CAUSES AND CONSEQUENCES OF MORTALITY AND MUTILATION IN THE CAPE PENINSULA BABOON POPULATION, SOUTH AFRICA

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DECLARATION

I know the meaning of plagiarism and declare that all of the work in the document, save for that which is properly acknowledged, is my own.

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ABSTRACT

In the Cape Peninsula, South Africa, the population of chacma baboons (*Papio ursinus*) has become locally fragmented and geographically isolated from all other populations in the Western Cape. A census performed in 1999 revealed a baboon population under severe human predation pressure with high levels of permanent injury and mortality, in addition to an adult sex ratio strongly biased towards females. There was no data on the causes or the distribution of deaths and permanent injuries on the Peninsula to inform management decisions. The aim of this study was thus to: a) quantify the frequency, distribution and causes of permanent injuries (mutilations) and deaths within the Cape Peninsula baboon population, and b) to quantify whether mutilations, affect the behaviour, diet and reproductive success of baboons.

Annual census data (age and sex class) in addition to the location, cause and date of all deaths and injuries were recorded for the period 2005–2008 for the entire Cape peninsula baboon population. To investigate the effect of mutilations I performed a detailed behavioural study over an eight month period on seven baboons that had sustained permanent limb injuries and seven uninjured (control) baboons that were matched for age, rank, oestrus state (females) and troop. In 2005 there were a total of 370 baboons in 11 troops within the Cape Peninsula which increased to 419 in 14 troops in 2008. My results revealed that while the population numbers on the Peninsula are fairly stable there is dramatic variation at a regional level with the southern subpopulation experiencing double the mortality of the northern subpopulation. Fifty percent of the baboons died from human induced deaths in 2005 which increased to seventy one percent in 2008. The most common cause of human induced death was motor vehicle accidents (15%) followed by gunshots (11%). The most common cause of natural death was infanticide (26%) which was directly linked to the exceptionally high rates of alpha male turnover within specific troops. The mean annual percentage mortality was similar for troops living inside versus outside the Cape of Good Hope section of the Table Mountain National Park but there were no permanent injuries for troops within the Park.

Permanent injury had a significant effect on the activity budget and diet of baboons. Injured baboons spent more time resting and travelling and less time feeding than uninjured (control) baboons. Injured and control baboons feed on the same range of food items but injured baboons reduced the percentage of food items in the diet that were difficult to process and targeted high return foods. There was no significant difference in grooming or social vigilance as might be expected if injury had compromised competitive ability. Furthermore there was no difference in the reproductive success of injured and uninjured baboons. Together these results suggest that while permanent injury does affect the behaviour and diet of Peninsula baboons, these constraints are offset by access to abundant high quality food in the form of both alien vegetation and high caloric anthropogenic sources.

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INTRODUCTION

Causes and consequences of commensalism in primates

Wild primate populations are generally threatened by habitat loss and fragmentation as a result of human development. However, in some species human impact can have a positive effect on primate numbers largely through increased access to high quality food and the simultaneous elimination of natural predators. Behavioural and dietary flexibility have enabled baboons to thrive in human modified environments, accessing high quality foods associated with agriculture, human settlements and tourism (Forthman Quick & Demment 1988; Lee *et al.* 1986, Fa 1991) and thus assuming a commensal relationship with humans (Gautier & Biquand 1994). Cultural attitudes can also favour commensalism with primates through both reverence (e.g. temple monkeys in India, *Macaca mulatta* and Tibet, *Macaca thibetana*) which involves active feeding (Malik & Southwick 1988; Zhao & Deng 1992) and through tolerance of raiding behaviour and the sharing of habitats (e.g. Thailand, *Macaca fascicularis*; Gibraltar, *Macaca sylvanus*)(Fa 1991).

Among commensal primates generalists such as baboons *(Papio spp.)*, macaques *(Macaca spp.)* and vervets' *(Ceropithecus aethiops)* are highly successful at raiding crops, human food and garbage (macaques: Malik & Southwick 1988; Malik & Johnson 1991; baboons: Strum 1994; Altmann & Muruthi 1988; Forthman Quick & Demment 1988; Else 1991; vervet monkeys: Brennan *et al.* 1985; Baskin & Krige 1973; Lee *et al.* 1986). The success of these species can be attributed to a number of common characteristics including opportunistic tendencies (Strum 1987a), and a mode of locomotion that is primarily terrestrial but with arboreal capabilities (Alberts & Altmann 2006; Else 1991). Baboons in particular have had a history of conflict with humans throughout Africa (Strum 1994; Hill 2005) and are regarded as the most problematic primate raiders, causing the most damage to crops (Hill 2000, 2005; Naughton-Treves *et al.* 1998).

Commensalism and the resultant proximity to humans may result in primate populations losing their fear of humans and even resorting to aggression to obtain food directly from humans (Lee & Priston 2005; Zhao & Deng 1992). Such conflict frequently culminates in humans assuming the role of predators to regulate raiding individuals and even whole troops (Hill 1997; Strum 1994; Else 1991). The inclusion of human food into the diet may have a marked effect on the activity budget of commensal primates and can result in a doubling of the time spent resting and a halving of the time spent feeding (Altmann & Muruthi 1988; Brennan *et al.* 1985; Saj *et al.* 1999; Forthman Quick 1986). A further consequence of food enhancement is the acceleration of sexual maturation in females and higher birth rates associated with reduced inter-birth intervals (Loy 1988). Both agricultural and urban raiding primates may be accompanied by a change in the typical behaviour of the species. Raiding groups may be smaller in size than naturally foraging groups and this may result in permanent fission from the parent troop (Forthman-Quick 1986; Strum 1987a). Furthermore vigilance may increase in crop raiding groups to detect humans whilst vocalisations that advertise presence may decrease to reduce detection (Maples 1969; Maples *et al.* 1976). Higher levels of aggression are associated with tourist raiding relative to both crop and garbage raiding situations and in the former humans are naive and non-threatening whilst in the latter humans are typically viewed as predators and are much feared (Else 1991; Brennan *et al.* 1985). In addition when raiding humans, the food source is generally clumped and of high value thus encouraging aggressive behaviour (Lee *et al* 1986). In contrast behaviour associated with a more abundant and dispersed food source such as provided by crops or bins is usually coupled with threat displays and mild aggression. As commensal primates become habituated to a consistent supply of a high quality food relative to their natural food supply, their numbers inevitably increase (Lyles & Dobson 1988; Brennan *et al.* 1985; Lee *et al.* 1986) leading to further conflict with humans and ultimately increased levels of mortality and injury (Baskin & Krige 1973; Lee *et al.* 1986; Brennan *et al.* 1985; Eley & Else 1984; Strum 1994; Hill 1997, 2005; Lee & Priston 2005). Mortality in baboons and vervets is known to be highest in troops with the most frequent contact with humans (Forthman-Quick & Demment 1988; Kansky & Gaynor 2000; Strum 1994, 2005) suggesting the need for conservation intervention for primate populations suffering from continual human encroachments (Gautier & Biquand 1994).

Causes and consequences of mortality in primates

Natural causes of primate mortality include predation (Strum 1987a, 2005; Smuts 1985, 1987; Cowlishaw 1994; Altmann *et al.* 1988; Cheney *et al.* 2006), fights with conspecifics during intra- or inter-group agonistic encounters (baboons: Drews 1996; Brain 1992; Altmann 1980; chimpanzees: Boesch 1991; macaques: Dittus & Ratnayeke 1989; Whitten & Smith 1984), environmental factors (drought: Hamilton 1986; food shortage: Altmann *et al.* 1977), falling from trees or cliffs (Beamish pers. obs., Teleki

1973)and disease (Barrett & Henzi 1998; Strum 2005; Brain 1992; Goodall 1983). Deaths from unnatural causes include human predation (Strum 1994; Southwick & Siddiqi 1994), hunting (Kano 1984; Goodall 1968), human infectious diseases (respiratory disease: Köndgen *et al.*, 2008; Leendertz 2006; tuberculosis: Sapolsky & Else 1987), vehicles, power lines and dogs (Pyle 1980; Printes 1999; Strum 2005).

Predation in wild populations is poorly documented due to the inherent difficulties associated with observing natural predation events (Altmann et al 1988; Cowlishaw 1994). Predation risk is known to vary locally and regionally for a given species (Cheney *et al.* 1988; Boesch 1991; Cowlishaw 1994) and may vary temporally at both an annual and seasonal scale (Bulger & Hamilton 1987; Hamilton & Busse 1982) with young or sick animals being more susceptible to adverse environmental conditions (e.g. drought) (Cowlishaw & Dunbar 2000). Natural predators include large carnivores such as lions *(Panthera leo)* and leopards *(Panthera pardus)*, smaller carnivores e.g. lynx *(Caracal caracal),* spotted hyena *(Crocuta crocuta)* and eagles (various spp.) which typically select smaller troop members (i.e. juveniles and infants) (Cowlishaw 1994; Cowlishaw & Dunbar 2000; Hamilton & Tilson 1982).

Predation and disease have a major influence on mortality rates and while birth rates are largely determined by food availability and quality (Altmann & Altmann, 1979; Cowlishaw & Dunbar 2000). However it is the balance between mortality rates, birth rates and migrations that determine the overall growth and stability of a population. Birth and death rates are also age related and together with migrations produce a sex-specific age structure for a given population. Populations that have access to high quality, abundant food sources typically show increased birth rates as a consequence of the females having shorter inter-birth intervals and maturing at a younger age (Cheney *et al* 1986; Lyle & Dobson 1988; Samuels & Altman 1990; Strum & Western 1982).

Mortality reduces population size and higher mortality in a particular age/sex class can have dramatic effects on the demography of the population, particularly in long lived species like baboons that reproduce slowly (Kansky & Gaynor 2000; Cowlishaw & Dunbar 2000; Cheney *et al* 2004). High levels of mortality in a specific age class or sex may occur in natural populations as a result of site specific predator activity with predators occasionally even targeting individuals according to their physiological state e.g. pregnant or lactating females (Cheney *et al.* 1988; Altmann *et al.* 1988; Cowlishaw & Dunbar 2000). Males generally suffer higher mortality than females (Dunbar, 1988; Cheney et al, 1986) due to migration of males between groups and the resultant increased exposure to predation. In addition, in sexually dimorphic species like baboons, males are more likely to receive fatal injuries as a result of fighting (Drews 1996, Brain 1992). Environmental conditions may also impact on specific age/sex classes and in extreme drought conditions, females may suffer higher mortality than males and in periods of food shortage males typically suffer higher mortality (Hamilton 1986).

Causes and consequences of injuries in primates

Primates often suffer injury to their limbs and bodies through both natural causes like predation (Smuts 1985, 1987; Cowlishaw 1994) and fights with conspecifics (Whitten & Smith 1984; Dittus 1977), accidental falls in arboreal species (Teleki 1973) and unnatural causes such as snares (Goodall 1968; Kano 1984; Stokes *et al.* 1999), human predation (Strum 1994), human disease (polio: Goodall 1968; leprosy: Kano 1984) and contaminants that produce congenital deformities (e.g. pesticides: Turner *et al.* 2008), vehicles and high voltage wires (Pyle 1980; Printes 1999).

Natural causes of injury in primates may take the form of flesh wounds inflicted during either inter or intra-group agonistic encounters (baboons: Drews 1996; macaques: Dittus & Ratnayeke 1989; Whitten & Smith 1984). Typically the wounding patterns associated with conspecific fights are non-random and depend on factors such as the sex, age class and dominance rank of the combatants (Ruehlmann *et al.* 1988; Whitten & Smith 1984). Studies on a number of different species report that amongst adults, males incur more injuries than females (Spider monkeys: Chapman & Chapman 1987; macaques: Ruehlmann *et al.* 1988; Whitten & Smith 1984; bonobos: Kano 1984). In yellow baboons, the wounds resulting from canine slashes in male contests occur almost exclusively on the neck, shoulders or head and usually heal within a few weeks (Drews 1996). Natural injuries may also arise as the result of encounters with predators however observations of these types of injuries in the wild are scarce as the encounters are rarely witnessed (Cowlishaw 1994; Cheney *et al.* 2006). Another naturally occurring injury recorded in arboreal primates is a fracture to the bones of the upper and lower limbs. These are generally temporary and are known to heal well enough for the limb to regain function (Teleki 1973).

Unnatural causes of injury in primates are more often permanent and typically result in the partial or complete loss or paralysis of either a hand and/or foot or limb and have been documented in chimpanzees (*Pan troglodytes*, Quiatt 1996; Goodall 1968), bonobos (Kano 1984) and Japanese macaques *(Macaca fuscata*, Turner *et al.* 2008). Snares are the most common cause of injury in chimpanzees (Waller & Reynolds 2001) as well as bonobos (Kano 1984) and are predominantly due to subsistence hunting or the bush meat trade. Injuries to chimpanzees are particularly well documented and have been recorded across their distributional range (Stokes *et al.* 1999). The prevalence of unnatural limb injuries may reach alarmingly high percentage in chimpanzees and studies in Uganda have recorded more than 20% of the chimpanzees as having some form of severe limb injury (Byrne & Stokes 2002; Munn 2006).

A permanent injury may adversely affect the fitness of an individual by impeding its locomotory, foraging and parenting skills. The ability to move with unhindered agility on the ground and in trees or on cliffs facilitates gaining access to food and social partners. In addition, unhindered movement also enables mothers to provide assistance to young and for all individuals to flee from potential predators. An attenuation of this freedom of movement through permanent injury has been found to affect different species in accordance with their primary mode of locomotion feeding techniques and social behaviour.

The loss or deformity of a limb has been shown to adversely affect terrestrial locomotion in chimpanzees (Quiatt 1996; Goodall 1968) and arboreal locomotion in spider monkeys *(Ateles geooffroyi)* (Chapman & Chapman 1987). Some species of primate are known to adapt well to physical injuries by modifying their locomotory techniques, although the movement is reported as being more awkward and slower than their uninjured counterparts (e.g. chimpanzees: Munn 2006; Goodall 1968; bonobos: Kano 1984). A more recent study on chimpanzees shows that they adapt to physical injuries by using modified forms of the pattern of locomotion typical of the species. Examples of this are a modified form of knuckle walking used when a hand is paralysed or tri-pedal walking achieved by holding the deformed limb off the ground when travelling fast or using the injured limb as a counterbalance when moving through arboreal space (Munn 2006).

Where complex manual processing of food is required the loss of, or injury to a forelimb could pose severe limitations to dexterity and control which may adversely affect an individual's ability to forage efficiently. Studies on the feeding patterns of gorillas and chimpanzees with snare injuries have revealed that while they utilise feeding techniques which resemble those of able bodied individuals, they introduce novel compensatory actions which necessitate individual learning and practice (Stokes & Byrne 2001; Byrne & Stokes 2002). As might be expected the choice of technique varied amongst individuals depending on the nature and extent of the injury. The ability to compensate through the modification of existing behaviours has resulted in individuals with forelimb loss or injury showing no reduction in overall feeding efficiency (Stokes 1999).

While behavioural plasticity in primates may allow them to adequately meet their specific dietary needs, injuries may still have an impact on their ability to socialise. Injured female chimpanzees in Uganda showed a preference for arboreal space and consequently spent more time foraging alone (Munn 2006). Injured male baboons avoided interactions with other males, even emigrating temporarily (Drews 1996; Harding 1980; Ransom 1981) and thus reducing their social and reproductive activity (Smuts 1985) and losing the benefits associated with group living including protection against predators, the ability to defend access to resources, increased foraging efficiency and improved opportunities for care of young (Dunbar 1988). Injury may impact on the ability to provide parental care as observed in chimpanzees where impaired agility when moving in arboreal space resulted in females carrying their offspring less often than uninjured females, particularly as the offspring got older (Munn 2006). Reduced parental care may have long term adverse effects on the social development of young and increase the risk of injury or death from a fall. Severe injury is known to cause a reduction in dominance rank in chimpanzees (Reynolds & Reynolds 1965) and baboons (Drews 1996; Altmann 1980) suggesting that injury may reduce an individual's competitive ability and thus impact negatively on their social status.

Injuries and baboon behaviour

Given the high prevalence of permanent deformities to limbs in the Cape Peninsula baboons it is important to know whether such injuries adversely affect their behaviour (foraging, travelling, socialising), diet and ultimately their reproductive success. Baboons are omnivorous and feed on a diverse array of food items including bulbs, grasses, fruits, invertebrates and even the occasional vertebrate (Oftedal 1991; Byrne *et al.* 1993; Gaynor 1994; Dunbar 1988). Their dietary diversity is largely achieved by foraging on a broad range of food items in a diverse array of habitats (arboreal, subterranean, and the seasonally productive herb and shrub layer) in addition to a high degree of selectivity of plants and parts of plants within these habitats (Norton *et al.* 1987; Whiten *et al.* 1991). Accessing such a broad menu is greatly facilitated by both manual dexterity and limb strength and it is thus highly probable that the loss of a limb or part thereof, may adversely affect an individual's ability to procure sufficient food and/or limit the range of food items that an individual can process. Reduced nutritional condition as a result of impaired foraging ability can impact on the activity budget and reproductive success of individuals by reducing their fecundity and increasing their susceptibility to disease which together may translate into reduced fitness (Cheney *et al.* 1988; Altmann 1980; Dunbar 1988).

While the loss of a limb or the distal elements of a limb obviously impacts on the locomotor ability of a baboon it is not known whether impaired locomotion will affect their relative travel time, or time spent resting. Chimpanzees with permanent injuries spend more time alone and in arboreal space (Munn 2006), but it is not known whether such injuries adversely affect the ability of the baboons to socialize with conspecifics through either reduced grooming and/ or play related behaviour. Grooming is an important activity, which ensures that hair and skin are clean and free from ecto-parasites thus reducing the risk of disease (Altmann 1980, Silk 1987a). At a social level, grooming functions to reduce social tensions and maintain social bonds in the troop via the release of endorphins into the brain which produce a feeling of well-being (Henzi & Barrett 1999). Anxiety in a social animal like baboons, may lead to the individual becoming isolated from group interactions to avoid potential conflict (Drews 1996; Harding 1980; Ransom 1981). Play behaviour too has an important role in social development, allowing the young baboon to develop the social skills needed for group living and the strength and motor skills required for adulthood (Barrett 2000).

Cape Peninsula Population

In the Cape Peninsula, South Africa, the local primate, chacma baboon *(Papio ursinus)*, has a long history of conflict with humans. The first record of their presence as a source of conflict was over 350 years ago when the Dutch East India Company established vegetable gardens on the lower slopes of Table Mountain (Gerber 2004). With the spread of both agriculture and residential land use practices, the Peninsula baboon population became both locally fragmented and geographically isolated from all other populations in the Western Cape Region.

Urban and rural developments on the Cape Flats and on the foothills of the Peninsula mountain chain have resulted in a dramatic loss of the more productive low lying natural habitat and as a result baboons were relegated to higher lying land outside of the urban edge that is not considered to be suitable for either agricultural or urban land transformation. Competition for access to low lying areas has resulted in ongoing conflict between residents and baboons with the latter regularly entering and damaging residential homes (Kansky & Gaynor 1998). This conflict initially led to the removal of entire troops from regions within the Peninsula including Kalk Bay, Silvermine and Chapman's Peak (Penn Lloyd, pers. comm. 2008) in addition to the selective removal of adult male baboons that were more adept raiders and perceived as being more of a threat to human safety. Captured baboons were frequently used as medical research subjects in hospitals such as Groote Schuur and Karl Bremner, in the Western Cape. In 1967, 100 of the estimated 200 baboons in the Cape Point Reserve (currently the Cape of Good Hope section of the Table Mountain National Park) were harvested for medical research purposes (Millar 1970). This practice was discontinued on the Peninsula following amendments to the legislation in 1997 (Nature & Environmental Ordinance 19 of 1974, Proclamation 12 of 1997) but baboons are still harvested from sources outside of the Peninsula (WCNB, 2008) for medical research.

