

Management of
Human - Wildlife
Interactions
and
Invasive Species
in India



Wildlife Institute of India 2015

Editors:

V.B. Mathur, S.S. Bist, M. Kaushik, N.A. Mungi and Q. Qureshi, 2015. Management of human-wildlife interaction and invasive species in India. Report number (TR-2015/004), Wildlife Institute of India, Dehradun.

Content

Introduction	1-2
Synthesis	
Human-Carnivore interactions	3-30
Human-Herbivore interactions	31-60
Human-Macaque interactions	61-66
Invasive species	67-87
Workshop proceedings and discussion	
Human-Carnivore interactions	88-92
Human-Herbivore interactions	93-95
Human-Macaque interactions	96-98
Invasive species	99-102
Law and Policy interventions	103-104
Draft guidelines	
Model operating guidelines for human-wildlife negative interactions	106-170
Human-Carnivore interactions	171-178
Human-Herbivore interactions	179-189
Human-Macaque interactions	190-194
Invasive species	195-203
Policy gaps	
Management of invasive species	204-218
References	219-235
Annexure I (List of Participants –Experts and researchers)	237
Annexure II NTCA SOP for straying tiger	
Annexure III NTCA SOP in case of tiger death	
Annexure IV MOEFCC guideline for the management of Human-leopard conflict	
Annexure V SOPs for bear	
Annexure VI Utility of <i>Prosopis juliflora</i>	

Acknowledgements

We thank Ministry of Environment, Forest and Climate Change for the funding to organize this workshop. Dr. P.K. Mathur, Dean, Wildlife Institute of India provided the conditions for fostering the working environment essential for completing this task as well as for providing his valuable suggestions on the draft report. We thank Dr. Pranab Pal, FTO, Sh. P.K. Aggarwal, administrative section, staff of finance office and store for providing all the essential support and services to conduct this workshop. We also thank IT, RS and GIS section of the Wildlife Institute of India for providing technical support. We thank our hardworking rapporteurs for recording the essence of each session during the workshop. We would like to acknowledge the help provided by Shweta Sharma and Ridhima Solanki for providing their editorial services. We are indebted to our reviewers for providing detailed comments and sharing their research insight on the draft report that definitely improved the quality. We also thank all the experts and participants of the workshop who discuss various aspects of the issues related to management of negative human-wildlife interactions and management of invasive species. Participants not only provided answers but also raised important research questions that need to be discussed for resolving these issues threatening India's biodiversity.

Executive summary

Human – carnivore conflict is perceived as one of the most negative interactions in wildlife and humans, owing to the direct loss of human life associated with the presence of carnivore. Tiger, lion, leopard, snow leopard, wolf, dhole and bear are the most conflict related species. Studies on conflict related to tiger, lion, snow leopard and leopard are available while that for wolf, dhole and bear are rarely conducted. Owing to the conservation value of tiger and lion, guidelines and policies have been centered to the conflict related to these flagship species. In almost all the cases, management system has guaranteed economic compensation. Standard operating protocol (SOP) is developed for identifying and removing an individual that has repeatedly reported in conflict with humans. As few of these carnivores need healthy habitat and ample prey species for their sustenance, co-existence with increasing human pressure seems distinct from the present facts. Thus, in order to minimize the negative interaction, it is essential to relocate human settlement from the protected areas inhabited by these species. Attack by leopard on humans is amongst the major conflict cases. As leopard and snow leopard also inhabit in areas dominated by humans, it is of immense importance to amplify the social carrying capacity through awareness camps and increasing the vigilance during peak activity time of a species in the shared area. Frequency of conflicts associated to leopard in human dominated areas has triggered concern about the sustenance of these species, as shown by recent series of studies invested on subject. Results of these studies were adapted to form guidelines in order to avoid and mitigate the conflict issue and the SOP is being developed for conflict scenario management. In all the cases of carnivore conflict, economic compensation has helped to elevate the social carrying capacity. Hence, timely facilitating the desired amount of compensation can reduce the negative perception associated with conflict case. In case of snow leopard, the medical and life insurance policy has helped in building positive perception towards snow leopard conservation. However, such solutions are possible by joint efforts from multiple sectors and active participation of governmental agencies; and hence should be considered for managing conflict of other species as well.

