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People-primate interactions: implications for primate conservation

T. Humle[1], C. Hill[2],

[1.] *Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Canterbury CT2 7NR, UK*

[2]. *Anthropology Centre for Conservation, Environment and Development, Faculty of Humanities & Social Sciences, Oxford Brookes University, Oxford OX3 0BP*

1 From Primate Conflict to Coexistence

1.1 Disciplines and shifts in terminology

Homo sapiens have, since they evolved, shared landscapes and resources with wildlife (Paterson 2005), and like other animals, compete with those species they share space with. Consequently it seems fair to assume there is a long history of interaction between people and wildlife; with interactions taking on a range of different characteristics from mutually beneficial or benign, to even harmful. It is these harmful, or apparently conflictual interactions, that are frequently referred to as ‘human-wildlife conflicts’. According to the 2005 International Union for the Conservation of Nature (IUCN) World Parks Congress, ‘*human-wildlife conflict occurs when the needs and behaviour of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife*’ (IUCN 2005).

Recent years have witnessed a notable shift away from employing the term ‘human-wildlife conflict’ or any other terms such as ‘crop-raiding’, ‘raider’, ‘thief’ that position wildlife as conscious antagonists of people (Peterson et al. 2010). Such terms are perceived as detrimental to promoting coexistence between people and wildlife, partly because they mask the fact that conflicts arise as a consequence of stakeholders ascribing different values to different animal species (Peterson et al. 2010; Redpath et al. 2013). This shift in terminology has coincided with a notable surge in research on interactions between people and primates. This trend parallels recent intensification of human encroachment into natural habitats linked to agricultural, ranching, and extractive industrial activities, as well as increased urbanisation across primate range states. The spatial overlap between people and primates is ever increasing; primates face declining availability of their wild food supplies and restrictions in their access to space, water, nesting sites and familiar and safe habitat. In this context, the human-primate interface poses an increasing challenge for conservation, and studying it requires a cross-disciplinary approach, combining methodological and theoretical approaches from both the social and natural sciences.

In this chapter we review primate-human relationships, patterns and lessons learnt, as well as studies that have sought to mitigate and/or prevent negative interactions between people and wildlife. We demonstrate that engaging with so called ‘primate-human conflict’ issues requires an ethically sensitive approach, encompassing the active participation and involvement of all stakeholders concerned, and especially those sharing landscapes with their primate relatives.

1.2 Characterizing interactions

1.2.1 Types of interactions

Interactions between people and primates can take on many different forms entailing a range of combinations of positive, neutral or negative outcomes for both parties. For instance, the Zanzibar red colobus (*Procolobus kirkii*) forage on damaged, immature coconuts; this pruning process, in effect, promotes palm productivity and monkeys in some areas, also attract tourists, thus potentially contributing, indirectly, to stimulating tourism locally (Siex and Struhsaker 1999). Small faunivorous nocturnal primates may find refuge from predators and/or increase their foraging success around human habitation where lighting attracts preferred prey, including insects and small reptiles (Bearder et al. 2002). Frugivorous primates may act as key seed dispersers thus playing a role in the maintenance of forest habitats which provide key ecosystem services to people (Chapman 1995; Chapman and Onderdonk 1998).

Severe negative outcomes directly impacting human lives, such as predation, are extremely rare. Such events primarily concerns adult male chimpanzees (e.g. at Gombe, Tanzania Frodo reportedly killed and ate a human baby: Kamenya (2002)). Although predation on people is atypical, reports of primate depredation on livestock are not uncommon. Chimpanzees are reported to eat young goats (*Capra hircus*), sheep (*Ovis aries*) and chicken (*Gallus gallus domesticus*) in parts of Senegal (Carter et al. 2003). Baboons are known to predate small livestock around the Pendjari Biosphere Reserve in north-western Benin (Sogbohossou et al. 2011) and young goats and sheep during periods of wild food shortage in Zimbabwe (Butler 2000) and Kibale and Bulindi in Uganda (Naughton-Treves et al. 1998).

Conversely, people hunting primates is a major cause of population decline and can extirpate populations locally, even in areas where suitable habitat is abundant (Fa et al. 2002; Fa and Brown 2009; Oates 1996). People hunt primates for a variety of purposes, including for meat, sale as live pets or for use in traditional medicines, rituals or as ornaments (Mittermeier 1987) (see also Chapter XXX). Primates have also long been hunted and persecuted because they are considered to be 'pests' (Davis et al. 2013; K. Hockings and Humle 2009), consuming or destroying crops or property, potentially affecting people's food supplies and/or economic and psychological wellbeing. During the period 1947-1962 the government of Sierra Leone sponsored large-scale monkey drives to reduce the impact of primates on agriculture within the country. Hunters were paid a bounty for each head or tail; according to government records approximately 245,000 individual primates were killed under this scheme (Tappen 1964).

Perhaps the most challenging types of interactions between people and primates include disease transmission and competition for space and resources. The risk of zoonotic pathogen transmission is elevated in situations where people and primates are in close proximity e.g. especially in the contexts of tourism or research activities (Fuentes et al. 2007; K. Hockings and Humle 2009; Macfie and Williamson 2010; Muehlenbein et al. 2010). When it comes to competition between people and wildlife, people often outcompete wildlife for limited resources, even sometimes causing species extinction locally. For example, the extinction of an isolated population of proboscis monkeys (*Nasalis larvatus*), numbering around 300 individuals, in the Pulau Kaget Nature Reserve, Indonesia, was attributed to the loss of their habitat caused by illegal agriculturein the reserve (Meijaard and Nijman 2000). This population was reportedly driven to the edge of the reserve and was 'starving to death' (p.66). On frequent exposure to people, some animals may succumb to disease either through stress or zoonotic transmission (Chapman et al. 2005; Gillespie et al. 2008; Kondgen et al. 2008). Others may be compelled to leave the area, or are extirpated intentionally through hunting, trapping and/or poisoning, out-competed by another colonising or invasive species, or simply captured and translocated elsewhere. In the case of the proboscis monkeys of Pulau Kaget Nature Reserve, nearly a third were eventually captured and moved nearby to unprotected sites. This process resulted in the death of 15% of the translocated individuals, while another 20% of the monkeys were transferred to a zoo where 60% died within 4 months of their capture (Meijaard and Nijman 2000).