In the Peninsula, human attitudes toward baboons vary from positive to intolerant both within and between communities (Kansky & Gaynor 1998). Consequently there are frequent negative interactions between humans and baboons with the latter suffering frequent persecution. As a consequence, Peninsula baboons are characterized by a diverse range of permanent injuries including the loss or partial paralysis of limbs, feet and/or hands. Most injuries and deaths are the result of conflict with humans (e.g. shootings and vehicle accidents) and exposure to dangers within urban areas (e.g. electric burns from exposed high-voltage wires and domestic dog bites) (Plate 1-3, Appendix). Six of the Peninsula troops (Tokai, Smitwinkels Bay, Redhill, Groot Olifantsbos, Slangkop and Da Gama) have home ranges that overlap substantially with urban areas while the remaining five have minimal urban overlap (Figure 1) but nevertheless experience low to high levels of interaction with people, motor vehicles and other human constructs (e.g. farms and tourist facilities).

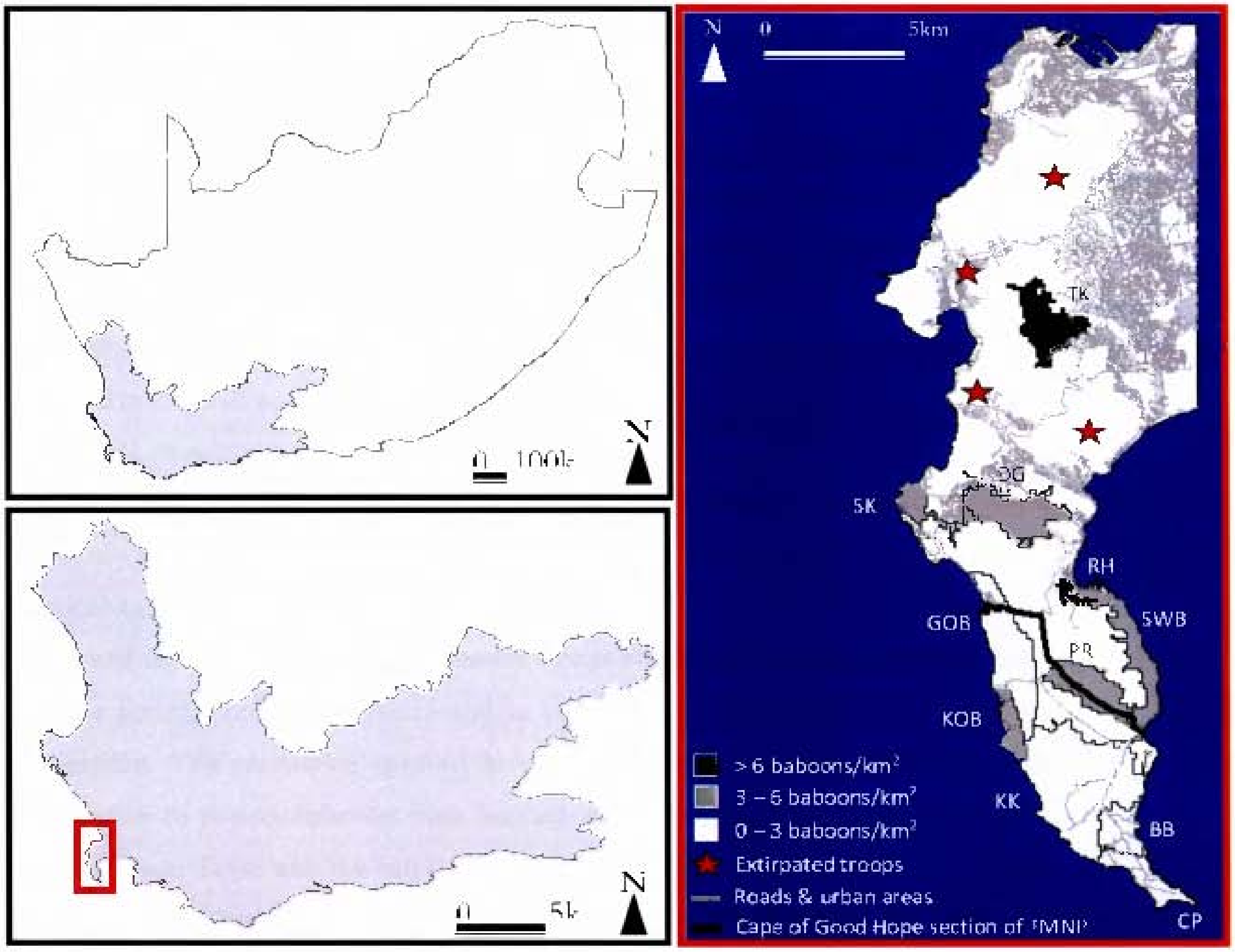


Figure 1: The distribution of the two study troops relative to the study area and the relative position of the Cape Peninsula to South Africa and Africa

A population census of extant troops was conducted between 1998 and 1999 (Kansky & Gaynor 2000) and revealed a total of 365 baboons living in 10 troops on the Peninsula. This census further revealed that one troop (Tokai, n = 95 individuals) was geographically isolated from the remainder of the population by dense residential development effectively splitting the population into a northern and a southern subpopulation. Despite there being no natural predators (the last record of a Cape leopard (*Panthera pardus*) on the Peninsula was in the middle of the 19th century (Skead 1980)) the mortality rate during 1998-1999 was exceptionally high (13%) and similar to that for a wild population experiencing heavy predation pressure (Bulger & Hamilton 1987, Cheney *et al.* 2004).

While birth rates were also high (47%), recruitment into the population was largely offset by high infant mortality (53%) and infanticide rates (17%), higher than recorded in any other studied population (Kansky & Gaynor 2000). The high mortality amongst adult males in the late 1990s resulted in 66% of the troops having only one or no adult males. This led to a highly skewed adult sex ratio with a strong female bias (1 male: 8 females) and the concern that if mortality rates remained high, extinction of the population was likely. Indirectly humans were responsible for increased infanticide as the removal of adult males from troops with one or no adult males seemed to be the most likely reason for the apparent higher alpha male turnover with a resultant increase in infanticide (Kansky & Gaynor 1999; W Petersen pers. comm. 2008).

The 1998 and 1999 censuses (Kansky & Gaynor 2000) only provided a snapshot of the Peninsula population and are thus of only limited value in interpreting the dynamics of the Peninsula population. However, while the potential for future survival of a population can only be determined from the pattern of fecundity and mortality over the lifetime of a typical animal, the high birth and mortality rate coupled with the highly skewed adult sex ratio and the lack of adult males in some troops suggested that the population was under severe human predation pressure and in need of management interventions to prevent extinction. This realisation resulted in a number of conservation initiatives; including legislation to protect baboons from hunting or persecution, the formation of a Baboon Management Team and the implementation of the baboon monitor program (Appendix p78). These initiatives resulted in an improved adult sex ratio by 2003 (1 male: 5 females) but failed to stem the high mortality rates and the southern subpopulation (SSP) had declined by a further 8.5% to 247 baboons (Kansky & van Doorn, unpubl). Permanent injuries to limbs were further testimony to conflict with humans and together with the highly stochastic population numbers pointed to the need for a detailed longitudinal demographic study to record the causes and consequences of both mortality and permanent injury to baboons within the Cape Peninsula population.

Rationale for this study

No other study on injury resulting from human conflict has been published on baboons. The prevalence of injury in baboons is not well documented and this study is the first to record the distribution, frequency and type of permanent injury in a population of chacma baboons. Furthermore this is the first study to quantify the consequences of permanent injury on the daily activity budget, in particular locomotion, feeding activities, social interactions and the impact of these on the reproductive success of free-living baboons.

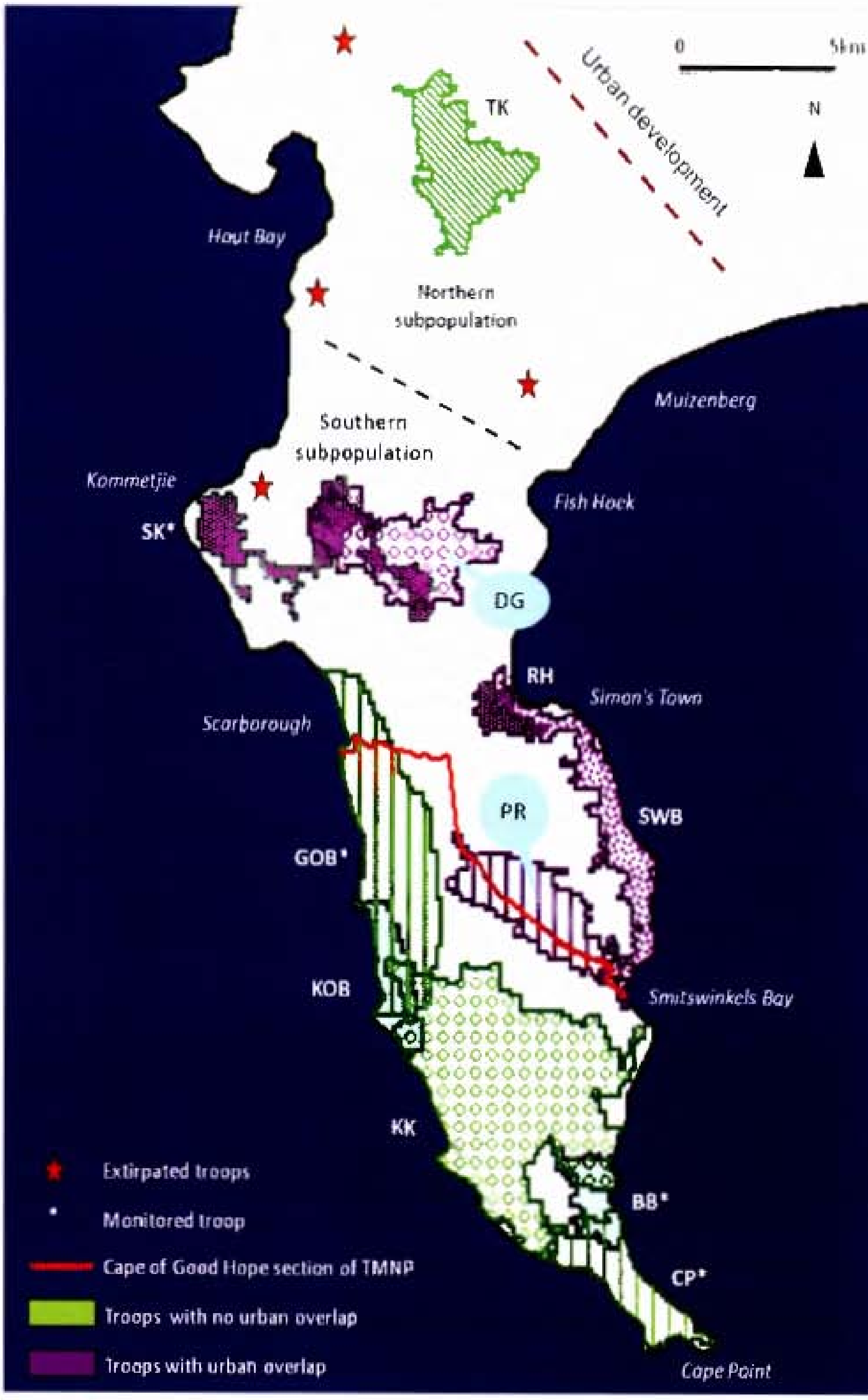
The primary aim of this study was thus to investigate the impact of human conflict (mortality and injury) on the population and more specifically to quantify how permanent injuries to the forelimbs or to the hindlimbs of chacma baboons affect their activity budget, diet and reproductive success relative to control uninjured baboons matched closely for age, rank, sex and reproductive status.

METHODS

Study site

The peninsula lies between 18°E-19°E and 32°S-33°S, with a range in altitude from sea level to 1 000m and is bordered by the Atlantic Ocean to the west, the Indian Ocean to the south and east and urban areas to the north and east. Almost half of the total land mass of the Peninsula, encompassing the central mountain chain and the southern extremity, forms part of the Table Mountain National Park (TMNP) which was proclaimed in 1998 (Figure 2). The Cape Peninsula population is currently divided into two broad geographical regions, the northern and southern subpopulations (NSP and SSP, respectively). The SSP is geographically isolated from the NSP by the Fish Hoek-Noordhoek urban belt. NSP comprises the Tokai troops which are in turn isolated from the troops to the North and East of the Cape Peninsula by urban and industrial development on the Cape flats. The SSP is comprised of 10 troops, five of which are within the Cape of Good Hope section of TMNP (CoGH) and five of which are outside.

The dominant vegetation in the Peninsula is fynbos, an indigenous flora of low productivity that forms part of the Cape Floral Kingdom (Cowling *et al.* 1996). Interspersed with the fynbos are pockets of alien plantations (e.g. *Pinus spp.* and *Eucalyptus spp.*) and large tracts of land that are infested to varying degrees by a variety of invasive alien trees (predominantly *Acacia spp.*). Alien vegetation is readily exploited by baboons (Davidge 1978b, Hoffmann and O'Riain, in press) both as a food resource and as a safe refuge for sleeping.



Troop names:

CP: Cape Point
KK: Kanonkop
BB: Buffels Bay
KOB: Klein Olifantsbos
GOB: Groot Olifantsbos
SWB: Smitwinkel's bay
RH: Redhill
DG: Da Gama
SK: Slangkop
TK: Tokai

Figure 2: The distribution of the Cape Peninsula baboon troops in the SSP (10 troops) and of the NSP (Tokai troops) and the relative location of the two focal study troops (Part B) Da Gama (DG) and Plateau road (PR)

Part A - *Population census and factors affecting the frequency and distribution of injury and mortality in Cape Peninsula baboons*

Census of the Cape Peninsula population

The census data were collected over a four year period from 2005 -2008 with the data collection taking place within a three month period during the austral summer (December to March). The first census was performed by van Doorn and Beamish (unpublished data) on the SSP in 2005. From 2006 I included the NSP in the annual census and repeated this for 2007 and 2008. For all years census data included demographic data on the age and sex class (*sensu* Altmann 1974) of all the individuals in each troop (Appendix Table 1). During each census a given troop was visited repeatedly on consecutive days until I obtained consistent results, on at least three separate censuses, for the total number of each age and sex class. Additional data on births, deaths and changes in age classes of individuals were recorded on an *ad hoc* basis during the remainder of the year as and when study troops were encountered in the field.

Quantifying and identifying causes of mortality and injury

Detailed records on the deaths and injuries of Peninsula baboons were collected from 2005 to 2008. These data were obtained from the Baboon Management Team (BMT), members of the public, Table Mountain National Park (TMNP) personnel and researchers working on different troops within the Peninsula. While the data on deaths and injuries are reliable for all troops of the SSP and NSP over this period, the infanticide data are accurate for only six of the troops that had either baboon monitors or researchers present on a regular basis (at least once per week). As there are no natural predators, infant mortality was recorded as infanticide in the following instances: i) the infanticide was witnessed by an researcher/monitor or ii) infanticide was suspected e.g. when an infant disappeared after a fight involving a male and females or at the same time that its mother sustained wounds resembling a baboon bite or if a healthy infant disappeared at the same time that a male killed other infants. The cause of death or injury to all baboons was typically diagnosed by a veterinarian through visual inspection of the trauma sustained and if uncertain a post mortem was performed to confirm the cause of death. If the exact cause of death was sufficiently obvious (e.g. vehicle accident) there was no need for a veterinarian to complete a diagnosis. The causes of death and injury were categorised into human induced which included guns, vehicles, dogs, poison and electric power lines and natural deaths which included infanticide, infant mortality, disease, old age and accidents (e.g., falls) where humans played no causative role.

Data analysis:

The data on births, deaths and injuries were collated for each troop and for each year between 2005 -2008. Percentage mortalities were calculated for the population as well as for age-sex classes as mortality in primates is known to vary with age and sex class. Mean annual rates were calculated for each year from 2005 – 2008 to allow for trend analysis. Where sample size was big enough a statistical analysis was done.

Part B - *The effects of permanent injury on the behaviour, diet and reproduction of select baboons within two study troops*

Study troops

It was not possible to obtain an adequate sample size of injured and uninjured animals from a single Peninsula troop and thus study animals were selected from the two Peninsula troops, Da Gama (DG) and Plateau Road (PR), which in addition to having the most injured baboons were the most similar in composition (Table 1) and had the highest number of permanently injured individuals.

Table 1: Composition of the two study troops, Da Gama and Plateau Road in January 2005

Troop	Count	No. of males*	No. of females*	No. of juveniles
Da Gama	35	4	14	17
Plateau Rd	36	2	14	20

* includes subadults

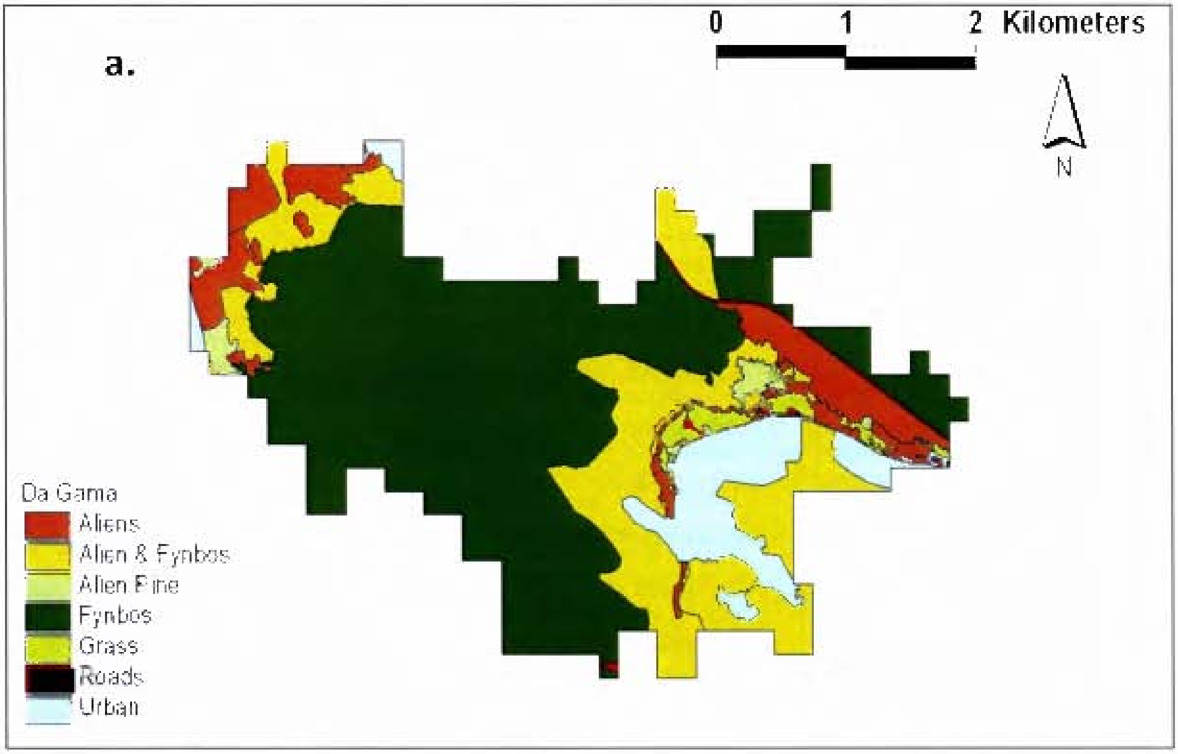
The home ranges of the DG and PR troops have a similar broad scale habitat composition (Table 2a & 2b and Figure 3), characterised by indigenous fynbos vegetation interspersed with varying densities of a variety of exotic tree species, areas of cleared alien species and both residential and rural land use areas. The home range of the DG troop has a higher percentage of overlap (9.2%) with urban development than the PR troop (2.5%) and is actively discouraged from urban raiding by 'baboon monitors'. Monitors are people employed specifically to herd troops away from the urban edge (van Doorn 2009). The central part of the DG home range is comprised of natural vegetation within the TMNP while most of the peripheral areas are urbanised (Figure 3a). The PR troop is on the northern boundary of Cape of Good Hope (CoGH) section of the Table Mountain National Park and their home range overlaps predominantly with low density agricultural small holdings incuding an ostrich farm (Figure 3b) which the troop visits regularly to raid feed pellets (van Doorn *et al.* 2010). The low density of human dwellings negates the need for a monitor program but the troop is nevertheless actively chased away from the ostrich farm or adjacent small-holdings in the area by the respective land owners/residents. This is achieved by infrequent and temporally unpredictable events of chasing the baboons either on foot or with dogs and by firing gunshots in the air above the troop.

