Review Article

DAMAGES BY NON-HUMAN PRIMATES AND MANAGEMENT STRATEGIES IN AGROECOSYSTEM

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ABSTRACT

India has long been known as one of the rich primate areas of the world, both in species diversity and population abundance. In recent times the problem of some primates is increasing in agriculture, horticulture and urban environs. The activities like human population growth, deforestation, intensive agricultural practices and urbanization lead to an ever increasing encroachment on wildlife habitats andreduction of wild animals' natural habitats forcing species to adapt to altered habitats and small marginal patches. In contrast, species with a high degree of flexibility can adapt to living in, or near, areas inhabited by man, where in some cases they end up using easily accessible food resources, like human cultivations and garbage. To date, there has been comparatively very little systematic research carried out to investigate patterns of crop raiding activity by wild animals, its potential impact on farmers' food and household economic security and ways and means to manage them. The majority of the research that exist at present has focused on the issues related to crop damage by rodents, however information on higher vertebrates such as primates and ungulates often cited as troublesome 'pests' in agricultural areas is scant and scattered.

INTRODUCTION

India is the seventh largest country in the world and Asia's second largest nation, which contains a great wealth of biodiversity and ranks top ten species-rich countries in the world. India, with 2.4% of the world's geographical area, has over 8% of the world's total biodiversity, making it one of the 12 mega diversity countries in the world (MoEF and Kalpavriksh, 2004). India has four global biodiversity hot spots (Eastern Himalaya, Indo-Burma, Western Ghats and Sunderland). This status is based on the species richness and levels of endemism recorded in a wide range of taxa of both plants and animals. The varied edaphic, climatic and topographic conditions and years of geological stability have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, deserts, and coastal and marine ecosystem (Chauhan, 2014). This diversity can be attributed to the vast variety of landforms and climates, resulting in habitats ranging from tropical to temperate and from alpine to desert. India is also considered one of the world's eight centres of origin of cultivated plants. Being a predominantly agricultural country, India also has a mix of wild and cultivated habitats, giving rise to specialised biodiversity, which is specific to the confluence of two or more habitats.

Primates diversity in India

The bio diversity of India support variety of flora and fauna and the Primates are one of them. India is home to large family of monkeys species distributed from evergreen Western Ghats to north east states and dry forests of central India. Primates are a group of mammals that includes monkeys, apes, langurs and lorises. India is having good diversity of primates represented with 22 species which includes two species of lorises, nine species of macaques, 10 species of langurs, one species of ape (Table 1). Though in India these many primates were recorded we find 11 primates occupy less than 15% of the total land area.Only Rhesus macaque and Hanuman langur are widely distributed in most of the geographical areas of the country (Karanth *et al*., 2010). Whereas the other endangered and vulnerable primates (Golden langur, Arunachal macaque, Pig-tailed macaque, stump-tailed macaque, Phayre's leaf monkey, Nilgiri langur and Lion-tailed macaque) are confined to small patches with restricted domestic ranges.