In other cases however, competition can result in what is known as niche differentiation (Schoener 1974), whereby competing species evolve or adapt to utilize different niches, or the same resources, in different ways. However, such processes typically take place over evolutionary time scales which do not match those facing most competitive interactions between people and wildlife. Nevertheless, management strategies such as fencing resources, zoning areas of resource use, and switching to agricultural crops not favoured by local primates and other wildlife could be viewed as artificial measures aimed at eliciting niche differentiation to help foster co-existence between people and wildlife.

1.2.2 Associated costs and benefits for people and tolerance capacity

Costs associated with people-primate interactions can be direct, indirect or opportunistic (K. Hockings and Humle 2009). Direct costs for people typically include crop losses, property damage or theft, livestock depredation, predation or attacks on people. They typically imply some economic loss or social impact, such as human injury or loss of life. The latter, as previously discussed, is relatively rare. In contrast, indirect costs typically include instances of zoonotic disease transmission, fear for safety (especially pertinent for primates occurring in large groups and/or large bodied-sized species such as baboons, orang-utans, chimpanzees or gorillas), restrictions on movement and travel, time and money spent on protecting crops, property theft or damage.

Indirect costs may also incorporate cultural ‘dilemmas’ whereby the balance between cultural or religious tolerance, or taboos associated with primates or particular species of primates, is challenged by the cost imposed by these animals on people’s financial, physical and psychological wellbeing. For example, the association between monkeys and the Hindu god, Hanuman, has in the past at least ensured the conservation of primates across parts of India, especially those populations ranging around temples (Pirta et al. 1997). However, Pirta et al. (1997) describe how local people's perceptions and attitudes towards rhesus macaques (*M. mulatta*) and Hanuman langurs (*Presbytis entellus*) are shifting. The ‘conservation ethic’ or the ‘cultural value’ that these species have for so long benefited from is being eroded, and people’s tolerance capacity for wild primates is being severely tested. Cultural values are indeed by no means static, shifting over time with changing experiences and conditions (C. M. Hill 2002; Lee and Priston 2005). For example, the way in which a macaque is considered or treated by an individual Balinese can be context specific; a macaque inside a temple is believed sacred, but a macaque found crop-feeding is considered demonic and an economic liability (Lane et al. 2010; Schillaci et al. 2010). A macaque is therefore not provided protection in every context, with individual macaques foraging on crops at risk of being shot, either for crop protection or for sport (Schillaci et al. 2010).

Opportunity costs associated with investing time and energy in guarding crops include foregoing alternative sources of income or missing school in the case of children. The extra time and energy spent on preventing animals foraging in crops can be exhausting and, in some cases, may render people more vulnerable to disease either through lack of sleep or exposure to disease vectors such as mosquitoes, tsetse and *Similium* sp. flies responsible for transmitting malaria, trypanosomiasis (sleeping sickness) and onchocerciasis (river blindness) respectively (e.g. elephant guarding, Kenya Woodroffe, Thirgood, & Rabinowitz (2005)). Finally, more and more research is focusing on such hidden costs, whether indirect or opportunistic, aimed at better understanding the negative repercussions of interactions between people and wildlife (e.g. Barua, Bhagwat, & Jadhav (2013)).

1.2.3 Interactions and balancing values

Mismatches between measured and perceived costs or even benefits significantly influence interactions between people and primates. A species or genus of primate may be valued differently by different groups of people. For example, in Malaysia, long-tail or crab-eating macaques (*M. fascicularis*) are trained to harvest coconuts and stinking beans (*Parkia* sp.) whose seeds are used for culinary purposes across most of southeast Asia; here the macaques are valued for their utilitarian and/or economic benefits (Richard et al. 1989). In other regions, macaques are primarily valued for socio-cultural and aesthetic reasons, as exemplified by macaques on the island of Bali, Indonesia (Fuentes et al. 2005). Other examples where primates are, in effect, protected because of cultural traditions among different groups of people and/or localities include Sclater’s guenon (*Cercopithecus sclateri*) in Nigeria (L. R. Baker et al. 2009); chimpanzees (*P. t. verus*) at Bossou, Guinea (Tatyana Humle and Kormos 2011; Kortlandt 1986); bonobos at Wamba, Democratic Republic of Congo (Lingomo and Kimura 2009); red colobus at the Boabeng-Fiema Monkey Sanctuary, Ghana (T. L. Saj et al. 2006); ring-tailed lemurs *(Lemur catta*) and Verreaux’s sifaka (*Propithecus verreauxi*) at the Beza Mahafaly Special Reserve, Madagascar (Loudon et al. 2006), and a range of Neotropical primates including taxa such as *Cebus* sp., *Alouatta* sp., *Aotus* sp., *Saguinus* sp., *Cacajoa* sp., *Lagotrix* sp. and *Ateles* sp. across different regions of the Amazon basin (Cormier 2006).

Most issues between people and wildlife can be attributed in some shape or form to conflict between people and divergences in how they value a species (Knight 2000). The most common scenario concerns the local people whose wellbeing and livelihoods are directly affected by interactions with wildlife, and conservationists who seek to protect biodiversity and ecosystem function. Many such scenarios arise around protected areas. Since protected areas imply legal prohibitions on resource use and on killing wildlife (whether for bushmeat or in the context of protecting one's crops), the presence of protected areas often exacerbates 1) negative perceptions that people hold towards wildlife and local authorities and 2) the impact of wildlife on people's crops and property. For example, post-gazetting of the Bwindi Impenetrable National Park, Uganda, East Africa, people were no longer allowed to chase gorillas back into the forest (K. Hockings and Humle 2009) or pursue commercial activities such as mining or pit sawing within park boundaries (J. Baker et al. 2012). This situation exacerbated conflict between local communities and park rangers (J. Baker et al. 2012), as well as damage sustained to banana palms, coffee bushes and eucalyptus trees by gorillas at the forest edge (J. Byamukama pers. comm. 2008). More recently, the gorillas have also incorporated maize and beans into their diet, and, unfortunately these two crops are important subsistence crops for people locally (J. Byamukama pers. comm. 2008). However, although farmers do now consider gorillas a problem species, the loss of subsistence crops at the forest edge remains a relatively minor trigger of conflict between park rangers and local people. Indeed, restrictions on extractive commercial endeavours within park boundaries, that are mostly affecting resource-poor households seeking additional sources of income, underlie most social conflict events in the area (J. Baker et al. 2012). In addition, the lack of an effective benefit-sharing scheme for tourism revenues generated from mountain gorilla tracking and viewing very likely influences people's value systems and tolerance of gorillas around Bwindi, further exacerbating conflict among stakeholders locally (Sandbrook and Adams 2012).

