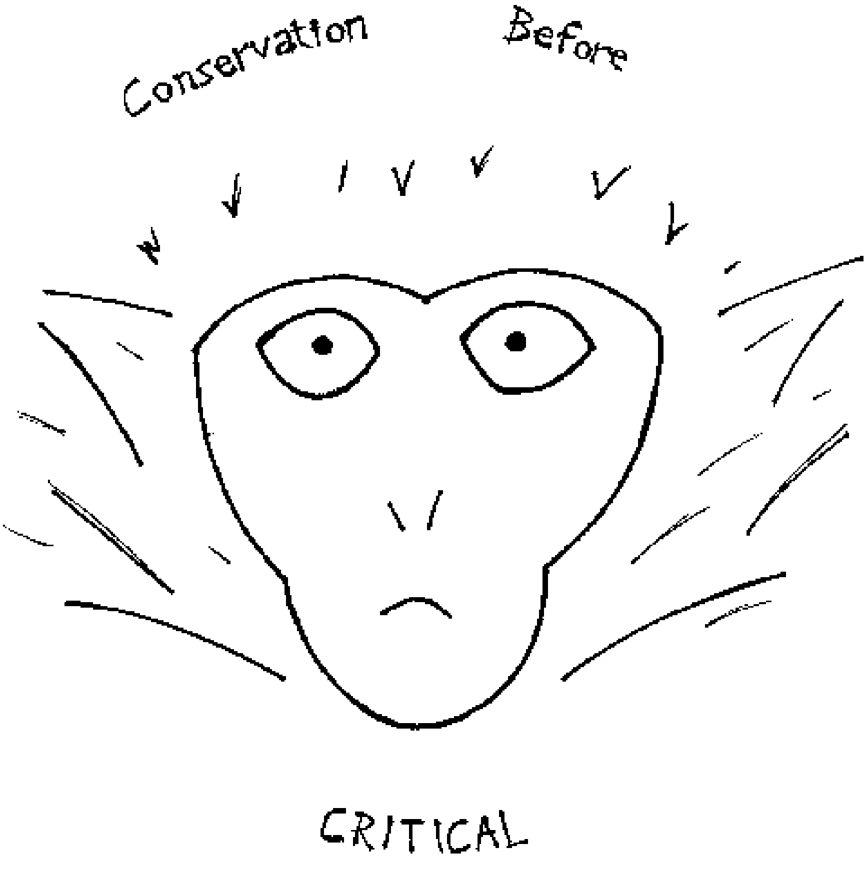
Conservation of vervets, Africa's most ubiquitous primates



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For Dino

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Abstract

When conservation concerns are multiple but budgets finite, conservation priority setting is often linked to the threat status of a species. Here, I aim to make a case for proactive conservation of common species. Vervets are ecologically flexible, widespread, relatively abundant monkeys with few major threats. Data were obtained through systematic literature reviews (habitat use, crop-raiding), analysis of CITES trade records (international trade, trophy hunting), websites and internet posts (trophy hunting) and direct observations at the Vervet Monkey Foundation (VMF) in South Africa (rescue centre intake).

Vervets occupy mangroves in Guinea-Bissau, Côte d'Ivoire, The Gambia, Senegal, and, to a lesser extent, Tanzania and Kenya. A potential habitat shift extension has been observed in Côte d'Ivoire where vervets were observed outside their previously described range.

Vervets dominate the CITES-reported international trade in individual primates of African origin, accounting for 35% of captive-bred trade and 51% of wild-caught. Although hunting only accounts for 3% of wild-caught trade, it has been increasing, particularly over the last decade. Baboons and vervets dominated with 100 hunting establishments in 9 countries offering vervets. They are the cheapest primate to hunt and are often 'opportunistic' kills offered free of charge.

Farmers rank vervets as problem animals with reported damage ranging from 2-20% of crops; the most common crops grown were also the most common crops raided by vervets. Intake in the VMF amount to almost 200 vervets over a decade, some injured (vehicle collision, shooting), most orphan infants.

Combined these results imply that, while vervets are common and adaptable, they face a plethora of anthropogenic risks because of their ability to exploit human-altered environments. It suggests we need to pay more attention to common species, their extraction, and, perhaps most importantly, try to address human-monkey conflict and the associated perceptions and obstacles to conserving common species.

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1. General Introduction

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1.1 Conservation before critical: An argument for proactive conservation to keep common species common

Biodiversity conservation policies are set in an environment of crisis and scientific uncertainty with irreversible losses at stake. There are varied approaches to priority setting in conservation that, in the main, are seeking to decide where, when, for what and how we are to focus our resource and efforts. These include but are not limited to: the hotspots approach (Myers et al., 2000; Bowen-Jones and Entwistle, 2002; Price, 2002; Mittermeier et al., 2011; Banks-Leite et al., 2014; Bellard et al., 2014; Durant et al., 2014; Liu et al., 2017; Pardo et al., 2017), conservation by proxy, i. e. umbrella species, flagship species, keystone species, etc. (Simberloff, 1998; Caro and O'doherty, 1999; Walpole and Leader-Williams, 2002; Caro et al., 2004; Clucas, McHugh and Caro, 2008; Boates and Fenton, 2011; Smith et al., 2012; Root-Bernstein et al., 2013; Roberge, 2014; Veríssimo et al., 2014; Bennett, Maloney and Possingham, 2015; Kalinkat et al., 2017; Senzaki et al., 2017) and prioritising the conservation of phylogenetically significant units (Moritz, 1994; Fabuel et al., 2004; Bonin et al., 2007; Isaac et al., 2007). There is not a systematic approach that has reached a general consensus in the conservation community and the merits of various strategies are widely discussed and debated (Gärdenfors et al., 2001; Hoekstra et al., 2005; Harris, Jenkins and Pimm, 2005; Brooks et al., 2006; Halpern et al., 2006; Miller et al., 2006; Rodrigues et al., 2006; Naidoo et al., 2008; Sitas, Baillie and Isaac, 2009; Pimm et al., 2014; Jenkins et al., 2015). Though there are several approaches to priority setting that do not focus solely on species (coldspot approach and landscape scale conservation, for instance), the species has become the logical target for conservation efforts as it is a measurable unit and has public appeal. There is a general recognition of the species as the unit of conservation in terms of management and assessment (Mace, 2004). Funding decisions and the setting of conservation priorities are often based on a species' threat status, as this is often the only information available (Possingham et al., 2002). Therefore, threatened species lists have inevitably become a central part of decision-making processes. The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (hereafter referred to as the IUCN Red List) is generally accepted as the standard for species global extinction risk (Agapow et al., 2004; Mace, 2004; Rodrigues et al., 2006; Hoffmann et al., 2008). Though the IUCN Red List it is not intended to be used in isolation for the setting of conservation priorities and responses, there is now an inevitable and inseparable link between the two (Mace and Lande, 1991; Mace, 2004; Bland et al., 2015; Rodríguez et al., 2015). It influences legislation on national, sub-national and regional levels, as well as informing multilateral agreements such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the RAMSAR Convention on Wetlands, the Convention on Biological Diversity, etc. It informs development and conservation planning in regional and national resource management; for example, the IUCN Red List is central to the Environment Impact Assessment process and can even guide site-level management and planning (Eken et al., 2004; Vié et al., 2009). Threat status is assigned based on the severity of the need for conservation intervention to ensure the survival of a species. Logically, it follows that the greater the threat status of a species the greater will be the investment in its conservation. Threatened taxa will be allotted greater resources while common species are a lower priority. Here, I will argue the merits of proactive conservation of Least Concern species, i.e. species that have been assessed following IUCN Red List criteria and that are deemed not to be threatened at a global level.

Commonness in itself is rare (Gaston, 1994; Gaston and Fuller, 2008). Not only is there a minority of common species at any one time, but most species never become common, or when they do it is only transient (Gaston, 2011). As a general rule, common species account for a very high proportion of the total number of individuals in taxonomic assemblage. And it is not unusual, from local to continental extents, for 50% of the individuals in an assemblage to be accounted for by less than 10% of the species, the most abundant 25% of species account for more than 80% of the individuals, and 50% of the locality records are accounted for by the most widespread 25% of species (Mackie et al., 1995; Robinson, Brawn and Robinson, 2000; Battersby, 2005; Condit, Hubbell and Foster, 2005; Hanski and Cambefort, 2014). And at a finer resolution of recording spatial extent, the lower percentages of occurrence will grow to converge with those for abundance (Gaston, 2011). Even in tropical assemblages, generally characterised by species rarity, the most common species still account for high proportions of total numbers. Though a species can be locally common but narrowly distributed or widely distributed but locally scarce, often species that are common in terms of abundance are also common in terms of distribution (Gaston, 2003).

There has been a recent increase in the study of common species due in part to concerns about declines in populations of common species and their potential ecological consequences (Gaston, 2010; Chapman, Tunncliffe and Bates, 2017; McGeoch, Latombe aand Hui, 2017; Wood, McKinney and Loftin, 2017). The ecological roles of common species; their conservation value both ecological and evolutionary; and their potential for promoting public engagement are not to be underestimated.

It may be that rare and common species contribute equally to diversification, but through different routes. There are arguments that commonness may actually hinder evolutionary diversification (Gavrilets, Li and Vose, 2000; Jablonski and Roy, 2003). It is thought that common species are an important source of evolutionary novelty (Gaston, 2011). Evolutionary novelty is defined as "*any newly acquired structure or property that permits the performance of a new function, which, in turn, will open a new adaptive zone*" (Mayer, 1963: but note that definitional diversity associated with the concept of evolutionary novelty, has led to contradictory claims as a novel trait according to one definition is not a novel trait according to another: Brigant and Love, 2012). Common species are frequently distributed over broad positional and environmental gradients, which can be several orders of magnitude greater that the typical dispersal distances of individuals, i.e. gradients of latitude, longitude, altitude, temperature, precipitation. Due to this broad distribution, there are many classical ecogeographic patterns, such as systematic trends in body size and reproductive traits, which are disproportionally exhibited by common species. It is argued that due to the broad ranges of common species, which are more likely to be broken by barriers to dispersal than smaller ranges, and because they extend over such a diversity of environments, there is an associated potential for local adaptive divergence (Rosenzweig, 1995). Such phenotypic variation often reflects the genetic adaptations of local populations supporting the argument that common species tend to show greater genetic variation and diversity than do rare species (Frankham, 1996). The great variation between individuals within large populations can be of significant behavioural and ecological import (Redford and Feinsinger, 2001; Hutchinson, 2008). Empirical evidence supports that geographical patterns of species richness (Gaston and Fuller, 2008; Gaston, 2010; Thompson and Johnson, 2010) and changes in species composition (Jetz and Rahbek, 2002; Lennon et al., 2004) are driven primarily by common species even when controlled for the distribution of common species comprising greater volumes of information than the same number of rare species.

Common species are disproportionately significant to ecosystem function (Grime, 1998; Smith and Knapp, 2003; Geider et al., 2001), though explicit empirical studies remain scarce. They are a pivotal influence in food web structure (Goldingay, Carthew and Whelan, 1991; Sekercioglu, 2006; Gaston, 2011) as they are on average exploited by larger numbers of species of predators, parasites, etc. than rare species (Gaston, 2011). There is a higher contribution of common species to biomass (Gaston and Fuller, 2008; Gaston, 2011). They influence ecosystem structure often providing a greater part of the biologically generated physical structure of ecosystems, mainly as a consequence of their larger contribution to overall biomass. Common species can be responsible for the bulk of primary production and carbon storage (Smith and Knapp, 2003; Bunker et al., 2005) and consumption (Dangles and Malmqvist, 2004). Abundance and large biomass makes common species significant ecosystem engineers (autogenic and allogenic), modifying, maintaining and creating habitats. Their impacts take effect on large and small scales, e.g. forests acting as biotic pumps that sustain ocean-to-land transport of atmospheric water, and thus precipitation (Makarieva and Gorshkov, 2007); ocean mixing by organisms including krill and fish (Kerr, 2006); fish convey marine nutrients inland (Hall, Jordaan and Frisk, 2011).

Common species perform ecosystem services upon which nature and we rely. Bees are pollinators. Edge species like vervet monkeys *Chlorocebus pygerythrus* are seed dispersers that can aid in forest regeneration (Foard, Van Aarde and Ferreira, 1994). Salmon and river herring transport nutrients (Hall, Jordaan and Frisk, 2011). Common species may also be the species that are most likely to adapt most successfully to climate change (Smith and Werner, 2009). Common species are good indicators of biodiversity and environmental change (Duelli and Obrist, 2003). This makes them practically useful as ecological monitoring (Devictor et al., 2007; Lindenmayer et al., 2011).

1.1.1 Population declines in common species

While it is true that "Abundance is a buffer from perturbation whereas rarity is perpetual vulnerability" (Redford, Berger and Zack, 2013, p. 157), this juxtaposition does not mean common and abundant species are impervious to anthropogenic and stochastic threats. If this were the case their conservation value would be justifiably of lesser interest. Yet there are numerous examples, both historic and contemporary, of abundant species undergoing population collapse, and even extinction. Population depletions in some cases can be relatively small proportional declines that in fact mean a large loss in terms of absolute numbers of individuals and biomass (Gaston and Fuller, 2008). Sometimes losses in common species are expressed in units that obscure the scale of population depletion (Gaston and Fuller, 2008). For instance, in commercial logging deforestation is expressed in terms of area logged rather than number of individual trees. From an evolutionary perspective, there are also genetic losses to consider. The spatial distribution of genetic diversity within a species is of vital importance. There are examples of species, although widespread and declining, that have experienced enormous genetic losses in small parts of their range where a great portion of their genetic diversity resides. For example, some *Scilla* species in KwaZulu Natal, South Africa have had genetic losses in a small part of their range where over 80% of their genetic diversity resides (Zschocke et al., 2000).

White-backed, *Gyps bengalensis*, and long-billed, *G. indicus*, vulture populations in India have undergone dramatic declines since 1990-1993 (Markandya et al., 2008; Prakash et al., 2003; Prakash et al., 2007). In the 1970s and 1980s they were found throughout the subcontinent and neither were considered to merit conservation measures or to face any significant threats (Grubh, Narayan and Satheesan, 1990). The white-backed vulture was described as possibly the most common raptor species in the world as recently as 1985 (Houston, 1985). Populations of Gyps vultures declined in the 1990s in areas of Peninsular Malaysia, Thailand and Indochina, where they were formerly common (Cambridge, 2001). These declines appeared to take place over decades and are attributed to improvements in human hygiene and subsequent increased human population, which led to reduced food availability for vultures and persecution and poisoning by humans (Cambridge, 2001; Galligan et al., 2014; Cuthbert et al., 2016; Paudel et al., 2016). More recently declines of more than 95% were reported between 1988 and 1999 (Prakash, 1999) in a National Park in north India. And since the early 1990s there has been a decline of over 92% in numbers of both species throughout India. This dramatic loss exceeds any previous recorded declines in common and widespread birds of prey.

A nocturnal Australian arboreal marsupial, the greater glider, *Petauroides volans*, is specialised on widespread environmental conditions (Youngentob et al., 2011). It has a wide distribution that is largely associated with eucalyptus forests. It is generally considered to be the most secure species of marsupial glider in Australia (Lindenmayer, 2002). This initially common species has experienced recent rapid population declines (Lindenmayer et al., 2011). These kinds of common species, those specialised on widespread environmental conditions, have been suggested to be particularly susceptible to environmental change (Lindenmayer et al., 2011). Some influential factors include harvesting and plantation establishment, forest logging (Kavanagh and Bamkin, 1995; Kavanagh and Webb, 1998) and wildfire, the prolonged periods of extreme temperature and below average rainfall that Australia has been subject to in the last decade (Cai and Cowan, 2008), and changes in trophic interactions in parts of its range (Lindenmayer et al., 2011). Australia also once supported a number of once-abundant mammal species (Bilney, Cooke and White, 2010). Many of these are now either extinct or rare.

If one of our central aims as conservation biologists is the prevention of species decline and loss (Sodhi and Ehrlich, 2010; Soulé, 1985), surely there is much support for the need to be proactive. Perhaps it is that the environmental impacts of common species are so obvious they are too easily overlooked. Declines in widespread and abundant species can be incremental rather than one acute incident. And perhaps as humans we are more adept at perceiving complete loss rather than gradual declines in populations [for example (Pain et al., 2008)]. This lack of perception of gradual change in an environmental feature is problematic as, due to the severity of nonlinearity of the relationship between population size and range size, later declines can be extremely rapid (Gaston, 2011). Therefore, as the aforedescribed examples would support, we need to improve our ability to detect threats to common species as well as changes in trajectories of abundance and contractions in distributions (Lindenmayer et al., 2011). We must rectify the disparity in conservation focus to a more balanced approach: rather than the focus we now have on rarity and extinction, we need to broaden conservation to include valuing common species and maintaining abundance (Gaston, 2011; Redford, Berger and Zack, 2013).

The prevalent approach to conservation interests and priority-setting somewhat overlooks the fact that, not only do common species also experience population declines, they are central to the biodiversity crisis. When habitat loss is presented in terms of, for example, forests or grasslands, it fails to acknowledge that this loss is one of common species and very large numbers of individuals, making common species the first victims of land-use change and habitat loss. Large scale exploitation of natural resources is concerned with common species perhaps most obviously through logging and fishing. In fact, as common species are involved in such a large number of biotic interactions and shape their environments in such a pronounced way, when over-exploitation and habitat loss impact common species it places them at the centre of the most pronounced resultant cascades of reductions and losses of other species (Gaston, 2010; Gaston, 2011). Due to their relatively high involvement in environmental engineering and their high involvement in biotic interactions declines in common species are almost invariably at the heart of the most marked population declines (Gaston, 2011), perhaps most obviously in their impact on specialist consumers and parasites (Koh et al., 2004), in the most extreme potentially resulting in co-extinctions (Gaston, 2011).

In addition to the ecological and evolutionary significance of common species, it has been argued that maintaining abundance is likely to be a cheaper and easier management effort than keeping rare species from extinction (Redford, Berger and Zack, 2013). But common species also have intrinsic value. The value of a species does not lie solely in its susceptibility to extinction risk, its influences on its environment, its value as a resource to humans, but in that it exists at all. But pragmatism compels us to offer justifiable practical reasons for species and habitat protection. Therefore, one further point in support of common species conservation is their potential to inspire and encourage public engagement with conservation efforts (Redford, Berger and Zack, 2013).

The subject of this dissertation is the vervets *Chlorocebus* spp. Let us now consider this species group, which incudes the grivet monkey *C. aethiops*, tantalus monkey *C. tantalus*, green monkey *C. sabaeus*, malrouck monkey *C. cynosures*, vervet monkey *C. pygerythrus*, and Bale monkey *C. djamdjamensis*, in light of this argument for common species conservation. Vervets frequently occur outside protected areas. They are highly visible and adaptable and therefore assumed to be common everywhere. As the genus is widespread and considered relatively common there is a lack of data on population numbers, compositions and trends. As a conflict species in much of their range it would be beneficial to make them a higher conservation priority as the arising human-monkey conflict could then be tackled with appropriate resources. But perhaps most alarmingly, they have in fact been extirpated from some former ranges, in Cote d'Ivoire (Bi et al., 2009) and Eritrea (Zinner, Peláez and Torkler, 2002). Furthermore, in South Africa, where there is much human-monkey conflict, although there is no population data, there have been reports from rescue centre directors of local declines in monkey populations (see Chapter 7).

1.2 The generalist nature of vervets

Here I will give a superficial description of the vervets on the genus level. Detailed accounts of each species and distribution maps can be found in the Appendices. The vervets are a group of generalist monkeys occurring through much of sub-Saharan Africa (Whittaker, 2013). They display great ecological flexibility that facilitates their exploitation of various habitats from dry savannah to gallery and rainforest (Whittaker, 2013; Barrett et al., 2016) and even mangroves (Head, Healy and Nowak, In Press). They thrive in disturbed habitat and exploit human-altered environments such as tourist parks and urban residential areas (Kavanagh, 1980; Brennan, Else and Altmann, 1985; Horrocks and Hunte, 1986; Boulton, Horrocks and Baulu, 1996; Fourie et al., 2015; Cancelliere et al., 2018; Mikula et al., 2018; Patterson et al., 2018). As a result of their ecologically and behaviourally robust and opportunistic nature they seem to only be limited by the availability of water and appropriate sleeping trees (Wrangham, 1981; McDougall et al., 2010; McFarland et al., 2014). They exploit secondary growth habitats and cultivated land and can vary foraging strategies, territoriality, ranging patterns, fecundity, and activity levels, depending on resource quality and seasonal fluctuations in conditions (Kavanagh, 1981; Harrison, 1985; Barrett et al., 2016). These characteristics result in a relative advantage to this genus over more specialist primate taxa that require protected closed-canopy forest for survival. They have few major threats and are widespread and relatively abundant, informing the Least Concern threat status of five of the six vervet species on the IUCN Red List (Butynski, 2008; Kingdon and Butynski, 2008; Kingdon and Gippoliti, 2008a; Kingdon and Gippoliti, 2008b; Kingdon et al., 2008). The exception is the Bale monkey which is listed as Vulnerable (Butynski et al., 2008) as it is endemic to the highlands of Ethiopia, occurs at low densities, has a specialist bamboo diet and is threatened by fragmentation, habitat loss and hybridisation with grivet monkeys. All six species will be retaining these statuses in 2017 (T. M. Butynski, pers. comm. 2017).

1.2.1 Human-monkey conflict

It is this very flexibility that brings vervets into conflict with humans. They frequently come to share human-dominated landscapes as increased urbanisation forces monkeys and humans into closer proximity (Henzi, 1979; Loudon et al., 2014). In rural cultivated areas vervets notoriously raid crops (Kavanagh, 1980; Cancelliere et al., 2018). Raiding events as well as farmers' perceptions of vervets have been documented in much of their range with several studies presenting the rank of vervets as pests per local farmers at study sites in Uganda (Saj, Sicotte and Paterson, 2001; Nampindo and Plumptre, 2005; Hartter, 2009; Hartter and Goldman, 2009; Wallace, 2010), Kenya (Mulu, 2010), Tanzania (Siege and Baldus, 1998) and Ethiopia (Quirin, 2005; Admassu, 2007). Farmers practice various crop-protection methods against these and other problem primates including the use of sling shots and dogs, and farmers will often shoot or spear monkeys on sight (Siege and Baldus, 1998; Mulu, 2010). In agricultural areas in South Africa vervet monkeys rank second only to baboons *Papio* spp. as crop-raiders and pests (Estes, 1991).

Conflict between humans and vervets is less well documented in a suburban context [but see (King and Lee, 1987) for Malawi). It is recorded in the southern parts of their range that they will enter houses and raid gardens in search of food (King and Lee, 1987; personal observation; See Chapter 8). Guy and colleagues (Guy, Stone and Curnoe, 2012a; Guy, Stone and Curnoe, 2012b) report people in KwaZulu Natal, South Africa responding to vervet monkeys in gardens and houses by shooting them with pellet guns, throwing stones and poisoning. I have made direct observations of vervet monkeys injured by stones, dogs, pellet guns, paintball guns, power lines and vehicle collisions. Although it is poorly documented, vervets are sometimes kept as pets (Fuentes, 2006; Grobler et al., 2006).

1.3 The *Chlorocebus* genus – taxonomy and synonymy

1.3.1 Taxonomic uncertainty, nomenclature, historical taxonomic assignment

Taxonomy of this species group is disputed on many levels with a lack of consensus on genus assignment, number of species and number of subspecies (Grubb et al., 2003). In the past they have been subsumed into the *aethiops* group of the *Cercopithecus* genus (Dandelot, 1959; Hill, 1953). Due to their phenotypic diversity 25 taxa have been recognised over the years (Grubb et al., 2003). This number has been reduced, most recently by Groves (2001), to twelve.

The greatest number of nominal subspecies (≤15) is among the vervets (Grubb et al., 2003). Their classification is complex and in need of revision (Groves, 2001) since the phylogenetic relationships between taxa is unresolved. A comprehensive phylogenetic analysis is needed to aid a taxonomic revision (Groves, 2001; Grubb et al., 2003; Haus et al., 2013). Indeed, Lernould (1988) commented: "*The classification of the savanna guenons of the aethiops group is very complex and the habit of field primatologists often speaking of* 'aethiops' *without more precision does not help to clarify the situation*." (Lernould, 1988)

Dandelot (1959) referred to this group as the '*aethiops* superspecies' of the genus *Cercopithecus*. He recognized three species: *Cercopithecus aethiops* (with subspecies-groups *aethiops* and *tantalus*), *C. pygerythrus* (with subspecies-groups *pygerythrus* and *cynosuros*), and *C. sabaeus*. He later raised *tantalus* to species level (Meester and Setzer, 1971). Dandelot (1959) speculated as to raising *C. cynosuros* to species level but retained it as a subspecies of *C. pygerythrus*. Grubb et al. (2003)

comment that the name of this pairing should be the *C. cynosuros* group as *cynosuros* dates from 1786 while *pygerythrus* dates form 1821.

Napier (1981), as cited by Grubb et al. (2003), also assigned the group to the *Cercopithecus* genus, grouping all as one species with four subspecies corresponding to Dandelot's four, i.e. *C. aethiops aethiops* (containing *C. a. aethiops*, *C. a. hilgerti*, and *C. a. matschiei*); *C. aethiops pygerythrus* (containing *C. a. pygerythrus*, *C. a. arenarius*, *C. a. callidus*, *C. a. centralis*, C. a. cynosuros, *C. a. excubitor*, *C. a. helvescens*, *C. a. johnstoni*, *C. a. marjoriae*, *C. a. nesiotes*, *C. a. rubellus*, *C. a. rufoviridis*, and *C. a. zavattarii*; *C. a. sabaeus*; and *C. a. tantalus*.

Within *Cercopithecus* (Dutrillaux, 1988) suggests a monophyletic clade as represented by *Cercopithecus diana*, *C. neglectus*, *C. mona*, *C. hamlyni*, *C. cephus*, and *C. nictitans* groups as they share 6 unique chromosome fissions; the *C. dryas* karyotype is unknown. Dutriillaux (1988) associated the *C. aethiops* and *C. preussi* groups and pata monkey *Erythrocebus patas* - all lacking the chromosome fissions - as one clade. The same cladistic arrangement has been suggested based on craniometric studies (Martin and MacLarnon, 1988), with the addition of the talapoins *Miopithecus* spp.

Groves (2001) suggested a relationship between *C. aethiops* and *E. patas* based on synapomorphic cranial characters. He then allocated *C. aethiops* to the genus *Chlorocebus*. Both Kingdon (2013) and Groves (2001) elevate six forms of the group to species level of the genus *Chlorocebus* (as first used by Gray in 1870). Groves (2001) recognises four monotypic species: the grivet *Chlorocebus aethiops*, the Bale Mountains monkey, *C. djamdjamensis*, the green monkey, *C. sabaeus*, and the malbrouck monkey, *C. cynosuros*; and two polytypic species the tantalus monkey with subspecies *C. tantalus budgetti*, *C. t. marrensis* and *C. t. tantalus*; and the vervet monkey, *C. pygerythrus* with subspecies *C. pygerythrus hilgerti*, *C. p. excubitor*, *C. p. nesiotes*, *C. p. rufoviridis*, and *C. p. pygerythrus*.

Grubb et al. (2003), following Napier, maintain one highly polytypic species group within the genus *Cercopithecus* retaining the name *Cercopithecus aethiops*. This is due mainly to uncertainty regarding the boundaries between the nominal species and due to Struhsaker's reservations based on the lack of vocal distinctiveness between forms (Struhsaker, 1970). They recognised six subspecies: *C. aethiops aethiops*, *C. a. djamdjamensis*, *C. a. sabaeus*, *C. a. cynosuros*, *C. a. tantalus*, and *C. a. pygerythrus*.

Tosi and colleagues recommend the assignment of the *aethiops* group to the genus *Chlorocebus* (Tosi et al., 2002; Tosi, Melnick and Disotell, 2004). Sex chromosome phylogenetic studies suggest a close evolutionary relationship between the terrestrial guenons surveyed (*Cercopithecus lhoesti*, *C. solatus*, *Chlorocebus aethiops* and *Erythrocebus patas*). Their findings, a monophyletic grouping of the terrestrial taxa, indicate a single transition to terrestriality in the guenons, placing them in a clade exclusive to all other Cercopithecini. It remains ambiguous however, as to whether the terrestrial common ancestor holds a basal or derived position among the guenons. This would mean that the *Cercopithecus* genus is paraphyletic as presently defined and requires taxonomic revision. Tosi et al. (2002, 2004) recommend two taxonomic schemes, both assigning *aethiops* to the genus *Chlorocebus*. One raises each of the terrestrial lineages to the genus level. The other groups all three terrestrial guenon taxa in the *Chlorocebus* genus.

Attempts have been made to clarify the genetic diversity of the group by analysing mitochondrial cytochrome b to delineate geographic ranges of the taxa and to clarify phylogenetic relationships (Haus et al., 2013). Haus et al. (2013) found that mtDNA diversity did not conform to existing taxonomic classification for both the six-species classification and the one-superspecies classification. They distinguish either seven or nine major clades, suggesting that the nine-clade division is more appropriate. They also assume introgressive hybridisation is responsible for the discordance in phylogeny and found some difference in geographic positions of species borders and contact zones. It was concluded however, that an analysis of one mitochondrial marker (cytochrome b) does not allow for definitive taxonomic inferences. Other attempts to use single mitochondrial markers to identify primates (not just vervets), such as cytochrome oxidase subunit I, have likewise run into problems with identifying vervets (Hajibabaei et al. 2006; Lorenz et al. 2005; Nijman and Aliabadian 2010). More recent, and importantly more comprehensive studies focussing on whole genomes (or at least multiple genes) have revealed greater insights into the molecular evolution of vervets (Huang et al. 2015; Laffler 2017; Turner et al. 2016; Warren et al. 2015; Svardal et al. 2017; Pfeifer 2017) but stopped short of resolving any taxonomic issues.

Ultimately, species or subspecies designation is difficult as it is possible that they fall within one very large cline. Here, I follow Groves' (2001) assignment of the group to the genus *Chlorocebus* as this assignment would seem to consider all recent genetic, morphological and ecological studies on the generic, species and subspecies levels. Groves (2001) recognises six species: *Chlorocebus aethiops*, *C. cynosuros*, *C. tantalus*, *C. sabaeus*, *C. djamdjamensis* and *C. pygerythrus*. This classification is also the one followed by the IUCN Red List of Threatened Species and the IUCN Primate Specialist Group. Detailed species accounts can be found in the Appendices.

1.3.2 Synonymy

There are many local and common names for vervets and allies, both as one collective group and for the various forms across their distributions. The synonymy of this species group is not simple (see Table 1). For the sake of clarity, I will use the six common species names as described in the species accounts below. To mitigate potential confusion, when referring to the entire genus I will use the terms 'vervet', 'vervets', or 'the *Chlorocebus* genus/species group'. When referring specifically to *C. pygerythrus* I will use the common name 'vervet monkey'.

Table 1. Synonymy of the Chlorocebus genus and the currently recognised species of this genus. Adapted from Groves (2001).

Genus *Chlorocebus* Gray, 1870
1862 *Callithrix* Reichenbach. *Cercopithecus callithrix* I. Geoffroy, 1851. Not of Erxleben, 1777 (*Platyrrhini*).
1870 *Chlorocebus* Gray. *Simia sabaea* Linnaeus, 1766 (fixed by Pocock [1907]).
1870 Cynocebus Gray. Cercopithecus cynosuros Scopoli, 1786.
Chlorocebus sabaeus (Linnaeus, 1766) Green Monkey
1766 *Simia sabaes* Linnaeus. "Cape Verde Islands" (probably Senegal).
1845 *Cercopithecus chrysurus* Blyth. No locality. (Usually placed in synonymy of *tantalus* but regarded as a synonym of *sabaeus* by Napier [1981]).
1850 *Cercopithecus werneri* I. Geoffroy. Africa.

1851 *Cercopithecus callitrichus* I. Geoffroy. West Africa.

Chlorocebus aethiops (Linnaeus, 1758) Grivet Monkey

1758 *Simia aethiops* Linnaeus. Sudan: Sennar (fixed by Schwarz [1928a].

1804 *Simia engytithia* Hermann. No locality.

1819 *Cercopithecus griseus* F. Cuvier. Africa.

1820 Cercopithecus griso-viridis Desmarest. Africa.

1821 *Simia subviridis* F. Cuvier. Africa.

1843 *C*[*ercopithecus*] *cano-viridis* Gray. Ascribed to Rüppell: hence, probably Ethiopia.

?1843 *C*[*ercopithecus*] *cinero-viridis* Gray. Ascribed to Temminck.

1902 *Cercopithecus matschiei* Neumann. Ethiopia: Omo River, Malo.

1916 *Cercopithecus* (*Chlorocebus*) *toldti* Wettstein. Sudan: Kordofan, Jebel Riha near Kadugli, Nuba Mountains.

1918 *Cercopithecus* (*Chlorocebus*) *cailliaudi* Wettstein. Sudan: Blue Nile.

1922 Lasiopyga (Cercopithecus) weidholzi Lorenz. Egypt.

1943 *Cercopithecus aethiops zavattarii* de Beaux. Ethiopia: Murle, River Omo, 5° 09' N, 36° 13' E.

Chlorocebus djamdjamensis (Neumann, 1902) Bale monkey

1902 *Cercopithecus djamdjamensis* Neumann. Ethiopia: bamboo forest near Abera, east of Lake Abaya, 3300m.

Chlorocebus tantalus (Ogilby, 1841) Tantalus Monkey

Chlorocebus tantalus tantalus (Ogilby, 1841)

1841 *Cercopithecus tantalus* Ogilby. No locality.

1897 *Cercopithecus passargei* Matschie. Nigeria: Yola.

1905 *Cercopithecus pousarguei* Mitchell. Lapsus for passarguei.

1909 Cercopithecus tantalus alexandri Pocock. Lake Chad.

1910 *Cercopithecus viridis* Schultze. Nigeria: Bornu. Nomen nudum.

1914 *Lasiopyga tantalus graueri* Lorenz. Congo-Zaire: Baraka, northwestern shore of Lake Tanganyika.

Chlorocebus tantalus budgetti (Pocock, 1907)

1907 *Cercopithecus tantalus budgetti* Pocock. Uganda: Butiaba, Lake Albert.

1909 *Cercopithecus tantalus griseistictus* Elliot. Congo-Zaire: Uele River, Bambara.

1912 *Cercopithecus* (*Chlorocebus*) *cynosurus itimiriensis* Matschie and Dubois. Congo-Zaire: Itimbiri River.

1914 *Lasiopyga tantalus beniana* Lorenz. Congo-Zaire: Beni.

Chlorocebus tantalus marrensis (Thomas and Hinton, 1923)

1923 *Cercopithecus tantalus marrensis* Thomas and Hinton. Sudan: foothills south of Jebel Marra.

Chlorocebus pygerythrus (F. Cuvier, 1821) Vervet Monkey

Chlorocebus pygerythrus hilgerti (Neumann, 1902)

1902 *Cercopithecus hilgerti* Neumann. Ethiopia: Webi Shebeyli, Gobele River.

1902 *Cercopithecus ellenbecki* Neumann. Ethiopia: Lake Zwai, Suksuki and Maki Rivers.

1907 [*Cercpoithecus pygerythrus*] *johnstoni* Pocock. Tanzania: Old Moshi, Mount Kilimanjaro District, 1500m.

1909 *Cercopithecus rubellus* Elliot. Kenya: Fort Hall.

1910 *Cercopithecus centrallis luteus* Elliot. Kenya: southwest of Mount Kenya, Wambugu.

1912 *Lasiopyga pygerythra callida* Heller. Kenya: south side of Lake Naivasha.

1913 *Lasiopyga pygerythra arenaria* Heller. Kenya: Merile water holes, Marsabit Road.

1913 *Lasiopyga pygerythra tumbili* Heller. Kenya: Taita Hills, Ndi.

1920 *Lasiopyga pygerythra contigua* Hollister. Kenya: inland of Mombasa, Changamwe.

Chlorocebus pygerythrus excubitor (Schwarz, 1926)

1923 *Chlorocebus voeltzkowi* Matschie. Nomen nudum

1926 *Cercopithecus aethiops excubitor* Schwarz. Kenya: Manda Island.

Chlorocebus pygerythrus nesiotes (Schwarz, 1926)

1923 *Chlorocebus pembae* Matschie. Pemba Island: Nomen nudum.

1926 *Cercopithecus aethiops nesiotes* Schwarz. Tanzania: Pemba, Chake Chake Island.

Chlorocebus pygerythrus rufoviridis (I. Geoffroy, 1843)

1843 *Cercopithecus rufo-viridis* I. Geoffroy. Africa.

1852 *Cercopithecus flavidus* Peters. Mozambique, Quitangonha, 15°S.

?1862 *Cercopithecus circumcinctus* Reichenbach. “W. Afrika”.

1870 *Chlorocebus rufoniger* Gray. Error for rufoviridis.

1900 *Cercopithecus centrallis* Neumann. Tanzania: Bukoba.

1907 *Cercopithecus pygerythrus whytei* Pocock. Malawi: Mount Chiradzulu.

1909 *Cercopithecus silaceus* Elliot. Zambia: south bank of Luangwa River

Chlorocebus pygerythrus pygerythrus (F. Cuvier, 1821)

1811 *Cercopithecus glaucus* Lichtenstein. South Africa. Nomem nudum.

1821 [*Simia*] *pygerythrus* F. Cuvier. “Africa”: if pusillus may be regarded as a substitute name, then type locality may be regarded as Keiskama (Schwarz 1928a).

1825 *Cercopithecus pusillus* Desmoulins. South Africa: Kwazulu-Natal, Keiskama near Great Fish River.

1829 *S*[*imia*] *erythropyga* G. Cuvier. Substitute for pygerythra.

1841 *Cercopithecus lalandei* I. Geoffroy. Substitute for pusillus.

1931 *Cercopithecus aethiops* cloetei Roberts. South Africa: Transvaal, Pilgrim’s Rest, Mariepskop.

1932 *Cercopithecus aethiops ngamiensis* Roberts. Botswana: Ngamiland, Toten-Maun Road.

1936 *Cerpithecus* [*sic*] *aethiops marjoriae* Bradfield. South Africa: Transvaal, Kuruman, Zoetvlei.

Chlorocebus cynosuros (Scopili, 1786) Malbrouck Monkey

1786 *Simia cunosuros* Scopoli. Congo-Zaire: Banana, Lower Congo (fixed by Schwarz [1928a]).

1833 *Cercopithecus tephrops* Bennett. No locality.

1912 *Cercopithecus* (*Chlorocebus*) *aethiops weynsi* Dubois and Matschie. Congo-Zaire: Banana.

1912 *Cercopithecus* (*Chlorocebus*) *cynosurus tholloni* Matschie. Congo-Zaire: Stanley Pool.

1919 *Cercopithecus pygerythrus katangensis* Lönnberg. Congo-Zaire: Funda Biabo, Shaba.

1926 *Cercopithecus pygerythrus helvescens* Thomas. Namibia: Cunene Falls.

1.5 Outline of this thesis

A plethora of literature – both published and grey – deals with vervets. The majority of these studies have focused on behaviour and vocalisations, primarily with psychological applications. To better our understanding of vervets and their conservation, I have conducted a multi-pronged study in a variety of conservation contexts. I have examined such subjects as the extraction of vervet monkeys for the international primate trade and human-monkey conflict issues. I have also elaborated on some ecological knowledge of vervets, describing their use of mangroves. Much of this work is edited from or expanding upon work published in these publications:

Head, J., Healy, A. and Nowak K. (in press) Primates in African Mangroves in *Primates in Flooded Habitats* eds. Barret, Matsuda and Nowak, Cambridge University Press, Cambridge

Nijman, V. and Healy, A. (2016) Present-day international primate in a historical context in *An Introduction to Primate Conservation* S Wich and A Marshall (eds.), Oxford University Press, Oxford

Healy, A. and Nijman, V. (2014) Pets and pests: vervet monkey intake at a specialist South African rehabilitation centre, *Animal Welfare* 23, 353-360

Chapter 2 – Monkeys in mangroves

This chapter elaborates on our understanding of vervet ecology, describing the use of mangrove habitats by the genus. This is an adaptation of a book chapter of which I am co-author for the Barnett, Matsuda and Nowak publication *Primates in Flooded Habitats: Ecology and Conservation* (in press) due to be published by Cambridge University Press, Cambridge.

Chapter 3 – International primate trade

I examined the CITES trade database to analyse the international trade in vervets, first as a proportion of all international primate trade, then with a more detailed analysis of African trade. This chapter is an adaptation of a book chapter of which I am co-author in the Wich and Marshall publication *An Introduction to Primate Conservation*. This book is intended for introductory level undergraduate and graduate students and to provide both students and conservationists an up-to-date overview of the various topics relevant to primate conservation.

Chapter 4 – Primates as hunting trophies

It is not well known that primates are hunted as trophies. Vervets and baboons account for the majority of reported primate trophy exports. I examined the results of the CITES trade database and examined the profiles of trophy hunting outfits, analysing the trophy fees and methods of killing employed. The chapter has been adapted from a poster presented at the Primate Society of Great Britain Spring Meeting in April 2014 (Healy, Iliff and Nijman, 2014).

Chapter 5 – Vervet crop-raiding

Even species that are behaviourally adapted to living in close proximity to humans – those that are omnivorous and adaptable, such as vervets - are in fact in a quite precarious position, though they may be apparently successful [*P. Anubis*: (Quick, 1986); *P. cynocephalus*: (Altmann and Muruthi, 1988); rhesus macaque *Macaca mulatta*: (Malik and Southwick, 1988). Survival is threatened by low tolerance for pests and eradication schemes are adopted to control pest populations. In view of this conflict I have reviewed vervet crop-raiding and farmers' perceptions of these problem animals.

Chapter 6 – Intake records of the Vervet Monkey Foundation

Vervet monkeys encounter a plethora of risks due to their ability to exploit human-altered environments. A systematic assessment of these risks has not been carried out to date. Here I aim to begin to address this gap in our understanding of human-monkey conflict presenting a descriptive analysis of the intake of monkeys to the Vervet Monkeys Foundation – a specialist vervet monkey rehabilitation centre in the Limpopo Province of South Africa. It aims to highlight the merits of publishing intake records and explores the welfare implications of the perceptions of and objections to these primates. This chapter is an expansion on the research article entitled *Pets and pests: vervet monkey intake at a specialist South African rehabilitation centre* (Healy and Nijman, 2014). This article was published in the journal *Animal Welfare* which is an international scientific and technical journal that publishes studies and reviews related to the welfare of kept animals (e. g. pets, companion animals,

animals in zoos and laboratories and on farms) and wild animals whose welfare is compromised by proximity to anthropogenic environments.

Chapter 7 – Discussion and recommendations

Though each chapter will have an individual discussion, this chapter will tie these topics together emphasising a common thread between monitoring the volume, means and purpose of the extraction of vervets from the wild, and to discuss the relevance of the prevailing perceptions of people who live in close proximity to these monkeys, and the resulting conflict. These subjects are discussed in the context of the importance of proactive conservation of Least Concern species.

2. Monkeys in mangroves

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2.1 Introduction to African mangroves

Mangrove ecosystems provide important habitat for a wide variety of fauna and can be rich in biodiversity. There are, to date, 70 species of mangrove recorded worldwide (Corcoran, Ravilious and Skuja, 2007), representing many important biomes and communities across the globe. This chapter specifically focuses on the use of mangroves by anthropoid primates in Africa. African mangroves represent almost one fifth of the world's mangrove biomass, and are found across 26 countries of Sub-Saharan Africa (Corcoran, Ravilious and Skuja, 2007). There is variation in the phytogeographical distribution of mangroves across Africa, with an estimated 70% of Africa's mangroves located in the equatorial regions of West and Central Africa, the same region in which African primate species richness is highest (Eeley and Foley, 1999). Species composition of West African mangroves is similar to that of the Americas while that of East African mangroves more closely resemble those found elsewhere in the Indian Ocean (WWF, 2001). In West and Central Afirca, six mangrove species families occur including Avicenniaceae *Avicennia germinans*, Combretaceae *Laguncularia racemosa*, *Conocarpus erectus* and Rhizophoraceae *Rhizophora harrisonii, R. mangle, R. racemosa*. *R. racemosa*, characterized by prop roots, is particularly dominant in this region. In Eastern Africa, 10 species of mangroves are found, with three dominant species (*R. mucronata, Ceriops tagal* and *A. marina*) occupying a total of 1.1million ha (Spalding, 2010). Mangroves are restricted to coastal areas at river mouths or in tidal lagoons and prefer warmer seas in humid tropical climates, although in parts of Mozambique and Tanzania, mangroves extend up to 50km inland (WWF, 2013).

These ecosystems support a wide variety of fauna, both aquatic and terrestrial. They provide crucial breeding grounds and nurseries for fish and shellfish living around coastal areas and shelter a wide array of crabs and other invertebrates. Mangroves provide nesting habitats for bird and reptile species, such as the striated heron, *Butorides striata*, and the Nile crocodile, *Crocodylus niloticus*, (Borghesio et al., 2009; Luiselli and Akani, 2002). These rich communities of smaller fish and invertebrates sustain communities of larger animals such as the African manatee, *Trichechus senegalensis*, and the African softshell turtle, *Trionyx triunguis* (WWF, 2001), in addition to providing important resources for large mammals such as primates.

