Wildlife—Human Conflict in India: An Ecological and Social Perspective

R. SUKUMAR

INTRODUCTION

'Elephants Invade City' screamed the newspaper headlines on 29 January, 1985. The previous morning the students of an engineering college in the suburbs of Bangalore had woken up to find a herd of nine elephants outside their hostel building. The elephants had walked some 15 km through cultivation during the night from the forests of Bannerghatta before entering the college campus. This unusual incident made headlines partly because it happened near a big city. But elephant incursion into human habitation is not something unusual or new. It has been going on ever since man took to agriculture within elephant habitat. The *Gajasastra* (or elephant lore) that can be traced back to the fifth or sixth century BC, narrates that wild elephants invaded the kingdom of Anga and caused considerable damage, a reference no doubt to crop raiding. People in the Indian sub-continent have dealt with 'rogue' elephants and man-eating tigers through the ages in a manner that can only be described as relatively tolerant; otherwise these animals would simply not have survived to this day given the long history of settlement and the large human population. Elsewhere people have often solved their problem by simply wiping out an offending species; an example of this is the extermination of the wolf, a predator on sheep, from Great Britain during the nineteenth century. Religious taboos no doubt played a role in the past in this tolerance towards other creatures. However, in the present context of a rapidly changing society such traditional attitudes to nature are unlikely to sustain the conservation ethos for long. It is both unrealistic and

unjust to expect only a certain section of society, the marginal farmers and tribals, to bear the entire cost of depredatory animals. We have to work towards ameliorating the impact of wildlife on people if conservation of wildlife and their habitats is to gain acceptance among such people who interact with these in their daily lives.

Why conserve wildlife in the first place? There are strong ethical, ecological, economic and aesthetic arguments as to why wildlife has to be conserved (Ehlrich and Ehlrich 1981). The ethical argument is basically that living creatures have an intrinsic right to exist, irrespective of their utility or otherwise to humans. From an ecological view point, large mammals such as the elephant or the tiger play a dominant role in an ecosystem by virtue of their large biomass or position at the summit of an intricate food web. Disappearance of such key species could lead to the disruption of ecosystem functioning, perhaps resulting in extinctions of other species. Economic justifications include the direct value of wild animals as sources of food for people (game ranching), returns from wildlife-oriented tourism and so on. Lastly, wildlife is a source of considerable pleasure for many people, thereby having a therapeutic value in promoting human well-being.

This essay describes the nature of the conflict between large mammals and people, provides ecological explanations for the origins of such conflicts, examines their socio-economic implications and discusses measures that can help in minimizing the impact of animals on people. It illustrates these conflicts by focussing on two mammals, the Asian elephant which is a herbivore and the tiger which is a carnivore.

2. THE NATURE OF THE CONFLICT

Large mammals come into conflict with human interests by destroying crops, livestock or property and sometimes by even killing people.

2.1 *Crop and livestock depredation*: A variety of mammals including elephants, wild pig, deer, rhino and monkeys are known to damage cultivated crops. Damage by wild pig is probably the most widespread because this species is found in almost all forested habitats including highly degraded and fragmented ones. Pigs are

commonly killed for this reason but this is not a major conservation issue anywhere. On a more localized scale the damage caused by elephants to crops can be considerable. All cereal and millet crops such as paddy, sorghum, maize and finger millet are potential targets for elephants, as are sugar cane, banana, mango, jack fruit, coconut, oil palm and various legumes. A few estimates are available of the economic loss due to elephants. The loss of crops due to elephants in Palamau, Bihar, was estimated to be Rs 40,000 during 1969–70 (Mishra 1971). In southern India, which has a wild elephant population of 6000–7000, the damage to crops was estimated to be about Rs 6.5 million during 1981–3 (Sukumar 1989). In the northeastern states of West Bengal, Assam, Arunachal and Meghalaya the loss seems to be much greater (Lahiri Choudhury 1980). Compared to these the loss to highly commercial agricultural ventures may be even greater; in peninsular Malaysia the damage to oil palm and rubber plantations by elephants runs into millions of dollars annually, averaging some 20 million dollars for a single agency FELDA (Blair *et al.* 1979). In addition to feeding on crops, elephants may also damage or destroy houses and other property occasionally.