Human - Herbivore conflicts are mainly centered towards the loss of agricultural crops. These losses are high if the crop fields are present around Protected Areas or in the forest used by herbivores involved in conflict. Nilgai, Wild pig, Elephant and Black buck are ranked as species

with highest conflict records owing to their vast distribution across India and habitat overlap with human settlements. While conflict caused by Rhino and Wild ass though restricted in few parts of the country, is similar conflict case. Particularly, in case of elephants, agricultural fields are used as corridors for colonizing or moving across adjacent protected forests. Conflicts with herbivores are speculated to be caused due to habitat degradation, absence of predator, absence of quality forage in the forest, etc. However, these speculations are not tested in field.

Nevertheless, looking at increased individual and group raiding on the crops, it is essential to put a control on the reproductive rate of these individuals to avoid long-term conflict. Reproductive control needs an understanding of optimal demographic age and sex ratios to be maintained for sustenance of species. Hence, it should be practiced only in addition to the ecological population monitoring. Techniques used in reproductive control are new to the country and should be executed by expert research team. In case of a species like wild pig that can cause repeated conflict, provision of declaring such species as vermin for a particular area is available. In case of managing the on-going crop raiding, bio-fencing around the crop fields, night vigilance, alarm alerts and barricades should be used. Elevating the social carrying capacity by forming a self-help group in the conflict prone villages that includes people from various sectors can provide immediate and economical solutions.

Human - Non-human primate conflict is one of most serious issue in the negative interactions in human and wildlife. Though Rhesus macaques, Bonnet macaques and Hanuman Langur carry cultural respect from the dominant society, their increasing population in human settlements is increasingly resulting in negative interactions. Devotees and animal lovers feel gratified in feeding monkeys in temples, highways or roof tops and consider it a religious deed. Apart from many monkeys getting diseased and killed due to these habits, they have become habitual of snatching food from people and attacking them. Macaque troops involved in conflict are often translocated to the forests or enclosures in many parts of the country. Often these empty habitats are re-colonized by the surrounding macaque troops, and the conflict continues. Reproductive control is the most convenient and long term solution for controlling the negative interactions, but should be carried with regular population monitoring to keep the densities at optimal low levels. Methods such as oral administrative contraceptives, intra-uterine devices, and blockade of tubal patency following transcervical administration of polidocanol foam should be used for female monkey sterilization. Removal of specific macaque individuals that show persistent

aggressive behavior or learnt raiding behavior should be implemented. Additionally social awareness about Solid waste management and proper disposal of rural organic waste as well as prohibition on feeding of monkeys in public places is of immense importance; as most of these troops colonize the area due to readily available food.

Management of prioritized invasive species by 2020 is India's 4th target of Fifth National Report to the Convention of Biological diversity. In total, 21 species were identified as high concern invasive species for 4 different ecosystems of India viz., terrestrial ecosystem (*Lantana species complex*, *Prosopis juliflora*, *parthenium hysterophorus*, *Mikania micrantha*, *Chromolaena odorata*, *Ageratina adenophora*, *Ageratum conyzoides*, *Xanthium strumarium*, *Mimosa diplotricha*, *Hyptis suaveolens*, *Senna tora* and Great African Snail (*Achatina fulica*)) island ecosystem (*Axis axis* and *Hoplobatrachus tigerinus*), freshwater ecosystem (*Oreochromis mossambicus*, *Salmo trutta fario*, *Clarias gariepinus*, *Cyprinus carpio*, *Ipomoea carnea* and *Eichhornia crassipes*) and marine ecosystem (*Kappaphycus alvarezii*). As a response to the impacts of these species, many regional managerial interventions are carried to remove the species. Most of these management practices are guided by the umbrella legislation of Wildlife (Protection) Act, 1972 and National Biodiversity Action Plan, 2008. It was also concluded during the workshop, that restoration of the native ecosystem should be the focus of management in the terrestrial ecosystem and hence the removal of any species should be followed by active/passive restoration of native ecosystem. The major gap that was observed was in the information about distribution and magnitude of invasion across country for any invasive species; and in the studies of restoration techniques in terrestrial ecosystem. The repeated introduction of fishes via aquaculture and escape through the controlled culture are the main invasion pathways in freshwater ecosystem. It should be addressed by enhancing the present quarantine techniques to identify the fry of these species during the import, and safeguarding the outlets of culture discharge (particularly in the floods).

