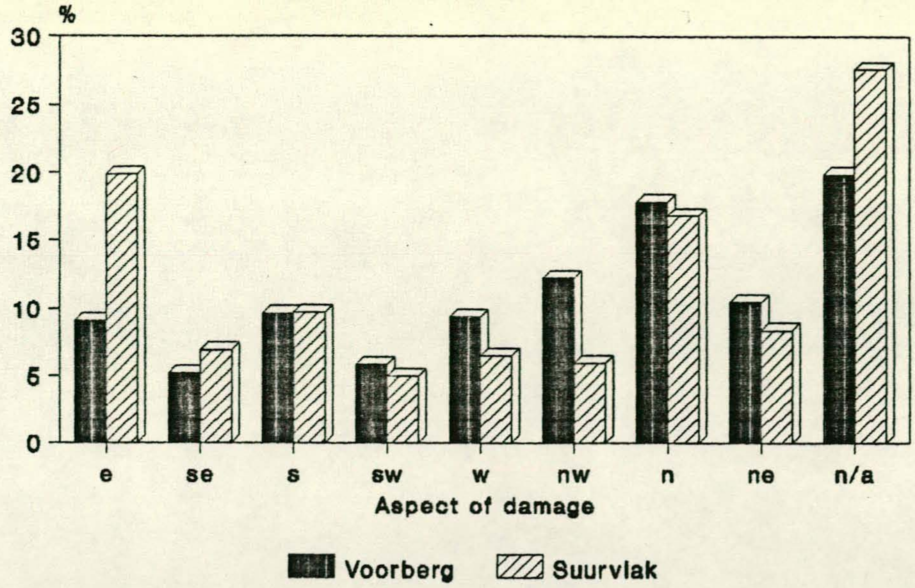


Fig. 10.7. Differences in aspect of damage between the Suurvlak and Voorberg.

Preez, 1989; pers. comm.). It is therefore of interest to examine the differences in damage between these two areas as the same baboon troop moves through both areas.

The only significant differences in type of damage (Table 10.4) was in the "broken branches" category (Fig. 10.6). This can be explained by differences in the age of damage (Fig. 10.5). There was more recent damage on the Suurvlak as the broken branches testify. On the Voorberg, damaged branches would have been removed during pruning operations if they had not already died and fallen off the tree. Furthermore, trees on the Suurvlak were in general younger than those on the Voorberg.

There were more trees with dead crowns on the Suurvlak than Voorberg. This can also be explained in terms of recent damage. Trees with dead crowns from the Voorberg could already have fallen off or been removed.

A significantly greater number of trees (Table 10.4) were damaged on the easterly side on the Suurvlak than on the Voorberg (Fig.

10.7). Damaged compartments on the Suurvlak were on the western edge of the plantation (Fig. 10.1). When entering the plantation from the Waterval mountain, baboons faced the easterly side of the trees. They would thus have climbed them and stripped them from the side they saw first. When moving through the plantation on the Voorberg, the troops were most often observed using the roads. If baboons approached from the side of compartment M10, more trees may be damaged on a northerly aspect.

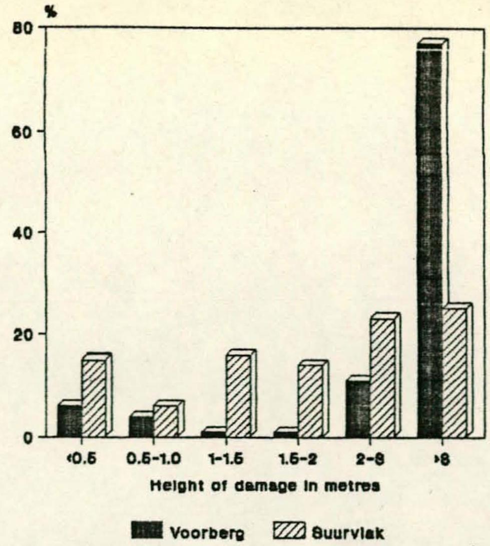


Fig.10.8. Differences in height of damage on the trunk of trees between the Suurvlak and Voorberg.

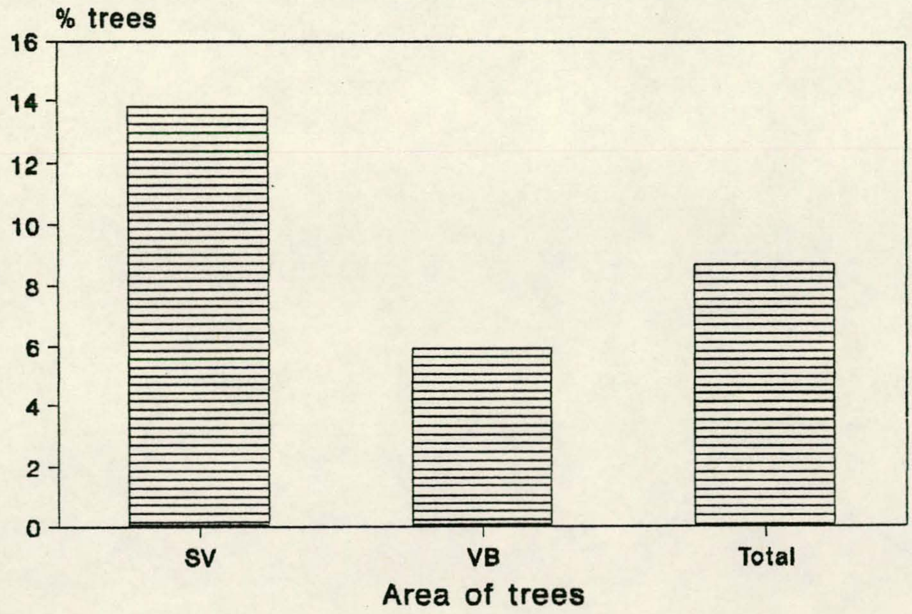


Fig. 10.9. Percentage of trees that were damaged more than once in total, and on the Suurvlak (SV) and Voorberg (VB).

Damage on the Suurvlak was significantly greater one to two metres high on the tree, while there was more above three metres on the Voorberg (Fig. 10.8; Table 10.4). This can be explained by the fact that Suurvlak trees are younger, and therefore shorter than those on the Voorberg, and damage is more recent in this area.

A large number of trees were damaged more than once (Fig.10.9). Thus 8.64% of the trees sampled, and 37.33% of the trees damaged were damaged more than once. This is a significant figure (Table 10.3). Consequences can be very serious as damage to both the crown and the base of the tree can result in total loss of utilizable timber.

Although the trees on the Voorberg were older, there was no significant difference in damage in total between the two areas.

The following patterns of damage are evident at Kluitjieskraal

1. the most common type was removal of bark from <50% of the circumference of the trunk;
2. damage occured significantly more on the northern side of the tree;
3. significantly more damage occured above three metres than lower down on the trunk;
4. most damage was old;
5. 8.64% of trees were damaged more than once;
6. differences in these patterns occured within a plantation depending on the location of the compartments and the conditions in each area.

10.2.8 Severity of damage

Waterval and Kluitjieskraal plantations were managed as a single unit. The number of compartments which recorded damage was 46, or 5,75% of the total (Table 10.5). Such levels are comparable with those reported elsewhere in the Western Cape (Table 10.8).

What is of more interest is the proportion of trees affected. This information was calculated using a combination of the sample

Table 10.5. Incidence of baboon damage to compartments at the Kluitjieskraal and Waterval State Forests.

Number of compartments damaged	Kluitjieskraal	30
	Waterval	16
Total compartments damaged		46
Total number of compartments		800
% compartments damaged		5.75%

figures from this study and estimates by Forestry officials, and the results given in Fig 10.10. In most compartments (41%) stripping affected 10-25% of the trees while in 73% of all compartments the figure was less than 25%. This did not take into account the severity of damage to the trees.

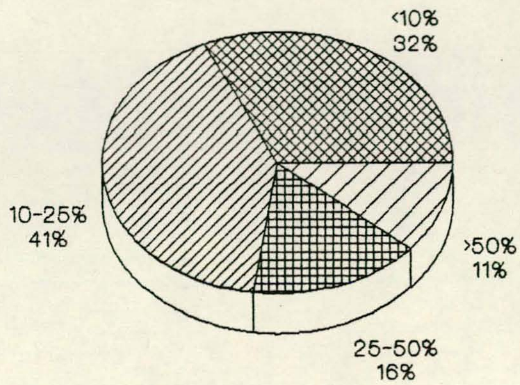


Fig. 10.10. The percentage of compartments with damage at levels of <10%, 10-25%, 25-50% and 50-75% at Kluitjieskraal (taken from the seven of the ten compartments sampled in this study).

Sampling figures from this study were compared with Forestry estimates for seven of the compartments sampled in this study (Table 10.6).

It was found that on average Forestry estimates were approximately 10% higher than the sampling from this study indicated. The difference between the two figures was found to be significant (Table 10.7).

In some cases, Forestry estimates were double and triple those from the study. As these estimates may have been years old by the time sampling was done, the apparent increase in damage in Suurvlak compartments (Z7b, Z8, Z9) found in this study can be explained by assuming continued damage over time. However, the lower damage

Table 10.6. Summary of damage figures for the seven compartments sampled in this study and the corresponding forestry estimates.

Compartment	Forestry Estimates	Study Figures
F12	60%	21.5%
G12	70%	31%
I12	75%	53.7%
W13	20%	17.5%
Z7b	10%	23.9%
Z8	10%	14.1%
Z9	10%	18.5%

figures from this study as compared to Forestry estimates cannot be explained. If all compartments were to be sampled, damage may be far less than that reported, and may well fall in the <10%, or at least the 10-25% category (Fig. 10.9).

Table 10.7. Statistical significance of the comparison between study figures and forestry estimates of bark stripping incidence.