Table 2a: Broad scale habitat types within the study areas including the dominant vegetation and land use within each habitat type

Alien	Areas dominated by plant species non-native to South Africa and the Cape peninsula such as: *Acacia cyclops, Acacia saligna, Acacia mearnsi and, Eucalyptus sp.*
Alien and Fynbos	Areas characterized by a mixture of alien and fynbos species.
Alien pine	Areas dominated by pine trees *(Pinus sp.)* non-native to South Africa and the Cape peninsula.
Fynbos	Areas characterized by plant species indigenous to South Africa many of which are endemic to the Cape Peninsula: *Carprobotus sp., Erica sp., Pelargonium sp., Restio sp., Watsonia sp.*
Grass	Indigenous and non-indigenous grasses.
Road	Areas which include roads, secondary roads and the road verge.
Urban	Areas which include houses, factories, stables and agriculture.
Other	Areas which are not part of the above categories and which are less than 0.3% of the area.

Table 2b: The relative percentage of the broad scale habitat types within the home range of the Plateau Road (PR) and Da Gama (DG) troops and the total area (km^2) of each home range (from van Doorn 2009)

Troop	**Alien**	**Alien & Fynbos**	**Alien Pine**	**Fynbos**	**Grass**	**Road**	**Urban**	**Other <0.3**	**Total km2**
D G	9.7	22.5	1.4	55.1	1.8	0.5	8.7	0.4	10.9
PR	8.9	4.4	1.6	77.6	4.9	1.3	1.2	0.1	9.0



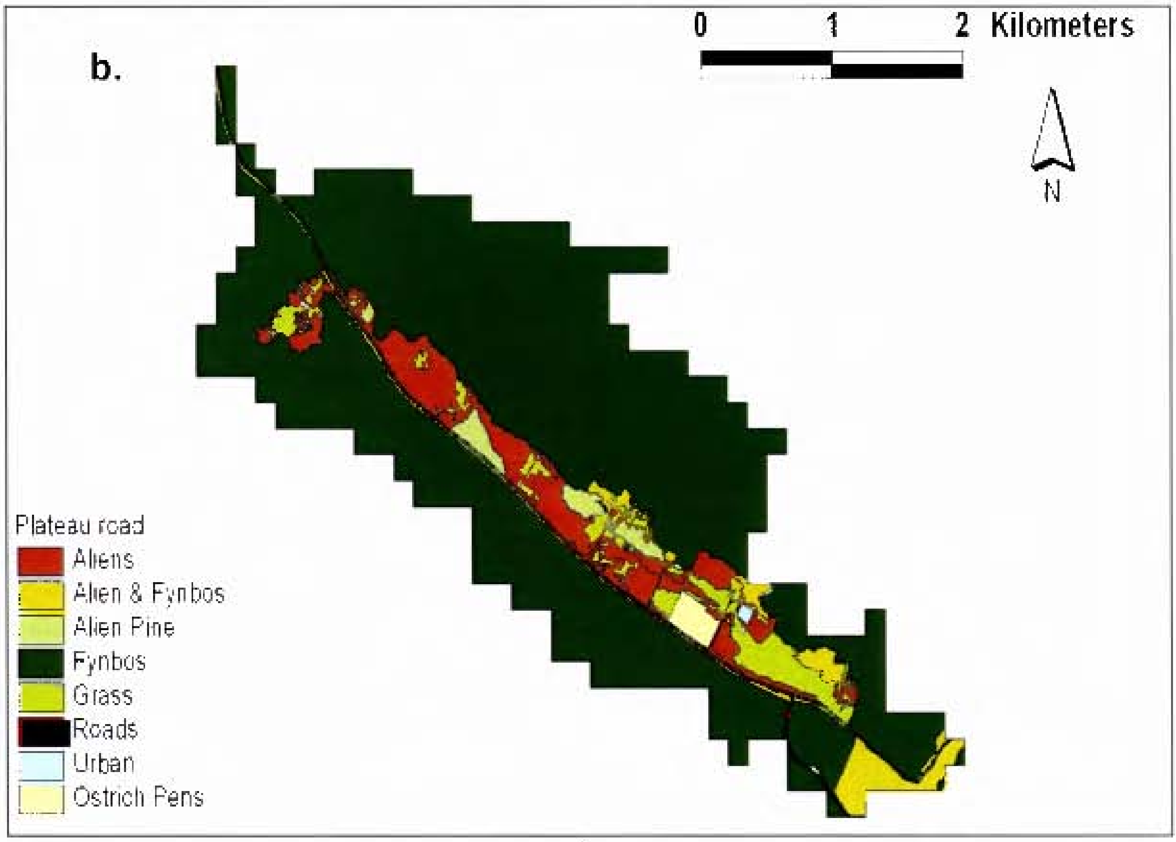


Figure 3: The home range of the Da Gama (a.) and Plateau Road (b.) troops including the broad scale habitat types within each home range (from van Doorn 2009)

Study animals

A total of seven individuals within the two troops had sustained permanent limb injuries and together formed the experimental group. Each injured animal was matched as closely as possible with respect to age, social status and oestrus state (in the case of females) with a control animal of the same sex and from the same troop (Table 3). The seven pairs comprised 12 females (10 adults and two sub-adults) and two males (juveniles). Sex and age classes were determined based on the classification of Altmann et al (1977) (Appendix: Table 1). It would clearly be preferable for all the injured and control individuals to be of same age and sex with the same type of injury. However the close matching of the injured animal with a control in conjunction with a paired statistical approach was considered a viable alternative to investigate the effects of injury given the paucity of same age/sex individuals with identical injuries.

Data collection

All study animals were habituated to the close proximity ($\geq$ 5 meters) of researchers allowing for detailed behavioural observations. Data were collected from May to November of 2005 by two observers performing simultaneous, continuous focal observations (Altmann 1974). Each observer focussed on one animal on any given day (injured or control) from a matched pair in the same troop. The focal subjects were typically observed for an entire day from dawn to dusk and data collection commenced once the observers had arrived at the troop (typically after sunrise at the sleeping site) and located their focal animals. Data collection ended once the baboons had returned to their sleeping site or if one or both of the observers lost sight of their study animal for $\geq$ 30 consecutive minutes. Focal observation sessions on a given day were only done on one pair of animals and the same pair was never observed on consecutive days. The order of selection of focal pairs was randomised. Injured and control pairs in a given troop were observed sequentially on different days before observers switched to pairs in the other troop. This ensured minimal temporal variation in the data collected for the observation pairs in the two different troops. Observers alternated between injured and control categories to reduce the potential effects of observer bias on the two categories (injured and control) of study animal (Appendix Table 2).

Table 3. The name, troop, rank, injury type, age category, sex, number of hours observed and a description and cause of the permanent injury of the 7 study pairs. Rank indicates the relative position in the troop hierarchy with 1 being most dominant (Appendix 10a – 10c). DG = Da Gama ; PR = Plateau Road, ukn = unknown

Pair No.	Name	Troop	Rank	Injury	Age	Sex	Hours observed	Description and cause of injury
1	Paula	PR	1	Hand	Adult	F	71.8	Missing right forearm from point midway up the forelimb. High voltage power line burn.
1	Olivia	PR	3	Control	Adult	F	71.4	None
2	Beatrice	PR	2	Hand	Adult	F	75.3	Left hand paralysed. Fingers and wrist withered and immobile. Snare injury.
2	Nanda	PR	4	Control	Adult	F	71.9	None
3	Pedro	PR	ukn	Hand and foot	Juvenile	M	55.9	Left hand and right foot missing from midway up the forelimb and hind limb. High voltage power line burn.
3	Manuel	PR	ukn	Control	Juvenile	M	55.1	None
4	Penny	DG	14	Hand	Adult	F	56.1	Missing right forearm from a point midway up the forelimb. High voltage power line burn.
4	Marilyn	DG	10	Control	Adult	F	54.8	None
5	Crook	DG	4	Hand	Adult	F	59.2	Left hand paralysed. Fingers are clawed and incapable of voluntary movement. Trap or snare suspected.
5	Kate	DG	1	Control	Adult	F	61.7	None
6	Ellie	DG	3	Leg	Adult	F	53.4	Leg amputated at the hip joint. Gunshot, fell and broke leg, fracturing pelvis.
6	Lucy	DG	5	Control	Adult	F	53.1	None
7	Thami	DG	11	Leg	Adult	F	39.4	Leg amputated at the hip joint. Gunshot.
7	Amy	DG	12	Control	Adult	F	42.8	None

Data collection/continued

Focal observations were recorded on a Palm Psion hand held computer that had been programmed with the Pendragon Forms software. The behaviour of the focal pair was recorded using detailed behavioural sub-categories (Table 4) that were subsumed within the broad scale behavioural categories of: feeding, moving, resting and socializing (*sensu* Altmann 1974). Data on all of these sub-categories were recorded continuously such that the change from one behavioural sub-category to another sub-category allowed the duration of a particular behavioural sub-category to be recorded. In this way the duration of all behavioural categories could be determined. In addition, data were collected on the type of food eaten as well as the partner in any social interactions.

Table 4: The four main behavioural categories and their associated subcategories including a description of each sub-category

Behavioural category	**Behavioural sub-category**	**Description of the behavioural sub-category**
Feed	Feed	Ingesting food, including check pouch feeding but not while travelling
	Food	Type of food eaten. For broad scale analysis food is included with feed.
	Forage	Search for food while stationery or while moving small distances when the predominant activity is foraging.
	Food handling	Processing of food and handling food items by hand or mouth. For broad scale analysis this is included with forage.
Move	Travel	All locomotor activities including walking and running.
	Climb	Climbing
Rest	Rest	Sleeping or lying down and the eyes may be closed
	Travel rest	Resting (sitting or lying down) in between travel bouts
	Inactive	Inactive posture, eyes open but no physical interaction with other individuals.
	Self-groom	Auto grooming. Does not include scratching.
	Vigilant - social - other	Actively looking around, not in search of food: Vigilance is directed toward the troop Vigilance is directed toward a car, an ostrich, humans or monitors (DG)
Social	Affilliative	Including the specific affiliative behaviour, the partner and response.
	Aggressive	Including the specific aggressive behaviour, the partner and response.
	Submissive	Including the specific submissive behaviour, the partner and response.
	Social Infant	Subject interacts with an infant; includes the behaviour toward infant.
	Groom another	Subject grooms another, includes the partner, who initiated the grooming and the response.
	Being groomed	Subject is groomed, includes the partner and who initiated the grooming.

Life history data were recorded *ad libitum* over a three year period from January 2005 to the December 2008 and included the reproductive state of females, all births and deaths to both injured and uninjured pairs (Appendix Table 3a and 3b). As an ultimate measure of the impact of injury on the fitness of injured baboons in the Peninsula, the ability to produce offspring and raise them to weaning age was determined over a period of four years (2005-2008).

Data analyses

Analyses of the overall frequency of winners and losers recorded in all dyadic interactions during focal and *ad libitum* observations performed in a parallel study on both troops (van Doorn 2009) were used to resolve the dominance hierarchies within each study troop. Agonistic behaviour categories were used to infer winners and losers in dyadic interactions (Appendix Table 4). This allowed for the estimation of the relative ranking of each injured and control pair using the method of De Vries and Appleby (2000) (Appendix Table 5a, 5b and 5c).

There was a disparity in the amount of time that members of each pair were visible during observation sessions. I thus calculated the activity budgets as a percentage of the total time that each member of a pair was visible. Comparisons between injured and control animals were made with a non-parametric sign rank test in Statistica. The activity budgets were comprised specifically of the percentage of time allocated to travel, feeding, socializing and resting as well as aspects of travelling or feeding that might be impacted on by injury to a limb.

To assess whether time spent feeding on particular food types or items was affected by injury I compared the percentage of time spent feeding on food types and those dietary items that comprised >3% of the overall diet (Figure 18 and 19) (Appendix Table 6 and 7). Feeding rates for frequently consumed food items (e.g. feed pellets) were determined by counting the total number of food items placed in the mouth, per minute of uninterrupted feeding. Samples of alien seeds that were commonly eaten were collected and analysed for energy and protein content (Appendix Table 8).

The data was tested for normality and found to be normally distributed. As a consequence of low sample size and $n = 7$ and normal distribution, non-parametric statistics were used.

RESULTS

Part A - *Population census and factors affecting the frequency and distribution of injury and mortality in Cape Peninsula baboons*

Population census

In 2005 there were 250 baboons living in 10 troops within the southern subpopulation. The northern subpopulation was not counted until 2006, however using the earlier estimate of 100 individuals (Kansky & Gaynor 1998), the population estimate for the CPP in 2005 was a minimum of 350 baboons in 11 troops (Table 5 & 6).

Table 5: The results of the 2005 census and demographic data for the 10 troops of the southern subpopulation

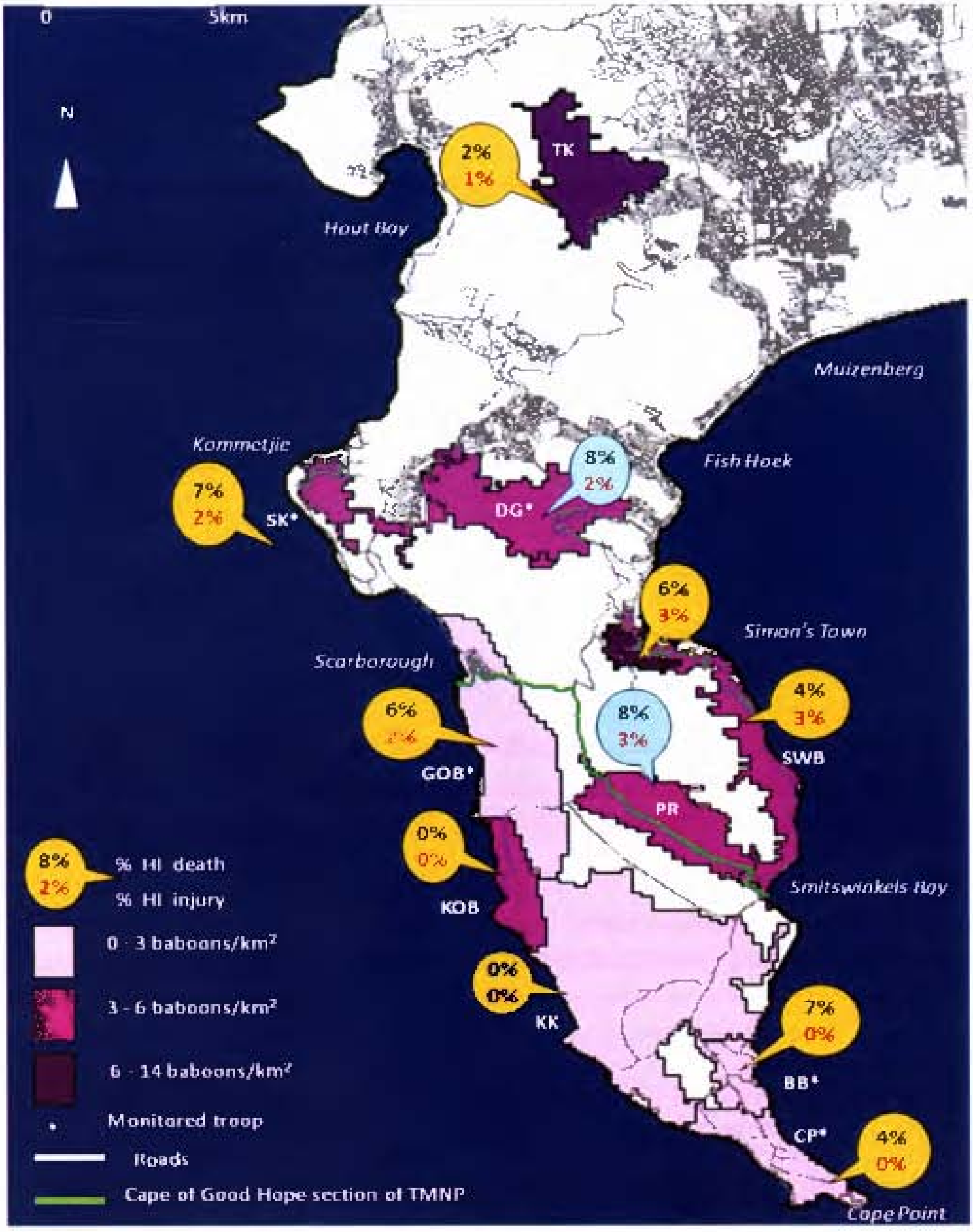
Troop name	Male	Female	Juvenile male	Juvenile female	Infant male	Infant female	Total
Cape Point	2	14	4	4	0	0	24
Buffels Bay	1	5	1	2	0	0	9
Kanonkop	6	12	8	9	6	1	42
Klein Olifantsbos	1	4	4	5	0	0	14
Groot Olifantsbos	5	16	4	4	0	0	29
Plateaux Road	2	14	6	8	1	5	36
Smitswinkel's Bay	3	8	8	2	3	0	24
Redhill	1	7	1	0	1	1	11
Slangkop	5	11	4	3	1	2	26
Da Gama Park	4	14	8	5	4	0	35
Total	30	105	48	42	15	8	250
Total including subadults	23+7	96+9	48	42	16	9	250

Table 6: Census data (total number of all baboons) for the entire Cape Peninsula population and the southern and northern subpopulations from 2005 to 2008

Year	Geographic region		
	CPP	SSP	NSP
2005	350	250	100*
2006	379	264	115
2007	388	260	128
2008	419	285	134
Mean	395	270	126

* 1999 count for NSP (Kansky & Gaynor 1999)

Human-induced injuries and mortalities are not evenly distributed across the Peninsula troops (Figure 4) with the highest percentage of mortalities in PR (8%) and the lowest percentage in KK and KOB (0%). PR, SWB and RH have the highest percentage of injuries (3%) and CP, BB, KK and KOB which have the lowest percentage of injuries (0%) are all troops permanently within the CoGH. GOB is largely within the CoGH but as a consequence of raiding an adjacent urban area, it has 2% injury and 6% mortality.



Troop names:

CP: Cape Point
KK: Kanonkop
BB: Buffels Bay
KOB: Klein Olifantsbos
GOB: Groot Olifantsbos
PR: Plateau Road
SWB: Smitwinkel's Bay
RH: Redhill
DG: Da Gama
SK: Slangkop
TK: Tokai

Figure 4: The home range, density and geographic location of 11 troops within the Cape Peninsula. The figures in the balloons indicate the mean percentage injury or death in each troop for the period 2005-2008. The two blue balloons are the study troops used in Part B of the study.

Mortality

Between 2004 and 2008 a total of 130 deaths were recorded for the Cape Peninsula population. The mean annual mortality was 9% (2006-2008) ranging from 6% (2007) – 12% (2006) (Table 7a). 58% of all deaths were human induced and 42% were natural deaths (Table 7b). The SSP experiences on average more than double the mortality of the NSP.

Table 7a: The percentage and count of mortality(natural and human- induced) in the Cape Peninsula population (CPP) from 2004 to 2008. Data were not available for the northern subpopulation (NSP) in both 2004 and 2005and hence it was not possible to obtain values for the CPP in those years.

Mortality						
	CPP		SSP		NSP	
Year	**%**	**Count**	**%**	**Count**	**%**	**Count**
2004	x		3	8	x	
2005	x		5	13	x	
2006	12	44	14	37	6	7
2007	6	24	8	22	2	2
2008	10	41	12	33	6	8
Mean 2006- '08	**9**	**36**	**11**	**31**	**5**	**6**

Table 7b: The total number of recorded deaths and the percentage that are human -induced deaths (HID) or natural deaths (ND) in the Cape Peninsula population from 2004 to 2008

Cape Peninsula population			
Year	**Total deaths**	**% HID**	**% ND**
2004	8	50	50
2005	14	50	50
2006	44	55	45
2007	24	63	38
2008	41	71	29
Mean	131	58	42

Causes of death

The predominant cause of death for peninsula baboons over the period 2004-2008 was infanticide 26% (n = 34). Six sources of human-induced death were identified with vehicles accounting for the majority 15% (n = 20) of such deaths followed by guns 11 % (n = 15), power lines 8% (n =10), dogs 6% (n = 9), poisoning 3% (n = 4) and disease 2% (n = 3). Natural deaths (here excluding infanticide and disease) accounted for 11% (n= 14) while deaths of unknown cause accounted for 17% (n = 22) of all deaths (Figure 5).

