Chapter 14
Managing Humans, Managing Macaques: Human–Macaque Conflict in Asia and Africa

Nancy E.C. Priston and Matthew R. McLennan

14.1 Introduction

Conflict between humans and wild animals is one of the greatest challenges to biodiversity conservation globally (Hill et al. 2002; Woodroffe et al. 2005). Expanding human populations and large-scale, accelerating conversion of natural habitats to alternative land uses mean that wildlife populations must adapt to human-dominated environments or disappear. At the same time, sustainable coexistence between people and wildlife in shared landscapes demands that humans share space and resources with wild animals. Today, the majority of non-human primates (hereafter 'primates') are severely threatened by habitat loss and modification (Chapman and Peres 2001; Cowlishaw and Dunbar 2000). However, the responses of individual taxa to increasingly 'agriculturalised' – and, in some circumstances, urbanised – environments occur along a gradient ranging from local extinction (inability to adapt) to apparent benefit (ecological and behavioural adaptation) (Gautier and Biquand 1994). Taken as a whole, the genus *Macaca* appears to typify this latter response, though considerable variation exists among macaques in their propensity to exploit anthropogenic environments and coexist with people. Due to this frequent association with humans, macaques feature prominently in the growing database of primate–people conflicts. In this chapter, we review the human–macaque conflict situation in Asia and Africa. Using specific case studies, we explore the influence of

N.E.C. Priston (✉) • M.R. McLennan
Faculty of Humanities and Social Sciences, Department of Social Sciences,
Oxford Brookes University, Oxford OX3 0BP, UK
e-mail: nancy@cantab.net

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cultural factors and differing interaction contexts on conflict scenarios and the influence of policy on mitigation strategies and conservation.

Macaques are among the most successful primate radiations (Fooden 1980). Aside from humans, they occupy the widest geographical range of any primate genus: natural populations occur in North Africa, throughout south and southeast Asia and southern China, and northeast to Japan, where *M. fuscata* has the most northerly and easterly range of any primate. Although formerly widespread in Europe, today the genus is represented by a small introduced population of Barbary macaques on Gibraltar (Abegg 2006). Macaques have also been introduced to regions far outside their natural range, for example, *M. mulatta* in Puerto Rico (Engeman et al. 2010) and *M. fascicularis* in Mauritius (Sussman et al. 2011) and in the Republic of Palau (Wheatley 2011). With a latitudinal range spanning 20°S to 40°N, macaques occupy a diversity of habitats, including grasslands, mangroves, tropical rainforests, deciduous and temperate forests, rocky cliffs and coastal regions, as well as anthropogenic habitats (Thierry 2011). Given this remarkable ecological adaptability, it is unsurprising that macaques are among the most taxonomically diverse of extant primate genera, with up to 23 species in five species groups currently recognised (Fooden 1980; Groves 2001; IUCN 2011; Ziegler et al. 2007; Table 14.1).

14.1.1 Macaques as 'Pest' Primates

The last two decades have seen a proliferation of studies reporting conflict between humans and wild primates, particularly in the context of crop raiding (Hill 2005). Crops offer energetic advantages over many natural foods for primates in human-modified habitats (Forthman-Quick and Demment 1988). As natural habitats are converted to farmland, the list of primates decried as crop pests continues to grow (review in Lee and Priston 2005). Species now known to supplement their natural diets with human foods include Asian colobines (e.g. *Presbytis thomasi*, Marchal and Hill 2009), Neotropical cebids (e.g. *Cebus libidinosus*, de Freitas et al. 2008), Madagascan lemurs (*Lemur catta*, LaFleur and Gould 2009) and African great apes (e.g. *Pan troglodytes*, McLennan 2008). However, few such taxa can be considered to prosper in disturbed habitats in association with people (Richard et al. 1989). Three groups of primate are particularly successful at exploiting the human–primate interface. These are the baboons (*Papio* spp.), vervet and tantalus monkeys (*Chlorocebus* spp.) in Africa and the macaques in Asia. (Wild Barbary macaques *M. sylvanus* in North Africa appear to fare less well in anthropogenic habitats compared to many members of their genus in Asia; Mouna and Camperio Ciani 2006) Broadly speaking, members of these genera exhibit a range of traits that enable them to exploit agricultural landscapes, notably, semi-terrestrial locomotion, large and complex social groupings, flexible and varied diets, intelligence, manual dexterity and agility, and a somewhat feisty and audacious temperament (Else 1991; Knight 1999; Strum 1994).

Table 14.1 Overview of macaque–human conflict situations and conservation status (in 2000 and 2008) in 23 currently recognised species of *Macaca* in Asia and Africa

Species	Distribution	IUCN status[1] 2000	IUCN status[1] 2008	Conflict situation	References
Barbary macaque *M. sylvanus*	Algeria, Morocco (introduced – Gibraltar)	V	E	Tourism/provisioning	Fa (1992), Fuentes (2006b), and Maréchal et al. (2011)
				Urban nuisance	Cortes and Shaw (2006) and Deag (1977)
				Crop-raiding	Camperio Ciani et al. (2001)
				Bark-stripping	Mouna and Camperio Ciani (2006)
Lion-tailed macaque *M. silenus*	India (Western Ghats)	E	E	Crop-raiding	Menon and Poirier (1996)
Crested macaque *M. nigra*	Sulawesi	E	CE	Crop-raiding	Bynum et al. (1999)
Gorontalo macaque *M. nigrescens*	Sulawesi	NT	V	Crop-raiding	Bynum et al. (1999)
Heck's macaque *M. hecki*	Sulawesi	NT	V	Crop-raiding	Bynum et al. (1999)
Tonkean macaque *M. tonkeana*	Sulawesi	NT	V	Crop-raiding	Supriatna et al. (1992), Riley (2007), and Riley and Priston (2010)
Moor macaque *M. maura*	Sulawesi	E	E	Crop-raiding	Supriatna et al. (1992)
Booted macaque *M. ochreata*	Sulawesi	DD	V	Crop-raiding	Bynum et al. (1999) and Riley et al. (2007)
Buton macaque *M. brunnescens*	Sulawesi	V	V	Crop-raiding	Priston (2005), Priston (2009), and Riley and Priston (2010)
Pagai macaque *M. pagensis*	Mentawai Islands	CE	CE	Crop-raiding	Fuentes (2002)