Table 1. Distribution and conservation status of Primates in India

Sl. No	Common Name	Scientific Name	IUCN Status	CITES	IWPA	Distribution in India
1	Slender Loris	*Loris lydekkerianus*	Least Concern	Appendix II	Schedule I	Southern and eastern India (Andhra Pradesh, Karnataka, Kerala and Tamil Nadu)
2	Slow Loris	*Nycticebus bengalensis*	Vulnerable	Appendix I	Schedule I	North-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura)
3	Lion-tailed Macaque	*Macaca silenus*	Endangered	Appendix I	Schedule I	South Indian States Karnataka, Kerala and Tamil Nadu
4	Northern Pig-tailed Macaque	*Macaca leonina*	Vulnerable	Appendix II	Schedule II	North-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura)
5	Bonnet Macaque	*Macaca radiata*	Least Concern	Appendix II.	Schedule II	Peninsular India (Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu)
6	Assamese Macaque	*Macaca assamensis*	Near Threatened	Appendix II	Schedule II	North-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttar Pradesh, and West Bengal)
7	Arunachal Macaque	*Macaca munzala*	Endangered	Appendix II	-	North-eastern India (Western Arunachal Pradesh)
8	Stump-tailed Macaque	*Macaca arctoides*	Vulnerable	Appendix II	Schedule II	North-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura provinces)
9	Rhesus Macaque	*Macaca mulatta*	Least Concern	Appendix II	Schedule III	Northern and central India (in the states of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chattisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkand, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tripura, Uttaranchal, Uttar Pradesh, West Bengal and Telangana)
10	Long-tailed Macaque	*Macaca fascicularis*	Least Concern	Appendix II	Schedule I	Andaman & Nicobar Islands.
11	White Cheeked Macaque	*Macaca leucogenys*	-	-	-	Arunachal Pradesh
12	Gee's Golden Langur	*Trachypithecus geei*	Endangered	Appendix I	Schedule I	North-eastern India (Assam)
13	Capped Langur,	*Trachypithecus pileatus*	Vulnerable	Appendix I	Schedule I	north-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura)
14	Phayre's Leaf-	*Trachypithecus*	Endangered	Appendix	Schedule	Northeastern India (Assam,

Sl. No	Common Name	Scientific Name	IUCN Status	CITES	IWPA	Distribution in India
	monkey	*phayrei*		II	I	Mizoram, and Tripura)
15	Southern Plains Gray Langur	*Semnopithecus entellus*	Least Concern	Appendix I	Schedule II	South-western and west-central India (Andhra Pradesh, Karnataka, Kerala, Maharashtra, Goa, Gujarat, Rajasthan, Madhya Pradesh, Uttar Pradesh and Telangana)
16	Himalayan Gray Langur, Kashmir Gray Langur,	*Semnopithecus ajax*	Endangered	Appendix I	Schedule II	North-western India (Himachal Pradesh and Jammu and Kashmir)
17	Gray Langur, Hanuman Langur,	*Semnopithecus hector*	Near Threatened	Appendix I,	Schedule II	Northern India (Uttaranchal, Uttar Pradesh, and West Bengal)
18	Nepal GrayLangur, Central Himalayan Langur	*Semnopithecus schistaceus*	Least Concern	Appendix I	Schedule II	High Himalayan elevations (1,500-4,000 m) of India
19	Black-footed Gray Langur, Dark-legged Malabar Langur, Malabar Sacred Langur	*Semnopithecus hypoleucos*	Vulnerable	Appendix I	Schedule II	South-western India (Goa, Karnataka and Kerala)
20	Tufted Gray Langur, Coromandel Sacred Langur, Madras Grey Langur	*Semnopithecus priam*	Near Threatened	Appendix I,	Schedules II	This species is widely distributed in southern India
21	Nilgiri Langur,	*Trachypithecus johnii*	Vulnerable	Appendix II	Schedule I	Western Ghats in south-western India (Karnataka, Kerala, and Tamil Nadu)
22	Hoolock Gibbon	*Hoolock hoolock*	Endangered	Appendix I	Schedule I	North-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura)

IUCN: International Union for Conservation of Nature and Natural Resources
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
IWPA: Indian Wildlife Protection Act

Crop raiding macaques

Primates from almost all families have been identified as crop-raiders although species differ in their ability to cope with encroaching human settlement. But the intensity of the crop raiding may vary with species to species. Macaques are medium sized primates of the family Cercopithecoidea (Old World Monkeys), sub-family Cercopithecinae and the genus Macaca, with 19 species (Groves, 2001). Macaques occupy the widest geographical range of any non-human primates, and the widest variety of habitats, including grassland, mangroves, deciduous forest, tropical rainforest, temperate forest, rocky cliffs and beaches (Melnick and Pearl, 1987).