Introduction

Managing human-wildlife negative interactions (HWI) and Invasive species are two major challenges faced by wildlife managers in India. Apart from the negative public perceptions towards wildlife and the Forest/Wildlife Department, managing HWI and invasive species also incurs heavy expenditure of the limited funds and other resources available to the department. Human-wildlife interactions and biological invasion may appear as distinct problems but in many occasions reduction in native food plants due to increase in cover of invasive plant species have been stated as one of the reasons of straying out of wild herbivore in search of food. For example, invasive species such as *Desmodium trifliatumum*, *Cardiospermum helicacabum*, *Ipomea cornea*, *Argemone maxicana* in Pabitora wildlife sanctuary are rapidly increasing in cover and competing with native fodder species leading to increase in crop-raiding incidents by Rhino. Similarly, increase in *Lantana camara* cover has resulted in decreased habitat use by elephant in dry deciduous forest of Mudumalai Tiger reserve.

While biologists have generated some scientific information on these issues in a few study areas, field managers at the site and the State Forest/Wildlife Department in general have taken up various measures to manage HWI and Invasive species in their respective areas. Although, we have a few site specific success stories and best practices, the problem is yet to be tackled at the State or National level in a holistic manner. Moreover, lack of basic research on the efficiency and consequences of available management often raises serious questions in front of forest department and scientific community.

Keeping this in view, the Wildlife Institute of India (WII), Dehradun, conducted a “*Workshop on Human-Wildlife Interactions and Management of Invasive Species*”, at WII, Dehradun on 23rd & 24th July 2014. A total of 110 participants actively discussed these issues over the two days of the workshop. Objective of this workshop was to bring together, scientist, forest official, researchers, and representative of leading NGOs dealing with these issues for a better knowledge about the current state of the problem and to find out a way forward. Workshop was conducted under five major themes 1) Human – Carnivore interaction, 2) Human – Herbivore interaction, 3) Invasive species management, 4) law and policy and 5) Human-macaque interactions.

Workshop was structured in such a way that the expert presented the overview of the current state of affairs, available management/ mitigation options and policies for human-wildlife interactions and invasive species on the first day to all the participants. Later, streamlined brainstorming session was held under above mentioned themes to identify the gaps in the current state of knowledge and to develop guidelines and on the second day.

On the first day of the workshop, Dr. V. B. Mathur, Director, Wildlife Institute of India, welcomed all the distinguished guest and participants and mentioned about the special request from the Ministry of Environment, Forest and Climate Change which laid foundation for this workshop. Ministry assigned this responsibility to Wildlife Institute of India with the hope to receive a road map for resolving these two biggest threats to the country's biodiversity. He highlighted the conscious effort of the institute for using the term "interaction" in workshop's title instead of the commonly used term "conflict" in an order to acknowledge both positive and negative aspects of the interaction between human and wildlife. Dr. Mathur mentioned about developing a combination of preventive and mitigative strategies to reduce the negative interactions between human and wildlife. He stated about the huge economic losses worldwide due to biological invasion and the efforts at international (CBD Aichi Biodiversity target-9) and national levels (National biodiversity target-4) to combat the ill and sometimes irreversible effects of the invasive species. He further added that lack of basic knowledge and management efforts at the local level especially in the protected areas is leading to downscaling of their fundamental role of biodiversity conservation.

This report has been compiled by a team of researchers from the Wildlife Institute of India under the supervision of Sh. Qamar Qureshi, Dr. Sathyakumar and Dr. K. Sankar. This report first provides the synthesis of existing information on the issues pertaining to human-wildlife interactions under the themes of carnivore, herbivore & macaque and a section dealing with invasive species. Later, it summarizes the key issues and suggestion provided by experts during the workshop in form of proceedings of the workshop. Finally, using existing literature and essence of discussion over the two days, draft guidelines has been designed to help in decision making process while dealing with these issues. Also, the existing Standard Operating Procedures (SOPs) relevant to the workshop have been provided as annexures.