Primate occupancy of mangroves varies greatly between species but can be broadly grouped into three categories – historical occupancy, seasonal/opportunistic occupancy; or occupancy resulting from a recent habitat shift in response to external factors. Species that exhibit morphological or behavioural adaptations for mangrove use (such as dietary specialisation on mangrove plants or animals) are considered to be historical occupants. For these species, mangrove use is frequent and mangrove habitat is associated with daily activities. A good example of a primate species that could be considered a historical occupant of mangrove habitat would be green monkeys *Chlorocebus sabaeus*, in Senegal (Galat and Galat-Luong, 1976). Seasonal, occasional and opportunistic occupants frequent mangroves on a temporary or seasonal basis for feeding or shelter. Their occupation is often associated with a specific function such as dispersal or movement between adjacent habitats - for example yellow baboons, *Papio cynocephalus*, in the coastal forests of Kenya (T.M. Butynski and Y.A. de Jong pers. comm. 2013). Such species do not typically exhibit morphological or behavioural adaptations for mangrove use. The third broad category of mangrove occupancy is that which results from a recent habitat shift in response to external factors, and includes novel behaviours such as an increase in frequency or duration of mangrove use, or a change of occupancy type in mangroves (e.g., from use as a corridor to use for foraging). Such changes occur in response to external factors for example human pressure, inter-specific competition and environmental change. Mangrove use by the Zanzibar red colobus, *Procolobus kirkii*, on Uzi Island off the Tanzanian coast would fall under the recent habitat shift category. It is, however, common for species to fall into two or more categories (e.g. green monkeys could equally be considered in the second and third occupancy categories depending on location), and as such these occupancy types are rarely exclusive.

Growing human populations, demand for resources and agricultural development threaten the future of many ecosystems and species globally, and African mangroves are no exception to these pressures. Given increasing fragmentation of remaining terrestrial forests, improving our understanding of the importance of mangroves as a refuge for species under intense human pressure and establishing what level of biodiversity mangroves can support is relevant for the conservation of a number of primate populations across Africa (Galat-Luong and Galat, 2005; Galat-Luong, Galat and Hagell, 2006; Nowak, 2013). This is particularly important in areas with high primate species richness, as species richness is associated with reduced habitat and dietary breadth among primates, or greater specialisation in diet or use of habitat (Eeley and Foley, 1999).

As explored in this chapter, primates may increase their frequency of mangrove use in response to human encroachment or destruction of terrestrial forest and savannah habitats and thus, the disappearance of mangroves - the only potential remaining refuge for some populations - may have negative consequences for their survival. This chapter aims to describe the use of mangroves by vervets *Chlorocebus* spp., their different occupancy types in mangroves and the extent of their mangrove use across the wider geographical range. The aim is to also review the importance of mangroves for African anthropoid primates.

2.2 Methods

Data acquisition

In October 2012 to March 2013 I conducted a detailed literature search to document the use of mangroves by vervets, baboons, and other diurnal primates. Primary sources included *The Directory of African Wetlands, All the World's Primates* website, *RAMSAR Site Information Service – African Wetland, The IUCN Red List, Field Guide to Primates of West Africa* (Oates and Nash, 2011) and *Histoire Naturelle des Primates d'Afrique Centrale* (Gautier-Hion et al., 1999). I only included studies or observations that made explicit reference to mangrove use by these primates. Merely being mentioned as using mangroves in one of the above-mentioned sources did not qualify for inclusion, but this was used as a starting point to find primary sources, if indeed available. If these sources could not be found, then their occurences were excluded.

Data preparation

Primate occupancy of mangroves varies greatly between species but can be broadly grouped into three categories – historical occupancy, seasonal / opportunistic occupancy; or occupancy resulting from a recent habitat shift in response to external factors. The extent of research effort (1-3) was estimated on an ordinal scale, with 3 representing well-detailed studies, e.g. the study of *Chlorocebus sabaeus* in Saloum Delta National Park, Senegal, specifically reported on mangrove use by this species (Galat and Galat-Luong, 1976). Areas or sites with moderate survey or study effort, e.g. a population or presence-absence survey, received a score of 2. Sites for which only a single sighting or vocalisation confirmed presence of a species in mangroves, but that did not provide any more detail, were ranked 1.

Occupancy was defined on an ordinal scale. 1) Historical occupancy: mangrove use is frequent, and mangrove habitat plays an important role in daily activities. Species exhibit morphological or behavioural adaptations for mangrove use, such as dietary specialisation on mangrove plants; 2) Seasonal, occasional and opportunistic occupancy: occupancy of mangroves is temporary or seasonal for feeding or shelter, or associated with a specific function such as dispersal or movement between adjacent habitats; 3) Potentially recent extension of range or habitat shift: novel use of mangroves resulting from a recent habitat shift, an increase in frequency or duration of mangrove use, or a change of occupancy type in mangroves (e.g., from use as a corridor to use for foraging). Such changes may occur in response to human pressure, inter-specific competition, or environmental change.

2.3 Use of mangroves by African primates

Twenty-four mangrove-using primate taxa are reported in 19 locations. Site, status of wetland, primate species present and their occupancy types, threat status of taxa and level of detail of study are presented in Table 2.

More detailed case studies describing the nature of mangrove use by several species follow. Of the 39 studies presented in Table 2, five give detailed reports of mangrove use by the study species. The remainder of the studies include minimal data, sightings or vocalisations to confirm presence, or survey/census data. Further study would be required to fully understand mangrove use by the majority of primate species. Figure 7 shows mangrove sites used by primates and indicates the richness of mangrove-using primates at each.

Table 2. Primate species, their location and primary occupancy type in mangroves. Adapted from Head, Healy and Nowak, In Press.

Country	Area, Wetland Status	Common name	Scientific name	RLS	Detail	Occupancy type	Reference
West Africa							
Senegal	Niokolo-Koba, National Park	Guinea baboon	*Papio papio*	NT	1	1	(Galat-Luong, Galat and Hagell, 2006)
Senegal	Saloum Delta, National Park and Ramsar	Green monkey	*Chlorocebus sabaeus*	LC	3	1	(Galat and Galat-Luong, 1976)
Senegal	Saloum Delta, National Park and Ramsar	Green monkey	*Chlorocebus sabaeus*	LC	2	NEI	(Galat-Luong and Galat, 2005)
Senegal	Saloum Delta, National Park and Ramsar	Patas monkey	*Erythrocebus patas*	LC	2	3	(Galat-Luong and Galat, 2005)
Senegal	Toubacouta-Sangalo area	Guinea baboon	*Papio papio*	NT	2	NEI	(Galat-Luong and Galat, 2013)
Senegal	Saloum Delta, National Park and Ramsar	Temminck's red colobus	*Procolobus badius temmincki*	EN	3	3	(Galat-Luong and Galat, 2005)
The Gambia	Saloum Delta, National Park and Ramsar	Green monkey	*Chlorocebus sabaeus*	LC	1	NEI	(Pourrut, Galat-Luong and Galat, 1996)
Guinea-Bissau	Cantanhez Forest, National Park	Green monkey	*Chlorocebus sabaeus*	LC	2	1	(Gippoliti and Dell'Omo, 1996)
Guinea-Bissau	Cantanhez Forest, National Park	Western chimpanzee	*Pan troglodytes verus*	EN	2	NEI	(K. Hockings pers. comm.)

Côte d'Ivoire	Ébrié Lagoon	Green monkey	*Chlorocbeus sabaeus*	LC	2	NEI	(Galat, 1983)
Côte d'Ivoire	Ébrié Lagoon	Eastern lesser spot-nosed monkey	*Cercopithecus petaurista petaurista*	LC	2	NEI	(Galat and Galat-Luong pers. comm.)
Côte d'Ivoire	Ébrié Lagoon	Olive colobus	*Procolobus verus*	NT	1	?	(Galat and Galat-Luong pers. comm.)
Côte d'Ivoire	Iles Ehotilé, National Park and Ramsar	Green monkey	*Chlorocebus sabaeus*	LC	3	3	(Bi et al., 2009)
Central Africa							
Cameroon	Southern Bakundu, Forest Reserve	Mona monkey	*Cercopithecus mona*	LC	2	3	(Gartlan and Struhsaker, 1972)
Equatorial Guinea	Rio Muni, Ramsar	Red-capped mangabey	*Cercocebus torquatus*	VU	3	2	(Jones and Sabater Pi, 1968)
Gabon	Sette Cama, on the edge of Loango National Park and Ramsar	Red-capped mangabey	*Cercocebus torquatus*	VU	2	NEI	(Cooke, 2005)
Gabon	Loango, National Park and Ramsar	Red-capped mangabey	*Cercocebus torquatus*	VU	2	1	(Head, pers. comm.)
Gabon	Loango, National Park and Ramsar	Northern talapoin	*Miopithecus ogouensis*	LC	1	NEI	(Head, pers. comm.)
Gabon	Loango, National Park and Ramsar	Western lowland gorilla	*Gorilla gorilla gorilla*	CR	3	2	(Head, pers. comm.)
Gabon	Loango, National Park and	Central	*Pan troglodytes*	EN	3	2	(Head, pers. comm.)

	Ramsar	chimpanzee	*troglodytes*				
Gabon	Loango, National Park and Ramsar	Grey-cheeked mangabey	*Lophocebus albigena*	LC	2	2	(Head, pers. comm.)
Gabon	Loango, National Park and Ramsar	Crowned monkey	*Cercopithecus pogonias*	LC	2	2	(Head, pers. comm.)
Gabon	Loango, National Park and Ramsar	Moustached monkey	*Cercocebus cephus*	LC	2	2	(Head, pers. comm.)
Gabon	Loango, National Park and Ramsar	Putty-nosed monkey	*Cercopithecus nictitans*	LC	2	2	(Head, pers. comm.)
East Africa							
Mozambique	Zambezi Delta	Zanzibar Sykes' monkey	*Cercopithecus mitis albogularis*	LC	??	??	(Nowak, pers. comm.)
Tanzania/ Mozambique	Ruvuma River	Zanzibar Sykes' monkey	*Cercopithecus mitis albogularis*	LC	??	??	(Nowak, pers. comm.)
Tanzania	Saadani, National Park	Zanzibar Sykes' monkey	*Cercopithecus mitis albogularis*	LC	??	??	(Nowak, pers. comm.)
Zanzibar	Uzi Island	Zanzibar Sykes' monkey	*Cercopithecus mitis albogularis*	LC	1	2	(Nowak and Lee, 2011)
Tanzania	Pangani	Vervet monkey	*Chlorocebus pygerythrus nesiotes*	LC	2	2	(de Jong and Butyksni pers. comm.)
Tanzania	Saadani, National Park	Vervet monkey	*Chlorocebus pygerythrus nesiotes*	LC	2	2	(de Jong and Butyksni pers. comm.)

Zanzibar	Pemba Island	Vervet monkey	*Chlorocebus pygerythrus nesiotes*	LC	2	2	(de Jong and Butyksni pers. comm.)
Zanzibar	Uzi Island	Zanzibar red colobus	*Procolobus kirkii*	EN	3	3	(Nowak, 2008; Nowak and Lee, 2011)
Zanzibar	Uzi Island	Garnett's great galago	*Otolemur crassicaudatus*	LC	1	3?	(Nowak, 2013)
Zanzibar	Uzi Island	Zanzibar galago	*Galagoides zanzibaricus*	LC	1	3?	(Nowak, 2013)
Kenya	Kiunga	Vervet monkey	*Chlorocebus pygerythrus hilgerti*	LC	2	2	(de Jong and Butyksni pers. comm.)
Kenya	Lamu Archipelago, Lamu tow is a UNESCO World Heritage Site	Vervet monkey	*Chorocebus pygerythrus excubitor??*	LC	2	2	(de Jong and Butyksni pers. comm.)
Kenya	Lamu Archipelago, Lamu town is a UNESCO World Heritage Site	Yellow baboon	Papio cynocephalus ibeanus	LC	2	2	(de Jong and Butynski pers. comm.)
Kenya	Lamu Archipelago - N Lamu and NW Manda Islands, Lamu town is a UNESCO World Heritage Site	Pousargues's white-collared monkey	Cercopithecus mitis albotorquatus	VU	1	NEI	(De Jong and Butynski, 2009)
Kenya	Kwale District	Angolan black-and-white colobus	Colobus angolensis palliates	LC	1	2	(Anderson, Rowcliffe and Cowlishaw, 2007)

RLS: Red List Status; Detail: 1 = under-studied, 2 = inventories/surveys, 3 = detailed study; NEI: Not Enough Information

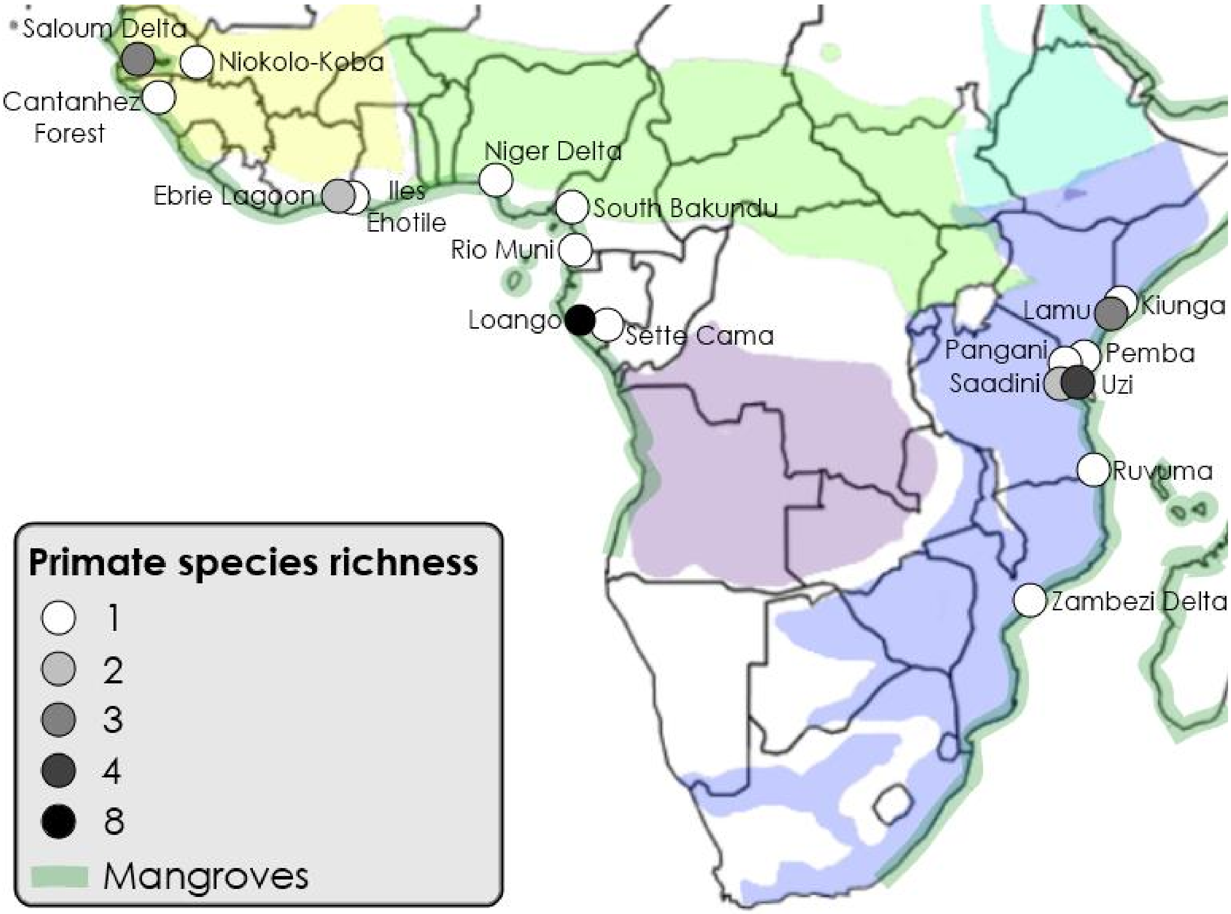

Figure 1. Distribution of mangroves across Africa, with species richness of mangrove-using species indicated. Adapted from Head, Healy and Nowak, In Press.

1. Historical occupancy

Green monkey *Chlorocebus sabaeus* – West African mangroves

The green monkey is an opportunistic generalist exploiting a very broad habitat rage from savannah woodland and dry forest to gallery forest and coastal scrub. It adapts relatively well to disturbed, secondary growth areas, and will exploit tourist lodges and cultivated land (Kavanagh, 1980; Brennan, Else and Altmann, 1985; Horrocks and Hunte, 1986; Boulton, Horrocks and Baulu, 1996). The green monkey also colonises mangroves, an ability attributed to its semi-terrestrial travel and capacity to make dietary adjustments (Galat and Galat-Luong, 1976). Mangrove use by green monkeys has been reported in several West African countries including Guinea-Bissau, Ivory Coast, The Gambia and Senegal (Table 2.)

A study of green monkeys inhabiting mangroves in Senegal demonstrated the central role which mangroves can play in the lives of some primate species (Galat and Galat-

Luong, 1976). The home range of the study group along the mangrove-terra firma border in the estuary of the Saloum River was characterised by red mangroves *Rhizophora mangle*, mangrove *R. racemosa* and black mangrove *Avicennia nitida*, and the study site was described as one of the best-preserved mangroves in Senegal. Mangroves were used by green monkeys for all activities including moving, resting, feeding, sheltering from predators, and even establishing sleeping sites with up to 80% of the group's time spent in mangroves. Mangroves were frequented most often during the hotter parts of the day for rest, shade, and water when monkeys were often seen with their bodies flush with the water's surface, presumably for thermoregulatory purposes. Movement through the mangroves was generally from crown to crown, and less frequently involved wading through the water, unlike the use of mangrove prop roots for travel by red-capped mangabeys and Zanzibar red colobus.

Mangroves were also important for safety. When in mangroves, green monkeys were observed eating in a measured manner throughout the day, whereas when on the ground, eating was rushed and vigilant, with monkeys filling cheek-pouches and retreating to the relative safety of the mangroves. Green monkeys were also observed to flee into the mangroves for shelter in the presence of perceived predation risk. 75% of feeding took place in the mangroves with the mangroves themselves constituting an important source of food including fruits of *A. nitida,* and the fruit, flowers, young shoots and leaves, seeds, twigs and spinal roots of *Rhizophora sp.* In addition, West African fiddler crab *Uca tangeri* were hunted daily and formed an important part of green monkey diet, an observation supported by much earlier reports that mangrove monkeys were fond of *U. tangeri* (Galat and Galat-Luong, 1976). Small, unidentified crabs and oysters were also consumed, and local people reported that green monkeys ate fish. Evidence of consumption of other crustaceans (molluscs) was evident from faeces, highlighting the importance of mangrove habitat for this species.

Guinea baboon, *Papio papio* – Senegal

Guinea baboon inhabits a wide range of habitats from coastal mangrove to Sahelian steppe within reach of water (Oates and Nash, 2011), also occurring in shrub, woodland savannah, gallery and secondary forests in the south of its range (Oates, Gippoliti and Groves, 2008b). While the guinea baboon is the least studied of the five

Papio species (Oates and Nash, 2011), there is evidence of mangrove use. In one case, a released group of guinea baboons in West Senegal in the region of Toubacouta, was observed entering mangroves to feed on *Uca tangeri* (Galat-Luong and Galat, 2013). These baboons were released over a period of several years (at least 1989-1992) by a monkey dealer who was disposing of excess stock and stock that was no longer useful.

Pousargues's white-collared monkey, *Cercopithecus mitis albotorquatus* – Kenya
Pousargues's white-collared monkey is reported at apparently low densities in the extensive mangrove forests of North Lamu Island, and both NE and NW Manda Island, Kenya (De Jong and Butynski, 2009). In the mangroves of North Lamu Island calls were heard from at least one group but due to poor weather no monkeys were seen. Very low densities, likely due to a lack of year-round access to fresh water, were also found on Manda Island where vocalisations were heard from the mangrove forest in the NW of the Island. In the SE of the island an individual was seen in the coastal shrub on coral rag on the edge of the mangroves. Local people of both islands are familiar with the monkeys and on Manda Island report that Pousargues's white-collared monkey occurs mainly in the mangrove forests there. These are the first reports of Sykes's moneys on these islands.

The "*mitis*" group is highly polytypic and its taxonomic organisation is as yet unsettled. It is not definitively known which subspecies was observed on Lamu and Manda Islands as it could be either Pousargues's white-collared monkey, *C. m. albotorquatus* or Patta Island Sykes' monkey, *C. m. phylax*. The distribution of the *phylax* form is restricted to the Lamu Archipelago (Groves, 2001). However, Hill (1966) notes that it is known only from its type locality, Patta Island. No published locality records of *C. mitis* for Manda and Lamu Islands have been found to clarify this inconsistency (De Jong and Butynski, 2009). *C. m. phylax* may be a synonym for *C. m. albotorquatus*. If Hill (1966) is correct in that *C. m. phylax* is restricted to Patta Island, then this survey reporting the presence of the species in mangroves is the first to confirm the presence of *C. mitis* on Lamu and Manda Islands.

2. Seasonal, occasionally or opportunistic occupancy
Red-capped mangabey, *Cercocebus torquatus* – Central African mangroves

The red-capped mangabey is limited to the Atlantic coastal basins of West and Central Africa (Gautier-Hion et al., 1999; Maisels, Pambou Makaya and Onononga, 2007), its range apparently restricted to coastal areas, extending to 80-100km inland (Matthews and Matthews, 2002). Almost all known populations of red-capped mangabeys occur within 300km of the coast with a decrease in abundance from West to East in Cameroon and Gabon; while further inland it is ecologically replaced by the drill, *Mandrillus leucophaeus* (Oates and Nash, 2011). The red-capped mangabey is rarely seen in dry forest, frequently colonising waterfronts and wetlands where it is known to inhabit mangrove forest (Gautier-Hion et al., 1999). They typically occupy the lower forest strata and most observations of the species occur at 3-10 metres in the canopy (Astaras et al., 2011), on the ground, and on mangrove roots (Jones and Sabater Pi, 1968).

Abstracted information from a long-term study in Sette Cama (Cooke, 2005) refers to mangrove use by red-capped mangabeys, reporting that although primarily observed in dryland forest (70%), they were frequently observed in mangrove forest (24%), and occasionally in beach forest (5%), and exclusively observed on the ground. More detailed information on mangrove use by red-capped mangabeys comes from an earlier study in Equatorial Guinea by Jones and Sabater Pi (1968). The study area in Rio Muni was a mangrove swamp dominated by *Rhizophora mangle* and surrounded by well-drained soils supporting adjacent primary and secondary forests. In this area, the authors carried out a comparative ecological study of red-capped and grey-cheeked mangabeys, *Lophocebus albigena*, and reported that the mangrove swamp (its lower strata often consisting entirely of mangrove roots) was the typical habitat of the red-capped, with 11 of the 23 individuals collected during the study period captured in these swamp forests. Jones and Sabater Pi also report that mangrove use by red-capped mangabeys was relatively seasonal, with the species frequenting the adjacent primary and secondary forest in the dry season and the mangrove swamps during the rainy season. In addition, on all occasions when red-caped mangabeys were disturbed by humans they sought refuge in the mangrove swamp forests, suggesting that this habitat may serve as a shelter for species under increased human pressure.

More recently, Maisels and colleagues confirmed the presence of red-capped mangabeys in Mayumba National Park, southern Gabon (Maisels, Pambou Makaya and Onononga, 2007). Here, they were commonly observed several hundred metres behind the beach, in the littoral forests along the shore and the marsh forests along the lagoon. In addition, they were frequently observed feeding, resting and travelling in the mangroves overlooking the beach in Loango National Park, Gabon and spent a large proportion of time in this habitat (Josephine Head, pers. comm., 2012). Conversely, Maisels and colleagues (2007) report that during surveys in Conkouati National Park, Republic of Congo, *C. torquatus* was never seen close to the coast but observed further inland, and the authors attribute this difference to site-level habitat preferences. While there is apparent variation in mangrove use by *C. torquatus* (probably as a result of a combination of ecological site-specific factors), the species' restricted range in coastal areas of Central Africa support the notion that mangroves are an important habitat for this species.

Vervet monkey, *Chlorocebus pygerythrus* – Tanzania and Kenya

The eastern form of the *Chlorocebus* genus, the vervet monkey, has also been observed in mangroves in the Wittu Islands of the Lamu Archipelago (*C. p. excubitor*), in Kiunga on mainland Kenya (*C. p. hilgerti*), in Saadani National Park and Pangani, Tanzania; and on Pemba Island, Zanzibar (*C. p. nesiotes*) (T.M. Butynski and Y.A. de Jong pers. comm., 2013). However, while mangrove use has been observed, the vervet monkey appears unable to survive exclusively in this habitat, as can the green monkey. This unsuitability has been attributed to a lack of fresh water, absence of tall sleeping trees and insufficient food sources (T.M. Butynski, pers. comm., 2013). It is noteworthy that annual rainfall in the Cantanhez Forest and the Saloum Delta (approx. 1600 mm per annum) is substantially higher than that of the coast of East Africa (889mm per annum in the Lamu Archipelago), possibly ensuring increased access to fresh water for the green monkey in the form of rainwater. As for the establishment of safe sleeping sites, it may be that the necessity for taller trees as safe sleeping sites is negated by a lack of predators such as leopards in West African mangroves, unlike the eastern coast where predation avoidance remains a necessity (except for islands, such as Zanzibar). These differences in habitat occupancy would benefit from further study, including an exploration of primate-predator interactions in mangroves, e.g. (Nowak, 2013).

Yellow baboon, *Papio cynocephalus* – Kenyan coast

The yellow baboon is a highly adaptable primate that persists in secondary and heavily fragmented vegetation including cultivated land close to human settlement (De Jong and Butynski, 2009). The yellow baboon uses a range of habitat types, avoiding forest but successfully occupying forest edge. Over a large part of its range, it is specific to fire-climax Miombo *Brachystegia* woodland (Kingdon, Butynski and de Jong, 2008), but within this zone it also occupies dry bushland, open woodland, forest-grassland mosaic, thickets, steppes and the coastal littoral forests, including mangroves.

De Jong and Butynski (2009) observed the yellow baboon in the coastal forests of Kenya where the subspecies *P.c. ibeanus* is locally common. It was observed moving along the edges of the mangroves as well as moving through mangroves to cross channels in the Lamu Archipelago. It has been suggested that *P. c. ibeanus* uses mangrove forest as a foraging habitat (although individuals were not observed within the mangroves themselves) but that it could not live solely in mangroves (T.M. Butynski and Y.A. de Jong pers. comm., 2013). The IUCN Red List (Kingdon, Butynski and de Jong, 2008) lists mangroves as one of many habitats exploited by the species but no further detail is provided.

3. Potential novel extension of range or habitat shift

Mona monkey, *Cercopithecus mona* – Niger Delta and Cameroonian creeks

The mona monkey is a generalist and versatile lowland forest species, relatively abundant close to rivers and in gallery forest and extending into savannah. It is highly adaptable and remains relatively common, even with the fragmentation and degradation of habitat throughout much of its geographic range (Oates, Gippoliti and Groves, 2008a). In some parts of eastern Nigeria where there is little remaining forest and the majority of anthropoid forest primates are now extinct, *C. mona* is often the only monkey species left (Oates and Nash, 2011), and is relatively common in marginal habitats including mangrove forest where other primate species can be rare or absent. In the mangrove zone of the Niger Delta, the mona monkey appears to be the only primate species present, while in Cameroon it has been observed swimming across a wide creek in a mangrove swamp (Gartlan and Struhsaker, 1972). Oates describes the species as “particularly frequent in mangroves” (Oates, 1988). Despite the ubiquity of the species in West Africa, there are few published data of field studies and the observations outlined here highlight the potential importance of mangroves as a refuge habitat for this adaptable species.

Green monkey *Chlorocebus sabaeus* – “mangrove monkey” – West African mangroves

A study in Côte d’Ivoire (Bi et al., 2009) observed a population of green monkeys outside its previously described range in the littoral forest of Iles Ehotilé National Park, restricted to the swamp and mangrove forests. The presence of the green monkey in the southern part of the country is not well known and its distribution in Côte d’Ivoire is discontinuous, with the southern and northern populations separated by approximately 300km of adjacent forest zone. Two hypotheses are posed to explain this disconnected occurrence. The first suggests this population was descended from reintroduced pets released by foreign tourists upon leaving the country, since the lagoon forests where the green monkey occurs are along the former north-south road to Abidjan or near points of tourist interest (Bi et al., 2009). The adaptability of the species suggests that they would be capable of successfully colonising the mangroves and surviving to reproduce in these areas. The second hypothesis is that the colonization of this coastal belt is the outcome of pressure from expanding agriculture and conversion of rainforest to a forest-agricultural mosaic, and a habitat shift that the green monkey has undergone elsewhere (Kavanagh, 1980). It is also possible that these are relic populations from a former continuous distribution, since there is some evidence for climatic fluctuations during the Pleistocene that caused several retreats and expansions of rainforest. If the green monkey subsisted on mangrove habitat when rainforest re-growth isolated them from the northern populations, this would represent evidence of the importance of mangroves during periods of environmental change.

In Guinea-Bissau, the green monkey was observed in mangroves of the Cantanhez Forest in the Cacine Basin (Gippoliti and Dell'Omo, 1996; Gippoliti[1] and Dell’Omo, 2003). The local name for *sabaeus* in the area is ‘macaco de terrafe’ which directly translates to “mangrove monkey”. This would indicate that the occurrence of the green monkey in this area may be limited to mangroves. It is suggested that this narrow habitat preference of the green monkey results from competition with Campbell's monkey *Cercopithecus campbelli campbelli*. Campbell's monkey was observed in closed forest and woodland savannah where one would typically expect to observe green monkeys, suggesting that mangroves may facilitate niche separation in areas where inter-specific competition is intense. Similar behaviour was reported for green monkeys in the mangroves of the Pirang Forest in The Gambia (Pourrut, Galat-Luong and Galat, 1996), where in the event of polyspecific associations with other primates, the green monkey increased its frequency of mangrove use compared to the use of the adjacent forest block.

Zanzibar red colobus, *Procolobus kirkii* - Zanzibar archipelago, Tanzania
Arguably, members of the genus *Cercopithecus* are more behaviourally flexible than members of *Colobus* and *Procolobus*. But given the high-tannin and folivorous diets tolerated by colobines, they, like many flexible and opportunistic cercopithecines, can also exploit mangrove habitat. At several East African mangrove sites, Sykes' monkey *Cercopithecus mitis* is sympatric with either Angolan black-and-white colobus *Colobus angolensis* or one of two species of *Procolobus* in coastal forests.
On Uzi Island, just south of the southern and main island of Zanzibar called Unguja, Zanzibar redcolobus and Sykes' monkey inhabit patches of mangrove forest. These mangrove patches now represent Uzi Island's last remaining forest with an intact canopy as the coral rag forest has been decimated, cleared for charcoal making and agriculture. The Uzi Island Zanzibar red colobus can spend >80% of their day in the species-poor mangroves, where water foraging and drinking increases with proportion of time spent in mangroves and with the proportion of diet made up of mangrove leaves (Nowak, 2008). While the consequences of mangrove herbivory for large mammals are not well studied, it appears that in the case of Zanzibar red colobus, mangrove leaf consumption induces thirst making it unlikely that this species can subsist exclusively off a mangrove diet.

Mangrove-dwelling groups of Zanzibar red colobus aggressively defend their home range, unlike their coral-rag living counterparts in other forests in Zanzibar, and this defence may have more to do with defence of water-collecting surfaces and tree holes than with defence of food resources. Mangrove groups are also significantly larger in size and more cohesive than coral-rag groups, and, it would appear, infant survival is higher in mangroves than in disturbed coral rag (Nowak and Lee, 2011). This suggests that mangroves are possible source habitats and make good refuges for Zanzibar red colobus, despite constraints on locomotion due to the tides and high salt loading in the diet. However, increasing pressure on mangrove-adjacent coastal thicket means that the Zanzibar red colobus and sympatric Sykes' monkey on Uzi Island are increasingly limited to and reliant on mangroves. They also end up in conflict with people as they are forced to supplement their mangrove diets by raiding human food crops (e.g., cassava, papaya) which now grow immediately next to mangrove forest patches where there once were coral rag species such as *Terminalia boivinii, Diospyros consolatae*, *Sorindeia madagascariensis* and *Grewia bicolor* – all exploited by Zanzibar red colobus for food.

2.4 Discussion

Observations of primates in mangrove habitat across Africa suggest its important and neglected role in African primate eclogy, evolution and persistence. Across their range, mangroves are used by many different primate species for feeding and socializing, as means of moving between adjacent habitats and for refuge from humans and likely other potential threats. While there is clear variability in mangrove occupancy across primate species, the behavioural flexibility and variability facilitated by mangroves highlights the importance of conserving this habitat type across Africa and worldwide. In the case of *Chlorocebus sabaeus* the role of mangroves as a secure refuge deserves particular mention. The use of mangroves as a refuge has also been observed for *Gorilla gorilla gorilla, Cercocebus torquatus* and *Procolobus kirkii* (Head, Healy and Nowak, In Press). It is likely that more in-depth studies will reveal similar patterns for other primate species. Mangrove ecosystems are not the principal natural habitat of many of these primate species, and while they may provide a short term or seasonal refuge for species at times of increased pressure, they are unlikely to hold all the resources necesssary to enable these species to flourish in the long term. It works to the advantage of vervets that they have the ability to exploit mangrove habitats. However, this is sub-optimal habitat and the long-term use of the habitat may not be ideal. It is therefore of equal importance to safeguard not only mangrove ecosystems, but also adjoining terra firma forests and the natural resources contained within.

Recommendations

Mangrove habitat is clearly and understudied area of vervet ecology. If forced into a habitat shift, it is likely that green monkeys *C. sabaeus* in West Africa would successfully adapt to mangroves. Observations in Tanzanai and Kenya suggest that, at least in East Africa where rainfall is lower that West Africa, vervets could not survive exclusively in mangroves due to the lack of fresh water, bsence of appropriate sleeping trees and inadequate food sources. Further investigation into primate use of mangrove habitat is necessary to establish whether or not this sub-optimal environment would be suitable as a refuge habitat and to endeavour to fill the gaps in our knowedge of these monkeys.

3. International primate trade

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3.1 Present-day trade in a historical context

Humans have had a plethora of uses for primates, even since pre-historic times. Fossil evidence from East Africa suggests *Homo erectus* possibly hunted the ancient giant gelada *Theropithecus oswaldi* between 400,000 and 700,000 years ago (Shipman et al., 1981). Pre-historic hunting has also been implicated in the extirpation of the orang-utanon Java (Rijksen, 1978) and of several giant lemur species on Madagascar (Perez et al., 2005). Archaeological sites at the earliest centres of human civilisation – Ancient Egypt and even earliest Mesopotamia – show evidence of primate use (Dunham, 1985). Over time these uses have been many and varied with both our historic and prevailing relationships with primates being overwhelmingly paradoxical. Primates have been attributed great medicinal properties (Alves, Souto and Barboza, 2010), eaten (Fa, Peres and Meeuwig, 2002; Fa et al., 2006), feared, detested, persecuted (Lee and Priston, 2005; Campbell-Smith et al., 2010; Hill and Webber, 2010), exploited for labour (Bertrand, 1967; Azis and Davis, 1980; Deputte and Anderson, 2009) and for the pet trade (Nekaris and Jaffe, 2007; Nekaris et al., 2013), protected, sacrificed as tributes and worshipped as gods (Nerlich et al., 1993; Von den Driesch, 1993).

The most immediately apparent and oldest use for primates is to eat them, though their uses go well beyond their simple value as a protein source, and while a great many uses of primates have been domestic, others have stimulated international trade since the very earliest days of human civilisation. Some of these drivers of international trade have persisted, though on varying scales to historical trade, some have fallen out of fashion, and others have come to the forefront. Below is an overview of some of the historical drivers of international primate trade and the transition from those historical societal and fashion trends to the modern international primate trade.

3.1.1 Primates hunted

People have hunted primates for meat since pre-historic times. Now, while a lot of hunting is for subsistence, many hunters trade a substantial portion of their hunting harvest at markets (Fa et al., 2006; Bersacola et al., 2014). This trade mainly revolves around stalls at roadsides and local markets supplying wild meat to villages, towns, and cities. The growing demand for primate meat means some primate hunting is done as a purely commercial enterprise and on a much larger scale to subsistence hunting. Though most trade in wild primate meat is domestic, there is an international component close to borders (Fa et al., 2006).

Furthermore, primates have been and continue to be hunted as trophies. It is well known that gorillas, *Gorilla* spp., and orang-utans, *Pongo* spp., were once sought-after targets for 19th and 20th European hunters. Parts would have been taken as trophies and the carcasses eaten, though not by the European hunters as the closeness of apes to humans was said to make these men uncomfortable and put some more sensitive Europeans in mind of cannibalism (Morris and Morris, 1966). It is less widely known that primate hunting continues today (see chapter 5). Now the apes are not hunted legally and primate targets are less a matter of prestige but rather one of sport and opportunity. Cercopithecids are now the more popular targets and these are often shot free of charge as "targets of opportunity". Trophy hunting outfitters seems to be almost exclusive to sub-Saharan Africa with a predominantly American and European clientele, and in the last 30 years almost 30,000 primate trophies have been exported from over 40 exporting countries/states to over 100 importing countries/states, the USA importing the largest volumes by far (see Chapter 5).

3.1.2 Primates worshipped

Primates have been worshipped as sacred animals across many cultures over time (Alves, Souto and Barboza, 2010). Japan gave us the legend of the three wise monkeys, inspired by the Japanese macaque, *Macaca fuscata*, (Smith, 1993). The story of the introduction of Buddhism to China features a monkey as the hero. In India Hanuman was the monkey ally of the God Rama (Wolcott, 1978). There is still some reverence towards monkeys in India that could be reminiscent of the respect held for Rama. These practices did not stimulate international trade.

In North Africa Barbary macaques, *Macaca sylvanus*, were protected by some tribes in Morocco and Algeria, but eaten in Tunisia and Libya. One theory for these disparate treatments of the same species by closely related tribes is that the macaques were totems to all the tribes but were protected by some groups and ceremonially eaten by others (Morris and Morris, 1966). The origins of the Barbary macaque population on Gibraltar are unclear but genetic evidence supports anecdotes that say they were introduced to the rock from North Africa between 711 and 1492 AD (Modolo, Salzburger and Martin, 2005; Modolo et al., 2008). Moorish tradition says the monkeys used submarine passages caves to travel from the continent to the island while other stories suggest they were introduced to Gibraltar by the people who considered them sacred. However they made their way there, the earliest written evidence of their presence on the island is from 1704 and although not necessarily sacred, the superstitions the British came to hold for these moneys stimulated the importing of macaques from North Africa to stock the island population. The British came to think of these monkeys as lucky during the war with Spain and the superstition began that the reign of the British on Gibraltar would last as long as the monkeys remained. This was the stimulus for the importing of macaques from North Africa during the Second World War. While Gibraltar was a strategic point during the war Churchill ordered that a colony always be maintained on the rock. The monkeys were put under official protection by the British army and then later by the Gibraltar regiment (Stockey and Grocott, 2012).

For much earlier and definitive evidence of primate worship we must look to Ancient Egypt. Some of the earliest monkey worship occurred in Egypt (Nerlich et al., 1993; Von den Driesch, 1993; Goudsmit and Brandon-Jones, 1999; Goudsmit and Brandon-Jones, 2000; DuQuesne, 2007). Some of the earliest Egyptian deities were depicted as monkeys including: Atum 'God of Creation', depicted as a vervet, and Hapi 'son of Horus' (see Figure 2), Re (Ra) the 'God of the Sun' and Thoth, the 'God of the Moon'which were depicted as baboons, *Papio* spp., In the hall of judgement in the underworld four baboons guarded the lake of fire. During this time in Egypt astronomy, the lunar cycle and time-keeping were linked to religion the female hamadryas *Papio hamadryas* was also worshipped due to their overt sexual swellings that were linked to the lunar cycle. Male hamadryas baboons were worshipped as an embodiment of masculine sexuality with depictions of the baboon god Bebon usually emphasising the phallus and virility.

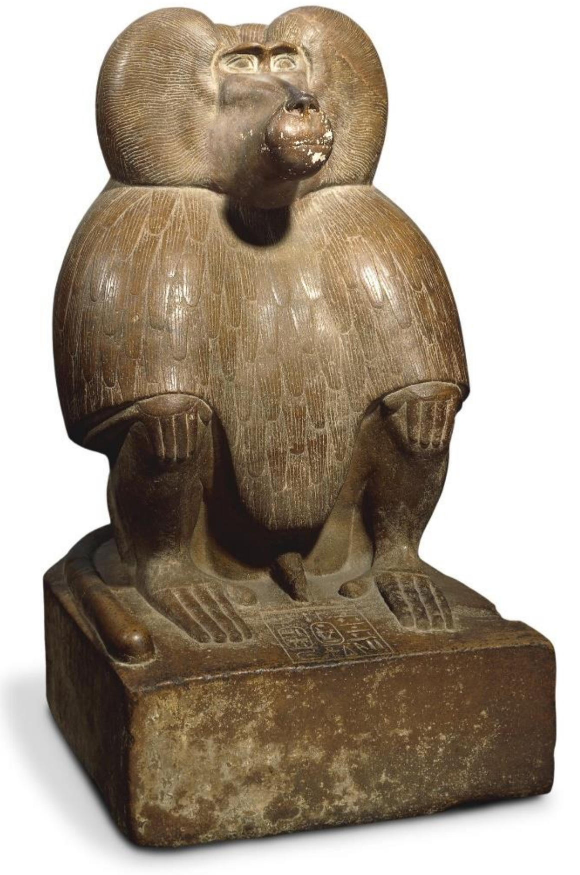

Figure 2. Quartzite figure of a baboon from the 18th Dynasty (approx. 1350 BC). Most likely a representation of Hapi from the mortuary temple of Amenotep on the west bank of the Nile. Source: Object No. EA36, Room 4, Egyptian sculpture, The British Museum.

Though it is possible that the baboons did occur in parts of Egypt until the Old Kingdom (approximately 2700-2100 BC), they were certainly being imported by the time of the New Kingdom (1500-1000 BC) from the land of Punt (Somalia, Djibouti, Eritrea, Northeast Ethiopia and the coast of Sudan) (Goudsmit and Brandon-Jones, 1999; Goudsmit and Brandon-Jones, 2000; Masseti and Bruner, 2009). By tradition when a new baboon was brought to the temples where the sacred troops were housed they would be presented with a tablet, reed pen and ink well. Those that passed this literacy test would be kept in the temples and their upkeep paid for by worshippers. When they died, these sacred baboons would be embalmed and mummified. Those that failed their 'literacy test' were trained to work picking fruit (Deputte and Anderson, 2009). Such scenes have been depicted in rock paintings, carvings and sculptures at burial sites dating from as early as the 12th Dynasty (2500-3450BC). Monkeys, on the other hand were not worshipped while alive. They were kept exclusively for ritual worship and deified after death. Monkeys often decorated toys and other objects, and a statue of a vervet monkey as the town god was in pride of place in the forecourt of the temple of Babylon in Old Cairo (Morris and Morris, 1966).

3.1.3 Primates in traditional medicine

There is evidence from as early as Ancient Mesopotamia of the bones of imported primates being used in drugs and potions (Dunham, 1985). Later, in 2nd century Europe, the idea spread that there were health benefits to eating primates. It was thought that since a lion ate primate meat to restore youth and vigour so too should primate consumption be beneficial to humans. At the same time, a Greek philosopher described a treatment for "scrofulous tumours" that involved a poultice of monkey faeces (Morris and Morris, 1966). In the much more recent past there was a great international trade in bezoar or geliga stones that are found in the lower digestive tract of folivorous monkeys. These were exported from South East Asia to Hindustan (North West of the Indian sub continent) in great quantities to be used as antidotes to snake bites, and for other complaints including fever and asthma. In 1949 a curator of the Sarawak Museum was dismayed by the pressure the international demand for these stones was putting on the survival of the Hose's langur *Presbytis hosei* from whom the stones were extracted. He worried that business had declined and there were complaints that the stones were rarer and considerably smaller than they had been. He surmised that unsustainable demand meant that the monkeys seldom reached a sufficient age to grow the stones to an acceptable size. This hunting pressure, brought on by international demand for bezoar stones, has arisen again today and the Hose's langur populations on Java have once again declined, and rapidly, in the last 20 years (Nijman, 2005).

Today primates are among the most commonly used mammal species in traditional folk medicine with over 70 species used in over 50 range countries (Alves, Souto and Barboza, 2010) in a host of treatments for ailments ranging greatly in severity a sore throat and cough to osteomuscular problems, rheumatism and general pains, to mental illness, malaria, typhoid, to male impotency. Sometimes the whole body is used but as is commonly the case when utilising vertebrates for zootherapeutical remedies, the desired extracts are often derived from body parts that do not have other uses, such as skulls, blood, bile, eyes, fat, eyes, viscera, brain (Sodeinde and Soewu, 1999; El-Kamali, 2000; Apaza et al., 2003; Alves and Rosa, 2006; Kakati, Ao and Doulo, 2006; Mahawar and Jaroli, 2006; Alves et al., 2009; Confessor et al., 2009; Hanazaki, Alves and Begossi, 2009) and thus many of these products are the result of initially hunting the animals for another purpose.