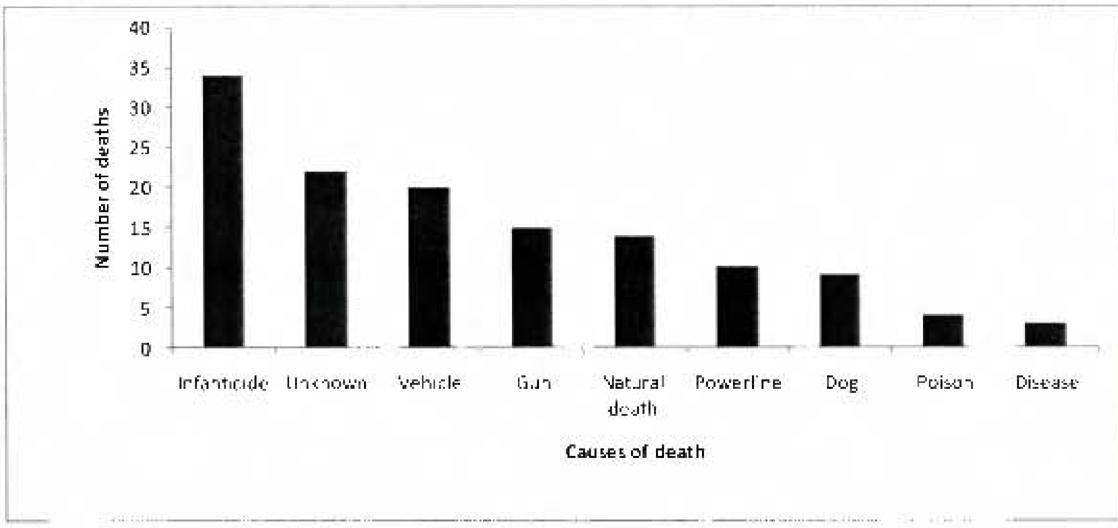


Figure 5: The total number of individuals (n=130) that died from the eight known causes of death in the Cape Peninsula baboon population between 2004 and 2008.

Annual variation in the number of deaths attributed to each cause is shown in Figure 6. Infanticide was responsible for the most deaths in 2006, 2007 and 2008. Infanticide and shootings both peaked in 2006 whilst deaths due to motor accidents were highest in 2008. The majority of unknown deaths are considered to be human induced as they occurred in troops where conflict with humans is common. The precise cause of death is listed in Table 9 in the Appendix.

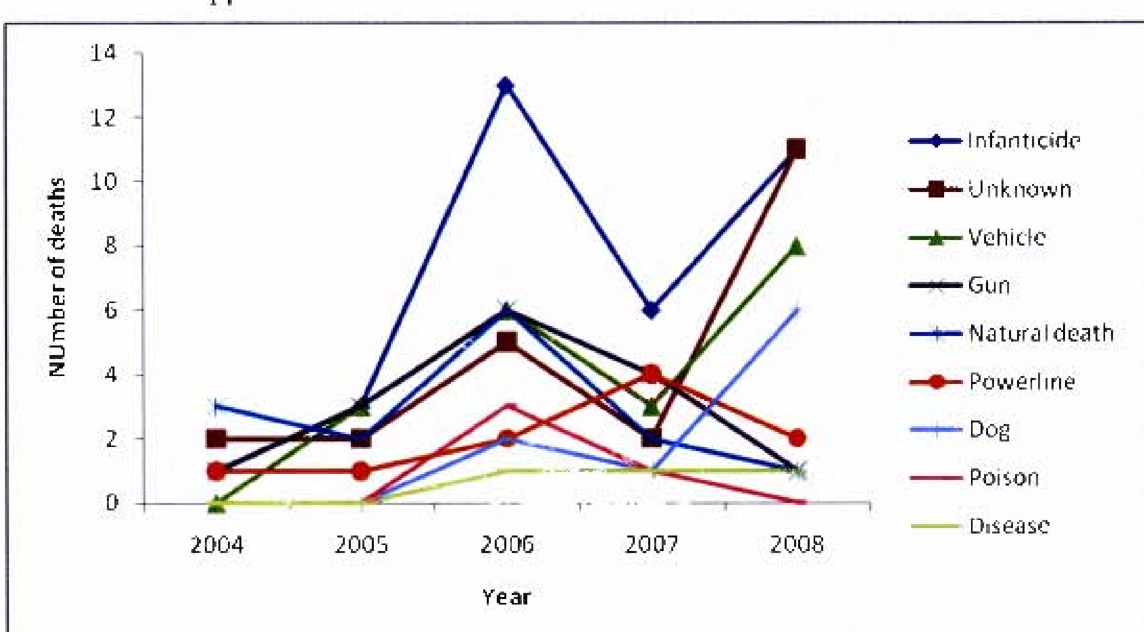


Figure 6: Annual variation in the eight known causes of death in the Cape Peninsula baboon population for the period 2004-2008

In the SSP the percentage of total deaths fluctuate more dramatically than the NSP (Table 7a) and ranged from 5% - 14% while human-induced deaths accounted for 2% - 8% of mortality in the SSP over the period 2005-2008. The highest number of deaths in a single year in the SSP was in 2006 (14%) the majority of which (8%) were human-induced (Figure 7).

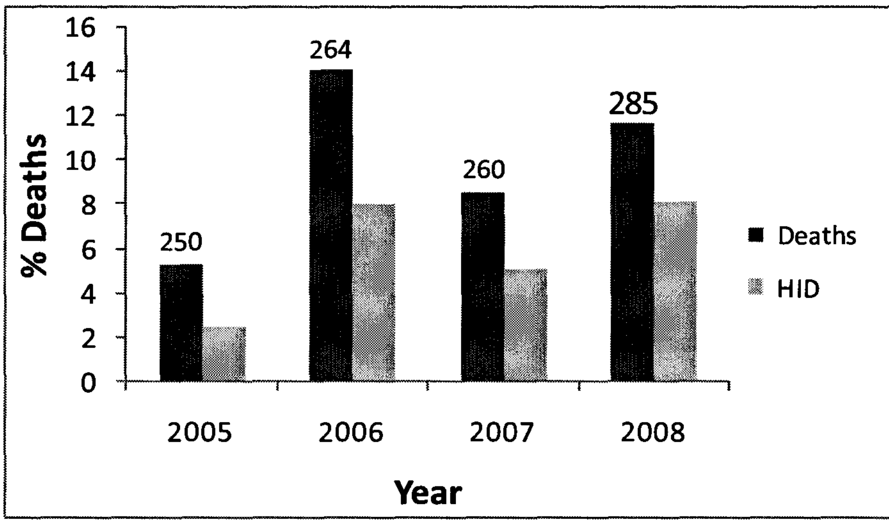


Figure 7: The percentage of all deaths and human- induced deaths (HID) for the southern subpopulation in four successive years (2005-2008). The total number of baboons in the SSP in each year is provided above each bar.

Mortality inside versus outside the Cape of Good Hope section of Table Mountain National Park

The mean annual percentage mortality for the population (5 troops) inside the CoGH was less than the mean annual percentage mortality for the population (5 troops) outside the CoGH over four consecutive years. The data set was too small to test for significance (Figure 8).

Table 8: Mean annual percentage mortality for the baboons living inside and outside of the Cape of Good Hope section of the Table Mountain National Park

YEAR	Inside CoGH	Outside CoGH
2005	6	8
2006	16	14
2007	9	8
2008	4	14
Mean	9	11

Injury and mortality

There was a continuum in the variation of the total number of deaths across all Peninsula troops, both inside and outside the CoGH section of the TMNP (Figure 8). Within the CoGH section of the TMNP the two troops (KK and KOB) that have the least interactions with humans and rarely raid human food items had the lowest total number of deaths all of which were from natural causes. By contrast the two troops (BB, CP) that regularly encounter humans and regularly raid human food sources had a total number of human induced deaths similar to troops outside of the CoGH section of TMNP with a low level of human-induced mortality (e.g. SWB, RH). Further BB & CP troops had levels of natural deaths similar to troops outside of the CoGH experiencing high levels of natural deaths (e.g. DG and PR). Permanent injuries were unique to troops outside of the CoGH section of the TMNP. Troops outside of CoGH varied markedly in the total number of ND's while two troops inside the CoGH (KK, KOB) had low levels of ND and two had high levels (CP, BB) (Figure 8).

The highest levels of natural deaths occurred in the CP troop followed by PR, DG and TK (Figure 8). Infanticide accounted for almost all (75%) of the natural deaths.

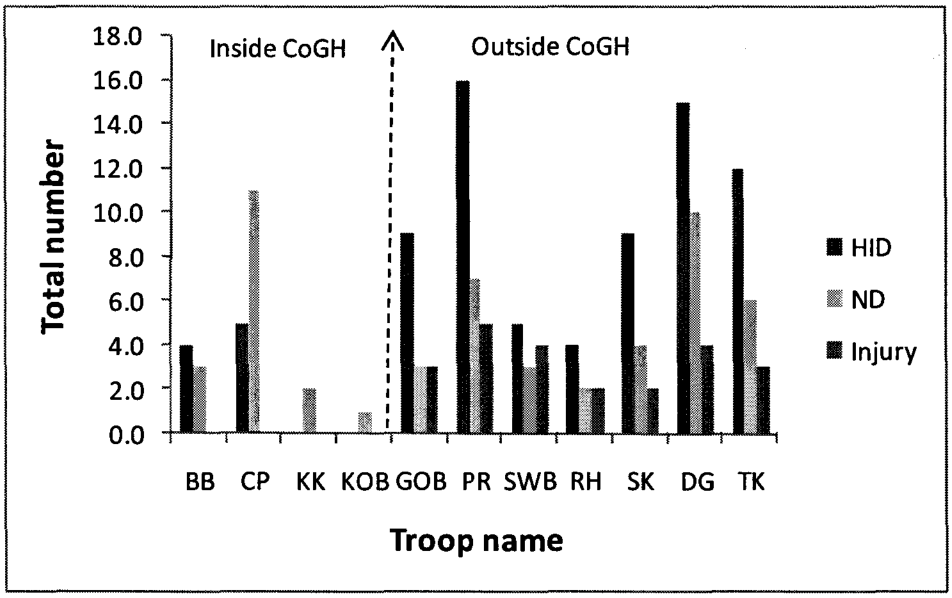


Figure 8: The total number of human induced and natural deaths and human induced injuries for each of the 11 troops of the Cape Peninsula population during the period 2004-2008. The Cape Peninsula population can be broadly split into four troops that live exclusively inside the CoGH section of the TMNP and seven troops that live outside this area. GOB and PR do occasionally enter the park.

The mean number of deaths across all Cape Peninsula troops for the period 2004-2008 is not significantly correlated with the mean number of permanent injuries (Spearman Rank co-efficient: r = 0.51, p > 0.05, n = 11) (Figure 9a).

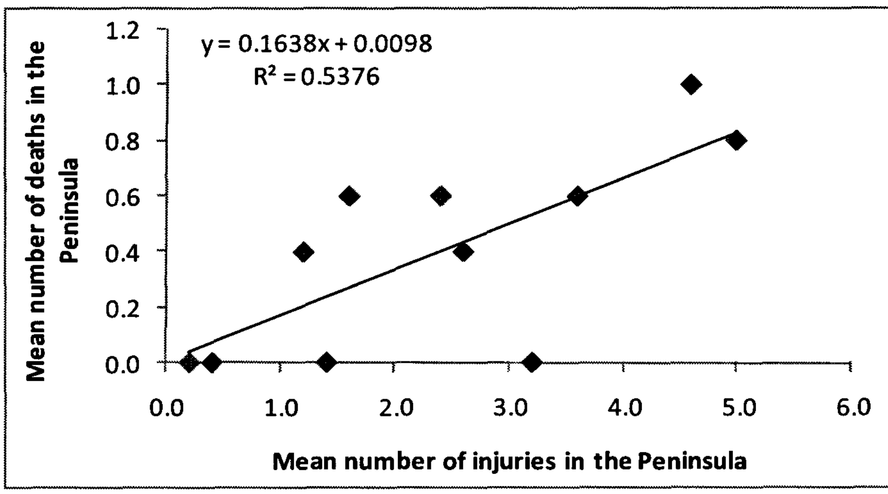


Figure 9a: The relationship between the mean number of deaths and permanent injuries in the 11 Cape Peninsula troops from 2004 to 2008

However the mean number of deaths in the seven troops outside the CoGH is significantly correlated with the mean number of injuries (Spearman rank co-efficient r = 0.729, p < 0.05, n = 7) (Figure 9b).

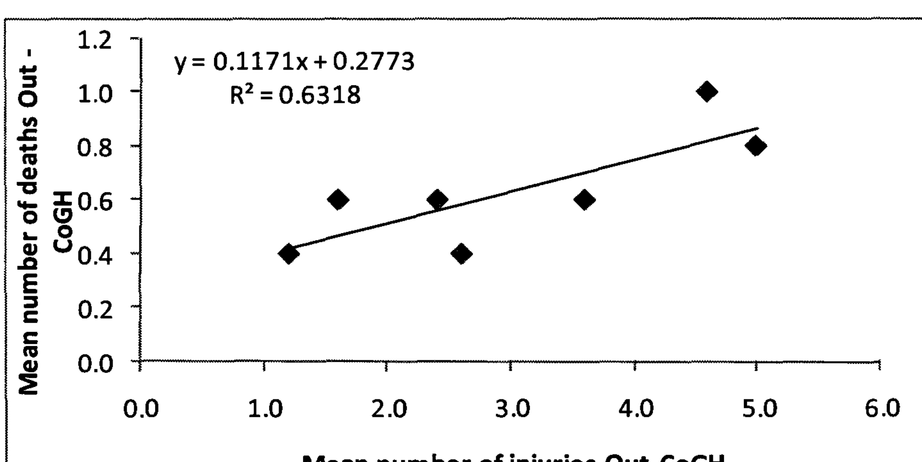


Figure 9b: The relationship between the mean number of deaths and permanent injuries in the seven troops outside the Cape of Good Hope section of the Table Mountain National Park from 2004 to 2008

The effects of age class on the percentage of natural and human induced deaths within the southern population

Natural deaths were highly skewed towards infants in each of the four years from 2005-2008 reaching a maximum of 35% in 2006. Significantly more infants died from natural deaths than adults (Kruskal-Wallis test: $H (2, N = 12) = 6.957$ $p = .0309$). The percentage of juveniles and adults that died of natural deaths over the same period was never higher than 2 % (Figure 10a). By contrast, human-induced deaths differ from natural deaths in that they are more evenly spread amongst the age classes (Figure 10b) and no consistent pattern was evident.

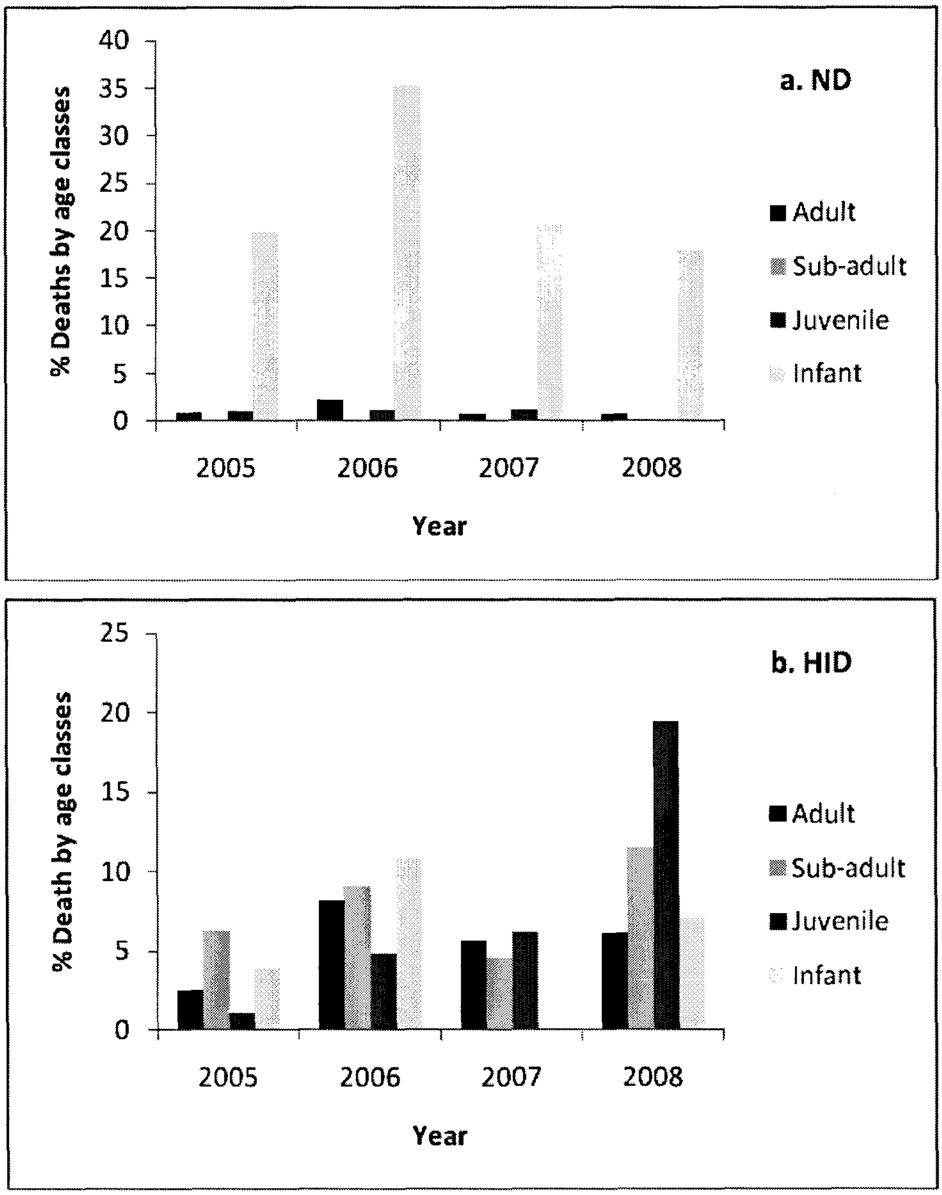


Figure 10a & b: The percentage of a) natural deaths (ND) and b) human induced deaths (HID) in the four different age classes for baboons within the southern subpopulation

The effects of sex class on natural and human induced deaths and injuries within the southern population

Adult males had a higher percentage of human-induced deaths compared to adult females in all years (Figure 11a) although this was not significantly different (Mann-Whitney U, z = 1.299, p>0.1). Human induced injury showed a similar trend except for 2006 (Figure 11b) when no injuries for males were recorded (Mann-Whitney U, z = 1.299, p>0.1). The sex determination of juveniles and infants was not as reliable as for adults and consequently an analysis of sex-age class mortality for human-induced death and human induced injury was not performed. The majority of infants suffered from natural causes of death.