(continued)

Table 14.1 (continued)

Species	Distribution	IUCN status[1] 2000	2008	Conflict situation	References
Siberut macaque *M. siberu*	Mentawai Islands	CE	V	Crop-raiding	Fuentes (2002)
Southern pig-tailed macaque *M. nemestrina*	Indonesia, Malaysia, Brunei, Thailand	V	V	Crop-raiding	Hashim et al. (2009) and Linkie et al. (2007)
Northern pig-tailed macaque *M. leonina*	Bangladesh, Cambodia, China, India, Lao PDR, Myanmar, Thailand, Vietnam	V	V	Crop-raiding	Choudhury (2003) and Srivastava (2006)
Toque macaque *M. sinica*	Sri Lanka	V	E	Crop-raiding	Nahallage et al. (2008) and Nijman and Nekaris (2010)
Bonnet macaque *M. radiata*	India	LC	LC	Crop-raiding	Chakravarthy and Thyagaraj (2005), Singh and Rao (2004), and Singh et al. (2011)
Assamese macaque *M. assamensis*	Bangladesh, Bhutan, China; India, Lao PDR, Myanmar, Nepal, Thailand, Vietnam	V	NT	Crop-raiding	Aggimarangsee (1992), Chalise and Johnson (2005), and Medhi et al. (2007)
Arunachal macaque *M. munzala*	India (Arunachal Pradesh)	–	E	Crop-raiding	Sinha et al. (2006)
Tibetan macaque *M. thibetana*	China	LC	NT	Tourism/provisioning	McCarthy et al. (2009), Ruesto et al. (2010), and Zhao and Deng (1992)
				Crop-raiding	Zhao (2005)
Stump-tailed macaque *M. arctoides*	Cambodia, China, India, Lao PDR, Malaysia, Myanmar, Thailand, Vietnam	V	V	Crop-raiding	Aggimarangsee (1992) and Hamada et al. (2007)

Long-tailed macaque *M. fascicularis*	Mainland SE Asia, Philippine and Indonesian archipelagos (introduced – various locales)	NT	LC	Tourism/provisioning	Fuentes and Gamerl (2005), Loudon et al. (2006), and Wheatley (1999)
				Urban nuisance	Malaivijitnond et al. (2011), Md-Zain et al. (2011), and Sha et al. (2009)
				Crop-raiding	Aggimarangsee (1992), Loudon et al. (2006), Marchal and Hill (2009), and Wheatley (2011)
Rhesus macaque *M. mulatta*	Afghanistan; Bangladesh, Bhutan, China, India, Lao PDR, Myanmar, Nepal, Pakistan, Thailand, Vietnam (introduced – various locales)	NT	LC	Tourism/provisioning	Jones-Engel et al. (2006) and Shek (2011)
				Urban nuisance	Chauhan and Pirta (2010a), Imam et al. (2002), Shek (2011), Southwick et al. (2005), Southwick and Siddiqi (2011), and Srivastava and Begum (2005)
				Crop-raiding	Chalise and Johnson (2005), Engeman et al. (2010), Pirta et al. (1997), Southwick et al. (2005), and Wang et al. (2006)
Japanese macaque *M. fuscata*	Japan	DD	LC	Tourism/provisioning	Knight (2005) and Watanabe and Muroyama (2005)
				Crop-raiding	Enari and Suzuki (2010), Knight (1999), Sprague (2002), Suzuki and Muroyama (2010), Watanabe and Muroyama (2005), and Yamada and Muroyama (2010)
Formosan macaque *M. cyclopis*	Taiwan	V	LC	Tourism/provisioning	Hsu et al. (2009)
				Crop-raiding	Poirier (1986)

[1] Listed IUCN categories in increasing order of concern: DD = Data Deficient; LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered (IUCN 2011). Species designated as V, E or CE are considered to be threatened with extinction.

Considering their wide geographical distribution and taxonomic diversity, the macaques are perhaps the most notorious and successful of 'pest primates'. All species raid crops (Table 14.1). Indeed, certain macaque species – the so-called weeds (Richard et al. 1989) – show a preference for foraging in the mosaic of habitats created by human settlement, cultivation and pastoralism and derive a substantial portion of their diet directly or indirectly from people (Richard et al. 1989). Unlike their 'pest' counterparts in Africa – the baboons and vervets – macaques have formed a commensal relationship with people in many Asian nations (Lane et al. 2010; Sha et al. 2009; Singh and Rao 2004; Southwick et al. 2005). Across Asia, macaques are found in proximity to villages and towns (Aggimarangsee 1992; Southwick et al. 1961; Watanabe and Muroyama 2005); some even make a living in densely populated urban areas (e.g. *M. mulatta* in Indian cities: Mathur and Manohar 1990; Srivastava and Begum 2005; *M. fascicularis* in residential Singapore: Lee and Chan 2011; Sha et al. 2009). This close association with people is facilitated by human cultural attitudes that imbue monkeys with religious and/or symbolic significance (Burton 2002; Knight 1999; Wheatley 1999; Wolfe 2002). For example, in Hindu mythology, monkeys are revered as representatives of Hanuman, the monkey god, following his key role in the Ramayana, a Hindu Sanskrit epic. Although Hanuman is usually depicted as a langur (*Semnopithecus entellus*), in many Hindu cultures, he has come to represent all monkeys, including macaques. Consequently, orthodox Hindus consider it their sacred duty to feed macaques (Pragatheesh 2011). More generally, macaques are commonly found in association with Hindu and Buddhist temples throughout south and southeast Asia and southern China, where they are provisioned by devotees and, at some sites, tourists (Aggimarangsee 1992; Jones-Engel et al. 2006; Loudon et al. 2006; Medhi et al. 2007; Southwick et al. 1961; Wheatley 1999; Zhao 2005). Whether the monkeys themselves are objects of worship or rather the sacred temples and shrines they often inhabit (Fuentes et al. 2005), cultural beliefs held in many parts of Asia have traditionally provided a context for tolerance and a measure of protection for macaque populations. Nevertheless, this close coexistence between humans and macaques inevitably leads to conflicts. Moreover, conflicts are increasingly challenging traditional relationships between people and macaques (Knight 1999; Southwick and Siddiqi 2011).