Carnivores such as tiger, leopard, lion and wild dog prey upon domestic livestock either by entering settlements in the vicinity of their habitat or when these come into the jungle for grazing. The Project Tiger authorities paid compensation for 622 cattle killed by tigers or leopards during 1974–83 near the Bandipur reserve. The Melghat Project Tiger authorities pay compensation for about 250–300 livestock kills every year (M. Watwe, pers. comm.). Many more cattle, buffaloes, sheep and goats would have fallen prey in other forest areas. The buffaloes kept by the Maldharis in the vicinity of the Gir Sanctuary of Gujarat form a substantial proportion of the diet of the lions there (R. Chellam, pers. comm.). Similarly, domestic livestock constitute 30 per cent of the tiger kills near the boundary of the Chitawan National Park in Nepal (Mishra 1982).

2.2 *Manslaughter*: Of greater concern than loss to crops or livestock is the incidence of human kills by large mammals. Wild elephants kill on average 30–50 people in south India, 30–50 in West Bengal, 5–10 in Uttar Pradesh, over 50 in Assam and perhaps another 50 in other states each year. A study in southern India showed that about 45 per cent of the incidents occurred within settlements when elephants came to raid crops and the rest occurred inside the forest (Sukumar 1989).

The man-eating tiger has been a problem historically in certain regions of the sub-continent such as Bengal, Central India and the *terai* tract along the Himalayan foothills (McDougal 1987). Tigers killed 57 people on the average each year during 1975–84 in the Sundarbans of India and Bangladesh (Khan 1987, Sanyal 1987). Most of the victims here have been fishermen and honey collectors. Elsewhere in the sub-continent another 10–20 people are killed annually. We must, however, remember that the incidence of man-eating by tigers in the sub-continent has come down substantially during the past two centuries due to elimination of over 95 per cent of the tiger population. In the year 1822 over 500 people were killed by wild animals, chiefly tigers, in a single district, the Khandesh of Bombay Presidency (McDougal 1987). In 1877 the tiger claimed 798 human victims in British India, while the figure was 909 during 1908.

The Asiatic lion is today confined to a single location, the Gir Sanctuary in Gujarat. In the past lions have not been a serious threat to human life but in recent years there have been incidents of lions straying far away from their habitat and mauling people.

3. An Ecological Perspective to the Conflict

Why do elephants raid crops or why do tigers take to man-eating? Although we do not have all the answers as yet, the basic causes of such behaviour can now be deduced from ecological theory and a knowledge of the social life of these mammals. These can be explained both in proximate terms (i.e. the immediate compulsion for an action) and in the ultimate (i.e. evolutionary) sense.

3.1 *Habitat and resource depletion*: As people continue to occupy more and more forest land for settlement, agriculture, building dams and other forms of development, the shrinking habitat area compresses the wildlife populations to levels beyond its carrying capacity. The carrying capacity is the number of individuals or biomass of a population that can be supported given the area and productivity of the habitat. When the carrying capacity is exceeded the interaction between people and wildlife is intensified in many ways. In the first place the increase in the length of the 'boundary' between forest and human settlement on a local scale means that

animals would make more frequent contact with settlement due to chance alone. Large mammals such as tiger and elephant move long distances both daily and seasonally. It is not unusual for them to move 10 or 15 km a day or have a home range of over 100 square kilometers. Small or fragmented habitats surrounded by cultivation are simply incompatible with the conservation of large mammals. Often new settlements spring up along traditional migration paths of elephant herds and these are naturally subject to damage before the animals find other routes or restrict their extensive seasonal movements.