1.3 What primate species and where?

Two thirds of peer-reviewed research articles concerned with ethnoprimatology[1], primate crop damage, 'conflict' and interactions with humans published since 1990 (N=75)[2]

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[1] An inter-disciplinary discipline combining the more traditional study and understanding of primate behavioural ecology alongside the cultural interpretations and uses of primates central to socio-cultural anthropology (Fuentes, 2006)

focus on cercopithecoids, i.e. cercopithecine and colobine species, while a quarter focus on great apes (Fig. 2). The majority of these studies relate to Africa (59%), followed by Asia (29%) and South and Central America (12%) with Uganda (23%) and Indonesia (13%) currently acting as the central foci for research in this area.

Although not all primates are able to survive in close proximity to people, some old world monkeys, i.e. cercopithecoids, have adapted particularly well to living alongside humans. Characteristics that influence species' capacity to coexist successfully with people are outlined in Table 1. The most successful extant genera of primates include three omnivorous taxa of cercopithecines, i.e. macaques (*Macaca* sp.), baboons (*Papio* sp.), and members of the *Chlorocebus* genus (includes vervet, grivet, green and Tantalus monkeys). Members of these genera are predominantly terrestrial, mainly generalist feeders and occupy a wide range of habitat types and anthropogenic areas, including roadsides, temples, tourist resorts, and urban to semi-urban centres (Lee and Priston 2005). In contrast to colobine monkeys, cercopithecines have the added advantage of cheek pouches, allowing them to retreat to a safe place to eat, thus alleviating feeding competition and reducing the risk of predation or retaliation by people (Lambert 2005). These genera typically exhibit female philopatry (i.e. females remain within their natal group) and male dispersal, with group size varying from approximately 10 to over 200 individuals. Groups or troops occurring in areas of human sympatry, particularly urban or semi-urban areas, tend to be larger and have a higher infant to adult female ratio than ones in more remote areas, reflecting their ability to exploit human resources and/or adapt to being provisioned (e.g. long-tailed macaques (*Macaca fascicularis*) Sha et al. (2009)).

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[2] Basic search terms included ethnoprimatology, primate crop-raiding, primate and human-wildlife conflict, primates and interactions with humans or people; each abstract was then reviewed for relevance.

Table 1. Characteristics that influence species-specific ability to sustain negative interactions with people.

VULNERABLE	**RESISTANT**
K-selected species*	r-selected species*
Of high utilitarian & economic value when dead	Of low utilitarian or economic value when dead
Narrow diet/Specialist	Broad diet/Generalist
Reduced ability to transport food	High degree of ability to transport food (e.g. hands, cheek pouch)
Prone to stress and susceptible to human diseases	Flexible response or resistance to disease and stress
Unprotected and/or of low conservation status	Protected by taboos or legislation
Exhibit aggressive/threatening behaviour towards people	Exhibit discreet/on-threatening behaviour towards people
Diurnal activity	Night activity/Nocturnal behaviour
Range can overlap with human-modified landscape	Range minimally overlaps with human-modified landscape
Species that generate negative perceptions & attitude (e.g. feared)	Species of cultural value or religious significance
Species that compete with humans for resources (e.g. food, water)	Species that minimally compete with humans for resources
Large body size, and/or highly visible	Smaller body size and/cryptic or secretive
Susceptible to social disturbance	Flexible social organisation & behavioural plasticity
Low dispersal capabilities	High dispersal capabilities
Weak behavioural flexibility	High behavioural flexibility
Of low economic, aesthetic or cultural value when alive	Of high economic, aesthetic or cultural value when alive

* K-selected species show lower metabolic needs, greater age at maturity, gestation length, inter-birth interval, lactation period and longevity and smaller litter size than r-selected species. R-selection and K-selection are relative terms and among NHPs this spectrum can vary with Strepsirhines being more r-selected than Hominoids.

Apes, especially chimpanzees (*Pan*) and orang-utans (*Pongo*) and, to some degree gorillas (*Gorilla*), have the adaptive and cognitive capacity to thrive in human-modified landscapes under particular circumstances (K. Hockings and Humle 2009). Indeed, great apes can flexibly exploit anthropogenic resources accessible to them, such as cultivars and foot paths. Great apes' ability to solve problems, learn socially, cooperate, incorporate diverse food types into their diet (although most are mainly frugivorous), and access embedded or hard to process foods, whether by hand or by using tools, facilitates their living at the interface with people. Other species such as long-tail macaques (e.g. Thailand: Gumert et al. (2009)) and capuchin monkeys (e.g. de Freitas et al. (2008), McKinney (2011)) also share similar abilities and propensities. However, smaller-sized and less cognitively advanced primates such as guenon species, including red-tailed monkeys (*Cercopithecus ascanius*), also employ effective strategies to forage on crops at the forest edge by adopting solitary, cryptic behaviours when foraging in crops (Baranga et al. 2012; Wallace and Hill 2012).