Conflicts between people and macaques occur in three broad contexts, all stemming from the macaques' dependence on humans for food, whether directly (i.e. provisioning) or indirectly (crop-raiding, food-stealing). First, macaques damage subsistence and/or cash crops in rural locales (Chakravarthy and Thyagaraj 2005; Chalise and Johnson 2005; Hashim et al. 2009; Priston 2005; Riley 2007; Supriatna et al. 1992; Suzuki and Muroyama 2010). Consequently, in agricultural areas, macaques may be viewed as serious vertebrate pests (Engeman et al. 2010; Knight 1999; Marchal and Hill 2009; Wang et al. 2006; Wheatley 2011). In rural Morocco, macaques damage commercially valuable timber by stripping the bark (Camperio Ciani et al. 2001). Second, macaques habituated to close interaction with people at temples and tourist attractions frequently show undesirable behaviours associated with provisioning, including human-directed aggression and food-snatching (Fa 1992; Fuentes and Gamerl 2005; Zhao 2005). Third, in urban towns and cities,

macaques are sometimes regarded as a worrisome, potentially dangerous nuisance. Typical problem behaviours include physical aggression towards people, snatching bags, entering and damaging property, stealing food and other items, fouling and raiding garbage (Chauhan and Pirta 2010a; Cortes and Shaw 2006; Imam et al. 2002; Md-Zain et al. 2011; Sha et al. 2009; Shek 2011; Southwick et al. 2005). The 'monkey problem' may reach such proportions that urban macaques are regarded as a serious menace (Southwick and Siddiqi 2011; Southwick et al. 2005; Srivastava and Begum 2005). A further area of 'conflict' arising from close interaction between people and macaques, not covered in this review, concerns the potential for zoonotic disease transmission (see, e.g. Fuentes 2006a; Jones-Engel et al. 2006; Lane et al. 2010, and Chap. 10 by Peterson and Riley, this volume).

Below, we use specific studies to explore these aspects of human–macaque conflict in more detail and the influence of human cultural beliefs on attitudes towards macaques. The distinction between macaque behaviour in agricultural and urban settings, and at temples or other tourist attractions, is to some extent artificial – temple-residing monkeys raid farmers' subsistence crops (Aggimarangsee 1992; Loudon et al. 2006; Medhi et al. 2007), macaques provisioned at recreation sites can cause a nuisance in nearby residential areas (Cortes and Shaw 2006; Sha et al. 2009; Shek 2011), while macaques in rural locales may threaten people (Hamada et al. 2007; Knight 1999) and damage property (Enari and Suzuki 2010). Nevertheless, it is useful to consider human–macaque interactions in these environments individually to explore the variety of contexts in which conflict occurs.

14.2 Conflict Case Studies

14.2.1 Human–Macaque Conflict in Agricultural Areas

14.2.1.1 Crop-Raiding in Sulawesi, Indonesia

The island of Sulawesi in the Indonesian archipelago covers a relatively small area of 179,426 km^2 but supports a diversity of endemic species including the six to seven recognised species of Sulawesi macaque, representing a unique radiation within *Macaca* (Fooden 1980; see Riley 2010a for a recent review). All species are declining and are considered threatened by the International Union for Conservation of Nature with a noticeable recent decline indicated by a change in status from 2000 to 2008 (IUCN 2011) (Table 14.1). The chief threats are land conversion for agriculture, habitat fragmentation and hunting (Bynum et al. 1999; Lee 1995; IUCN 2011; Supriatna et al. 1992). Across Sulawesi, agriculture is one of the main economic activities, and much of the human population are engaged in subsistence agriculture (notably, sweet potato and maize) (Priston 2005; Whitten et al. 2002). However, recent years have seen an increase in cash-cropping, and many farmers now engage in wet-rice agriculture, and most also practise some form of plantation agriculture including coffee, cacao, cashew nut, palm oil and cloves (Riley and Priston 2010).

Fig. 14.1 Crop-raiding Buton macaque, Sulawesi (Courtesy: N. Priston)

Islam is the dominant religion in Sulawesi, but Christians form a substantial minority; Hindus and Buddhists are represented by small communities only. Earlier work identified crop-raiding as a critical obstacle to conservation of Sulawesi macaques (Bynum et al. 1999; Supriatna et al. 1992).

Current research on human–macaque interactions has focussed on two taxa, the Tonkean macaque *M. tonkeana* in central Sulawesi and the Buton macaque *M. brunnescens* on Buton Island in the southeast (synopsis in Riley and Priston 2010). These studies have considered crop-raiding as part of the macaque's ecological strategy in forest–farm ecotones and examined its impact on local livelihoods and the role of cultural attitudes in shaping local attitudes towards crop losses to monkeys (Priston 2005, 2009; Riley 2007, 2010b). Here, we focus principally on the Buton macaque. On Buton, local people engage predominantly in subsistence agriculture, with little cash-cropping; consequently, raiding of staple foods such as sweet potato, maize and banana is the primary concern in this region. These crops form an important component of the diet of some Buton macaques, with studied groups spending more than one-third of feeding time crop-raiding (Priston 2005) (Fig. 14.1). Nevertheless, sympatric wild pigs (*Sus* spp.) cause substantially more damage to sweet potato than monkeys (Priston 2009). Farmers' perceptions of loss were generally accurate, with farmers estimating an average loss of 9% of the farms' crops to monkeys at any one time versus actual measured losses of 10% (Priston 2005). This contrasts with the situation at Lore Lindu National Park where

Tonkean macaques were considered the most salient raiders of cacao, the region's major cash crop, despite causing considerably less damage than forest rats *Taeromys* sp. (Riley 2007)