In Vietnam it is common to find monkeys in bottles of alcohol (Lippold and Thanh, 2008) to be used as tonics for medicinal purposes and for consumption as monkey wine and also as energy drinks. In Cambodia, for instance, the traditional Khmer medicine practice claims that lorises can treat 100 diseases. Slow lorises *Nycticebus* spp. are among the most commonly observed mammals in traditional medicine shops in Cambodia. The international component of the trade does seem to be restricted Southeast Asia where demand in China is greatest and in the areas of Indo-China closest to China primates are threatened by collection to supply the high demand of the Chinese traditional medicine industry and the country's consistently growing buying power (Gray, 2001). For example, in Vietnam the pygmy slow loris *N. pygmaeus* is captured by local hunters and smuggled out of the country to meet the demand in China for their use in medicinal preparations (Nekaris et al., 2010; Starr et al., 2010).

3.1.4 Primates in fashion

Primates have played their part in fashion with pelts being commercially traded internationally at least since medieval times. Black-and-white colobus *Colobus guereza* have been heavily hunted for their attractive pelts. Domestically, in East Africa, they were used for ceremonial garb, to cover shields, and to make decorative costumes, while in Central Asia they were coveted by khans and wealthy merchants (Morris and Morris, 1966; Mittermeier, 1973; Oates, 1977). During the Middle Ages, they were exported by Arabs and Abyssinians through India to Europe where there was much curiosity about the extraordinary and before unseen furs. European furriers, when they first saw these furs in Italy made up as shoulder capes, were sure there was some new and yet unlearned skill involved in inserting the long white hairs into the black skins (Morris and Morris, 1966). These skins became increasingly sought after in women's fashion through the latter half of the 18th century and as the demand grew so too did the numbers hunted and exported from range countries. They were hunted in every part of their range with increasing efficiency as rifles replaced bows and arrows. In 1892 175,000 colobus skins reached Europe alone (Morris and Morris, 1966). Many pelts were damaged with shotgun pellets and these flawed items were not accepted. Perfect specimens only are counted in this given figure. It is estimated that over 2 million colobus were killed while their skins were at the height of fashion (see Figure 3).

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Figure 3. Black-and-white colobus pelt rug.
Rug made from the pelts of approximately 80 black-and-white colobus sold at auction through Phillips Auctions in 2013. The piece is likely to have been made in 1974 and was bought originally in Addis Ababa, Ethiopia in 1975.

The pelt of the golden snub-nosed monkey *Rhinopithecus roxellana* was another popular fashion statement (Kirkpatrick, 1995). The golden hair of the males would be plucked and woven into fabric for officials' robes. It was estimated that in the mid 1980s 10,000 to 20,000 primate skins were traded annually from China (Wang and Quan, 1986). Monkey skins made popular lampshades, rugs and mats. Primate pelts have fallen out of fashion since the 20th century and as a fashion statement are now more niche than in previous centuries (www.fashionintime.org/history-fur-fashion-introduction). The fashion industry is no longer an international driver of commercial trade in primate products, though they are still traded as antiquities.

3.1.5 Primates as entertainers, pets and status symbols

Primates have been popular entertainers and pets, both domestically and internationally, throughout history (Morris and Morris, 1966; Burgess, 1959; Kanagavel et al., 2013; Svensson et al., 2015). The Ancient Egyptians imported pet primates, mostly African guenons *Cercopithecus* spp. The Romans imported pet primates from 50 BC. Barbary macaques and African guenons were the popular pets of affluent Greek households from at least the 7th century BC with some additional species arriving in Europe in trade caravans from India. These primate pets were treated lavishly, given human clothes and expensive gold collars. By the third century BC primate pets was widespread across all walks of Greek life. Roman and Greek writings also talk of monkey entertainers that could “play” musical instruments such as the harp and lyre, shoot a bow and arrow, and walk on stilts. Unlike the majority of exotic animals imported to Ancient Rome, primates, in the main, escaped the arenas, though there are some ambiguous writings that suggest it is likely that either gorillas or large-bodied baboons also fought in the games (Morris and Morris, 1966).

Monkeys were not known in Western Europe until the 11th or 12th centuries AD when Barbary macaques and their trainers were imported from North Africa across the Mediterranean. Medieval princes would customarily keep monkeys that would be carried around by court jesters for entertainment. Royal menageries were also stocked with imported primates for entertainment as well as for zoological study. The menagerie at Versailles established by Louis XIV imported many monkeys to the collection. They became expensive status symbols, and were kept by the rich and influential to impress upon the lower classes their power and wealth. For one hundred years, monkeys were even kept on display in the cloisters of Notre Dame in Paris until the practice was discouraged by the papal legate. By the Middle Ages monkeys were popular amongst the ordinary but wealthy citizenry, the trade being so strong in Paris that a tax was levied on every monkey entering the city to be sold. In the Middle Ages monkeys were trained by travelling minstrels and put on shows similar to those of Roman and Greek performers. Depictions of monkeys became incorporated into family crests. In 13th century Ireland the Earls of Kildare in the 13th century adopted a monkey as their emblem (see Figure 10). William de Pole in the

15th century had as his heraldic device the clog and chain that would have been used in that time to control a monkey, informing the phrase “jackanapes”.

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Figure 4. Fitzgerald family crest.
Anecdotes say that a monkey was incorporated into the family crest following a fire in the castle of the Earl of Kildare in which a monkey is said to have saved the family.

Monkey enthusiasts abounded in Western Europe, particularly amongst the politically influential, when new trade routes opened up to the New World. The variety of species on offer increased greatly at this time and the smaller New World monkeys, the marmosets and tamarins (*Callithrix, Cebuella, Callibella, Mico, Sanguinus*), became the newest fashion craze. Marmosets were particularly popular amongst the French aristocracy. By the middle of the 17th century, monkeys were so popular in the UK, being very much enjoyed in London as performers and with all women of fashion having some kind of monkey pet, that the Chancellor of the time considered a tax on monkeys as a source of significant revenue. The fondness for monkey pets persisted and Victorian owners even had their dead monkeys stuffed and kept as mementos. Inevitably, when they could be easily acquired they were no longer great status symbols and fell out of high fashion.

In the late 19th century, minstrels were replaced by travelling musicians who were, like the travelling minstrels of the 17th and 18th centuries, accompanied by monkeys. These ‘musicians’ were in truth often disguised beggars who played the street organ for donations. Their monkeys, often capuchins *Cebus* spp. and rhesus macaques *Macaca mulatta*, would collect money from onlookers in the street. Primate-based entertainment developed from street performing monkeys to more elaborate and sophisticated entertainment as time went on with primates making their way onto the stage by the 1900s, with the first chimpanzee stage show in 1926, and eventually onto television screens by the latter half of the 20th century.

The international trade in primates for the pet trade is not a great as it was, though commercial trade in live primates is on the rise. However, the proportion of this trade composed of pets is not readily quantifiable, and the source of the pet primates in non-range countries is generally unknown.

3.1.6 Primates in research and 20th century trade

Many historical uses for primates, which stimulated significant international trade, have not persisted on the same scale. Rather, a growing driver of the trade has been the increasing usefulness of primates as research models. Primates have been contributing to medical research since Roman times. For instance, Galen's famous writings on human anatomy were based on macaque dissection. Barbary macaques would have been the more popular research animals of the time. Primates continued to become increasingly useful models and research tools and finally their prominence as a biomedical model was solidified in the 1870s when researchers turned their attentions to the primate brain. Ferrier described the potential comparability between the monkey and human brain and later the neuroscientists Horsley and Beevor mapped the brain of the bonnet macaque, *Macaca radiata*, and later the orang-utan *Pongo* spp. By the late 19th century, their usefulness in disease research became apparent and primates have been serving in research since in ever-increasing numbers.

By the 20th century monkeys were being exported from range countries, primarily from India, Colombia and Peru, in their hundreds of thousands to supply the biomedical research industry, the trade reaching its peak in the mid 1900s (Wolfheim, 1983; Mack and Mittermeier, 1984). In 1938 alone, 250,000 rhesus macaques from India were imported to the USA. The 1950s saw India exporting 100,000 to 200,000 rhesus macaques a year. By the end of the 1950s, there were reports of commercial exporters having trouble filling demand. Exports of rhesus macaques declined through the following two decades and by 1975 annual exports had been cut to 20,000. Rhesus macaques are no longer the most popular research primate nor the most highly traded. In 1978, India banned export of its macaques to the US as the US was in violation of an agreement to only use the monkeys in research that would benefit humans. This was in response to the military using monkeys to test the effets of weapons and high explosives. Between 1950 and 1975 at least 4 million primates, almost exclusively wild-caught, were traded internationally. Rhesus macaques dominated the trade with 2 million monkeys traded over the 25-year period. Long-tailed macaques, *Macaca fascicularis*, from Peninsular Malaysia and squirrel monkeys *Saimiri* spp. from Cambodia and Peru, accounted for 1 million and 400,000 individuals respectively.

3.1.7 The inception of CITES and analysis of the Trade Database

With such unsustainable extraction, there were growing concerns for the survival of many species. Though it may seem obvious to us now that there is a need to monitor trade in endangered species of fauna and flora, when discussions began about a global international multilateral agreement for the regulation and monitoring of this sort of trade it was a relatively novel idea. Agreements of the earlier portion of the 1900s were regionally limited, had too little national support to be effective, and having been written for a more colonial world they, in part, lost their relevance. Global concern for species survival and the conservation impact of over-exploitation for international trade was first expressed in 1960 at the seventh general assembly of the IUCN in Poland. In 1973, representatives attended a global plenipotentiary conference from 80 countries/states. The Convention was signed by 21 of these, and ratified by 10 Parties and in 1975 the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) became a reality. As of 2016, 182 Parties (Parties are mostly sovereign states, but also include the European Union as the first regional economic integration organisation to join the Convention) have ratified the Convention.

CITES is an international agreement between governments with the aim to monitor international trade in endangered species. The primary aim of the Convention is to ensure that international trade does not threaten the survival of CITES-listed species. Species are listed in three Appendices according to the degree of protection needed. The approximately 1,000 species listed on Appendix I are threatened with extinction and international trade is precluded. For the 35,000 species listed on

Appendix II, international trade is regulated below levels of extraction that would threaten their survival. As of 2013, about 10 primate species are listed in Appendix I and all remaining species are listed on Appendix II. CITES keeps a trade database, managed by the United Nations Environment Programme (UNEP) World Conservation Monitoring Centre (WCMC) on behalf of the CITES Secretariat, that holds approximately 10 million records of trade in wildlife with about 50,000 scientific names of taxa. Approximately 700,000 records of international trade in CITES-listed species are reported annually and entered into the database – a requirement of all 182 Parties. Each Member Party's management authority is responsible for the issuing of the necessary permits and for the compilation of annual reports, though this reporting system (Blundell and Mascia, 2005; Nijman and Shepherd, 2011; Bickford et al., 2011; Phelps et al., 2010; Smith, Williams and Purves, 2011; Bowman, 2013). However, these annual reports submitted by the Parties are the only available means of consistent monitoring of the global international wildlife trade and the implementation of the Convention.

A review of the international primate trade, focused primarily on the biomedical trade and captive breeding, was published in 1984 (Mack and Mittermeier, 1984). Since then there have been few comprehensive studies of primate trade. In 2011, Nijman and colleagues presented a brief overview of the international primate trade describing trade as a significant impediment to primate conservation, highlighting the need to quantify the extent of this trade and calling for further studies of the international trade records. Unsustainable and unregulated levels of trade in long-tailed macaques out of Southeast Asia have been reported recently (Foley and Shepherd, 2011). Furthermore, since 1981 four or five of the top five mammal species traded have been primates. In view of this gap in our knowledge, and with the Primates being the most highly traded mammal order, analysis of the CITES Trade Database seemed timely.

Below is a detailed overview of the CITES-reported trade in individual primates. The main aims of this overview are to (a) describe the temporal trends in annual volumes of trade; (b) identify the major exporting and importing countries/states involved in the trade; (c) identify the taxa traded in the largest quantities; (d) compare the captive-bred and wild-caught components of the trade; (e) identify the foremost drivers of the trade; and (f) put CITES-reported trade in an appropriate temporal context.

3.2 Methods

Data acquisition
I downloaded data from the UNEP-WCMC-CITES Trade Database (http://www.unep-wcmc-apps.org/citestrade) on 7 November 2017. The CITES trade database provides all records of imports, exports, and re-exports as reported by countries and states that are Party to CITES. The legal framework for regulating the international trade in CITES-listed species is based on the issuing of permits or certificates for the international trade in these listed specimens. Parties are responsible for the issuing of these permits and the compilation of annual reports. Reports are required to be submitted by 31 October of the year following the one in which the transaction took place and are then entered to the CITES Trade Database. The inevitable time delay puts the available records two years in arrears; therefore, data were downloaded for the years 1975-2015 (inclusive). I obtained data by searching for each genus individually. As output mode, I used the comparative tabulations reports.

I obtained additional trade data, especially where they pertained to the pre-CITES period (i.e. before 1975), from the appendices and species profiles of Wolfheim's 1983 compendium *Primates of the World: Distribution, Abundance and Conservation* and from Mack and Mittermeier's 1984 review *The International Primate Trade: Volume 1 - Legislation, Trade and Captive Breeding*. Trade data in these volumes were compiled from a variety of sources including customs reports from the USA and from several European importers and from the records of governmental bodies responsible for natural resource management in a variety of export countries.

Data preparation
Each database entry contains: the year of the transaction; whether or not the species was included on Appendix I, II or III; taxon; importer; exporter; origin (if not being exported from the country of origin, i.e. re-exports); importer quantity (as reported by importing body); (re-)export quantity (as reported by exporting body); terms (such as bodies, bones, derivatives, live trophies); purpose (including breeding,

commercial, hunting trophy, (re-)introduction, medical, personal, scientific, zoo); and source (including bred in captivity, born in captivity, confiscated specimens, pre-convention specimens, ranched specimens, i.e. reared in a controlled environment, taken from the wild, unknown).

For the purpose of this study I focussed on those items that could be unambiguously identified as, or equated to, an individual animal that has been removed from a captive or wild population. The types of primate products traded include live animals, whole dead animals, and a wide variety of parts and derivatives. In addition to the live animals and bodies, a further portion of the parts could be identified as – or, in the case of hands, tails, skulls, etc. unequivocally equated to – individuals. However, the majority of parts could not be attributed to individuals. I included 11 of the 38 terms listed in the database in this analysis of trade in 'individual' primates: bodies; ears; feet; garments; live; skeletons; skins; skulls; tails; trophies; unspecified. The remaining majority of terms however, were excluded due to ambiguity. For instance, some of these items include biological samples that are unlikely to represent an individual's removal from a population. Furthermore, many of these products are described in units that give no indication of real volume, e.g. shipments, or boxes, or in units too small to reasonably be equated to individual animals, e.g. micrograms, millilitres.

To differentiate between captive-bred and wild-caught individuals I filtered for source. For the purpose of this report the captive-bred category includes animals bred in captivity for commercial purposes (source codes C and D), animals born in captivity (source code F) and ranched specimens, i.e. animals removed from the wild and reared in a controlled environment (source code R). The wild-caught category includes animals definitely taken from the wild (source code W) but also, to avoid misleading under-representation of wild-caught specimens, confiscated or seized specimens (source code I), pre-convention specimens (source code O) and animals of an unknown source (code U).

It must be noted that the reliability of CITES records depends on the accuracy of reporting by the Member Parties. There are often large discrepancies between quantities reported by importers and those reported by exporters(Blundell and

Mascia, 2005; Nijman and Shepherd, 2009; Nijman and Shepherd, 2011; Phelps et al., 2010). Researchers account for these discrepancies in different ways. Some chose either the import or export quantity and consistently use these records throughout (Luiselli et al., 2012), while others will choose the larger of the two quantities where there is a discrepancy (e.g. Nijman and Shepherd, 2009). Here, I used import quantities unless it could be judged with a relative degree of confidence that the export figure was a more accurate representation of real trade. For instance, for years prior to an exporter joining CITES the import quantities will not be representative of the real volume of trade. Nor will import quantities be representative of trade from exporters not Party to the Convention. These discrepancies could be mitigated for to some degree by accounting for the year a country or state joined. If an importer was not yet a Party to CITES by a certain year, then the export figures were taken for years prior to joining. For example, Mexico did not become a Party to CITES until 1991 and therefore export quantity figures were taken for years prior to 1991 in order to more accurately reflect real trade. Where the importing country/state was not a Party to CITES I took export quantities for all years. Furthermore, some importers, though they may be a Party to CITES report not at all or very little. In these cases, export figures were taken instead. For instance, the Russian Federation became a Party to CITES in 1992 and has reported one trade transaction since (of 30 individuals). However, export quantities to the Former Soviet Union and to the Russian Federation (which have been combined and treated as one entity for the purpose of this study) are in excess of 16,000 items. In this case export figures were taken for all years, even after joining. A further several importing countries/states that either are not Party to CITES or that are but have never reported importing primates include: American Samoa, Andorra, Angola, Bahrain, Former Czechoslovakia, Former East Germany, French Polynesia, Former Serbia and Montenegro, Former Yugoslavia, Gibraltar, Hong Kong, Iraq, Isle of Man, Lebanon, Martinique, New Caledonia, North Korea, Puerto Rico, Reunion, Syrian Arab Republic and Taiwan. Export quantities were taken for all transactions involving these importers.

3.3 The global trade

3.3.1 CITES-reported trade in primates and their derivatives 1975-2015

The CITES Trade Database contains 60,000 transactions reporting primate trade between 1975 and 2015. Types of products traded include live animals, dead whole animals, various animal parts, trophies (which can be whole animals or parts), derivatives such as bone carvings and garments, and other products such as scientific specimens and cultures. Some of these items could be unambiguously identified as – or, in the case of hands, tails, skulls, etc. equated to – individual animals that have been removed from a population. These products include products such as live animals, bodies, skins, skulls, skeletons, and tails. The majority of CITES-reported trade however, is in parts and derivatives. These products include skin pieces, bones, bone pieces, derivatives, and specimens. Some of these ambiguous items are described in non-standard units such as bags, boxes, and shipments that can give no indication of real volume. Others are described in small units like milligrams, micrograms, and millilitres, and are too small to sensibly be equated to an individual animal. Some are biological samples and therefore may not represent removal of any individuals from a population.

Over 23 million primate-derived products obtained from 350 taxa were traded internationally between 1975 and 2015. These items were traded between ~200 exporting countries/states and ~200 importing countries/states. There has been an overall increase in this reported trade over the 40-year period growing from tens of thousands of products reported as traded annually in the earlier years to hundreds of thousands from the late 1990s onwards and to the order of one million per year by 2011. The majority of the trade is comprised of primate parts/derivatives, and it is this component of the trade that has so drastically increased in recent years. In 2012 alone 11 million primate parts/derivatives were traded.

3.3.2 International trade in individual primates

Trade in individuals accounts for 7% of the total volume, 1.6 million animals, and has increased over time. There was a brief dip in trade in the mid 1990s that was followed by a recovery by the latter half of the decade and a further rise that continued into the 2000s.

Over the 40-year period covered by CITES reporting there has been a relatively even representation of captive-bred and wild-caught animals. However, as shown in Figure 5, this distribution has not been even over time; the recent increase in annual volumes has been supplied for the most part by captive-bred animals. Between 1975 and 1994 the overwhelming majority of individual trade, ~90%, was in wild-caught primates. The period of the early 1990s shows a shift away from wild-caught trade in favour of captive breeding and from 1995 onwards captive-bred animals have supplied over 80% of the individual primate trade.

The number of taxa traded – over 200 – made an initial increase in the first five years but remained relatively stable for the remainder of the period with approximately 105 taxa traded annually. Asian taxa were traded in the largest quantities by far, making up almost 80% of overall individual trade. African and Neotropical taxa are traded in smaller quantities, ~15% and <10% respectively. The five taxa traded in the largest volumes, accounting for 89% of the individual trade, are *M. fascicularis* (~70%), *Chlorocebus* spp. (<10%), *M. mulatta* (<10), *Saimiri sciureus* (5%) and *Papio anubis* (<5%).

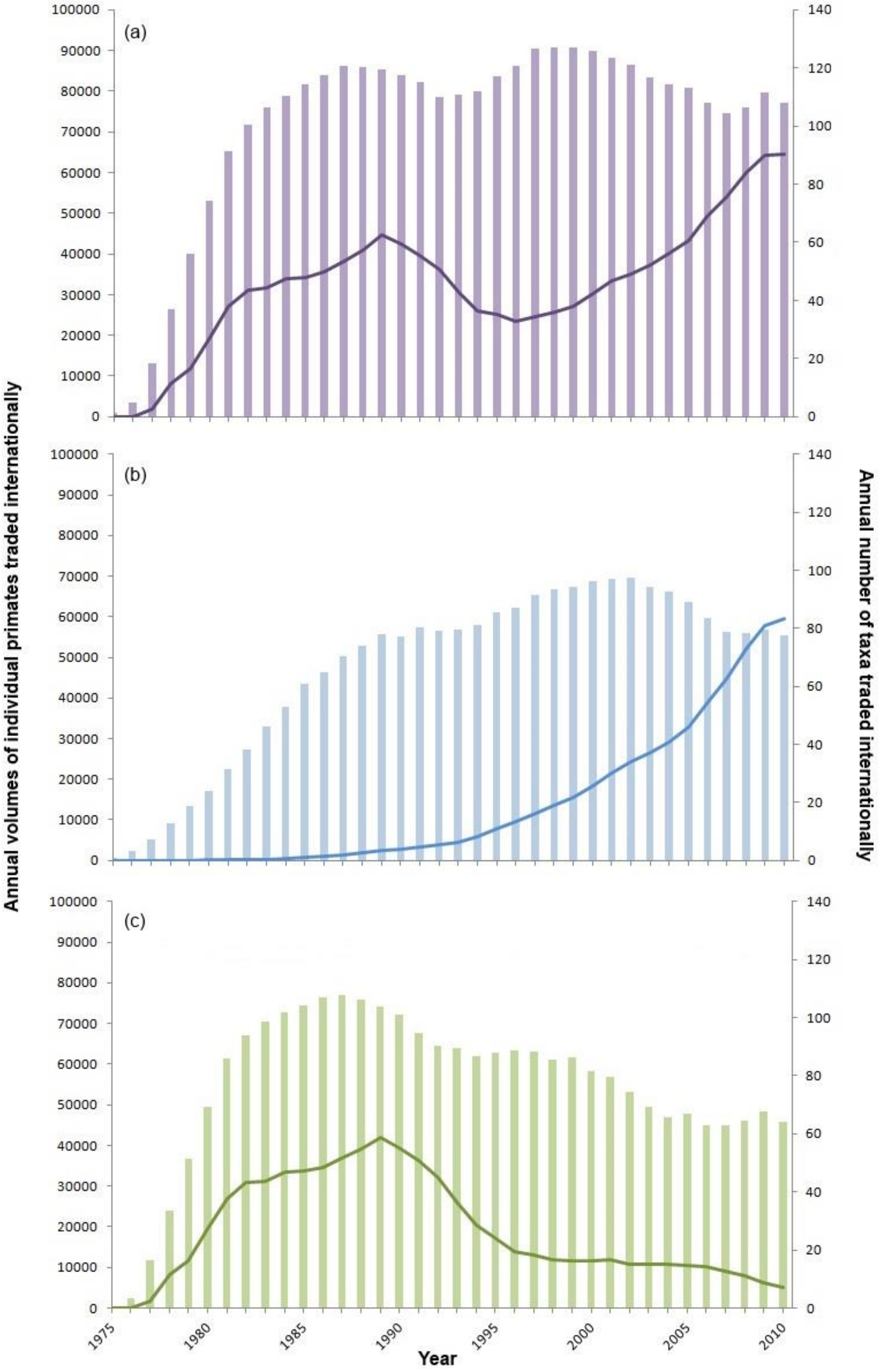


Figure 5. Annual volumes of CITES-reported individual primates traded (lines), as well as the number of taxa traded (bars) annually are presented here for (a) all primates, (b) captive-bred primates and (c) wild-caught primates.

As shown in Figure 6, the dominance of Asian taxa in the trade is most pronounced when looking exclusively at captive-bred trade where they account for an overwhelming majority of ~95%, leaving only ~2% accounted for by African taxa and ~4% by taxa from the Neotropics. Asian taxa make up a less pronounced majority in wild-caught trade but this is still significant at 60% while African and Neotropical taxa account for ~25% and ~15% respectively.

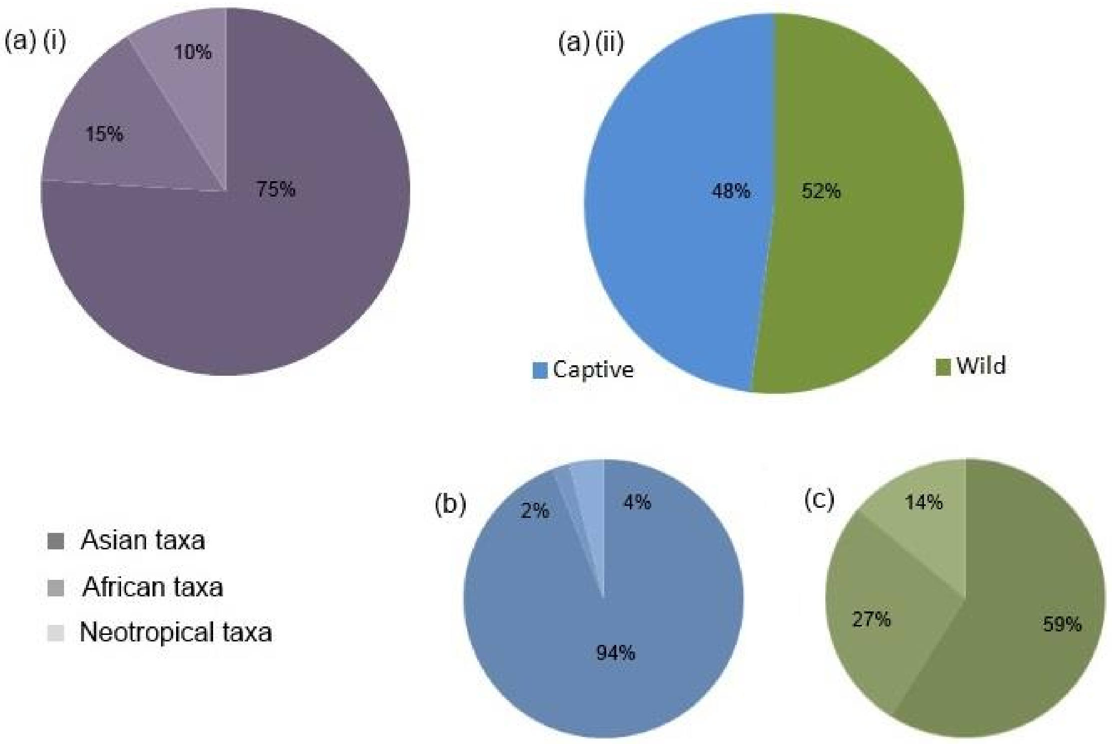


Figure 6. Continental contributions are not equal across the three categories (a) all idividuals; (b) captive-bred individuals; and (c) wild-caught individuals

The five foremost exporters are China (~20%), Indonesia (~15%), the Philippines (~10%), Mauritius (~10%) and Viet Nam (~5%), collectively accounting for ~65% of trade. The five leading importers account for ~75% of individual trade. The largest importer by far is the USA (~45%) followed by Japan (~10%), China (<10%), the UK (~10%), and France (~5%).

Table 3. Composition of the CITES-reported trade in individual primates between 1975 and 2015, with some noteworthy differences in composition highlighted across the three categories: All individuals; Captive-bred; and Wild-caught.

	All individuals		Captive-bred		Wild-caught	
Individuals	1,490,000		880,000		720,000	
Taxa	273		210		256	
Top 5 taxa	*M. fascicularis*	69%	*M. fascicularis*	86%	*M. fascicularis*	53%
	Chlorocebus spp.	7%	*M. mulatta*	7%	*Chlorocebus spp.*	14%
	M. mulatta	6%	*C. jacchus*	2%	*S. sciureus*	9%
	S. sciureus	5%	*M. nemestrina*	1%	*M. mulatta*	4%
	P. anubis	2%	*Chlorocebus spp.*	<1%	*P. anubis*	4%
Exporters	174		147		164	
Top 5 exporters	China	19%	China	37%	Indonesia	21%
	Indonesia	12%	Mauritius	15%	Philippines	18%
	Philippines	12%	Viet Nam	12%	Guyana	8%
	Mauritius	11%	Cambodia	10%	Kenya	7%
	Viet Nam	6%	Indonesia	7%	Mauritius	7%
Importers	197		151		189	
Top 5 importers	USA	46%	USA	44%	USA	47%
	Japan	11%	Japan	15%	Japan	8%
	China	7%	China	13%	UK	8%
	UK	7%	France	6%	Russian Federation	5%
	France	5%	UK	6%	France	4%

3.3.3 Re-exports

Seven per cent of the individual primate trade consisted of re-exports. Around one eight of these were from unknown origins. Of those whose origins were known many re-exported primates originated in the Philippines, Kenya, China, and Indonesia. The USA is the largest re-exporter sending the majority of its re-exports to Canada, Japan and France. The Netherlands is another significant re-exporter, re-exporting in the main to the Russian Federation. The UK, another significant re-exporter, re-exports primarily to the Unites States and to a lesser extent to Japan and Mexico. Some major apparent re-export routes include the re-export of large quantities of *M.*

fascicularis from the Philippines through the USA to Japan, France and Canada; re-export of Kenyan *Chlorocebus* spp. through the Netherlands to the Russian Federation; re-export of Chinese *M. fascicularis* through the USA to France, Italy and Canada; and re-export of *M. fascicularis* from Indonesia through the USA to France, Italy and Canada.

3.3.4 International trade in captive-bred primates

Since 1975 over 880,000 individual captive-bred primates of 210 known taxa were exported from 147 countries/states to at least 151 importing countries/states. This captive-bred trade has been on the rise increasing steadily since the 1990s (see Figure 5b).

The dominance of Asian taxa is most pronounced in captive-bred trade, accounting for an overwhelming 95% of the volume (see Figure 6). Only 2% is accounted for by African taxa and 4% by taxa from the Neotropics. *M. fascicularis* is the most traded captive-bred primate, accounting for 86% of captive-bred trade. The four next most significant contributors collectively account for a further 10%. The composition of the top five captive-bred taxa traded remains relatively similar to that of the top five taxa involved in overall individual trade, with the exception of *Callithrix jacchus* replacing *S. sciureus* (see Table 3).

As can be seen in Table 3, the composition of the top five exporters remains mostly unchanged from that of overall trade with the exception of Cambodia taking the place of the Philippines (see Figure 7). The top five importers remain unchanged with the USA continuing to account for the largest volume, ~45%, of the trade. The same remaining top four importers continue to account for substantially fewer imports than the USA.

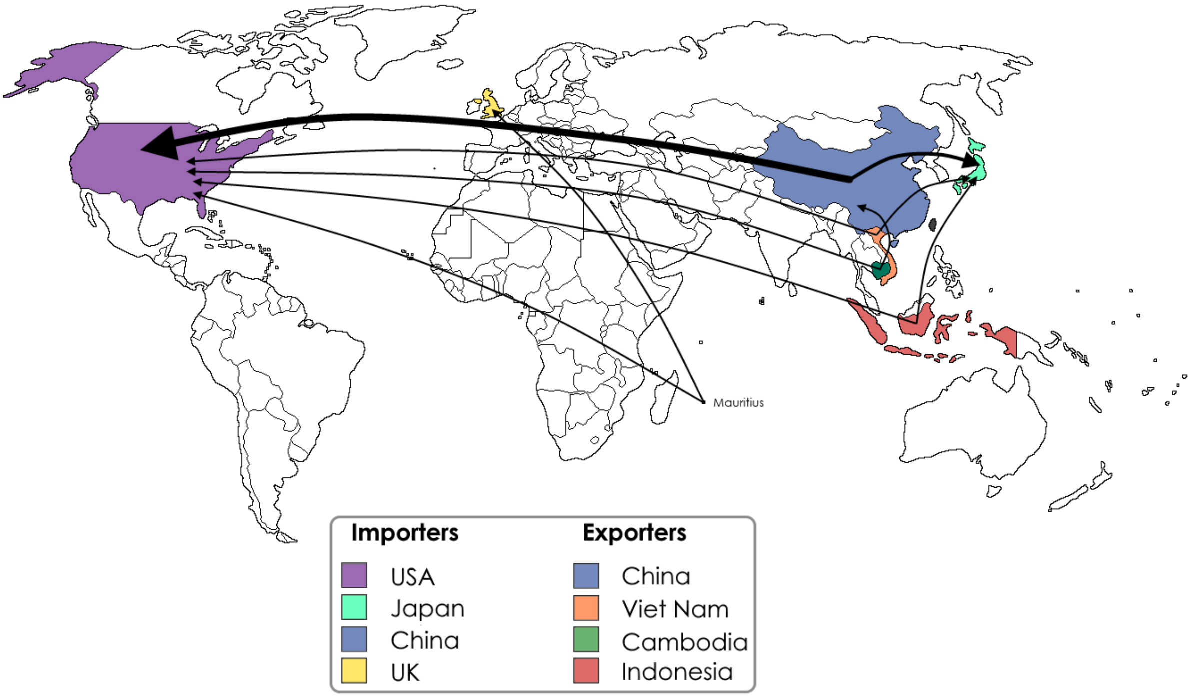


Figure 7. Major exporters and importers of captive-bred primates

3.3.5 International trade in wild-caught primates

Over 720,000 wild-caught individual animals, of 256 taxa, were traded between 165 exporters and 190 importers between 1975 and 2015. While trade in captive- bred animals has been on the rise, trade in wild-caught individual primates is declining. Asian taxa make up a less pronounced but still a clear majority of wild-caught trade, at ~60%. African taxa account for much more wild-caught trade than captive at ~25%, while Neotropical taxa account for ~15%. *M. fascicularis* continues to account for the majority of wild-caught trade, though by a lesser margin than that of captive-bred trade, at ~50% (to captive-bred trade's 85%).

The composition of the top five taxa, accounting for 84% of wild-caught trade, is not unlike that of overall trade and captive-bred trade. However, *Chlorocebus* spp. contributes a greater portion of wild-caught trade at 14% and *C. jacchus* is replaced by *S. sciureus* as one of the top five (see Table 4) taxa make up a less pronounced but still a clear majority of wild-caught trade, at 59%. African taxa account for much more wild-caught trade than captive at ~25%, while Neotropical taxa account for ~15%. *M. fascicularis* continues to account for the majority of wild-caught trade, though by a lesser margin than that of captive-bred trade, at ~50% (to captive-bred trade's 85%).

Notably, China is not a top exporter. Rather, Indonesia exported the largest volume of wild-caught individuals and accounts for 20% of wild-caught trade (see figure 7). The Philippines, not as top exporter of captive-bred primates, accounts for ~20% of wild-caught trade. Guyana and Kenya, neither previously featuring as top exporter, both account for <10% of wild-caught individuals trade along with Mauritius, also <10%. The USA remains the top importer, importing ~45% of wild-caught individuals (see Table 4).

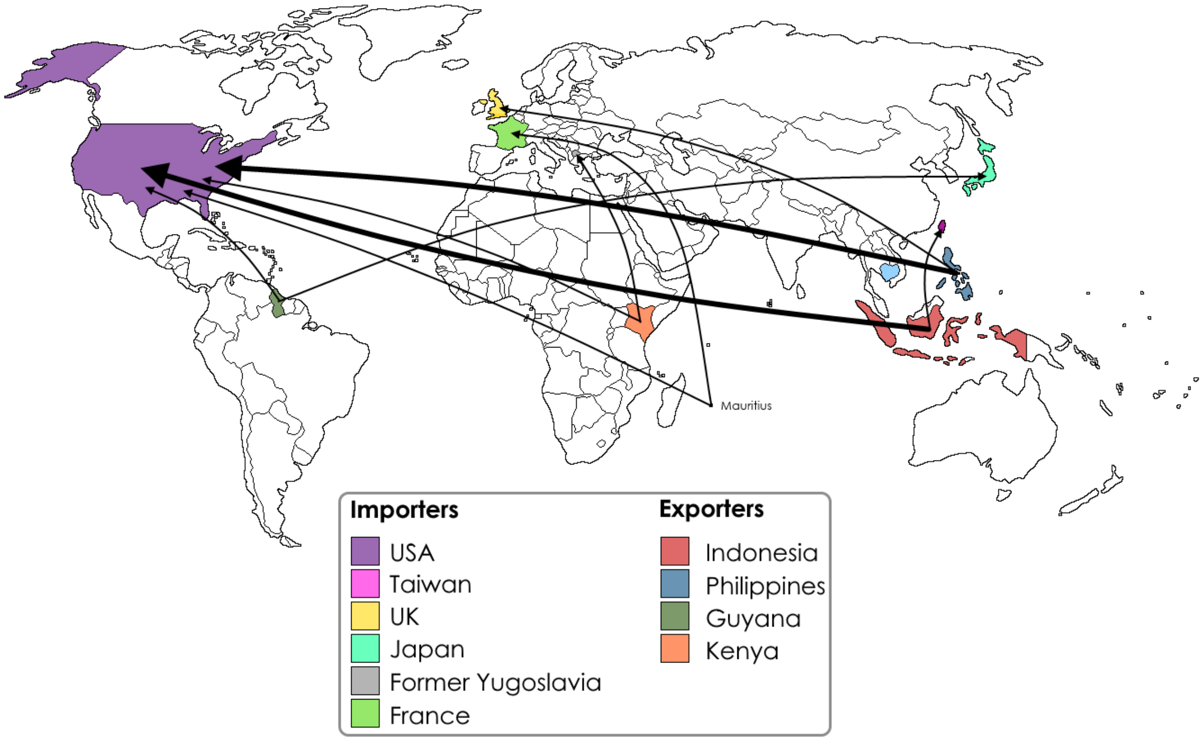


Figure 8. Major exporters and importers of wild-caught primates.

3.3.6 Drivers of trade

Terms

The vast majority of individual primate trade is in live primates (see Table 4). The remaining trade in dead primates is mostly comprised of trade in trophies, skulls, unspecified terms, bodies and skins. Less commonly traded terms include skeletons, garments, feet, tails and ears (<1% of dead trade). Table 4 summarises the composition of trade terms for all individual trade, captive trade and wild trade, showing that trade terms are not similarly represented across captive-bred and wild-caught trade. As would be expected, trophies account for a much larger portion of dead wild-caught trade (~50%) than dead captive-bred trade (1%).

Purposes

The primary purpose of primate trade is commercial (~55%). After commercial trade, captive-bred trade is driven mostly by trade for medical (~25%) and scientific (~15%) purposes, whereas wild-caught trade is made up of trade of an undisclosed purpose (blank ~20%) and scientific trade (~15%). As with terms, unsurprisingly trophy hunting is a larger contributor to wild-caught hunting than captive-bred, though still a relatively small component of wild-caught trade at <5% (see Table 4).

3.3.7 CITES-reported trade in an appropriate temporal context

Though there has been an increase in CITES-reported trade in individual primates, individual primate trade has in fact declined since the 1960s. Furthermore, the trade in wild-caught animals has declined substantially as pre-CITES trade was almost exclusively wild-caught. Much larger volumes of primates were traded in the decades prior to the inception of CITES (see Figure 9): an estimated 4 million animals were traded internationally between 1950 and 1975. It was *M. mulatta* that dominated this early trade with 2 million monkeys traded over the 25-year period. *M. fascicularis* from Peninsular Malaysia was the next most significant contributor, followed by *S. sciureus* from Colombia and Peru, each accounting for 1 million and 400,000 monkeys respectively (Wolfheim, 1983; Mack and Mittermeier, 1984).

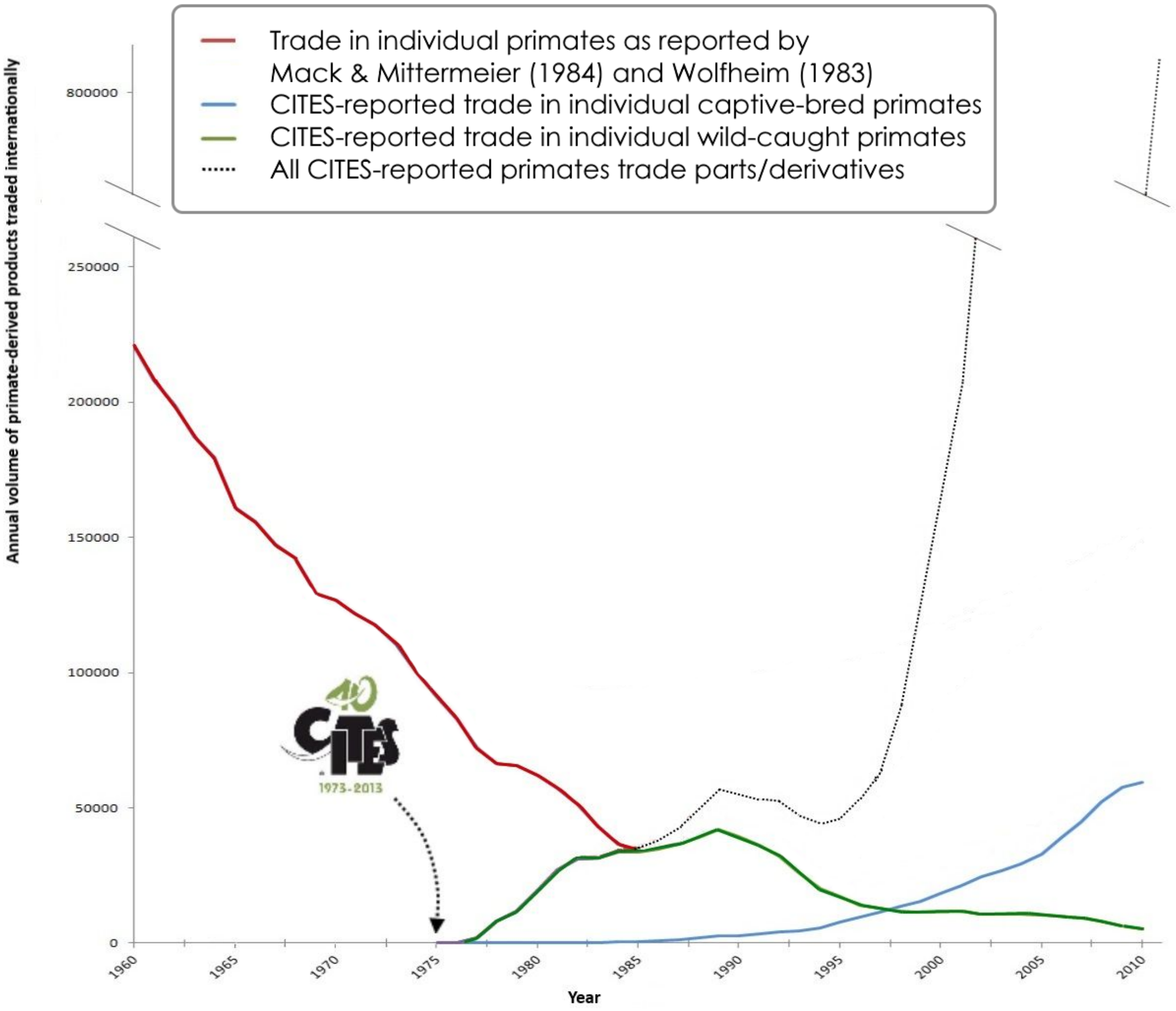


Figure 9. Reported international trade in individual primates has declined since the 1960s.

3.4 Primate trade in and from Africa

3.4.1 CITES-reported trade in African primates and their derivatives 1975-2015

The CITES Trade Database contains over 30,000 transactions reporting trade in African taxa between 1975 and 2015, totalling over 1.6 million products from 167 taxa traded between 171 (re-) exporting countries/states to 195 importing countries/states. Of these products, over 170,000 items (~10%), from 124 taxa, were unambiguously identified as or equated to individual animals specifically of African origin. These were traded between 51 (re-) exporting countries/states to 167 importing countries/states. Only 1% of trade in individual primates out of Africa has been captive-bred, at an annual average of 30 animals traded per year, compared to the annual average of over 4,000 wild-caught animals traded. It was not until

2010 that annual captive-bred trade exceeded 100 animals per year. An overview of captive-bred trade is presented in Table 4.

Table 4. Composition of CITES-reported trade in individual captive-bred and wild-caught primates out of Africa between 1971 and 2015

	Captive-bred		Wild-caught	
Individuals	3,700		170,000	
Taxa	60		122	
Top 5 taxa	*Chlorocebus spp.*	35%	*Chlorocebus spp.*	51%
	Pan troglodytes	13%	*Papio anubis*	16%
	P. ursinus	9%	*P. ursinus*	11%
	Macaca sylvanus	7%	*P. hamadryas*	5%
	P. anubis	5%	*Erythrocebus patas*	3%
Exporters	33		49	
Top 5 exporters	South Africa	30%	Kenya	31%
	Zambia	15%	Tanzania	20%
	Guinea	10%	Ethiopia	12%
	Kenya	10%	South Africa	8%
	Morocco	7%	Zimbabwe	6%
Importers	73		160	
Top 5 importers	Taiwan	15%	USA	29%
	USA	15%	Russian Federation	18%
	China	11%	Former Yugoslavia	9%
	France	11%	Netherlands	8%
	Japan	8%	UK	8%

3.4.2 Wild-caught trade in individual primates out of Africa

Between 1975 and 2015 over 170,000 wild-caught primates of 122 taxa were exported from 49 African countries/states to 160 countries/states around the world (Figure 10).