Chi-squared	Degrees of Freedom	Significance
34.9763	6	1.52112E-6

10.2.9 Comparison with other areas

Baboon damage was found on three State Forests in the Western Cape and its incidence by compartments damaged is compared in Table 10.8. All areas recorded damage in less than 6% of the total number of compartments. These figures were found not to differ significantly.

A survey in the Dedza Plantations in Malawi revealed that baboon damage to six pine compartments was in the range of 1-23%, all of it being old (Darwin, 1981). It was concentrated on the edges of young compartments, near roads, footpaths and firebreaks where baboons found it easy to move. This concurs with findings in this study. In older stands where the canopy suppressed undergrowth, damage tended to be distributed more evenly.

Table 10.8. Damage levels on the three State Forests in the Western Cape that recorded damage.

	Kluitjieskraal	La Motte	Grabouw
Total no. compartments:	800	441	275
No. comp. damaged:	46	22	10
% comp. damaged:	5.75	5	3

Concentrated damage on the edges of compartments was also reported by Gieson (1984), Engelbrecht (1988; pers. comm.) and Notley (1989; pers. comm.).

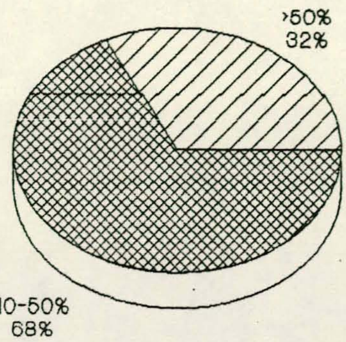


Fig. 10.11. The percentage of compartments at Bergplaas State Forest in one of the two categories - >50% and <50% of trees damaged (after van Schalkwyk, 1984).

At Bergplaas State Forest in the Southern Cape, 53 compartments were found damaged in 1985 (Fig.10.11). A visit to the area in 1989 established that 18 compartments are affected, some having as much as 50-80% damage, and others as little as 0.5% damage. Most of the compartments with damage were clearfelled before the visit, some prematurely and others as part of the clearfelling programme.

Total losses due to baboon damage were estimated at R600 000 in 1984 (Notley, 1989; pers. comm.). This represented approximately 1% of the total realized from timber in that year. A compartment with damage levels of 1.5% in 1979 and 3% in 1982 showed an increase to 72% in 1984 (van Schalkwyk, 1984). Extensive control operations were carried out in 1984 when 229 baboons were trapped and killed (van Schalkwyk 1984). Damage continued despite such measures (Notley, 1989; pers. comm.).

At Stormsriver State Forest in the Tsitsikamma region, 15% of the total number of compartments (Fig. 10.12) were reported as damaged

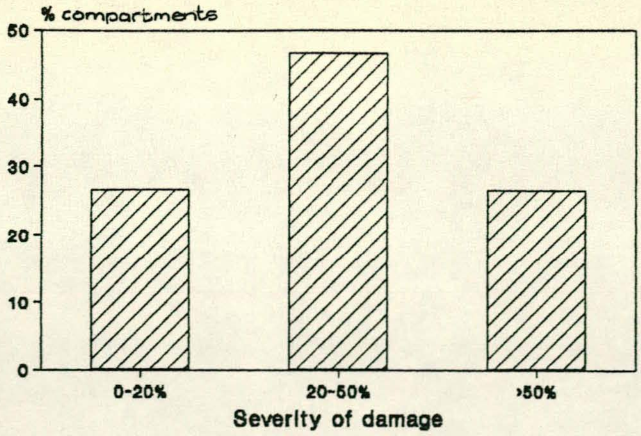


Fig. 10.12. The percentage of compartments with either 0-20% or 20-50% or>50% of the trees damaged at Storms River State Forest (Best, 1989; pers. comm.)

(Best, 1989; pers. comm.). Losses were estimated at one and a half to two million rand, which represented 2% of the total annual income from timber for this area.

Sampling of damaged compartments is complicated by the fact that older trees damaged previously, may recover externally. The effects are thus only revealed once the tree is felled and processed (Engelbrecht, 1987; pers. comm.). Damage in the form of branches broken may lead to a decreased growth rate and trees may not reach their full potential (Engelbrecht, 1987; pers. comm.). Removal of the growing tip of the young pine results in two secondary branches forming main trunks. This leads to reduced quality and volume of timber. Variable amounts of bark may be stripped. Where it is removed from less than 50% of the circumference of the trunk, the tree may recover but the wound is susceptible to fungal infection and resin inclusion. This results in staining or deformation of the timber, or both. Should bark be removed from more than 50% of the circumference, a larger area is open to infection. Growth rate is also decreased due to the decreased ability of the xylem and phloem to transport water and nutrients (Scharfetter, 1982). Death may result when the entire circumference of the trunk is stripped and the tree ringbarked. This is due to the removal of xylem and phloem tissues and the growth cells (the cambial layer) responsible for the regeneration and healing of the damaged area.

10.3 Conclusion

Baboon damage at Kluitjieskraal State Forest affects approximately 6% of all compartments. In most compartments, less than 25% of the trees were affected. Damage to the trees varied in severity.

Patterns of damage were determined and were found to differ between areas within a plantation. Patterns of damage in this study support the limited evidence in literature.

11. Financial Implications of Baboon Damage.

11.1 Introduction

There is no accurate financial estimate of damage by baboons to pine plantations in South Africa. The problem is considered to have severe financial implications and much time, money and effort is spent trying to limit damage. It is therefore imperative that some yardstick be placed on damage in an effort to determine the economic significance. Such an endeavour is complicated by numerous factors. No compartment is the same size, or produces the same quantity and quality of timber. The severity of damage on each tree differs. Damage estimates are at present incomplete, and figures in no way accurately reflect the damage levels. Future damage cannot be estimated. The following exercise can therefore not take all these considerations into account, and merely extrapolates from known figures in small areas to give a picture of the current situation in South Africa based on 1992 estimates.

11.2 Results and Discussion

11.2.1 Loss of timber due to baboon damage

The forester at La Motte station, Mr J. Roussouw and student forester, Mr G. Thornton, estimated damage of 15-25% for compartment D1. The estimate took into account the clumping effect characteristic of baboon damage. 10% damage was estimated in the centre of the compartment and 25 - 30% at the edges. Damage was

Table 11.1. Potential and realized value of 100 trees sampled at La Motte State Forest, with 35 damaged trees.

	Total	Mean	%
Potential Value of 100 trees	R5110.37	R51.10	
Realized value of 100 trees	R4339.60	R43.40	
Loss on 100 trees	R770.77	R7.70	15.08%
Potential value of 35 damaged trees	R1669.00	R47.69	
Realized value of 35 damaged trees	R898.25	R25.66	
Loss on 35 damaged trees	R770.75	R22.02	46.18%

judged to be representative of the type and severity of damage to trees and compartments in South Africa.

Of the 100 trees sampled, 35 were damaged. The high percentage of damage can be ascribed to the fact that the trees were not selected randomly, and the clumping effect already mentioned would thus be incorporated in the sample. The results are given in Table 11.1.

R4 339.60 of a potential R5 110.37 from the sample was realized. This represents a loss of 15.08% on 100 trees. Of the 35 tree that were damaged, a mean of R47.68 per tree would be gained were there no damage. However, these trees yielded a mean of R25.66. This represented a loss of R22.02 per tree (46.18%) and a total of R770.75 for the 35 trees.

The various classes of damage to a tree were discussed in Chapter 10.2.3. If the percentages of damage in each class are taken as representative of baboon damage and applied to the trees from this experiment, the following emerges. 52% of damage to trees is in Class 1 (less than 50% of the circumference of the bark removed). 13.58% is in Class 2 (more than 50% of the circumference of the bark removed), and 10.84% in Class 5 (tip of the tree removed so that the tree has survived with the main trunk forked). Other classes of damage would not be represented at the clearfelling stage. Thus the loss due to Class 1 damage is R15.06, R3.87 due to Class 2 damage and R3.09 due to Class 5 damage per tree. Most damage is in the category of damage that has the least serious impact on the resultant quality and volume of timber.

Questionnaire data (discussed in Chapter 9) revealed that 20 of the 70 State Forests experienced damage. This represented a total of 364 damaged compartments on State land. Each forester was questioned about the damage levels in the five worst damaged compartments on each station. Of a potential 100 State Forest compartments, 81 had damage. The sample revealed that 50.6% of the compartments had damage in the 0-25% category (185 compartments), 33.3% in the 25-50% class (120 compartments) and 16.1% in the >50% category (59 compartments).

Table 11.2: Estimated financial loss due to baboon damage for three categories of damage on afforested land in South Africa.

	% Damage in Compartments		
	0-25%	25-50%	>50%
Interval midpoint	12.5%	37.5%	75%
No. of compartments (SF*)	185	120	59
No. of compartments (total)	197	122	59
Average no. of trees damaged	237	710	1419
Value of loss per comp.	R5 218.74	R15 634.20	R31 246.38
Loss (S.F.*) for all comp.	R965 466.90	R1 876 104.00	R1 843 536.42
Total Loss for all comp.	R1 028 091.78	R1 907 372.40	R1 843 536.42
TOTAL LOSS (SF*)	R4 685 107.32		
TOTAL LOSS	R4 779 000.60	*SF = State Forest	

Table 11.3: Return on R4 685 107 (money lost due to damage) were it invested, at different interest rates, and for different periods of time.