Frequent damage to both subsistence and cash crops by macaques on Sulawesi, and the absence of a predominant Hindu or Buddhist culture that might be expected to foster tolerance of monkeys, predicts high levels of conflict between macaques and local people. In fact, currently, that appears not to be the case. For example, on Lore Lindu, traditional folklore envisions macaques as biologically and culturally related to humans, and harming crop-raiding macaques is traditionally taboo, lest the monkeys seek retribution (Riley 2010b). On Buton, there is little traditional folklore surrounding macaques. Nevertheless, the majority Muslim population is surprisingly tolerant of crop damage by monkeys, claiming that, though they dislike them, they do not wish to harm them (Priston 2005; Riley and Priston 2010). They describe macaques in human terms and express pity towards them as fellow creatures that also need food to survive. A commonly expressed sentiment is, 'if you don't want monkeys to come to your farm, don't open a farm', and losses to macaques are generally considered acceptable except in extreme cases (Priston 2005). Further, cashew farmers actually express positive attitudes towards crop-raiding macaques. The monkeys eat only the fruit, leaving the nuts scattered on the ground and easier for farmers to harvest (Priston 2005). In contrast, Hindus on the island (transmigrants from Bali) predominantly farm rice crops which are not raided by macaques. Despite this, and in spite of the traditional connection of monkeys to Hanuman in Hindu mythology, Buton's Hindus exhibit less tolerance of macaques compared to Muslims, and report hunting and eating them (Priston 2005; Riley and Priston 2010). These recent studies point to overall low current levels of human–macaque conflict on Sulawesi, despite frequent crop-raiding (Supriatna et al. 1992). Nevertheless, cultural attitudes towards wildlife and tolerance of crop losses are liable to change in accordance with shifting socio-economic and sociocultural conditions (see below). With continuing forest clearance and increased cash-cropping on Sulawesi, conflict between people and macaques is expected to increase.

14.2.1.2 Bark-Stripping in Morocco, North Africa

Barbary macaques (*M. sylvanus*) are the only members of the *Macaca* genus occurring naturally in the wild outside Asia. The species is popularly known from the introduced population on Gibraltar, which are visited by thousands of tourists annually (Fa and Lind 1996). However, the remaining wild *M. sylvanus* populations are limited to fragmented relict forests in mountainous or rocky areas in Morocco and Algeria. Surveys point to a sharp decline in Moroccan populations in recent decades associated with human degradation of the cedar and oak forests – the macaque's preferred habitat – as well as poaching for the illegal pet trade, predation by domestic dogs and drought (Camperio Ciani et al. 2005; Camperio Ciani and Mouna 2006; Mouna and Camperio Ciani 2006; van Lavieren 2008; van Lavieren and Wich 2010, also Chap. 11 by Majolo et al. this volume).

Unlike in Asia, local human cultures in North Africa do not attach religious sentiment to macaques.

The cedar oak forests of Morocco's Middle Atlas mountains represent the global stronghold for *M. sylvanus*. However, a conflict scenario has emerged between macaques and the human users of the forest. Macaques strip bark from commercially valuable cedar trees to satisfy water requirements and obtain certain nutrients (Camperio Ciani et al. 2001). Forest officials claim the density of monkeys in the Middle Atlas is increasing – contrary to research showing the population has declined (Camperio Ciani et al. 2005; van Lavieren and Wich 2010) – with resultant damage to the forest and, in particular, an increase in bark-stripping, which decreases the commercial value of the trees, occasionally causing their death. The monkeys are therefore considered economic pests, leading the Moroccan authorities to plan the relocation of macaques as a population management strategy (Mouna and Camperio Ciani 2006). Throughout the preceding decade, the Middle Atlas region was beset by drought, prompting shepherds to settle permanently near water sources. This had the effect of excluding monkeys from their natural water supply. Research indicates that the principal cause of the increase in bark-stripping by macaques stemmed from water shortage in response to drought and exacerbated by human occupation of water sources (Camperio Ciani et al. 2001). Despite clear evidence of the macaques' low density, and the detrimental impact of goats and sheep on the underbrush (e.g. reduced regeneration), many forest officials continue to espouse the viewpoint that macaque numbers are out of control (Mouna and Camperio Ciani 2006). Thus, endangered macaques have been made scapegoats for human-induced habitat degradation regionally.

14.2.2 Human–Macaque Conflict at Tourism Sites

Across Asia, at temples, nature parks, recreation sites and other tourist attractions, humans interact closely with macaques (*M. thibetana* in China: Matheson et al. 2006; Zhao 2005; *M. mulatta* in India and Nepal: Jones-Engel et al. 2006; Wolfe 2002; *M. fascicularis* in Indonesia and Thailand: Aggimarangsee 1992; Fuentes et al. 2005; *M. fuscata* in Japan: Knight 2005; *M. cyclopis* in Taiwan: Hsu et al. 2009) (Fig. 14.2). Elsewhere, free-ranging *M. sylvanus* are a long-established tourist attraction at Gibraltar in Europe (Fa and Lind 1996), and macaque viewing is currently being developed as a tourist attraction within the natural range of *M. sylvanus* in North Africa (e.g. Ifrane National Park, Morocco: Maréchal et al. 2011). While macaques lack religious connotations outside of Asia, a unifying characteristic of macaque-viewing sites is that the monkeys receive food from people. For religious devotees in Asia, feeding monkeys at sacred Hindu or Buddhist sites provides a means to obtain spiritual merit (Aggimarangsee 1992; Zhao 2005). Thus, macaques at tourist and/or religious sites are often conditioned to expect food from human visitors and therefore seek interactions with them. A small but growing literature concerns problems associated with provisioning free-ranging macaques at tourist

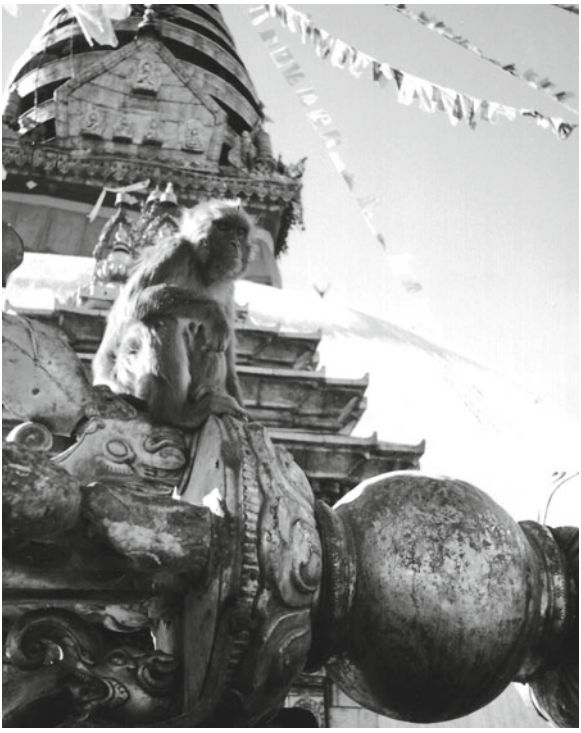

Fig. 14.2 Buddhist temple-dwelling rhesus macaque, Nepal (Courtesy: M. R. McLennan)