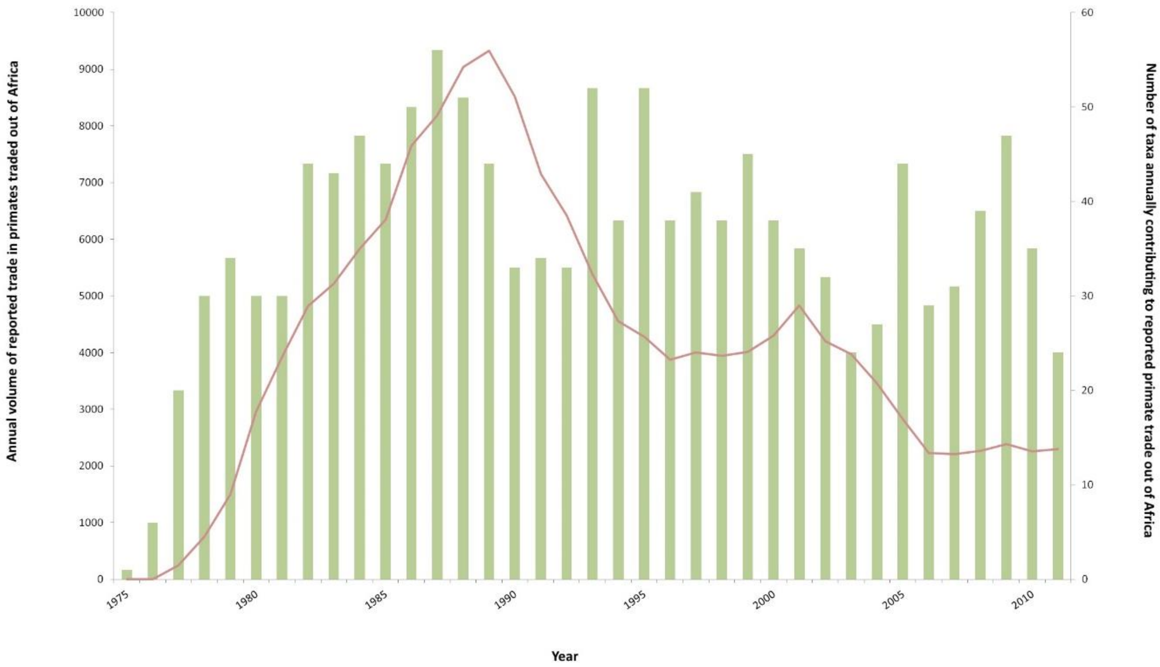


Figure 10. Annual volumes of CITES-reported trade in individual wild-caught primates out of Africa for the period of 1975 to 2011.

As shown in Figure 11, the trade has been dominated by *Chlorocebus* spp. which have accounted for over half the overall volume of trade. Papio anubis and *P. ursinus* have also been significant contributors at 16% and 11% respectively. *P. hamadryas* and *Erythrocebus patas* have been less significant contributors at 5% and 3% respectively. Cumulatively, these top five taxa account for ~85% of the overall volume of trade. While there has been no marked change in the annual volumes of four of these top five taxa, with the exception of *P. ursinus*.

As demonstrated in Figure 12, the top five exporters of primates from Africa have been Kenya (~30%), Tanzania (20%), Ethiopia (12%), South Africa (<10%) and Zimbabwe (<10%). These top exporters account for ~75% of the trade with the top ten cumulatively accounting for ~95%. The top five importers of wild-caught African primates, accounting for 70% of the trade, are the USA (~30%), the Russian Federation (~20%), Former Yugoslavia (~10%), the Netherlands (<10%) and the UK (<10%).

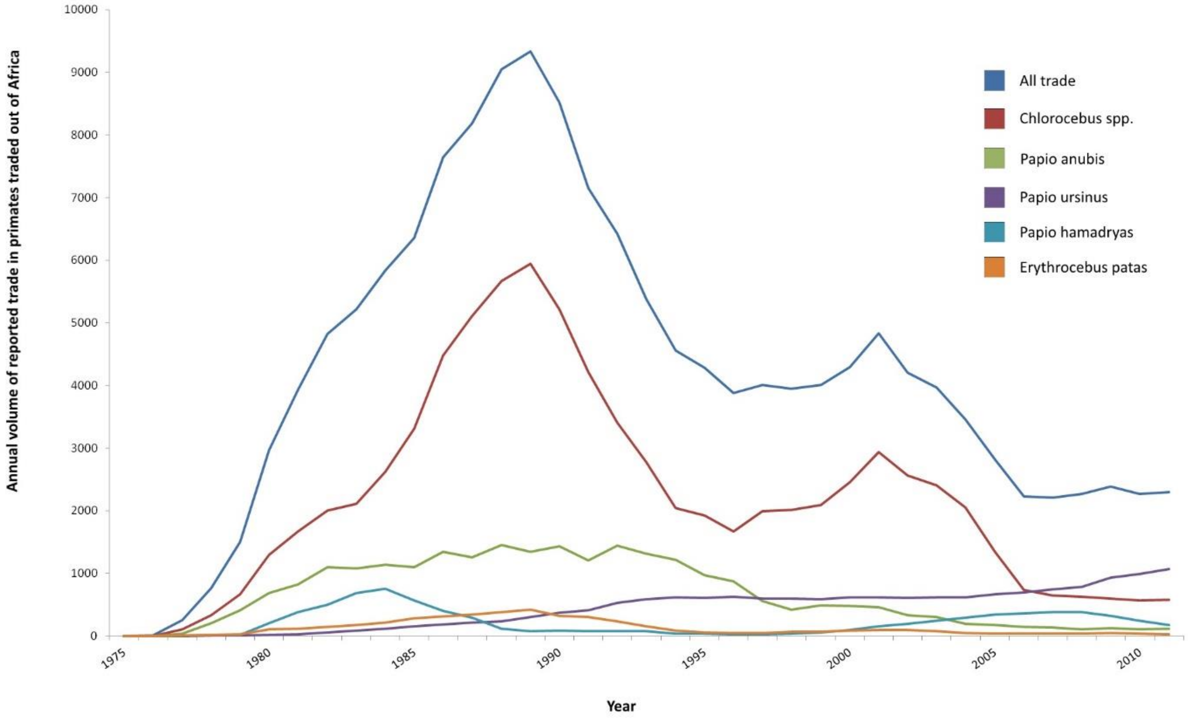


Figure 11. Species composition of CITES-reported trade out of Africa.

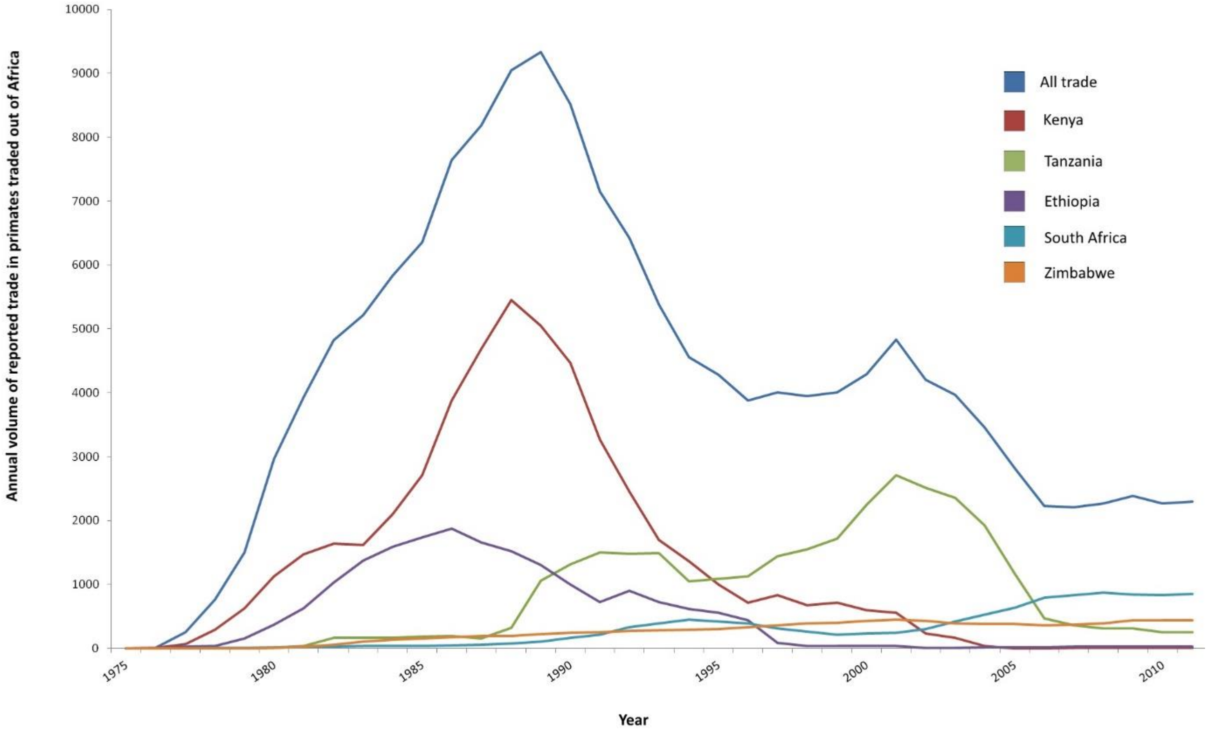


Figure 12. Top African exporters of CITES-reported primate trade.

The composition of exports from the top five exporting countries differs from that of the overall trade out of Africa, though not dramatically, with only those same top five taxa traded in volumes exceeding 1,000 animals. *Chlorocebus* spp. are among the top five taxa exported from all top five exporters, clearly dominating Kenyan and Tanzanian primate exports at 75% and 85% respectively. In Ethiopia *Chlorocebus* spp. account for only ~30% of the trade while *P. anubis* dominates at ~55%. In South Africa *Chlorocebus* spp. account for ~40% of trade while *P. ursinus* accounts for ~45%. *Chlorocebus* spp. account for only 10% of Zimbabwean primate exports while *P. ursinus* accounts for ~75%. The major importers of primates from these top exporters, with the U.S. A. featuring heavily, are presented in Figure 13.

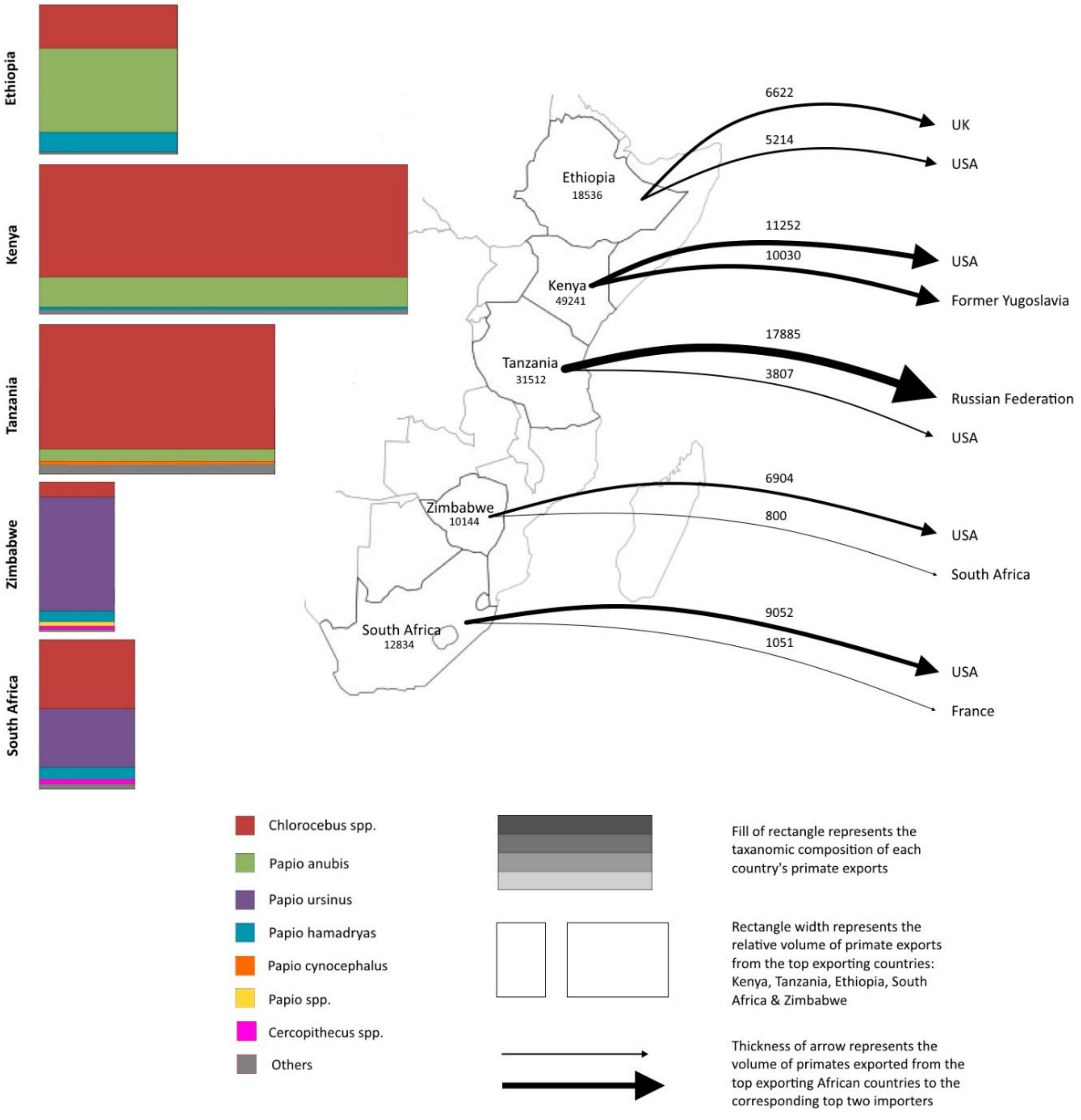


Figure 13. Relative volume of trade between the top five exporters of CITES-reported trade in individual primates out of Africa to their respective top two importers.

Additional significant importers of primates from these top exporting countries are the Russian Federation (importing almost 20,000 primates from Tanzania), Former Yugoslavia (importing ~10,000 primates from Kenya) the UK (importing ~7,000 primates from Ethiopia), France (importing 1,000 primates from South Africa) and South Africa which imported 800 primates from Zimbabwe.

3.4.3 Drivers of trade – Terms

The majority of wild-caught African primate trade, ~75%, has been in live animals and ~25% of trade has been dead specimens. As shown in Figure 14, live trade has shown a decline while trade in dead primates has been on the rise.

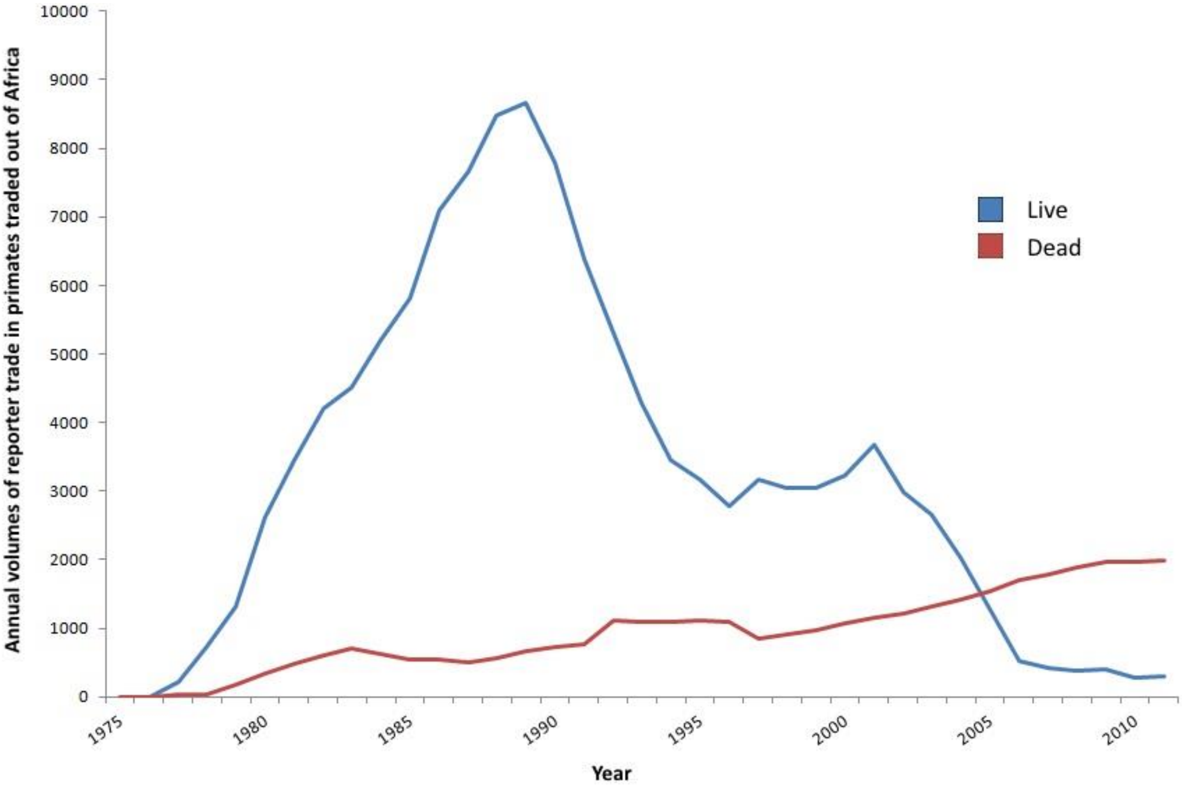


Figure 14. Annual CITES-reported trade in live and dead primates out of Africa for the period of 1975 to 2011.

The more prevalent dead trade terms are trophies, skulls, skins and bodies, with other less common terms accounting for less than 1%. There has been no marked change in the annual volumes of trade in skins or bodies. However, as shown in Figure 15, there has been an increase over time in the volumes of trophies and skulls traded. Terms of trade vary across taxa with live and dead terms accounting for significantly varied proportions of trade in the top four taxa.

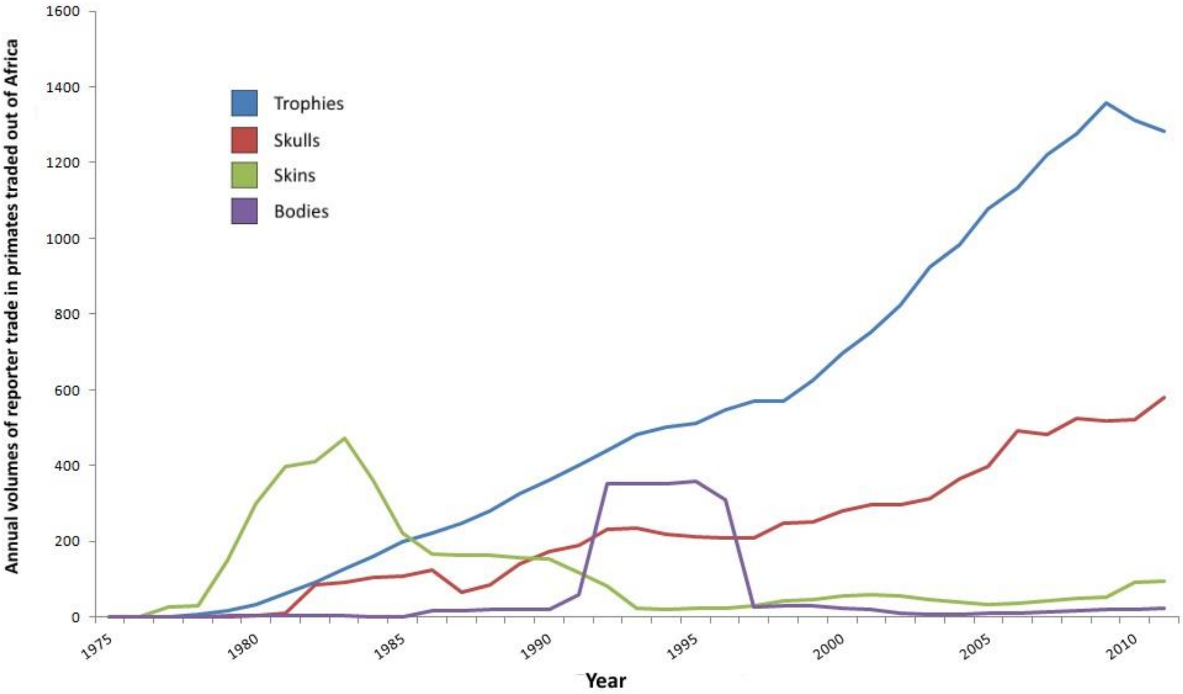


Figure 15. Temporal trends in the CITES-reported trade in the top four dead terms.

As demonstrated in Figure 16, there is further inter-taxa variation in the composition of the dead terms of trade across the top four traded taxa: though trophies consistently account for the greatest proportion of dead trade (*Chlorocebus* spp.: ~50%; *P. anubis*: ~50%; *P. ursinus*: ~70%; *P. hamadryas*: ~55%) both the proportion and total volume of *P. ursinus* trophies traded is significantly greater than trophies of other taxa; a significantly larger volume of *P. anubis* bodies have been traded than bodies of other taxa (~45% of dead *P. anubis* compared to 1% of other taxa); and significantly fewer *P. anubis* skulls have been traded, at only ~5% compared to ~40% of dead *Chlorocbeus* spp. trade, ~40% of *P. hamadryas* and ~25% of *P. ursinus*; each of these top exporters has traded in relatively low volumes and proportions of skins.

3.4.4 Drivers of trade - Purposes

The purpose of ~15% of trade has not been described, but of the remaining 125,000 items ~50% were traded for commercial purposes, making commercial trade the lead driver of African primate trade. Scientific purposes account for ~20% of trade and Medical purposes ~10%. Hunting Trophy was listed as the purpose of trade for 15% of primates while ~5% of primates were traded for Personal purposes.

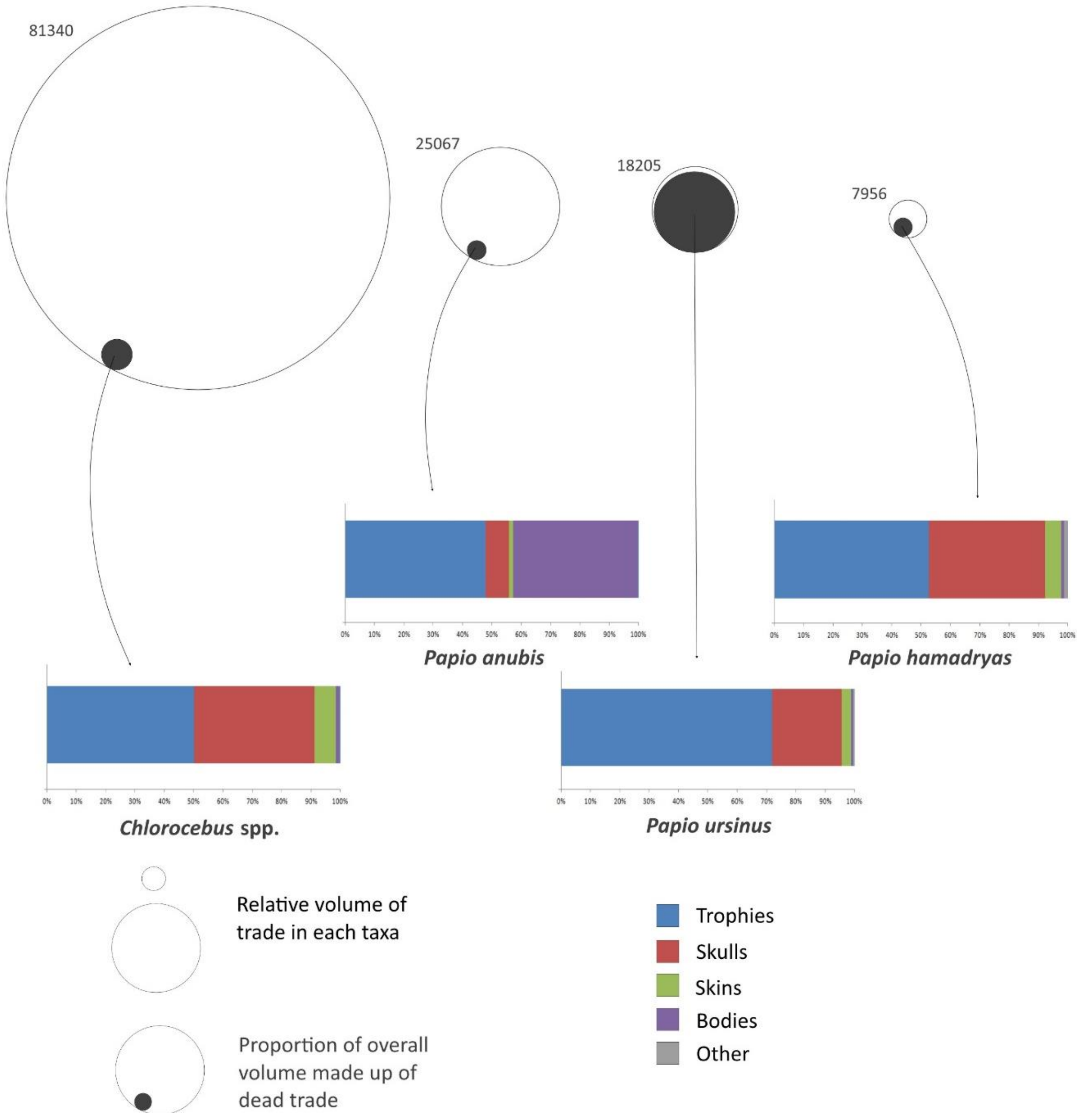


Figure 16. Terms of CITES-reported trade in top four taxa exported from Africa for the period of 1975 to 2011.

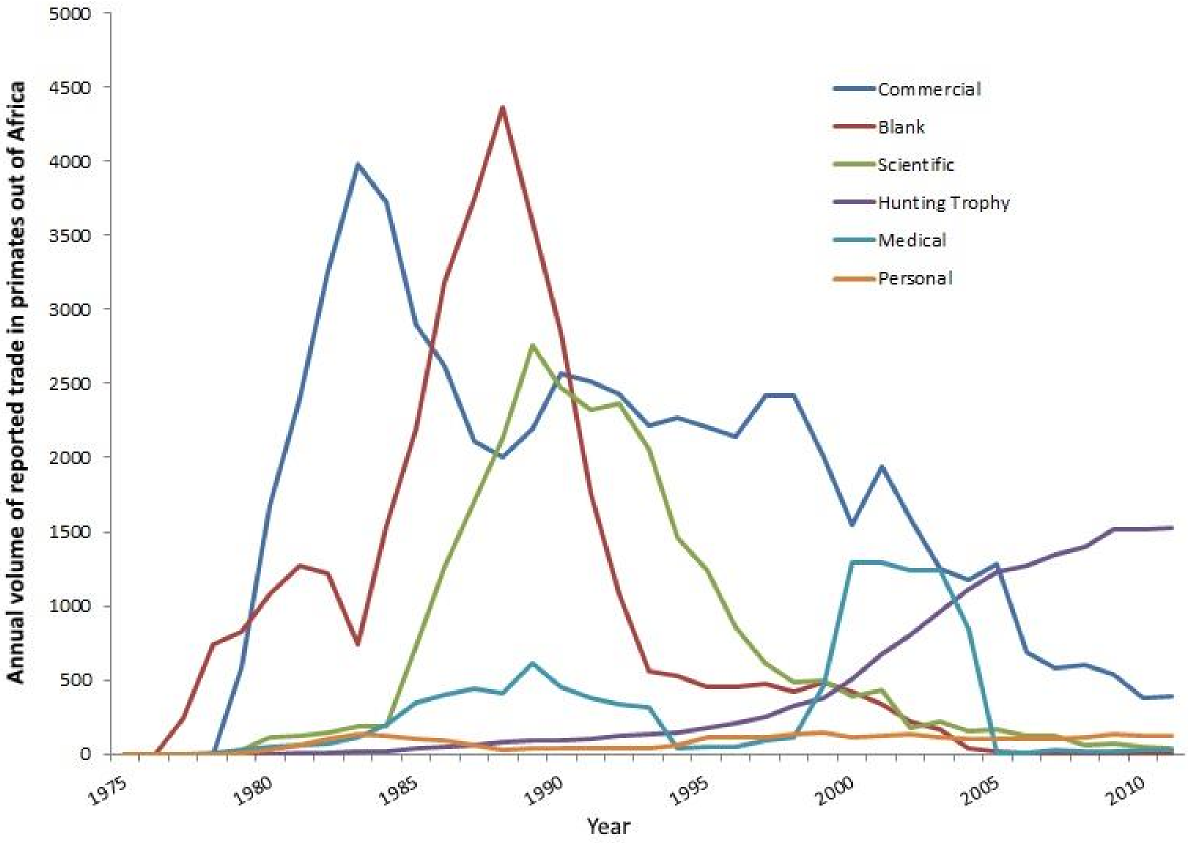


Figure 17. Annual CITES-reported trade in live and dead primates for the period of 1975 to 2011.

The purpose of trade varies across the top four traded taxa. Figure 18 shows this inter-taxon variation in trade purposes across the top four traded primate taxa. *Chlorocebus* spp. were traded primarily for the purpose of commercial use (~35%) with trade conducted for undisclosed purposes accounts for ~30. Trade in *P. anubis* is dominated by commercial trade (~55%) with scientific research also accounting for a substantial volume (~20%). *P. ursinus* were primarily traded as hunting trophies (~60%) with ~20% of trade not specified. *P. hamadryas* was mainly traded for commercial purposes (~45%) and as hunting trophies (~35%). A low volume of trade has been carried out for personal purposes across all four top traded species.

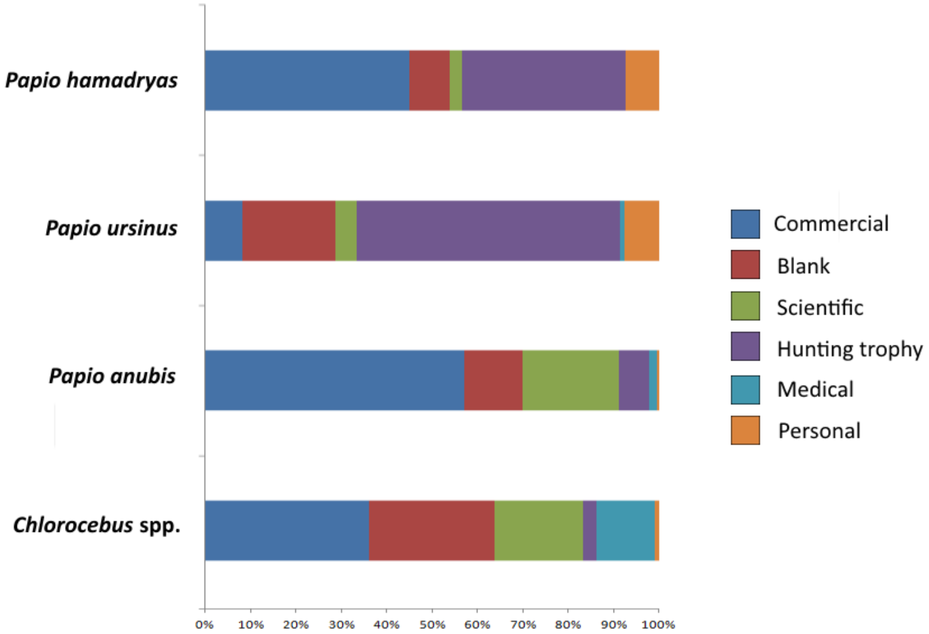


Figure 18. Purposes of CITES-reported trade in top four taxa exported from Africa for the period of 1975 to 2011.

3.5 Trade in vervets in and out of Africa

There are more than 2,000 transactions in the CITES Trade Database reporting trade of wild *Chlorocebus* spp. out of Africa between 1977 and 2015. These transactions total approximately 80,000 animals that have been traded between 32 known exporting countries/states and 101 known importing countries/states. There has been trade in all six species of the genus but in varying proportions. *C. pygerythrus* and *C. tantalus* have dominated the trade with 56,351 *C. pygerythrus* accounting for 70% of *Chlorocebus* trade and 19,111 *C. tantalus* accounting for 24%. Collectively the remaining four species make up the remaining 6% with *C. aethiops* accounting for 3%, *C. djamdjamensis* for 2%, *C. sabaeus* for 1% and *C. cynosuros* for less than 1%.

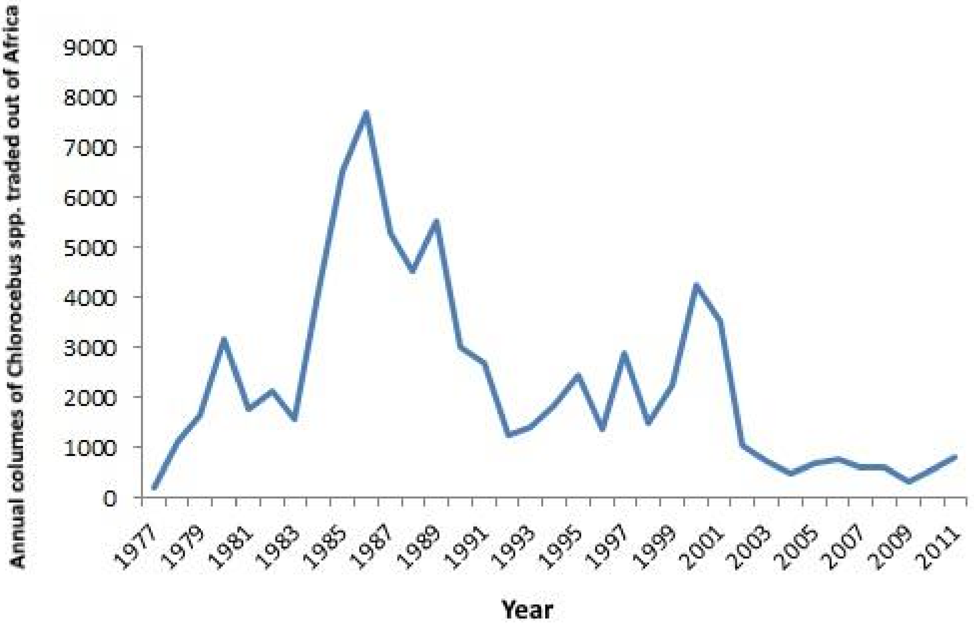


Figure 19. Annual CITES-reported trade in wild-caught *Chlorocebus* spp. out of Africa for the period of 1977 to 2011.

As outlined in Table 5, the export of *Chlorocebus* spp. has been dominated by Kenya (~45%) and Tanzania (~35%), and to a lesser extent by Ethiopia, South Africa and Somalia (each <10%). The top five exporters of *Chlorocebus* spp. collectively account for ~95% of the overall trade in the genus. The exporting trends of the entire genus are reflected in those of *C. pygerythrus*, maintaining the same top five exporters but in a slightly different configuration: Tanzania exports ~45% of *C. pygerythrus*, Kenya exports ~35%, South Africa, Somalia and Ethiopia each <10%. Kenya is also the primary exporter of *C. tantalus* accounting for ~95% of the trade in this species. Sudan exports <5% of the *C. tantalus* trade and Togo accounts for 1%. There have been some temporal patterns of trade from some of these top exporters. The earlier peak in trade in the late 1990s was supplied in the main by Kenya, with the later and less profound peak of the early 2000s supplied mostly by exports from Tanzania.

Table 5. Top importers and exporters of CITES-reported wild-caught *Chlorocebus* spp. between 1977 and 2015.

	Chlorocebus spp.		*C. pygerythrus*		*C. tantalus*	
Volume	80,500		56,000	70%	1,900	24%
Exporters	32		12		12	
	Kenya	46%	Tanzania	47%	Kenya	96%
	Tanzania	33%	Kenya	33%	Sudan	2%
	Ethiopia	7%	South Africa	9%	Togo	1%
	South Africa	6%	Somalia	6%	Cameroon	<1%
	Somalia	5%	Ethiopia	3%	Ghana	<1%
		96%		98%		99%
Importers	101		87		55	
	Russian Federation	35%	Russian Federation	40%	Russian Federation	26%
	USA	18%	USA	21%	Former Yugoslavia	26%
	Former Yugoslavia	17%	Former Yugoslavia	15%	Netherlands	25%
	Netherlands	15%	Netherlands	13%	USA	10%
	Italy	3%	Italy	2%	Italy	2%
		88%		91%		90%

Live trade has been the primary driver of *Chlorocebus* spp. trade accounting for over 90%. Purposes of trade have been more varied. Commercial trade dominates at 35% with undisclosed trade accounting for 28% and scientific and medical trade accounting for 19% and 13% respectively. Hunting is the one purpose, though only accounting for 3% of trade, that has been increasing over time, particularly over the last decade. Trophy hunting will be examined in detail in the following chapter.

3.6 Discussion

The nature of the international primate trade has changed since the time of Mack and Mittermeier's 1984 review. First, and perhaps most notably, is the vast and growing trade in primate parts and derivatives. This recent rapid ascent in the trade in primate parts and derivatives took off in earnest in the late 1990s. It now forms the overwhelming majority of the trade with almost 1 million parts traded in 2011 alone. Further analysis of these transactions will give a much more complete and informative picture than the limited portion of trade analysed here, putting trade in whole individual animals in the appropriate context.

Second, per these records the volumes of individual primates traded internationally have been declining since the 1960s, 50s, and before. In 1938 alone 250,000 *M. mulatta* were exported from India (Wolfheim, 1983) to supply the biomedical industry. Over the following decades volumes of animals traded decreased by tens of thousands annually. Between 1950 and 1960 100,000 to 200,000 *M. mulatta* were exported annually from India, declining to 50,000 in 1964-66, with the view to reduce further to 30,000 in 1974 (Wolfheim, 1983). In 1975 these exports were cut to 20,000. India then prohibited export of rhesus macaques to the US in 1978 due to violation of an agreement that the monkeys were intended for biomedical research that would benefit humanity, and not for military or commercial projects (Wolfheim, 1983). Historically, primates were extracted for international trade in even greater numbers. For instance, in 1892 175,000 colobus skins reached Europe alone to supply the fashion industry (Morris and Morris, 1966). As rifles replaced bows and arrows, increasing hunting efficiency, pellets damaged the skins but only perfect skins were accepted by merchants. This given estimate is a count of perfect pelts only. It is estimated that over 2 million colobus were killed while their skins were at the height of fashion. Monkey fur fell out of fashion for the most part by the 1930s (www.fashionintime.org) and the fashion industry is no longer an international driver of commercial trade in primate products.

Third, not only has there been a decline in the number of individual animals traded, there has been a shift away from trade in wild-caught animals in favour of captive breeding. Pre-CITES trade was almost exclusively wild-caught, and while the 1950s saw a conservative estimate of 200,000 primates extracted from the wild each year to supply the international market, the 2000s have seen an average annual wild-caught trade of approximately 8000 animals. Wild-caught trade continues to decline while captive breeding supplies a growing portion of the trade each year, taking the majority and holding it since 1995.

And fourth, additional to the supply of the medical and scientific research industries, which have been the major drivers of the trade since the early 1900s, commercial trade is once again a significant driver of the modern trade in individual primates. More specific descriptions of the components of this commercial trade are not available however since, while CoP15 attempted to define 'primarily commercial purposes', it was acknowledged that such a definition could not be provided. Alternative to a definition, guidelines and general principles were outlined. One such general principle states that "An activity can generally be described as 'commercial' if its purpose is to obtain economic benefit (whether in cash or otherwise), and is directed toward resale, exchange, provision of a service or any other form of economic use or benefit." (Wijnstekers 2011 p129). It is further advised that the term 'commercial purposes' be defined by the country of import as broadly as possible in order to include any activity that is not completely 'non-commercial' in the 'commercial' category. In the case of individual primate trade one such commercial activity would include the supply of the exotic pet trade. Unfortunately, a detailed breakdown of the nature of these commercial transactions are not readily available. Additional to the ambiguity of the commercial category, further shortcomings of these data included incomplete data prior to 1980, the confounding effects of taxonomic changes and the inconsistent assignment of source categories for introduced populations such as *M. fascicularis* on Mauritius and *C. sabaeus* on Barbados.

Of course complete accurate trade volumes, both captive-bred and wild-caught, are unknowable due to illegal trafficking and laundering (Nijman, 2005; Maldonado and Peck, 2014). Many factors conspire to stimulate illegal wildlife trade and undermine the legal frameworks that prevent trafficking including lack of resources, a dearth of alternative economic activities, weak law enforcement and widespread corruption (Maldonado and Peck, 2014). Encouragingly, the significance of the illegal wildlife trade is now beginning to be recognised by governments and the international political and law enforcement communities as a major criminal activity which undermines the rule of law, and has hugely detrimental economic and social consequences additional to the long-recognised environmental ones (London Conference on the Illegal Wildlife Trade, 2014).

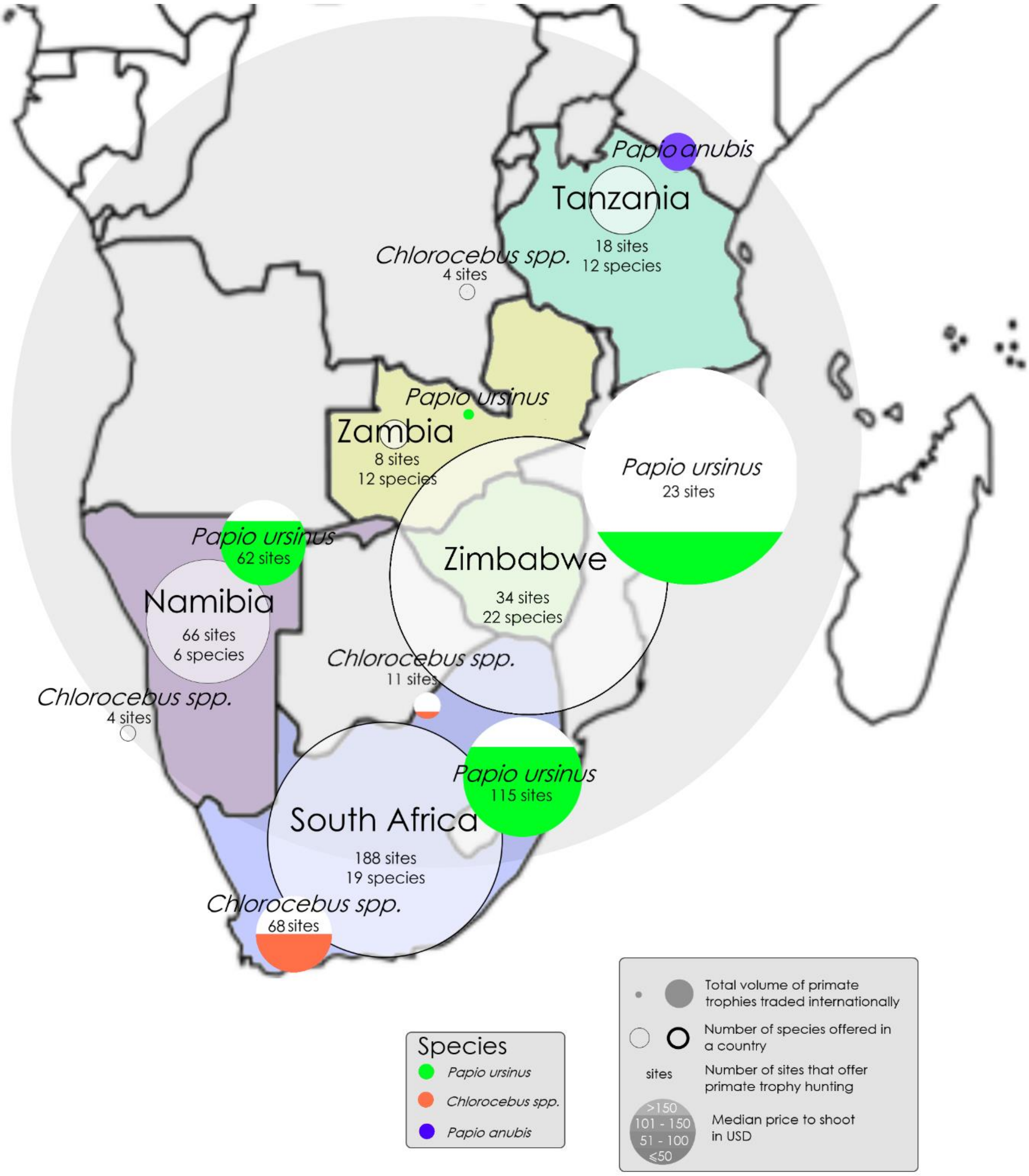
Additionally, interpretation and analyses of the CITES Trade Database can differ between users resulting in discrepancies in reported trade across various authors. For instance, the trade volumes presented here differ from the initial overview presented by Nijman and colleagues in 2010 and also from the volumes presented by Foley and Shepherd (Foley and Shepherd, 2011). While Foley and Shepherd report an export of approximately 11,000 individual *M. fascicularis* from China for the period of 2004-2008, here 93,000 is reported for the same period; according to my data 98,500 fewer macaques were exported from the Philippines than reported by Foley and Shepherd. Nijman and colleagues reported that China and Mauritius were the two leading exporters in live primates from 1990 to 1999, accounting for 31% and 18% respectively. According to the dataset used in this overview Mauritius was the leading exporter in live primates at 18%, followed by Indonesia (18%), the Philippines (17%), and only then by China at 15%. These discrepancies could be due to any number of reasons such as whether import or export figures are used, how users have accounted for the lack of reporting by some countries/states.