Period Invested (years)	Interest rates			
	12.5%	15%	17.5%	20%
1	R5 270 745	R5 387 873	R5 505 001	R5 622 128
2	R5 929 589	R6 196 054	R6 468 376	R6 746 554
3	R6 670 787	R7 125 462	R7 600 342	R8 095 865
4	R7 504 636	R8 194 281	R8 930 401	R9 715 038
5	R8 442 715	R9 423 424	R10 493 222	R11 658 045
6	R9 498 054	R10 836 937	R12 329 535	R13 989 655
7	R10 685 311	R12 462 478	R14 487 204	R16 787 585
8	R12 020 975	R14 331 849	R17 022 465	R20 145 103
9	R13 523 597	R16 481 627	R20 001 396	R24 174 123
10	R15 214 046	R18 953 871	R23 501 641	R29 008 948
11	R17 115 802	R21 796 951	R27 614 428	R34 810 737
12	R19 255 278	R25 066 494	R32 446 953	R41 772 885
13	R21 662 187	R28 826 468	R38 125 169	R50 127 462
14	R24 369 961	R33 150 439	R44 797 074	R60 152 954
15	R27 416 206	R38 123 004	R52 636 562	R72 183 545
16	R30 843 231	R43 841 455	R61 847 960	R86 620 254
17	R34 698 635	R50 417 673	R72 671 353	R103 944 304
18	R39 035 965	R57 980 324	R85 388 840	R124 733 165
19	R43 915 460	R66 677 373	R100 331 887	R149 679 798
20	R49 404 893	R76 678 979	R117 889 967	R179 615 758

The average number of trees per compartment was determined, from sampling done at Kluitjieskraal State Forest, to be 1892. Although this cannot be regarded as a representative figure for all areas, it was the only reliable figure available and was thus used. A mean loss of R5 218.74 could be expected for a compartment with 12.5% damage, R15 634 with 37.5% damage and R31 246.38 with 75% damage (Table 11.2). When the predicted loss was multiplied by the number of compartments damaged in each category, and added, the total losses amounted to R4 685 107.32 for all State Forests, and R4 779 000.60 for all Forest stations from which questionnaires had been received. As questionnaire data (Table 9.6) reveals, only 2% of all State Forest compartments are damaged. Thus, R4 685 107.32 of a potential R234 255 266 (State Forests) and 1.67% for total Forests questioned, is lost as no baboon damage is expected from the other 98% compartments. This is not the loss per year, but the loss on all State land afforested at present.

A further hidden loss due to baboon damage is experienced as that amount that is lost cannot be invested. Table 11.3 tabulates the returns that could be expected were the R4 685 107 invested at various interest rates, over different periods of time. This amounts to a considerable figure over a long period of time.

The estimate arrived at above is based on a compartment with 35% damage. This is not necessarily a realistic figure (but tends towards over estimation) as the sample of trees was not a random one. This was to facilitate the process of accumulating the data by forestry officials. Some damaged compartments may be larger or smaller than the average figure used. More or fewer trees than the median may be damaged, and the severity of damage differs on each tree. As stated in Chapter 10, Forestry estimates of damage are often higher than those gained by sampling. It is thus impossible to propose anything other than guidelines for average damage levels, and the corresponding financial implications.

11.2.2 Volume and Value yields of timber

The estimates in 11.2.1 were supported by a "rule of thumb" calculation, using 1988 Government prices and a study of timber prices by Bremner (1989). If the Department of Forestry's sawtimber regime was followed, a 30 year old stand of *P. patula* from an intermediate site, should support 250 stems/ha and have a utilizable volume of 384m^3/ha (Loveday, 1983). The value of the hectare was calculated to be R14 533.29 (Table 11.4). The volume and value of a single tree in the above stand was 1.54m^3 and R58.21 respectively. If 4823.11ha were totally lost in South Africa (Table 9.6), one could expect a loss of approximately R70 095 656.

Table 11.4. Volume and value yields from one hectare of 30 year old *Pinus patula* on a site of intermediate quality (after Bremner, 1989).

Size classes	Intake Proportions (%)	Volume Yields (m^3)	1988 Nominal prices (R/m^3)	Value Yields (R)
A	9.5	36.48	14.91	543.92
B1	16.4	62.98	18.32	1 153.79
B2	18.1	60.50	36.65	2 547.18
C1	6.4	24.58	26.47	650.63
C2	24.5	94.08	47.80	4 497.02
D1	2.8	10.75	33.44	359.48
D2	22.3	85.63	56.07	4 801.27
	100.00	384.00		14 553.29

* Intake proportions - based on size-classes harvested from State plantations in 1974/75 (Du Toit, 1983).
* Volume yields - the utilizable timber from one hectare (Loveday, 1983) is split into the seven size-classes using the above proportions.
* 1988 Nominal prices - the Government-list price.
* Value yields - Volume yields x roadside prices.

However, the real prices fetched by timber are less than the nominal prices and the nominal prices are thus adjusted using a weighting factor. When the weighted average nominal price is divided by the Consumer Price Index and multiplied by 100, a real price is derived. According to the 1988 figures, the real price fetched by timber was R12.66/m^3. As 4823.11ha are damaged in South Africa, and one expects a utilizable volume of 384m^3/ha, a loss of approximately 1 852 074m^3 can be expected. However, as on average, less than 25% of the compartment is damaged, one would more reasonably expect a loss of 463 019m^3. The value of 463 019m^3 in terms of real prices is thus R5 861 814.

Not all trees that are damaged are completely unusable, even though the quality of the timber may be poor. Undamaged parts of the tree are still used, as is common practice in the Western Cape (Swanepoel, 1989; pers. comm.). Small logs may thus be retrieved, or the tree may be used for pulp.

The comparison between the study results and those from Bremner's work show the mean value of a tree at R51.10 and R58.21 respectively. The damage on State Forests according to Bremner (1989), not taking into account that parts of damaged trees are still utilizable, was found to be R5 861 814. As 46.18% of trees with damage were lost at La Motte, this figure was applied to the Bremner result. Thus a loss of R2 706 985.71 could be expected.

Thus results from both studies indicate that losses are less than R5 000 000.

The above figures can be used as estimates only, as a great many contributing factors are not taken into account. Many of the figures used to make the estimation are means, and the figures are thus approximates. The loss of growth of the tree due to damage is not considered, nor are the trees that have died as a result of damage. Furthermore future damage cannot be estimated. In many areas, such as Kluitjieskraal, Bergplaas and Stormsriver State Forests, pruning and thinning operations have been terminated due to extreme damage, and the compartments have been clearfelled prematurely. The differences in the quality of timber retrieved from different areas will account for differences in the volume of timber retrieved per hectare, and the value of such timber.

11.2.3 Losses experienced at the sawmill

Losses due to damage are also experienced by the sawmills. The timber is sold to sawmills once visibly damaged wood has been removed. The timber from this compartment at La Motte was sold to the Wemmershoek Sawmill. Mr Koos Burgher (1992; per. comm.), manager of the Wemmershoek Sawmill claimed that this compartment showed the worst damage of any he has seen in the last five years.

23% of all butt (first) logs were damaged. The damage is often not seen until after the timber has been transported, cut, dried and graded. This represents a substantial loss in terms of labour. Mr Burgher stated that it is extremely difficult to estimate losses due to damage as much depends on the position of the damage. If damage is on one side and straight down the length of the tree, then shorter logs than normal are retrieved. If damage is across the diameter of the tree, logs may be lost. Usually 1 - 1.5m are lost due to damage, although up to 2.5m have been lost. This may represent a loss of approximately 0.0628 m^3 on 0.3275 m^3 (29%) which represents a value of R21.45 per log.

11.3 Conclusion

It is impossible to calculate accurately the financial implications of damage on a nation-wide scale, due to the complicated and interwoven factors contributing to the final result, not to mention the considerable lack of data available. The above figures do however provide some idea of the severity of the damage, and will also enable suitable authorities to determine whether it is practical and economical to introduce long term control measures. Indications are that the losses in South Africa amount to less than R5 000 000 on present areas afforested.

12. Control options.

12.1 Introduction

The baboon has always been attracted to the resources that areas settled by humans provide. Man's livelihood has on numerous occasions been threatened (Strum, 1985; Bigalke and van Hensbergen, 1990). Many managers and researchers, like Eltringham (1979) believe that animals that are destructive to cultivated lands cannot be tolerated.

Under such circumstances action is taken against animals in one or more ways. The term control is often used to describe the artificial regulation of the size of baboon populations that are allegedly responsible for the destruction of agricultural and forestry produce. Other methods used to keep baboons away from cultivated land include shooting at individuals to scare them, and in some instances, erecting electric fencing. These options are described in detail in Section 2.7.

Data collected from questionnaires is presented to give some indication of the current situation in South Africa as regards the use of control and its effectiveness. An extensive review on the effects of control on population dynamics is included.

12.2 Results

12.2.1 Current situation

It was found that 30% of all Forest Stations reporting damage used some form of control (Fig. 12.1). 30-50% of stations in all regions used trap cages. This was the most commonly used control method. Other methods of control included releasing five leopards into the area to prey on the baboons (Entabeni State Forest in the Northern Transvaal). This may have no real effect, particularly in the Western Cape, as leopard predation on baboons is not great enough to reduce the population size significantly (Norton et al, 1986). Other areas such as Ruitersbos State Forest (Southern Cape) have attempted to scare the baboons by shooting at them.

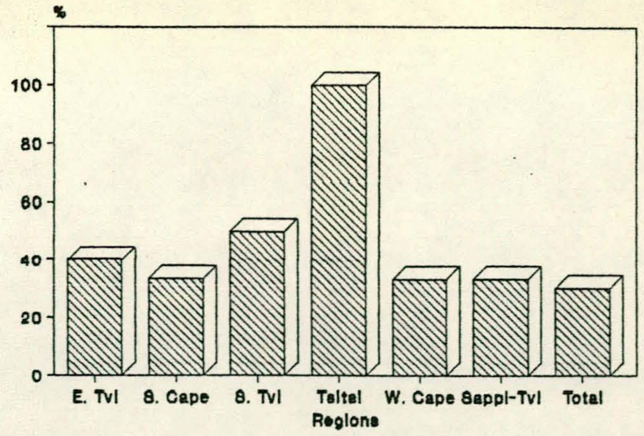


Fig. 12.1. Percentage of stations in South Africa with damage, where control operations were undertaken.