2 The changing landscapes of primate interactions and adaptation

2.1 Primates' behavioural and social plasticity

Habitat encroachment, destruction and fragmentation are some of the main drivers forcing primates into competition for resources with humans. Such events may be influenced by stochastic events, such as the dry conditions caused by El Niño and the consequential destructive forest fires that are known to have affected primate habitat in Indonesia for example, and impacts of climate change on the environment (see Chapter X). However, human-induced changes to the landscape are responsible for fuelling most negative interactions between primates and people. Increased demand for arable land and rapid encroachment into primate habitat increase the likelihood of encounters between primates and people, or property, including crops. Industrial or commercial development projects also expedite primate habitat loss, often resulting in large influxes of people, exacerbating people-wildlife exposure to human activity, and increasing risk of inter-species disease transmission. Additionally, extractive or agricultural industries can intensify the level of hunting in an area, as employees engage in hunting wildlife for food, or road infrastructure development facilitates hunter access and the bushmeat trade thus exacerbating the risks (e.g. Poulsen et al. (2009); Wilkie & Carpenter (1999); Wilkie et al. (2000)).

The development of commercial plantations and expansion of monocultures, such as oil palm, rubber, acacia or eucalyptus, across Indonesia and parts of Malaysia, have marginalized and isolated orangutans, forcing individuals to become obligate or semi-obligate crop feeders to survive (Campbell-Smith et al. 2011b; Meijaard et al. 2010). Some orangutans occupying these rapidly changing landscapes are unable to meet their nutritional needs (Ancrenaz et al. 2008). These individuals experience undue stress, and are thus having to be rescued and placed in rehabilitation centres which are barely able to cope with this influx of animals and sustaining release efforts across a limited number of remaining suitable areas (Ancrenaz et al. 2008; Robins et al. 2013). This is of particular concern because, like chimpanzees in many parts of Africa, the majority of wild orangutans (approx. 75%) occur outside protected areas, where land is generally managed to meet human needs and its use underpins economic development (Wich et al. 2012). However, Campbell-Smith et al. (2011b) confirm that orangutans can adapt to living in agroforestry landscapes, but only where tolerated by local people. Meijaard et al. (2010) also demonstrate that, in the short-term at least, orang-utans can survive in relatively high densities in plantation landscapes dominated by *Acacia* spp., though it remains unknown how long they can persist under these conditions, or at what cost to apes, plantation owners or labourers.

Primates demonstrate an array of ecological and behavioural responses to living at the interface with humans. Shifts in ranging behaviour as a result of human presence or activity can vary significantly among species. In some cases chimpanzees may shift their range away from human activity, such as in logging concessions (Morgan et al. 2013); by contrast, macaques may restrict their ranging area and inflate their density, in response to favourable conditions associated with provisioning, as found around temples and tourist areas (e.g. Fuentes et al. (2005)). However, Berman et al. (2007) showed that such range restriction among macaque populations around tourist areas with ongoing provisioning also comes at a cost. Aggression rates are generally elevated among individual macaques in restricted provisioned areas, and, over time, the rates are positively correlated with infant mortality. Provisioning is well known to influence aspects of population life history (e.g. birth rate, life span and reproductive parameters) and demography, and to be associated generally with increased intra-group aggression (D. A. Hill 1999), reduced activity rates and obesity, especially among more dominant individuals who have priority access to food (Fuentes et al. 2007; Zhao 2005).

Similarly, crops embody typically easily digested, calorie-dense foods, and feeding on crops may benefit the reproductive success of particular populations, providing there is no retaliation from farmers. A crop-feeding baboon troop (*Papio anubis*) around the Gashaka Gumti National Park in Nigeria and a crop-feeding community of chimpanzees (*Pan* *troglodytes verus*) in Bossou, Guinea, West Africa, show significantly shorter inter-birth intervals (IBI) and higher infant survival rates compared with conspecifics more dependent on wild foods (baboons: Higham et al. (2009); chimpanzees: Sugiyama & Fujita (2011)).

Primates may also shift their social organization and/or structure and modify their social associations depending on their environment. For example forest dwelling populations of bonnet macaque (*M. radiata*) typically form multi-male and multi-female groups. However, provisioned troops across peninsular India tend to adopt a single male social structure, with multiple females and a high tendency for female dispersal, atypical of other cercopithecine primates (Sinha et al. 2005). Sapolsky & Share (2004) reported an outbreak of tuberculosis among a troop of semi-urban Chacma baboons causing a social shift in the troop to a more 'relaxed' dominance hierarchy which still persisted ten years on. The circumstances of the outbreak were linked to dominant, more aggressive, adult males scavenging garbage who consequently were the animals who succumbed to tuberculosis, leaving behind a cohort of atypically unaggressive survivors. Such social plasticity is not unique to cercopithecines. Chimpanzees at Bossou, Guinea, are more cohesive during crop-feeding and road-crossing events (K. J. Hockings et al. 2006, 2012). Solitary red-tail monkeys (*C. ascanius*), which are harder to detect than when in social groups (Wallace and Hill 2012), venture further from the forest edge and consequently cause proportionally greater damage than animals foraging in groups (Baranga et al. 2012). These results illustrate the high level of behavioural and social plasticity primates are capable of, especially when living in human-modified landscapes.

2.2 Vulnerability, risk perception and habituation

Farmers sometimes describe primates and their behaviour in anthropomorphic terms, i.e., as if they were human. For example, farmers living around the edge of the Budongo Forest Reserve in Uganda refer to baboons as "*vindictive, damaging crops for the sake of it rather than for food alone*" (C. M. Hill 2000), and as '*enemies*' or '*rebels*' (C. M. Hill and Webber 2010). Where people hold negative attitudes towards primates, and other wildlife species, this ultimately intensifies people's perceptions of risk associated with these animals (Naughton-Treves 1997).

Risk perception implies an intuitive assessment of the risks to one's safety, property, wellbeing and/or welfare (Smith et al. 2000). The concept of risk perception can be applied to both wildlife and people, as risk perception irrevocably affects the way people will behave in the presence or hypothetical presence of wildlife. An increasing number of studies have highlighted the value in evaluating the mismatch between the quantified (real/measured) and subjective (perceived) frequency of incidences (occurrence) of crop-foraging events, and the real and perceived ranked severity of damage attributed to different species in a specific locality. For example, around the Budongo Forest Reserve, Uganda, baboons are responsible for a large proportion of crop damage in comparison to other species, but the farmers' perception of risk is often disproportionately high when compared with measured damage (C. M. Hill and Webber 2010).