The species like Rhesus macaque, Bonnet macaque, Assamese macaque and Hanuman langur were the most predominant species which are involved in the regular menace with the farmers. The basic reasons for menace with the monkeys is loss of species specific habitats, habitat degradation and fragmentation, intensive agricultural practices, insufficient prey base and food material, increase in human and livestock population, competitive exclusion of wild herbivores, land use transformation, developmental activities, growing interest in ecotourism and increasing access to natural reserves. The basic requirements of space, shelter and food overlap between humans and wildlife create conflicts. As forests are cleared for demands in agricultural expansion and population growth continues to rise, human and wildlife habitats is overlapping (Ayyappan *et al*., 2016).

Diseases transmitted by monkeys

Monkeys are susceptible to several fatal infections that are also dangerous to human beings but not to lower animals. Although this susceptibility has enormous practical value in biomedical research, the very same attribute is a potential

hazard to human beings who come in contact with infected monkeys. Many viral diseases from different virus like herpes virus, pox virus, yaba virus and rabies are affecting the primates and being spread to humans.Many virus diseases that cause only minor problems in monkeys are severe or fatal when the virus enters a human being. Over the eons that monkeys have developed, their diseases have developed with them. There are certain strategies that all diseases develop to survive. One is that to be spread successfully, they must not kill their natural host. But when they enter the wrong host species, the strategies that keep them in check do not work. The virus multiplies out of control and often attacks tissues and organs in ways it does not do when it is present in monkeys. Bacterial diseases like tuberculosis, shigellosis and salmonellosis and camphylo bacteria cause several diseases in primates and are also having potential to transfer to human beings.Parasitic diseases like diarrhoea and dysentery are two important protozoan diseases transmitted by protozoa giardia and *Entamoeba histolytica* common in primates and possible to reach humans through contaminations. The nematodes like *Strongyloides sp*. and *Hyemnolepsisnana* and*Trichaphytonmentagrophytes* are the common species affecting the primates and similarly to the humans. Arthropods like lice, mites and fleas cause several skin diseases and also they spread to humans and they can be the important hosts for some deadly parasitic diseases and involuntary vectors for several infectious organisms.There are other dangerous diseases that monkeys transmit to people in their homelands. Those diseases, like Yellow Fever, Falciparum Malaria, Kyasanur Forest disease, Tanapox and Mayaro virus depend on mosquitoes, ticks and biting flies to transmit from monkeys to humans. Others, like leprosy, have never been reported to have transmitted from infected monkeys to humans.

Species of agricultural importance

Rhesus Macaque

Scientific status:

Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Primates
Sub order	: Haplorhini
Superfamily	: Catarrhini
Family	: Cercopithecidae
Genus	: *Macaca*
Species	: *mulatta*

The Rhesus monkey is one of the famous species of Old World monkeys and distributed in large population across the country. It is native to Asia and has a widest geographic range in India. In India, rhesus macaques are found in flat, cultivated areas, where agricultural fields dominate the landscape and in the plains, foothills and mountainous regions where habitat includes cultivated fields, tropical forests and dry, deciduous forests.In urban areas of India, they are found on roadsides, canal banks, in railway stations, villages, towns, and temples (Richard *et al.*, 1989). It is estimated that 48.5% of rhesus macaques in northern India live in villages, towns, cities, temples and railway stations where they are in close and frequent contact with people at all times. About 37.1% of the population lives with some human contact on roadsides and canal banks and only 14.4% of the rhesus macaques in the northern part of the country live in isolation from humans and do not rely on them at all for food (Southwick and Siddiqi, 1994). It lives in a wide range of habitats, from flatlands to high elevations up to 3000 meters in Himalayas and shows a great deal of adaptability to acclimate to a variety of climatic extremes, from the hot, dry temperatures found in deserts, to cold winter temperatures which fall to well below the freezing point.