Evaluation of the success of control is inconclusive (Fig. 12.3). 32% of all stations using control found it to be successful, while 32% did not and 36% claimed they did not know whether control was successful or not. One of the greatest problems with control operations is that adequate records are not kept. No notable data on damage figures are available, thus the effectiveness of control cannot be determined.

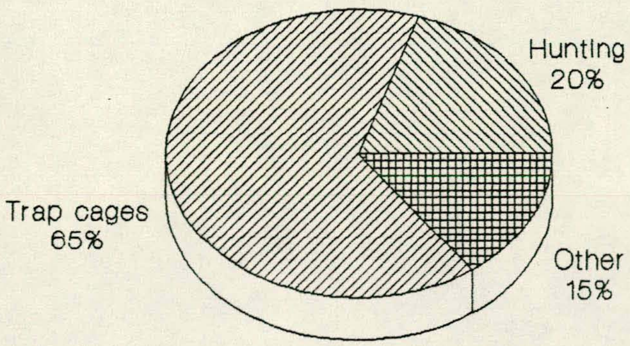


Fig. 12.2. Percentage of forest stations using different control methods.

The Breede River Regional Services Council maintains a hunter to deal with problem animals in the farming area of the Breede River valley. In his January and February monthly reports Dyer (1992a and 1992b) gave details of what damage was caused by a particular animal, and what action was taken.

Once again no indication of the extent of the damage, or estimates of losses was provided. Thus the pattern of action without knowledge of costs, or the result of certain actions continues. It is therefore imperative that damage levels be investigated and recorded. Control operations cannot be rationally initiated until the level of damage and its financial value have been established.

12.2.2 Electric Fence

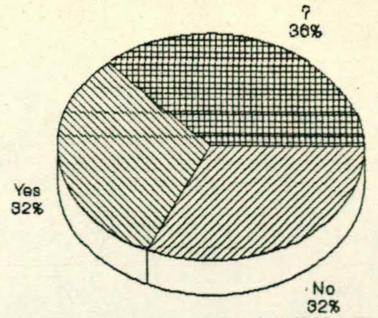


Fig. 12.3. Percentage of forest stations finding control operations to be successful (or not).

An electric fence (Fig. 5.3) of 700m was erected around a section of a pine compartment bordered on one side by steep mountain slope and on the other by a road. A perennial stream passes through the area. The fence took four days to erect, using on average five labourers a day. The cost of the fence was R1847.00 (Table 12.1), which represents R263/100m. This particular fence was not successful in keeping baboons out due to an error in design. The top strand of the fence was an earth and not a live wire, thereby allowing baboons to get over. This was substantiated by signs of recent damage within the enclosed area not observed previously, and fresh droppings. A small experimental fence was erected elsewhere by Mr D. Pepler (Dept. of Nature Conservation, University of Stellenbosch). This fence followed the above design, but had a live top wire. This has proved to be 100% effective. Other electrical fences aimed at deterring baboons have been erected at Algeria State Forest (Cederberg, Western Cape) and Cape Point Nature Reserve (Cape Peninsula). The fence at Algeria was 1,2m high and consisted of six strands, three earth and three live. The top wire was live, with two offset live wires, one offset by 455mm at 0.9m and one offset by 225mm at 0.25mm. The fence at Cape point was 1.2m with three live wires, the top offset by 455mm. Neither of these fences have been effective.

A free-standing electric fence has proved to be successful for over five years at Cedara Agricultural College in Natal (John Scheepers, 1989; pers. comm.). The fence was constructed of four foot high diamond mesh fencing. Offset brackets with live wires were placed at the top, bottom and middle of the fence. This design, although successful, was rejected due to the high cost of the diamond mesh.

Table 12.1. Details of the study fence and cost of components (1989 prices).

	Type	Units needed	Cost
No. standards		24	supplied by Forestry Dept
No. of droppers		48	"
Offsets	DM M140; 22mm	144	R227.53
Offset insulators	UNW M130	144	R59.40
Insulators	M140-M150	144	R47.52
Wire	4.4mm	5600m	R638.00
Nails and screws			R34.00
Generator	Gallagher G342	1	R417.32
Battery		2	R40.00
Labour		23.5	R383.28
Length of fence		700m	R1847.05
			R263/100m

The estimated cost of the fence at Cedara, using similar prices and materials to those used in the study fence was R486.90 per 100 meters. The mesh was priced in 1991, using Government contract prices. This fence is almost double the cost of the study fence per meter.

Pretorius (1989; pers. comm.) described a fence that also proved competent at deterring baboons from a forest reserve in the Eastern Cape. This fence was 1.4m high, with ten strands, five live and five earth. At the top were two 255mm offsets, one on either side, holding a live wire.

12.3 Discussion

12.3.1 Scaring baboons

Endeavours in the past to scare baboons by shooting at them (Bigalke and van Hensbergen, 1990) or by using dogs to hunt them (Maples et al, 1976; Brand and Jordaan, 1991) have all proved to be unsuccessful and expensive as a long term control means.

Poisoning using Telodrin and strychnine has been attempted, but discontinued due to the undesirable environmental consequences, and the non-selectivity of the method (Bigalke and van Hensbergen, 1990; Brand and Jordaan, 1991).

Anon (1990) described a deterrent consisting of an egg and paint mixture, harmless to all animals. This was sprayed on plants and has been tested successfully in New Zealand against rabbits and hares. This has not as yet been tested in South Africa.

12.3.2 Trap cages

The most widely used method of decreasing the numbers of a problem population is by trapping individuals and then shooting them. This method has been used in Forestry for a number of years. The only records of the effectiveness of this method are scant (Appendix H). The trap cages are based on those designed by Fitzsimons (1955). Brand and Jordaan (1991) carried out a study to determine the effectiveness of this means of control. They describe the three phases of the operation

1. pre-baiting in an area visited regularly by the troop
2. accustoming the troop to the traps by feeding in cages
3. setting the trap cages and capturing the baboons.

Brand and Jordaan (1991) claim that if all the guidelines are carefully followed, a troop of baboons can be wiped out. The process takes approximately 22 days, with an average cost of R350 per operation (1988-1989 costs). This represents less than R10 per baboon caught. The majority of the costs were attributed to transport and labour.

12.3.3 Electric fencing

Electric fencing can act as a very effective deterrent if properly constructed (Byford-Jones, 1992). There are however problems associated with electric fencing. Batteries have to be changed regularly if the system is not fitted with a solar powering device.

The fence needs to be patrolled frequently to check that grasses and fallen branches do not cause a short circuit to the system (Pretorius, 1989; pers. comm.). The fence operates by giving a short but very intense shock. This is not sufficient to kill the animal, but serves as a very strong deterrent.

One of the most important factors when erecting a fence is that it is highly visible to the animal, and that the animal is familiar with its presence. Thus one must attract the animal to the fence and ensure that it receives a shock. Once this has occurred, the animal will stay well clear of the fence.

There are certain features of a fence that make it more effective. An angled fence is better at deterring jumping animals (Williamson, 1992; pers. comm. in Byford-Jones). The use of offsets on the fence achieves the benefits of an angled fence, while being easier to construct and maintain. Live wires should be placed as high as two-thirds of the height of the animal for which the fence has been erected, and in the case of baboons, live wires must run over the top of the straining posts. The fence must be constructed away from trees and slopes that will allow the baboon to clear the fence easily.

Points to remember about the fence are

1. use high powered low impedance energizers;
2. solar power can charge the fence so that batteries do not have to be replaced;
3. galvanized spring offsets should be used on the wire and not the rigid posts to prevent them breaking easily;
4. the fence should be adequately earthed, especially in drought prone areas - place stainless steel earth spikes into a 100mm by 1,2m deep hole filled with sodium benzoate and salt (Byford-Jones, 1992);
5. high quality porcelain insulators should be used in fire-prone areas;
6. an electric fence costs approximately a third of the price of a conventional barbed wire fence (Byford-Jones, 1992);
7. the longer an electrical fence, the cheaper the cost per hectare enclosed (Pretorius, 1989; pers. comm.).

Due to the expense and the problems associated with erecting and maintaining such a fence, it is not practical to even consider fencing all or most of a plantation. Damage is however localized to mountainous areas and areas close to sleeping sites (Chapter 10.2.1). Such mountainous areas often offer poor quality timber, as at La Motte State Forest (Van Heerden, 1989; pers. comm.). The timber produced on the Suurvlak at Kluitjieskraal State Forest is of the better quality produced in the Western Cape (du Preez, 1989; pers. comm.). Damage in these areas is high as baboons tend to move through this plantation area to get from the Waterval Mountains to the Voorberg (Chapter 6). It may thus be cost effective to fence off this relatively small area, and other sensitive areas of value should damage be great enough to warrant this.

12.3.4 Food enhancement to change ranging patterns

An example of imaginative control was recently reported by CNN (G.M.S.A. on S.A.B.C. TV.; 29.1.1990). Wild elk (*Cervus elaphus canadensis*) in Northern America were causing damage to agricultural crops. The wildlife authorities decided to provide an alternative source of food on a daily basis away from the problem area to change ranging patterns and divert the elk. This has proved to be highly successful in decreasing damage levels and has had an additional spin-off. The local tourist industry takes sightseers out in a pony driven cart to observe the elk feeding. Part of the proceeds from this lucrative venture are given towards feeding the elk. Ecotourism is becoming increasingly popular throughout the world. One need only think of the many cars that stop along the roads in the Western Cape to watch "wild" baboons to realize that they have great appeal for the city dweller. An attitude of this nature is not common in Southern Africa and it may be that we need to change our way of approaching problems to be more successful in solving them.

Foresters in the Southern Cape and Tsitsikamma regions claim that damage occurs in winter, and that in summer baboons tend to move away to neighbouring farms to utilize resources that occur there seasonally (Notley and Best, 1989; pers. comm.). Similar ranging habits were found for the troops at Kluitjieskraal (Chapter 6). A possibility of feeding away from problem areas to change ranging patterns artificially may result in decreased damage.