locations, particularly Gibraltar (e.g. Fa 1992; Fuentes 2006a,b) and the 'monkey temples' of Bali (Fuentes and Gamerl 2005; Fuentes 2006a; Lane et al. 2010; Loudon et al. 2006; Wheatley 1999; also Chap. 6 by Mallapur, this volume). Here, we use the example of Tibetan macaques in China to illustrate aspects of conflict that can arise from 'macaque tourism'.

14.2.2.1 Tourists, Temples and Tibetan Macaques: *M. thibetana* in China

Tibetan macaques and tourists interact at two sites in east-central China: Mt. Emei, a sacred Buddhist centre (Zhao 2005), and Mt. Huangshan, an ecotourism destination (Matheson et al. 2006). Both sites are popular attractions for domestic and international tourists. At Mt. Emei, pilgrims and tourists follow trails leading from the base of the mountain to the summit, along which they are intercepted by groups of macaques expecting food (Zhao 1999). Historically, limited feeding of macaques was performed by Buddhists monks and pilgrims, but following China's economic reform in 1980, growing numbers of visitors to Mt. Emei began feeding the monkeys for enjoyment. The macaques were thus conditioned to treat visitors as potential feeders (Zhao 2005). Arising from this scenario is one of the most extreme human–macaque conflicts thus far documented. *M. thibetana* is the largest and heaviest

member of its genus, with adult male weighing as much as 22 kg (Zhao 1996). Their large body size makes these primates an intimidating and potentially dangerous adversary for humans. Macaques at Mt. Emei are fearless around visitors, routinely harassing them, for example, by manually inspecting clothes and baggage and 'robbing' them of food and possessions (Zhao and Deng 1992). This harassment can escalate into violent conflict, as when macaques chase, grab and bite humans, occasionally inflicting serious injury. A vicious circle has emerged: the monkeys are conditioned to use aggression to obtain food, while visitors use food as a 'passport' to aid safe passage (Zhao 2005). Extraordinarily, the deaths of ten visitors were indirectly attributed to macaques: six fell to their deaths retreating from threatening monkeys on narrow cliff paths, two others fell while trying to recover stolen possessions and a further two were killed by falling stones dislodged by macaques moving on cliffs above (Zhao and Deng 1992).

Macaques at Mt. Emei plainly distinguish visiting humans from locals, tending to target visitors who – unprepared for the monkeys' aggressive begging and robbing – typically adopt submissive behaviour (e.g. throwing food to placate the monkeys). Conversely, macaques show conditioned avoidance of local people who exhibit dominance behaviour towards them, for example, by using stones or other objects to drive them away. This defensive behaviour has had a deterrent effect, enabling locals to sell food without harassment from macaques, recover stolen property for tourists and escort frightened visitors past the monkeys (Zhao 2005). Despite these considerable problems, the management authority and travel agencies have been reluctant to highlight risks associated with feeding the macaques and educate visitors about appropriate behaviour, perhaps anticipating a reduction in entry fees (Zhao 2005).

At Mt. Huangshan, visitors are restricted to observation platforms and are officially prohibited from feeding macaques (Matheson et al. 2006). As a result, levels of aggression witnessed at Mt. Emei have largely been avoided at this site. Nevertheless, tourists' motivation to interact with monkeys frequently provokes aggressive threats from the macaques (McCarthy et al. 2009; Ruesto et al. 2010). For example, the most frequent macaque behaviours following pointing and rail-slapping – both common tourist behaviours – are facial threats and lunges/ground slaps, respectively (McCarthy et al. 2009). Tourist decibel levels on the viewing platform and the overall frequency of tourist behaviours – often of an attention-seeking nature – are associated with increased occurrence of macaque threats (Ruesto et al. 2010).

14.2.3 Human–Macaque Conflict in Urban Environments

14.2.3.1 Rhesus in Indian Towns and Cities

The rhesus macaque (*M. mulatta*) has the widest geographical distribution of the macaques and arguably the strongest commensal tendency. In many respects, it is the archetypal 'weed' macaque (Richard et al. 1989). In India, rhesus are found at

temples, along roadsides and canals, in parks, rail stations, university campuses, in villages, towns and cities (Devi and Saikia 2008; Imam and Yahya 2002; Mathur and Manohar 1990; Medhi et al. 2007; Southwick et al. 1961, 2005). Surveys made by Southwick and colleagues since 1959 have revealed marked human-induced changes in the size of India's rhesus population and a shift in their habitat distribution. Between the late 1950s and 1970s, rhesus numbers declined by about 90% (Southwick and Siddiqi 1988). Contributing to this decline was a combination of anthropogenic factors: excessive trapping for biomedical research abroad, large-scale agricultural development, and weakening of cultural attitudes that traditionally afforded macaques protection from persecution (see below). Compared to rural areas, however, rhesus in towns fared better (Southwick and Siddiqi 1968). Rhesus numbers began to stabilise in the 1970s following reduced trapping and an eventual export ban in 1978. The 1970s also witnessed an increase in agricultural production and improved general economic conditions, which may have lessened animosity to rhesus compared with the 1960s when crop production was poor (Southwick et al. 2005). At any rate, local populations began to increase in some areas (Southwick et al. 1983; Southwick and Siddiqi 1988), and by the 1980s and 1990s, India's rhesus population showed signs of recovery (Southwick and Siddiqi 1988; Southwick et al. 2005).