Acknowledging these obstacles in the use of the CITES Trade Database, and while the functional effectiveness of CITES continues to be a controversial subject of debate rousing highly divergent arguments (see Bowman 2013 for detailed discussion), there can be no doubt as to its value a conservation resource since the empirical quantification of the extent of trade is imperative to mitigation and ultimately to conservation.

Recommendations

The results of this research give only a partial picture international primate trade. There is probably more trade between African countries that is not reported and this would be worth investigation. To develop a more comprehensive understanding of the international trade the domestic trade would need to be examined in more detail. What we do know, however, is that live trade is the primary driver of African primate trade. Perhaps, this extraction from the wild could be mitigated by an increase in captive breeding.

4. Primates as hunting trophies



4.1 Primate trophy hunting

Primates are exploited for a variety of uses including food, traditional medicine, the pet trade, and for use in the biomedical industry (see Chapter 4 for details). One lesser known utility is primates as a source of trophy hunting. While is is well known that gorilla sand orang-utans were once sought-after targets for 19th and 20th century European hunters, it is less widely known that the practice continues today. The Great Apes are no longer hunted legally and the killing of primates by trophy hunters is less a matter of prestige but one of sport and opportunity. Trophy hunting now is almost exclusive to sub-Saharan Africa where Cercopithecids are the popular targets.

Trophy hunting is the selective hunting of wild game animals, with the hunter keeping parts, such as antlers or a head, or the whole animal as a memorial or 'trophy'. A photograph of the hunter with their kill can also be considered a trophy. There is a lack of consensus regarding the role of trophy hunting as a conservation strategy (Lindsey et al., 2006; Lindsey, Roulet and Romanach, 2007; Deere, 2011). While advocated by some as a tool to aid conservation and resource management (as asserted ,for example, by online journal *African Indaba* www.africanindaba.com [accessed 30.10.2014]) (Leader-Williams and Hutton, 2005) it is heavily opposed by others either on welfare grounds or as an inappropriate management strategy (Coltman et al., 2003; Leader-Williams and Hutton, 2005; Mayaka et al., 2005; Lindsey et al., 2006).

Trophy hunting, including of primates, typically is legal with the hunter (or their representatives) having obtained prior permission to take a certain number of animals. Hunts are frequently conducted on private reserves that specifically tailor for trophy hunting tourism. Most trophy hunters have their trip organised by a professional operator and order in advance the number of species that will be hunted – a 'wish list'. Pre-packaged tours are also available. The price of the animal is usually additional to the price of the hunt itself, which typically covers accommodation, catering, hunting vehicles, the services of a professional hunter or guide and field staff, and often the field preparation of plains game trophies. The cost of transporting the trophy to a taxidermist is often additional. If a hunter wants to export the trophy this comes at a premium that covers taxes, permits and taxidermy as required.

Typically, primate trophy hunting and indeed most trophy hunting, is done with rifles. These are generally 30.06 calibre rifles with heavy bullets, an old African calibre .375 H&H for instance would be considered suitable (Syeinhausen Jagd, Namibia). Alternatively, some operators offer bow hunting. This involves establishing hides near waterholes. This is a popular method of hunting monkeys.

Trophy prices range hugely depending on the species (Table 10). Primates are (except for the gelada, *Theropithecus gelada*) most often listed amongst the cheapest species offered, along with impala *Aepyceros malampus,* black-backed jackal *Canis mesomelas* and rock hyraxes *Procavia capensis*; and baboons *Papio* spp. and vervets *Chlorocebus* spp. are frequently shot free of charge.

In addition to pre-ordered animals, hunters are often permitted to kill ‘targets of opportunity’. Baboons and vervets are popular opportunity kills and several operators explicitly state that “there are no limits on the number of baboons and vervets hunted” (Kateno Hunt, Namibia). One hunting outfit described baboons and rarely being a trophy of choice for a first timer, but that they are often the first thing on the wish list for second visits. Culling hunts are also offered for non-trophy standard hunts (e.g. Kowas Hunting Safaris, Namibia). This is generally at a much lower fee than standard trophy prices or even free of charge. Cull hunts are frequently offered for baboons and vervets, impala and black-backed jackal. Baboons and vervets are frequently shot to be used bait for hunting leopards. This will be a much cheaper rate or free of charge.

All primates are included on Appendix I or II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and all international trade is reported annually. Except for East Timor all primate range-countries (countries where primates occur naturally) are Party to CITES. Here I report on over 30 years of CITES-reported international trade in primates hunted. Primate trophy hunting is almost exclusive to sub-Saharan Africa and thus I have focused on the

African continent here. I also report on the trophy fees as listed on the online profiles of over 400 trophy hunting operators from 12 African countries.

4.2 Methods

Data acquisition

I extracted those transactions pertaining to trade in primate trophies from the complete dataset by selecting a subset from the total CITES data. I included all transactions listing 'trophies' as the trade term or trade purpose.

I carried out Google searches between 19 and 23 May 2012 using the following search terms: trophy hunting price list; trophy hunting monkey; trophy hunting vervet; trophy hunting baboon; trophy hunting colobus; trophy hunting blue monkey; trophy hunting hamadryas baboon; trophy hunting gelada baboon; trophy hunting Ethiopia.

I analysed pricelists from all sites listed in the first 20 pages of the Google search results, following all links to the websites of hunting establishments and recording all price lists in US Dollars, rounding to the nearest USD. I gained a more comprehensive of how hunting establishments operate by studying these online profiles and websites.

Data preparation

I excluded re-exports (where the country of origin was not the exporting country) to avoid inaccurate overestimations of traded specimens as a result of double-counting. I also excluded non-native species. I examined and renamed the *Chlorocebus* species originally listed as *Cercopithecus pygerythrus* in accordance with recent taxonomy.

When for one transaction the quantity reported by the importing country differed from the quantity reported by the exporting country, where all other details were matching, I used the larger figure. I treated two or more entries [rows] as one transaction when the year, species, importing country and exporting country matched. These entries are likely to pertain to the same transaction but data could have been entered incompletely or inaccurately and therefore appear as separate entries in the database. In these cases, I summed the import and export quantities and took the larger of the two to be the traded quantity.

4.3 International trade in primate trophies

4.3.1 General overview

For the period of 1978 to 2010, almost 27,300 primate trophies were traded internationally. Zimbabwe (38%), South Africa (29%), Namibia (15%), Tanzania (8%) and Zambia (3%) are the top five exporters of primate trophies, collectively accounting for 89% of total trophy trade. The US has imported the vast majority of primate trophies (64%), while the next four top importers (Germany, Spain, South Africa and Denmark) account for 25% collectively. The top five traded taxa account for 92% of the trade. Chacma baboons *Papio ursinus* are traded in the largest volumes (55%), followed by hamadryas baboons *P. hamadryas* (13%), grivet monkeys *Chlorocebus aethiops* (11%), olive baboons *P. anubis* (8%) and yellow baboons *P. cynocephalus* (5%).

Table 9 gives an overview of the top exporters of CITES-reported primate trophies. Percentage of trade given here is a percentage of the volume of trade from these top five exporters only, not the total volume of trade. South Africa boasts the greatest number of trophy hunting establishments, 188, while Namibia offers 66. Zimbabwe, the exporter of the largest volume of trophies, has only 34 sites, while Tanzania has 18 and Zambia eight.

Table 6. Overview of CITES-reported trophy hunting, for the period 1978 - 2010.

		Volume	%
Zimbabwe		Volume	%
Volume exported	9305		38%
Top five species	*Papio ursinus*	7161	77%
	Chlorocebus aethiops	851	9%
	Papio hamadryas	714	8%
	Papio spp.	281	3%

	Cercopithecus spp.	129	1%
Number of sites	34		
South Africa			
Volume exported	7798		32%
Top five species	*Papio ursinus*	3997	51%
	Chlorocebus aethiops	2066	26%
	Papio hamadryas	797	10%
	Chlorocebus pygerythrus	454	6%
	Cercopithecus spp.	250	3%
Number of sites	188		
Namibia			
Volume exported	4098		17%
Top five species	*Papio ursinus*	2838	69%
	Papio hamadryas	1190	29%
	Papio spp.	44	1%
	Papio anubis	11	0%
	Chlorocebus aethiops	9	0%
Number of sites	66		
Tanzania	9%		
Volume exported	2276		
Top five species	*Papio anubis*	1276	56%
	Papio cynocephalus	548	24%
	Papio hamadryas	206	9%
	Papio spp.	59	3%
	Chlorocebus aethiops	17	1%
Number of sites	18		
Zambia			
Volume exported	939		4%
Top five species	*Papio ursinus*	350	37%
	Papio hamadryas	285	30%
	Papio cycocephalus	219	23%
	Papio spp.	28	3%
	Papio anubis	22	2%
Number of sites	8		

4.3.2 The early years: 1978-2001

Between 1978 and 2001, approximately 11,500 primates, from 36 known taxa, were exported as trophies from 24 African countries and imported to 81 countries around the world. The vast majority were wild born, with a minimal exception of 30 captive-bred individuals from South Africa and 13 from Zimbabwe.

The top-five trophy species – making up 93% of the total trade (22,988) – are the chacma baboon (48%), vervet monkey *C. pygerythrus* (18%), hamadryas baboon (13%), olive baboon (9%) and yellow baboon (5%). Less likely trophy primates are five species of bushbaby (56 individuals), pottos (11), gorillas (5), mandrills (2), and a single angwantibo. Most primate species traded as trophies are not considered globally threatened. Exceptions included one Near Threatened individual (*Procolobus verus*), 13 Vulnerable (*Mandrillus sphinx* and *Colobus polykomos*), two Endangered (one *Cercocebus galeritus* and one *Cercocebus sanjei*), and five Critically Endangered gorillas *Gorilla gorilla*.

The top five exporting countries account for 91% of the total trade (22548). These are South Africa (41%), Zimbabwe (10%), Tanzania (10%), Zambia (4%) and Botswana (3%). All of these countries was a member party of CITES by 1981. Accounting for 70% of the total trade (17,334), the United States is by far the most significant importer with the remaining top-four – Spain, South Africa, France and Germany – dealing in much smaller quantities – 6, 4, 3, and 2% respectively.

4.3.3 Recent years: 2001 - 2010

Most trade (59%) occurred between 2001 and 2010. In this ten-year period, 14,518 primate trophies, from at least 18 taxa, were exported from 16 African countries. The top-five exporting countries make up 92% of the total trade for this period (13,297) and remain, as in the 30-year overview, South Africa (51%), Zimbabwe (26%), Tanzania (9%), Zambia (3%) and Botswana (3%). The top five species, comprising 91% of the total for this period (13,988) are, again as in the 30-year overview, the chacma baboon (45%), vervet monkey (21%), hamadryas baboon (17%), olive baboon (8%) and yellow baboon (5%).

4.3.4 Temporal trends in trophy trade

There has been a steady increase in international trade in primate trophies in the last 30 years growing from a few dozen in the eighties to over 1,500 a year during the 2000s (R^2=0.8828) (see Figure 20). After an initial increase, the number of species remains more or less stable at some 10 species traded a year. The increase in individual trophies traded in recent years has been driven primarily by the export of chacma baboons and vervets from South Africa and Zimbabwe.

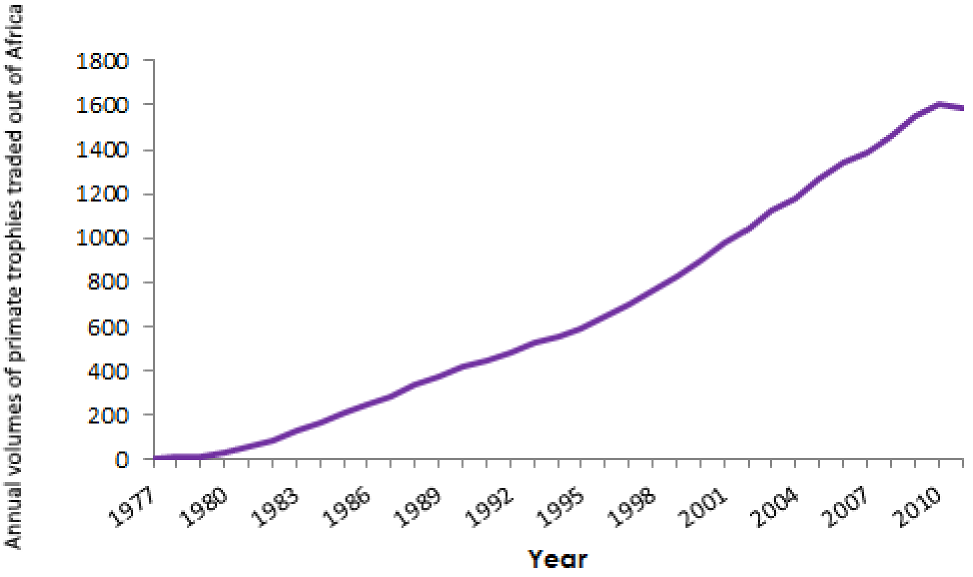


Figure 20. Temporal trend in CITES-reported international trade for the period of 1977 to 2010.

4.4 Primate trophy fees

A total of 394 prices for primate trophies were found through the search described in chapter 2. Nine primate species are offered from 12 countries. Species offered were the chacma baboon, vervet monkey, yellow baboon, olive baboon, black-and-white colobus, blue monkey, hamadryas baboon, gelada, and grivet monkey. At least one *Papio sp*. was offered in all 12 countries, *Chlorocebus sp.* in nine. Though vervets are offered in the most countries, more operators offer chacma baboons than any other primate species. Table 10 presents a general overview of species offered, in which countries and the mean trophy fee asked for each.

Table 7. Summary of the online profiles of hunting operators detailing the species offered; in what countries; by how many operators, and for what trophy fee.

	Operators	Mean ± St. Dev.
Papio ursinus		
Zimbabwe, Namibia, Mozambique, Botswana, South Africa	228	250 ± 113
Chlorocebus pygerythrus		
Zimbabwe, Namibia, Zambia, Mozambique, Botswana, Uganda, Tanzania, South Africa	94	87 ± 64
Papio cynocephalus		
Zambia, Tanzania	19	127 ± 49
Papio anubis		
Central African Republic, Benin, Uganda, Cameroon, Ethiopia	16	193 ± 196
Colobus guereza		
Ethiopia	10	513 ± 140
Cercopithecus mitis		
Ethiopia, Botswana, South Africa	10	134 ± 104
Papio hamadryas		
Ethiopia	7	943 ± 199
Theropithecus gelada		
Ethiopia	6	2817 ± 902
Chlorocebus aethiops		
Ethiopia	4	70 ± 20

Chlorocebus are the cheapest primates to hunt with an average trophy fee of USD87. They are often “opportunistic” kills included in a package free of charge. The most expensive primate species to hunt in Africa is the gelada, endemic to Ethiopia, with an average trophy fee of USD 2817 and a maximum of USD 3300.

Ethiopia offers the widest selection of primate species to hunt. This is to be expected as more species of primate occur in Ethiopia than in other countries offering hunting. The most hunting packages, almost half, are available in South Africa.

4.5 Discussion

The role of trophy hunting as a conservation tool may not apply to the hunting of vervets and baboons. Given the low trophy fee their killing is likely to contribute only a negligible proportion of the revenue generated from the industry. The argument for trophy hunting as a conservation tool refers to the income generated without jeopardizing wildlife population growth. Given that so many trophy hunting outfits offer free hunting of vervets the argument does not apply.

Recommendations

Furthemore, the volume hunted is not reflected in the number exported. It can be assumed that there are more hunted than are exported internationally, therefore, the actual extraction numbers and the resulting impact on vervet monkey populations is unknown. Investigation of the actual numbers hunted would be informative and valuable research.

5. Vervet crop-raiding

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5.1 Crop-raiding primates

Studies of human-wildlife interactions have become increasingly prominent in conservation research in the last 30 years, particularly in Africa, as the human population continues to grow and more land is given over to cultivation. Human encroachment on previously uninhabited land and unsustainable resource utilisation leads to competition for space and, in turn, resource depletion and a decline in biodiversity (Kinnaird, 1992; Medley et al., 1995; Wieczkowski and Mbora, 2002). One result in rural environments is an increase in the frequency of human-wildlife interactions (Mwakatobe et al., 2014; McKinnney, Westin nad Serio-Silva, 2015; Smith and Nijman, 2016; Hill, 2017; Spagnoletti et al., 2017.

Crop raiding is one such interaction that poses a threat to all parties. Crop loss due to wildlife is a significant obstacle for farmers. In Tanzania, for example, 60% of farmers (n = 916) rated pests as their primary economic problem, above low crop prices, lack of transport, failed rains and poor soils (Porter, 1976), and in Zimbabwe farmers ranked pests first amongst 30 factors that would need to change to improve quality of life.

Non-human primates in particular can be more destructive than other large mammals due to their intelligence, adaptability and their often-omnivorous character. Control techniques are often unsuccessful (Knight, 2017). Where some species, even elephants and other large mammals, can be contained by fences and barriers, primates can jump over and dig under fences. They learn to climb on electric insulators and can find 'dead spots' in electric fences. It even seems that killing primates is not effective in dissuading others the remaining animals simply learn extreme caution and continue to raid (Maples et al., 1976; Strum, 1994).

For wildlife, the negative consequences of crop raiding include injury, potential displacement, and even eradication. Where more specialist primates are understandably at risk, due to their specialist natures and the necessity for a protected closed-canopy forest for survival, even omnivorous, adaptable species that are behaviourally equipped to living in close proximity to humans are at risk [*Papio anubis* (Quick, 1986); *P. cynocephalus* (Altmann and Muruthi, 1988); *Macaca mulatta* (Malik and Southwick, 1988)]. Vervets *Chlorocebus* spp. and baboons *Papio* spp. that appear to be successful are in a quite precarious position. Living long-term in a human dominated habitat can lead to population declines (Southwick, Malik and Siddiqi, 1998; Saj, Sicotte and Paterson, 2001). Their survival is threatened by low human tolerance for pests and the eradication schemes adopted to control their populations. Furthermore, this antagonism between primates and farmers makes other wildlife conservation efforts more difficult, breeding negative attitudes towards primate conservation (Mulu, 2010).

5.1.1 Crop-raiding as a multi-disciplinary research subject

Crop-raiding is studied from several perspectives, utilising various research methods. Some studies include formal and informal interviews, focus groups, discussion groups and questionnaires with farmers to ascertain their perceptions of crop damage, the extent of this damage, and which species are responsible. Quantitative, comparable data, such as actual damage to crops or impacts of different species and factors that may predict patterns of damage are recorded less frequently. Several studies include crop protection measures practiced. These studies have been carried out at farm, village, regional and national levels.

5.1.2 Vervets as crop-raiders

Vervets display adaptive features that optimise their ability to live in human-dominated landscapes. One such adaptation is the ability to be a successful crop-raider (Kavanagh, 1980). In Bakossi, Cameroon, tantalus monkeys *Chlorocebus tantalus* moved into the area from the savannah soon after the forest in the area was cleared for agriculture. Kavanagh’s study described some pre- and post-adaptations of the savannah monkeys that enabled their successful exploitation of farmland and made them an important agricultural pest in a relatively short time after they invaded the new habitat (70 years at the time of study). Pre-adaptations include their flexible omnivorous diet and facilitation of consumption of novel species by lack of dietary specialisation (Poirier, 1972; Dunbar and Dunbar, 1974); the savannah pattern of foraging that require them to move out in to open area to forage for hours before returning to the relative safety of the trees; their terrestriality; their cryptic nature and ability to hide in limited cover; flexibility of group sizes. Post-adaptations included temporal irregularity of ranging patterns that allow them to evade discovery by farmers; adapting their vocalisations to use quieter calls in the place of louder more detectable calls for the purpose of avoiding farmers (Horrocks and Hunte, 1986); male vigilance or ‘look out’; response to canid presence changes from retreating to the trees and uttering loud alarm calls to retreating to trees but becoming as quiet and inconspicuous as possible, this change being attributed to the association of dog with farmer the predator. These adaptations of the savannah-dwelling monkeys demonstrate to some extent how they have become such efficient crop raiders and so notoriously difficult to control, if indeed they can be controlled at all. These adaptive features of the savannah-dwelling tantalus monkey can be attributed to all crop-raiding vervet populations.

The objectives of this review are to collate the available literature on crop-raiding vervets and to outline some general rules regarding their crop-raiding behaviour. Details of where they have been recorded crop-raiding, what crops they damage, how much damage is attributed to them, perceptions of farmers, their rank as a problem animal and crop protection measures in place at study sites are to be addressed to enable a general overview of the crop-raiding behaviour of and damage caused by vervets and to facilitate comparisons to be made across study sites.

5.2 Methods

Data acquisition

From March to May 2012, I conducted a comprehensive literature search for records published in English that reported wild vervet use of anthropogenic environments, extracting information referring to cultivar feeding throughout the range of the genus. I carried out initial searches in Google Scholar and Web of Science. This was a starting point from which to locate addition material through examination of reference lists of each publication. The search was not restricted to peer reviewed journals [as in (Kansky, Kidd and Knight, 2014)] but extended to reports and theses. Although almost 30 of the reviewed studies named vervets as a problem animal or as a crop raider, I only included those studies that explicitly named the cultivars consumed by vervets and/or reported on the perceived rank of vervets as a problem animal. The objectives of each research group, and hence methods adopted, varied as did the level of detail across studies. While some authors measured farmers' perceptions of crop damage through semi-structured and informal interviews, focus groups, discussions and supplementary questionnaires, others reported direct observation of crop consumption. Given that the negative attitudes and perceptions of those living in close proximity to wildlife are as vital an obstacle for conservationists to overcome as genuine crop revenue loss, I included studies of both perceived and actual damage. I obtained further data on the nutritional composition of the named crops were obtained from the Food and Agricultural Organisation of the United Nations (www.fao.org).

Data preparation

For the purpose of this study the terms 'crop' and 'cultivar' will be used interchangeably. I used the definition of crop/cultivar outlined by Brickell et al. (2009), following Hockings and McLennan (2012). Bricknell and colleagues (pp. 6) define a cultivar as "an assemblage of plants that (a) has been selected for a particular character or combination of characters, (b) is distinct, uniform and stable in these characters and, (c) when propagated by appropriate means, retains those characters".

Given the variation in style, discipline and aims across studies, reliable data on how vervets obtained crops were sparse. Therefore, I made the focus of this review the identification of crops consumed, rather than the way these food items were obtained. Where such data were available, I considered these features in this review: crops grown at each study site; nature of the propagation (i.e. subsistence farming or cash crops); crops damaged by vervets; parts of the plants damaged; proportion of crop damage attributed by farmers to vervets; crop protection methods practiced; and the perceived rank of vervets as a problem animal. Additionally, I also noted: objectives of each study; data collection methods; duration of study; and whether vervets are a central or incidental study genus.

Crops grown but not consumed by vervets, or indeed other conflict species, were not always noted. Nor were there records of total area planted. Therefore, site-specific comparison on crops grown and crops consumed was not possible. Rather, I combined the available data from all sites to compile a list of potential crops available in areas where vervets have been reported to crop raid.

5.3 Results

5.3.1 Rank of vervets as a problem animal

Vervets were ranked as one of the top five problem animals in eight of the eleven studies reviewed here. Naughton Treves & Treves (2005) tabulated the results of 25 studies of wildlife pests in Africa. This table featured vervets in three studies, one that also features in this review (Hill, 1997). This review was combined with the Naughton-Treves and Treves study and the results presented in Table 11.

Table 11 outlines the study area, duration of study and the damage caused by vervets and their rank as problem animals of 11 studies that directly or indirectly featured data on the crop-raiding behaviour of vervets. Studies varied in duration from 2 weeks to 2 years and were carried out in Uganda (7), Ethiopia (2), Tanzania (1), and Kenya (1). Data collection varied across sites with the majority of studies involving interviews or focus groups focusing on the farmers' perceptions of crop damage. 55% of these reports were supported with observations and measurements of actual crop damage. One study measured actual damage only. It must be noted that measurement of crop damage was not always species-specific. All sites but one practiced a combination of subsistence and cash crop farming. Six studies reported what proportion of damage was attributed to vervets but on differing scales. Some reported damage as a percentage of total crop damage where one reported damage as a proportion of total area of cultivation and another as a monetary value per season.

Table 8. An overview of 11 studies that featured vervets as a problem animal, outlining the area of study, objectives, methods of study, vervet-attributed damage and rank of vervets as problem animals.

Area of study	Vervet monkey-attributed damage	Rank as problem animal	Reference
Surrounds of Kibale National Park, Uganda	2%		(Naughton-Treves, 1998)
Surrounds of Kibale National Park, Uganda		2	(Hartter, 2009)
Corridors linking Queen Elizabeth National Park to surrounding proteccted areas, Uganda		2; 3; not ranked; not ranked	(Nampindo and Plumptre, 2005)
Masindi District, Uganda		3	(Hill, 1997)
Forest edge of Entebbe, Uganda	Seasonal losses between USD80 to USD400	One of top 4	(Saj, Sicotte and Paterson, 2001)
Uganda	10%	3 (monkeys ranked together)	(Wallace, 2010)
Tana River, Kenya	3%	4 out of 5	(Mulu, 2010)
Selous Game Reserve, Tanzania		5	(Siege and Baldus, 1998)
Metu Wereda region of Illubabor zone, Ethiopia	6% to 20%	1 at one study site; 2 at two others	(Quirin, 2005)
Wonja Shoa, Ethiopia	3.3% to 4% per hectare	2	(Admassu, 2007)
Edge of Budongo Forest Reserve, Uganda		3 (after baboon and bush duiker)	(Webber, 2006)

Table 9. Farming practices, crops grown and damaged, part of crop damaged, portion of damage attributed to vervets.

Farming	Crops grown	Crops damaged	Parts of crops damaged	Reference
Cash and Subsistence	Maize, beans, cassava, sweet potato, finger millet, banana, taro, sorghum and others	Primarily maize, beans, cassava, sweet potato		Hill, 1997
Cash and Subsistence	Cassava, corn, sweet potatoes, beans, yam, mango, peanut	Corn, sweet potato, banana, mango, yam, peanut	All of crop	Saj, Sicotte Paterson, 2011
Cash and Subsistence	Banana, cassava, cow peas, green gram, kale, maize, mango, onion, orange, pawpaw, pumpkin, rice, sugar cane, sweet potato, lemon, millet, tomato, watermelon	Maize, mango, green gram, rice, sweet potato, stomato		Mulu, 2010
Cash and Subsistence	Maize, sorghum, rice, banana, cassava, sugar cane, cashew nut, coconut, beans, melon, pawpaw, mango, orange	Maize and sorghum		Masunzu, 1998
Cash and Subsistence	Sorghum, maize, banana, mango, pawpaw, kale, barley, coffee, teff, potato, tomato, wheat, legume	Sorghum, maize, banana, mango, pawpaw, kale, barley, coffee, teff	Sorghum – tassel, germinating plant, young cob, stalk; maize - cob, new shoots, planted seeds; banana, mango, papaya, kale – leaves; barley – seeds; coffee – ripe berry; cereals - while flowering	Quirin, 2005
Cash	Sugar cane	Sugar cane	Cutting centre of mature plant, esp. node	Admassu, 2007
Cash and Subsistence	Cassava, maize, banana, yam, mango, pawpaw, jack fruit, bean/pea, sweet potato, pineapple, sugar cane, pumpkin, tobacco, aubergine, sorghum, avocado, coffee, okra, chilli, passion fruit, groundnut, millet, orange, sesame, tomato, onion, rice, soursop, cabbage, castor, sunflower, guava, potato	Maize, banana, pawpaw	Maize – cob; Pawpaw and banana – fruit	Webber, 2006
Subsistence	Maize, beans, sorghum, banana, cassava, tobacco, millet, sesame, sugar cane, ground nut, rice, yam, vanilla, sweet potato, soya bean	72% beans, 28% maize	Damage was measured as stems damaged	Wallace, 2010

Across all studies reviewed here, the most common crops grown were also the most common crops raided. However, not all crops were raided, including rice and tomatoes. Table 12 lists farming practices, crops grown and damaged, crop parts damaged and the portion of damage that is attributed to vervet monkeys, while Table 13 lists the top ten most commonly grown crops and the top ten most commonly damaged.

Table 10. Nine of them most common crops grown and frequency of reported damage.

Crop	Number of farms growing cultigen	Frequency of damage
Maize	7	6
Banana	7	4
Cassava	6	1
Sorghum	6	2
Sweet potato	6	2
Beans	6	2
Mango	5	2
Rice	5	
Sugarcane	5	1

6.3.2 Crop protection measures

Passive and active protection measures were practiced to varying degrees at each site. Passive measures of deterring animals from entering the fields included fencing and the use of scarecrows. Active measures varied in severity. Some methods aimed to remove the monkeys from the fields and others were potentially lethal. These active measures included chasing, the use of sling shots and the use of guard dogs. Potentially lethal methods included shooting, setting traps/snares and the use of poisoned bait. Crop-related protection measures included changing cultigens, leaving field edges fallow and planting buffer crops.

6.4 Discussion

A detailed overview cannot be made of crop raiding habits of vervets. Different studies examined different combinatios of variables and therefore comparisons could not be made across sites. Reports of what crops are damaged, what parts of these crops, and the proportion of crop damage that can be attributed to vervets are insufficient or lacking entirely. The majority of studies analysed in this review did not attempt to support farmers' perceptions of loss with systematic measurements of actual crop losses. Differences in crop loss and yields were not consistently reported and even where they were it was on different scales, from farm to village to region. When proportion of loss was attributed to vervets it was also done on different scales. Vervet-attributed damage was reported as a percentage of total loss to pests, it was reported as a percentage of crops per hectare, and it was in one case described as $USD per season. In one case, it was said to damage crops "to a greater extent" than most pests but less than elephant, buffalo, bush pig and baboons, giving its rank but no indication of a measurement of actual damage caused.

People's perceptions of losses and risk of living in such close proximity with wildlife are as important as actual losses as perceptions influence behaviour. However, measurement of actual damage is vital as perceptions are often based on inaccurate data. Relying solely on interviews introduces inaccuracies as investigations have revealed disparities between reported and observed damage with farmers often overestimating damage. There is also a problem of researchers extrapolating results from an area of high crop-raiding occurrences to entire regions, and rarely do they compare farmers' reports with systematic field measurements (Naughton-Treves and Treves, 2005). Absence of this information hinders effective management, accurate comparisons between sites and appropriate policy development. Perceptions can often focus on rare, extreme damage events more than persistent small losses that accumulate to a possibly greater amount (Naughton-Treves and Treves, 2005). Farmers may rank highest those species that are conspicuous either by size or by the kind of damage they cause (Litsinger, Canapi and Alviola, 1982). In the case of vervets, it may be quite difficult to attribute damage specifically to them as they have a cryptic nature and can successfully avoid detection.

If it is the case that vervets do damage crops indiscriminately crop protection measures would be a pivotal area of research. It is generally agreed that it is particularly difficult to keep primates away from crops (Strum, 1994). Vervets seem to even outdo other primates in that respect. Prevention of crop damage is obviously a management priority. Trapping or eliminating the raiding group would not only be destructive to the monkeys but would inevitably lead to a reinvasion by troops from surrounding areas, and typically proves expensive and ineffective in the long-term (Lee et al., 1986). The complex communication skills of the vervets allow them to differentiate between a real and false auditory threat so loud noises are unlikely to be successful deterrents (Seyfarth, Cheney and Marler, 1980). Inexpensive deterrent methods that would reduce contact with monkeys and encourage more positive attitudes, and prevent monkeys from damaging crops are difficult to find. King and Lee (1987) reported that humans themselves seem to be the most effective guard against primates. Slingshots when used with small pellets were found to be good weapons against vervets. They reported that “the mere sight of a person armed with a sling shot can be enough to send a group fleeing”. This study also reported monkeys avoiding gardens that were guarded by uniformed security staff. As this is a single study, based in the suburbs of Malawi, it could prove a rewarding avenue of further research.

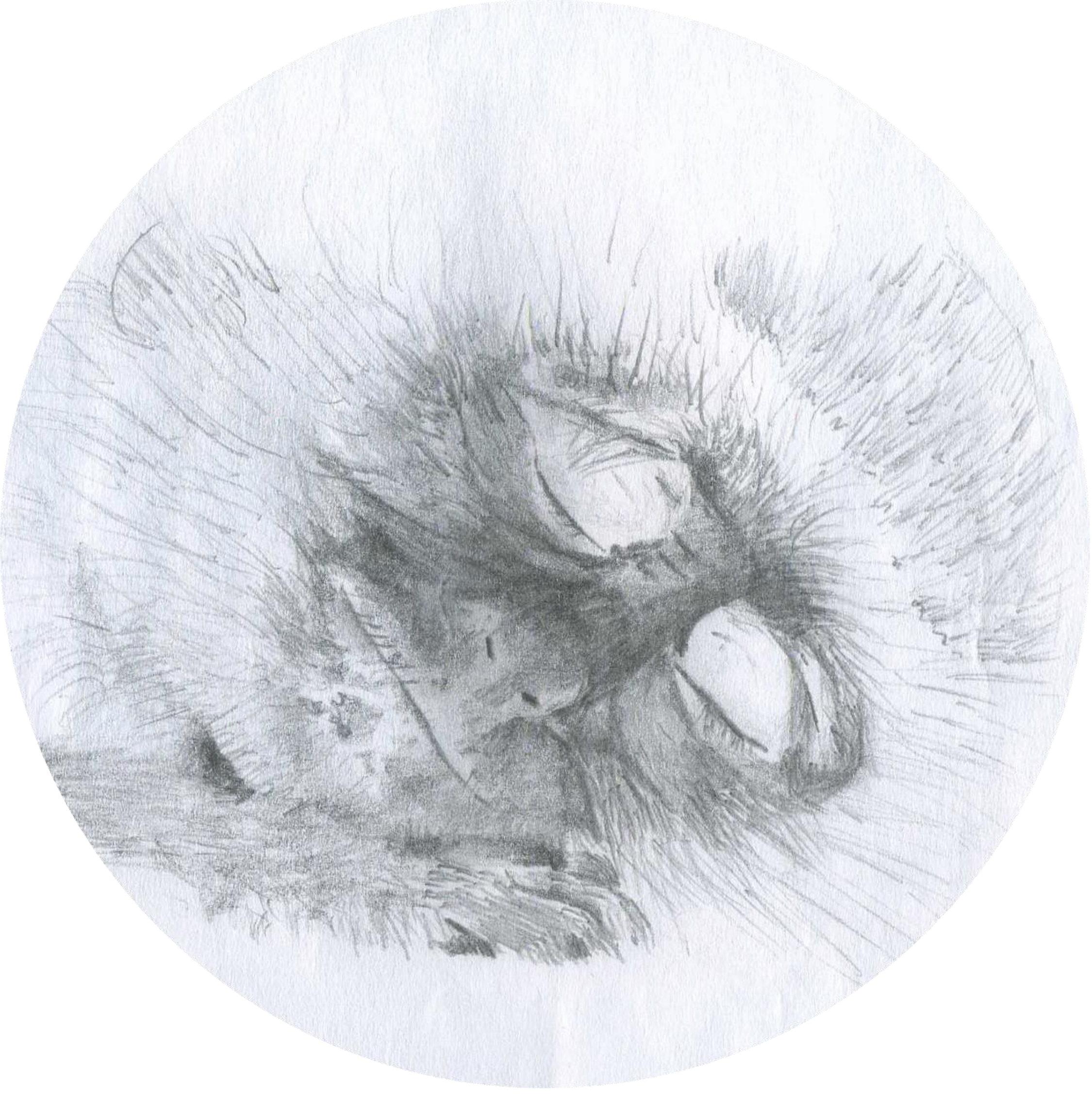
It is also noteworthy that these studies have been carried out in only seven countries within the *Chlorocebus* range. The lack of studies in South Africa is particularly surprising as there is a large amount of vervet research conducted in the country. Their removal from the vermin list in 2005 may have had consequences for people’s behaviour or attitudes towards them which may be interesting to explore.

Vervets are remarkably successful, with their wide distribution and adaptability in changing habitats. But even they cannot maintain their success indefinitely in such close proximity to humans (Zinner, Peláez and Torkler, 2002). Given that many populations fo vervets exist outside protected areas their survival is influenced by the attitudes of humans and a willingness to co-exist with them. Understanding the tolerance of farmers would influence strategies to alleviate conflict. Consistent, comparable data on patterns of the raiding behaviour of this genus and identifying the factors that affect these patterns would be beneficial for management of conflict between these monkeys and their human counterparts in rural areas.

Recommendations

Some form of consistency across crop-raiding studies would prove very beneficial and allow for accurate comparisons of crop damage, crop protection methods and attitudes towards problem animals across study sites. Longitudinal studies would prove most beneficial in order to monitor any changes in raiding behaviour, crop damage and or perceptions of problem animals over time.

6. Intake records of the Vervet Monkey Foundation



6.1 Vervet monkeys in South African rescue centres

Rescue and rehabilitation centres hold a somewhat marginal position in the conservation community, often being relegated to a welfare issue (Schoene and Brend, 2002). This may be a failure to acknowledge causal factors such as habitat loss, conflict with humans and for some species unsustainable hunting. In the context of rescue and rehabilitation centres conservation and welfare are inextricably linked. Human activities can damage ecosystems, populations and individuals alike, leading to both conservation and welfare concerns (Dubois and Fraser, 2013). Yet, the care of injured and displaced animals, though initially seeming to be predominantly welfare driven, should not be based solely on welfare grounds (Kirkwood and Sainsbury, 1996). Rehabilitation centres can play a key role in conservation through releases that could potentially support wild populations and through educational outreach in the local community, informing the public of the threats faced by their local wildlife and what part they could play in contributing to its protection. Of course, release of rehabilitated animals can pose a threat to wild populations (Grobler et al., 2006), be it through competition, disease transmission and/or disrupting genetic diversity as there is a risk that the forming of social groups in rescue centres can ignore genetic structuring. It could also be argued that rehabilitation can divert funds from other conservation concerns such as habitat protection and research (Kirkwood, 1992).

Funding and capacity issues are problematic, as well as separation from other conservation initiatives and restrictions in grant allowances (Schoene and Brend, 2002). In South Africa, most rehabilitation centres are funded personally by the rehabilitators themselves (Wimberger, Downs and Boyes, 2010), or through paying volunteers. In a review of South African rehabilitation centres, there was a reported desire among rehabilitators for acknowledgement of their work by local governments. Others expressed wishes for financial support from government bodies and other willing donors (Wimberger, Downs and Boyes, 2010).

Acknowledging these considerations, there is a role in conservation for rescue centres, rehabilitation centres and sanctuaries. Intake data could be used to help develop a comprehensive picture that identifies immediate anthropogenic threats to wildlife. These data could be used as part of a holistic approach to assessing the threats faced by species that live in close proximity to humans and to monitor public perception of these species. There is, however, a dearth of such literature reporting on sanctuary and rehabilitation centre data detailing intakes, release reports and other valuable records such as educational outreach programmes in the local community and the effectiveness of such programmes. This shortcoming prevents sanctuaries/rescue centres from taking a more active role in wider conservation.

There have been a number of studies of the rehabilitation and sanctuary of several primate taxa including pygmy slow lorises *Nycticebus pygmaeus* (Streicher, 2004), Guianan brown capuchins *Cebus paella* (Suarez et al., 2001), black howler monkeys *Alouatta pigra* (Horwich et al., 1993), vervet monkeys *Chlorocebus pygerythrus* (Rhind and Lawes, 1998; Grobler et al., 2006; Wimberger, Downs and Boyes, 2010; Guy, Stone and Curnoe, 2012b; Guy, Stone and Curnoe, 2012a; Guy et al., 2015; Stone and Guy 2017), yellow baboons *Papio cynocephalus* (Gruesen, 2007), various gibbon species *Hylobates* spp. (Cheyne, Campbell and Payne, 2012), including Müller's Bornean gibbon *Hylobates muelleri* (Bennett, 1992) and the silvery Javan gibbon *Hylobates moloch* (Ware, 2001), gorillas *Gorilla* spp. (Farmer and Courage, 2008; King, Chamberlan and Courage, 2014) and chimpanzees *Pan troglodytes* (Humle et al., 2011; Ongman et al., 2013). These studies have covered topics including the evaluation of release and reintroduction success and methods, survivorship, and post-release monitoring protocols (Horwich et al., 1993; Rhind and Lawes, 1998; Suarez et al., 2001; Streicher, 2004; Gruesen, 2007; Humle et al., 2011; Wimberger, Downs and Boyes, 2010; King, Chamberlan and Courage, 2014; Guy et al., 2015) welfare implications of release (Guy, Stone and Curnoe, 2012a; Guy, Stone and Curnoe, 2012b; Guy et al., 2015); rehabilitation methods (Cheyne, Campbell and Payne, 2012; Guy, Stone and Curnoe 2012b; Ongman et al., 2013; Guy et al., 2015); and the role of rehabilitation and reintroduction as a conservation tool (Bennett, 1992; Ware, 2001; Farmer and Courage, 2008). One study of sanctuary chimpanzee populations analysed historic demographic patterns and projected future population dynamics to predict capacity demand on these sanctuaries in the future (Faust et al., 2011). Grobler and colleagues (2006) discussed genetic restructuring of vervet monkey groups in South African sanctuaries and rescue centres and the risk that may pose to the genetic integrity of wild population (Grobler et al., 2006).

Studies of admittance data from sanctuary and rehabilitation centre populations have been less common despite growing anthropogenic pressures and the increase in rehabilitation and sanctuary programmes in welfare and conservation strategies. What studies there have been have focused on rare and endangered taxa such as the African great apes (Farmer, 2002; Ghobrial et al., 2010; Faust et al., 2011; Hughes et al., 2011). For example, one study traced the origins of rescued chimpanzees in Cameroon revealing that hunting is widespread across Cameroon and that live animal smuggling occurs locally as well as internationally (Ghobrial et al., 2010). Vervet monkeys are a more common species admitted to such centres yet the history and composition of these rescue/rehabilitation centre populations have not been studied to date. Studies of the release of rehabilitated vervet monkeys have discussed some individual histories in the context of suitability for release (Rhind and Lawes, 1998; Wimberger, Downs and Boyes, 2010; Guy, Stone and Curnoe, 2012a; Guy, Stone and Curnoe, 2012b; Guy et al., 2015. However, as the cause of admittance of the study populations was not the focus of these studies, the composition of these rehabilitation centre populations was not described and the anthropogenic threats faced by this conflict species remain largely unreported in the academic literature.

Vervet monkeys are ecologically flexible primates that range throughout eastern and southern Africa (Whittaker, 2013). They can exploit various habitats from dry savannah to gallery forest, thrive in disturbed growth habitat, and exploit human-altered environments such as tourist parks, agricultural land and urban residential areas (Whittaker, 2013). As per the genus, they can vary foraging strategies, territoriality, ranging patterns, fecundity, and activity levels, depending on resource quality and seasonal fluctuations in conditions (Kavanagh, 1981; Harrison, 1985; Whittaker, 2013). Limited only by the availability of water and appropriate sleeping trees (Wrangham, 1981; McDougall et al., 2010), they have an ecological advantage over more specialist taxa that require protected closed-canopy forest for survival. They have few major threats and are widespread and relatively abundant, informing their Least Concern threat status on the IUCN Red List of Threatened Species (Kingdon et al., 2008).

It is this very flexibility that brings vervet monkeys into conflict with humans. They frequently come to share human-dominated landscapes as increased urbanisation forces them into closer proximity with humans (Henzi, 1979). To farmers in rural areas throughout the entire *Chlorocebus* range (occurring patchily throughout sub-Saharan Africa), these monkeys are notorious crop raiders (see Chapter 6 for details). This conflict is relatively well documented with raiding events reported as well as several studies reporting the rank of vervets as pests per local farmers at study sites in Uganda (Saj, Sicotte and Paterson, 2001; Nampindo and Plumptre, 2005; Hartter, 2009; Hartter and Goldman, 2009; Wallace, 2010), Kenya (Mulu, 2010), Tanzania (Siege and Baldus, 1998) and Ethiopia (Quirin, 2005; Admassu, 2007). In South Africa, vervet monkeys rank second only to baboons as crop-raiders and pests (Estes, 1991). Suburban conflict is less well documented with the exception of a study in Malawi (King and Lee, 1987). One publication from South Africa reported that people in KwaZulu-Natal responded to vervet monkeys in gardens and houses by shooting monkeys with pellet guns, throwing stones and poisoning (Guy, Stone and Curnoe, 2012a).

Wildlife rehabilitation in South Africa, initialised in the 1950s by nature conservation agencies (Wimberger, Downs and Boyes, 2010), was a private sector concern by the late 1980s. The formation of a 'Rehabilitation Council' was discussed in the late 1980s at the only national rehabilitation conference to date (Wimberger, Downs and Boyes, 2010). This did not come to pass, and the issue was not raised again until Ezemvelo KwaZulu-Natal Wildlife developed documents on the subject: *Ex Situ Wild Animal Management Policy*; *Norms and Standards for Care and Management of Ex Situ Vervet Monkeys* Cercopithecus aethiops *in KwaZulu-Natal*; and *Norms and Standards for the Management of Primates in KwaZulu-Natal*. In the province of KwaZulu-Natal primate rehabilitators require a permit and are expected to complete a course on captive indigenous primate care and management; measures not, yet, adopted in other provinces (Wimberger, Downs and Boyes, 2010).