There is evidence that primate populations tend to increase in size when being artificially fed (Rowell, 1969; Sugiyama and Oshawa, 1982). Dittus (1979) claims that food supply, rather than factors such as predation, govern the net growth rate of primate populations. Substantial food enhancement leads to rapid sexual maturation, shortened inter-birth intervals and increased birth rates, resulting in increased population growth rates in the Japanese monkey (Loy, 1988). Loy (1988) claims however, that individual variation between species can equal or exceed apparent effects of provisioning as shown by comparison between rhesus and Japanese macaques. Sugiyama and Oshawa (1982) also state that the effect of provisioning will depend on the amount and distribution pattern of the feeding. Thus the effect on baboons is uncertain, although Lyles and Dobson (1988) claim that data for 43 primate species suggest the above is true for most primate species.

Forthram-Quick and Demmet (1988) state that many species, as is the case with the baboons in this study, are already food-enhanced as a result of human expansion (Altmann and Altmann, 1970; Crockett and Wilson, 1980; De Vore and Hall, 1965; Kummer, 1968; Kalter, 1977). As human populations increase therefore, occurrences of incidental food-enhancement result more often. The effect on the baboon population is that less time is spent feeding (Harding, 1976 and Forthram-Quick, 1986). Baboons in one study spent 12% of their time feeding, as apposed to 50% under "natural" conditions (Forthram-Quick, 1988). Time no longer spent feeding was used in passive behaviour. Food that is spatially concentrated, and abundant at predictable intervals may thus contribute to restricted ranging patterns and decreased activity levels (Forthram-Quick, and Demmet, 1988). These authors further found that troops that fed the most on artificial sources had decreased home ranges centred around areas of high human population density.

It would thus seem that the baboons in this study are already experiencing food enhancement and the resultant effect on the population. Feeding in areas remote from plantations to shift centres of ranging activity and decrease large home ranges is an option that should be investigated. Costs incurred in such an operation would include transport, food and one worker's salary. Costs may well be less than those for other methods.

12.4 The effect of control on population dynamics

As controlling baboon problem populations is the aim of the manager in the forestry situation, it was felt that it is essential to understand the effect of control (in terms of removal of individuals) on a population. Managers may then determine what effect their actions may have, and in so doing, achieve their intended objectives. The incorrect application of control options can have disastrous consequences. With this in mind, a review section on the effect of control is included.

Much research has been directed at the effect of control on the dynamics of vertebrate populations. Although this research is not necessarily directly concerned with baboons, it does allow for extrapolation, and has implications for management of baboon populations.

Population dynamics is concerned with the fluctuations of the number of organisms within a population (separated from other organisms of the same species by a barrier, be it geographical or topographical), and with those influences that cause these fluctuations (Caughley, 1977). Growth of a population is controlled by

1. influx of individuals (natality and immigration) and
2. efflux of individuals (mortality and emigration).

The population increases in size when the natality rate is greater than the mortality rate and vice versa. The population eventually reaches a point where no more increase is possible, usually when the habitat becomes saturated or when a limiting factor becomes critical.

When a vertebrate population impacts on a crop to such an extent that control operations are required, Brooks (1990a) claims that

there are several essential questions to ask.
These are

1. what environmental factors influence the abundance of the species in different habitats and seasons;
2. how fast can a population increase;
3. is there an optimum time of year to execute control procedures;
4. at what level of infestation/occupation should control operations be resumed;
5. how long will the population take to recover to previous levels.

Brooks (1990a) also states that it is not economically viable to consider eradicating vertebrate pests entirely from crop areas, as the remaining 10% of the populations prove to be too expensive to remove. This approach is refuted by Brand and Jordaan (1991) who detail methods to remove an entire troop. Brooks (1990a) claims that the key to success is to intervene as little as possible to reduce damage. This may take the form of excluding pests from the area by electric fencing, or by reducing the population just prior to expected damage.

Other options are "cultural" methods that aim at changing agricultural procedures so as to evade or minimize damage (Brooks, 1990b). These methods differ depending on the habits of the pest. To reduce rodent or wild boar damage, for example, areas that serve as food and cover for the animals should be eliminated or reduced as far as possible. However, in the case of bird damage, areas of natural vegetation should be maintained to divert birds from crops and provide alternative sources of food (Brooks, 1990b).

Baboons in South Africa, on both State and private land, have been removed periodically in an attempt to reduce their numbers and/or eliminate the population. The removal of individuals may affect the structure of the population and its functioning profoundly as regards the population size, age distribution and sex ratio.

12.4.1 Population size

The following discussion is based on a series of computer models (Caughley, 1977) aimed at determining the effect of the removal of a certain number of individuals from a population over a certain period of time (logistic growth parameters are k=1000; r_m=0.5). If a constant proportion of a population of 1000 is removed each year, the population will remain constant after an initial decrease. The greater the proportion that is removed, the smaller the resulting population. However once more than 50% of the population is removed each year, the population will crash (if individuals do not immigrate in large numbers from surrounding populations).

If a constant number of individuals is removed each year from a population of 1000, with a maximum sustained yield (MSY) of 150, then once again after an initial decrease, the population would remain at a constant level. If the MSY were removed each year, the population would begin to decline gradually. If more individuals than the MSY were removed each year, then the population would crash within 25 years. Thus for a population to be eliminated, more than 60% of the population would have to be removed each year, or a greater number of individuals than the MSY.

Removing individuals may lead to a reduction in competition amongst individuals as more resources are available for each survivor (Teague and Decker, 1979; Macdonald, 1980; Caughley, 1981b). The result is often increased reproductive success for the females, and a resultant increase in population size. This would explain the increase in numbers of the large mammal populations in the example quoted earlier.

Although there are no data to substantiate that this is what is happening to baboon populations, there is evidence from casual observations that the proportion of young in troops being controlled on State Forests is very high (Notley, 1989; pers. comm; Roscher, 1988; pers. comm.; Bigalke and van Hensbergen, 1990). This supports the concept that there may be an increase in the birth rate, which results in an increased population size unless more individuals are removed than are being born (Caughley, 1977).

Strum (1987) studied a troop of olive baboons that habitually raided crops in Kenya, and were shot at by the farmers. Females were found to have offspring at far more regular intervals than other troops in the area. She also found that this troop was far more subject to death, disappearance and injury of young baboons than was previously the case.

A further factor to consider is that increases in population size may be held in check by natural biological control mechanisms inherent to the population (Macdonald, 1980). When individuals are removed as part of a control programme, this mechanism may no longer operate. This may result in females having more regular oestrus cycles or females beginning to breed at an earlier age (Caughley, 1976).

12.4.2 Age distribution

Macdonald (1980) notes that selective removal of individuals can have a profound effect on the age structure of the population, and resultant effects on social organization and community structure. A study on coyotes (Knowlton, 1967 in Macdonald 1980), showed that in intensively controlled populations, the ratio of young to adult was at times 15,7:1, whereas in lightly controlled populations, the ratio was 4:1. Hewson and Kolb (1973 in Macdonald 1980) reported that in areas where there was no control, apart from sport hunting, the number of young did not increase when adults were removed. In heavily controlled populations however, there was an increase in the proportion of young under similar conditions. This is known as rapid turn over (Teague and Decker, 1979) and may have disadvantages in animals where much of their behaviour is learnt as some of the experience of the older individuals is lost.

Primates follow the typically U-shaped mammalian mortality pattern of Caughley (1976), where a relatively high rate of mortality occurs at infancy, followed by a low rate at puberty and a progressively increasing rate thereafter (Fig. 12.4).

The consequences of any disruption will depend on the proportion of the age classes represented in the population, and their relation to one another. If animals are removed in the same proportions they are found in the population, a reduction in population size and not a major disruption should occur. If,

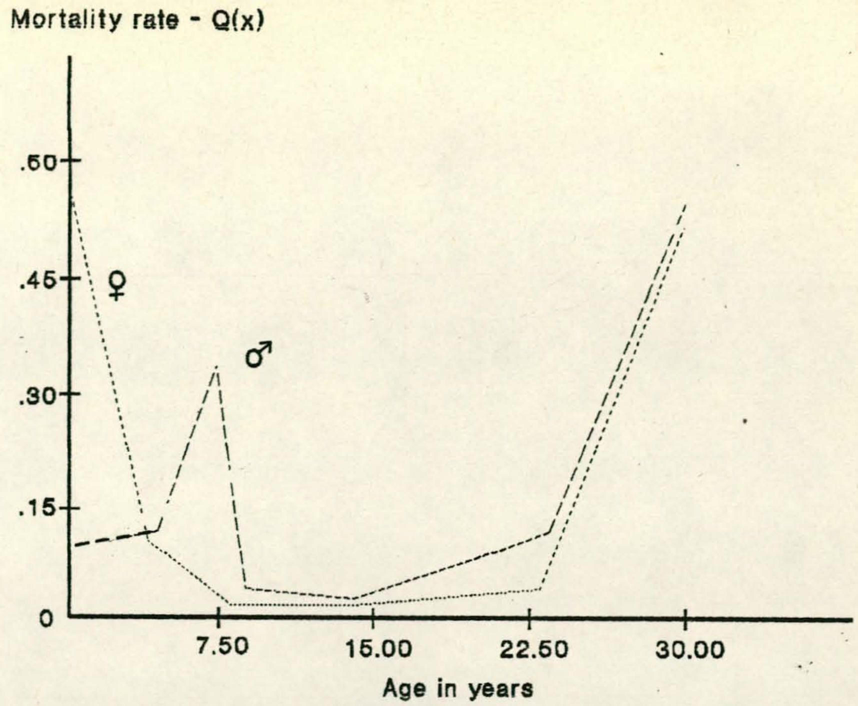


Fig. 12.4. The age-specific mortality rate of Toque macaques at Polonnaruwa, Sri Lanka (after Dittus, 1975).

however, mostly adults and adolescents are removed, leaving only females, a disruption could be expected (Lloyd, 1989; pers. comm.). Limited evidence indicates that young baboons and adult males are most prone to capture (Bigalke and van Hensbergen, 1990). Brand (1989) found that of 286 baboons captured, 90 were adults, 92 juveniles, 54 adolescents and 82 infants (Table 12.1). This would represent a major disruption of the typical mortality pattern

Table 12.2. Age class of baboons captured during experimental control operations (After Brand, 1987).