Encouraging informants to speak for themselves and voice their worries can eventually help identify interconnected issues that underlie people's insecurities and concerns. This process can also serve to highlight misperceptions and help to: 1) inform awareness raising campaigns, 2) prioritise the management of negative interactions between people-wildlife. Finally, such an approach can also help to understand the effects of direct experiences of negative interactions, and other socio-economic, cultural, religious and gender variables on people's perceptions and behaviour.

Risk, whether for people or wildlife, can also be spatially and ecologically influenced. For example, Naughton-Treves (1997, 1998) demonstrated that forest-dwelling wildlife, including chimpanzees, baboons and red tailed monkeys living in the Kibale National Park in Uganda were more likely to damage crops in fields within 500m of the forest edge. Similar patterns have been demonstrated across a range of sites and species inhabiting protected areas (e.g. Hill (1997); Sitati et al. (2003); Linkie et al. (2007)). Foraging on crops in fields or orchards where such incursions are not tolerated is potentially very risky behaviour for primates; they are likely to be chased away, injured or even killed. This pattern explains why in some cases adult males tend to forage on crops more frequently than adult females or subadults (e.g. Hanuman langurs (*Semnopithecus entellus*), Chhangani and Mohnot (2004); vervets (*Chlorocebus aethiops pygerthrus*), Saj et al. (1999); Anubis baboons (*Papio anubis*), Forthman-Quick (1986); chimpanzees (*Pan troglodytes*), Hockings (2007) and Wilson et al. (2007)). However, if risk associated with foraging on crops is low e.g. low levels of retaliation and intolerance from farmers, and if intra-specific competition is low, then females may forage on crops as frequently as males, perhaps even more because of their need to meet reproductive demands, as exemplified in a study of wild Sumatran orang-utans (*Pongo abelii*) in an agroforestry landscape (Campbell-Smith et al. 2011a).

Reduced fear of humans among primates can also exacerbate primate-people interactions and elicit negative shifts in people's perceptions of them. For example, one-quarter of mountain gorillas (*Gorilla beringei*) in Uganda's Bwindi Impenetrable National

Park are reported to visit farms and plantations neighbouring the park, including habituated and unhabituated groups (S. Asuma pers. comm. 2008). Bwindi gorillas apparently foraged on crops before habituation for tourism began. However, prior to the gazetting of the national park, gorillas only infrequently ventured outside the current park boundaries and were easily chased away. Unfortunately loss of fear of humans may have since heightened the gorillas' assertiveness when foraging in crops (K. Hockings and Humle 2009). Reduced fear of humans can indeed exacerbate the frequency of crop damage events, encourage primates' presence around human activity, and precipitate incursions into human settlements, as well as their use of roads and paths (e.g. great apes: Hockings and Humle (2009); Hockings et al. (2006)). The effect of habituation combined with the exodus of people away from rural areas into urban conglomerates in countries such as Japan is also accentuating these issues (Knight 2000). The increasingly elderly population in rural Japan is less able to chase off animals feeding on their crops and implement prevention strategies. Japanese macaques (*M. fuscata*) and wild boars (*Sus scrofa*) apparently thrive particularly well in such areas since risks associated with foraging on crops is much reduced (Knight 2000).

Where primates are habituated to human presence and/or when NHPs perceive people as threatening, the risk of aggressive acts between the two can also be heightened (K. Hockings and Humle 2009). For example, all aggressive events reported between 1995 and 2009 between habituated chimpanzees and people at Bossou, Guinea, have been linked to some sort of human provocation (K. J. Hockings et al. 2010). These events may vary in the temporal interval between provocation and retaliation, especially since chimpanzees demonstrate a capacity for episodic memory (the what, where and when) (Martin-Ordas et al. 2010) and for facial recognition (Tomonaga 1999). More recently, however, some acts of aggression of chimpanzees towards people appear to reflect displacement acts of aggression rather than acts of retaliation or 'revenge' per se (Humle pers. obs). McLennan and Hill (2013) noted that unhabituated chimpanzees at Bulindi in Uganda started stalking researchers and their field assistants soon after an outbreak of small-scale logging in local forest patches, in response to a misconception by people that the forest would be set aside for protection and that human access to resources would be restricted and regulated. Provocation and/or a feeling of insecurity are clear drivers of aggression whether of primates towards people or vice versa. Indeed, risk perception may affect inter-specific aggression and/or intolerance, as the landscape shifts from being stable and secure to less predictable and more precarious for both wildlife and people. Koutstaal (2013) describes anecdotal cases of how people's behaviour towards, and encounters with wild chacma baboons (*Papio ursinus*) in the Cape Peninsular of South Africa underlie the animals' behaviour towards people, from curious and harmless to aggressive depending on people's response to their presence. Hurn (2011) further details how growing fear among tourists and residents promulgate aggressive management measures directed at baboons from paintball guns to enthanasia of so called problem individuals. Such cases exemplify how different primate populations, groups and/or individuals, including humans, may display different tipping points in tolerance capacity and how perceptions influence people-primate interactions (see section 2.3 below).

2.3 Predicting human intolerance and its consequences on primates

People's tolerance towards wildlife that damage crops may be influenced by an array of ecological, socio-cultural and economic factors (Naughton et al. 1999; Naughton-Treves 1997). Indeed, ecological factors such as 1) crop attributes, e.g. size, value, seasonality, and growth patterns, 2) patterns in crop loss and damage, e.g. the timing of raids relative to harvest, crop part damaged, circadian timing of damage event, and the extent and frequency of the damage, and 3) landscape attributes, e.g. proximity to forest edge, field size and habitat heterogeneity and crop diversity, are known to influence the probability and the extent of crop damage and therefore people's tolerance of wildlife-related crop-loss (C. M. Hill 1997, 2000; Naughton-Treves 1997). However, predicting tolerance is not always a straightforward affair. While some studies suggest that people are more likely to resent wildlife damage to staple crops, such as rice or cassava (Mascarenhas 1971), others indicate that farmers are less tolerant of damage to high-value cash crops (K. J. Hockings and McLennan 2012). Such differences may reflect variations in people's perceptions and expectations as influenced by their cultural and educational backgrounds, social status, gender, and their capital and labour investment, as well as their financial security, needs and aspirations (Naughton-Treves 1997).