Synthesis of Human-Carnivore Negative Interactions



Authors

Monica Kaushik, Kausik Banerjee, Dipanjan Naha, Y.V. Jhala, S.Sathyakumar & Qamar Qureshi

Reviewers

Dr. A.J.T Johnsingh, Dr. Yashveer Bhatnagar & Dr. S.P.Goyal

Expert panel

Dr. Vinay Sinha, Sh. A.K. Singh, Dr. Vidya Athreya, Dr. NVK Ashraf, Dr. Samrat Mondal , Sh. Subharanjan Sen, Dr. Bilal Habib, Dr. Y.V. Jhala

Rapporteur

Dipanjan Naha, Puneet Pandey, Nilanjan Chattarjee, Sumit Arya, Devanshi, Nikit Pallavi, Pragya, Prerna Sharma, Kaushik Banerjee, Srinivas Y, Stotra Chakra

Photo Credits

Dharmendra Khandal

Human-Lion Interaction in India

Current population status and distribution of species

Asiatic lions (*Panthera leo persica*) once ranging from Persia to Palamau in the eastern India, were almost extinct by indiscriminate hunting and habitat loss. A single relict population of about 50 lions persisted in the Gir forests, Gujarat by 1880's. With stringent protection by the Junagadh *Nawabs* and subsequently by Gujarat forest department, lions have increased with an annual rate of 2% to a current population of over 400 (Banerjee & Jhala, 2012). Lions were restricted to the Gir forests (1,800 km²) till 1980's, but have since dispersed occupying over 10,000 km² of agro-pastoral Saurashtra landscape. Although the population is stable but due to its low size the species has been designated as endangered by IUCN (www.iucnredlist.org). CITES keeps a vigil on illegal trade of the species or its parts by listing lion in appendix-I (www.cites.org). Within India, Asiatic Lion is classified in the Schedule-I of the Wildlife Protection Act (1972) which accords the highest legal protection available to any species.

Status of negative interaction

Owing to timely protection provided by the Nawab of Junagadh and the state-run Gujarat Forest Department against hunting, the population of the Asiatic population has increased from less than 50 individuals, in the 1920s, to the currently estimated total of more than 400 individuals at an annual growth rate of about 2% (Banerjee & Jhala, 2012). Also, there was a range expansion after the mid-1980s, with the current lion population occupying over 10,000 km² of the Saurashtra landscape, which comprises Gir Protected Area (Gir PA, 1800 km²), Girnar Sanctuary (180 km²) and human-dominated agro-pastoral landscapes of Saurashtra (Banerjee & Jhala, 2012; Singh & Gibson, 2011). Lions have been locally extinct in these areas at least for the past five generations, and the people have no experience of living in the lion's habitat. Thus, with lions re-appearing in these areas and living close to humans, conflicts are inevitable. Major lion-human conflict documented in the Gir landscape included a) livestock predation by lions (Banerjee et al., 2013; Joslin, 1973; Meena et al., 2011; Singh & Kamboj, 1995; Srivastav, 1997), b) human-lion confrontations resulting in human injuries and death (Banerjee 2012; Meena & Kumar, 2012; Saberwal et al., 1994) and c) human-induced lion mortality (Banerjee & Jhala, 2012; Joslin, 1973; Pathak et al., 2002; Meena & Kumar, 2012).

Reasons for negative interaction

Decrease in wild prey, high density and easy catchability of livestock (especially cattle) compared to wild prey were the main reasons behind livestock predation inside the Gir PA (Joslin, 1973; Saberwal et al., 1994; Singh & Kamboj, 1995; Srivastav, 1997). Some authors have ascribed thickening of habitat within the Gir PA unsuitable for hunting of wild ungulates by lions (Sinha et al., 2004). Change in cropping patterns (more cash crops such as sugarcane and mango orchards) and rapid fragmentation of the peripheral forests (grasslands) were also ascribed as major cause of lion-human conflict in and around Gir PA (Meena & Kumar, 2012; Sinha et al., 2004). Srivastav (1997) identified lower vigilance of *Maldharis* (pastorals) on grazing livestock herds owing to Government compensation scheme significantly offsetting their losses.