Locality	Age Class				Total
	Infant	Juvenile	Adolescent	Adult	
New Munster	6	19	7	27	59
Kluitjieskraal	3	19	15	6	43
Meulplaas	3	10	5	5	23
Limerick	6	0	4	3	13
Kriega	8	3	3	1	15
Kruisrivier	10	23	7	19	59
Matjiesrivier	4	4	4	8	20
Wittepoort	10	14	9	21	54
Total	50	92	54	90	286

under most natural conditions. The individuals that are removed are often the fittest members of the population, and their removal reduces competition (Teague and Decker, 1979). This increases the chances of survival of the weaker individuals, leading to a "weak" population (Teague and Decker, 1979).

12.4.3 Sex ratio

As most removal methods tend to concentrate on the males of the population, the proportion of females increase, and due to reduced competition, so too does the proportion of breeding females (Teague and Decker, 1979). Females may also become sexually mature at an earlier age, and the reproductive rate of the population increases (Teague and Decker, 1979). As already stated, Bigalke and van Hensbergen (1990), found evidence to indicate that young baboons and males were most frequently removed. Kapp (1989; pers. comm.) supports this view, following observations from limited capture operations. Bigalke and van Hensbergen (1990) postulate using computer modelling that consistent removal of these classes will result in the increase of the proportion of females in the population. This may result in an increase in the population growth rate of up to 50% a year.

In his study, Brand (1989) gives data regarding the sexes of adult baboons trapped. A sex ratio of males:females of 7:9 was reported. However as only 110 adults were trapped (at seven different locations), a large sample size is not indicated.

At present there does not appear to be enough information to draw any conclusions, but models clearly indicate what effect selective removal of the male may have.

12.4.4 Discussion

When discussing the control of numbers in problem populations of foxes in Europe, Macdonald (1980) stated "... populations are extremely resilient to control, not only because individuals are difficult to catch and kill, but more importantly because the reduced population has a considerable capacity for increasing again rapidly." This applies equally well to baboon populations in South Africa. De Vore and Hall (1965) reported a population growth rate of 8.79% per annum for baboons in Nairobi Park, Kenya. Based on similar growth rates for baboons in the Western Cape, Bigalke and van Hensbergen (1990) claim that the reduction of population numbers should not present a problem. Large numbers of baboons, as mentioned earlier, have been removed in individual areas of South Africa. At Bergplaas State Forest in the Southern Cape, over 1000 baboons have been removed over a period of eight years (Notley, pers. comm.). At Kluitjieskraal State Forest in the Western Cape, 600 baboons have been killed in six years (Engelbrecht, pers. comm.). Despite such operations (of which data for only two areas are known) the numbers of baboons, and the problems associated with them in these areas show no signs of declining.

When considering the establishment of a programme aimed at removing individuals from a population, it is essential to understand clearly what is to be achieved. A different approach is required to reduce the population for the maintenance of lower densities of animals in the area to that which aims to eliminate it altogether. In both cases it is necessary to understand thoroughly the dynamics of the population in question (Teague and Decker, 1979; Macdonald, 1980). Teague and Decker (1979) indicate that the dynamics and structure of a population are influenced by the sex ratio, age distribution, nutritional state, stresses of weather, disease and crowding amongst others. Therefore the dynamics of one population may differ considerably from a neighbouring population. One must therefore know and understand, the individual population before attempting to introduce control measures.

Another very important consideration is that of the rate of recovery of the population, as this will affect the degree of control that is necessary (Macdonald, 1980). Research did not reveal any such data on baboon population dynamics being available to those implementing control operations in South Africa.

Few attempts have been made to determine the impact of the damage on the area in question. Control of problem animals is expensive and time consuming. It is therefore essential to establish

1. the dynamics of the population;
2. the effect of the control on the population;
3. the financial value of the damage (Jewell and Holt, 1981);
4. a clear understanding of the practicalities of the most appropriate method of control (Erasmus, 1989).

Failure to first consider these factors may have the opposite effect to that desired, and result in an enormous waste of time and money.

A number of difficulties are associated with control of a problem animal population. Constant and regular effort is required to eliminate the population or reduce its density. A predetermined number of individuals, or proportion of the population, must be removed annually (Caughley, 1977). This becomes more difficult with time, as the individuals that are not caught at first become very wary. Also those that remain are best adapted to avoid capture (Caughley, 1977; Macdonald, 1980), and thus, as the density of the population decreases, more time and effort is required to catch the remaining individuals. The expenditure in this respect may be more than is warranted by the extent of the damage. This is a further incentive for the establishment of data banks on both population dynamics of the troop in question, and on the problem itself before launching expensive control operations.

Furthermore, it is important to adhere to a control programme over a period of time to ensure its success. Control operations in the Western Cape are of a sporadic nature, with the removal of large numbers of individuals at irregular intervals. As is already becoming apparent this merely has the effect of increasing the birth rate, with no decrease in damage levels occurring. As baboons are intelligent animals with memories (Strum, 1987; Moss, 1975) such practices have the effect of making baboons wary of any contact with humans.

Also important is the "vacuum effect". When animals are removed from a defined area, the space or "vacuum" created in the population, is soon filled by individuals from neighbouring areas (Macdonald, 1980; Jewell and Holt, 1981). Bigalke and van Hensbergen (1990) relate the continuing levels of damage in the Western and Southern Cape Forestry areas to the immigration of new individuals from surrounding areas. Von dem Bussche and van der Zee (1985) claim that if an entire troop of samango monkeys were removed (for causing damage in commercial plantations similar to that by baboons) then a new troop would move into the old troop's home range.

At Kommetjie in the Cape Peninsula (Geldenhuys, 1992; pers. comm.) action was taken against a troop of 18 baboons in November and December 1991. This troop was a sub-unit of a larger troop that split into three after a large fire in the area in December 1990. The troop had taken to raiding the local residents' homes and terrorizing the inhabitants. The entire troop was removed using the trap cage method by the District Services. Within one and a half to two months of removing the troop, complaints were beginning to surface again. The other two sub-units are causing similar problems at Ocean View and Scarborough, which are both three to five kilometers away from Kommetjie. Whether it is one of these two troops moving into this "empty" area is not yet entirely clear, although there is a very strong possibility that this is the case. The "vacuum" created by the removal of a troop is thus soon filled, and there is no guarantee that the new troop moving into the home range of an eliminated problem troop will not continue the raiding or bark stripping habit. As it is very difficult to kill all the members of a troop (Notley, 1989; pers. comm.), the few individuals remaining are always in a position to "teach" the crop-raiding, and/or bark-stripping habit to the new troop (Strum, 1987).

Should the proportion of younger individuals increase, then there is an escalation of intra-specific competition amongst the increased proportion of juveniles and adolescents. This is the age at which male baboons emigrate to new troops (Strum, 1987).

The effect of control may be a relatively large mobile population as occurs with foxes following control operations in Europe (Macdonald, 1980). This may in turn lead to an increased risk of a spread in the bark-stripping or crop-raiding habit. Forthram-Quick (1986) found that baboon populations with a large proportion of young (i.e. an expanding population) are more likely to become serious agricultural pests. She states furthermore, that the smaller, more conspicuous troops are more likely to benefit from frequent, systematic exploitation of crops. Thus by attempting to decrease population densities, and the resultant increase in the proportion of young, those factors leading to problem populations may be exacerbated.

It is clear that the baboon problem is complex and cannot be solved without effort, and unfortunately, expense on the part of the manager. However, control of problem populations is possible. Experiments have proved that areas can be fenced to eliminate baboons successfully, and thus prevent damage. Problem populations can also be decreased significantly, or even reduced completely. Whether decreasing population densities does in fact lead to decreased damage levels must still be established. What needs to be determined now is how great financial losses are, and whether the expense of any control operation is warranted.

12.5 Conclusion

There are practically no data on control programmes in the Western Cape, despite the fact that control has been carried out in Forestry areas since the early 1960's on an irregular basis. The present conditions and the effectiveness of electric fencing as a control method are discussed. A discussion dealing with the effect of control on mammals in general is included, due to the scarcity of detailed information about baboons. What becomes evident is that it is imperative to understand the population dynamics of specific baboon populations to exercise effective control.

13. Management Recommendations.

Conflict between baboon and landowner has escalated as forestry and agricultural practices have expanded over the years, providing additional resources in concentrated areas. The problem caused by baboons in plantations is a direct result of the existence of these plantations within their natural range. The extreme adaptability of the baboon has allowed it to adjust its needs to the changing environment, rather than to be eliminated, as has happened in the case of more sensitive species.

There is no magic solution to prevent baboons from stripping trees. One will not be able to find an inexpensive way of eliminating the problem. The manager must accept that in areas where baboons exist naturally, this is a potential problem, as is the risk of fire and hail. The manager must rather look to ways of reducing damage to acceptable levels by silvicultural, mechanical or other means. Present options are listed below.

1. Do not replant trees in those parts of a plantation that already experience damage. On some stations, the areas where baboons are found are marginal sites, eg. the mountain slopes at La Motte with poor quality soil, steep slopes and high fire risk (Rossouw, 1990).
2. When planning new areas for afforestation, the potential risk of baboon damage should be evaluated, and those areas surrounding known sleeping sites, and areas heavily used by baboons, should be avoided.
3. Prevent baboons from entering areas they habitually damage by mechanical means such as electric fencing.
4. Remove individuals from the troop in question in a controlled long-term operation (or eliminate it altogether) in the hope that this will decrease damage levels.
5. In areas of heavy damage it may be advisable to test all methods of control under strictly regulated conditions. This may include such methods as taste

averting and chemical deterrents, as well as methods such as placing human hair in nylon stockings and hanging these around the plantation, or scaring baboons from plantations for successive generations.