Apart from restricting the area, and thus the amount of resources, available for wildlife populations, human exploitation of the forest for timber, fuel wood and fodder may also degrade the habitat and lower the resource base considerably. This would be especially true if resources flow out of a region without a corresponding input. Bamboo stocks for instance have been overexploited over much of country's forests for use by paper mills (Prasad and Gadgil 1981). To a limited extent the exploitation of primary forest does not necessarily lower habitat quality for large mammals. Typically the highest biomass of large mammals is found in forest and grassland under some human use (Bell 1971) but this trend does not continue indefinitely. For example, shifting cultivation practised on a small scale with sufficient interval between rotation of sites does not seem to have any adverse impact on wildlife populations. On the other hand, the expansion of human populations has increased the area under shifting cultivation and decreased the period between rotation of sites to less than five years in many states in the northeast and in Orissa. The result is that the land remains perpetually as low quality grassland dominated by weedy plants such as *Imperata*, *Chromolaena* and *Lantana* with no tree cover. This has been disastrous for elephant populations here because elephants need not only grassland but also forest for meeting their nutritional requirements (Lahiri Choudhury 1980, Sukumar 1989). Elephants may also be subject to heat stress in the absence of adequate shade in pure grasslands.

Competition between people and wildlife for resources may also occur indirectly. Large numbers of domestic livestock held in the vicinity of wildlife areas compete with the herbivores for forage. There have been no quantitative studies to clearly evaluate the impact of livestock on wildlife populations in India but this can be often deduced from subjective observations. Overgrazing by livestock

reduces the amount of forage available for wild herbivores both directly and indirectly by causing adverse changes to soil properties through trampling. Ungulates such as deer, antelopes and gaur, which have a high degree of food niche overlap with livestock, seem to be the most affected by this competition. Reduction in ungulate prey for the carnivores would force them to hunt domestic livestock.

When wildlife populations exceed the carrying capacity of their habitat, either due to reduction in its area or reduction in food resources through competition from people, they would tend to spill over into settlements, if their numbers are not being correspondingly reduced artificially or by natural processes. A natural reduction in a population may occur through lower fertility and or higher mortality, although in large mammals there is usually considerable time lag before this actually takes place. On the other hand, more commonly the reduction has occurred through hunting (as of the tiger) or capture (as of the elephant).

3.2 *Optimum foraging theory and conflict*: Ecological theory predicts that animals would tend to feed in a manner that maximizes their nutrient (energy, protein, minerals, etc.) intake in the minimum possible time (reviewed by Pyke *et al.* 1977). A tiger should, therefore, hunt prey that will provide it sufficient meat (that is, nutrients) with the least possible effort. It is easy to see that cattle, adapted to a relatively secure life under domestication, would fall prey to a carnivore far more easily than their wild cousin, the gaur, or the fleet-footed antelopes.

A study on crop raiding by elephants showed that cultivated grasses such as paddy and finger millet provide more protein, calcium and sodium than the wild grasses consumed during the corresponding season (Sukumar 1989, 1990). It is important to realize here that the proximate reason for elephants to prefer cultivated crops is their higher palatability. Succulent finger millet plants or sweet sugar canes would surely appeal to the elephant's palate much more than fibrous and siliceous grasses found in the wild. Herbivores are also able to detect minerals such as calcium and sodium by taste; hence they often eat soils rich in such minerals. But such an ability to seek out the most nutritious plants or parts is also adaptive in that it promotes better health and ultimately better reproduction. Thus, crop raiding by elephants or predation on

domestic livestock by tigers can be thought of simply as an outcome of their foraging strategy shaped by evolution. This has important implications in planning for the control of such depredations. A certain level of depredation would still persist even if the wildlife species concerned had adequate food resources in the wild.

3.3 *Animal social organization and conflict*: The social organization of the animal may play a role in promoting its conflict with people. Many large mammals are polygynous and some males tend to sire a large number of offspring while other males may fail to reproduce; by contrast the females would contribute more equally to the next generation (Trivers 1985). Evolution has favoured in such species a dimorphism between the sexes, with the male being typically larger in size than the female. A large body size is important for the male to dominate other males in the competition for mates and thus reproduce more successfully. Good nutrition and body condition are also essential for a male during the 'rut' when most of the breeding occurs. The male of the species thus has a greater stake in obtaining the nutrition necessary for growing large and healthy, and its willingness to take greater risks to achieve this goal may result in a more intensified conflict with human interests (Sukumar, in press).