Generally they live in multi male and multi female troops comprising 20–200 individuals with an average sex ratio of 1:4 male for females in a troop. Males and females both have separate hierarchies in the troop. Females reach puberty around age three while males are sexually mature by age four, females reproduce from three until about 20 years of age (Rawlins and Kessler, 1986), Though males are capable of reproducing by age four, they are not reproductively successful until after age eight, or when they reach adult size. During this time between becoming sexually mature and when they begin to mate, young rhesus macaques are learning the social skills, including fighting ability that will influence their success throughout their lives (Bercovitch *et al.*, 2003). They breed throughout the year and peaks associated with food availability. Each successful pregnant female can produce a single young one and the gestation period is around 165 days. When kept under uniform conditions in captivity, females maintain a steady estrus cycle of 26 to 28 days. The average life span of rhesus macaque in wild goes up to 30 years, where as in captivity it is around 36 years.

Fig. 1. Rhesus Macaque

They are diurnal animals, live both arboreal and terrestrial mode of life. Mostly herbivorous, feeding on mainly fruit, but also eating seeds, roots, buds, bark, leaves, flowers, and cereals. They have also been observed eating termites, grasshoppers, ants, beetles, bird eggs and also sometimes cooked meet. The food habits can vary greatly depends upon the locality where they live. When food is abundant, they are distributed in patches and forage throughout the day in their home ranges. They have specialized pouch-like cheeks, allowing them to temporarily hoard their food.

They are very aggressive in nature and are able to adapt to the varying environments and live very comfortably among human habitation. With its nature and fast acclimatization, it is dominating the other sympatric species like bonnet macaque in the southern parts of the country and invaded into its geographic area, competing with them for all the resources. Rhesus macaque is the top most primate species in India, which damages maximum agricultural crops than other species.

Bonnet Macaque

Scientific status:

Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Primates
Sub order	: Haplorhini
Superfamily	: Catarrhini
Family	: Cercopithecidae
Genus	: *Macaca*
Species	: *radiata*

Fig. 2. Bonnet Macaque

The Bonnet macaque are endemic to south India with habitats including evergreen high forest and dry deciduous forest of the Western Ghats and some of the Eastern Ghats ranges as well. Bonnet monkey have a greyish brown back and a well defined circular cap on the head and with long tail which is two-thirds of its body length. Like rhesus macaque these are also lives in multi male and multi female groups with an average troop size is about 30 individuals. Bonnet macaques are arboreal and terrestrial quadrupeds, although they spend much of their time on the ground. They are typically active during the day. Bonnet macaque troops maintain a home range which varies in size, averaging 50 ha for the core area. Daily use patterns are dependent on food distribution and the distribution of predators. They may stay in the same general area for several months before exploring a new area.

Bonnet macaque populations reproduce annually in discrete mating seasons, males form unique bonds. Dominant males tolerate the sexual activity of young males, who begin sexual interactions at 2 years old and are able to mate at age 3. Young males are primarily partnered with young or sub-dominant females. However, adult and adolescent males are equally sexually active with females in estrous, which may translate to higher reproductive success for adolescent males. The primary difference between adolescent and adult males seems to be access to dominant females. High-ranking males have a tendency to relate and mate with the same female over a period of several days while younger males might mate with several females in a short amount of time. Mating season peaks around September to October to produce a birthing season around February and April. Single young one will be produce in each breeding and the gestation period is around 168 days.The average life span of bonnet macaque in wild conditions goes up to 20–25 years, where as in captivity it is around 30 years (Campbell *et al.,* 2007; RAO *et al.*, 1998; Silk, 1994).

The bonnet macaque feeds on fruits, nuts, seeds, flowers, invertebrates and cereals. This species is problematic in some limited region where it is widely distributed. The preferred habitat of the bonnet macaque is human dominated landscapes especially agricultural landscapes which are along the roadsides. The conflicts with humans have led to injuries, and unplanned translocations and killings of macaques led to number of bonnet macaques is drastically declining from roadside habitats where they obtain required food primarily by raiding crops in the surrounding agricultural fields.