In some cases, intolerance may result in the 'deliberate killing', 'lethal control', 'retaliation', 'persecution' or 'retributive or defensive killing' of individuals. This is illegal when endangered species are concerned, creating conflicts between farmers, government and/or protected area authorities and conservationists. Meijaard et al. (2011) carried out social surveys across several hundred villages and amassed nearly 7,000 responses from across Borneo, Indonesia. Nearly a quarter of those who reported 'conflict' with orang-utans also reported personally killing an orang-utan as opposed to 7% of respondents who reported no 'conflict'. However, there does not appear to be a significant relationship between killing rates and frequency of conflict. As previously discussed, 'retaliatory or retributive killings' can affect the local survival of a species, its ranging behaviour, its behaviour towards humans, its social organization, its genetics, its ecology and the ecosystem, and may also exacerbate the risk of zoonotic disease transmission. Great apes are particularly vulnerable as a result of their life history; they reproduce slowly and are therefore vulnerable to demographic disturbances. Minimum age at first pregnancy for great apes is between 8 and 15 years and the IBI is typically between 4 and 8 years (Williamson et al. 2013). Demographic recovery can be particularly slow, especially since infant mortality can also be relatively high in the first year, e.g. as high as 20% among some chimpanzee communities (K. Hill et al. 2001).

Legal lethal control of non-threatened primate species also occurs and may be promoted and managed by government authorities and/or NGOs locally. Such is the case in South Africa with chacma baboons where adults males are on occasion trapped and euthanized because they are considered too dangerous, threatening and intrusive (Hurn 2011). It was rumoured that the Department of Wildlife and National Parks of Malaysia culled or 'got rid of' nearly 100,000 macaques in 2012 alone (Vinod 2013). However, plans to selectively remove or cull males could result in a skewed sex-ratio which could then impact the population's genetic health by reducing its effective population size and increasing genetic drift. Such an effect could ultimately create an inbreeding depression in a small-sized population of mammals (Sukumar 1991).

Lethal control was adopted as a strategy to deal with invasive rhesus and patas monkeys in Puerto Rico (Engeman et al. 2010). These monkeys were introduced to coastal islets in secure breeding facilities in the 1930s for medical research purposes for a period of more than forty years. Escapees joined the mainland of south-western Puerto Rico and quickly adapted to foraging on crops to survive. The Department of Agriculture estimated the total economic losses by commercial farmers ranged between $1.13 million US to $1.46 million US per year between 2002 and 2006; this is an underestimate because it fails to account for the destruction of native wildlife, the threat of disease spread, i.e. herpes and hepatitis, and property damage. A major campaign aimed at mitigating the problem resulted in the culling of 800 monkeys (mostly patas) in 2008 (Lin 2010). Such management strategies are highly contentious, ignite severe criticism from the public and animal welfare groups, and are of unproven effectiveness. For example, Quirin and Dixon (2012) revealed in a study in western Ethiopia that a baboon cull which took place in 2004 had a variable effect on farmers' perceptions of current crop losses. Some perceived crop damage to have declined while others thought crop losses due to other species had significantly increased compared with pre-cull levels; suggesting either that culling was ineffective, at least based on people's perceptions, or perhaps baboons were not as important a cause of crop losses as initially perceived by local people.

3 Prevention and mitigation strategies

3.1 Primate translocation and other mitigation strategies

Translocation of primates can sometimes be viewed as the most suitable strategy to manage negative interaction between primates and people, especially if weighted against options such as culling or euthanasia. However, such an option should typically be considered only when the situation in situ is unmanageable and the impact on both people and/or primates is deemed irreducible by any other means (K. Hockings and Humle 2009). Translocations have to date mainly concerned invasive primates, situations where primates hold a special cultural or religious significance for people (Kavanagh and Caldecott 2013) or when the problem(s) or human-induced impact concerns an endangered species, e.g. as in the case of orang-utans in parts of Borneo and Sumatra (K. Hockings and Humle 2009).

However, translocations are most often not well managed and planned. For example, in India, protests against government apathy towards reported issues with urban NHP damage to property and harassment of people encouraged the authorities to resort to indiscriminate trapping and release of individuals in rural areas (Pirta et al. 1997). Problems quickly arose between translocated individuals and local people in these areas who were unused to bold and threatening urban primates who were quick to pass on their bad habits onto their more naive rural conspecifics (T. Simlai pers. comm). Such unplanned and mismanaged translocations could spatially disseminate ‘conflict issues’ and further strain people’s religious and cultural values with respect to wildlife in other regions of the country.

Reports of exemplary translocations are unfortunately rare. One such example is that of three olive baboon (*Papio anubis*) troops in an area in Kenya where baboons were perceived as ‘pests’ and human encroachment was increasingly threatening their habitat (Strum 1994). This translocation involved the capture in 1984 of 131 baboons; these social units were relocated more than 200km away from their natal area into a drier zone also harbouring wild conspecifics in the Laikipia Plateau. This initiative involved extensive pre- and post-release monitoring of translocated individuals, especially of the Pumphouse Gang (PHG) (Strum 2005). The PGH troop adapted well to its novel environment, demonstrating that translocation can in some cases be a successful strategy (Strum 2005, 2010).

Nevertheless, translocation or relocation is rarely a useful and feasible option for many species, given that suitable habitats are often scarce and the process is ethically and logistically complicated, especially for NHP species that are long-lived and subsist in complex social groupings (e.g. Hockings and Humle (2009)). In addition, releasing individuals into areas already populated by conspecifics could result in mortalities as a result of intra-specific aggression, especially among males (e.g. chimpanzees: Goosens et al. (2005); Humle et al. (2011)) or disease transmission if individuals are not appropriately quarantined and tested prior to being released (Beck et al. 2007; Kavanagh and Caldecott 2013).