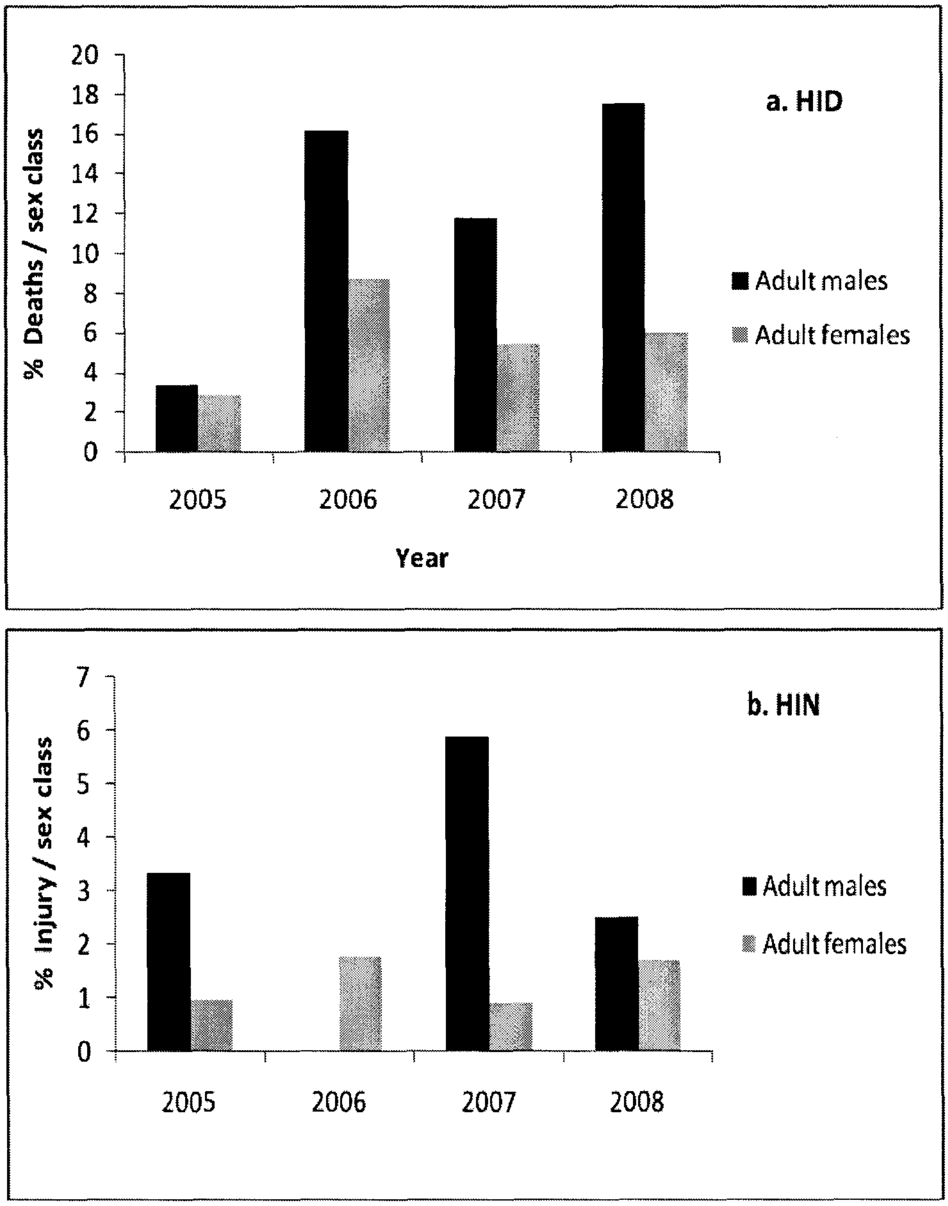


Figure 11a & b: The percentage of a) human induced deaths and b) human induced injury (HIN) in adult males and females in the southern subpopulation

Death and injury from medium-voltage power lines

Between 2004 and 2008 a total of twelve deaths (15% of all HID deaths) and 16 mutilations (64% of HI injuries) were directly attributed to burns sustained following contact with above ground power lines. These incidents were distributed amongst individuals in five of the eleven peninsula troops. A GIS overlay of the distribution of above ground power lines throughout the Peninsula revealed that electrical burns were restricted to troops with above ground power lines within their home range (Figure 12). Thus the percentage of individuals with electrical burn injuries in four troops (Redhill, Da Gama, Groot Olifantsbos and Plateau Road) was 36%, 8.50%, 9.5% and 10%, respectively. No burn injuries were evident in the four southern most troops within CoGH, a region which has no power lines at all. 60% of all injuries and deaths from electric burns occurred in females and 40% in males. Photographic documentation of burn injuries resulting in injury or death are shown in Plates 3 - 5 in the Appendix.

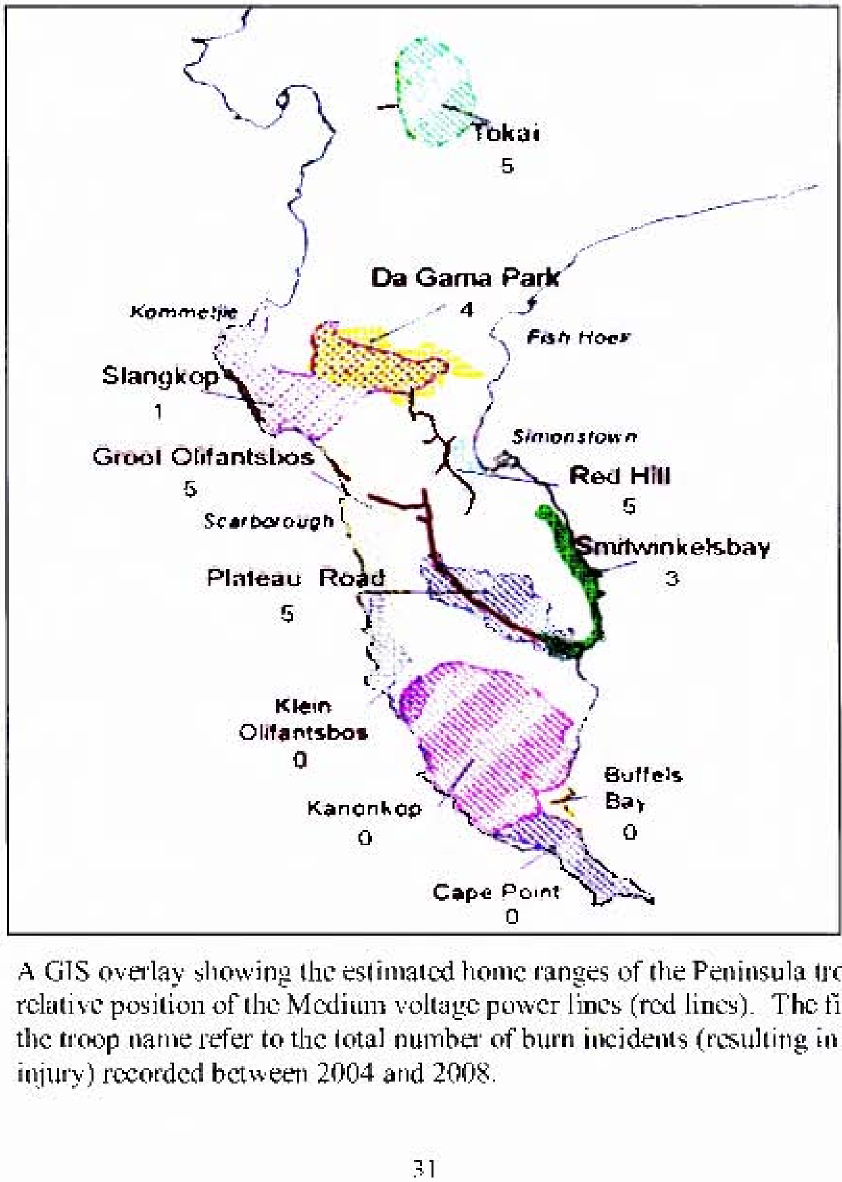


Figure 12: A GIS overlay showing the estimated home ranges of the Peninsula troops and the relative position of the Medium voltage power lines (red lines). The figures below the troop name refer to the total number of burn incidents (resulting in death and injury) recorded between 2004 and 2008.

Part B - *The effects of permanent injury on the behaviour, diet and reproduction of select baboons within two study troops.*

A summary of all births and deaths to each of the female study animals within the two study troops is provided in Table 9. Eight of the 10 adult females gave birth in 2004 and 2006 and two adult females gave birth in 2003 and 2005. The sub-adult females both had their first birth in 2005.

Table 9: A summary of the reproductive history of injured and control females from 2004 to 2007

Study pair	Troop name	Individual name	Reproductive State across years				# of live births	Birth rate	# and cause of infant deaths	Total # of infants surviving to 6 months
			2004	2005	2006	2007				
1A	PR	Paula	BR	L	BR	L	2	0.5	0	2
1B	PR	Olivia	BR	L	BR	L	2	0.5	0	2
2A	PR	Beatrice	BR	L	BR	L	2	0.5	0	2
2B	PR	Nanda	BR	L	BR	L	2	0.5	0	2
3A	DG	Ellie	P:MC	C	BR	L	1	0.25	1: MC	1
3B	DG	Lucy	BR	L	BR	L	2	0.5	0	2
4A	DG	Crook	C	BR: HID	BR: INF	P	2	0.5	1: HID 1: INF	0
4B	DG	Kate	BR: SB	BR: SB	C	P	0	0	2: SB	0
5A	DG	Penny	L	BR	BR: INF	P	2	0.5	1: INF	1
5B	DG	Marilyn	L	BR	BR: INF	P	2	0.5	1: INF	1
6A	DG	Thami	C	BR	HID	P	1	0.25	1: HID	0
6B	DG	Amy	C	BR: INF	BR: INF	P	2	0.5	2: INF	0
A= Injured, B = Control, HID = Human induced death, INF = Infanticide, BR = Birth, L= Lactating, P= Pregnancy, C = Cycling, MC = Miscarriage, SB = Stillborn.										

Activity budget

The mean percentage time that injured baboons spent feeding (Figure 13) was significantly less than control baboons (Sign Test: z = 2.268, p = 0.023, n= 7). Injured baboons spent a significantly higher mean percentage of time both resting and travelling than controls (Sign Test, rest: z = 2.268, p = 0.023, n= 7; travel: z = 2.268, p = 0.023, n= 7). There was no significant difference between injured and control baboons in the percentage of time spent performing social activities (Sign Test: z = 1.512, p = 0.131; n= 7).

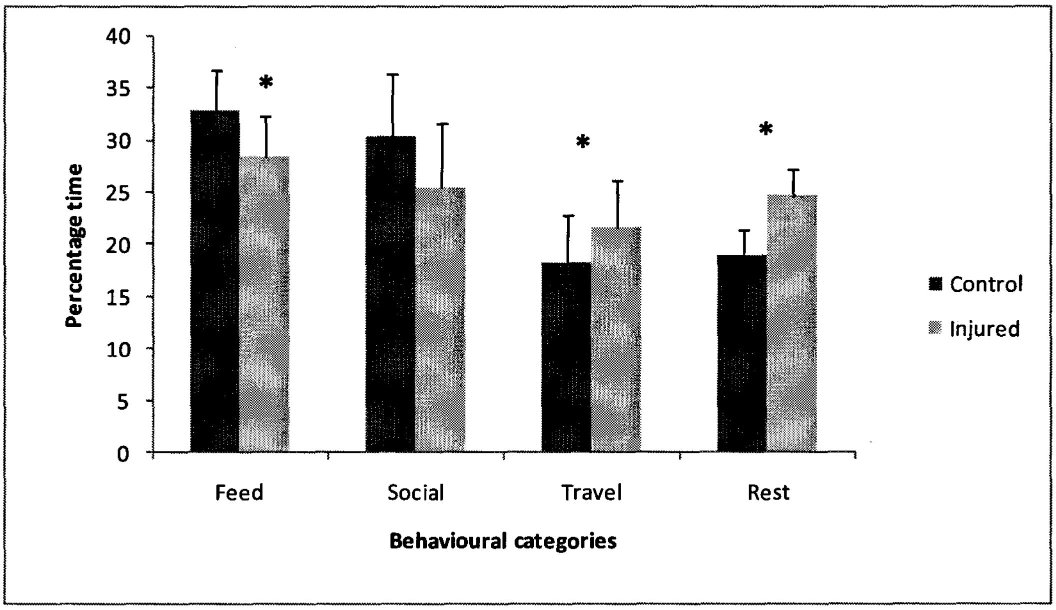


Figure 13: Mean percentage time that injured versus control baboons engaged in the four main behavioural categories that comprise the activity budget

When analysed separately, the mean percentage of the individual behavioural categories associated with feeding did not differ between injured and control individuals (Figure 14) (Sign Test, drink: $z = 0.7559$, $p = 0.449$; food handling: $z = 0.00$, $p = 1.00$; feed: $z = 0.7559$, $p = 0.449$, forage: $z = 0.7559$, $p = 0.449$; $n = 7$ for all analyses).

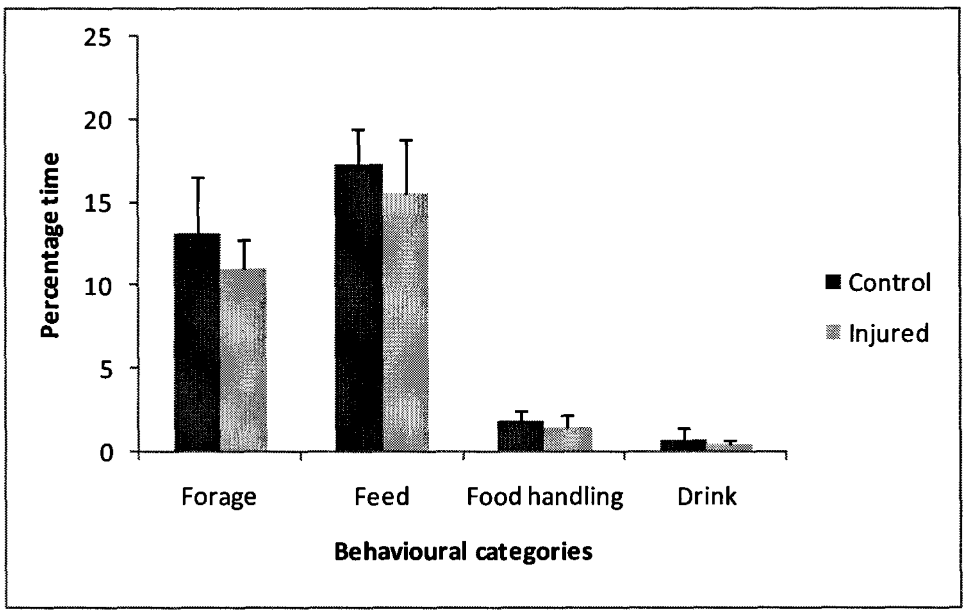


Figure 14: Mean percentage time that injured versus control baboons engaged in behaviours that comprise the feeding budget

The mean percentage time (Figure 15) that injured baboons engaged in rest related activities was significantly higher for the inactive rest subcategory only (Sign Test, inactive: z = 2.27, p = 0.023 n = 7). There was no difference in the mean percentage time that injured and control individuals engaged in other rest categories (Sign test, rest: z = 1.512, p = 0.130; travel rest: z = 1.7889, p = 0.0736; self groom: z = 0.756, p = 0.450; vigilant other: z = -0.00, p = 1.000; vigilant social: z = 0.7559, p= 0.450; n= 7).

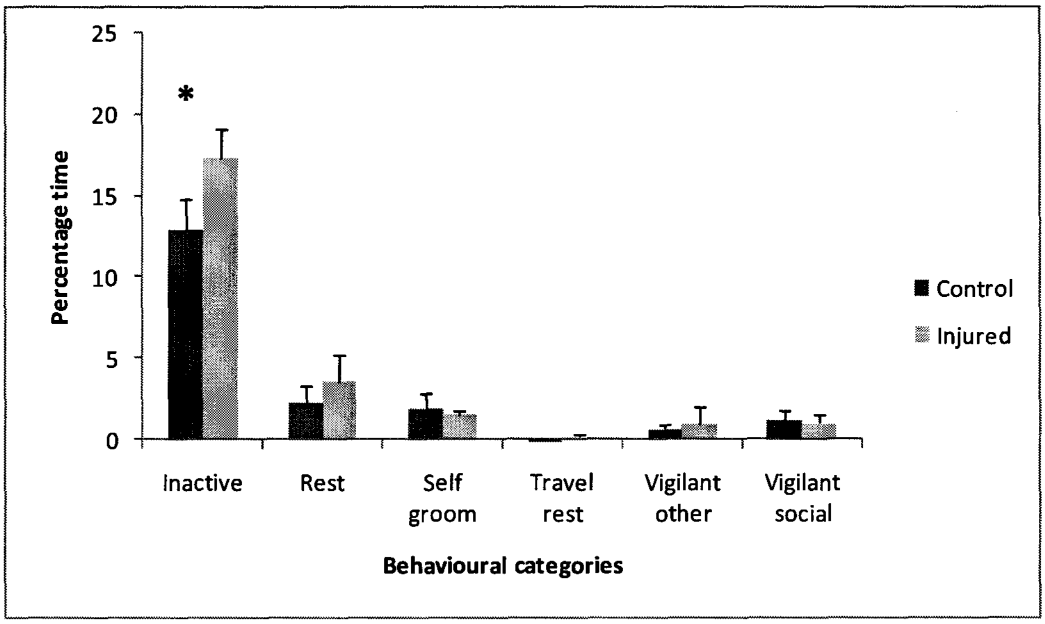


Figure 15: Mean percentage time that injured versus control baboons engaged in behaviours that together comprise the resting budget

The mean percentage time (Figure 16) that injured baboons spent travelling was significantly higher than control individuals (Sign test, travel: z = 2.267, p = 0.023: n = 7). There was no difference in the percentage time that injured and control individuals spent climbing (Sign Test, climb: z = 0.756, p = 0.450; n= 7).

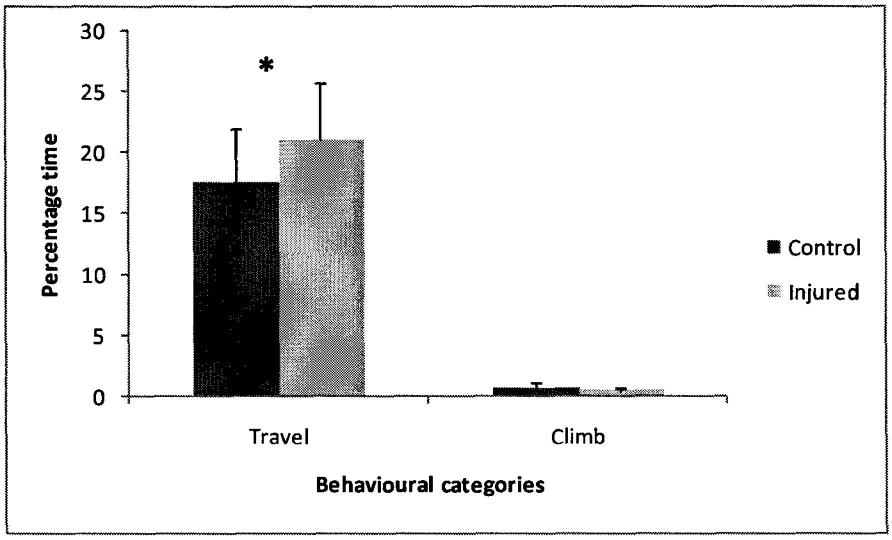


Figure 16: Mean percentage time that injured versus control baboons engaged in travel (terrestrial) versus climbing (arboreal locomotion)

The mean percentage of time (Figure 17a) that injured baboons engaged in social activities did not differ between injured and control individuals (Sign test, social affiliative: z = -0.00, p = 1.00; social aggressive: z = 0.00, p = 1.00; being groomed: z = 0.756, p = 0.450; social submissive: z = 0.756, p = 0.450; groom another: z = 0.756, p = 0.450; n = 7 for all analyses).