Hanuman Langur/Gray Langur

Scientific status:

Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Primates
Sub order	: Haplorhini
Superfamily	: Catarrhini
Family	: Cercopithecidae
Genus	: *Semnopithecus*
Species	: *entellus*

Fig. 3. Gray Langur

There are six species of gray langur or hanuman langur found in India, Black footed gray langur and tufted gray langur mostly found in forest of South India, the other species like Kashmir Gray Langur, TaraiGray Langur, Northern Plains Gray Langur, Southern Plains Gray Langur occupy the northern part of the country. The Hanuman langurs are biggest species of Old World monkeys found in the Indian subcontinent. They are classified as folivorous primates. Habitat destruction for agricultural activities, permanent settlement, collection of fuel and fodder and for minor forest produce is made the species to move from their habitats to adapt and occupy village woodlands. Crop raiding began due to their habitat loss.

Hanuman langurs, though commensal rarely reach the pest status of rhesus macaques. They are less aggressive and not considered as pests by many. Birth rates are lower and infant mortality is higher compared to Rhesus macaques. They tend to depend more on natural vegetation and less on crop raiding and thus are a lesser pest than Rhesus monkeys. Although their population fluctuated, they were more stable than Rhesus Monkeys.Langurs cause severe damage to crops in many parts of the country. In India people do not kill the langurs because of the prevalent religious sentiments and the Wildlife Protection Act 1972. It is regarded not only as sacred but divine by Hindus. It is a cultural practice throughout the country to feed them especially near temples.

Hanuman langurs live in social groups. Basically troops are of two kinds-all male bachelor groups of around 60-70 animals and larger groups, sometimes as many as hundred monkeys of females and their offspring led by one or two dominant male/s. The females are closely kint and usually adhere to the same territory throughout life. In contrast, the same group beyond two years. Each group occupies its own home range of about 0.5 to 1.5 km^2 (Chhangani *et al.*, 2006). Females typically reach sexual maturity by 2.9 years of age, with males reaching sexual maturity by 5 years of age. Females reach puberty around 2.9 years of age, while males are sexually mature by age five, Hanuman langurs breed between July and October, and parturition occurs between February and April. Gestation lasts for 200 to 212 days, after which a single infant is usually born. Although rare, females may also give birth to twins. The average life span of hanuman langur in captive conditions goes up to 30 years, where as in captivity males live up to 18 years and female can live till 30 years.

Factors influencing the crop raiding by macaques

1. Increasing trend for potential conflicts between wildlife and people resulting damage to resources and threat to human health and safety.
2. Increase in human population and expansion of human dwellings and settlement, the wildlife species have been restricted to small patches of land.
3. Indiscriminate destructions and fragmentation of natural habitats, blocks migration routes, facilitates encroachment, and encourages poaching.
4. Non availability of sufficient food sources for the survival of macaques in their home range.
5. Attraction towards agricultural crops due to its higher availability and more nutritive.

Management Practices

Different management practices that can be employed in managing the crop raiding monkeys are listed in table 2. The practices like guarding and throwing stones and keeping dogs and langurs at the fields were effective for some extent, but due to the intelligence and higher steadiness the management strategies that have not helped in managing the monkey menace in agricultural crops. There is a need to develop the suitable cost effective management strategies to reduce the damage by crop raiding monkeys.

Constraints in management

Management of problematic species mainly depends on their status as per the Indian Wildlife Protection Act 1972 (IWPA) and International Union for Conservation Nature (IUCN). The problematic species like *Macacamulatta, Macacasilenus, Macaca leonine, Macacaassamensis, Macacamunzala, Macacaarctoides, Trachypithecusgeei, Trachypithecuspileatus, Trachypithecusphayrei, Semnopithecus entellus, Semnopithecus ajax, Semnopithecus hector, Semnopithecus schistaceus, Semnopithecus hypoleucos, Semnopithecus priam, Trachypithecus johnii and Hoolock hoolock* were listed as endangered, vulnerable and near threatened in IUCN and Schedule I, II and III of the IWPA, 1972. The status of these species as per IWPA and IUCN is the stumbling block in managing these species in agricultural landscapes.