6. Further research must be carried out to determine the role of zinc in the baboons' diet, and whether this is one of the factors causing baboons to strip pine trees.

All these options require either acceptance of financial losses or expenditure to achieve the end.

It is clear that it is necessary to have some idea of financial losses experienced due to baboon damage. What has become very apparent in this study is that this kind of information is not available, and it would appear that present control management is very haphazard, with no real scientific basis. It would also appear that baboon damage in total is somewhat exaggerated, and that losses are not quite as severe as often claimed.

With this in mind a questionnaire was compiled and is included. The manager must calculate the following

1. the average number of trees per compartment on his station;
2. each compartment with damage must be evaluated and the damage estimated according to the categories on the questionnaire;
3. the number of compartments in each category of damage must be filled in, and multiplied by the average number of trees per compartment and the interval midpoint;
4. the number of trees damaged in each class must be added and the total multiplied by R22.02 (this is the figure determined in Chapter 11 as the mean loss per tree damaged by baboons);
5. the number of trees damaged must be presented as a percentage of the total number of trees.

This will give some idea of the relative damage on each station, as well as the financial losses to be expected. These are not accurate figures due to the many complicating factors, but they do act as a yardstick. It is essential that such aspects be investigated more thoroughly in order to determine whether, if in fact at all, control is needed in many areas. Some stations are more severely affected than others, and here it is suggested that if timber is of a good quality, such options as electric fencing be considered.

ESTIMATION OF ECONOMIC LOSSES:

Name of Forest Station:

Total number of compartments:

Average number of trees per compartment:

	A	B	C	D
% Class of damage	No. of comp. in each damage class	Average no. of trees per comp.	Interval Midpoint	No. trees damaged
0-10%			5%	
10-20%			15%	
20-30%			25%	
30-40%			35%	
40-50%			45%	
>50%			75%	
eg. 0-10%	7	1500	15%	1575
			TOTAL	

FORMULA: A x B x C = D

TOTAL [ ] x R22.02 = [ ]

$$\frac{\text{Total trees damaged x Average no. trees per comp.}}{100}$$

= [ ]

These are the approximate financial losses that can be expected from baboon damage on this station (1992 prices)

14. Discussion of the problem.

Baboons have become a problem in some afforested areas, mainly as a result of the steady expansion of forestry. Pine plantations now occupy what was previously part of the baboons' natural range. Plantations offer sources of food and shelter to the baboon, thereby encouraging them to inhabit these developed areas. A large percentage of State Forests record the presence of baboons in and around the plantations (77%), while few (26%) report that damage occurs. There is thus mostly peaceful co-existence between forester and baboon. The instances where damage occurs, however, merit great attention. Although damage is great in localized areas, the problem is not as serious when considered on a national level.

The national losses due to damage on State Forests at the time of this study are in the order of 2% of the total value, i.e. less than R5 000 000. Many of the areas where damage occurs are those bordering on, or close to natural vegetation. Often these areas, especially in the Western Cape, are those on mountainous slopes with poor site quality, where timber extraction is difficult and expensive, and timber quality poor. It would not appear to be worthwhile afforesting areas that have marginal site quality and a risk of baboon damage. Control options to decrease damage levels in areas that produce quality timber are a viable option.

It is ironic to consider the attempts made to eradicate baboons from many forestry areas. Man has unintentionally exterminated certain species, while he has, despite continuous efforts, been unable to eradicate others (Caughley, 1977). Most species are eliminated if their habitat is drastically transformed, whereas deliberate attempts to eliminate populations have been directed at removing the individuals themselves. This results rather in an increased quality of life for those surviving. Transforming the habitat may thus be a more effective and long term control term measure (Teague and Decker, 1979). This, however, is precisely what has caused baboons to become problem animals. Baboons with their extreme adaptability, have thus adjusted well to change, and would probably continue doing so.

Any form of control is an option that involves expense and effort, whether it be erecting an electric fence, reducing the population size, or feeding elsewhere to change ranging patterns. It is thus imperative that records regarding costs of losses due to damage, and the expense of control be thoroughly investigated to determine how serious the situation is, and what level of control is justified. If this is not appreciated, then the result will be the needless destruction of animals, which may, under some circumstances, be a waste of time, money and effort (Erasmus, 1988).

Management must thus determine how seriously they view the situation at the present time. A reliable and complete data base must be built. Once this is done, suitable control measures can be evaluated. It is however, imperative to realize that baboon damage is an inherent risk in areas where baboons occur. This risk must thus be incorporated into the planning of a forest station, and it must be put in perspective as regards the total loss from a plantation.

Appendix A:

Data sampling sheet for baboon movements.

DATA SHEET: BABOON MOVEMENTS.

ate: 2/10/89. Time: 8h05 Grid Ref.: 33/53 (Second Last comp Att rd.)

roop: UB3 Vegetation: Pltn. Heard: ✓

lo. seen: Composition:

Veather: overcast/warm.

Other: Saw droppings feeding/pine cones etc. Been in area a lot.

DATA SHEET: BABOON MOVEMENTS.

Date: 2/10/89 Time: 10h00 (12h00 barked) Grid Ref.: 54/40. 5U - 3rd rd to mnt Above 27b.

Troop: UB2 Vegetation: Fynbos/pltn. Heard: ✓

No. seen: Composition:

Weather:

Other: Saw where they crossed the rd. 47/34

- next trip - 8h00 - barked on S side of 27b in mnts.

Appendix B.

Questionnaire distributed to farmers in the vicinity of Kluitjieskraal State Forest.

QUESTIONNAIRE FOR FARMERS:

Name of farmer: Mr Knoop (Mr Malherbe (manager)) Date: ____

Name of Farm: Elandskloof Farm no.: ____

Area (ha): ± 100 ha. Position on map: ± 414

Do baboons come onto the farm: Yes.

Time of year: Dec / Jan / Feb. (sometimes ± 1 a month throughout the year)

Time of day: Anytime.

What do they eat: % damage:

orchards: ____ ____

type: ____ ____

____ ____

____ ____

vineyards: ✓ (just top vineyards ± 1/5 of farm.) destroy vineyard 80%

livestock: ____ ____

type: ____ ____

How many baboons in the troop: +100 two troops.

Where do they come from: 1 troop from SW (smaller troop) 2 troop from Baineskloof side. (larger troop ± 100)

Where do they go to: where they came from

Are control methods used: Yes.

What are the methods: Shooting

How often are they applied: 2 baboons in 2 yrs

Are they effective: ? no not sure.

* lots of babies in troop 2.

____

Comments: Destroy ± 4 ha.

= ± R80 000. in damage.

Break sticks. completely

destroyed.

Appendix C.

Data sampling sheet used for analysis of faeces.

osition: JII side of FH **Date:** 3/1/89 (B) **Fraction:** 15ml.

1	Restio	26	Restio	51	Grass	76	Pine flower
2	Grass	27	Pine flower	52	Dicot leaf	77	Pine flower
3	Grass	28	Grass.	53	Restio	78	Pine needle
4	Grass	29	Restio	54	Pine flower	79	Insect
5	Pine flower	30	Pine flower	55	Dicot leaf	80	Pine seed wing
6	Grass.	31	Pine flower	56	Restio	81	Pine flower
7	Restio	32	Grass.	57	Restio	82	Restio
8	Pine flower	33	Grass	58	Grass	83	Dicot leaf
9	Pine flower	34	Grass	59	Pine flower	84	Grass
10	Restio	35	Restio	60	Pine flower	85	Insect
11	Grass.	36	Grass	61	Restio	86	Pine needle.
12	Grass.	37	Restio	62	Pine seed wing	87	Pine flower
13	Grass.	38	Insect.	63	Pine needle	88	Insect
14	Restio	39	Pine needle	64	Insect	89	Pine flower
15	Restio seed.	40	Dicot leaf.	65	Grass.	90	Monocot leaf
16	Pine flower	41	Grass	66	Restio	91	Pine cone bark
17	Restio	42	Grass	67	Pine flower	92	Dicot leaf
18	Pine needle	43	Dicot leaf	68	Pine flower	93	Pine flower
19	Pine flower	44	Pine seed coat	69	Insect	94	Pine flower
20	Pine seed wing	45	Grass	70	Pine needle	95	Pine flower
21	Grass	46	Dicot leaf	71	Pine flower	96	Dicot leaf
22	Restio	47	Dicot leaf	72	Grass.	97	Dicot leaf
23	Pine flower	48	Grass	73	Pine flower	98	Pine flower
24	Grass.	49	Grass	74	Pine seed wing	99	Grass
25	Pine seed wing	50	Pine flower	75	Grass	100	Insect wing

Sien keersy vir afrikaans

QUESTIONNAIRE:

Baboon Damage in the Afforested Areas of Southern Africa.

Forest region: Southern Cape District: Homtini

Forest Station: Karatara

Name of Forester-in-charge: C.J. Wiese

Address: Karatara State Forest
P.O. Karatara 6580.

Telephone number: code(04456) 640

Area afforested: 4420,7 Ha

Number of compartments: i) pines: 455

ii) Eucalyptus: 178

iii) other species: 7

name of species: Acacia melanoxylon

Form filled in by: M.G. Spratt

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Cross the appropriate block, i.e. [X]

1. Do baboons occur on your station ?

Yes	No
[X]	[ ]

2. Does baboon damage occur on your station ?

Yes	No
[X]	[ ]

If no, return Questionnaire without answering Questions 3 - 17.