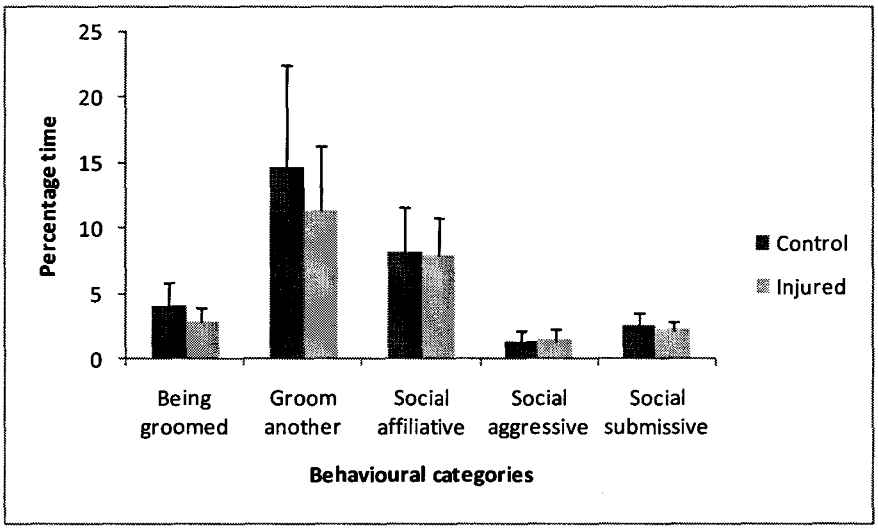


Figure 17a: Mean percentage time that injured and control baboons engaged in behaviours that together comprise the social budget

Grooming and social vigilance

The mean percentage time that injured baboons engaged in grooming activities or social vigilance did not differ significantly between injured and control individuals (Figure 17b)

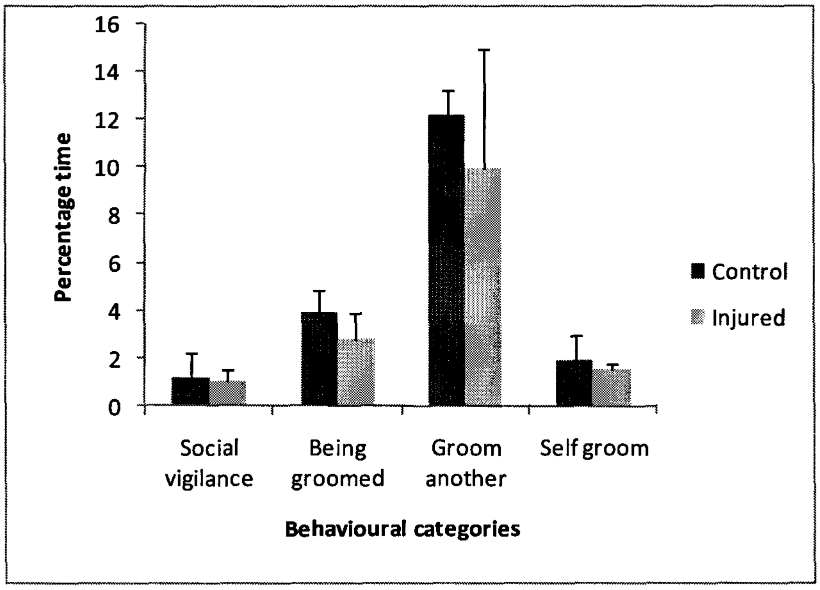


Figure 17b: Mean percentage time that individuals engaged in social vigilant and grooming activities

The mean percentage time (Figure 18) that injured baboons spent feeding on different food types was significantly higher for raided foods and significantly lower for alien foods compared to the control individuals (Sign test, alien: z = 2.267, p = 0.0233; raid: z = 2.267, p = 0.023; n=6). There was no difference in the time spent feeding on annuals, fynbos or other food types (Sign test, annual: z = -000, p = 1.00; fynbos: z = -0.00, p = 1.00; other: z = -0.00, p = 1.00; n = 7).

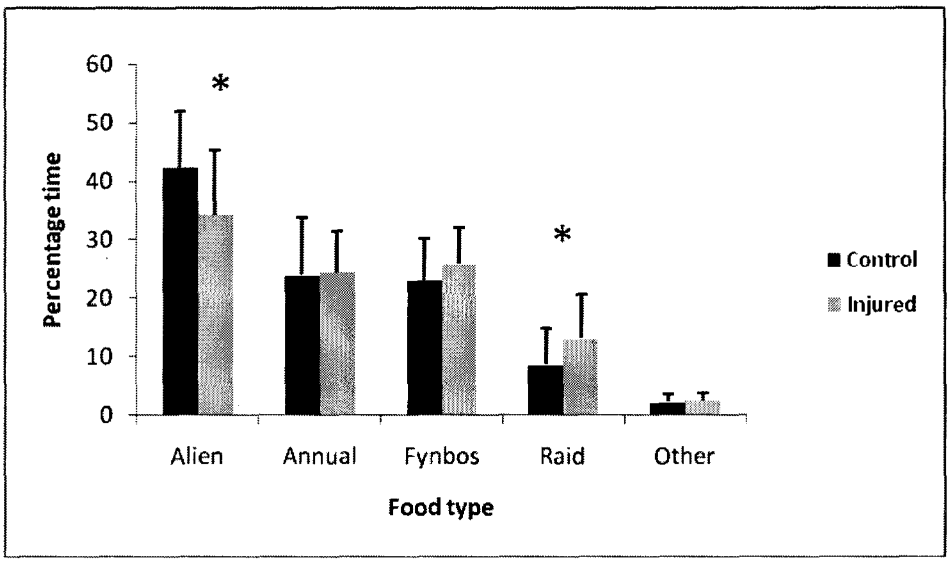


Figure 18: The mean percentage time that injured and control baboons spent feeding on different food types

The mean percentage time (Figure 19) that injured baboons spent feeding on pine cones was significantly less than control baboon (Sign Test, Pine cones: z = 2.26, p = 0.023; n =7). The mean percentage time spent feeding on raided food was significantly higher for injured than for control animals (Sign Test, raid: z = 2.26, p = 0.023; n =7). There was no difference in the mean percentage time that injured and control individuals spent feeding on other food types (Sign test, alien seed: z = -0.00, p = 1.00; alien other: z = -0.00, p = 1.00; fynbos bulb: z = 0.00, p = 1.00; fynbos flower: z = -0.00, p = 1.000; fynbos other: z = 1.51, p= 0.130; n= 7; grass: z = -0.00, p = 1.000; other: z =-0.00, p= 1.00; n= 7).

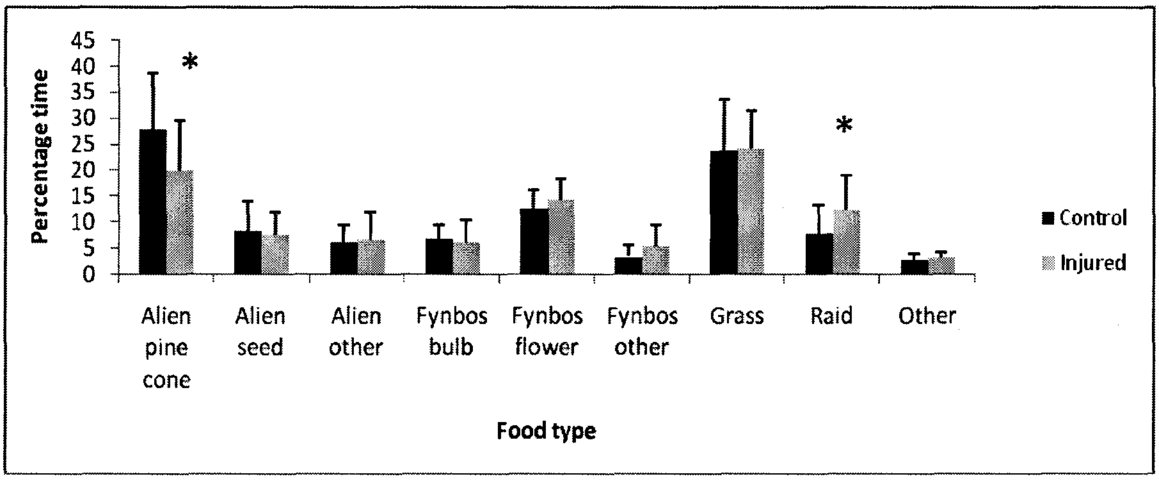


Figure 19: The mean percentage time injured versus control baboons spent feeding on items that comprise more than 3% of their diet

The mean percentage time that injured individuals spent feeding on alien pine cones found on the ground versus in trees (Figure 20) was not significantly different from control individuals (Sign test, ground: $z = 1.512$, $p = 0.130$; tree: $z = 1.512$, $p = 0.130$; $n = 7$).

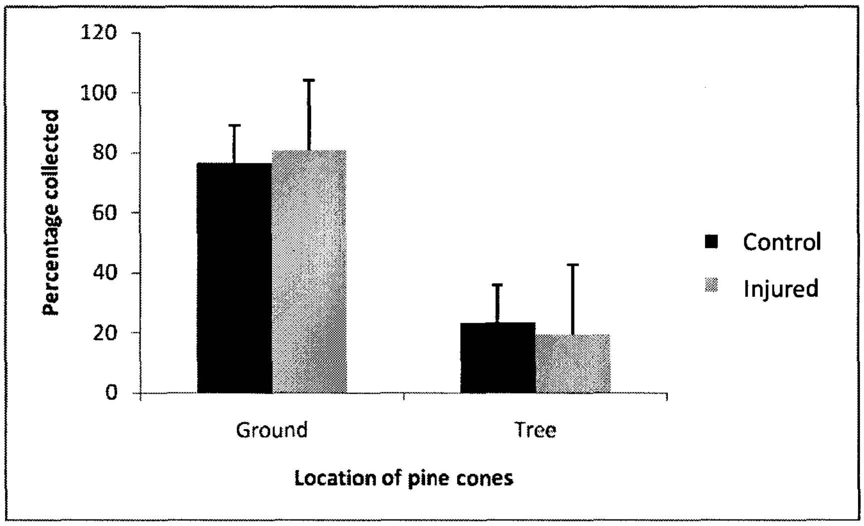


Figure 20: The mean percentage of pine cones collected on the ground and in trees by injured versus control baboons

The mean percentage time that injured animals spent foraging above or below ground (Figure 21) was not significantly different from the controls (Sign test, above ground: $z = 1.512$, $p = 0.130$; below ground: $z = 1.512$, $p = 0.130$; $n = 7$).

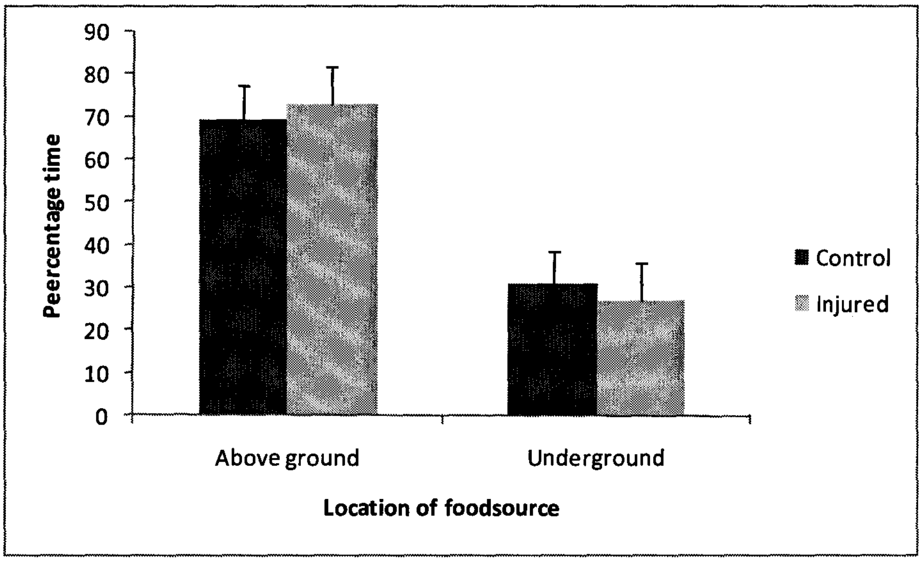


Figure 21: The mean percentage time spent on feeding activities with food obtained above or below ground by injured versus control baboons.

DISCUSSION

Part A - *Population census and factors affecting the frequency and distribution of injury and mortality in Cape Peninsula baboons*

Despite the stochastic nature of the peninsula population (Figure 7) the demographic structure of the population in 2005 had improved substantially from 1998 with an adult sex ratio of 1 : 3.5 relative to the 1:8 in 1998 (Kansky & Gaynor 2000), within the normal range for chacma baboons (Dunbar, 1988; Henzi *et al.*, 1999). The immature: adult female ratio was close to parity, indicative of a population in neither a growth nor decline phase (Southwick et al 1977). The high level of mortality (13%) in the SSP in 1998 (unusual for a population with no natural predators) had declined to 5% in 2005 indicating a reduction in human: baboon conflict. The troop of the southern subpopulation ranged in size from 9 (smallest) to 42 (largest) and the number of troops increased from nine to ten with SWB fissioning to form a daughter troop RH. SWB troop are adept raiders of tourists and this fission is possibly indicative of growth due to access to high energy anthropogenic foods leading to increased competition for the food resource. At a troop level the sex ratio showed signs of the previously high levels of male mortality ranging from a strong female bias of 1: 7 in CP to within the normal range of 1: 2 in KK (Table 14). Chacma baboons operate as multi-male and multi-female social groups and male baboons evolved to consort with and mate-guard a single female. Consequently troops that have an ASR with a strong female bias tend to show slow growth as males cannot consort with several females at once when their oestrous cycles overlap. It is thus of concern that mortality in the SSP troops is skewed toward adult male baboons.

Mortality

Whilst the peninsula baboons are free-ranging and have access to large tracts of uninhabited land on the Peninsula much of the low lying optimal foraging areas have been usurped by the approximately 5 million humans living within greater Cape Town. Thus while natural predators have been eliminated and fatal disease is relatively rare, human predation presents an ever growing threat to the continued survival of the Peninsula baboons. The CPP had a mean annual mortality rate of 9% over the period 2006-2008 (Table 16a) across all age groups and a mean annual growth rate of 3.6% (Beamish unpubl. data) suggesting that the population is experiencing an intrinsic mean annual birth rate of approximately 12.6% resulting in a positive growth despite the heavy human predation pressure.

At a regional level mortality rates differ with the SSP having on average more than double the mortality rate of the NSP (Table 16a). The SSP has shown a mean annual mortality rate of 11% (mean n = 31) over the period 2005-2008 (Table 7a) which is slightly lower than the 14% (n = 36) recorded over a single year from 1998-1999 (Kansky & Gaynor 2000). A more detailed look at the data for the SSP for the same period revealed fluctuating annual mortality rates (Figure 7) typical of wild populations (Cheney *et al.* 1988; Altmann *et al.* 1988). It is thus apparent that despite the implementation of novel management strategies in the 1990's to reduce high levels of human-baboon conflict (e.g. the monitor program), human induced mortality has remained a defining characteristic of the SSP.

Although the mean annual mortality rate of the five troops within the Cape of Good Hope section of Table Mountain National Park is not significantly different than the mean mortality rate for the five troops outside the CoGH (Table 8) there is a trend of an annual reduction in the mean mortality within the CoGH as a result of improved management strategies of the relevant conservation authorities.

The different causes of mortality and their relative contribution to overall mortality in baboon populations are poorly understood due to the difficulty of accurately recording causes of death in the wild (Cheney *et al.* 2006; Cowlishaw 1994, Cowlishaw & Dunbar 2000). In the Cape Peninsula the large residential population facilitates the detection of both injuries and deaths which are readily communicated to the Baboon Management Team and researchers. Consequently I was able to obtain a large accurate data set on both the causes and demographics of mortality. These data have allowed for a detailed analysis of the previous and current threats to the sustainability of the Peninsula population, which are used within the BMT to inform the discussions of public policy and management. The majority of baboon deaths during the study period are human induced (mean 58%) increasing from 50% in 2005 to 64% in 2008 (Table 7b) and it is alarming that these figures are substantially higher than the 17% recorded for HID deaths by Kansky & Gaynor (2000). Vehicles account for most human induced mortalities followed by shootings, electrocutions, domestic dogs and poisoning (Figure 5). However, the single greatest cause of death between 2004 and 2008 was natural (infanticide). High levels of infanticide are themselves indicative of poor management and although no data has been presented specifically on alpha male turnover or infanticide at the troop level there appears to be a link (see below), with the high turnover of adult males as a result of conflict with humans. There was substantial annual fluctuation in the number of deaths attributed to the five major causes of human induced death. Infanticide was consistently the highest cause of death on an annual basis but this too varied markedly on an annual basis as did the human induced causes of death with vehicles and guns peaking in 2006 and vehicles peaking again in 2008 (Figure 6). The similarity in patterns of human induced deaths in adult males (Figure 11a) and natural deaths of infants (Figure 10a) is noteworthy and supports the notion of a link between high levels of adult male mortality and high levels of infant mortality. Thus it seems critical to research the impact of high alpha male turnover as a result of human predation and management interventions on infant mortality and specifically infanticide in the peninsula baboon population.

Similar to other baboon populations (Altmann 1980) natural deaths were higher for infants than any other age class (Figure 10a) while human induced deaths were more evenly distributed across the four age classes (Figure 10b). In agreement with the findings of Kansky & Gaynor (1998), human induced death and injury was skewed towards adult males relative to females (Figure 11a and 11b) although the difference was not significant. Higher adult male mortality is attributed to the propensity for adult males to come into contact with humans when both dispersing and raiding. Adult males are known to be more confident, persistent and threatening to humans. They are also more likely to be alone while raiding or dispersing and are thus more likely to get killed by humans when in urban areas (Forthman Quick 1986, Strum 1987a).

Age-specific mean annual mortality rates for the SSP period 2005 -2008 are similar to those recorded for 1998-1999 (Kansky & Gaynor 2000) for juveniles (6% vs 9%) and infants but not for adults with mean adult mortality increasing almost 4-fold from 4% to 15%. This is most likely a result of increased intrinsic growth due to human derived foods (refuse in the SSP and pine in the NSP) leading to increased conflict along the urban edge. While the infant mortality rate decreased from 53% in 1999 to a mean annual rate of 29% for 2005 -2008 it still shows dramatic annual fluctuations ranging from 46% in 2006 to 21% in 2007 (Figure 10a and 10b) in line with other populations experiencing high infant mortality rates (Cheney et al 2004). This is of concern for the population of baboons in the SSP as infant survival is known to impact on lifetime reproductive success and to have a particularly large effect on long-lived animals that reproduce slowly like baboons. This shows how human predation on a sub-set of the population can impact on population dynamics and the demographic structure of the whole population.

Permanent injuries

The total percentage of individuals in the CPP that have suffered permanent injuries was 3% in 2005 which increased to 5% in 2008. There was a positive but non-significant relationship between the number of permanent injuries and deaths in the CPP (Figure 9a). This relationship was not significant because two of the troops that have sustained fairly high mortalities (i.e. Cape Point and Buffels Bay) had no baboons with permanent injuries. It is interesting to note that there are no baboons with permanent injuries in any of the troops that live exclusively within the CoGH section of the TMNP. This suggests that permanent injuries are a characteristic of baboons living in proximity to urban residential and agricultural areas. This is exemplified by the fact that the two study troops PR and DG both had 11% permanent injuries at the onset of the study in 2005 and this had increased to 15% for PR and decreased marginally to 10% for DG by 2008. Mean mortality was significantly correlated with the mean number of injuries in troops living outside of the CoGH (Figure 9b). This suggests that permanent injuries can be used as a reliable indicator of mortality rates in Peninsula troops outside of the CoGH and furthermore that permanent injury and mortality are both associated with proximity to agricultural and urban areas.

Thirteen individuals living in five of the eleven Peninsula troops have sustained permanent injury following contact (electrocution) with above ground power lines. Between 2005 and 2008 a total of ten individuals (14.5% of all human induced deaths) died from injuries sustained through electrocution. No such injuries (i.e. burns) were evident for troops within the CoGH that do not have above ground power lines within or immediately adjacent to their home ranges. Similar to findings in studies on baboons in Kenya (Strum 2005) and Malawi (Printes 1999) these results suggest that above ground power lines are a common source of both mutilation and death in baboons. It is thus imperative that methods are found to deter baboons from coming into contact with the transformers and live electrical wires.

Part B - *The effects of permanent injury on the behaviour, diet and reproduction of injured versus uninjured baboons*

The results of this study suggest that permanent injury, typically the loss or paralysis of a hand, foot or both, has a significant effect on the behaviour of free-ranging chacma baboons on the Cape Peninsula. The percentage time spent resting and travelling was significantly higher in injured baboons than in uninjured baboons while the time engaged in feeding activities was significantly lower in injured baboons. The only behavioural category for which there was no significant difference between injured and uninjured animals was the percentage time spent performing social activities (Figure 13).

Baboons are group living mammals and while the movement patterns of individual troop members are largely dictated by the dominant troop members, even if these movements are not in the interests of the majority of the troop members (King *et al.* 2008), their social structure facilitates the movement of the troop as one unit. In addition, movement patterns of the Da Gama troop are to a large extent dictated by the baboon monitors herding activities (van Doorn 2009). Thus injured individuals are forced to travel the same distance as uninjured individual troop members if they are to remain with the troop and benefit from the advantages associated with group living (see Dunbar 1988). My results suggest that injured troop members compensated for their impaired locomotory ability relative to control individuals by spending more time travelling the same distance with significantly more time spent inactive (Figure 15). Periods of inactivity in injured troop members may well represent an attempt to recover from the effort of sustained travelling.