The adult male elephant for instance raids crops about five to six times more frequently than does an average number of a female-led family group (Sukumar & Gadgil 1988, Sukumar 1989). Because of its larger body size and food requirements, the male elephant also consumes about twice as much crops per raid as a family herd member. Added to this the adult male may also damage the economically more valuable crops such as coconut. The net result is that the average adult male elephant ends up causing over 20 times as much damage in economic terms as compared to that inflicted by an average member of a family herd. An adult male caused damage worth Rs 6700 per year compared to only Rs 320 by a herd member (Sukumar 1989).

The male elephant is also the chief culprit in cases of manslaughter. An investigation of over 150 such cases in southern India revealed that sub-adult and adult male elephants (above 10 years of age) were responsible for over 80 per cent of the killings even though they made up less than 10 per cent of the total elephant population. Nearly half the incidents occurred within cultivation (and the rest inside

forest) and most of these were due to raiding male elephants.

The social organization of tigers may also drive the males into a more intense conflict with people. Male tigers have to establish and defend territories if they are to breed successfully (Sunquist 1981). When a male tiger is ousted from its territory by a rival male it may move into peripheral habitats adjoining settlements where it is likely to come into frequent contact with people. Male tigers with wounds or a 'wounded pride' can be expected to be aggressive. Some of the incidents of manslaughter by tigers near the Royal Chitwan National Park in Nepal seem to have been due to this reason (McDougal 1987). A study of the man-eating phenomenon in the Sundarbans showed that 10 out of 13 man-eating tigers were males and these accounted for 86 per cent of the victims (Hendrichs 1975). It is however not absolutely clear from other accounts of man-eaters that the male tiger is always the *bete noire*; there have been many notorious female man-eaters as well (e.g. see Corbett 1944).

4. MANAGEMENT OF ANIMAL-HUMAN CONFLICTS

The impact of wildlife on people has to be minimized through a variety of methods, ranging from creating wildlife proof barriers to selectively culling offending individuals to providing a measure of social security for people.

4.1 *Barriers to wildlife movement*: Physical barriers to prevent animals from crossing into human settlements may be feasible only in few cases. A barrier against elephants would be very expensive to create. Trenching the boundary of cultivation with forest is the most common method used in the country, but the costs may range from Rs 25,000 to 50,000 per kilometer. There would be additional maintenance costs. If a trench is even slightly shallower than the minimum depth of 7 feet needed to keep away elephants, a large bull might negotiate it. Even otherwise elephants might cross a trench by digging the soil with their feet, or more commonly the trench eventually fills up with soil washed down by rain. In actual practice most trenches fail due to improper maintenance, unless they surround a small piece of land.

4.2 *Psychological warfare*: Animals learn much of their behaviour

during their lifetime and it may be possible to deceive them into learning to fear people or objects that protect them. The most successful example of this 'psychological warfare' is the imaginative use of electrified dummies and masks against tigers in the Sundarbans of West Bengal (Sanyal 1987, Rishi 1988). Tigers were conditioned to associate humans with pain by allowing them to attack electrified clay models placed in natural settings inside the jungle. These dummies resembling fishermen and honey-collectors are dressed in used clothing to give them a human smell and wrapped in wire. The wire is connected to a 12-volt battery through an energizer which delivered a current of 230 volts. Man-eaters attacking the dummies receive a shock but a safety fuse and a low current of 20-25 milliamps ensure that this is not fatal to the animal (Sanyal 1987). The incidence of man-eating reduced by half, from an average of 45 per year during 1975–82 to 21 per year during 1983–5. Since then the tiger has been tricked by another simple, cheap device—a mask resembling a human face worn at the *back* of the head. Tigers generally attack their victims from behind, catching them off-guard. A mask worn in this fashion gives the predator an impression that it is being watched and hence it may be reluctant to attack. Some 2500 masks made of a rubberized plastic were distributed during November 1986–October 1987 among honey-collectors, fishermen and wood-cutters permitted to work inside the buffer zone of the Sundarbans reserve. Not a single person using the mask fell victim to a tiger. On the other hand, all the 30 people killed during this period were not using a mask (Rishi 1988). Although it is too early to say whether the tiger can be continued to be fooled in this manner, the success of these techniques is remarkable.