3. Which pine species are affected ?

Pinus patula:	[ ]	Pinus elliottii:	[ ]
Pinus taeda:	[ ]	Pinus radiata:	[X]
Pinus pinaster:	[X]	Pinus roxburghii:	[ ]
Pinus caribaea:	[ ]	Pinus oocarpa:	[ ]

.....if any other species, name.............................

4. Are any Eucalyptus species affected ?

Yes	No
[ ]	[X]

if yes, name species ....

5. Are any other species affected ?

Yes	No
[ ]	[X]

if yes, name the species ....

~ Fill in Questions 6 - 17 with regard to pines only. ~

6. Percentage of compartments damaged?

0 - 5%	5 - 15%	15 - 25%	>25%
[X]	[ ]	[ ]	[ ]

Questionnaire distributed to State and private Forests in SA.

Appendix D.

Sien keersy vir afrikaans

7. Estimation of percentage trees damaged in the five worst compartments:

	0 - 25%	25 - 50%	>50%
compartment 1	X		
compartment 2	X		
compartment 3	X		
compartment 4	X		
compartment 5	X		

8. When was damage first noticed ? During the last:

1 year	1-5 years	5-10 years	>10 years
	X		

9. Has the damage increased over the years ?

Yes	No
	X

.... if yes, has the number of trees damaged each year increased ?

Yes	No
	X

10. Method of control ?

None:	X	Hunting:	
Trap cages:		Other:	

explain ....
....

11. Is control effective in decreasing damage ?

Yes	No	?
	X	

12. Have you noticed any relationship between where damage occurs and, ...

i) location of sleeping sites:

Yes	No	?
	X	

ii) location of watering points:

Yes	No	?
	X	

iii) a particular food source

Yes	No	?
	X	

if yes, explain ....

iv) particular soil type:

Yes	No	?
	X	

if yes, explain eg. poor soil etc ....

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Sien keersy vir afrikaans

13. Have you noticed any relationship between where damage occurs and .....

i) season:

Yes	No	?
☐	☒	☐

if yes, explain ....

ii) temperature:

Yes	No	?
☐	☒	☐

if yes, explain ....

iii) wind:

Yes	No	?
☐	☒	☐

if yes, explain ....

14. Have you noticed an increase in stripping after ? No noticeable stripping.

	Yes	No	?
i) pruning:	☐	☐	☐
ii) any other silvicultural practice:	☐	☐	☐

..... if yes, explain ....

15. Have you observed baboons stripping a tree?

Yes	No
☐	☒

if yes, were the baboons ....

young	old
☐	☐

16. Have you observed baboons return to a stripped tree?

Yes	No
☐	☒

17. Any comments or suggestions:

No stripping of bark has been observed. The only damage done is ~~to~~ branches that have been bent or broken by baboons climbing on them. They only seem to go after the pine cones for the seeds.

Your assistance is greatly appreciated ☺

Appendix E.

Data sheet used for sampling compartments for damage at Kluitjieskraal State Forest.

BABOON DAMAGE SAMPLING SHEET

Compartment: Z7a **Date:** 5/12/89. **Form filled in by:** Diane.

Species: P. radiata **Age:** 12yr.

1 row = 10 trees along.

Row:	Tree no.	Severity:	Age:	Height:	Aspect:	Other:
1a	1	m.				
	2	m.				
	3	Un				
	4	Un.				
	5	m.				
	6	1	2.	0,5 - 1,0m	E.	
	7	1	2	0,5 - 1,0m	E	
	8	Un.				
	9	Un.				
	10	m.				
	11	Un				
	12	m.				
	13	Un				
	14	m.				
	15	Un.				
	16	m.				
	17	Un.				
	18	Un				

Appendix F.

Data sheet used to sample volume of wood at La Motte State Forest.

BABOON DAMAGE: LAMOTTE STATE FOREST VOLUME LOSS MARCH 1992 COMPT D1 PAGE NO: 5

WITH OR WITHOUT	CLASS	DIAM	LENGTH	VOLUME	CLASS	DIAM	LENGTH	VOLUME	CLASS	DIAM	LENGTH	VOLUME	CLASS	DIAM	LENGTH	VOLUME	CLASS	DIAM	LENGTH	VOLUME	CLASS	DIAM	LENGTH	VOLUME	TOTAL VOLUME	DIFF IN VOLUME	THICK END
O																										X	25
W	2	23	63		2	19	18		2	19	24		1	17	24		1	15	21		6	100	30				25
O	2	19	18		2	19	24		1	17	24		1	15	21		6	100	30		6	99	30			X	25
W	6	99	30																								25
O	4	63	35		3	27	63		2	25	63		2	21	48											X	41
W		NO	DAMAGE																								41
O	3	19	30		2	23	48		6	110	7		6	100	21		6	124	24		6	99	24			X	29
W	2	23	30		2	23	18		2	21	48		6	159	7		6	100	24		6	99	24				29
O	4	39	63		4	35	60		3	27	63		2	25	36											X	51
W		NO	DAMAGE																								51
O	2	21	48		2	21	39		2	19	24		1	17	21		1	15	24		1	15	21			X	27
W	2	25	63		2	23	45		2	19	42		1	17	24		1	17	18		1	15	24				27
O	5	8	24																							X	27
W																											27
O	3	31	63		3	27	63		2	21	48		2	19	24		1	17	24							X	3'
W	5	8	24		1	15	24		2	21	24		2	23	24		3	27	63		2	23	48				37
TAL																											[illegible]

Appendix G

List of plant species eaten by baboons in other studies that are found in the vegetation surrounding Kluitjieskraal State Forest.

Metalasia muricata	Davidge, 1978
Cotula turbinata	Davidge, 1978
Senecio. sp.	Davidge, 1978
Othonna heterophylla	Davidge, 1978
Chrysanthemoides monilifera	Davidge, 1978
Arctotis. sp.	Davidge, 1978
Berkheya. sp.	Davidge, 1978
Hypochoeris. sp.	Davidge, 1978
Diospyros glabra	Davidge, 1978
Olea. sp.	Davidge, 1978
Lobostemon. sp.	Davidge, 1978
Lobelia pinifolia	Davidge, 1978
Corymbium africanum	Davidge, 1978
Phylica. sp.	Davidge, 1978
Passerina. sp.	Davidge, 1978
Erica cerinthoides	Davidge, 1978
Erica coccinea	Davidge, 1978
Erica mammosa	Davidge, 1978
Erica plukeneti	Davidge, 1978
Pelarsonuim. sp.	Davidge, 1978
Oxalis polyphylla	Davidge, 1978
Coleonema. sp.	Davidge, 1978
Heeria argentea	Seydack & Grewar, 1974
Rhus lucida	Davidge, 1978
Maytenus oleoides	Davidge, 1978
Aspalathus. sp.	Davidge, 1978
Perlargonium longifolium	Davidge, 1978
Perlargonium tabulare	Davidge, 1978
Rumex. sp.	Davidge, 1978
Carpobrotus. sp.	Davidge, 1978
Watsonia. sp.	Davidge, 1978
Satyrium. sp.	Davidge, 1978
Monadenia micrantha	Davidge, 1978
Myrica. sp.	Davidge, 1978
Mimetes. sp.	Davidge, 1978
Protea arborea	Seydack & Grewar, 1974
Protea cynaroides	Davidge, 1978
Protea. sp.	Seydack & Grewar, 1974
Protea repens	Seydack & Grewar, 1974
Leucospermum. sp.	Davidge, 1978
Leucadendron coniferum	Davidge, 1978
Leucadendron salignum	Davidge, 1978
Aloe nitriformis	Seydack & Grewar, 1974
Aloe. sp.	Seydack & Grewar, 1974
Alfuca. sp.	Davidge, 1978
Asparagus asparagoides	Davidge, 1978
Wachendorfia. sp.	Davidge, 1978
Moraea. sp.	Davidge, 1978
Bobartia Gladiata	Davidge, 1978
Bobartia indica	Davidge, 1978
Aristea spiralis	Davidge, 1978
Gladiolus. sp.	Davidge, 1978
Tritoniopsis. sp.	Davidge, 1978
Elegia vaginulata	Davidge, 1978
Hypodiscus aristatus	Davidge, 1978

Willdenowia Lucaeana	Davidge, 1978
Scirpus. sp.	Davidge, 1978
Tetraria involucrata	Davidge, 1978
Tetraria thermalis	Davidge, 1978
Pinus pinaster	Davidge, 1978

Appendix H.

Table 1. Records control of baboons (from Annual Reports submitted to the Departments of Forestry and Environmental Conservation and Water Affairs, Forestry and Environmental Conservation (1969 - 1980). (Published and Unpublished).

Year	Region/ station	No. baboons killed	Comment on effect	Area (ha) damaged	Estimated Loss
1969/70	W. Cape	43	fairly successful		
1970/71	W. Cape	5			
1971/72	Tsitsi.	22			
1977/78	La Motte	?	reasonable	300ha	R200
	K'kraal	?	none	80ha	
	Tsitsi.	?	good	200ha	
	E. Tvl	?	none		
1978/79	E. Tvl			16ha	R487
	N. Tvl			41ha	R200
	La Motte	20	damage increased		
1979/80	E. Tvl			14.3ha	R987
	N. Tvl				
1980/81	K'kraal	80	no effect		
	W. Cape			430 ha	R5000
	N. Tvl				
1981/82	W. Cape	84	little effect		
	N. Tvl				
	S. Tvl				
1982/83	W. Cape	128	no effect		
	S. Cape	28			
1983/84	W. Cape	77		220ha	R20000
	S. Cape	44		400ha	
	Tsitsi.				
	Natal				
	S. Tvl			0.25ha	R1125
1984/85	K'kraal	61	no effect		
	W. Cape			20ha	R4000
	S. Cape			?	R2400
	E. Cape				
	S. Tvl	23			
	E. Tvl	?	considerable number		
	N. Tvl				
1985/86	W. Cape			714.7ha	R10651
	S. Cape			10ha	
	S. Tvl	23			
	E. Tvl	?	considerable number		
	N. Tvl				

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