Excluded from large parts of their former range by agricultural expansion and deforestation, rhesus monkeys have entered urban areas in increasing numbers (Southwick and Siddiqi 2011). Their successful colonisation of India's towns and cities was aided by human tolerance: unlike in rural areas, most urban residents are not farmers, and macaques do not compete directly with people for subsistence. Instead, the niche assumed by urban rhesus has been likened to that of rodents, pigeons or stray dogs; the monkeys often range around markets, bazaars and commercial areas living off food scraps, wastage and spillage (Southwick and Siddiqi 1968; Southwick et al. 1983). Additionally, some rhesus groups occupy temple grounds and leisure areas such as parks and receive food from visitors (Mathur and Manohar 1990). As discussed above, throughout the natural range of *Macaca*, humans feed macaques for pleasure. With competition over food relaxed, citizens of India's towns and cities are more inclined to share food with monkeys out of religious sentiment.

Nevertheless, recent studies indicate increased public concern over growing numbers of rhesus in India's urban centres (Chauhan and Pirta 2010a; Imam et al. 2002; Pirta et al. 1997; Southwick et al. 2005; Srivastava and Begum 2005). Escalating problems associated with macaques have been presented in the media or by management authorities as a 'monkey menace' (Chauhan and Pirta 2010b; Southwick and Siddiqi 2011). Surveys of public attitudes recount residents' feelings of harassment by macaques (Devi and Saikia 2008; Imam et al. 2002; Srivastava and Begum 2005). Common complaints are that rhesus invade homes and offices and steal food, clothes and other loose items; cause damage to roofs, television antennas and other electric wires; and 'vandalise' gardens. In Vrindaban town, near Agra City, residents complained that food could not be left unguarded or clothes dried in open areas. Money had to be spent fortifying homes and buildings with screens, iron grills and barbed wire to stop monkeys from entering (Imam et al. 2002; Southwick et al. 2005).

Moreover, rhesus macaques can be belligerent primates, and human-directed aggression is a potentially serious threat to human health and safety in urban centres. Aside from grabbing food, bags and other items – for example, snatching spectacles to obtain food in exchange (Chauhan and Pirta 2010a; Imam et al. 2002) – attacks on humans, including bites, are recorded regularly in some populations (Devi and Saikia 2008; Southwick et al. 2005). Most seriously, human-directed aggression by rhesus has been implicated in the deaths of several people in Indian cities. In circumstances paralleling the fatal interactions between tourists and Tibetan macaques at Mt. Emei (Zhao and Deng 1992), several people have fallen to their deaths from rooftops during aggressive altercations with rhesus (Southwick et al. 2005; Southwick and Siddiqi 2011). In an especially newsworthy incident, the deputy major of Delhi died after falling from his roof fending off monkeys (BBC News 2007). As in other contexts where people and macaques interface (e.g. at tourist attractions), an additional concern arising from close human–macaque contact in urban environments – particularly monkey bites – is the potential for disease transmission (e.g. herpes B virus; see Jones-Engel et al. 2006; Southwick et al. 2005).

The ecological and spiritual relationship that people traditionally had with macaques in India has undergone change. Whereas religious taboos previously fostered tolerance, in today's rapidly modernising India, people are more pragmatic. Managers of large-scale agricultural developments have no sentimental attachments to rhesus (Southwick et al. 1983). Damage to personal property and other nuisance behaviour by urban monkeys – in particular, occasional incidents of severe aggression – fosters unsympathetic attitudes among citizens of India's towns and cities. Revealingly, many Hindus in Guwahati City, Assam, expressed no religious sentiment towards rhesus (Srivastava and Begum 2005). Southwick and Siddiqi (2011:288) point out that the rhesus macaque's transition from revered representatives of Hanuman to economic and public health pests has produced 'cultural and philosophical conflicts for many people of India'. While some Hindus continue to feel uncomfortable about translocation or culling as management options for troublesome macaques (Chauhan and Pirta 2010b), others are calling for solutions to their 'monkey problem' (see below). The worsening relationship between people and India's most commensal of primates has wider implications. More than half of India's primates are rare and endangered (Southwick and Siddiqi 2001). There are fears that the escalating conflict between rhesus and people will erode public support for primate conservation in general (Imam et al. 2002; Southwick and Siddiqi 2001).

It is not only in India where paradoxical attitudes towards macaques prevail or where 'cultural and psychological conflicts' have emerged out of a shift in human–macaque ecological interactions (see, e.g. Knight's (1999) cultural analysis of the growing conflict between people and macaques *M. fuscata* in rural Japan). People's perceptions of, and attitudes towards, wildlife are not fixed in time or space. Across Asia, cultural beliefs that traditionally fostered tolerance of macaques are weakening in rapidly modernising societies. As farmers become absorbed into a market economy, losses to macaques, which previously may have been accepted as part of general crop returns, assume a far greater perceptual importance (Lee and Priston 2005; Southwick and Siddiqi 2011). Increasingly, tolerance of macaques may have

more to do with their economic value as tourist attractions and less to do with traditional religious sentiments (Schilaci et al. 2010). Changing sociocultural circumstances can result in relaxation of taboos. For example, while traditional indigenous folklore fosters human–macaque coexistence in central Sulawesi (Riley 2010b), migrants have no such taboos. This implies that increased transmigration will have negative consequences for Sulawesi macaques (Riley 2007). Further, the lower tolerance shown by migrant Balinese Hindus towards macaques compared to Muslims on Buton Island (Priston 2005; Riley and Priston 2010) illustrates that Hindus are not necessarily more accommodating of macaques than followers of religions that do not mythologise monkeys.

14.3 Conflict Management

The rise in human–macaque conflicts throughout the natural range of *Macaca*, and in regions where macaques have been introduced (Engeman et al. 2010; Wheatley 2011), present substantial challenges to the sustainability of human–macaque relationships and call for effective management strategies to facilitate coexistence. Since conflicts occur in a variety of settings (including farms, villages, temples, recreational areas, town and cities) and contexts (resource overlap, crop-raiding, food provisioning, tourism, commensalism), multiple management strategies are needed. Specific conflicts may require an integrated approach with interventions tailored to local situations (e.g. Shek 2011). A thorough discussion of the relative advantages and disadvantages of various conflict management approaches is beyond the scope of this chapter (for a comprehensive overview of human–macaque conflict mitigation strategies, see Jones-Engel et al. 2011). However, it is important to emphasise that conflict mitigation should not be considered in isolation from other factors affecting the sustainability of macaque populations (e.g. habitat destruction, loss of natural food source, hunting) but as part of an integrated conservation strategy. Here, we discuss several conflict management approaches which fall into two broad categories: (1) interventions that aim to alter the behaviour of macaques and/or people and (2) interventions that seek to control the size, demography or distribution of macaque populations.