Electrified barriers against elephants have also been parttly successful. A high-voltage electric fence typically consists of two or three wires appropriately strung on hard wood or stone posts and connected to an energizer which draws power from the mains or a battery. A current of 5000 volts is given in pulses of very short duration, about 1/3000 second. An elephant coming in contact with the wire would receive a severe shock but is in no danger because of the short duration of the current. Electric fences in oil palm plantations in Malaysia are reported to have a 80 per cent success rate. They are also considerably cheaper than trenches, although some feel that in a country like India a labour-intensive method like trenching is more appropriate. In the course of time elephants also learn

that the tusks and the soles of the feet are poor conductors and use these to break down electrified fences in order to enter cultivation.

4.3 *Habitat management*: The impact of wildlife on people can be ameliorated to some extent by proper management of its habitat. Such management has to be balanced between the needs of wildlife and people. Land-use for agriculture or other forms of development near wildlife areas has often proceeded in a haphazard fashion. To take an example the cultivation of sugar cane near forest often draws prey animals and tigers behind them. Tigers may even give birth in sugar cane fields which resemble their natural tall grassland habitats. The stage is thus set for confrontation between tigers and people. Sugar cane is also too great a temptation for elephants. Not only should attention be paid in future to the type of agriculture being encouraged near wildlife habitats but also to maintaining the integrity of the habitat. It is better to have a single compact block of natural habitat for wildlife with the minimum interface with human settlement, rather than have a fragmented habitat of equal area interspersed with cultivation. This may inevitably mean that some settlements in certain problematic areas have to be translocated.

Use of forests for human needs has to be properly regulated. All too often the natural habitat for wildlife has been devastated through indiscriminate cutting of trees, raising monoculture plantations of exotic species such as eucalyptus, mining, construction of dams and overgrazing by livestock. Illegal hunting of prey species such as deer has to be curbed in order to provide an adequate food base for the carnivores. When the carrying capacity of the habitat is reduced the excess animals tend to spill over into human settlements. On the other hand, the opposite trend has also occurred in some places. The creation of reservoirs through dam construction has provided perennial water sources for wildlife, thereby increasing their populations artificially beyond the normal carrying capacity of the habitat, and causing them to intrude into settlements. It is beyond the scope of this essay to go into specific details of habitat management; each region has to be obviously dealt with according to the peculiar conditions prevailing there.

4.4 *Animal population management*: Wildlife populations that come into severe conflict with human interests may have to be directly managed to keep their levels below tolerable limits. This will involve

removal of problem animals from the population. A proper under-standing of the demography of the species is important if one is to ensure that a viable population is maintained. One example of how elephant populations can be managed to minimize conflict and yet maintain their viability can be outlined from a synthesis of our knowledge of social organization, demography and population genetics of the species. It is clear that the adult male elephants are inherently more predisposed to raiding crops as a consequence of social organization. The removal of an adult male elephant from the population would have a far greater effect in reducing crop-damage (by a factor of 20 in economic terms) and saving human lives than the removal of an elephant from a family herd. Our under-standing of demographic processes in such polygynous species also show that the loss of a certain proportion of males is not likely to affect the intrinsic rate of growth of the population (Sukumar 1989). The removal of females from the population would certainly reduce its growth rate. Hence, the selective culling of male elephants identified as inveterate crop raiders or rogues would be the best form of population management. Some of this culling can simply be cap-ture for domestication. A successful example of this is the capture of nine elephants by chemical immobilization in the Kattepura Forest Reserve of Karnataka during 1986 (Appayya 1989). All the elephants were males which had moved into this small forest patch, isolated by a reservoir, and were in regular conflict with nearby settlements.

Beyond a certain point the distorted sex ratio, with a predomi-nance of females, caused by selective removal of males may lead to genetic problems such as loss of variation and inbreeding depression if population sizes are small (Frankel and Soule 1981). In southern India the high rates of poaching of male elephants for tusks has created some of the most unequal sex ratios known for elephant populations anywhere. Further culling of males here may not be justified other than in exceptional cases. Other elephant populations such as those in northeast India have a high proportion of tuskless males (up to 80 per cent of the male segment). These can be expected to have a more equal sex ratio and hence can tolerate a certain amount of selective male removal (Sukumar, in press).