The management techniques have became difficult at field level due to limited resources available with famers and intelligence of animal. Each location and species presents a particular scenario with different factors affecting the

intensity and occurrence of crop raiding that will require unique methods or a combination of strategies for better management of monkeys. Therefore, if crop raiding species cannot be eradicated, it certainly must be minimized and managed to reduce the damages to farmers.

Table 2. Existing management methods used to control the entry of monkeys in to the agricultural crops

Sl. No	Method	Details of use and effectiveness	References
1	Noise/bells etc	Beating the drums and plates to make noise will make the animal to avoid the cropped areas, but habituation is a problem. Quite effective in control of monkeys	(Biquand *et al.,* 1992b; Biquand *et al.,* 1994; Hill, 2000; Naughton Treves, 1998a, b; Sekhar, 1998; Strum, 1987a, b, 1994, 1998)
2	Guarding/chasing	Guarding field in person or employing a wage, often by women or children, will certainly helps in driving away the crop raiding monkeys from the field, but it is expensive and keeps people away from other activities. Effective in protecting the crops from monkey damage.	(Balakrishnan and Ndhlovu, 1992; Bell, 1984a; Biquand *et al.,* 1992b; Biquand *et al.,* 1994; Hill, 2000; King and Lee, 1987; Knight, 1999; Maples *et al.,* 1976; Pirta *et al.,* 1997; Sekhar, 1998; Southwick *et al.,* 1961; Southwick and Lindburg, 1986; Southwick and Siddiqi, 1977; Strum, 1987, 1994, 1998)
3	Rice balls	Keeping the rice balls (boiled rice + crushed ground nut seeds + red chilli powder + coconut oil) around the field deters the monkeys. As soon as they taste the mixture of rice balls, feels burning of tongue and thirstiness due to which monkeys will automatically avoid the area. Care should be taken that no water availability in the vicinity.	Naresh and Vasudeva Rao (under process)
4	Stones/slingshots/ spears	Throwing stones by using slingshot or locally made 'gophan' are useful in chasing the monkeys, but causes considerable damage and distress to monkeys (welfare issues). Particularly effective but human presence is necessary.	(Biquand *et al.,* 1992b; Biquand *et al.,* 1994; Hill, 2000; King and Lee, 1987; Maples *et al.,* 1976; Naughton Treves, 1998a, b; Strum 1987a, b, 1994, 1998)
5	Dogs/Langurs	Often very effective, they fear about and avoid unfamiliar species like dogs and langurs. But requires a culture of keeping dogs and langurs.	(Biquand *et al.,* 1994; Hill, 2000; King and Lee, 1987; Maples *et al.,* 1976; Strum, 1987a, b, 1994, 1998)
6	Dry fish	Tying of dry fishes to the branches of trees around the fields and above the crop will help in keeping away the crop raiding monkey because of the smell emitted from the dry fish. Effective in initial period but animal habituates over a period of time.	Naresh and Vasudeva Rao (under preparation)
7	Shooting / hunting	Legal issues in many areas where the pest species is also a Red List species, or where legislation controls hunting or the issue of licences.	(Balakrishnan and Ndhlovu, 1992; Bell, 1984a; Bertram and Ginsberg, 1994; Sekhar, 1998; Yongzu *et al.,* 1989)
8	Trapping/culling	Results in population skews. Effective in the short term, but can result in 'mining' populations as new groups move into the empty habitat.	(Balakrishnan and Ndhlovu, 1992; Bertram and Ginsberg, 1994; Biquand *et al.,* 1992b; Biquand *et al.,* 1994; Boulton *et al.,* 1996; Brennan *et al.,* 1985; Lee *et al.,* 1986; Martin, 1984a, b; Mitchell and Tilson, 1986; Pirta *et al.,* 1997; Southwick *et al.,* 1961a, b; Southwick and Siddiqi, 1977, 1994; Southwick and