14.3.1 Behavioural Management

14.3.1.1 Crop-Raiding

Macaques that are considered a significant threat to local livelihoods are unlikely to be viewed as a resource to conserve. Thus, development of non-lethal strategies to alleviate crop damage by macaques is imperative. Once established, however, crop-raiding behaviour in cognitively complex animals such as primates can be extremely difficult to change (Chakravarthy and Thyagaraj 2005; Hill 2005; Strum 1994), and

no single method is wholly effective at preventing monkey raids. Among commonly used techniques, vigilant guarding and chasing off intruding monkeys (using dogs, slingshots, firecrackers and so on) can be a successful deterrent but is costly in time and labour (Hill 2005). On the other hand, crop damage to cacao by Tonkean macaques in Sulawesi was independent of guarding frequency (Riley 2007). Traditional fences (e.g. made of thorns or branches) are largely ineffective against raiding primates, which can usually navigate around them owing to their extreme agility (Wang et al. 2006). In Japan, specially designed electric fences effectively exclude large to medium crop-raiding wildlife, including macaques *M. fuscata* (Honda et al. 2009).[1] However, their high cost makes them impractical in most rural localities in Asia and North Africa where macaque crop-raiding is a problem. Experimental studies of taste aversion in baboons have produced promising results (Forthman et al. 2005) but appear not to have been replicated with wild crop-raiding macaques. Chakravarthy and Thyagaraj (2005) reported that trimming and debranching of shade trees significantly reduced damage to cardamom plantations by bonnet macaques, *M. radiata*.

An alternative or complementary strategy for farmers is to plant alternative, buffer crops which are unattractive to monkeys in high-conflict zones such as along the edges of macaque habitat. For example, coffee is the second most important cash crop for farmers in central Sulawesi and is not raided by macaques (Riley 2007). However, promotion of buffer crops requires consideration of relative market prices and harvesting costs between crops. Farmers are unlikely to switch to alternative crops if it involves economic or labour costs (Riley and Priston 2010). A fuller understanding of conflicts associated with crop damage in rural landscapes requires studies of the ecology of macaque crop-raiding (Yamada and Muroyama 2010). When human activities reduce natural foods to the extent that they are insufficient to support resident macaques, population management strategies are needed to resolve conflicts over resources (see below).

14.3.1.2 Macaque Tourism

Studies of tourist–macaque interactions in China and elsewhere where humans interact with free-ranging macaques (e.g. Gibraltar and Bali) clearly indicate that reduced opportunities for physical contact between visitors and macaques and greater regulation of visitor behaviour are necessary to promote a more positive tourist experience at macaque-viewing sites. At Mt. Huangshan, the second of the

[1]The Japan situation is notable because, unlike many other parts of Asia, increased acculturation of macaques to anthropogenic environments and an associated rise in crop-raiding is not linked to human population growth in the macaques' range. Rather, a significant human depopulation of rural areas has occurred since the 1950s (Watanabe and Muroyama 2005). Reduced human presence on the land has compromised farmers' ability to protect their farmland. However, changes in land use, particularly the replacement of natural vegetation with conifer plantations, are also likely contributory factors in the escalation of conflict (Agetsuma 2007; Watanabe and Muroyama 2005).

sites where Tibetan macaques and tourists interact, ecotourism was developed intentionally to avoid problems experienced at Mt. Emei. Visitors are restricted to viewing platforms, thereby minimising physical proximity, and provisioning is performed by trained staff at scheduled times (Matheson et al. 2006). These measures have substantially reduced aggressive interactions between people and macaques relative to Mt. Emei (Zhao 2005). Even so, there and at other macaque-viewing sites, stronger regulations need to be put in place to discourage visitor behaviours that provoke aggressive responses from macaques (Fuentes and Gamerl 2005; McCarthy et al. 2009; Zhao 2005), including noise regulation (Ruesto et al. 2010). Thus, there is a parallel need for improved public education about macaque behaviour and appropriate human behaviour at interaction sites, for example, through prominent signage, staff talks and visitor centres (Lee and Chan 2011; Shek 2011). Increasingly, such information is available to visitors at macaque-viewing sites to varying extents, but a major problem is that tourists may disregard it. For example, while public feeding of macaques is officially prohibited at Mt. Huangshan, surreptitious provisioning occurs nonetheless (Ruesto et al. 2010). In Gibraltar, frequent unofficial feeding by tourists, tour guides and taxi drivers is the main reason for physical interaction between people and Barbary macaques (Fuentes 2006b), despite laws and public campaigns to address the problem (Cortes and Shaw 2006). Even so, public education programmes combined with proper law enforcement can be effective in limiting undesirable human behaviours including unofficial feeding, thereby substantially reducing negative human–macaque interactions as well as the potential for pathogen transmission. In Singapore, auxiliary police and surveillance cameras are used to enforce a no-feeding law. The fine for feeding long-tailed macaques was recently increased to SGD$500 (Lee and Chan 2011; Sha et al. 2009). However, such stringent measures are unlikely to be feasible in all macaque-viewing contexts (e.g. rural temples, roadsides). An additional problem is that stricter regulations are likely to be unpopular with some local people such as vendors who sell monkey feed to visitors (Zhao 2005) and tour guides who use food to lure monkeys to interact with tourists (Fuentes 2006b). Given the important role of macaque viewing in providing financial incentives for local people to support conservation efforts, care must be taken to avoid alienating local communities.

Education efforts can also help ameliorate conflicts in urban and residential areas. Since most human–macaque conflicts are food-related, practical interventions to reduce nuisance behaviours include limiting macaques' access to refuge, for example, through replacing rubbish bins with animal-proof bins and managing refuge collection so as to remove food sources (Jones-Engel et al. 2011; Md-Zain et al. 2011; Shek 2011). Fortification of buildings with protective barriers such as screens, bars and wire or electric fences will help prevent monkey incursions into homes and offices but may not be fully effective; long-tailed macaques in urban Thailand have been observed climbing over such barriers (Malaivijitnond et al. 2011). In Hong Kong, food trees were planted within country parks to discourage macaques from straying into nearby residential areas in search of food (Shek 2011). Similarly, fruit trees along residential streets in Singapore were replaced by trees that are less attractive as food for macaques (Lee and Chan 2011).