Similar arguments may be applicable to other polygynous mam-mals that come into conflict with people. The tiger is highly endan-gered and every effort should be made to avoid culling of these animals. However, there would be no other option but to capture

or shoot identified man-eaters. The decision to cull should be easier to take if the offender is known to be a male tiger.

4.5 *Social security*: To mitigate the impact of wildlife on people, a variety of social security schemes should be made a part of conservation plans. Project Tiger did take this into account by providing compensation for livestock killed by tigers or leopards near reserves. Many schemes are in operation now but in practice some of these are not adequate. States such as Karnataka and West Bengal do have schemes for compensating damage to crops by elephants, but others such as Tamilnadu do not. Crop insurance has yet to be seriously tried out anywhere. Moreover, a serious problem with social welfare schemes in a country like India is that they are prone to abuse through corruption.

Compensation for loss of life is generally made in most states but here again the amounts are low. The maximum amount paid is about Rs 15,000 while in states like Tamilnadu this may be as low as Rs 2000. The compensation for people killed by elephants within cultivation should be higher than for those who fall victim inside the forest; the reasoning here is that the elephant had no business to enter legal settlement. Under the law a person can probably kill an elephant within settlement and get away by pleading self-defence, although people hardly ever resort to this. In some states such as Tamilnadu, the tribals engaged in forestry operations or collection of minor produce are insured under the Janatha Accident Insurance Scheme. An annual premium of Rs 12 provides a cover for Rs 15,000 against accidental death. Such insurance schemes must be popularized in regions where people face the risk of being killed by animals. These can be promoted through co-operative societies as is being done in Tamilnadu.

CONCLUSIONS:

There is a pressing need both to conserve wildlife and to minimize its impact on human lives and property. We live in a rapidly changing society. On the one hand a highly materialistic culture is arising—witness the advertising culture particularly over television which reaches a large section of the population—while on the other the majority of people barely manage to survive. When the

rich and middle classes are caught up in the consumerist boom (really an anti-thesis of conservation), it will be too much to expect the poor to remain as silent spectators. Conflict over access to natural resources is bound to only increase in future. Conservation can succeed only if the legitimate aspirations of people dependent on forests for their livelihood can be met by the rest of society. To cite an example of the prevailing attitude—when officials tried to explain to villagers in the Gir Sanctuary the need to protect lions, they were told to take all the lions with them to Delhi!

Today the local people see sanctuaries or national parks as simply the pleasure resorts of the affluent. There is urgent need to reorient management of our wildlife reserves so as to pass on economic benefits to local communities. This can be done in many ways. In the Chitwan Park of Nepal, an attempt is being made to balance the needs of people and wildlife by allowing people to remove tall grass from the park in a fashion that does not cause any adverse impact (Mishra 1982). About 30,000–50,000 permits are issued each year and the value of the produce removed during 1978–82 was about 3 million US dollars. Thus the Chitwan people recognize that most of the tall grass outside the park has disappeared, but the reserve is protecting those left in the district.

Wildlife reserves have enormous potential for generating income from tourism, but so far the benefits from this have not reached the local people in the way it should have. If an adequate proportion of the income derived from tourism is retained by the local economy there would be increased motivation for people to value wildlife and their habitats rather than deplete them through over-grazing, wood cutting or illegal hunting. Such schemes have been successfully tried out in the Luangwa valley of Zambia (Lewis *et al.* 1990). Not only do the resident villagers participate in wildlife management, considerable revenues generated through wildlife *safaris* are retained by the local communities. As a result poaching has dropped dramatically and village attitudes toward wildlife conservation become more positive. It is time that we also take bold new approaches towards reconciling economic development with conservation. In the words of ecologist Norman Myers, 'Conservation should not only sustain the spirit but also the stomach'.

REFERENCES

Appayya, M. K.,
1989   Destroy the Jungle, Move the Elephants, *Sanctuary*,9 (No. 3), 48–51.

Bell, R. H. V.,
1971   A Grazing Ecosystem in the Serengeti, *Scientific American*, 224, 86–93.