There are no other studies on the effect of injury on chacma baboons, however a similar study on chimpanzees (Stokes 1999; Munn 2006) suggest that injuries do not have a significant effect on the general activity budget of injured animals. This contradictory finding may be a consequence of differences in the relative abundance and distribution of food within the habitats of these two primates. The quality and distribution of resources has been found to be associated with the daily distances travelled to meet energetic needs with periods of food scarcity or poorer habitat quality leading to significantly longer travel distances (Anderson 1981; Henzi *et al.* 1992; Davidge 1978a; Barton *et al.* 1992, Hoffman & O 'Riain 2010). Similarly provisioned troops of baboons (Altmann & Muruthi 1988) and macaques (Fa 1998) typically travel less than non-provisioned troops. It is generally acknowledged that the wider the area over which a primate population's food resources are spread, the greater the daily path length will be. Tropical forests have a much higher primary productivity than the temperate fynbos biome even with the addition of exotic vegetation (Cowling *et al.* 1996; Rebelo *et al.* 2006). Chimpanzees are primarily frugivorous with fruit comprising a high percentage of the diet (Hladik 1977; Wrangham 1977). In the Sonso study troop, 57% of the year-round diet is comprised of fruit with one genus of fig accounting for 50% of the diet (Stokes 1999). The high density and asynchronous fruiting of figs facilitate an efficient feeding effort in terms of nutrients, energy and time. By contrast, terrestrial species such as baboons tend to have longer daily path lengths and larger annual home ranges than primarily arboreal species like chimpanzees (Oates 1987; Clutton-Brock & Harvey 1977). A further distinction in foraging ecology between chimpanzees and baboons is that baboons typically forage in large cohesive groups and do not subgroup unless food is scarce (Anderson 1981). As a consequence of the increased competition for food associated with group living baboons need to travel further to meet the individuals energetic needs than do solitary animals or those living in small groups, such as chimpanzees. In contrast chimpanzees are rarely cohesive and typically forage in small parties. This fission –fusion social system typical of chimpanzees would have the effect of reducing both feeding competition and travel distances for chimpanzees compared to baboons. Thus injured chimpanzees in the tropical Budongo forest may not have to travel as far or as fast on a daily basis as baboons on the Cape Peninsula. Another possible explanation for the contradictory findings on activity budget, relative to the Sonso study may be found in the nature and severity of the injuries in the two groups. Five of the seven injured baboons studied had either partial or complete loss of a limb/s while in the study by Munn (2006) on locomotion in chimpanzees, only one of the five females suffered the loss of a hand with the rest having various degrees of paralysis of the hand. In the study on feeding by Stokes (2000), three of the eight chimpanzees studied had a hand or foot missing while the rest experienced paralysis of the hand. Further Munn's study revealed that severity of injury did significantly affect the time spent moving and that two chimpanzees with severe injuries spent half as much time moving as did the rest of the group.

In the Cape Peninsula, the mean daily distance travelled by the study troops is almost double that of chimpanzees and a third longer than that reported for baboons in a typical woodland habitat. Hoffman & O'Riain (2010) reported a mean of 6.2 km with a range 1.6-11km and Davidge (1978a) reported an annual average of 7.9km for the Cape Point troop, while the day range given for chimpanzees is 3.9km (Goodall 1968) and 3km (Wrangham 1977) and the mean daily distance travelled for woodland baboons is 4.9km (Gaynor 1994). Clearly there are some days in which the troop travels substantial distances and for an animal that has suffered a severe limb injury this may prove both energetically expensive and physical uncomfortable resulting in more time spent travelling with more frequent rests and periods of inactivity. Chimpanzees with deformed limbs are known to have difficulty in keeping up with travelling groups (Goodall 1968) and those with hind limb injuries are slow and awkward in their movement (Quiatt 1996). Further, given the increase in travel time and concomitant decrease in travel speed one would expect injured baboons to be at higher risk of predation. In the Cape Peninsula, humans are the only predator and no correlation between injury and human induced mortality is apparent. However in a predator rich environment such as Moremi (Cheney *et al.* 2006) or Amboseli (Altmann & Altmann 1970) injured baboons are more likely, due to their slower and more cumbersome locomotion to fall prey to leopards or lions and less likely to survive and reproduce as successfully as uninjured baboons.

While there were no differences in any of the subcategories (i.e. foraging, handling food, ingesting food and drinking) relevant to feeding the combined data revealed that injured animals spent significantly less time engaged in feeding related behaviour than control individuals (Figure 14). A study on chimpanzees in the Budongo Forest, Uganda, showed that severe injuries did not result in a reduction in time spent feeding (Munn 2006) and that there was no significant difference in feeding efficiency (Stokes 1999). The key to efficient feeding appeared to be maximizing energy intake by targeting food items with minimum processing costs (Stokes & Byrne 2006). Injured individuals may achieve this by modifying their existing repertoire of processing skills rather than inventing novel food preparation skills (Byrne & Stokes 2002). The injured baboons in this study appeared to compensate for their reduced feeding time by feeding significantly more on raided food from anthropogenic sources compared to control individuals. The benefits of raiding for injured animals are obvious as most human derived food items have a higher calorific value, require less handling time and are more easily digested (Forthman Quick 1986) than food items from either indigenous or exotic vegetation. Raiding is however a risky behaviour for it often leads to conflict with humans and may result in either further injury or death. However the presence of researchers is thought to reduce the risk of predation by natural and human predators and conflict with humans (Altmann & Altmann

1970; Strum 1987a; Hill 2000). In this study the risks associated with raiding were thus probably ameliorated by the presence of researchers during the study period for both troops and throughout the year by the presence of monitors on the Da Gama troop. Feeding rates of injured versus uninjured baboons on ostrich pellets were not significantly different and this was achieved by the injured baboons modifying their feeding position, lying down proximal to the food source and reducing the distance from the food source to their mouth. A similar feeding technique was observed with alien seeds. The adoption of this posture whilst feeding may reduce the injured animal's ability to be vigilant for predators and living within a group may thus carry significant benefits to injured baboons. In addition the absence of natural predators, leopards and lions (Skead 1980) from the Cape Peninsula may well allow the use of this feeding technique and facilitate the reproductive success of injured baboons.

Grasses and pine cones each account for at least 20% of the food items consumed by both control and injured baboons. While control individuals spent significantly more time feeding on alien vegetation in general and pine cones specifically, there was no significant difference in the amount of grasses consumed (Figure 19). Accessing the seeds within pine cones requires considerable manual dexterity and forelimb strength and it is thus not surprising that injured animals spent less time feeding on pine cones. Grasses on the other hand require little manipulation and would be easily processed by injured and control baboons alike. Baboons have dexterous feet and injured baboons were frequently observed to use their feet to support the pine cone while processing it with their uninjured hand and or teeth. Stokes (1999) noted in her study on injury in chimpanzees that able-bodied individuals rarely used their feet in bi-manual processing while individuals with injury to one or both upper limbs used their feet significantly more than their able-bodied counterparts. While the use of feet in bi-manual processing was not quantified in this study it seems probable that baboons with injured hands use their feet as a substitute limb when feeding on pine cones. Together these results suggest that injured baboons maximize their energy intake by targeting high energy foods rather than by altering food preparation, feeding or foraging time. Injured chimpanzees were similarly shown to choose food items that gave them maximum energy with minimum processing costs (Stokes 1999).

However, the fact that injured animals show similar reproductive success to uninjured animals with four of the five adult female pairs giving birth to two offspring each and the sub-adult pair producing one infant each in the four year period (Table 18) suggests that the energetic intake of the injured baboons is adequate for the purposes of reproduction. The finding that injured individuals significantly reduced their feeding time thus suggests that they maintain a positive energy balance by improving their feeding efficiency. Injured animals in DG raided human derived food more than their uninjured counterpart while in the PR, ostrich feed pellets were the raided food item. The fact that human derived foods have nutritional advantages over wild foods such as fynbos (a nutrient poor food source (Cowling 1992)) and ostrich pellets are highly accessible and have a high protein content (14%) would suggest that injured baboons seek out high return foods as a mechanism for increasing efficiency of feeding (Appendix Table 8; Kansky & Gaynor 2000). Although injured baboons eat significantly less pine cones than control animals, pine cones still form a substantial part of their diet suggesting that they are nutritionally valued food items (Appendix Table 8). While higher rank may mediate access to higher quality food and positively impact on reproductive success, the advantage is often negated by factors such as predation, which is not correlated with rank (Cheney *et al.* 2006) and a dispersed food source which prevents monopolisation of resources (Mori 1979). In both of these troops the anthropogenic food sources, food derived from human transformed land (alien seeds) and the fall back food (fynbos) are not clumped but rather dispersed reducing the ability of individuals to monopolise such food items. Thus for example the ostrich pellets are dispersed throughout the ostrich pens effectively preventing dominant individuals from monopolising the entire resource. Furthermore, all study pairs gave birth irrespective of rank and all offspring survived the first year (only one exception), suggesting that food was not limiting to injured animals and rank mediated access to food was not a factor impacting on reproductive success. The data is inadequate to conclude that rank had no influence on long-term fertility or offspring survival. However it is apparent that injured females are not more likely to incur infanticide/infant mortality than uninjured females because infant deaths/infanticide occurred equally often in injured and in control females. Twenty infants were born between 2004 and 2007 to the six pairs of females and although eight of these died, the cause of death in six of them was infanticide. The other two deaths were human induced and injury may well have impacted on the ability of the mother to escape as in both instances the injuries impeded locomotion (entire limb loss).

Baboons are agile climbers and injured baboons were equally capable of climbing and spent an equal amount of time in the arboreal habitat as the uninjured baboons. Furthermore injured and control individuals spent a similar amount of their total time foraging for pine cones within the pine trees and on the ground. Together these results suggest that limb injuries do not prevent baboons from arboreal locomotion and accessing food within the tree canopy. Chimpanzees with forelimb injures are known to use modified but successful adaptations for moving in arboreal space (Quiatt 1996, Munn 2006). Furthermore injured baboons did not show any preference for feeding on above ground versus below ground food despite the observations by Hill & Dunbar (2002) that foraging for food items above ground rather than digging for them yielded a higher energy return on foraging effort.

Injured and uninjured baboons spent a similar amount of time engaging in social behaviours suggesting that the maintenance of social bonds is equally important to both categories of baboons. While allo-grooming is regarded as a strategy to reduce anxiety in primates and may decrease stress by releasing endogenous opiods (Shutte et al. 2007; Wittig et al. 2008) self-grooming is part of a suite of self directed behaviours (yawning, scratching) that correlate positively with anxiety and may be indicators of stress in non-human primates (Castles *et al.* 1999; Maestripieri *et al.* 1992). In my analysis of grooming behavior I excluded infant grooming bouts as maintenance of social bonds was not the primary motivation. My finding that there was no significant difference in the percentage of time allocated to self-grooming and indeed all grooming behaviours for injured versus control individuals is surprising as one might expect injured baboons to be more stressed and have higher levels of social vigilance because of reduced competitive ability. I considered social vigilance in the study animals and found that injured individuals did not increase their social vigilance relative to uninjured baboons. While the reasons for this are not clear, it is possible that where food is not scarce or clumped and competition for food is not high that group members are tolerant of injured individuals. Furthermore proximity to female kin or to a male friend may provide injured baboons with social support. Proximity to female kin in baboons has been shown to increase offspring survival and enhance the lifetime fitness of baboons and sociality with female kin is thought to reduce stress in baboons (*Silk* et al 2003, Silk et al 2009). Female baboons are known to stay close to adult males that may protect them from harassment and their offspring from infanticidal attacks (Smut 1985, Palombit et al 1997, Palombit

1999). There is also some evidence of supportive behaviour toward injured individuals in spider monkeys (Chapman & Chapman 1987) and Japanese monkeys (Berkson 1973) where conspecifics engaged in supportive behaviour toward the injured individual. While I noticed examples of supportive behaviours (e.g. siblings carrying or waiting for an injured juvenile) between all troop members and injured juveniles there was no evidence of support between troop members and injured adult females.

A study on chimpanzees (Reynolds et al. 1965) suggests that injury reduces the social rank of an individual. Inferring a change in rank necessitates rank data on individuals before and after they sustain an injury. I had only one example of this – a top ranking adult female in the Da Gama troop, Ellie, who had her hind limb amputated following a gunshot wound and a subsequent fall from a building. Ellie was absent from the troop for a six-week rehabilitation period (Table 10a and 10b). Following her return to the troop her rank dropped by two places to third highest in the troop. It is possible that the loss of social status was a result of being away from the troop for a sustained period and/or her injury.

While injury to any part of the fore- or hindlimb appears to affect the behaviour of baboons it does not appear to adversely affect the reproductive success of adult females, viz. the number of young surviving to weaning. This is testimony to the remarkable adaptability of baboons, a trait that has enabled them to live in almost every known habitat type within Africa including those heavily impacted by both agricultural and urban human land use practices. It is likely that in the absence of high quality human foods and nutrient rich exotic vegetation and with the introduction of natural predators that the impact of injury on Cape Peninsula baboons would have a more marked negative effect on their reproductive potential. Fortunately there are very few seriously injured baboons in Cape of Good Hope section of the Table Mountain National Park which is characterized by the nutrient poor indigenous fynbos vegetation and an almost complete lack of alien vegetation. Under these circumstances the physical limitations imposed by injury, and the limited capacity of injured individuals to compensate manually for loss of function, may result in injured individuals having reduced reproductive success.

CONCLUSIONS

1. My results revealed that while the population numbers on the Peninsula are fairly stable there is dramatic variation at a regional level with the southern subpopulation experiencing double the mortality of the northern subpopulation. Most importantly numbers increased from 370 baboons in 11 troops in 2005 to 419 in 14 troops in 2008.

2. Most deaths were directly attributed to humans and varied from 50% in 2005 to 71% in 2008. The most common causes of human induced death were motor vehicle accidents, gunshots, power lines, domestic dogs and poisoning. Troops that experience frequent contact with humans both inside and outside of the Cape of Good Hope section of the Table Mountain National Park have the highest levels of human induced mortality. However only troops outside the Park have animals with permanent injuries.

3. There was a significant positive relationship between the mean number of injuries and the mean number of deaths for the seven troops outside of the Cape of Good Hope section of the Table Mountain National Park. This suggests that injuries can be used as an indicator of troops with a high risk of mortality.

4. Troops whose home ranges encompassed above ground power lines had higher numbers of deaths due to electrocution and electrical burns leading to permanent limb mutilations. 64% of human induced injuries were directly attributed to burns sustained following contact with above ground power lines.

5. Permanent injury, in particular the loss of a hand, foot or limb, had a significant effect on the behaviour of baboons living on the Cape Peninsula. Injured baboons spent more time resting and travelling than their uninjured counter parts and less time feeding.

6. Injured baboons reduced their energy output/conserved energy by travelling more slowly and resting more often. To compensate for the reduced time available for foraging, the injured baboons adopted a time minimizing strategy and targeted high return foods.

7. Injured and uninjured baboons forage for and ingest the same diverse array of food items. However food items that are more difficult to process constitute a smaller percentage of the diet of injured baboons relative to uninjured individuals.

8. It seems that injury does not impact on the reproductive success of the injured animal either by diminished nutritional status as a result of compromised foraging ability or by impacting on infant care. Over a four-year period all five pairs of adult females reproduced twice while the sub-adult pair reproduced once. While birth rate was not compromised, survival rate of infants was impacted on by infanticide and human induced death in both injured and uninjured animals in an adult female pair of low rank and the sub-adult female pair.

9. Social behaviour is highly conserved despite an expectation that injury would result in loss of competitive ability and a consequent increase in anxiety in injured individuals. While the loss of rank that occurred in one of the high ranking females subsequent to her being injured supports this, the lack of any significant difference in grooming or social vigilance behaviour is contrary to expectation. The latter finding may only hold true in a food rich environment as experienced by these troops (and supported by the reproductive success of both injured and control animals), where competitive ability for food is not as critical.

10. The occurrence of deaths and mutilations attributable to burns sustained from contact with medium voltage power lines is cause for concern in particular as they occur repeatedly in 4 of the 11 troops with the incidence of electrical burn injuries in these troops ranging from 8.5% to 36%. The data from this study should be used to advise the authorities of the importance of improving the insulation of power lines and preventing baboons from experiencing these mutilations and electrocutions.

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APPENDIX

Table 1: Age & sex class classification for Chacma baboons (adapted from Altmann *et al.* 1977)

Class	**Age in years**	**Physical characteristics**
Infant 1	0 - ½	Hair black (natal coat). Skin, ears, nose and scrotum (males) pink. Clings to belly of female.
Infant 2	½ - 1	Hair grey/brown. Skin pigmented black. Eyebrows change colour becoming brown. Clings to belly and rides on the back of the mother.
Juvenile 1 male and female	1 - 2	Not sharply demarcated from Infant 2. Eyebrow ridge becomes grey. More independent but still rides on the mother's back.
Juvenile 2 male and female	2 - 3	Fur grey brown like an adult. Females: Ischial callosities separated into two round bum pads. Males: Ischial callosities form a horizontal figure 8 bum pad.
Juvenile 3 female	3 - 4.5	Fur grey brown like an adult. Nipples not developed, button like at the end of this period.
Juvenile 3 male	3 - 4	At the end of this period the canines extend beyond tooth row and the male is bigger than a female.
Sub-adult female	4.5 - 5.5	First sexual cycle begins; nipples button-like.
Adult female	5.5 plus	Sexually mature: sexual skin swells periodically. Regarded as adult from birth of first infant. Nipples elongated in more mature females and may show loss of colour in older females.
Sub-adult male	4 - 7	Development of secondary sexual characteristics: mantle, canines, nose ridges, larger than an adult female, angular shape.
Adult male	over 7	Secondary sexual characteristics fully developed. Physical bulk increases and thickness of neck.

Table 2: The hours of observation of the seven injured and control pairs

Matched pair	**1**	**1**	**2**	**2**	**3**	**3**	**4**	**4**		
Da Gama Troop	**Kate**	**Crook**	**Marilyn**	**Penelope**	**Amy**	**Thami**	**Lucy**	**Ellie**	**Total**	**Average**
Hours	**Control**	**Injured**	**Control**	**Injured**	**Control**	**Injured**	**Control**	**Injured**	**hours**	**hours**
Actual observed	46.60	47.90	33.90	41.00	24.70	28.00	39.30	41.70	303.10	37.89
Observed plus Not visible	50.10	49.80	38.80	45.80	31.50	30.90	44.80	44.90	336.50	42.08
Total observed	61.70	59.20	54.80	56.10	42.80	39.40	53.10	53.40	420.50	52.56
% Not visible	5.67	3.21	8.94	8.56	15.89	7.36	10.36	5.99	7.94	8.25
% 'Other'	18.80	15.88	29.20	18.36	26.40	21.57	15.63	15.92	19.98	20.22
% Not visible and Other	24.47	19.09	38.14	26.92	42.29	28.93	25.99	21.91	27.92	28.47

Matched pair	**5**	**5**	**6**	**6**	**7**	**7**		
Plateau Road Troop	**Nanda**	**Beatriz**	**Olivia**	**Paula**	**Manuel**	**Pedro**	**Total**	**Average**
Hours	**Control**	**Injured**	**Control**	**Injured**	**Control**	**Injured**	**hours**	**hours**
Actual observed	45.90	51.00	45.60	49.60	34.80	39.10	266.00	44.33
Observed plus Not visible	60.40	62.50	60.60	57.60	46.80	46.50	334.40	55.73
Total observed	71.90	75.30	71.40	71.80	55.10	55.90	401.30	66.90
% Not visible	20.17	15.27	21.01	11.14	21.78	13.24	17.04	17.10
% 'Other'	15.99	17.00	15.13	19.78	15.06	16.82	16.67	16.63
% Not visible and Other	15.99	17.00	15.13	19.78	15.06	16.82	16.67	16.63

'Other' includes: the time taken to initiate the Start and End of each observation period on the palm computer as well as to record the oestrous states of the females in the troop and any equipment problems e.g. battery failure.