Sl. No	Method	Details of use and effectiveness	References
			Siddiqi, 1967; Struhsaker, 1967)
9	Poison	Tends to be detectable and thus learned avoidance minimises effectiveness.	(Bertram and Ginsberg, 1994; Priston, 2001)
10	Chemical deterrents	Tend to be ineffective in the long term due to learning.	(Bell 1984a; Biquand *et al.*, 1994; Strum, 1987a, b, 1994, 1998)
11	Taste-aversion Conditioning	Ineffective long term due to learning and the species tendencies to sample foods despite aversion. Generally not practical owing to expense and need to trap animals.	(Forthman Quick, 1986a, b; Strum, 1986, 1987a, 1998; Strum and Southwick, 1986)
12	Fences / electric fences	Ineffective as primates can climb or get through almost all barriers.	(Bell, 1984a; Maples, 1969; Maples *et al.,* 1976; Sekhar, 1998)
13	Playback of alarms	Ineffective – individuals habituate rapidly.	(Bell, 1984a; Strum, 1987a, b, 1994, 1998)
14	Painting Individuals	Involves the capture of one troop member, usually the dominant male, painting him white/red and rereleasing him, thereby scaring the troop away as he runs towards them.	(Priston, 2001)
15	Translocation	Can be effective in rare cases, requires a suitable unoccupied habitat and requires some provisioning and monitoring. It is often very expensive. Only one long term study has assessed the effectiveness (in baboons (Strum 2005)) and found after an initial adjustment period with increased mortality translocated groups performed similarly to indigenous groups. However, it required several interventions, some provisioning and many years intensive monitoring. It can be effective in smaller population.	(Biquand *et al.,* 1994; Caldecott and Kavanagh, 1983; Imam *et al.,* 2002; Lee *et al.,* 1986; Pirta *et al.,* 1997; Southwick *et al.,* 1998; Southwick and Siddiqi, 1994; Strum, 1987a, b, 1994, 1998; Strum, 2005; Strum and Southwick, 1986)
16	Sterilization/Birth control	Sterilization could be effective but requires capture of animal and sterilization	(Bertram and Ginsberg, 1994; Biquand *et al.,* 1994; Boulton *et al.,* 1996)
17	Cropping patterns	Alter crops grown and timing of planting and harvesting – causes disruption to traditional agricultural practices and regular non availability food to monkeys. Crops like chilli, thorny brinjal and ginger etc. may be grown in larger area in one season which is not preferred by monkeys due to which there will not be food availability at that particular area. So they will move to other areas in search of food.	(Bell, 1984a; Boulton *et al.,* 1996; Else, 1991; Horrocks and Baulu, 1994; Naughton Treves, 1998a, b; Strum, 1994)
18	Buffer zones	Regions of partially cleared land surrounding farms or buffers of less desirable crops – particularly effective when barrier crops are grown for 'sacrifice'. Difficult when specific areas of land are allocated to people.	(Biquand *et al.,* 1994; Boulton *et al.,* 1996; Else, 1991; Hill, 2000; Horrocks and Baulu, 1994; Naughton Treves, 1998a, b; Pirta *et al.,* 1997; Strum, 1987a, b, 1994)
19	Conservation of forest Refugia	Necessity for many species' survival. Suitable forest habitats may lessen the need for primates to encroach on farms.	(Boulton *et al.,* 1996; Else, 1991; Horrocks and Baulu, 1994; Naughton Treves, 1998a, b; Pirta *et al.,* 1997; Strum, 1986, 1987a, b, 1994)

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