Banerjee (2012) identified major reasons of lion-human conflicts in the human-dominated Saurashtra landscape; these are a) rapid change of traditional land use pattern, b) loss of habitat refuge patches for lions, c) change of human attitudes toward lions outside Gir in absence of any incentive, d) little experience of staying with lions in memorable time and e) human psychology of fear & retaliation. Open irrigation wells, electrocution as a non-target species, poaching and road/rail kills were major factors behind human-induced lion mortality (Banerjee & Jhala, 2012; Meena & Kumar, 2012). People suddenly encountering a lion and/or attempting to deter lions from killing their livestock were more prone to lion attacks in the human-dominated Saurashtra landscape (Banerjee, 2012).

Management of negative interaction

→ **Current mitigation measures**

- Several mitigation measures have already been put in place by the Gujarat Forest Department (Meena & Kumar, 2012; Pathak et al., 2002; Singh & Kamboj, 1996)
- Compensation scheme for livestock predation.
- *Ex-gratia* for damages due to wildlife is provided by Gujarat Forest Department. *Ex-gratia* in case of human injury varies from 2500-10000 and 100000 in case of human death (<http://www.gujaratforest.org/gr-man-animal>).
- Strong protection regime for lions and wildlife crimes across the landscape.

- Geographic Information System & on-ground surveillance for controlling illegal activities (encroachment, illegal grazing, lopping, wood cutting etc.).
- Covering of open irrigation wells with permanent rubble walls or parapets.
- Capture, rescue and translocation of ‘problem’ animals.
- A village level network of informants (*Vanya Prani Mitra*) vigilant on livestock predations, suspicious movements of people etc.
- A mobile team from the forest department monitoring and evaluating conflict issues across the landscape.
- Capacity building & training of staff to mitigate & handle conflict situations in field.

→ **Mitigation measures suggested**

- Maintaining lion density within social threshold outside the PA & management (capture and removal) of problem lions from the landscape (Banerjee, 2012; Meena & Kumar, 2012; Pathak et al., 2002). These lions may be sent to various national and international zoos for building up a conservation breeding program for Asiatic lion (Chellam, 1993; Saberwal et al., 1994).
- Government compensation for livestock depredation should include capital loss (market price of predated livestock unit) and incorporate lost opportunity cost i.e. opportunity to earn from the predated livestock in the years to come had it not been killed (Banerjee et al., 2013). Funds can be disbursed through community based institutions, instead of direct disbursement by the Forest Department.
- Regular revision of livestock compensation scheme (3-5 yrs.) with reflectance to change in market prices (Banerjee et al., 2013; Mena & Kumar, 2012).
- Prompt & timely payment of the compensation amount. The compensation scheme should be transparent and the amount should be in proportion to loss incurred by the family (Banerjee et al., 2013; Mena & Kumar, 2012).
- Livestock insurance scheme was proposed at village level (Banerjee, 2012; Meena & Kumar, 2012; Sinha et al., 2004). Improved livestock husbandry practice in the region (Meena et al., 2011) and fencing of livestock holding areas of villages to minimize carnivore attacks at night (Meena & Kumar, 2012).

- Encouraging Gaushalas and Panjrapoles in the landscape with veterinary inspection. These would provide lions with food sources in terms of surplus unproductive cattle and thereby predation on high priced productive domestic livestock would be low (Banerjee, 2012).
- Injuries caused by lion attacks may permanently cripple a victim. Therefore, one-time compensation may not always be sufficient for an affected family. Besides providing compensation for human deaths/injuries, some provision for giving the nearest kin of the victim employment in the forest department (or some other departments) could be explored to gain better support from the local communities for lion conservation (Banerjee, 2012).
- Management of the habitat inside GPA to enhance the carrying capacity for the wild ungulate population (Johnsingh et al., 1998; Joslin, 1973; Singh & Kamboj, 1995). Conservation of habitat refuges and lion breeding patches outside GPA through legislation (designation of areas as ‘Eco-sensitive’, ‘Conservation Reserve’, etc. and eco-restoration without compromising the local communities’ livelihood needs (Banerjee, 2012; Meena & Kumar, 2012; Saberwal, 1994; Sinha et al., 2004). Intensive management of grasslands (*vidis*), wastelands and pasture lands in the landscape to increase fodder production and develop buffers/corridors for lions and other wildlife (Mahadev & Chauhan, 2000; Srivastav, 1997).
- Improving protection against poaching, human-caused lion mortality, illegal encroachments and other wildlife crimes (Chellam, 1993; Joslin, 1973; Meena & Kumar, 2012; Pathak et al., 2002).
- Translocation of lions in some other parts of the species’ historical range (Chellam, 1993; Johnsingh et al., 1998; Saberwal et al., 1994).
- Making the land policy of the forest department lion friendly and instituting inter-sectoral collaborations (revenue, police, tourism, electricity, railway, highways, agriculture, etc.) to monitor and mitigate conflicts in the landscape (Banerjee, 2012; Meena & Kumar, 2012).
- Awareness campaigns educating people about the biology, movements and activity peaks of the lion, conservation issues and ongoing government schemes and programmes and