14.3.2 Population Management

Solutions to human–macaque conflicts sometimes necessitate population management through control of the size, demography or distribution of macaque populations. Official culling of macaques as a method to address problem behaviour has been carried out in several Asian range countries (e.g. *M. fascicularis* in Singapore: Sha et al. 2009; *M. fuscata* in Japan: Knight 1999), in Gibraltar (Fa and Lind 1996; Cortes and Shaw 2006) and in an attempt to eradicate introduced *M. fascicularis* on Ngeaur Island, Republic of Palau (Wheatley 2011). Culling was recently proposed as a strategy to eliminate invasive *M. mulatta* in Puerto Rico (Engeman et al. 2010). However, culling may be an undesirable management strategy both for conservation and cultural reasons – for example, it is unacceptable to devout Hindus in parts of Asia (Chauhan and Pirta 2010b) – and other methods to manage populations should be considered in most situations.

14.3.2.1 Translocation

Translocation (or relocation) of problem macaques has been employed as a non-lethal solution to human–macaque conflicts, particularly concerning urbanised rhesus in India (Imam et al. 2001, 2002; Imam and Yahya 2002). In one intervention, 600 monkeys were successfully translocated from Vrindaban, where conflict had reached high levels, to eight semi-forested sites deemed to have adequate natural food, water and shelter for macaques. (In fact, release sites were located in areas where rhesus were formerly present but had been extirpated following intensive trapping in the 1950s and 1960s; Southwick et al. 2005). Four years following this intervention, all troops remained at their release sites, apparently accepted by local people (Imam et al. 2002). However, in addition to the potential high costs involved, among other concerns (see Massei et al. 2010), there are some situations where translocation is inappropriate – for example, when there is a lack of suitable habitat to move animals because of extensive habitat modification by people (Srivastava and Begum 2005). In forest–farm ecotones removal (or elimination) of macaques may not necessarily end a crop problem due to immigration of monkeys from adjacent areas (Chakravarthy and Thyagaraj 2005). Further, translocation may simply spread the 'monkey menace' from one place to another. One relocated rhesus troop increased from 20 to 258 individuals in 25 years, potentially stretching local people's tolerance to the limit (Southwick and Siddiqi 2011). Thus, in some circumstances, translocation may be ineffective at controlling macaque populations.

The decision to relocate wild macaques must be based on a sound appraisal of the relative costs and benefits of such a management approach and a good understanding of the causes of a conflict situation. In Morocco's Middle Atlas, translocation of endangered *M. sylvanus* was deemed necessary by forest authorities based on the erroneous assertion that macaque damage to commercially valuable timber stocks (bark-stripping) was due to overpopulation. In fact, macaques in the

region are declining (Camperio Ciani and Mouna 2006). As discussed above, the main factor eliciting bark-stripping was lack of access to water due to settlement around water sources by shepherds. Consequently, the problem could potentially be alleviated by enabling the macaque's access to water sources – a likely more effective and economical strategy than large-scale population relocation (Camperio Ciani et al. 2001).

14.3.2.2 Fertility Control

Sterilisation and/or contraceptive programmes represent alternative management tools that are increasingly proposed as effective means of controlling macaque populations, particularly in urban settings (Malaivijitnond et al. 2011; Rattan 2011; Shek 2011). In Hong Kong, a large-scale contraceptive and neutering programme has been running since 2007 in an attempt to limit the expanding monkey population (Shek 2011). After trapping, female macaques are injected with an immunocontraceptive vaccine while males are vasectomised. As of 2010, 50–60% of Hong Kong's macaques have been treated, and initial results indicate a decline in the total population (Shek 2011). Fertility control is an attractive management option for reducing human–macaque conflict because it avoids directly killing animals as well as the various costs and problems associated with translocation. Moreover, where local people are uncomfortable with culling or removal of macaques out of religious sentiment, sterilisation programmes are likely to gain public support (Chauhan and Pirta 2010b). However, as Jones-Engel et al. (2011) point out, long-term studies of the effects of sterilisation/contraceptive programmes on populations and individuals (including behavioural consequences), and the efficiency of this approach to mitigate human–macaque conflict, are presently lacking. Clearly, systematic investigation in this regard is needed.

Finally, Southwick and Siddiqi (2011) suggest that moderate harvest for legitimate biomedical research represents an option for controlling India's growing rhesus population, potentially to the benefit of both people and macaques. They argue that the decision in 1978 to halt all trapping for export was short-sighted because it failed to consider the rhesus monkey's high reproductive rates and commensal tendency and the ongoing destruction of their natural habitats. They acknowledge, however, that cultural and religious factors may preclude the sustainable harvesting of rhesus as a population management and conflict mitigation strategy.

14.4 Conclusions

Macaque–human relationships are complex and culturally specific, ranging from relatively peaceful coexistence to extreme levels of conflict. Of all primates, macaques adjust particularly well to human-modified environments, both rural and urban, and in some contexts, develop commensal, mutually beneficial relationships

with humans. In this chapter, we focussed on three main areas of human–macaque interaction: rural crop damage, tourism sites and urban contexts. Despite high levels of potential conflict, there are remarkable levels of human tolerance to macaques in these contexts, demonstrated either through deliberate provisioning, seeking out of interactions (in the tourist context) or relative indifference (e.g. Buton). This provides hope for the conservation of macaques. For every example of tolerance, however, there are numerous instances of conflict, and with ever-expanding human populations, increased movement of people within and between countries, and changing socio-economic conditions, the future of human–macaque relationships is likely to be an uneasy one. As illustrated in India, changing cultural attitudes can change traditional human–macaque relationships, usually detrimentally for macaques. Macaque conservation requires a multiple management strategy approach depending on the specific context, and no single management strategy will suit all sites of human–macaque interaction. Conservation strategies should focus on promotion of tolerant cultural attitudes in addition to reduction of negative interactions in order to ensure long-term survival of macaque populations.

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