In South Africa, vervet monkeys were subject to the South African Problem Animal Control Ordinance (Ordinance 26, 1957), which allowed them to be destroyed as vermin. They were removed from this list in 2005 but, for many people, retain their reputation as pests. Complaints from residents about monkeys near and on their property and various incidents of monkey injuries and killings are reported on local news sites (such as www.looklocal.co.za). To keep a non-human primate as a pet is an illegal practice in South Africa that results in confiscation if detected (Grobler et al., 2006). Nevertheless, though poorly documented, pet vervet monkeys are sometimes kept (Fuentes, 2006; Grobler et al., 2006). As a result of this human-monkey conflict many South African rescue centres, rehabilitation centres and sanctuaries take in injured, orphaned and ex-pet vervet monkeys (Wimberger, Downs and Boyes, 2010).

Rhind and Lawes (1998) reported an annual intake of 70 vervet monkeys to the Centre for the Rehabilitation of Wildlife in Durban. Over a decade later Wimberger and Downs (2010) reported that vervet monkeys were the most common mammalian species to be admitted to that same centre, where 365 monkeys arrived over four years. Monkey Helpline, KwaZulu-Natal, rescued 326 monkeys in the first 6 months of 2010 (Guy, Stone and Curnoe, 2012a). Grobler and colleagues (2006) estimated a sanctuary population of approximately 3,000 in South Africa. However, I would describe this as a conservative estimate.

When the Vervet Monkey Foundation (VMF) was established in Tzaneen in 1989 it was the only centre for vervet monkeys in the Limpopo Province. There are now four more in Limpopo and at least six in neighbouring KwaZulu-Natal (Dave du Toit, VMF Director, pers. comm., 2011). There are now at least 23 rescue centres in South Africa that take in vervet monkeys (Healy, unpublished data) and long-established networks to facilitate communication between centres (e.g. African Primates). Yet, despite being aware of the issue, intake at these centres, and the prevalent human-monkey conflict in South Africa, have not been documented in the academic literature. The aim of this report is to begin to fill this gap.

Here, I aim to present descriptive statistics of the intake records of one specialist vervet sanctuary and rehabilitation centre in the Limpopo Province of South Africa

— the VMF — identifying apparent trends in age, sex, season of arrival, and causes of injury and orphaning. I will also discuss the merits of monitoring and sharing such records as well as the important role of these centres in education efforts to reduce the numbers of vervet monkeys needing rescue. We also discuss the importance of identifying and addressing people's perceptions of and attitudes towards these 'pest' primates in an attempt to reduce the number of vervet monkeys entering these centres.

6.2 Methods

Data acquisition

The VMF is a non-profit organisation in the Tzaneen area of the Limpopo Province of South Africa founded to provide rehabilitation and sanctuary for vervet monkeys in the locality. It was registered as a charity in 1993 having taken in its first individual - an infant male - in 1989. The VMF is a member of the Pan African Sanctuary Alliance, and is verified by the Global Federation of Animal Sanctuaries. By 2008 the VMF housed over 800 vervet monkeys, comprised of orphan infants, ex-pets, injured individuals, groups taken in from other sanctuaries, one group from a biomedical research facility, and monkeys born at the VMF. Breeding occurred in social groups until 2010 when all adult males were vasectomised.

I gathered two datasets from the VMF. The first dataset focuses on infant intake from October 2003 to March 2012. Through correspondence with other voluntary staff and my own notes from time there as a volunteer I could obtain reliable data on the number of infants arriving at the VMF dating from October 2003 to March 2012. The second dataset contains data on intake of all age classes from March 2009 to March 2012. The VMF maintains a database of records of all monkeys and their individual histories including the circumstances of an individual's arrival, any known details of its background, veterinary records and rehabilitation/social integration notes. This database is only complete for animals arriving after February 2009. The management of the VMF shared a comprehensive dataset of intake of all age classes fo the period of March 2009 to March 2012 for the purposes of this study.

Data preparation

Here I define "infants" as monkeys of six months or younger based on the age at which offspring will move independently of their mothers (Bolter and Zihlman, 2003). Before this age, they are more likely to cling ventrally to their mothers when the troop is moving. Juveniles are seven months to three years for females and five years for males, the age at which sexual maturity is reached (Fairbanks and McGuire 1984).

6.3 VMF intake

Between October 2003 and March 2012, at least 191 vervet monkeys arrived at the VMF. This is a conservative estimate since prior to March 2009 no admittance data were available for juvenile and adult age classes.

6.2.1 Orphan infant intake from October 2003 to March 2012

Between October 2003 and March 2012, 161 orphan infants arrived at the VMF. As shown in Figure 27, there has been a steady decrease in annual infant intake.

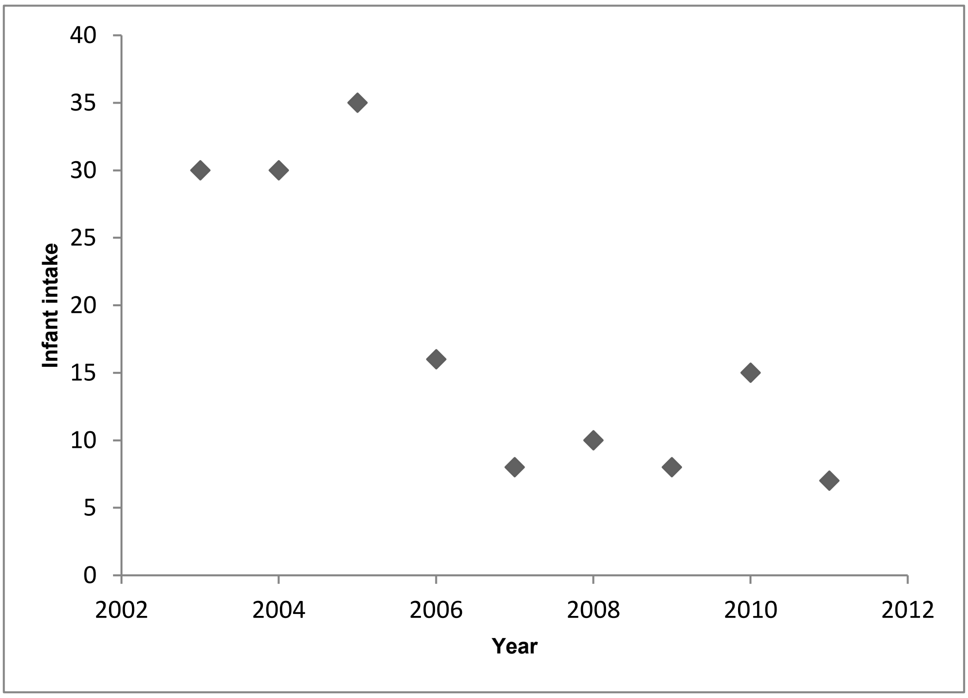


Figure 21. Number of infant vervet monkeys arriving at the VMF over the period of October 2003 to March 2012.

6.2.2 Intake of all age classes from March 2009 to March 2012

Between March 2009 and March 2012 there was a total intake of 50 vervet monkeys at the VMF, namely two adults (one male, one female), 16 juveniles (8 males, 7 females, one unsexed) and 32 infants (13 males, 18 females, one unsexed). There was no significant difference in intake apparent between sexes. There is a significant difference in intake apparent across age classes ($\chi^2 = 26.62$, df = 2, $P < 0.0001$) with significantly more young (juvenile and infant) monkeys arriving than adults ($\chi^2 = 42.32$, df = 1, $P< 0.0001$), and significantly more infant intake than juvenile ($\chi^2 = 5.33$, df = 1; $P = 0.02$).

Six vervet monkeys were euthanized upon arrival due to the severity of their injuries; one individual died of its injuries shortly after arrival. Six monkeys were released (one adult, four juveniles, one infant) following a brief period of recovery from their injuries, since the locations of their troops were known and they were judged behaviourally and physically fit. In the case of the infant release, a wild female of the identified natal group was observed by staff upon release approaching the infant and carrying it back to the troop. All others remained at the VMF for rehabilitation until eventual release.

There was an equal intake of injured and uninjured monkeys (Table 11). The most common cause of injury was vehicle collision (56%). Other causes of injury included shooting by farmers (12%), attack by dogs, some injuries of unknown causes and one case of electric shock by power lines. One injured infant found alone in the bush was presumed to be injured in an inter-troop encounter. Injured infants listed under 'Car' and 'Shot' were injured when their mothers were killed. No statistically significant difference was found between thecause of injury to males and females ($\chi^2 = 0.43$, df = 1; $P = 0.83$). Infants were no more likely to be injured than juveniles ($\chi^2 = 0.39$, df = 1; $P = 0.53$).

Table 11. Circumstances of arrivals at the VMF during the period of March 2009 to March 2012.

Age class and sex	Condition/circumstance of arrival						
	Injured			Uninjured			
	Car	Shot	Other	PHO*	FIB**	Conf.	Other
Adult Male; female; unsexed	1; 1; 0						
Juvenile Male; female; unsexed	3; 3; 0		1; 2; 1	4; 1; 0			0; 1; 0
Infant Male; female; unsexed	4; 2; 0	1; 2; 0	1; 2; 1	2; 4; 0	2; 4; 0	2; 1; 0	1; 3; 0

*PHO = Pet hand-over; **FIB = Fund in bush.

The majority of uninjured monkeys were ex-pets handed over voluntarily to the VMF (44%). The length of time these monkeys were kept as pets, as described by owners, ranged from two weeks to four years. Three uninjured infants were confiscated; one by Nature Conservation, one by a veterinarian when the monkey's owner brought him in wearing a nappy, and the third by the director of the VMF when she was seen in a man's arms in the local supermarket. Six uninjured infants were reported to have been 'found alone in the bush'. Uninjured infants under the 'Other' category arrived through a variety of circumstances. One was found on the side of the road with a chain around its waist, thought to be intended for sale. One was brought into a house uninjured by a family's pet dog. Another was handed into a pet shop and the VMF notified by shop staff. How the people who made the hand-over came to be in possession of the monkey is unknown. One other infant was uninjured but orphaned when its mother was shot by a farmer. The one uninjured juvenile in the 'Other' category came from another rescue centre.

6.2.3 Temporal intake patterns

Between March 2009 and March 2012 monkeys arrived in all months but July and September. It should also be noted that the VMF was under quarantine from April to September of 2009 and so no animals were accepted during this period, accounting for the absence of arrivals in these months. There is a clear peak in admittance in the months of November and December (ten arrivals in total in both months) (see Figure 22). Seventy-eight percent of arrivals (39 monkeys) arrived between the months of October and March, significantly more than the number of arrivals during the second half of the year ($\chi^2 = 15.68$, df = 1; $P < 0.0001$).

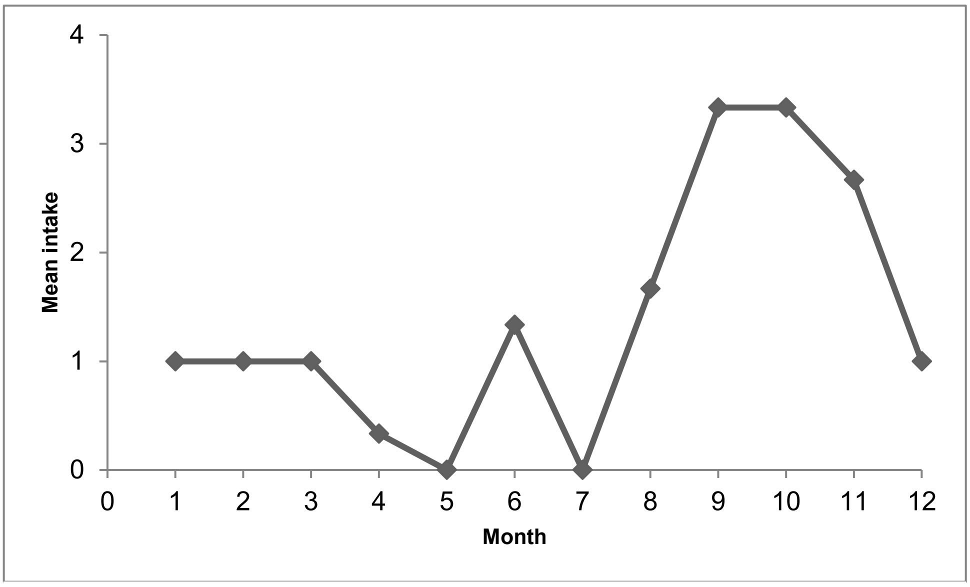


Figure 22. Mean monthly arrivals of vervet monkeys at the VMF, Tzaneen, South Africa for the period March 2009 to February 2012.

6.3 Discussion

Rescue and rehabilitation centres hold a somewhat marginal position in the conservation community, often being relegated to a welfare issue (Schoene and Brend, 2002). This may be a failure to acknowledge causal factors such as habitat loss, conflict with humans and, for some species, unsustainable hunting. In the context of rescue and rehabilitation centres conservation and welfare are inextricably linked. Human activities can damage ecosystems, populations and individuals alike, leading to both conservation and welfare concerns (Dubois and Fraser, 2013). Yet the care of injured and displaced animals, though initially seeming to be predominantly welfare driven, should not be based solely on welfare grounds (Kirkwood and Sainsbury, 1996). Rehabilitation centres can play a key role in conservation through releases that could potentially support wild populations and through educational outreach in the local community informing the public of the threats faced by their local wildlife and what part they could play in assisting its protection.

There is a general trend of common species living in close association with humans being those most frequently admitted to rehabilitation centres (Deem, Terrell and Forrester, 1998), as there is an increased probability of injury and of subsequent detection (Reeve, 1998; Barnett and Westcott, 2001). Studies of rescue centre intake records are relatively few (Kelly and Sleeman, 2003; Mazaris et al., 2008; Wimberger and Downs, 2010; Hughes et al., 2011; Molina-López, Casal and Darwich, 2011; Randall, Blitvich and Blanchong, 2012; Griffith et al., 2013). Data that have been published report on trends in causes of injury and admission of animals, and discuss the usefulness of such reports in mitigation-related decision making. For instance, Griffith and colleagues (2013) reported on 30 years of koala (*Phascolarctos cinereus*) admissions to a rehabilitation centre in coastal New South Wales highlighting trends and reported an increase in vehicle collisions as a cause of injury to koalas in the area, supporting the enhanced action of local authorities in their pursuit of traffic-calming measures in the area if the koala population is to be maintained. Molina-Lopez and colleagues (2011) reported on the cause of injury to the wild raptor population of Catalonia over a 12-year period highlighting trends across seasons and over the years, discussing the potential impact of morbidity and mortality causes on wild bird populations. An evaluation of the potential threats to birds in Greece examined a ten-year dataset from a rehabilitation centre (Mazaris et al., 2008) recommending a reduction of the hunting period and improvements in law enforcement with respect to biodiversity conservation legislation. An ongoing initiative of the Colobus Conservation to reduce primate road deaths and injuries in Diani Beach, Kenya, involved the construction of canopy-level ‘bridges’ across stretches of road identified as high risk to monkeys. These have been shown to be beneficial to vervets as well as Sykes’ monkeys (*Cercopithecus mitis albogularis*) and black-and-white colobus (*Colobus angolensis palliates*) (Andrea Donaldson, Colobus Conservation manager, personal communication, 2013). Wimberger and Downs (2010) report on the intake records of a large urban wildlife rehabilitation centre in South Africa. This study suggests that the numbers of animals in rehabilitation and rescue centres could be reduced through increased public awareness.

The data obtained from the VMF show there has been a steady decline in infant intake over time. It is possible that with the removal of vervets from the vermin list in 2005 there has been a genuine decrease in the need for rehabilitation and sanctuary. Alternatively, there may now be some reluctance to admitting to having injured or killed vervets, or keeping one as a pet, preventing people from comfortably handing over monkeys they find or pets they no longer want. However, a more likely factor is the growing number of number of sanctuaries in the region. When the VMF was established in 1989 it was the only sanctuary for vervets in Limpopo province and indeed South Africa as a whole. There are now four more in the Limpopo, at least six in KwaZulu-Natal (Dave du Toit, VMF Director, personal communication, 2011), and at least nine additional ones elsewhere in South Africa (Wimberger, Downs and Boyes, 2010). In South Africa the vervet is the most common mammal in rehabilitation centres (Wimberger, Downs and Boyes, 2010). In KwaZulu-Natal suburbia vervets are relatively common (Skinner and Chimimba, 2005), due in the most part to the decrease in natural habitat and the increased foraging potential around houses and gardens in the suburbs (Henzi, 1979). One vervet rescue operation in the region, The Monkey Helpline, rescued 326 vervets in the first 6 months of 2010 (Guy, Stone and Curnoe, 2012b) while a rehabilitation centre in Durban admitted an average of 91 vervet monkeys each year over 4 years, the most common mammal species cared for by the centre (Wimberger and Downs, 2010).

There is a seasonal pattern of intake at the VMF with a clear peak during the austral summer (October–March). This is to be expected given that in regions of their range where there are clear wet and dry seasons, as in South Africa, mating generally occurs during the dry season and birthing tends to occur from the beginning of the wet season (October to March) when resources once again become plentiful (Lee, 1984). Wimberger and Downs (2010) also report seasonal increases in rescue centre arrivals, linked directly to the increased abundance of juveniles and infants during the spring and summer months. In fact, an overwhelming majority of VMF admissions – 96% – were either juveniles or infants, and of those a clear majority – two thirds – were infants, a trend also reported in Durban (Wimberger and Downs, 2010). As a large portion of injured infants were brought in when their mothers were killed by vehicle collisions, addressing this could reduce this seasonal influx of infants. Perhaps local authorities could be prevailed upon to initiate traffic-calming measures, or alternatives such as aerial 'bridges', at key areas to increase the safety of wildlife and humans alike.

Shooting is the second most common cause of injury to vervets admitted to the VMF. In the case of crop-raiding animals, farmers could be encouraged to employ non-lethal methods of crop protection. However, it is recognised that non-human primates, in particular, are more problematic to farmers than other large mammals due to their intelligence, manual dexterity, size and their often omnivorous character commonly making control techniques unsuccessful (Hill, 2002). Where some other large mammals can be contained by barriers, primates can jump over and dig under fences, they learn to climb on electric insulators and can find 'dead spots' in electric fences (Strum, 1994). Even killing crop-raiding primates can be ineffective in dissuading others from the behaviour as the remaining animals simply learn extreme caution and continue to raid (Kavanagh, 1980). Awareness-raising programmes targeting farmers could highlight the ineffectiveness of shooting monkeys that are crop-raiding. Farmers could instead be encouraged to employ alternative crop-protection techniques. The presence of humans guarding crops is a potentially effective method. Educational messages could also raise awareness of the presence of suckling infants during the birthing season.

In the residential context, where monkeys enter gardens, conflict could be mitigated if people could be encouraged to 'monkey proof' bins. Insect mesh or screens could be placed in front of windows if they are to be left open to prevent monkeys from entering houses. Leaving food visible and accessible should be avoided. As the majority of uninjured monkeys were ex-pets it is imperative that people are educated as to why non-human primates are not appropriate companion animals.

However, any proposed mitigation measures would be purely academic without concurrently addressing attitudes. A quantitative assessment of these attitudes and perceptions of vervets in South Africa is lacking, but from informal discussion with the public and those that hand over monkeys it is clear that they are generally not liked or tolerated at best. Some negative terms used by members of the public when referring to vervet monkeys have included ‘hate’, ‘nuisance’, ‘malicious’ and ‘cause too much damage’. Farmers in addition commented on the economic losses they incurred due to the presence of vervet monkeys, and to an absence of any benefit brought by them (Josie du Toit, co-director of the VMF, personal communication, 2012). In July 2012, a vervet monkey was deliberately killed, dragged by a cord and tied to a post by the main gates of the VMF (Josie du Toit, co-director of the VMF, personal communication, 2012). Although it was not the sole piece of evidence demonstrating the attitudes of the neighbouring public towards these monkeys it was the most violent. These perceptions must be addressed. It is widely acknowledged that understanding attitudes to ‘pest’ primates, and other commensal species, is imperative for mitigating conflict (Else and Lee, 1986; Parry and Campbell, 1992; Pirta, Gadgil and Kharshikar, 1997; Gillingham and Lee, 1999; Hill, 2002; Lee and Priston, 2005; Hill and Webber, 2010; McLennan and Hill, 2012). Informing local communities about how to successfully live with these monkeys could potentially reduce conflict. The VMF has become more active in its education and community outreach in recent years. Raising its profile through increased involvement with the local community will likely influence future interactions with people who live closely with monkeys, could aid in improving relations between people and monkeys, and may contribute to future data collection. Awareness events as well as educational visits by school groups and by the general public to the VMF and other facilities would be an opportune time to conduct such research into the attitudes and perceptions of local people towards problem animals.

The VMF has become more active in its educational community outreach following a change in management in 2009, including the erection of an on-site education centre to facilitate school visits. In 2012 a partnership was established with a local sustainable agriculture initiative and the VMF hosted training for local graduates of the South African Wildlife College, teaching compassionate living with wildlife with the view to establishing an education programme in the greater Tzaneen area. Raising the profile of the VMF through increased involvement with the local community will likely impact future interactions with people who live closely with vervet monkeys and could aid in improving relations between people and monkeys and may contribute to future data collection.

Wildlife sanctuaries and rescue and rehabilitation centres do not use a uniform comparable recording system that would facilitate the sharing of intake records (Harden, Dickerman and Elliston, 2006). Such comparable data would be of great use both for conservation- and welfare-related research. If databases such as this one were maintained over time we could categorically identify the anthropogenic causes of harm to wildlife, in this case vervet monkeys in South Africa, enabling the development of preventative measures to reduce harm to individuals and to protect local populations (Smith, 2006). The development of a compilation of these data across sanctuaries throughout the vervet range would have conservation benefits. Such data would go some way to developing a more comprehensive picture of the vervet monkeys' situation in the wild and their robustness against the associated threats of living in such close proximity with humans. Areas where threats are highest could be identified (cf. Schoene and Brend, 2002; Kelly and Sleeman, 2003; Harden, Dickerman and Elliston, 2006; Drake, 2007; Randall, Blitvich and Blanchong, 2012; Souza, Teixeira and Young, 2012; Serangeli et al., 2012; Dubois and Fraser, 2013). Preventative measures to mitigate the threats could be attempted; comparisons could be made between sanctuaries based on location, human development, proximity to roads and other anthropogenic threats; intake numbers at one centre could be compared over time; records of where an individual was found would facilitate possible release, as well as identifying the locations and status of resident groups. Where vehicle collisions are the primary cause of injury to wild animals it could be recommended to reduce the speed limit on a given stretch of road. Attitudes of local people towards problem animals could be identified and addressed through raising awareness and providing practical solutions to some problems.

This more holistic approach to compassionate conservation may bring rescue centres, sanctuaries and rehabilitation centres in from the fringes of conservation research. With the co-operation of rescue centres and other invested stakeholders, such as those studying human-wildlife conflict in the region, these efforts could go some way to reducing the number of vervet monkeys arriving at centres, playing an intrinsic role in improving the welfare of these wild animals living in close proximity to humans, while simultaneously contributing to conservation efforts.

Recommendations

Further investigation of intake records of other centres across the country would be a highly valuable investigation and could go a long way to developing a picture that most accurately reflects the situation of these monkeys in proximity to people. Perceptions and attitudes would then be informed more by accurate data than by the impression given by such tenacious and visible monkeys.

7. Discussion and recommendations

This thesis makes a case for the proactive conservation of vervets *Chlorocebus* spp. Combined, results suggest that, despite the adaptable nature of the genus, and while vervets are common and adaptable, they nonetheless face a plethora of anthropogenic risks because of their ability to exploit human-altered environments. A potential habitat shift extension has been observed in Côte d'Ivoire where monkeys were observed outside their previously described range, restricted to swamp and mangrove forests (Bi et al., 2009). Vervets dominate the CITES-reported international trade in individual primates of African origin, accounting for half of the wild-caught trade. Vervets, alog with baboons, are the most heavily exported primate trophy species. Vervets are the cheapest primate species to shoot and are often opportunistic kills made free of charge. Farmers rank vervets among the top five probem animals and report damage ranging from 2% to 20% of crops. Crop-protection measures seem unsuccessful in the main and are sometimes lethal. The VMF took in almost 200 monkeys in a decade, mostly orphan infants, half injured. It suggests we need to pay more attention to common species, their extraction, and, perhaps most importantly, try to address human-monkey conflict and the associated perceptions and obstacles to conserving common species. There is a place fro citizen science in informing priority management and conservation efforts in the highly complex human-monkey interface in suburbn landscepes (Patterson et al., 2018).

Many more cases exist of common species experiencing declines or extinction including the classic and dramatic case of the passenger pigeon *Ectopistes simigratorius* which went from tens of millions to extinct in a matter of decades (Halliday, 1980) and the Rocky Mountains grasshopper *Melanoplus spretus* (Chapco and Litzenberger, 2004). Similar examples include several species of bumblebee *Bombus* (Cameron et al., 2011). Others include a large number of common and widespread butterflies that have declined rapidly due to human use of landscapes (Van Dyck et al., 2009). One of the most abundant trees in the north eastern USA, the American chestnut *Castanea dentate* went extinct in a matter of decades (Van Fleet, 1914; Freinkel, 2007). Many common bird species have declined in agricultural areas in Europe, including the common starling *Sturnus vulgaris* and house sparrow *Passer domesticus* in the UK (Krebs et al., 1999; Vincent, 2005; Freeman et al., 2007), and others in areas of the North Island of New Zealand (Elliott et al., 2010). In

Madagascar one of what used to be the world's most abundant tortoises, the radiated tortoise *Astrochelys radiata*, is now almost extinct (O'Brien et al., 2003). Similarly, a large number of once common and widespread fish species that are targets for commercial fishing have experienced dramatic declines due to over-exploitation (Levin et al., 2006).

Bonnet macaques *Macaca radiata* and Hanuman langurs *Semnopithecus entellus* (since taxonomically revised with five species recognised), common and widespread primate species, were surveyed in the Karnataka state of India between 2001 and 2004 where they were found to be experiencing declines in many districts in the northern and southern plains respectively (Kumara, Kumar and Singh, 2010). Earlier surveys in India also reported declines in the populations, and/or changes in group size and composition of Hanuman langurs (Sugiyama and Parthasarathy, 1978; Das-Choudhuri and Roy, 1989; Ross, Srivastava and Pirta, 1993), bonnet macaques (Singh and Rao, 2004) and rhesus macaques *Macaca mulatta* (Ross, Srivastava and Pirta, 1993). In this most recent survey Kumara and colleagues (2010) reported that bonnet macaques were eliminated from 47% of tourist spots and temples surveyed. Surveys in the coastal region recorded over 90% elimination and those in the Western Ghats and Southern Plateau 53% and 36% respectively. The bonnet macaques and Hanuman langurs can adapt to a wide range of habitats from plains to the relatively high altitude of the Western Ghats (2100 m asl), and the bonnet macaque is also reported to have a tendency to move towards human habitation (Zinner et al., 2013). Both the bonnet macaque and Hanuman langur are often commensal with humans, which has led to the general assumption that because they are visible they are common everywhere (Kumara, Kumar and Singh, 2010). There are also many assumptions regarding their religious protection (Southwick and Siddiqi, 1994) that are in fact only true in a few regions. The bonnet macaques are extirpated from coastal regions including temples (Kumara, Kumar and Singh, 2010). Traditional protection of rhesus macaques changed in recent decades, resulting in sharp declines in populations (Southwick and Siddiqi, 1977). These most recent declines of bonnet macaques reported by Kumara and colleagues have been attributed to translocation of crop-raiding groups. It has been previously asserted that declines in bonnet macaques have been due to increased conflict with people (Singh and Rao, 2004). In the case of the Hanuman langurs it is suspected that the lack of appropriate trees, the development of monoculture plantations, hunting for meat, and general agricultural expansion into forest area have contributed to their decline (Kumara, Kumar ad Singh, 2010). As there remains taxonomic uncertainty regarding the assignment of Hanuman langur taxa and the geographic range of each taxon is unknown for certain there are evolutionary consequences for local extinction of a little-known species or subspecies (Kumara, Kumar and Singh, 2010). Bonnet macaques are found mostly outside protected areas (Kumara and Singh, 2004; Singh and Rao, 2004; Kumara, Kumar and Singh, 2010). As a result, they are afforded little conservation attention. As conflict species they should be of a higher conservation priority since maintaining populations may avoid the clustering that arises resulting in human-monkey conflict (Kumara, Kumar and Singh, 2010).

Another example of a common primate species experiencing rapid decline is the long-tailed macaque *Macaca fascicularis*. The long-tailed macaque thrives in secondary forest in Southeast Asia and often lives commensally with humans (Eudey, 2008). There has been an increase in encroachment in forest habitat and an associated increase in macaque crop raiding which has led to more human-wildlife conflict, both rurally where the macaques crop-raid and in urban environments where they have become pests exploiting human food and rubbish (Twigg, 2008). Trade in wild-caught macaques has been on the increase to supply the pharmaceutical industry (Eudey, 2008). As the species has been widespread and considered common there are deficient data on population numbers, compositions and trends (Muroyama and Eudey, 2004) but in 2008 it became the first "widespread and rapidly declining" species (Eudey, 2008).

The implications are that, although vervets are common and flexible, they face a plethora of anthropogenic risks because of their ability to exploit human-dominated environments. This suggests that we as conservationists need to pay closer attention to common species, and furthermore, that it is essential to attempt to address human-monkey conflict and the associated perceptions and obstacles to conserving common species. Perhaps most importantly, this body of work suggests that complacency has no place in conservation.

Bibliography

Admassu, M. (2007) Damage caused by large mammals in Wonji-Shoa sugar cane plantation, central Ethiopia. Msc Thesis, Addis Abeba University, pp. 76.

Agapow, P. M., Bininda- Emonds, O. R., Crandall, K. A., Gittleman, J. L., Mace, G. M., Marshall, J. C. and Purvis, A. (2004) 'The impact of species concept on biodiversity studies', The quarterly review of biology, 79(2), pp. 161-179.

Agmen, F. L., Chapman, H. M. and Bawuro, M. (2010) 'Seed dispersal by tantalus monkeys (*Chlorocebus tantalus tantalus*) in a Nigerian montane forest', African Journal of Ecology, 48(4), pp. 1123-1128.

Altmann, J. and Muruthi, P. (1988) 'Differences in daily life between semiprovisioned and wild- feeding baboons', American Journal of Primatology, 15(3), pp. 213-221.

Alves, R. and Rosa, I. L. (2006) 'From cnidarians to mammals: The use of animals as remedies in fishing communities in NE Brazil', Journal of Ethnopharmacology, 107(2), pp. 259-276.

Alves, R., Souto, W. and Barboza, R. R. (2010) 'Primates in traditional folk medicine: a world overview', Mammal Review, 40(2), pp. 155-180.

Alves, R. R., Barbosa, J. A., Santos, S. L., Souto, W. M. and Barboza, R. R. (2009) 'Animal-based remedies as complementary medicines in the semi-arid region of Northeastern Brazil', Evidence Based Complementary and AlternativeMedicine, 2011, pp. 89.

Anapol, F., Turner, T., Mott, C. and Jolly, C. (2005) 'Comparative postcranial body shape and locomotion in *Chlorocebus aethiops* and *Cercopithecus mitis*', American Journal of Physical Anthropology, 127(2), pp. 231-239.

Andelman, S. J. (1987) 'Evolution of concealed ovulation in vervet monkeys (*Cercopithecus aethiops*)', The American Naturalist, 129(6), pp. 785-799.

Anderson, J., Rowcliffe, J. M. and Cowlishaw, G. (2007) 'Does the matrix matter? A forest primate in a complex agricultural landscape', Biological conservation, 135(2), pp. 212-222.

Apaza, L., Godoy, R., Wilkie, D., Byron, E., Huanca, T., Leonard, W., Peréz, E., Reyes-García, V. and Vadez, V. (2003) 'Markets and the use of wild animals for traditional medicine: a case study among the Tsimane'Amerindians of the Bolivian rain forest', Journal of Ethnobiology, 23(1), pp. 47-64.

Astaras, C., Krause, S., Mattner, L., Rehse, C. and Waltert, M. (2011) 'Associations between the drill (*Mandrillus leucophaeus*) and sympatric monkeys in Korup National Park, Cameroon', American journal of primatology, 73(2), pp. 127-134.

Azis, H. and Davis, T. (1980) 'Macaque monkey, a master harvester of palms', Indian Coconut Journal, 11(7), pp. 1-4.

Baldellou, M. and Adan, A. (1997) 'Time, gender, and seasonality in vervet activity: A chronobiological approach', Primates, 38(1), pp. 31-43.

Banks-Leite, C., Pardini, R., Tambosi, L. R., Pearse, W. D., Bueno, A. A., Bruscagin, R. T., Condez, T. H., Dixo, M., Igari, A. T. and Martensen, A. C. (2014) 'Using ecological thresholds to evaluate the costs and benefits of set-asides in a biodiversity hotspot', Science, 345(6200), pp. 1041-1045.

Barnett, J. and Westcott, S. (2001) 'Distribution, demographics and survivorship of grey seal pups (*Halichoerus grypus*) rehabilitated in southwest England', Mammalia, 65(3), pp. 349-362.

Barrett, A.S., Barrett, L., Henzi, P. and Brown, L.R. (2016) ‘Resource selection on woody plant species by vervet monkeys (*Chlorocebus pygerythrus*) in mixed-broad leaf savanna’, *South* African Journal of Wildlife Research, *46*(1), pp.14-21.

Battersby, J. (2005) 'UK mammals: species status and population trends', JNCC/Tracking Mammals Partnership. 3 November 2006.

Bellard, C., Leclerc, C., Leroy, B., Bakkenes, M., Veloz, S., Thuiller, W. and Courchamp, F. (2014) 'Vulnerability of biodiversity hotspots to global change', Global Ecology and Biogeography, 23(12), pp. 1376-1386.

Bennett, J. (1992) 'A glut of gibbons in Sarawak–is rehabilitation the answer?', Oryx, 26(03), pp. 157-164.

Bennett, J. R., Maloney, R. and Possingham, H. P. (2015) 'Biodiversity gains from efficient use of private sponsorship for flagship species conservation', Proceedings of the Royal Society of London B: Biological Sciences, 282(1805), pp. 20142693.

Bersacola, E., Svensson, M., Bearder, S., Mills, M. and Nijman, V. (2014) 'Hunted in Angola—surveying the bushmeat trade', SWARA, 38, pp. 31-36.

Bertrand, M. (1967) 'Training without reward: traditional training of pig-tailed macaques as coconut harvesters', Science, 155(3761), pp. 484-486.

Bi, S. G., Bené, J. K., Bitty, E. A., Koné, I. and Zinner, D. (2009) 'Distribution of the green monkey (*Chlorocebus sabaeus*) in the coastal zone of Côte d'Ivoire', Primate Conservation, 24, pp. 91-97.

Bickford, D., Phelps, J., Webb, E. L., Nijman, V. and Sodhi, N. S. (2011) 'Boosting CITES Through Research - Response', Science, 331(6019), pp. 857-858.

Bilney, R. J., Cooke, R. and White, J. G. (2010) 'Underestimated and severe: small mammal decline from the forests of south-eastern Australia since European settlement, as revealed by a top-order predator', Biological conservation, 143(1), pp. 52-59.

Bland, L. M., Collen, B., Orme, C. D. L. and Bielby, J. (2015) 'Predicting the conservation status of data- deficient species', Conservation Biology, 29(1), pp. 250-259.

Blundell, A. G. and Mascia, M. B. (2005) 'Discrepancies in reported levels of international wildlife trade', Conservation Biology, 19(6), pp. 2020-2025.

Boates, J. Sherman, and M. Brock Fenton (2011) 'Flagship Species–Flagship Problems: recovery of species at risk and the conservation of biodiversity in Canada', pp. 369-370.

Bolter, D. R. and Zihlman, A. L. (2003) 'Morphometric analysis of growth and development in wild- collected vervet monkeys (*Cercopithecus aethiops*), with implications for growth patterns in Old World monkeys, apes and humans', Journal of Zoology, 260(1), pp. 99-110.

Bonin, A., Nicole, F., Pompanon, F., Miaud, C. and Taberlet, P. (2007) 'Population adaptive index: a new method to help measure intraspecific genetic diversity and prioritize populations for conservation', Conservation Biology, 21(3), pp. 697-708.

Borghesio, L., Amakobe, B., Bakari, S., Balidy, H., Biasiol, D. and Menomussanga, M. (2009) 'A bird survey of the Ruvuma Delta, northern Mozambique', Bull. ABC, 16, pp. 197-203.

Boulton, A., Horrocks, J. A. and Baulu, J. (1996) 'The barbados vervet monkey (*Cercopithecus aethiops sabaens*): Changes in population size and crop damage, 1980–1994', International Journal of Primatology, 17(5), pp. 831-844.

Bowen-Jones, E. and Entwistle, A. (2002) 'Identifying appropriate flagship species: the importance of culture and local contexts', Oryx, 36(02), pp. 189-195.

Bowman, M. (2013) 'A Tale of Two CITES: Divergent Perspectives upon the Effectiveness of the Wildlife Trade Convention', Review of European, Comparative & International Environmental Law, 22(3), pp. 228-238.

Brennan, E., Else, J. and Altmann, J. (1985) 'Ecology and behaviour of a pest primate: vervet monkeys in a tourist- lodge habitat', African Journal of Ecology, 23(1), pp. 35-44.

Brigandt, I. and Love, A.C. (2012) ‘Conceptualizing evolutionary novelty: moving beyond definitional debates’, Journal of Experimental Zoology Part B: Molecular and Developmental Evolution, 318(6), pp.417-427.

Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A., Gerlach, J., Hoffmann, M., Lamoreux, J. F., Mittermeier, C. G., Pilgrim, J. D. and Rodrigues, A. S. (2006) 'Global biodiversity conservation priorities', Science, 313(5783), pp. 58-61.

Bunker, D. E., DeClerck, F., Bradford, J. C., Colwell, R. K., Perfecto, I., Phillips, O. L., Sankaran, M. and Naeem, S. (2005) 'Species loss and aboveground carbon storage in a tropical forest', Science, 310(5750), pp. 1029-1031.

Burgess, M. (1959) 'Fairs and Entertainers in 18th-Century Russia', The Slavonic and East European Review, pp. 95-113.

Butynski, T. M. (2008) *Chlorocebus cynosuros*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 26 February 2017).

Butynski, T. M., Gippoliti, S., Kingdon, J. and De Jong, Y. (2008) *Chlorocebus djamdjamensis*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 26 February 2017).

Cai, W. and Cowan, T. (2008) 'Dynamics of late autumn rainfall reduction over southeastern Australia', Geophysical Research Letters, 35(9).

Cambridge, U. 2001. Bird Life International Threatened birds of Asia: The BirdLife International Red Data Book. UK: Bird Life International.

Cameron, S. A., Lozier, J. D., Strange, J. P., Koch, J. B., Cordes, N., Solter, L. F. and Griswold, T. L. (2011) 'Patterns of widespread decline in North American bumble bees', Proceedings of the National Academy of Sciences, 108(2), pp. 662-667.

Campbell- Smith, G., Simanjorang, H. V., Leader- Williams, N. and Linkie, M. (2010) 'Local attitudes and perceptions toward crop- raiding by orangutans (*Pongo abelii*) and other nonhuman primates in northern Sumatra, Indonesia', American Journal of Primatology, 72(10), pp. 866-876.

Cancelliere, E.C., Chapman, C.A., Twinomugisha, D. and Rothman, J.M. (2018) ‘The nutritional value of feeding on crops: Diets of vervet monkeys in a humanized landscape’, *African Journal of Ecology* (online first)

Caro, T., Engilis, A., Fitzherbert, E. and Gardner, T. (2004) 'Preliminary assessment of the flagship species concept at a small scale', Animal Conservation, 7(1), pp. 63-70.

Caro, T. and O'doherty, G. (1999) 'On the use of surrogate species in conservation biology', Conservation Biology, 13(4), pp. 805-814.

Chapco, W. and Litzenberger, G. (2004) 'A DNA investigation into the mysterious disappearance of the Rocky Mountain grasshopper, mega-pest of the 1800s', Molecular Phylogenetics and Evolution, 30(3), pp. 810-814.

Chapman, A. S., Tunnicliffe, V., & Bates, A. E. (2017) ‘Both rare and common species make unique contributions to functional diversity in an ecosystem unaffected by human activities’, *Diversity and Distributions*.

Cheney, D. L. and Seyfarth, R. M. (1983) 'Nonrandom dispersal in free-ranging vervet monkeys: social and genetic consequences', The American Naturalist, 122(3), pp. 392-412.

Cheyne, S., Campbell, C. and Payne, K. (2012) 'Proposed guidelines for in situ gibbon rescue, rehabilitation and reintroduction', International Zoo Yearbook, 46(1), pp. 265-281.

Clucas, B., McHugh, K. and Caro, T. (2008) 'Flagship species on covers of US conservation and nature magazines', Biodiversity and Conservation, 17(6), pp. 1517.

Coltman, D. W., O'Donoghue, P., Jorgenson, J. T., Hogg, J. T., Strobeck, C. and Festa-Bianchet, M. (2003) 'Undesirable evolutionary consequences of trophy hunting', Nature, 426(6967), pp. 655-658.

Condit, R., Hubbell, S. and Foster, R. (2005) 'Barro Colorado forest census plot data', Online Dataset. URL http://ctfs. si. edu/datasets/bci.

Confessor, M. V., Mendonça, L. E., Mourão, J. S. and Alves, R. R. (2009) 'Animals to heal animals: ethnoveterinary practices in semiarid region, Northeastern Brazil', Journal of Ethnobiology and Ethnomedicine, 5(1), pp. 1.

Cooke, C. 'The cercopithecid community of sette cama, gabon: A preliminary study'. American Journal of Primatology. 66, pp. 151-152.

Corcoran, E., Ravilious, C. and Skuja, M. (2007) Mangroves of western and central Africa. UNEP/Earthprint.

Cuthbert, R. J., Taggart, M. A., Saini, M., Sharma, A., Das, A., Kulkarni, M. D., Deori, P., Ranade, S., Shringarpure, R. N. and Galligan, T. H. (2016) 'Continuing mortality of vultures in India associated with illegal veterinary use of diclofenac and a potential threat from nimesulide', Oryx, 50(01), pp. 104-112.

Dandelot, P. (1959) 'Note sur la classification des Cercopithèques du groupe *aethiops*', Mammalia, 23(3), pp. 357-368.

Dandelot, P. (1971) 'Order Primates', The mammals of Africa: An identification manual', Washington, D. C.: Smithsoniam Institution, pp. 1-45.

Dangles, O. and Malmqvist, B. (2004) 'Species richness–decomposition relationships depend on species dominance', Ecology Letters, 7(5), pp. 395-402.

Das-Choudhuri, A. and Roy, B. (1989) 'A preliminary note on the survival status of the Hanuman langur *Presbytis entellus* in some villages of Nadia district, West Bengal', J Bombay Natural History Society, 86, pp. 233-235.

De Jong, Y. and Butynski, T. (2009) 'Primate biogeography, diversity, taxonomy and conservation of the coastal forests of Kenya', Report to the Critical Ecosystem Partnership Fund. Eastern Africa Primate Diversity and Conservation Program, Nanyuki, Kenya.

Deem, S. L., Terrell, S. P. and Forrester, D. J. (1998) 'A retrospective study of morbidity and mortality of raptors in Florida: 1988-1994', Journal of Zoo and Wildlife Medicine, pp. 160-164.

Deere, N. J. (2011) 'Exploitation or Conservation? Can the Hunting tourism Industry in Africa Be Sustainable?', Environment: Science and Policy for Sustainable Development, 53(4), pp. 20-32.

Deputte, B. and Anderson, J. (2009) 'Baboon Palm Nut Harvesters in Ancient Egypt: New (Ancient) Evidence, New Questions', Folia Primatologica, 80(2), pp. 70-73.

Devictor, V., Godet, L., Julliard, R., Couvet, D. and Jiguet, F. (2007) 'Can common species benefit from protected areas?', Biological Conservation, 139(1), pp. 29-36.

Drake, A. (2007) Mallard duckling care and survival at a wildlife rehabilitation center. University of British Columbia.

Dubois, S. and Fraser, D. (2013) 'Rating harms to wildlife: A survey showing convergence between conservation and animal welfare views', Animal Welfare, 22(1), pp. 49-55.

Duelli, P. and Obrist, M. K. (2003) 'Biodiversity indicators: the choice of values and measures', Agriculture, Ecosystems & Environment, 98(1), pp. 87-98.

Dunbar, R. and Dunbar, E. (1974) 'Ecological relations and niche separation between sympatric terrestrial primates in Ethiopia', Folia Primatologica, 21(1), pp. 36-60.

Dunham, S. (1985) 'The monkey in the middle', Zeitschrift für Assyriologie und Vorderasiatische Archäologie, 75(2), pp. 234-264.

DuQuesne, T. (2007) Anubis, Upwawet, and Other Deities: Personal Worship and Official Religion in Ancient Egypt. American University in Cairo Press.

Durant, S., Wacher, T., Bashir, S., Woodroffe, R., Ornellas, P., Ransom, C., Newby, J., Abáigar, T., Abdelgadir, M. and El Alqamy, H. (2014) 'Fiddling in biodiversity hotspots while deserts burn? Collapse of the Sahara's megafauna', Diversity and Distributions, 20(1), pp. 114-122.

Dutrillaux, B. (1988) 'New interpretation of the presumed common ancestral karyotype of platyrrhine monkeys', Folia Primatologica, 50(3-4), pp. 226-229.

Eeley, H. A. and Foley, R. A. (1999) 'Species richness, species range size and ecological specialisation among African primates: geographical patterns and conservation implications', Biodiversity & Conservation, 8(8), pp. 1033-1056.