Blair, J. A. S., Boon, G. G. & Noor, N. M.,
1979   Conservation or Cultivation: The Confrontation between the Asian Elephant and Land Development in Peninsular Malaysia, *Land Development Digest* 2, 27–59.

Corbett, J.,
1944   *The Man-Eaters of Kumaon*, Oxford University Press, London.

Ehrlich, P. R., & Ehrlich, A. H.,
1981   *Extinction : The Causes and Consequences of the Disappearance of Species*, Random House.

Frankel, O. H., & Soulé, M. E.,
1981   *Conservation and Evolution*, Cambridge University Press, Cambridge, U. K.

Hendrichs, H.,
1975   The Status of the Tiger *Panthera tigris* (Linn., 1758) in the Sundarbans Mangrove forest (Bay of Bengal). *Saugetierikundliche Mitteilungen*, 23, 161–99.

Khan, M. A. R.,
1987   The Problem Tiger of Bangladesh, in *Tigers of the World: The Biology, Biopolitics, Management and Conservation of an Endangered Species*, ed. R. L. Tilson & U. S. Seal, Noyes Publications, Park Ridge, New Jersey, pp. 92–6.

Lahiri Choudhury, D. K.,
1980   An Interim Report on the Status and Distribution of Elephants in Northeast India, in *The Status of the Asian Elephant in the Indian Sub-continent* (IUCN/SSC Report), ed. J. C. Daniel, pp. 43–58, Bombay Natural History Society, Bombay.

Lewis, D., Kaweche, G. B. & Myenya, A.,
1990   Wildlife Conservation Outside Protected Areas—Lessons from an Experiment in Zambia, *Conservation Biology*, 4, 171–80.

McDougal, C.,
1987   The Man-eating Tiger in Geographical and Historical Per-
        spective. In *Tigers of the World : The Biology, Biopolitics, Man-
        agement and Conservation of an Endangered Species*, ed. R. L.
        Tilson & U. S. Seal, Noyes Publications, Park Ridge, New
        Jersey, pp. 435–48.

Mishra, H. R.,
1982   Balancing Human Needs in Nepal's Royal Chitwan Park,
        Ambio 11(5), 246–51.

Mishra, J.,
1971   An Assessment of Annual Damage to Crops by Elephants
        in Palamau District, Bihar, *Journal of the Bombay Natural
        History Society*, 68, 307–10.

Prasad, S. N., & Gadgil, M.,
1981   *Conservation of Bamboo Resources of Karnataka*, Karnataka
        State Council for Science and Technology, Bangalore.

Pyke, G. H., Pulliam, H. R. & Charnov, E. L.,
1977   Optimal Foraging: A Selective Review of Theory and Test,
        Quarterly Review of Biology, 52, 137–53.

Rishi, V.,
1988   Man, Mask and Maneater, *Tigerpaper* Jul–Sep. 1988, pp. 9–14.

Sanyal, P.,
1987   Managing the Man-eaters in the Sundarbans Tiger Reserve
        of India—A Case Study, in *Tigers of the World: The Biology,
        Biopolitics, Management and Conservation of an Endangered
        Species*, ed. R. L. Tilson & U. S. Seal, Noyes Publications,
        Park Ridge, New Jersey, pp. 427–34.

Sukumar, R.,
1989   *The Asian Elephant : Ecology and Management*, Cambridge
        University Press, Cambridge, U. K.

Sukumar, R.,
1990   Ecology of the Asian Elephant in Southern India. II. Feeding
        Habits and Crop Raiding Patterns, *Journal of Tropical Ecol-
        ogy*, 6, 33–53.

Sukumar, R.,
(In Press) The Management of Large Mammals in Relation to Male
        Strategies and Conflict with People, *Biological Conservation*.

Sunquist, M. E.,
1981   The Social Organization of Tigers (*Panthera tigris*) in Royal
        Chitwan National Park, Nepal, *Smithsonian Contributions to
        Zoology*, 336, 1–98.

Trivers, R. L.,
1985   *Social Evolution*, Benjamin/Cummings, Menlo Park,
        California.