providing other relevant information to foster better tolerance (Banerjee, 2012; Meena & Kumar, 2012; Pathak et al., 2002; Sinha et al., 2004; Saberwal et al., 1994).

→ **Existing policies**

- Standard operating procedure have been formulated by the National Tiger Conservation Authority to deal with the straying carnivore in human dominated landscape (http://projecttiger.nic.in/Final_SOP_11_01_2013, Annexure 1)
- Guideline for monitoring the lions, co-predators, prey, habitat and conflicts in the Gir Conservation Area was prepared by the Wildlife Institute of India in 2004 (Jhala, 2004). Many of the monitoring protocols and management recommendations prescribed therein were included in Gir Management Plans (Meena & Kumar, 2012; Pathak et al., 2002; Singh & Kamboj, 1996; see mitigation measures).

Human-Tiger interaction in India

Current population status and distribution of species

In India, the tiger (*Panthera tigris*) is currently distributed across seventeen states. It occurs in a variety of habitats, from rainforests to grasslands and from dry deciduous forests to mangroves. Considering its role as a top predator in various ecosystems and as a flagship species, the Government of India started a countrywide effort for conservation of the tiger, named Project Tiger, in 1972 (<http://envfor.nic.in/division/introduction-18>). A recent census conducted in year 2014 indicate numbers of tigers to range from 1949 to 2491 (Jhala et al., 2015).

The IUCN has designated the tiger an endangered species due to the decline in its occupancy as well as population size within its geographic range over the past three tiger generations (www.iucnredlist.org). It is listed in the Appendix-I of CITES, which makes it illegal to trade in the species. Indian laws provide the highest degree of legal protection to the tiger by listing it in Schedule-I of the Wildlife Protection Act (1972).

Status of negative interaction

Human–tiger conflicts can be grouped into three categories: (1) attacks on humans, (2) livestock depredation and (3) tigers that stray into human-dominated areas. Depredations on domestic animals are the most common type of human–tiger conflict. In extreme situations, losses might be as high as 12% of local herds and 17% of annual household incomes (Madhusudan & Mishra, 2003; Sangay & Vernes, 2008; Wang & Macdonald, 2006), and livestock can make up over 25% of the tiger’s diet (Wang & Macdonald, 2006). India harbours the highest number of tigers (Jhala et al., 2014) and has the largest number of man-eating cases (Corbett, 1991; Khan, 1986; McDougal, 1987). Tigers killed 19% of all the livestock killed by carnivores in Bhutan from 2003 to 2005 (Sangay & Vernes, 2008).

Reasons for negative interaction

Tigers require abundant large prey (Smith et al., 1987; Smith et al., 1998) and extensive forested habitats to sustain themselves (Smith et al., 1987; Smith et al., 1998; Sunquist, 1981). With the rising human population and increasing requirement of resources to sustain it, vast stretches of wild lands have been fragmented and cleared to make way for agriculture. Rapid encroachment and habitat fragmentation have resulted in tigers occupying only isolated small pockets of forest

(Jhala et al., 2011, Smith et al., 1998,). For instance, in Tadoba-Andhari as well as in the Sundarbans, local people frequent the forested areas to collect firewood and other forest products. This has been identified as the major reason of conflict (Das, 2012; Dhanwatey et al., 2013). Corridors are crucial to connect source populations to other protected areas for tiger movement, which is important for long-term tiger conservation and conflict management (Qureshi et. al., 2014).