Eken, G., Bennun, L., Brooks, T. M., Darwall, W., Fishpool, L. D., Foster, M., Knox, D., Langhammer, P., Matiku, P. and Radford, E. (2004) 'Key biodiversity areas as site conservation targets', BioScience, 54(12), pp. 1110-1118.

El-Kamali, H. (2000) 'Folk medicinal use of some animal products in Central Sudan', Journal of Ethnopharmacology, 72(1), pp. 279-282.

Elliott, G. P., Wilson, P. R., Taylor, R. H. and Beggs, J. R. (2010) 'Declines in common, widespread native birds in a mature temperate forest', Biological conservation, 143(9), pp. 2119-2126.

Else, J. and Lee, P. (1986) 'Primate-Human Conflict. Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society. PC Lee', New York, Cambridge University Press, 2, pp. 213-214.

Estes, R. (1991) 'Behavioral guide to African mammals: including hoofed mammals, carnivores, primates', University of California Press, Berkeley, California.

Estrada, A., Garber, P.A., Rylands, A.B., Roos, C., Fernandez-Duque, E., Di Fiore, A., Nekaris, K.A.I., Nijman, V., Heymann, E.W., Lambert, J.E. and Rovero, F. (2017) 'Impending extinction crisis of the world's primates: Why primates matter', *Science Advances*,3(1), p.e1600946.

Eudey, A. A. (2008) 'The crab-eating macaque (Macaca fascicularis): Widespread and rapidly declining', Primate conservation, 23(1), pp. 129-132.

Fa, J. E., Peres, C. A. and Meeuwig, J. (2002) 'Bushmeat exploitation in tropical forests: an intercontinental comparison', Conservation Biology, 16(1), pp. 232-237.

Fa, J. E., Seymour, S., Dupain, J., Amin, R., Albrechtsen, L. and Macdonald, D. (2006) 'Getting to grips with the magnitude of exploitation: bushmeat in the Cross–Sanaga rivers region, Nigeria and Cameroon', Biological Conservation, 129(4), pp. 497-510.

Fabuel, E., Barragán, C., Silió, L., Rodriguez, M. and Toro, M. (2004) 'Analysis of genetic diversity and conservation priorities in Iberian pigs based on microsatellite markers', Heredity, 93(1), pp. 104-113.

Fairbanks, L.A. and McGuire, M.T. (1984) 'Determinants of fecundity and reproductive success in captive vervet monkeys', American Journal of Primatology, 7(1), pp.27-38.

Farmer, K. H. (2002) 'Pan African Sanctuary Alliance: Status and range of activities for great ape conservation', American Journal of Primatology, 58(3), pp. 117-132.

Farmer, K. H. and Courage, A. (2008) 'Sanctuaries and reintroduction: a role in gorilla conservation?', Conservation in the 21st century: Gorillas as a case study: Springer, pp. 79-106.

Faust, L. J., Cress, D., Farmer, K. H., Ross, S. R. and Beck, B. B. (2011) 'Predicting capacity demand on sanctuaries for African chimpanzees (*Pan troglodytes*)', International Journal of Primatology, 32(4), pp. 849-864.

Fedigan, L. and Fedigan, L. (1988) '*Cercopithecus aethiops*: a review of field studies. A primate radiation: evolutionary biology of the African guenons', Cambridge University Press, Cambridge.

Foard, S., Van Aarde, R. and Ferreira, S. (1994) 'Seed dispersal by vervet monkeys in rehabilitating coastal dune forests at Richards Bay', South African Journal of Wildlife Research, 24(3), pp. 56-59.

Foley, K.-E. and Shepherd, C. R. (2011) 'Box 1.2 Trade in long-tailed macaques (*Macaca fascicularis*)', Monkeys on the Edge: Ecology and Management of Long-Tailed Macaques and their Interface with Humans', 60, pp. 20.

Fourie, N.H., Turner, T.R., Brown, J.L., Pampush, J.D., Lorenz, J.G. and Bernstein, R.M. (2015) 'Variation in vervet (*Chlorocebus aethiops*) hair cortisol concentrations reflects ecological disturbance by humans. *Primates*, 56(4), pp.365-373.

Frankham, R. (1996) 'Relationship of genetic variation to population size in wildlife', Conservation Biology, 10(6), pp. 1500-1508.

Freeman, S. N., Robinson, R. A., Clark, J. A., Griffin, B. M. and Adams, S. Y. (2007) 'Changing demography and population decline in the Common Starling *Sturnus vulgaris*: a multisite approach to Integrated Population Monitoring', Ibis, 149(3), pp. 587-596.

Freinkel, S. (2007) American chestnut: the life, death, and rebirth of a perfect tree', University of California Press.

Fuentes, A. (2006) 'Human-nonhuman primate interconnections and their relevance to anthropology', Ecological and Environmental Anthropology (University of Georgia), pp. 1.

Galat-Luong, A. and Galat, G. (2005) 'Conservation and Survival Adaptations of Temminck's Red Colobus (*Procolobus badius temmincki*), in Senegal', International Journal of Primatology, 26(3), pp. 585-603.

Galat-Luong, A. and Galat, G. (2013) '*Papio papio* Guinea Baboon', in Butynski, T.M., Kingdon, J. & Kalina, J. (eds.) The Mammals of Africa. London: Bloomsbury Publishing, pp. 218-221.

Galat-Luong, A., Galat, G. and Hagell, S. (2006) 'The social and ecological flexibility of Guinea baboons: implications for Guinea baboon social organization and male strategies', Reproduction and fitness in baboons: Behavioral, ecological, and life history perspectives', Springer, pp. 105-121.

Galat, G. (1983) 'Socio-écologie du Singe vert (*Cercopithecus aethiops sabaeus*) en référence de quatre Cercopithecines forestiers sympatriques (*Cercocebus atys*, *Cercopithecus campbelli*, *C. diana* et *C. petaurista*) d'Afrique de l'ouest'.

Galat, G. and Galat-Luong, A. (1976) 'La colonisation de la mangrove par *Cercopithecus aethiops sabaeus* au Senegal', Terre et la Vie, 30, pp. 3-30.

Galligan, T. H., Amano, T., Prakash, V. M., Kulkarni, M., Shringarpure, R., Prakash, N., Ranade, S., Green, R. E. and Cuthbert, R. J. (2014) 'Have population declines in Egyptian Vulture and Red-headed Vulture in India slowed since the 2006 ban on veterinary diclofenac?', Bird Conservation International, 24(03), pp. 272-281.

Gärdenfors, U., Hilton- Taylor, C., Mace, G. M. and Rodríguez, J. P. (2001) 'The application of IUCN Red List criteria at regional levels', Conservation Biology, 15(5), pp. 1206-1212.

Gartlan, J. S. and Struhsaker, T. T. (1972) 'Polyspecific associations and niche separation of rain- forest anthropoids in Cameroon, West Africa', Journal of Zoology, 168(2), pp. 221-265.

Gaston, K. (1994) 'What is rarity?', Rarity Population and Community Biology Series: Springer Netherlands, pp. 1-21.

Gaston, K. J. (2003) The structure and dynamics of geographic ranges. Oxford University Press.

Gaston, K. J. (2010) 'Valuing common species', Science, 327(5962), pp. 154-155.

Gaston, K. J. (2011) 'Common ecology', Bioscience, 61(5), pp. 354-362.

Gaston, K. J. and Fuller, R. A. (2008) 'Commonness, population depletion and conservation biology', Trends Ecol Evol, 23(1), pp. 14-9. doi: 10.1016/j.tree.2007.11.001.

Gautier-Hion, A., Colyn, M., Gautier, J.-P., Dewynter, M. and Bouchain, C. (1999) Histoire naturelle des primates d'Afrique Centrale. Ecofac Libreville, Gabon.

Gavrilets, S., Li, H. and Vose, M. D. (2000) 'Patterns of parapatric speciation', Evolution, 54(4), pp. 1126-1134.

Geider, R. J., Delucia, E. H., Falkowski, P. G., Finzi, A. C., Grime, J. P., Grace, J., Kana, T. M., La Roche, J., Long, S. P. and Osborne, B. A. (2001) 'Primary productivity of planet earth: biological determinants and physical constraints in terrestrial and aquatic habitats', Global Change Biology, 7(8), pp. 849-882.

Ghobrial, L., Lankester, F., Kiyang, J. A., Akih, A. E., De Vries, S., Fotso, R., Gadsby, E. L., Jenkins, P. D. and Gonder, M. K. (2010) 'Tracing the origins of rescued chimpanzees reveals widespread chimpanzee hunting in Cameroon', BMC ecology, 10(1), pp. 1.

Gillingham, S. and Lee, P. C. (1999) 'The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania', Environmental Conservation, 26(03), pp. 218-228.

Gippoliti', S. and Dell'Omo, G. (2003) 'Primates of Guinea-Bissau, West Africa: distribution and conservation status', Primate Conservation, 19, pp. 73-77.

Gippoliti, S. and Dell'Omo, G. (1996) 'Primates of the Cantanhez forest and the Cacine basin, Guinea-Bissau', Oryx, 30(01), pp. 74-80.

Goldingay, R., Carthew, S. and Whelan, R. (1991) 'The importance of non-flying mammals in pollination', Oikos, pp. 79-87.

Goudsmit, J. and Brandon-Jones, D. (1999) 'Mummies of olive baboons and Barbary macaques in the Baboon Catacomb of the Sacred Animal Necropolis at North Saqqara', The Journal of Egyptian Archaeology, pp. 45-53.

Goudsmit, J. and Brandon-Jones, D. (2000) 'Evidence from the baboon catacomb in North Saqqara for a west Mediterranean monkey trade route to Ptolemaic Alexandria', The Journal of Egyptian Archaeology, pp. 111-119.

Gray, D. 2001. Indochina primates face extinction.

Griffith, J. E., Dhand, N. K., Krockenberger, M. B. and Higgins, D. P. (2013) 'A retrospective study of admission trends of koalas to a rehabilitation facility over 30 years', Journal of Wildlife Diseases, 49(1), pp. 18-28.

Grime, J. (1998) 'Benefits of plant diversity to ecosystems: immediate, filter and founder effects', Journal of Ecology, 86(6), pp. 902-910.

Grobler, P., Jacquier, M., deNys, H., Blair, M., Whitten, P. L. and Turner, T. R. (2006) 'Primate sanctuaries, taxonomy and survival: a case study from South Africa', Ecological and Environmental Anthropology, University of Georgia, pp. 2.

Groves, C. P. (2001) 'Primate taxonomy', Smithsonian.

Grubb, P., Butynski, T. M., Oates, J. F., Bearder, S. K., Disotell, T. R., Groves, C. P. and Struhsaker, T. T. (2003) 'Assessment of the diversity of African primates', International Journal of Primatology, 24(6), pp. 1301-1357.

Grubh, R., Narayan, G. and Satheesan, S. (1990) 'Conservation of vultures in (developing) India', Conservation in developing countries, Eds: Daniel, JC & JS Serrao, Bombay Natural History Society and Oxford University Press, Bombay, pp. 360-363.

Gruesen, P. (2007) A Case Study of the Rehabilitation of a Troop of Captive Yellow Baboons (*Papio cynocephalus*) after Release into a Protected Area in Zambia. ProQuest.

Guy, A. J., Stone, O. M. and Curnoe, D. (2012a) 'Assessment of the release of rehabilitated vervet monkeys into the Ntendeka Wilderness Area, KwaZulu-Natal, South Africa: a case study', Primates, 53(2), pp. 171-179.

Guy, A. J., Stone, O. M. and Curnoe, D. (2012b) 'The release of a troop of rehabilitated vervet monkeys (Chlorocebus aethiops) in KwaZulu-Natal, South Africa: outcomes and assessment', Folia Primatologica, 82(6), pp. 308-320.

Guy, A.J., Curnoe, D. and Stone, O.M. (2015) 'Assessing the release success of rehabilitated vervet monkeys in South Africa' *South African Journal of Wildlife Research*, 45(1), pp.63-75.

Hajibabaei, M., Singer, G.A. and Hickey, D.A. (2006) Benchmarking DNA barcodes: an assessment using available primate sequences', *Genome*, 49(7), pp.851-854.

Hall, C. J., Jordaan, A. and Frisk, M. G. (2011) 'The historic influence of dams on diadromous fish habitat with a focus on river herring and hydrologic longitudinal connectivity', Landscape Ecology, 26(1), pp. 95-107.

Halliday, T. (1980) 'The extinction of the passenger pigeon *Ectopistes migratorius* and its relevance to contemporary conservation', Biological Conservation, 17(2), pp. 157-162.

Halpern, B. S., Pyke, C. R., Fox, H. E., Chris Haney, J., Schlaepfer, M. A. and Zaradic, P. (2006) 'Gaps and mismatches between global conservation priorities and spending', Conservation Biology, 20(1), pp. 56-64.

Hanazaki, N., Alves, R. R. and Begossi, A. (2009) 'Hunting and use of terrestrial fauna used by Caiçaras from the Atlantic Forest coast (Brazil)', Journal of Ethnobiology and Ethnomedicine, 5(1), pp. 1.

Hanski, I. and Cambefort, Y. (2014) 'Dung beetle ecology', Princeton University Press.

Harden, J., Dickerman, R. W. and Elliston, E. P. (2006) 'Collection, value, and use of wildlife rehabilitation data', Journal of Wildlife Rehabilitation, 28(1), pp. 10-+.

Harris, G. M., Jenkins, C. N. and Pimm, S. L. (2005) 'Refining biodiversity conservation priorities', Conservation Biology, 19(6), pp. 1957-1968.

Harrison, M. J. (1985) 'Time budget of the green monkey, Cercopithecus sabaeus: some optimal strategies', International Journal of Primatology, 6(4), pp. 351-376.

Hartter, J. (2009) 'Attitudes of rural communities toward wetlands and forest fragments around Kibale National Park, Uganda', Human Dimensions of Wildlife, 14(6), pp. 433-447.

Hartter, J. and Goldman, A. C. (2009) 'Life on the edge: Balancing biodiversity, conservation, and sustaining rural livelihoods around Kibale National Park, Uganda', Focus on Geography, 52(1), pp. 11-17.

Wood, C.M., McKinney, S.T. and Loftin, C.S. (2017) 'Intraspecific functional diversity of common species enhances community stability', Ecology and evolution, 7(5), pp.1553-1560.

Haus, T., Akom, E., Agwanda, B., Hofreiter, M., Roos, C. and Zinner, D. (2013) 'Mitochondrial diversity and distribution of African green monkeys (*Chlorocebus* Gray, 1870)', American Journal of Primatology, 75(4), pp. 350-360.

Head, J., Healy, A. and Nowak, K. (In Press) 'Primates in African Mangroves', in Barnett, A.A., Matsudu, I. & Nowak, K. (Eds.) Primates in Flooded Habitats: Ecology and Conservation. UK: Cambridge University Press.

Healy, A., Iliff, J. and Nijman, V. 'Primates as Hunting Trophies'. Primate Society of Great Britain, Spring Meeting. Oxford, UK.

Healy, A. and Nijman, V. (2014) 'Pets and pests: vervet monkey intake at a specialist South African rehabilitation centre', Animal Welfare, 23(3), pp. 353-360.

Henzi, P. (1979) 'The vervet crisis', African Wildlife, 33, pp. 8-10.

Hill, C. M. (1997) 'Crop-raiding by wild vertebrates: The farmer's perspective in an agricultural community in western Uganda', International Journal of Pest Management, 43(1), pp. 77-84.

Hill, C. M. (2002) 'Primate conservation and local communities - ethical issues and debates', American Anthropologist, 104(4), pp. 1184-1194.

Hill, C. M. and Webber, A. D. (2010) 'Perceptions of nonhuman primates in human–wildlife conflict scenarios', American journal of primatology, 72(10), pp. 919-924.

Hill, W. C. O. (1953) Primates: Catarrhini, Cercopithecoidea, Cercopithecinae. 1966. At the University Press.

Hill, C. M. (2017) 'Primate crop feeding behavior, crop protection, and conservation', International Journal of Primatolgy, 38(2), pp. 385-400.

Hoekstra, J. M., Boucher, T. M., Ricketts, T. H. and Roberts, C. (2005) 'Confronting a biome crisis: global disparities of habitat loss and protection', Ecology letters, 8(1), pp. 23-29.

Hoffmann, M., Brooks, T. M., da Fonseca, G. A., Gascon, C., Hawkins, A., James, R., Langhammer, P., Mittermeier, R. A., Pilgrim, J. and Rodrigues, A. S. (2008) 'Conservation planning and the IUCN Red List', Endangered Species Research, 6(2), pp. 113-125.

Horrocks, J. and Hunte, W. (1986) 'Sentinel behaviour in vervet monkeys: who sees whom first?', Animal Behaviour, 34(5), pp. 1566-1568.

Horwich, R. H., Koontz, F., Saqui, E., Saqui, H. and Glander, K. (1993) 'A reintroduction program for the conservation of the black howler monkey in Belize', Endangered Species Update, 10(6), pp. 1-6.

Houston, D. (1985) 'Indian white-backed vulture (*G. bengalensis*)', Conservation studies on raptors. Technical publication, 5, pp. 465-466.

Huang, Y.S., Ramensky, V., Jasinska, A.J., Jung, Y., Choi, O.W., Cantor, R.M., Juretic, N., Wasserscheid, J., Kaplan, J.R., Jorgensen, M.J. and Dyer, T.D. (2015)', Sequencing strategies and characterization of 721 vervet monkey genomes for future genetic analyses of medically relevant traits. BMC Ecology, 13(1), pp. 41.

Hughes, N., Rosen, N., Gretsky, N. and Sommer, V. (2011) 'Will the Nigeria-Cameroon chimpanzee go extinct? Models derived from intake rates of ape sanctuaries', Primates of Gashaka: Springer, pp. 545-575.

Humle, T., Colin, C., Laurans, M. and Raballand, E. (2011) 'Group release of sanctuary chimpanzees (*Pan troglodytes*) in the Haut Niger National Park, Guinea, West Africa: ranging patterns and lessons so far', International Journal of Primatology, 32(2), pp. 456-473.

Hutchinson, W. F. (2008) 'The dangers of ignoring stock complexity in fishery management: the case of the North Sea cod', Biology letters, 4(6), pp. 693-695.

Isaac, N. J., Turvey, S. T., Collen, B., Waterman, C. and Baillie, J. E. (2007) 'Mammals on the EDGE: conservation priorities based on threat and phylogeny', PloS one, 2(3), pp. e296.

Isbell, L. A., Pruetz, J. D., Lewis, M. and Young, T. P. (1998) 'Locomotor activity differences between sympatric patas monkeys (*Erythrocebus patas*) and vervet monkeys (*Cercopithecus aethiops*): implications for the evolution of long hindlimb length in Homo', American Journal of Physical Anthropology, 105(2), pp. 199-207.

Jablonski, D. and Roy, K. (2003) 'Geographical range and speciation in fossil and living molluscs', Proceedings of the Royal Society of London. Series B: Biological Sciences, 270(1513), pp. 401-406.

Jaffe, K. E. and Isbell, L. A. (2010) 'Changes in ranging and agonistic behavior of vervet monkeys (*Cercopithecus aethiops*) after predator- induced group fusion', American Journal of Primatology, 72(7), pp. 634-644.

Jenkins, C. N., Van Houtan, K. S., Pimm, S. L. and Sexton, J. O. (2015) 'US protected lands mismatch biodiversity priorities', Proceedings of the National Academy of Sciences, 112(16), pp. 5081-5086.

Jetz, W. and Rahbek, C. (2002) 'Geographic range size and determinants of avian species richness', Science, 297(5586), pp. 1548-1551.

Jones, C. and Sabater Pi, J. (1968) 'Comparative ecology of *Cercocebus albigena* (Gray) and *Cercocebus torquatus* (Kerr) in Rio Muni, West Africa', Folia primatologica, 9(2), pp. 99-113.

Kakati, L., Ao, B. and Doulo, V. (2006) 'Indigenous knowledge of zootherapeutic use of vertebrate origin by the Ao tribe of Nagaland', Journal of Human Ecology, 19(3), pp. 163-167.

Kalinkat, G., Cabral, J.S., Darwall, W., Ficetola, G.F., Fisher, J.L., Giling, D.P., Gosselin, M.P., Grossart, H.P., Jähnig, S.C., Jeschke, J.M. and Knopf, K. (2017)', Flagship umbrella species needed for the conservation of overlooked aquatic biodiversity', Conservation Biology, 31(2), pp. 481-485.

Kanagavel, A., Sinclair, C., Sekar, R. and Raghavan, R. (2013) 'CEPF Western Ghats Special Series: Moolah, misfortune or spinsterhood? The plight of Slender Loris *Loris lydekkerianus* in southern India', Journal of Threatened Taxa, 5(1), pp. 3585-3588.

Kansky, R., Kidd, M. and Knight, A. T. (2014) 'Meta-analysis of attitudes toward damage-causing mammalian wildlife', Conservation Biology, 28(4), pp. 924-38.

Kavanagh, M. (1980) 'Invasion of the forest by an African savannah monkey: behavioural adaptations', Behaviour, pp. 238-260.

Kavanagh, M. (1981) 'Variable territoriality among tantalus monkeys in Cameroon', Folia Primatologica, 36(1-2), pp. 76-98.

Kavanagh, M. (1983) 'Birth seasonality in *Cercopithecus aethiops*. A social advantage from synchrony', Perspective in Primate Biology. Today and Tomorrow's Printers and Publishers, New Delhi, pp. 89-98.

Kavanagh, R. P. and Bamkin, K. L. (1995) 'Distribution of nocturnal forest birds and mammals in relation to the logging mosaic in south-eastern New South Wales, Australia', Biological Conservation, 71(1), pp. 41-53.

Kavanagh, R. P. and Webb, G. A. (1998) 'Effects of variable-intensity logging on mammals, reptiles and amphibians at Waratah Creek, southeastern New South Wales', Pacific Conservation Biology, 4(4), pp. 326.

Kelly, T. R. and Sleeman, J. M. (2003) 'Morbidity and mortality of red foxes (*Vulpes vulpes*) and gray foxes (*Urocyon cinereoargenteus*) admitted to the Wildlife Center of Virginia, 1993-2001', Journal of wildlife diseases, 39(2), pp. 467-469.

King, F. and Lee, P. (1987) 'A brief survey of human attitudes to a pest species of primate - *Cercopithecus aethiops*', Primate Conservation, 8, pp. 82-84.

King, T., Chamberlan, C. and Courage, A. (2014) 'Assessing reintroduction success in long-lived primates through population viability analysis: western lowland gorillas *Gorilla gorilla gorilla* in Central Africa', Oryx, 48(02), pp. 294-303.

Kingdon, J. and Butynski, T. M. (2008) *Chlorocebus aethiops*. The IUCN Red List of Threateed Species 2008. www.iucn.org (Accessed: 26 February 2017).

Kingdon, J., Butynski, T. M. and de Jong, Y. (2008) *Papio cynocephalus*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 12 December 2012).

Kingdon, J. and Gippoliti, S. (2008a) *Chlorocebus sabaeus*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 26 February 2017).

Kingdon, J. and Gippoliti, S. (2008b) *Chlorocebus tantalus*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 26 February 2017).

Kingdon, J., Gippoliti, S., Butynski, T. M. and de Jong, Y. (2008) *Chlorocebus pygerythrus*. The IUCN Red List of Threatened Species. www.iucnredlist.org (Accessed: 26 February 2017).

Kinnaird, M. F. (1992) 'Competition for a forest palm: use of Phoenix reclinata by human and nonhuman primates', Conservation Biology, 6(1), pp. 101-107.

Kirkpatrick, R. C. (1995) 'The natural history and conservation of the snub-nosed monkeys (genus *Rhinopithecus*)', Biological Conservation, 72(3), pp. 363-369.

Kirkwood, J. K. 'Wild animal welfare'. Report of the Whale Welfare and Ethics Workshop, 66.

Kirkwood, J. K. and Sainsbury, A. W. (1996) 'Ethics of interventions for the welfare of free-living wild animals', *Animal Welfare Potters Bar*, 5, pp. 235-244.

Knight, J. (2017). Human Dimensions of Primate Manageent. *The International Encyclopedia of Primatology*.

Koh, L. P., Dunn, R. R., Sodhi, N. S., Colwell, R. K., Proctor, H. C. and Smith, V. S. (2004) 'Species coextinctions and the biodiversity crisis', Science, 305(5690), pp. 1632-1634.

Krebs, J. R., Wilson, J. D., Bradbury, R. B. and Siriwardena, G. M. (1999) 'The second silent spring?', Nature, 400(6745), pp. 611-612.

Kumara, H. and Singh, M. (2004) 'Distribution and abundance of primates in rain forests of the Western Ghats, Karnataka, India and the conservation of *Macaca silenus*', International Journal of Primatology, 25(5), pp. 1001-1018.

Kumara, H. N., Kumar, S. and Singh, M. (2010) 'Of how much concern are the 'least concern'species? Distribution and conservation status of bonnet macaques, rhesus macaques and Hanuman langurs in Karnataka, India', Primates, 51(1), pp. 37-42.

Leader-Williams, N. and Hutton, J. M. (2005) 'Does extractive use provide opportunities to offset conflicts between people and wildlife?', Conservation Biology Series, Cambridge, 9, pp. 140.

Lee, P. C. (1984) 'Early infant development and maternal care in free-ranging vervet monkeys', Primates, 25(1), pp. 36-47.

Lee, P. C. and Priston, N. E. (2005) 'Human attitudes to primates: perceptions of pests, conflict and consequences for primate conservation', Commensalism and conflict: The human-primate interface, 4.

Leffler, E.M. (2017) ‘Evolutionary insights from wild vervet genomes’, Nature Genetics, 49(12), pp. 1671-1672.

Lennon, J. J., Koleff, P., Greenwood, J. J. and Gaston, K. J. (2004) 'Contribution of rarity and commonness to patterns of species richness', Ecology Letters, 7(2), pp. 81-87.

Lernould, J. (1988) 'Classification and geographical distribution of guenons: a review', A primate radiation: Evolutionary biology of the African guenons, pp. 54-78.

Levin, P. S., Holmes, E. E., Piner, K. R. and Harvey, C. J. (2006) 'Shifts in a Pacific Ocean fish assemblage: the potential influence of exploitation', Conservation Biology, 20(4), pp. 1181-1190.

Lindenmayer, D. (2002) Gliders of Australia: a natural history. UNSW Press.

Lindenmayer, D., Wood, J., McBurney, L., MacGregor, C., Youngentob, K. and Banks, S. (2011) 'How to make a common species rare: a case against conservation complacency', Biological Conservation, 144(5), pp. 1663-1672.

Lindsey, P., Roulet, P. and Romanach, S. (2007) 'Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa', Biological Conservation, 134(4), pp. 455-469.

Lindsey, P. A., Alexander, R., Frank, L., Mathieson, A. and Romanach, S. (2006) 'Potential of trophy hunting to create incentives for wildlife conservation in Africa where alternative wildlife- based land uses may not be viable', Animal Conservation, 9(3), pp. 283-291.

Lippold, L. K. and Thanh, V. N. (2008) 'The time is now: survival of the douc langurs of Son Tra, Vietnam', Primate Conservation, 23(1), pp. 75-79.

Litsinger, J., Canapi, B. and Alviola, A. (1982) 'Farmer perception and control of rice pests in Solana, Cagayan Valley, a pre-green revolution area of the Philippines', Philippine Entomologist (Philippines).

Liu, S., Yin, Y., Cheng, F., Hou, X., Dong, S. and Wu, X. (2017) ‘Spatio-temporal variations of conservation hotspots based on ecosystem services in Xishuangbanna, Southwest China’, PLoS One, 12(12), p.e0189368.

Loudon, J.E., Grobler, J.P., Sponheimer, M., Moyer, K., Lorenz, J.G. and Turner, T.R. (2014) ‘Using the stable carbon and nitrogen isotope compositions of vervet monkeys (*Chlorocebus pygerythrus*) to examine questions in ethnoprimatology’, PLoS One, 9(7), p.e100758.

Lorenz, J.G., Jackson, W.E., Beck, J.C. and Hanner, R. (2005) ‘The problems and promise of DNA barcodes for species diagnosis of primate biomaterials’, Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 360(1462), pp.1869-1877.

Luiselli, L. and Akani, G. C. (2002) 'An investigation into the composition, complexity and functioning of snake communities in the mangroves of south- eastern Nigeria', African Journal of Ecology, 40(3), pp. 220-227.

Luiselli, L., Bonnet, X., Rocco, M. and Amori, G. (2012) 'Conservation implications of rapid shifts in the trade of wild African and Asian pythons', Biotropica, 44(4), pp. 569-573.

Mace, G. M. (2004) 'The role of taxonomy in species conservation', Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 359(1444), pp. 711-719.

Mace, G. M. and Lande, R. (1991) 'Assessing extinction threats: toward a reevaluation of IUCN threatened species categories', Conservation Biology, 5(2), pp. 148-157.

Mack, D. and Mittermeier, R. A. (1984) 'The International Primate Trade: Legislation, Trade and Captive Breeding', Traffic (USA).

Mackie, A. S., Oliver, P. G., Rees, E. I. S., Bamber, R. N. and Meechan, C. J. (1995) 'Benthic biodiversity in the southern Irish Sea. National Museums and Galleries of Wales'.

Mahawar, M. M. and Jaroli, D. (2006) 'Animals and their products utilized as medicines by the inhabitants surrounding the Ranthambhore National Park, India', Journal of Ethnobiology and Ethnomedicine, 2(1), pp. 1.

Maisels, F., Pambou Makaya, Q. and Onononga, J.-R. (2007) 'Confirmation of the Presence of the Red-capped Mangabey (*Cercocebus torquatus*) in Mayumba National Park, Southern Gabon, and Conkouati-Douli National Park, Southern Republic of Congo', Primate conservation, 22(1), pp. 111-115.

Makarieva, A. and Gorshkov, V. (2007) 'Biotic pump of atmospheric moisture as driver of the hydrological cycle on land', Hydrology and Earth System Sciences Discussions, 11(2), pp. 1013-1033.

Maldonado, A. M. and Peck, M. R. (2014) 'Research and in situ conservation of owl monkeys enhances environmental law enforcement at the Colombian-Peruvian border', American Journal of Primatology, 76(7), pp. 658-669.

Malik, I. and Southwick, C. (1988) 'Feeding behavior and activity patterns of rhesus monkeys (*Macaca mulatta*) at Tughlaqabad, India', Ecology and Behavior of Food-Enhanced Primate Groups. New York: Alan R Liss, Inc, pp. 95-111.

Maples, W. R., Maples, M. K., Greenhood, W. and Walek, M. L. (1976) 'Adaptations of crop- raiding baboons in Kenya', American Journal of Physical Anthropology, 45(2), pp. 309-315.

Markandya, A., Taylor, T., Longo, A., Murty, M., Murty, S. and Dhavala, K. (2008) 'Counting the cost of vulture decline—An appraisal of the human health and other benefits of vultures in India', Ecological Economics, 67(2), pp. 194-204.

Martin, R. and MacLarnon, A. (1988) 'Quantitative comparisons of the skull and teeth in guenons', A primate radiation: evolutionary biology of the African guenons, pp. 160-183.

Masseti, M. and Bruner, E. (2009) 'The primates of the western Palaearctic: a biogeographical, historical, and archaeozoological review', Journal of Anthropological Science, 87(3), e91..

Matthews, A. and Matthews, A. (2002) 'Distribution, population density, and status of sympatric cercopithecids in the Campo-Ma'an area, Southwestern Cameroon', Primates, 43(3), pp. 155-168.

Mayaka, T. B., Hendricks, T., Wesseler, J. and Prins, H. H. (2005) 'Improving the benefits of wildlife harvesting in northern Cameroon: a co-management perspective', Ecological Economics, 54(1), pp. 67-80.

Mayr, E. (1963)'Animal species and evolution', Cambridge MA: The Belknap Press of Harvard University Press.

Mazaris, A. D., Mamakis, Y., Kalpakis, S., Poulopoulos, Y. and Matsinos, Y. G. (2008) 'Evaluating potential threats to birds in Greece: an analysis of a 10-year data set from a rehabilitation centre', Oryx, 42(03), pp. 408-414.

McDougall, P., Forshaw, N., Barrett, L. and Henzi, S. (2010) 'Leaving home: responses to water depletion by vervet monkeys', Journal of Arid Environments, 74(8), pp. 924-927.

McFarland, R., Barrett, L., Boner, R., Freeman, N.J. and Henzi, S.P. (2014) 'Behavioral flexibility of vervet monkeys in response to climatic and social variability', American Journal of Physical Anthropology, 154(3), pp.357-364.

McGeoch, M. A., Latombe, G., & Hui, C. (2017). 'Considering common species in measuring and monitoring biodiversity and turnover', Biomath Communications Supplement, 4(1).

McKinney, T., Westin, J. L., & Serio-Silva, J. C. (2015) 'Anthropogenic habitat modification, tourist interactions and crop-raiding in howler monkeys', In: Howler Monkeys, Springer, New York, NY, pp. 281-311.

McLennan, M. R. and Hill, C. M. (2012) 'Troublesome neighbours: changing attitudes towards chimpanzees (*Pan troglodytes*) in a human-dominated landscape in Uganda', Journal for Nature Conservation, 20(4), pp. 219-227.

Medley, K. E., Okey, B. W., Barrett, G. W., Lucas, M. F. and Renwick, W. H. (1995) 'Landscape change with agricultural intensification in a rural watershed, southwestern Ohio, USA', Landscape ecology, 10(3), pp. 161-176.

Meester, J. and Setzer, H. W. (1971) The mammals of Africa. An identification manual. Smithsonian Institution Press, Washington DC, USA.

Mekonnen, A., Bekele, A., Fashing, P. J., Hemson, G. and Atickem, A. (2010a) 'Diet, activity patterns, and ranging ecology of the Bale monkey (Chlorocebus djamdjamensis) in Odobullu Forest, Ethiopia', International Journal of Primatology, 31(3), pp. 339-362.

Mekonnen, A., Bekele, A., Hemson, G., Teshome, E. and Atickem, A. (2010b) 'Population size and habitat preference of the Vulnerable Bale monkey Chlorocebus djamdjamensis in Odobullu Forest and its distribution across the Bale Mountains, Ethiopia', Oryx, 44(04), pp. 558-563.

Mekonnen, A., Bekele, A., Fashing, P. J., LERNOULD, J., Atickem, A. and Stenseth, N. C. (2012) 'Newly discovered Bale monkey populations in forest fragments in southern Ethiopia: Evidence of crop raiding, hybridization with grivets, and other conservation threats', American journal of primatology, 74(5), pp. 423-432.

Mikula, P., Šaffa, G., Nelson, E. and Tryjanowski, P. (2018) 'Risk perception of vervet monkeys Chlorocebus pygerythrus to humans in urban and rural environments', Behavioural Processes, 147, pp. 21-27.

Miller, R. M., Rodríguez, J. P., Aniskowicz-Fowler, T., Bambaradeniya, C., Boles, R., Eaton, M. A., Gärdenfors, U., Keller, V., Molur, S. and Walker, S. (2006) 'Extinction risk and conservation priorities', Science, 313(5786), pp. 441-441.

Mittermeier, R., Rylands, A. and Wilson, D. E. (2013) 3: Primates. Barcelona: Lynx Edicions. Handbook of the Mammals of the World.

Mittermeier, R. A. (1973) 'Colobus monkeys and the tourist trade', Oryx, 12(01), pp. 113-117.

Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M. and Gascon, C. (2011) 'Global biodiversity conservation: the critical role of hotspots', Biodiversity hotspots: Springer, pp. 3-22.

Modolo, L., Martin, R. D., van Schaik, C. P., van Noordwijk, M. A. and Kruetzen, M. (2008) 'When dispersal fails: unexpected genetic separation in Gibraltar macaques (*Macaca sylvanus*)', Molecular ecology, 17(18), pp. 4027-4038.

Modolo, L., Salzburger, W. and Martin, R. D. (2005) 'Phylogeography of Barbary macaques (*Macaca sylvanus*) and the origin of the Gibraltar colony', Proceedings of the National Academy of Sciences of the United States of America, 102(20), pp. 7392-7397.

Molina-López, R. A., Casal, J. and Darwich, L. (2011) 'Causes of morbidity in wild raptor populations admitted at a wildlife rehabilitation centre in Spain from 1995-2007: a long-term retrospective study', PLoS One, 6(9), pp. e24603.

Moritz, C. (1994) 'Defining 'evolutionarily significant units' for conservation', Trends in ecology & evolution, 9(10), pp. 373-375.

Morris, R. and Morris, D. (1966) 'Men and apes', Hutchinson London.

Mulu, K. S. 2010. Are the endemic and endangered Tana River primates' culprits of crop raiding? Evaluating Human–Nonhuman primate conflict status around Tana River Primate Reserve. Kenya.

Mwakatobe, A., Nyahongo, J., Ntalwila, J., & Roskaft, E. (2014) 'The impact of crop raiding by wild animals in communities surrounding the Serengeti National Park, Tanzania', International Journal of Biodiversity and Conservation, 6(9), 637-646.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. and Kent, J. (2000) 'Biodiversity hotspots for conservation priorities', Nature, 403(6772), pp. 853-858.

Naidoo, R., Balmford, A., Costanza, R., Fisher, B., Green, R. E., Lehner, B., Malcolm, T. and Ricketts, T. H. (2008) 'Global mapping of ecosystem services and conservation priorities', Proceedings of the National Academy of Sciences, 105(28), pp. 9495-9500.

Nakagawa, N. (2000) 'Seasonal, sex, and interspecific differences in activity time budgets and diets of patas monkeys (*Erythrocebus patas*) and tantalus monkeys (*Cercopithecus aethiops tantalus*), living sympatrically in northern Cameroon', Primates, 41(2), pp. 161.

Nakagawa, N. (2003) 'Difference in food selection between patas monkeys (*Erythrocebus patas*) and tantalus monkeys (*Cercopithecus aethiops tantalus*) in Kala Maloue National Park, Cameroon, in relation to nutrient content', Primates, 44(1), pp. 3-11.

Nampindo, S. and Plumptre, A. (2005) 'A Socio-Economic Assessment of Community Livelihoods in Areas Adjacent to Corridors Linking Queen Elizabeth National Park to Other Protected Areas in Western Uganda', Wildlife Conservation Society, pp. 68.

Naughton-Treves, L. and Treves, A. (2005) 'Socio-ecological factors shaping local support for wildlife: crop-raiding by elephants and other wildlife in Africa', Conservation Biology Series, Cambridge, 9, pp. 252.

Naughton- Treves, L. (1998) 'Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda', Conservation biology, 12(1), pp. 156-168.

Nekaris, K. and Jaffe, S. (2007) 'Unexpected diversity of slow lorises (*Nycticebus spp.*) within the Javan pet trade: implications for slow loris taxonomy', Contributions to Zoology, 76(3), pp. 187-196.

Nekaris, K. A.-I., Campbell, N., Coggins, T. G., Rode, E. J. and Nijman, V. (2013) 'Tickled to death: analysing public perceptions of 'cute'videos of threatened species (slow lorises *Nycticebus spp.*) on web 2.0 Sites', PloS one, 8(7), pp. e69215.

Nekaris, K. A. I., Shepherd, C. R., Starr, C. R. and Nijman, V. (2010) 'Exploring cultural drivers for wildlife trade via an ethnoprimatological approach: a case study of slender and slow lorises (*Loris* and *Nycticebus*) in South and Southeast Asia', American Journal of Primatology, 72(10), pp. 877-886.

Nerlich, A. G., Parsche, F., Von Den Driesch, A. and Löhrs, U. (1993) 'Osteopathological findings in mummified baboons from ancient Egypt', International Journal of Osteoarchaeology, 3(3), pp. 189-198.

Nijman, V. (2005) 'Decline of the endemic Hose's langur *Presbytis hosei* in Kayan Mentarang National Park, east Borneo', Oryx, 39(02), pp. 223-226.

Nijman, V. and Aliabadian, M. (2010) 'Performance of distance-based DNA barcoding in the molecular identification of Primates', Comptes Rendus Biologies, 333(1), pp.11-16.

Nijman, V. and Shepherd, C. (2009) 'Wildlife trade from ASEAN to the EU: Issues with the trade in captive-bred reptiles from Indonesia', TRAFFIC Europe Report for the European Commission, Brussels, Belgium.

Nijman, V. and Shepherd, C. R. (2011) 'The role of Thailand in the international trade in CITES-listed live reptiles and amphibians', PloS One, 6(3), pp. e17825.

Nowak, K. (2008) 'Frequent water drinking by Zanzibar red colobus (Procolobus kirkii) in a mangrove forest refuge', American Journal of Primatology, 70(11), pp. 1081-1092.

Nowak, K. (2013) 'Mangrove and peat swamp forests: refuge habitats for primates and felids', Folia Primatologica, 83(3-6), pp. 361-376.

Nowak, K. and Lee, P. C. (2011) 'Demographic structure of Zanzibar red colobus populations in unprotected coral rag and mangrove forests', International Journal of Primatology, 32(1), pp. 24-45.

O'Brien, S., Emahalala, E. R., Beard, V., Rakotondrainy, R. M., Reid, A., Raharisoa, V. and Coulson, T. (2003) 'Decline of the Madagascar radiated tortoise Geochelone radiata due to overexploitation', Oryx, 37(03), pp. 338-343.

Oates, J. (1988) 'The distribution of Cercopithecus monkeys in West African forests', A primate radiation: Evolutionary biology of the African guenons, pp. 79-103.

Oates, J. F. (1977) 'The guereza and man', Primate conservation, pp. 419-67.

Oates, J. F., Gippoliti, S. and Groves, C. P. (2008a) *Cercocebus torquatus*. The IUCN Red List of Threatened Species 2008. www.iucnredlist.org: IUCN 2012 (Accessed: 20 November 2012).

Oates, J. F., Gippoliti, S. and Groves, C. P. (2008b) *Papio papio*. IUCN Red List of Threatened Species. www.iucnredlist.org: IUCN 2012 (Accessed: 12/12/2012).

Oates, J. F. and Nash, S. D. (2011) Primates of West Africa: a field guide and natural history. Conservation International.

Ongman, L., Colin, C., Raballand, E. and Humle, T. (2013) 'The "Super Chimpanzee": The ecological dimensions of rehabilitation of orphan chimpanzees in Guinea, West Africa', Animals, 3(1), pp. 109-126.

Pain, D. J., Bowden, C. G., Cunningham, A. A., Cuthbert, R., Das, D., Gilbert, M., Jakati, R. D., Jhala, Y., Khan, A. A. and Naidoo, V. (2008) 'The race to prevent the extinction of South Asian vultures', Bird Conservation International, 18(S1), pp. S30-S48.

Pardo, I., Roquet, C., Lavergne, S., Olesen, J.M., Gómez, D. and García, M.B. (2017) Spatial congruence between taxonomic, phylogenetic and functional hotspots: true pattern or methodological artefact? Diversity and Distributions, 23(2), pp. 209-220.

Parry, D. and Campbell, B. (1992) 'Attitudes of rural communities to animal wildlife and its utilization in Chobe Enclave and Mababe Depression, Botswana', Environmental Conservation, 19(03), pp. 245-252.

Patterson, L., Kalle, R. and Downs, C. (2017) ‘A citizen science survey: perceptions and attitudes of urban residents towards vervet monkeys’, Urban Ecosystems, 20(3), pp. 617-628.

Patterson, L., Kalle, R. and Downs, C. (2018) ‘Factors affecting presence of vervet monkey troops in a suburban matrix in KwaZulu-Natal, South Africa’, Landscapes and Urban Planning, 169, pp. 220-228.

Paudel, K., Amano, T., Acharya, R., Chaudhary, A., Baral, H. S., Bhusal, K. P., Chaudhary, I. P., Green, R. E., Cuthbert, R. J. and Galligan, T. H. (2016) 'Population trends in Himalayan Griffon in Upper Mustang, Nepal, before and after the ban on diclofenac', Bird Conservation International, 26(03), pp. 286-292.

Perez, V. R., Godfrey, L. R., Nowak-Kemp, M., Burney, D. A., Ratsimbazafy, J. and Vasey, N. (2005) 'Evidence of early butchery of giant lemurs in Madagascar', Journal of Human Evolution, 49(6), pp. 722-742.

Pfeifer, S.P. (2017) ‘The demographic and adaptive history of the African green monkey’, Molecular Biology and Evolution, 34(5), pp. 1055-1065.

Phelps, J., Webb, E. L., Bickford, D., Nijman, V. and Sodhi, N. S. (2010) 'Boosting CITES', Science, 330(6012), pp. 1752-1753.

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., Raven, P. H., Roberts, C. M. and Sexton, J. O. (2014) 'The biodiversity of species and their rates of extinction, distribution, and protection', Science, 344(6187), pp. 1246752.

Pirta, R. S., Gadgil, M. and Kharshikar, A. (1997) 'Management of the rhesus monkey *Macaca mulatta* and Hanuman langur *Presbytis entellus* in Himachal Pradesh, India', Biological Conservation, 79(1), pp. 97-106.

Poirier, F. (1972) 'The St. Kitts green monkey (*Cercopithecus aethiops sabaeus*): ecology, population dynamics, and selected behavioral traits', Folia Primatologica, 17(1-2), pp. 20-55.

Porter, P. (1976) 'Agricultural development and agricultural vermin in Tanzania'. Annual meeting of the American Association for the Advancement of Science, Boston, February.