Table 3a: A record of the infant births for injured and control individuals, 2003 -2008: A- injured ; B-control; L-lactating; C-cycling; P-pregnant; INF-infanticide; HID- human induced death ; TL-tubal ligation; (M)- male, (F)- female: sex of infant; (18)- inter-birth intervals in months

	Year	2003	2004	2005	2006	2007	2008
Name	Status		Births	Births	Births	Births	Births
Paula	1A		Sep (F)	L P Sep	Feb (18) (F)	L	Jan(23)
Olivia	1B		Sept (F)	L P Sep	Feb (18) (F)	L	Jan(23)
Beatriz	2A		Dec (F)	L P Dec	June (19)	L	P
Nanda	2B		Oct (M)	L P Sep	Feb (18) (M)	L	P
Ellie	3A		Feb stillborn Injury: TL	C	Jul(29) (M)	L	C
Lucy	3B		Aug (M)	L C May	Jul (24) (F)	L	?
Crook	4A		nulliparous	Jul (0) INF Jul P Oct	March (8) (F) INF Sep	P Jan	Dec
Kate	4B		Dec (0) Stillborn	Sep (9mths) Stillborn C Oct	C	P Jan	
Penny	5A	Sep	L	Jan (17)(M)	Nov (22) INF Dec	C	Sep
Marilyn	5B	Nov	L	Mar (18) (M)	Dec (21)	INF Jan	
Thami	6A		nulliparous	Nov (0) (M)	L HID June	P Jan	Sep
Amy	6B		nulliparous	Nov (0) (M) INF Nov	Oct (11) (F) INF (?)	P Feb	?

Table 3b: A record of infant mortalities for injured and control individuals, 2004 -2008

Individual	Category	Birth	Death	Cause	Natural/Human induced death
Ellie	Injured	February 2004	February 2004	Stillborn	Natural death ND
Kate	Control	December 2004	December 2004	Neonate mortality	Natural death ND
Kate	Control	September 2005	September 2005	Stillborn	Natural death ND
Crook	Injured	July 2005	November 2005	Unknown	Human induced death HID
Crook	Injured	March 2006	September 2006	Infanticide	Natural death ND
Penny	Injured	December 2006	December 2006	Infanticide	Natural death ND
Marilyn	Control	December 2006	January 2007	Infanticide	Natural death ND
Amy	Control	November 2005	November 2005	Infanticide	Natural death ND
Amy	Control	November 2006	November 2006	Infanticide	Natural death ND
Thami	Injured	July 2006	July 2006	Car	Human induced death HID
Beatriz	Injured	2007	2007	Possible infanticide	Natural death ND
Nanda	Control	2007	2007	Possible infanticide	Natural death ND

Table 4: Agonistic and submissive behaviours used to decide the winner and loser in dyadic interactions used to determine rank

WINNER		LOSER	
Social aggressive (dominant) behaviours		**Social submissive (submissive) behaviours**	
Chase	Pin to ground	Displaced	Solicit aid
Displace	Eyelid flash	Being chased	Fear scream
Stare	Attack	Fear grin	Run away
Slap ground	Bite	Biten	Hurry past
Threaten	Head bobbing	Avoid	Fear geck
Hit	Mount	Nervous glance	Present
Presented to (by other)	Yawn	Startle away	Tail away
		Run for protection to	

Table 5a: Winner versus loser interactions for Da Gama troop after Ellie's injury, August 2004 – July 2005

LOSER	Kate	Frida	Ellie	Crook	Lucy	Dara	Zoey	Asticka	Grace	Marylin	Thami	Amy	Sadie	Penelope	Total
Kate		1	3	1			1					1			7
Frida	3		2		1					1					7
Ellie	8	4			1										13
Crook	9	3	15		1				1	1			1		31
Lucy	14	4	10	6		1									35
Dara	6	2	4		5				1						18
Zoey	8	9		7	3	2									29
Asticka	5	5	2	6		1	3								22
Grace	4	3	10	8		1	3	1			1				31
Marylin	2	1	4	3	3	8	3	9	2						35
Thami	1	2	1	1	1	1	1	2							10
Amy	2			2	2				3		1				10
Sadie	1	2	1	3		4	6	1			1				19
Penelope	1	1	2		2	1	3	4	7						21
Grand Total	64	37	54	37	19	19	20	17	14	2	3	1	1		288

Table 5b: Winner versus loser interactions for Da Gama Troop from before Ellie's injury, April 2004 – July 2004

LOSER	Ellie	Kate	Frida	Crook	Lucy	Dara	Zoey	Grace	Asticka	Marylin	Thami	Sadie	Amy	Penelope	Total
Ellie		8	7	1	1										17
Kate	11		1	2			3						1		18
Frida	9	3			2					1					16
Crook	20	13	5		7	1		1		1		1			49
Lucy	14	20	6	19		3									62
Dara	7	14	3		5			1		2					32
Zoey	5	11	10	11	4	4									45
Grace	12	8	3	10		2	4		1		1				42
Asticka	2	7	5	6	2	1	3	4		1					32
Marylin	4	4	3	7	3	9	7	3	9						49
Thami	1	2	3	1	1	1	2		2						13
Sadie	3	3	4	5	1	8	7		1	1	1				36
Amy		2		2	2			3			1				10
Penelope	2	3	1	2	4	1	4	7	4						28
Grand Total	90	98	53	66	32	33	32	19	17	6	3	1	1	0	457

Table 5c: Winner versus loser interactions for Plateau road troop, 2004 -2005

LOSER	Paula	Beatriz	Nanda	Olivia	Gigi	Susana	Elisa	Xana	Raquel	Carolina	Julia	Ursulina	Margarita	Daniela	Total
Paula						1		1							2
Beatriz	13											1			14
Nanda	11	2										1			14
Olivia	9	4	5				1								19
Gigi	5	2	4	3		1	1			1	1				18
Susana	17	6	6	5	20					1		1			56
Elisa	13	9	8	5	9	3		4	3	3	2	4	2		65
Xana	9	2	4	1	10	16	9		5	2		3	1		62
Raquel	5	2	7	2	9	8	11	5			3	2		1	55
Carolina	3		6	2	11	11	4	3	2		1	1			43
Julia	8	5	5	1	11	5	6	10	9	1			1	1	63
Ursulina	3	5	8	4	9	5	7	6	1	7	5				60
Margarita	10	2	10	3	5	12	12	9	5	8	2	3			81
Daniela	4	1	1	2	3	4	4	8	3	2	1	1	15		49
Total	110	40	64	28	87	66	55	46	28	25	14	17	19	2	601

Table 6: Percentage time that DG spent feeding on food items for the period May – November 2005

Da Gama Individuals	**Kate**	**Crook**	**Marilyn**	**Penelope**	**Lucy**	**Ellie**	**Amy**	**Thami**	**Total**
Alien berry	0.00	0.65	0.07	0.00	0.00	0.00	0.00	0.00	0.11
Alien flowers	0.00	0.70	1.50	0.00	0.00	0.00	0.72	1.71	0.50
Alien leaf	0.57	1.10	0.13	0.00	0.80	0.00	3.35	0.00	0.73
Alien pine cone	29.78	18.38	26.50	20.68	30.34	16.69	30.17	19.25	24.22
Alien pine cone seed	3.70	0.26	0.29	0.07	0.28	0.12	1.17	0.00	0.93
Alien pinenut	8.68	15.45	5.33	9.13	4.76	3.13	0.49	0.00	6.64
Alien rooikrans seeds	2.46	3.47	2.33	2.66	4.17	5.31	15.55	13.23	5.55
Alien root/bulb	0.45	5.54	0.00	0.00	0.00	0.16	0.00	0.46	0.98
Alien seed sprout	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.04
Alien stem/bark	1.79	0.28	0.05	0.00	0.00	0.06	0.00	0.00	0.38
Alien stink bean	0.27	0.00	1.33	1.55	0.00	0.85	0.00	0.00	0.47
Alien unknown	4.37	5.20	1.01	1.86	2.94	4.43	5.89	11.92	4.57
Charcoal	1.17	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.26
Clay	0.48	0.23	0.00	0.00	0.20	0.95	0.28	0.00	0.28
Fruit	1.72	0.09	2.29	2.67	2.65	3.99	2.62	1.74	2.11
Fybos erica	0.00	0.00	0.11	0.00	0.00	0.00	0.00	1.63	0.17
Fynbos berry	2.97	2.43	1.49	7.74	0.63	0.38	0.38	0.05	2.22
Fynbos flower	3.61	1.24	7.87	3.52	1.42	2.34	9.90	5.56	4.06
Fynbos leaf	1.41	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.33
Fynbos oxalis	0.00	0.00	0.00	0.76	0.00	0.00	0.11	0.00	0.11
Fynbos pelargonium	1.53	1.80	0.02	2.66	0.40	0.00	0.00	0.00	0.95
Fynbos protea	1.17	1.19	4.17	4.16	11.92	7.79	4.85	3.89	4.61
Fynbos restio seeds	0.08	0.29	0.07	0.48	0.78	0.00	1.42	0.80	0.45
Fynbos restio stem	0.92	0.69	0.20	0.00	0.00	0.98	1.72	1.22	0.69
Fynbos root/bulb	8.47	0.34	2.61	2.61	8.13	6.02	2.69	1.12	4.30
Fynbos sour fig	0.74	1.38	0.94	0.00	0.00	0.22	0.73	4.72	1.00
Fynbos stem/bark	0.63	0.48	0.00	0.00	0.00	0.27	0.00	0.55	0.27
Fynbos unknown	1.42	5.89	6.51	1.16	4.75	9.23	1.96	9.21	4.67
Fynbos watsonia bulb	0.32	0.18	5.28	1.73	0.00	0.87	4.01	2.23	1.54
Grass or weed	14.31	21.87	24.36	25.06	21.49	27.48	8.24	12.40	19.37
Grass or weed root/bulb	3.99	2.39	1.01	1.64	0.37	1.12	0.75	0.00	1.65
Horse hay	0.97	0.50	1.04	3.28	0.35	2.88	0.03	2.87	1.42
human food	0.14	4.30	0.39	0.44	1.96	2.23	0.08	3.03	1.58
Invertebrate	0.18	0.12	0.00	0.67	0.07	0.74	0.00	0.38	0.26
Mushrooms	1.55	3.54	1.43	1.97	0.59	0.60	1.78	2.03	1.74
Nest	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.11
Oak bark	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.04
Uknown leaf	0.00	0.00	0.07	0.79	0.07	0.00	0.00	0.00	0.12
Unknown Berry	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.02
Unknown flower	0.00	0.00	0.30	0.27	0.00	0.42	0.00	0.00	0.11
Unknown root/bulb	0.15	0.00	0.91	1.51	0.81	0.28	0.00	0.00	0.45
Unknown stem/bark	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.01
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 7: The percentage time that PR spent feeding on food items for the period May - November 2005

Plateau road	**Nanda**	**Beatriz**	**Olivia**	**Paula**	**Manuel**	**Pedro**	**Total**
Alien berries	0.0	0.0	0.0	0.7	0.0	0.0	0.13
Alien flowers	1.7	0.2	0.0	1.4	1.6	0.0	0.79
Alien leaf	0.0	0.0	0.0	0.0	0.1	0.0	0.01
Alien pine cone	15.4	7.6	8.5	2.8	15.6	17.0	9.8
Alien pine cone seed	0.0	0.0	1.3	0.2	0.0	0.0	0.31
Alien pinenut	1.1	0.6	2.2	6.3	7.9	0.4	2.6
Alien rooikrans seeds	10.9	13.0	8.8	4.1	1.4	3.5	8.5
Alien root/bulb	2.0	0.2	0.5	0.0	0.0	0.0	0.58
Alien stem/bark	0.0	1.2	0.8	0.0	1.0	0.3	0.56
Alien stinkbean	2.3	0.8	5.7	3.5	3.0	0.0	2.70
Alien unknown	7.1	2.1	4.2	4.5	0.0	1.9	3.84
Bread	0.0	0.0	0.0	0.0	0.0	1.0	0.08
Cactus	0.0	0.0	0.3	0.0	0.0	0.0	0.05
Candy paper	0.0	0.0	0.0	0.0	0.2	0.0	0.02
Clay	0.2	0.0	0.3	0.0	0.0	0.1	0.11
Clover	0.0	0.5	0.0	0.0	0.0	0.0	0.13
egg	0.0	0.0	0.1	0.8	0.1	0.0	0.17
Fruit	1.0	0.1	0.0	0.2	2.4	1.5	0.55
Fybos erica	0.6	0.3	0.7	0.0	0.0	0.7	0.39
Fynbos berry	0.8	2.7	2.9	1.9	0.0	0.0	1.78
Fynbos flower	0.3	4.1	2.6	3.2	5.5	2.0	2.80
Fynbos oxalis	2.2	2.1	1.6	1.3	0.0	0.0	1.56
Fynbos pelargonium	1.0	0.4	0.0	0.2	0.0	0.0	0.34
Fynbos protea	1.7	1.5	1.1	4.0	0.1	0.0	1.74
Fynbos restio seeds	0.4	0.2	0.3	0.4	0.0	0.0	0.27
Fynbos restio stem	0.0	0.4	0.1	0.6	0.0	7.7	0.82
Fynbos root/bulb	3.4	4.9	9.1	13.4	2.9	0.0	6.53
Fynbos sour fig	1.9	5.1	4.3	2.3	2.8	2.0	3.34
Fynbos stem/bark	0.0	0.2	0.3	1.5	0.0	0.0	0.42
Fynbos unknown	1.7	2.0	2.3	2.7	0.1	0.6	1.88
Fynbos watsonia bulb	0.0	1.4	0.6	0.9	0.0	6.4	1.11
Grass or weed	21.1	17.8	17.9	16.2	31.0	34.5	20.42
Grass or weed root/bulb	6.0	3.5	5.6	3.8	9.9	0.3	4.72
Honey	0.4	1.0	0.0	0.2	0.0	0.0	0.38
Human food	0.2	0.0	0.0	0.9	0.5	0.0	0.26
Invertebrate	0.7	1.0	0.4	0.3	0.0	0.0	0.54
Mushrooms	0.6	2.7	3.0	0.8	0.7	0.2	1.65
Ostrich pellets	14.9	19.5	14.1	17.5	11.6	19.9	16.54
Unknown flower	0.0	0.9	0.0	0.0	0.0	0.0	0.23
Unknown leaf	0.0	0.4	0.0	0.0	1.5	0.0	0.22
Unknown root/bulb	0.5	1.3	0.4	3.3	0.0	0.0	1.15
Unknown stem/bark	0.0	0.0	0.0	0.1	0.0	0.0	0.02
Grand Total	100.0	100.0	100.0	100.0	100.0	100.0	100.00

Table 8: Nutrient content of food items sourced from alien vegetation or human derived food

Food item	Protein/100gm	Fat	Carbohydrate	Fibre	Energy 100g
Ostrich pellets	14g	2.5g		16.5g	316kJ
Black wattle seeds *Acacia mearnsii*	18.5g				1900kJ
Pine nuts *Pinus pinea*	21.3g	50.6g	19.7g		26607kJ

Table 9: Causes of death /injury in 11 troops in the Cape Peninsula population for the period 2004-2008

Year	Troop	HID/INJ	ND/INJ	Dead	INJ	INF	ND	Missing	Car	Dog	Gun	Poison	P/lines	Disease
2004	BB	2		2				2						
2005	BB	1		1				1						
2006	BB	2	2	4		2		1	1					
2006	CP	3	4	7		3	1	2			1			
2007	CP	1	5	6		3	2	1						
2008	CP	1	2	3		2			1					
2005	KK		1	1			1							
2007	KK		1	1			1							
2006	KOB		1	1			1							
2005	GOB	1		1					1					
2006	GOB	5	1	5	1	1				3			2	
2007	GOB	3	2	5		2					1	1	1	
2008	GOB	2		1	1					1			1	
2005	PR		4	4		3	1							
2004	PR	2		1	1								2	
2004	PR		2	2		1	1							
2005	PR	1			1								1	
2006	PR	3	1	4		1		1	1	1				
2007	PR	3		1	2						1		2	
2008	PR	4		4				1	2		1			
2005	SWB	1			1								1	
2006	SWB		1	1			1							
2007	SWB	2		2					2					
2008	SWB	3	2	5		2		2		1				
2006	RH	2	1	2	1	1							2	
2007	RH	3		2	1								3	
2008	RH	1	1	2		1								1
2005	SK	2		2							1		1	
2006	SK	4	1	5		1						3		1
2007	SK	1		1					1					
2008	SK	1	4	5		3	1			1				
2004	DG	1	2	3			2				1			
2005	DG	3	1	4			1		1		2			
2006	DG	4	4	8		3	1		1	1	2			
2007	DG	4	2	5	1	2					2		2	
2008	DG	4	1	5		1		1	1				2	
2005	TK	2		1	1				1				1	
2006	TK	4	4	7	1	3	1		3				1	
2007	TK	3		2	1					1			1	1
2008	TK	7	1	8		1			4	3				
	Total	86	51	124	13	36	15	12	20	12	12	4	23	3

Abbreviations: HID- human induced death/injury; ND- natural death; INJ- injured; INF- infanticide; P/lines- power lines

Plate 1 - 2: Examples of mortalities as a result of human conflict with baboons in the Cape Peninsula.

This female baboon was shot by a resident for taking a piece of chocolate cake (visible in the picture)

Plate 1

A female baboon: victim of a gunshot.

Plate 1

A female baboon: victim of a motor vehicle accident.

Plate 3 5: Photographic examples of permanent injury in Cape Peninsula baboons.

Power line burns on baboons typically result in injury or loss of limb extremities. In Plate 3 & 4 below I provide photographic examples of burn casualties that have resulted in either the death or permanent mutilation of baboons living within the peninsula (Plate 3 and 4)

Pedro, 2 years old, showing his charred forearm. January 2005

Plate 3:

Trauma resulting from an electric burn to the left forearm and right foot that culminated within 6 weeks in the permanent loss of the hand and foot in the study animal "Pedro".

Pedro, Plateau Road Troop, March 2005

A burn wound

Pedro, 4 years old, missing a hand and a foot, 2007.

Burns from electric power lines typically present as multiple injuries (Plate 4a and 4b).

Plate 4 a:

A close-up view of multiple injuries caused by an electric burn. This female baboon was captured a week after being burnt, she developed septicaemia and was euthanased.

Da Gama, March 2007

Plate 4b:

The view of a dead juvenile female baboon showing the loss of the right foot and exposure of the tibia and fibula due to an electric burn. She was captured two weeks after the trauma and died as a result of septicaemia.

Red Hill Troop, November 2007.

Baboons are inherently resilient and some survive their injuries and adapt to life without limbs even reproducing successfully. The four study baboons below, two without a leg and two with hand injuries, successfully produced offspring (Plate 5).

Plate 5

Four study baboons; Penny - missing a hand from an electric burn; Crook - mutilated hand of unknown origin; Ellie - amputated leg resulting from a gunshot; Thami - amputated leg from a gunshot.

Da Gama 2005

THE BABOON MONITOR PROGRAMME

As a result of the severity of baboon: human conflict in the Cape peninsula (Kansky & Gaynor 1998) a Baboon Management Team (BMT) was established by the authorities to reduce baboon: human conflict. The BMT was composed of representatives of the three local conservation authorities in the Cape Peninsula: Table Mountain National Park, Cape Nature and the City of Cape Town as well as representatives from civil society where conflict was rife and biologists with relevant experience in baboon biology. A baboon management plan was formulated by these stakeholders which included amongst other recommendations (Kansky & Gaynor 2000) the use of baboon monitors to actively herd baboons away from urban areas. Of these management options, baboon monitors, held the potential for the greatest reduction in conflict.

The monitors function to actively herd baboons out of residential areas thus preventing them from accessing human derived foods. The guidelines for monitors (Kansky & Gaynor 1998) were formulated taking in to account baboon behavioural ecology and socio-biology and accommodated natural foraging while herding the baboons away from the urban fringe.

Although studies have indicated that baboon monitors are effective in their goal of reducing raiding (Kansky & Gaynor 1998, 2000; van Doorn 2009) and the program offered employment to unskilled South Africans, it requires a large budget and has as a consequence been beset with management problems ever since inception.

Plate 6: A baboon monitor, Mzukis Nkewu, assists with an urban capture of a dispersing male.