Very few studies have tested alternative mitigation techniques. Hill and Wallace (2012) experimented with different locally-appropriate and developed techniques aimed at reducing crop damage by baboons, chimpanzees, vervet, red tail and blue monkeys around Budongo Forest Reserve, Uganda. They developed and trialled four categories of deterrents in collaboration with local farmers: barriers, alarms, repellents and systematic guarding. Systematic guarding proved highly effective, as did net fencing with bells attached along its length that functioned as an alarm, signalling primate attempts to negotiate the fence. Impenetrable living Jatropha hedges, multi-strand barbed wire fences combined with ocimum (*Camphor basil*) planted along the bottom of the fence, and rope fences coated with chilli paste were also effective at reducing primate crop damage. Barbed wire fences on their own showed mixed results, and simple ropes strung with bells were ineffective on their own. These measures varied in their costs and practical implementation as barbed wire fence is expensive and a hedge cannot readily be moved around in a landscape characterised by shifting agriculture, although such an approach could be highly effective in protecting permanent gardens. This study also revealed that these measures led to wildlife shifting their attention to unprotected neighbouring farms, displacing the problem, and highlighting the importance of implementing mitigation schemes simultaneously across all neighbouring farms. Persistent efforts could eventually lead to a significant decrease in primate crop damage events where the animals have adequate natural forage available, something that should be assessed a priori. A year later farmers at this site were still using and maintaining most of the barriers and warning systems trialled in the original study, and some neighbouring farmers had also adopted similar methods (Hsaio et al, 2013).

Campbell-Smith et al. (2012) trialled noise deterrents and netting of trees to deter Sumatran orang-utans from raiding fruit orchards in an agro-forestry landscape. Implementing these measures improved local farmers’ attitudes towards orang-utans. Netting of trees and noise deterrents proved highly effective when comparing pre-trial and post-trial damage events and there was no difference in crop damage incidents between pre-trial and post-trial control farms. Although netting trees proved most effective, resulting in a significant increase in crop yield, farmers were no longer employing this technique within 6 months of the end of the study. The authors argued that this technique was more expensive and logistically complex to put in place, therefore recommended the development of nets that were easier to install. Interestingly, farmers who trialled the tree nets were more likely to inflate crop losses than were control participants, perhaps because they had hopes of receiving compensation (Campbell-Smith et al. 2012).

Reducing primate aggression towards people can be promoted by changing people's behaviour towards primates and vice versa (K. Hockings and Humle 2009), enforcing rules and regulations at tourist sites (Macfie and Williamson 2010) and managing provisioning and waste disposal and recovery (Fuentes et al. 2007). In some cases, preventing surprise encounters between people and ground travelling apes, such as chimpanzees, on shared paths by improving visibility could potentially act to reduce aggressive incidents (K. Hockings and Humle 2009).

3.2 Agricultural practices, land use management & policy

Land use development whether across rural or urban areas will necessarily impact primate resource and space requirements. Understanding the requirements of displaced and isolated populations of primates is therefore essential for land use management and conservation planning (Hoffman and O'Riain 2012; Sha et al. 2009). However, not all changes to the landscape restrict animal movements. Bali has extremely high human densities at approximately 500 individuals per square kilometre and Balinese macaques (*M. fuscicularis*) occur throughout the island aside from the capital city (Fuentes et al. 2005). Still, macaque groups are substantially or integrally food enhanced, i.e. their nutritional requirements are met from human provisioning or activity (Wheatley 1999). Incidental or voluntary provisioning occurs at temples or shrines where the majority of macaques occur, and where people commonly make food offerings. Lansing (1991) described how Bali, over the course of millennia, has become a mosaic of riparian forest corridors and forest islands outlined by culturally specific land use patterns such as wet-rice agriculture, irrigation systems and temple complexes. Fuentes et al. (2005) claim this landscape has strongly favoured macaque ranging, foraging and male dispersal patterns, demonstrating their ability to adapt and maintain genetic viability (Fuentes et al. 2006). Landscape features are valuable in promoting individual dispersal but may also help to reduce encounter rates between people and macaques. Indeed, Sha et al. (2009) recommend that designing buffer zones around reserve areas could help minimise primate foraging on crops and overlap in land use between people and primates.

Wich et al. (2012) argue that it is vital to understand wild orangutan and other threatened wildlife overlap with protected areas and commercial-scale or industrial concessions to inform conservation planning. The challenge lies in the fact that more than 50% of orang-utan distribution lies in undeveloped forest, oil palm and tree planting concessions and any infringement into these areas conflicts with national laws concerned with species protection. Wich et al. (2012) therefore suggest for example that urgent efforts need to focus on improving yields in current plantations and on expanding concessions in deforested areas. It is urgent to align land use management, conservation and development policy and the valuing of ecosystem services of forested areas such as water provision, flood control, carbon sequestration, and provisioning of natural resources supporting people's livelihoods (see Chapters XX).

However, where primates can survive and thrive on natural resources and they share the landscape with people, agricultural development should focus on maintaining natural resources, promoting connectivity to ensure wildlife population viability and minimising crop damage and loss. One way of preventing crop loss or damage is to switch land use activities or promote zero- or low-risk crops instead (K. J. Hockings and McLennan 2012). However, such strategies may not always result in equal or greater economic benefit to farmers or land owners. To avoid damage to fruit and vegetable crops by invasive patas and rhesus monkeys on Puerto Rico, some land owners converted their land, at an economic loss, to pasture for livestock or the production of forage (Engeman et al. 2010). However, some crops can help balance both economic and conservation objectives. Hockings and Sousa (2012) demonstrated that cashew (*Anacardium occidentalis*) production across a forested-agricultural matrix around the Cantanhez National Park in Guinea-Bissau, West Africa, can benefit both wild chimpanzees and people, providing an example of co-utilization. While this tree species is of high economic value, it is also nutritionally beneficial to wild chimpanzees. Chimpanzees focus on the fleshy part of the fruit leaving behind the valuable casing, where the seed, i.e. the cashew nut, is located, for farmers to harvest. Although this crop species appears to meet both livelihood and conservation objectives, it must be noted that unmanaged expansion of cashew plantations, or any other low conflict crop of high market value, could result in significant habitat loss for wild chimpanzees and other wildlife. Such risks highlight the necessity of promoting mixed approaches to rendering land use planning compatible with wildlife conservation.