Pourrut, X., Galat-Luong, A. and Galat, G. (1996) 'Associations du Singe vert avec d’autres especes de Primates au Sénégal: la transmission interspécifique du SIVagm doit être fréquente dans la nature', Revue de Médecine Vétérinaire, 147, pp. 47-58.

Prakash, V. (1999) 'Status of vultures in Keoladeo National Park, Bharatpur, Rajasthan, with special reference to population crash in Gyps species', Journal Bombay Natural History Society, 96(3), pp. 365-378.

Prakash, V., Green, R., Pain, D., Ranade, S., Saravanan, S., Prakash, N., Venkitachalam, R., Cuthbert, R., Rahmani, A. and Cunningham, A. (2007) 'Recent changes in populations of resident Gyps vultures in India', Journal of the Bombay Natural History Society, 104(2), pp. 129-135.

Prakash, V., Pain, D., Cunningham, A., Donald, P., Prakash, N., Verma, A., Gargi, R., Sivakumar, S. and Rahmani, A. (2003) 'Catastrophic collapse of Indian white-backed *Gyps bengalensis* and long-billed *Gyps indicus* vulture populations', Biological Conservation, 109(3), pp. 381-390.

Price, A. R. (2002) 'Simultaneous' hotspots' and'coldspots' of marine biodiversity and implications for global conservation', Marine Ecology Progress Series, 241, pp. 23-27.

Quick, D. (1986) 'Activity budgets and the consumption of human food in two troops of baboons, *Papio anubis* at Gilgil, Kenya', Primate Ecology and Conservation. Cambridge University Press, Cambridge, pp. 221-228.

Quirin, C. (2005) 'Crop Raiding by Wild Vertebrates in the Illubabor Zone, Ethiopia', Report Submitted in Partial Fulfillment of The Post-Graduate Diploma in Wildlife Management, pp. 1-52.

Randall, N. J., Blitvich, B. J. and Blanchong, J. A. (2012) 'Efficacy of wildlife rehabilitation centers in surveillance and monitoring of pathogen activity: a case study with West Nile virus', Journal of wildlife diseases, 48(3), pp. 646-653.

Redford, K. H., Berger, J. and Zack, S. (2013) 'Abundance as a conservation value', Oryx, 47(02), pp. 157-158.

Redford, K. H. and Feinsinger, P. (2001) 'The half-empty forest: sustainable use and the ecology of interactions', Conservation Biology Series, Cambridge, pp. 370-400.

Reeve, N. (1998) 'The survival and welfare of hedgehogs (Erinaceus europaeus) after release back into the wild', Anima l Welfare Potters Bar, 7, pp. 189-202.

Rhind, S. G. and Lawes, M. J. (1998) 'A descriptive assessment of the rehabilitation and reintroduction to the wild of captive vervet monkeys (*Chlorocebus aethiops*)': Department of Botany and Zoology, University of Natal.

Rijksen, H. D. (1978) 'A field study on Sumatran orang utans (*Pongo pygmaeus abelii* Lesson 1827). Ecology, behaviour and conservation', Mededelingen Landbouwhogeschool Wageningen Netherlands, (78-2).

Roberge, J.-M. (2014) 'Using data from online social networks in conservation science: which species engage people the most on Twitter?', Biodiversity and Conservation, 23(3), pp. 715-726.

Robinson, W. D., Brawn, J. D. and Robinson, S. K. (2000) 'Forest bird community structure in central Panama: influence of spatial scale and biogeography', Ecological Monographs, 70(2), pp. 209-235.

Rodrigues, A. S., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M. and Brooks, T. M. (2006) 'The value of the IUCN Red List for conservation', Trends in Ecology and Evolution, 21(2), pp. 71-76.

Rodríguez, J. P., Keith, D. A., Rodríguez-Clark, K. M., Murray, N. J., Nicholson, E., Regan, T. J., Miller, R. M., Barrow, E. G., Bland, L. M. and Boe, K. (2015) 'A practical guide to the application of the IUCN Red List of Ecosystems criteria', Philisophical Transactions of the Royal Society, Biology, 370(1662), pp. 20140003.

Root-Bernstein, M., Douglas, L., Smith, A. and Verissimo, D. (2013) 'Anthropomorphized species as tools for conservation: utility beyond prosocial, intelligent and suffering species', Biodiversity and Conservation, 22(8), pp. 1577-1589.

Rosenzweig, M. L. (1995) ‘Species diversity in space and time’, Cambridge University Press.

Ross, C., Srivastava, A. and Pirta, R. (1993) 'Human influences on the population density of hanuman langurs *Presbytis entellus* and rhesus macaques *Macaca mulatta* in Shimla, India', Biological Conservation, 65(2), pp. 159-163.

Saj, T. L., Sicotte, P. and Paterson, J. D. (2001) 'The conflict between vervet monkeys and farmers at the forest edge in Entebbe, Uganda', African Journal of Ecology, 39(2), pp. 195-199.

Schoene, C. and Brend, S. (2002) 'Primate sanctuaries-a delicate conservation approach', South African Journal of Wildlife Research, 32(2), pp. 109-113.

Sekercioglu, C. H. (2006) 'Increasing awareness of avian ecological function', Trends in Ecology and Evolution, 21(8), pp. 464-471.

Senzaki, M., Yamaura, Y., Shoji, Y., Kubo, T. and Nakamura, F. (2017) 'Citizens promote the conservation of flagship species more than ecosystem services in wetland restoration', Biological Conservation, 214, pp. 1-5.

Serangeli, M., Cistrone, L., Ancillotto, L., Tomassini, A. and Russo, D. (2012) 'The post-release fate of hand-reared orphaned bats: survival and habitat selection', Animal Welfare, The UFAW Journal, 21(1), pp. 9.

Seyfarth, R. M., Cheney, D. L. and Marler, P. (1980) 'Vervet monkey alarm calls: semantic communication in a free-ranging primate', Animal Behaviour, 28(4), pp. 1070-1094.

Shipman, P., Bosler, W., Davis, K. L., Behrensmeyer, A. K., Dunbar, R., Groves, C. P., Thackeray, F., Van Couvering, J. A. H. and Stucky, R. K. (1981) 'Butchering of Giant Geladas at an Acheulian Site [and Comments and Reply]', Current Anthropology, pp. 257-268.

Siege, L. and Baldus, R. D. (1998) 'Assessment of Crop Damage and Application of Non-Lethal Deterrents for Crop Protection East of Selous Game Reserve': Tanzania Wildlife Discussion Paper.

Simberloff, D. (1998) 'Flagships, umbrellas, and keystones: is single-species management passé in the landscape era?', Biological Conservation, 83(3), pp. 247-257.

Singh, M. and Rao, N. R. (2004) 'Population dynamics and conservation of commensal bonnet macaques', International Journal of Primatology, 25(4), pp. 847-859.

Sitas, N., Baillie, J. and Isaac, N. (2009) 'What are we saving? Developing a standardized approach for conservation action', Animal Conservation, 12(3), pp. 231-237.

Skinner, J. D. and Chimimba, C. T. (2005) The mammals of the southern African sub-region. Cambridge University Press.

Smith, A. (1993) 'On the ambiguity of the three wise monkeys', Folklore, 104(1-2), pp. 144-150.

Smith, A. S. (2006) 'Optimalising the role of animal rescue centres by researching the source of the problem', Animals, zoos and conservation. Zoological Garden in Poznan, Poznań, pp. 111-117.

Smith, M. D. and Knapp, A. K. (2003) 'Dominant species maintain ecosystem function with non- random species loss', Ecology Letters, 6(6), pp. 509-517.

Smith, J., and Nijman, V. (2017). Buffer Cropping. *The International Encyclopedia of Primatology*.

Smith, M. J., Williams, R. J. and Purves, D. W. (2011) 'Boosting CITES Through Research', Science, 331(6019), pp. 857-857.

Smith, M. S. and Werner, P. A. (2009) 'Australia's biodiversity and climate change', CSIRO Publishing.

Smith, R. J., Veríssimo, D., Isaac, N. J. and Jones, K. E. (2012) 'Identifying Cinderella species: uncovering mammals with conservation flagship appeal', Conservation Letters, 5(3), pp. 205-212.

Sodeinde, O. and Soewu, D. (1999) 'Pilot study of the traditional medicine trade in Nigeria', TRAFFIC Bulletin, Cambridge TRAFFIC International, 18, pp. 35-40.

Sodhi, N. S. and Ehrlich, P. R. (2010) 'Conservation biology for all', Oxford University Press Oxford, United Kingdom.

Soulé, M. E. (1985) 'What is conservation biology?', BioScience, pp. 727-734.

Southwick, C., Malik, I. and Siddiqi, M. (1998) 'Translocations of rhesus monkeys in India: Prospects and outcomes', American Joural of Primatology, 45(2), pp. 209-210.

Southwick, C. H. and Siddiqi, M. F. (1977) 'Population dynamics of rhesus monkeys in northern India', Academic Press, New York.

Southwick, C. H. and Siddiqi, M. F. (1994) 'Population status of nonhuman primates in Asia, with emphasis on rhesus macaques in India', American Journal of Primatology, 34(1), pp. 51-59.

Souza, C., Teixeira, C. and Young, R. (2012) 'The welfare of an unwanted guest in an urban environment: the case of the white-eared opossum (*Didelphis albiventris*)', Animal Welfare,-The UFAW Journal, 21(2), pp. 177.

Spagnoletti, N., Cardoso, T. C. M., Fragaszy, D., and Izar, P. (2017) 'Coexistence between humans and capuchins (*Sapajus libidinosus*): Comparing observational data with farmers' perceptions of crop losses', International Journal of Primatology, 38(2), pp. 243-262.

Spalding, M. (2010) World atlas of mangroves. Routledge.

Starr, C., Nekaris, K., Streicher, U. and Leung, L. (2010) 'Traditional use of slow lorises Nycticebus bengalensis and N. pygmaeus in Cambodia: an impediment to their conservation', Endangered Species Research, 12(1), pp. 17-23.

Stockey, G. and Grocott, C. (2012) 'Gibraltar: a modern history', University of Wales Press.

Stone, O.M. and Guy, A.J. (2017) 'Predicting Optimal Release Sites for Rehabilitated Monkeys: a Vervet Monkey (*Chlorocebus aethiops*) Case Study', International Journal of Primatoogy, 38(3), pp. 485-499.

Streicher, U. (2004) 'Aspects of ecology and conservation of the pygmy loris Nycticebus pygmaeus in Vietnam', Unpublished PhD thesis. Ludwig-Maximilians Universität, Germany.

Struhsaker, T. T. (1967a) 'Ecology of Vervet Monkeys (*Cercopithecus aethiops*) in the Masai- Amboseli Game Reserve, Kenya', Ecology, 48(6), pp. 891-904.

Struhsaker, T. T. (1967b) 'Social structure among vervet monkeys (*Cercopithecus aethiops*)', Behaviour, 29(2), pp. 83-121.

Struhsaker, T. T. (1970) 'Phylogenetic implications of some vocalizations of Cercopithecus monkeys', Old World Monkeys, pp. 365-444.

Strum, S. C. (2001) 'Prospects for management of primate pests'. Symposium" Les primates commensaux", tenu à Strasbourg, France, le 19 août 1994, à l'occasion du XIVe congrès de la Société internationale de Primatologie: Société nationale de protection de la nature et d'acclimatation de France, Paris.

Suarez, C., Gamboa, E., Claver, P. and Nassar-Montoya, F. (2001) 'Survival and adaptation of a released group of confiscated capuchin monkeys', Animal Welfare, 10(2), pp. 191-203.

Sugiyama, Y. and Parthasarathy, M. (1978) 'Population change of the Hanuman langur (*Presbytis entellus*), 1961–1976', Dharwar area, India', Journal of the Bombay Natural Histiry Society, 75, pp. 860-867.

Svardal, H., Jasinska, A.J., Apetrei, C., Coppola, G., Huang, Y., Schmitt, C.A., Jacquelin, B., Ramensky, V., Müller-Trutwin, M., Antonio, M. and Weinstock, G. (2017) Ancient hybridization and strong adaptation to viruses across African vervet monkey populations. Nature Genetics, 49(12), pp. 1705-1713.

Svensson, M. S., Ingram, D. J., Nekaris, K. A. I. and Nijman, V. (2015) 'Trade and ethnozoological use of African lorisiforms in the last 20 years', Hystrix, the Italian Journal of Mammalogy, 26(2), pp. 153-161.

Thompson, K. and Johnson, J. (2010) ‘Do We Need Pandas?: The Uncomfortable Truth about Biodiversity’, Green Books Foxhole, Totnes.

Tosi, A. J., Buzzard, P. J., Morales, J. C. and Melnick, D. J. (2002) 'Y-chromosomal window onto the history of terrestrial adaptation in the Cercopithecini', The Guenons: Diversity and Adaptation in African Monkeys: Springer, pp. 15-26.

Tosi, A. J., Melnick, D. J. and Disotell, T. R. (2004) 'Sex chromosome phylogenetics indicate a single transition to terrestriality in the guenons (tribe Cercopithecini)', Journal of Human Evolution, 46(2), pp. 223-37.

Turner, T., Anapol, F. and Jolly, C. (1994) 'Body weights of adult vervet monkeys (Cercopithecus aethiops) at four sites in Kenya', Folia Primatologica, 63(3), pp. 177-179.

Turner, T. R., Anapol, F. and Jolly, C. J. (1997) 'Growth, development, and sexual dimorphism in vervet monkeys (*Cercopithecus aethiops*) at four sites in Kenya', American Journal of Physical Anthropology, 103(1), pp. 19-35.

Turner, T.R., Coetzer, W.G., Schmitt, C.A., Lorenz, J.G., Freimer, N.B. and Grobler, J.P. (2016) Localized population divergence of vervet monkeys (*Chlorocebus spp.*) in South Africa: Evidence from mtDNA, American Journal fo Physical Anthropology, 159(1), pp. 17-30.

Twigg, I. (2008) ‘A warning of the possible decline in long-tailed macaques (*Macaca fascicularis*) in Penninsular Malaysia due to a programme of indescriminate culling’, Primate Conservation. UK: Oxford Brookes University.

Van Dyck, H., Van Strien, A. J., Maes, D. and Van Swaay, C. A. (2009) 'Declines in common, widespread butterflies in a landscape under intense human use', Conservation Biology, 23(4), pp. 957-965.

Van Fleet, W. (1914) 'Chestnut Breeding Experience How the American Chestnut, Threatened by Extinction, May be Saved to Horticulture, even if not to Forestry - Promising Crosses Between Chinquapin and Asiatic Species - Trees Bear Early, Produce Good Nuts and Show Resistance to Blight', Journal of Heredity, 5(1), pp. 19-25.

Veríssimo, D., Pongiluppi, T., Santos, M. C. M., Develey, P. F., Fraser, I., Smith, R. J. and Macmilan, D. C. (2014) 'Using a systematic approach to select flagship species for bird conservation', Conservation Biology, 28(1), pp. 269-277.

Vié, J.-C., Hilton-Taylor, C., Pollock, C., Ragle, J., Smart, J., Stuart, S. N. and Tong, R. (2009) 'The IUCN Red List: a key conservation tool', Wildlife in a changing world - An analysis of the 2008 IUCN Red List of Threatened Species, pp. 1.

Vincent, K. E. (2005) Investigating the causes of the decline of the urban House Sparrow *Passer domesticus* population in Britain. De Montfort University.

Von den Driesch, A. (1993) 'The raising and worship of monkeys in the late period of ancient Egypt', Tierarztliche Praxis, 21(2), pp. 95-101.

Wallace, G. E. (2010) Monkeys in maize: primate crop-raiding behaviour and developing on-farm techniques to mitigate human-wildlife conflict. Oxford Brookes University.

Walpole, M. J. and Leader-Williams, N. (2002) 'Tourism and flagship species in conservation', Biodiversity & Conservation, 11(3), pp. 543-547.

Wang, S. and Quan, G. (1986) 'Primate status and conservation in China', Primates: Springer, pp. 213-220.

Ware, D. (2001) 'Gibbon rehabilitation and reintroduction: the problems along the road before use as a viable conservation tool', The Apes: Challenges for the 21st Century, pp. 259-261.

Warren, W.C., Jasinska, A.J., García-Pérez, R., Svardal, H., Tomlinson, C., Rocchi, M., Archidiacono, N., Capozzi, O., Minx, P., Montague, M.J. and Kyung, K. (2015) The genome of the vervet (*Chlorocebus aethiops sabaeus*). Genome Research, 25(12), pp. 1921-1933.

Webber, A. D. (2006) Primate crop raiding in Uganda: actual and perceived risks around Budongo Forest Reserve. Oxford Brookes University.

Whittaker, D. (2013) 'Chlorocebus: species accounts', Handbook of the Mammals of the World, 3, pp. 672-675.

Wieczkowski, J. and Mbora, D. (2002) 'Recent forest destruction and its impacts on critically endangered primates in the lower Tana River, Kenya'. American Journal of Physical Anthropology, pp. 164.

Wimberger, K. and Downs, C. (2010) 'Annual intake trends of a large urban animal rehabilitation centre in South Africa: a case study', Animal Welfare, 19(4), pp. 501.

Wimberger, K., Downs, C. and Boyes, R. (2010) 'A survey of wildlife rehabilitation in South Africa: is there a need for improved management?', Animal Welfare, 19(4), pp. 481.

Wolcott, L. T. (1978) 'Hanumān: The power-dispensing monkey in North Indian folk religion', The Journal of Asian Studies, 37(4), pp. 653-661.

Wolfheim, J. H. (1983) 'Primates of the world: distribution, abundance and conservation', Psychology Press.

Wrangham, R. (1981) 'Drinking competition in vervet monkeys', Animal Behaviour, 29(3), pp. 904-910.

WWF (2001) Central African mangroves (AT401). WildWorld WWF Full Report. http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at1401_full.html (Accessed: 5 February 2013).

WWF (2013) East Africa Mangroves (AT1402). http://worldwildlife.org/ecoregions/at1402 (Accessed: 14 February 2013).

Youngentob, K. N., Wallis, I. R., Lindenmayer, D. B., Wood, J. T., Pope, M. L. and Foley, W. J. (2011) 'Foliage chemistry influences tree choice and landscape use of a gliding marsupial folivore', Journal of Chemical Ecology, 37(1), pp. 71-84.

Zinner, D., Peláez, F. and Torkler, F. (2002) 'Distribution and habitat of grivet monkeys (*Cercopithecus aethiops aethiops*) in eastern and central Eritrea', African Journal of Ecology, 40(2), pp. 151-158.

Zschocke, S., Rabe, T., Taylor, J., Jäger, A. and Van Staden, J. (2000) 'Plant part substitution–a way to conserve endangered medicinal plants?', Journal of Ethnopharmacology, 71(1), pp. 281-292.

Appendices

Below are detailed species accounts for the six species of vervet sourced from review publications (Wolfheim, 1983; Fedigan and Fedigan, 1988; Gautier-Hion et al., 1999) and site-specific studies, describing taxonomy, morphology and locomotion (Turner, Anapol and Jolly, 1994; Turner, Anapol and Jolly, 1997; Isbell et al., 1998; Groves, 2001; Anapol et al., 2005), ecology (Struhsaker, 1967a; Struhsaker, 1967b; Cheney and Seyfarth, 1983; Harrison, 1985; Nakagawa, 2000; Nakagawa, 2003; Agmen, Chapman and Bawuro, 2010; Jaffe and Isbell, 2010; McDougall et al., 2010; Mekonnen et al., 2010a; Mekonnen et al., 2010b), life history and reproduction (Kavanagh, 1983; Horrocks and Hunte, 1986; Andelman, 1987; Baldellou and Adan, 1997; Nakagawa, 2000) and conservation (Saj, Sicotte and Paterson, 2001; Zinner, Peláez and Torkler, 2002; Bi et al., 2009; Mekonnen et al., 2012). The format of these accounts follow that of the species accounts in *The Handbook of the Mammals of the World Volume 3: Primates* (Mittermeier, Rylands and Wilson, 2013).

Appendix A Grivet monkey *Chlorocebus aethiops*

Monotypic

Distribution: (Figure 23) This species is present from Khartoum in Sudan, northwards to east of the White Nile River and south to Mongolia in South Sudan, extending east to the Ethiopian Rift Valley and south to the Omo River in Ethiopia. The grivet monkey occurs in Eritrea, Djibouti and Ethiopia. Range formerly extended along the Nile Valley.

Descriptive notes: Head-body ♂ 45 – 83 cm, ♀ 40 – 61 cm; tail ♂ 55 – 114 cm, ♀ 50 – 65 cm; weight ♂ 4·1 – 7 kg, ♀ 2·6 – 5·6 kg (Anapol et al., 2005). The grivet monkey displays a slight sexual dimorphism in size, with males slightly larger than females. The grivet monkey has a warm olive-coloured grizzled dorsum with a yellower crown, grey limbs and light brown digits, with a white underside. On the face, there is a narrow white brow band, continuous with the prominent, laterally elongated cheek whiskers (Dandelot, 1971). Skin of the face is black face with a fine white moustache. Hands and feet are pale. There is a white tuft at the base of the tail. The grivet monkey scrotum is sky blue.

Hybridisations: *C. aethiops* × *C. pygerythrus hilgerti* is reported from the Omo River, Ethiopia; *C. aethiops* × *C. djamdjamensis* hybridisation is reported from three sites in the Oromia region of southern Ethiopia (Ekuma Mountain, Kulla Mountain, and

Wotiye), exhibiting coat colours, tail lengths, and whisker lengths intermediate between the Bale Monkey and grivet monkey.

Habitat: Opportunistic generalists that exploit the majority of forest, savannah and mosaic habitats, grivet monkeys seem only to be restricted by the availability of water and sleeping trees, utilizing acacia-dominated savannah as well as dense riverine forests. This species occurs in moist tropical, riverine, gallery, evergreen forest habitats, as well as deciduous, dry forest, savannah, acacia forest, forest mosaic. They also utilize secondary growth and edge forests, as well as mangrove, swamp and thorn scrub forests. In the highlands, they have also been recorded in eucalyptus forest. Being extremely adaptable they can live in human-dominated rural and urban environments. Crop-raiding is reported throughout its range. Altitudinal range extended from approximately 750 m to over 2500 m asl in a study carried out in eastern and central in Eritrea. Average altitude was 1690 m asl. In this study grivet monkeys were found in areas with the highest rainfall in Eritrea, but not in areas with less than 35 cm per year. Precipitation was between at least 35 and 1000 cm per year.

Food and feeding: The grivet monkey is a generalist, opportunistic omnivore. They consume fruit, seeds, leaves, both young and mature, flowers, gum, bark to a lesser degree, grass and insects. They are also reported to consume swollen thorns. Although the consumption of small mammals, reptiles, birds and bird eggs is not recorded, it is likely that diet is similar to the much-studied vervet monkey *C. pygerythrus*. Acacia trees are a central part of the *Chlorocebus* diet.

Activity patterns: The grivet monkey is diurnal and semi-terrestrial. Quadrupedal locomotion is reported for up to 54% of time, climbing between 5% and 30%, and leaping up to 9.6%. Bipedal upright posture is adopted in open areas when there is a need for vigilance. Preferred height utilization is reported as follows: ground used 19.4% of time; ground to 5 m used 29.1% of time; 5 m to 10 m used 17% of time; 10 to 20 m used 17.2% of time; 20 m to 30 m used 17.3% of time.

Movements, home range and social organization: Study of this species is not highly abundant and home range and day range of the species are not reported. They live in male-dominant, hierarchical, multi-male multi-female social groups. Females remain with their natal group and males migrate. Group sizes range from three to 22.

Breeding: Though mating system data for this species are not explicitly reported, it can be presumed to be as per genus.

Status and conservation: The grivet monkey is listed on CITES Appendix II and on Class B of the African Convention on the Conservation of Nature and Natural Resources. Listed on *The IUCN Red List* as Least Concern as it is widespread and abundant with no major threats. However, very few data are available for their current distribution and abundance in the majority of their range. Information is incomplete and outdated due to decades of civil war making their range largely inaccessible. Grivet monkeys were once present as far north as 19° N in the Nile RIver Valley in Sudan, but over the last hundred years they have experienced extirpations in many localities due to deforestation and the northern limit along the Nile River is now thought to be south of 15° N. It is thought that Eritrea now holds the northernmost population of the species. Zinner et al. (2002) report survey results from Eritrea that report intensifying conflict between grivet monkeys and humans, due to the need for increased agriculture as a result of resettlement programmes for refugees from Ethiopia and Sudan. They report that these factors represent a real danger of extinction of grivet monkeys in Eritrea and thus, the northernmost population of the genus.

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Figure 23. Distribution of the grivet monkey.

Appendix 2 Tantalus monkey *Chlorocebus tantalus*

Three subspecies are recognised here: *C. t. budgetti*, *C. t. marrensis*, and *C. t. tantalus*.

Subspecies and distribution: (Figure 24) The tantalus monkey is present in sub-Saharan West Africa from east of the Massina district of Mali and east of the Volta River in Ghana; from the Accra Plain and Salaga; extending east to the White Nile in Sudan, from the Imatong Mountains in the south to Jebel Marra in the North, to the Lake Turkana district of Kenya. Occurs in Mali, Burkina Faso, Ghana, Togo, Benin, Niger, Nigeria, Chad, Cameroon, Central African Republic, Sudan, South Sudan, DR Congo, Rwanda, Uganda, and Kenya.

C. t. marrensis Thomas and Hinton, 1923 – present in west Sudan and is isolated from the rest of the species by desert.

Descriptive notes: Head-body ♂ 46 cm, ♀ N/A; tail ♂ 65 cm, ♀ N/A; weight N/A. Sexual dimorphism in size. Like the grivet monkey, the tantalus monkey has a grizzled golden-greenish crown and dorsum that extends to the tail base. There is a white basal tuft and creamy tail tip. Limbs are grey and the underside is white. The face is black. The scrotum is sky blue. The tantalus monkey differs in having long stiff yellowish cheek whiskers with black tips, separated from a sinuous, tapered, white brow band by a black line running from the corner of eye back along the temples. A zone of long orange hairs surroundsthe scrotum. *C. t. tantalus* tends to be olive green in dorsal colour; hairs are multi banded of alternating grey and yellow. *C. t. budgetti* is more of an olive brown; cheek whiskers are more yellowish with more extensive speckling; hands, feet and tail tip are darker; digits blackish. *C. t. marrensis* tends to be a lighter olive-fawn colour.

Hybridisations: A *sabaeus* specimen from Bole, Ghana, within the range of *sabaeus*, with a white brow band suggests limited C. sabaeus × C. t. tantalus hybridisation; *C. t. budgetti* × *C. p. centralis* hybridisation occurs north and northwest of Lake Edward, DR Congo and northwest Uganda.

Habitat: The tantalus monkey is present in a variety of habitats including savannah, open woodland, and forest-grassland mosaics, montane, riverine and gallery forest. This species is reported to show a preference for woodland over grassland, especially gallery forest. As per the genus, they are restricted by proximity to water and the availability of sleeping trees. A study in northern Cameroon reported tantalum monkeys to establish home ranges along rivers where the water was never completely depleted, even during the dry season. Demonstrating the flexibility of the genus, they are reported to inhabit cultivated land in Bakossi, Cameroon, to reside in degraded habitat and forest edges, and is found in both rural and urban environments. Altitudinal range of those studied in the Ngel Nyaki Forest Reserve in Nigeria extends from 1400 m to 1600 m. Annual rainfall fluctuates throughout the range of the species. A study in Cameroon in the late 1970s that covered various habitat types of the tantalus monkey reported average annual rainfall of the semi-arid region of Kalamaloue to be approximately 65 cm per year; that of the Buffle Noir, with a marked wet season is approximately 145 cm per year; and in Bakossi, where rain may fall at any month the average rainfall in a year is approximately 358 cm per year.

Food and feeding: The tantalus monkey is a generalist, opportunistic omnivore. Fruit is reported to compose of up to 51% of the tantalus monkey diet. They also consume leaves, flowers, gum, buds, insects and other small animal matter. Insects are reported to compose of up to 25% of their diet.

Activity patterns: The tantalus monkey is diurnal and semi-terrestrial. Though locomotion is not explicitly reported for this species, it can be presumed to be primarily quadrupedal as per genus. Reported in Cameroon to spend approximately in third of their time on the ground.

Movements, home range and social organization: A study in northern Cameroon reported day ranges of 1400 m to 2540 m. Home ranges ranged from 43 ha to 90 ha. They live in male-dominant, hierarchical, multi-male multi-female social groups. Females remain with their natal group and males emigrate. Social groups range in size from 16 to 21 individuals.

Breeding: Though mating system data for this species is not explicitly reported, it can be presumed to be as per genus.

Status and conservation: The tatalus monkey is listed on CITES Appendix II and on Class B of the African Convention on the Conservation of Nature and Natural Resources. Listed by *The IUCN Red List* as Least Concern as the species is relatively common and widespread with no known major threats. The tantalus monkey is reported to be present in many protected areas.

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Figure 24. Distribution of the tantalus monkey.

Appendix C Green monkey *Chlorocebus sabaeus*

Monotypic

Distribution: (Figure 25) This species is present from Senegal in the south to Sierra Leone in the east; extending east to Goundam in Mali and south to west of the Volta River system in Ghana. Present in Mauritania, Senegal, Guinea, Guinea-Bissau, Mali, Burkina Faso, Côte d'Ivoire, Ghana, northern tip of Liberia. This species has been introduced to Cape Verde and to the Caribbean islands of Barbados, Saint Kitts and Nevis.

Descriptive notes: Head-body N/A; tail N/A; weight ♂ 4·6 – 6·5 kg, ♀ 3·3 – 5·9 kg. Green monkeys display a slight sexual dimorphism in size. They are long-legged with a grizzled golden-green dorsum, extending down limbs and to the base of the tail. The crown is a speckled greenish brown; underside off white; hands and feet pale; tail tip golden yellow; backs of thighs yellow; cheek whiskers yellow directed upwards in front of ears and over temple from a whorl before the ears; light brow band poorly expressed or absent. Scrotum very light blue.

Hybridisation: A specimen from Bole, Ghana, with a white brow band suggests limited *C. sabaeus* × *C. tantalus* hybridization; *C. tantalus* × *Erythrocebus patas patas* hybridization is reported; *C. tantalus* × *Macaca mulata* hybridization has occurred in captivity.

Habitat: The green monkey Inhabits moist and dry forests alike and, like the rest of the genus, is restricted only by the availability of water and sleeping trees. It has been recorded in range of habitats from riverine gallery forest to acacia savannah, in moist habitats including the edge of lowland tropical forest, riverine, gallery, rainforest, flooded forests, mangrove, swamp forest and back water forest and in drier habitats including acacia dominated forest mosaics, coastal forest, dry forest, savannah and scrubland. The green monkey also inhabits human-dominated habitats and on the Caribbean islands of Barbados, St. Kitts and Nevis where they show a preference for secondary growth areas. They crop-raid on the Caribbean Islands and are reported to successfully exploit tree plantations. Rainfall in their range in Senegal has ranged from 73.8 cm to 105 cm per year. The highest elevation at which they are found in Senegal is 400 m.

Food and feeding: The green monkey is a generalist, opportunistic omnivore. It is reported to consume fruits, seeds, leaves, flowers, gum, bark, lichen, soil, insect larvae, insects, birds (plucked before being eaten), bird eggs, small mammals. Acacia trees are central to their diet. Animal matter has been recorded to compose up to 40% of the green monkey diet. In the mangroves of Senegal, where they were studied in the 1970s, they are reported to consume fiddler crabs. One study on the Senegal River in northern Senegal in the rainy season of 1976 28% of all the animal prey were birds, with the majority of the rest of animal prey being insects. By the end of the dry season of that year 47% of the animal prey was composed of the Nile Rat.

Activity patterns: The green monkey is diurnal and semi-terrestrial. Locomotion is quadrupedal with bipedal walking observed. Reported to spend between 28% and 75% climbing, habitat dependent. Clinging and leaping is reported up to 15% of time. Studies in Senegal report preferred height utilization as follows: ground used 28% – 61% of time; ground to 5 m used 80% of time (in mangroves); 5 m to 10 m used 12% – 20%; 10 m to 20 m used 2% – 8%. Rarely spend time above 20 m. Exceptions are during territorial displays of males and in some taller trees in gallery forests in Burkina Faso.

Movements, home range and social organization: Home range sizes fluctuate greatly depending on habitat, with some ranging from 15 ha and 30 ha and others from 157 ha to 164 ha. Day ranges in one area of Senegal were between 2000 m and 8000 m. The trip of one adult male to find drinking water was 11000 m. Live in male-dominant, hierarchical, multi-male multi-female social groups. Normally females remain with their natal group and males migrate, though female migration has been observed. Solitary males have been observed. Group sizes range from four to 19 in some areas. The maximum group size recorded was in Senegal 1983 at 174 individuals.

Breeding: In regions of their range where there are clear wet and dry seasons, mating generally occurs during the dry season and birthing tends to occur at the beginning of the wet season when resources once again become plentiful. Otherwise, mating and birthing are year-round. Gestation is approximately five to six months after which a single infant is usually born. Females reach sexual maturity at approximately three years, and males at approximately six years. Allomothering is practiced. Live for up to 30 years in captivity. The estimated life span in the wild is 27 years.

Status and conservation: The green monkey is listed on CITES Appendix II and Class B of the African Convention on the Conservation of Nature and Natural Resources . It is listed by *The IUCN Red List* as Least Concern as the species is common, widespread and reasonable abundant, particularly in the delta areas of West African rivers, with no known major threats. It is present in many protected areas. However, in Côte d'Ivoire, where it is thought to be mainly distributed through the savannah and savannah-forest mosaic habitats north of the rain forest zone, the species has been reported absent from areas where it was present 30 years ago. Gonedelé Bi et al. (2009) failed to confirm the presence of green monkeys in any of the forest reserves in the southern forest zone of the country. They do however, report three populations from unexpected areas, one population in a littoral forest outside its expected range and two others in forests in the coastal region, highlighting the urgent need for further surveys in the region. Other populations are also reported to be extirpated, including the Senegal River valley population. Their colonization of the Caribbean islands of St. Kitts, Barbados and Nevis have prompted various population control measures to be introduced over the centuries, including a bounty on the head of every individual killed and human trapping programmes. The current method employed is live-trapping to supply the biomedical trade in the USA.

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Figure 25. Distribution of the green monkey.

Appendix D Malbrouck monkey *Chlorocebus cynosuros*

Monotypic

Distribution: (Figure 26) This species is present form southern Democratic Republic of Congo; west to the southern tip of Gabon; throughout Angola, south to northern Namibia; east to the Luangwa Valley in Zambia; and south to the Zambezi.

Descriptive notes: Head-body N/A; tail N/A; weight N/A. This species is similar in most respects to *C. pygerythrus* but a paler olive-grey. The face is blotched instead of completely black as in the other forms. The bare skin of the palms and soles are pale. Ischial callosities are rose pick. Cheek whiskers are longer, directed upwards and backwards. The scrotum is a lapis blue.

Habitat: There is no published field research from the range of this species. However, it can be presumed that the adaptable nature of the genus is also true for this form. Therefore presumed to inhabit the same variety of environments including savannah, open woodland, and forest-grassland mosaics, wooded habitat, and moist forests; restricted only by proximity to water and the availability of sleeping trees; and exploiting human-dominated rural and urban environments. Data for altitude range of the species and precipitation levels are not available.

Food and feeding: Although there are no publications pertaining to this species, it can be presumed that diet and feeding is as per genus - generalist, opportunistic, omnivorous.

Activity patterns: The malbrouck monkey is diurnal and semi-terrestrial. Though locomotion is not explicitly reported for this species, it can be presumed to be primarily quadrupedal as per genus.

Movements, home range and social organization: No publications explicitly describing the social organization of this species but presumed to be as per genus.

Breeding: Though mating system data for this species is not explicitly reported, it can be presumed to be as per genus.

Status and conservation: The malbrouck monkey is listed on CITES Appendix II and on Class B of the African Convention on the Conservation of Nature and Natural Resources. Listed by *The IUCN Red List* as Least Concern in view of its wide range, and because there are no major threats believed to be resulting in any major population declines. Population estimates for this species are unknown but in much of the area in which it occurs there is a relatively low human population density, therefore it is presumed to be reasonably common.

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Figure 26. Distribution of the malbrouck monkey.

Appendix E Vervet monkey *Chlorocebus pygerythrus*

Within the *C. pygerythrus* group, extending from Ethiopia southwards to the Cape of Good Hope, it is extremely difficult to accurately denominate subspecies since the characters involved are mainly those of colour, and one subspecies blends with another across the range. Groves (2001), however, lists five subspecies: *C. p. hilgerti*, *C. p. excubitor*, *C. p. nesiotes*, *C. p. rufovirdis*, and *C. p. pygerythrus*.

Subspecies and distribution: (Figure 27) *C. p. hilgerti* Neumann, 1902 – present from the Ethiopian Rift Valley into parts of the highlands east of the Rift; the eastern lowlands of Ethiopia; Somalia; through Kenya to northern Tanzania and west into Uganda.

C. p. excubitor Schwarz, 1926 – present in northern Kenya and Witu Island.

C. p. nesiotes Schwarz, 1926 – present on Pemba and Mafia Islands, Tanzania.

C. p. rufoviridis I. Geoffroy, 1843 – present from Zambezi, east of the Luangwa, North to Lake Victoria.

C. p. pygerythrus F. Cuvier, 1921 – present south of the Zambezi.

Descriptive notes: Head-body N/A; tail ♂ 67 cm, ♀ 55 cm; weight ♂ 4·1 – 6 kg, ♀ 2·6 – 3·2 kg. The species displays a slight sexual dimorphism in size. Pelage is a grizzled grey or olive dorsum, extending to the outer surface of the limbs, which are not grey. A white brow band and short cheek whiskers broadly fuse to form a complete face-ring, grading into a greenish speckled crown and neck. Hands, feet and tail tip are darker, rather than lighter as the other species tend to be. There is no tuft at the base of the tail but instead the anal region at the base of the tail is a bright red. The scrotum is turquoise blue. *C. p. hilgerti* is generally a paler brownish yellow that other forms. *C. p. excubitor* is similar to *C. p. hilgerti* but smaller in size. *C. p. rufoviridis* is a more fawn or orange-yellow colour with long speckled whiskers. The underside of this form is often reddish infused. *C. p. nesiotes* is similar to *C. p. rufoviridis* but smaller in size. *C. p. pygerythrus* is ashy grey to olive green, tending to be greyer in the west and greener in the east.

Hybridisation: *C. pygerythrus* × *C. tantalus* hybridisation is reported from the northern and western shores of Lake Victoria; in the northern extent of its range *C. pygerythrus* × *C. aethiops* hybridisation is reported from Uganda, Kenya and Ethiopia; *C. pygerythrus* × *Cercopithecus mitis* hybrids have been reported in Kenya; *C. pygerythrus* × *Erythrocebus patas* hybridisation has been reported in captivity.

Habitat: The vervet monkey is primarily found in close proximity to water, be it rivers, swamps or lakeshores. This species is present in savannah, open woodland, forest-grassland mosaic, especially close to rivers, and riverine forest. It predominantly inhabits acacia-dominated habitats. Like other of the genus it is extremely versatile and can persist in secondary forest as well as highly fragmented habitat. It can exploit cultivated rural areas and is also found in urban environments. Generally, it is absent from desert areas and deep forest within its range, unlike its West African counterparts. Occur at elevations from 600 m to 2000 m asl with annual rainfall ranging from 30 cm to 72 cm per year.

Food and feeding: The vervet monkey is a generalist, opportunistic omnivore. This species consumes fruit, seeds, leaves, both young and mature, flowers, gum, bark to a lesser degree, insects, grass. They are also reported to consume swollen thorns, bird eggs, land snails, small mammals, birds and reptiles. Acacia trees are a central part of the diet. The vervet monkey has been recorded leaping to catch termites in South Africa, some waiting at exit holes to catch the termites as they take flight.

Activity patterns: The vervet monkey is diurnal and semi-terrestrial. Locomotion is primarily quadrupedal with climbing, leaping also observed. Bipedal posture is adopted in environments where vigilance is required. The locomotion of these semi-terrestrial primates has been studied in some depth in relation to the study the evolution of human bipedalism.

Movements, home range and social organization: Home ranges of 23 ha to 60 ha have been recorded. Day ranges vary greatly, with ranges of 200 m to 1632 m recorded. The vervet monkey lives in male-dominant, hierarchical, multi-male multi-female social groups. Females remain with their natal group and males migrate, sometimes in groups, and often twice in a lifetime, once on reaching sexual maturity and again after siring offspring. Group sizes of eight to 40 have been recorded. Solitary males have been observed as well as groups of two and three individuals (most likely to be migrating males). Group fusions have been recorded between 1984 and 1988 in a declining population of vervet monkeys in the Amboseli National Park, Kenya, where remaining group members of dwindling groups abandoned their group territory and joined a neighboring group shortly after the loss of their penultimate adult.

Breeding: In regions of their range where there are clear wet and dry seasons, mating generally occurs during the dry season and birthing tends to occur at the beginning of the wet season when resources once again become plentiful. Otherwise, mating and birthing are year-round. Gestation is approximately five to six months after which a single infant is usually born, though twins have been observed. Weaning occurs between 270 and 540 days. Females reach sexual maturity at approximately three years, and males at approximately six years. Ovarian cycle is approximately 30 days. Allomothering is practiced. Infanticide has been observed. They can live for up to 33 years in captivity but normally some years younger in the wild.

Status and conservation: The vervet monkey is listed on CITES Appendix II and on Class B of the African Convention on the Conservation of Nature and Natural Resources. Listed by *The IUCN Red List* as Least Concern as it is a widespread and abundant species with no major threats. It is present in most protected areas within its range. It is patchily distributed through its range, probably due to its need to have daily access to water. It is classed as vermin in parts of its range due to crop-raiding and is shot and hunted in areas where they interact with humans. In more urban settings, such as the suburbs of South Africa, they are often killed or injured by cars, electricity pylons, and dogs, and are shot with pellet guns. Vervet monkeys are a source of bushmeat in some areas.

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Figure 27. Distribution of the vervet monkey.

Appendix F Bale monkey Chlorocebus djamdjamensis

This high-altitude taxon was 'rediscovered' and recognized as being distinct from *Cercopithecus aethiops* by Dandelot and Prevost (1972), who assigned this group to the *Cercopithecus* genus. The taxon had previously been regarded as a synonym of *matschiei* but the name *djamdjamensis* was resurrected by Dandelot and Prevost having described specimens from the headwaters of the Webi Shebeyli River and noted it as being distinct from other forms. It was first elevated to species status in 1977 by Kingdon (1977). Following Groves (2001) it is monotypic.

Distribution: (Figure 28) Endemic to the highlands of Ethiopia east of the Ethiopian Rift Valley; restricted to the Bale Mountains and Hagere Selam regions.

Descriptive notes: Head-body ♂ N/A; tail N/A; weight N/A. This species has a short tail with a reduced or absent tuft. The dorsum fur is thick and a deep grizzled brown.

Limbs and tail are grey. The hands and feet are dark grey and underside is a creamy-white mixed with grey on the chest. There is no white on the face but a fine white moustache. There is a very bushy white beard and cheek ruff present and a barely indicated white brow band that is separated from the cheek ruffs by a broad black band from eye to ear. There is an inconspicuous reddish brown tuft at the base of the tail, Scrotum is blue.

Hybridisation: Apparent *C. aethiops* × *C. djamdjamensis* hybrids were observed at three locations in the Oromia region of southern Ethiopia, Ekuma Mountain, Kulla Mountain, and Wotiye.

Habitat: The Bale monkey inhabits montane, tropical and subtropical forest in the highlands of Ethiopia. Originally this species was thought to be restricted to the bamboo forest of its limited range. However, a report from the Oromia area of southern Ethiopia where there has been increased removal of the bamboo plant for the purpose of the growing agricultural demand in the region, has shown the species ability to demonstrate more habitat flexibility than originally reported, adapting to the remaining suboptimal habitat and raiding crops. Altitudinal range extends from 2400 m to 3250 m asl. Average annual rainfall is approximately 69 cm, ranging from 1-2 cm per month in the dry season to 8-14 cm per month during the wet season.

Food and feeding: This species was originally believed to be a bamboo specialist; bamboo shoots do make up the majority of the diet of this species. Two species of bamboo (*Arundinaria alpina* and *Dombeya torrida*) have been recorded to make up between 75% and 83% of their diet, season dependant. However, with recent habitat loss, they are reported to adapt to this edge habitat and to crop raid.

Activity patterns: The Bale monkey is diurnal and semi-terrestrial. Though is it not explicitly stated in the literature, locomotion can be presumed to be primarily quadrupedal.

Movements, home range and social organization: Day ranges of 724 m to 1288 m are reported with home ranges of eight to 18 ha. The Bale monkey lives in male-dominant, hierarchical, multi-male multi-female social groups. Females remain with their natal group and males migrate. Group sizes range from nine to 60 individuals.

Breeding: Though mating system data for this species is not explicitly reported, it can be presumed to be as per genus.

Status and conservation: The Bale monkey is listed on CITES Appendix II and on Class B of the African Convention on the Conservation of Nature and Natural Resources. Listed by *The IUCN Red List* as Vulnerable as the range of the species is less than 20,000 km^2 and the species occurs in low densities in a specialized and unusual habitat of bamboo forest that is severely fragmented. There is a continuing population decline due to ongoing habitat loss and degradation as a result of bamboo extraction and human development and cultivation. The species is also threatened by hunting, in response to crop-raiding, and by hybridization with *C. aethiops*.

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Figure 28. Distribution of the Bale monkey.