3.3 Increasing mutual tolerance

Sillero-Zuberi et al. (2007) proposed an ‘impact reducing scheme’ aimed at mitigating ‘conflict’ issues based on whether problems can be reduced effectively or not, leaving behind residual impact, i.e. impact that is currently irreducible (see Fig. 1). By this scheme, the only mechanism by which the latter can be managed is by influencing people’s tolerance capacity via different approaches including education or direct and indirect benefit schemes. However, factors influencing people’s willingness or capacity to tolerate sharing landscapes, with wildlife are not well understood (Treves and Bruskotter 2014). It is often assumed that a lack of tolerance towards wildlife, including primates, is a consequence of people’s concerns about economic losses incurred. While this is often a focus of people’s expressed concerns, it is not always the primary factor affecting people’s tolerance towards their animal neighbours. For example, research by Marchini and Macdonald demonstrates that ranchers expression of intent to kill jaguars is not necessarily a retaliatory response to livestock losses or even perceived threats to people, but are better explained by ‘social norms’, i.e., ranchers were more likely to kill or threaten to kill a jaguar if that was the locally acceptable response (Marchini and Macdonald 2012). Recent research in Uganda has revealed that while people generally do not regard chimpanzees as a significant threat to people’s crops, the fact that people fear them is an important determinant of people’s attitudes towards them, and perhaps their willingness to tolerate their presence within a shared landscape (McLennan and Hill 2012). The important point here is that, while most researchers concur that increasing people’s willingness or capacity to tolerate wildlife, including primates, is key to improving relationships between people and wildlife, how improved tolerance is to be achieved is not necessarily straightforward or obvious. Should increasing tolerance not abate the problem, then it is expected that lethal control whether legal or not will ensue as discussed previously.

Insert Fig. 1 ‘Impact reduction scheme’ adapted from Sillero-Zuberi et al. (2007) about here

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Community outreach programmes aim to help rural villagers acquire or develop practical skills or new tools for defending their crops and livestock, for managing waste from its handling, collection, transportation to its disposal, and for minimising the risk of attack when faced with NHPs, and for switching from high to low conflict crops (e.g. Hockings and Humle 2009). Under an optimistic scenario, such an approach could strengthen local capacity for conflict prevention and resolution, and change people's perceptions, attitudes and behaviour towards NHPs. It could also result in reduced risks for both people and NHPs, improvements in people's livelihoods and a reduction in their vulnerability to negative interactions with NHPs. This could potentially help to promote people's commitment towards conservation, to raise awareness of the essential role of NHPs in ecosystem functioning and their intrinsic and economic importance.

Direct compensation schemes designed to increase people's tolerance levels to damage caused by NHPs and to prevent retaliation are often funded by conservation organizations, although government schemes also exist. However, compensation can only at best address the symptoms of the problem and not its causes (Bulte and Rondeau 2005; Hoare 2001), which are often less to do with the animals' behaviour and more a consequence of conflict and disagreement between different human groups (Dickman 2010; Madden and McQuinn 2014). The failure of most direct compensation schemes can be attributed to bureaucratic inadequacies, corruption, fraudulent claims, and the practical barriers that less literate farmers must overcome to submit a compensation claim (Hoare 2001). Such schemes are also difficult to manage logistically in practice and are most often financially unsustainable (Dickman et al. 2011; Nyhus et al. 2003).

Indirect compensation schemes typical imply wildlife valuing schemes, such as Community-Based Natural Resource Management (CBNRM) programmes (K. Hockings and Humle 2009). But such benefit-sharing approaches are expensive and require sustained funding (K. Hockings and Humle 2009). Lamarque et al. (2009) highlight several other issues related to indirect compensation schemes. Generated income is often insufficient to counter losses and damages, let alone to share these revenues with neighbouring communities. They also suffer from issues of ownership, participation, administrative arrangements and disbursement of income; for such a scheme to be at all effective these need to be universally agreed upon before any such venture is attempted. However, other schemes have been developed with potential to increase people's tolerance of NHPs and wildlife in general. Conservation through Public Health (CTPH) is one such example. This NGO based in Uganda runs programs aimed at improving public, livestock and wildlife health in order to minimise the risk of zoonosis around gorilla habitat. They also facilitate family planning and assist with local-level development and raising environmental awareness by providing people with internet access and training them in using information and communication technology.

Innovative compensation schemes also include insurance schemes whereby farmers pay a premium for cover against a defined risk (Lamarque et al. 2009). Such schemes require an accurate assessment of the cause of crop damage, or injury caused by wildlife. Because such schemes can operate on a more local scale, it is easier to verify reported cases. However, the scheme's efficacy can be improved if certain practices are imposed upon participating farmers, i.e. they need to be proactive in preventing crop foraging by wildlife by adopting deterrent techniques. Such schemes have to date primarily be applied to livestock depredation. It therefore remains to be ascertained whether such an approach could help with addressing issues between people and NHPs.

4 Conclusion: a matter of values?

This chapter highlights the complexities of interactions between people and NHPs and the different scales of interactions influencing co-existence, stressing the potentially significant impact of conflict among people and stakeholders on the relationship between people and NHPs. Clearly some primate species are more able than others to manage changing landscapes and co-habitation with humans. Coexistence also depends on a multitude of factors, often temporally and spatially dynamic affecting socio-economic and cultural norms and values, as well as people's and NHP's perceptions. Understanding animal-human interactions requires a multifaceted approach bringing together a detailed understanding of both the context and perspectives of both the NHPs and people and relevant organizations and institutions at play, as well as the drivers of change of patterns of co-existence. Failing to grasp and address these could represent today potentially one of the biggest threats to the long-term survival of many NHPs species across the globe. As demonstrated above, no single kit can mitigate or prevent effectively the erosion of interactions between people and animals. Disentangling issues at stake on a case by case basis can help to inform grassroots schemes and policy across a wider landscape and to manage contexts demonstrating deteriorating relationships between people and NHPs.

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Figure 1. ‘Impact reduction scheme’ adapted from Sillero-Zuberi et al. (2007)