Poaching is the primary reason for local extinction, followed by prey depletion, in the past 100 years (Karanth & Stith, 1999). Tigers readily kill livestock and dogs in areas where the wild prey is depleted, the reasons for which are usually hunting, habitat degradation and competition offered by livestock (Johnson et al., 2006; Miquelle et al., 2005; Sangay & Vernes, 2008; Wang & Macdonald, 2006). Local people have poisoned and hunted down tigers to avenge personal and economic losses.

Management of negative interaction

→ Current mitigation measures

- Tiger involved in attacks on humans (especially man-eaters) are either translocated to a captivity or killed. Often, it's the only resort available to the managers for a strayed out or alleged "problem" animal. However, in areas with small population such repeated lethal control may result in local extirpation of the species, as many non-problem tigers are generally killed in the process of controlling the problem one (Karanth & Gopal, 2005).
- The traditional method of guarding and fencing was found to be the most effective measure in reducing livestock losses across protected areas in different biogeographic zones (Karanth et al., 2013a).
- WWF-India and the Corbett Foundation, apart from the government, provide "interim relief" compensation for loss of livestock and human lives for providing immediate assistance to the victim. The two biggest problems with this approach are the high level of donor input required and unavailability of the scheme in remote areas with potentially high levels of conflict.
- In Sunderbans, a couple of innovative preventive methods have been tested so far. The use of nylon mesh in villages vulnerable to tiger entry is one of these. The use of electrified human

dummies as an aversive conditioning of tigers is another. Although the authorities involved claim that the deployment of these methods has resulted in a reduction in the number of conflict cases, no experiment have been conducted to test their efficacy (Karanth & Gopal, 2005).

→ **Mitigation measure suggested**

- Translocate problem animal and/or dispersing individual, reaching to close proximity of human settlement, in suitable tiger habitat based on sound science i.e., accounting for biogeographic differences in tiger population, proximity to other tiger populations and prey densities.
- Reducing the dependence of local people on forest products by providing alternate energy sources (i.e., biogas, solar power, etc.) could reduce the frequency of entry of humans into forests and therefore conflicts (Dhanwatey et al., 2013).
- Regulating grazing activities within protected areas and having human herders guard herds are expected to reduce the number of livestock depredation cases (Karanth & Gopal, 2005; Karanth et al., 2013).
- Rapid response teams should be formed to deal with emergencies. This could prevent and mitigate conflicts in affected areas. The teams should be composed of experts in wildlife capture, veterinarians and officials of the forest department (Dhanwatey et al., 2013)
- Spatial segregation or zoning of human and tigers by translocating human- settlements outside protected areas has been advocated as the most effective measure for preventing conflict and ensuring the long-term survival of the tiger. Moreover, local communities also gain access to better living conditions. In a recent study conducted in the western part of the Terai Arc Landscape, the forest-dwelling Gujjar community was found to be willing to move outside the protected area. The major reasons for this were (i) reduction in forest productivity affecting the income and (ii) lack of education as well as health facilities within the protected area (Harihar et al., 2014). However, attitude and willingness to move out of protected could vary across communities.

→ **Existing Policies**

- Standard operating procedures have been formulated by the National Tiger Conservation Authority (NTCA) to deal with straying carnivore in human dominated landscape ([http://projecttiger.nic.in/Final SOP 11 01 2013.pdf](http://projecttiger.nic.in/Final_SOP_11_01_2013.pdf)).

- The Government of India has decided to request the State Governments of increasing the amount of ex-gratia payment in cases of death or permanent incapacitation of any person by a wild animal from 20000 to 100000.
- The National Tiger Conservation Authority (NTCA) and state forest departments help resolve human–tiger conflicts in India by providing compensation for livestock injured or killed by wild animals and by providing cages/traps, tranquilizers and rescue vehicles for capturing problem animals (projecttiger.nic.in).

Human-leopard interaction in India

Current population status and distribution of species

The leopard (*Panthera pardus*) is widely distributed throughout India except in the deserts and Sundarban mangroves (<http://www.iucnredlist.org>, Johnsingh et al., 1990; Khan, 1986). Due to its wider niche breadth and ability to adapt to human-induced land use patterns, it also occupies human-dominated landscapes (Athreya et al., 2014).

The leopard is included in Schedule-I of the Wildlife Protection Act 1972, as a result of which it enjoys the highest degree of legal protection available under Indian legislation. The IUCN has recognized the leopard as a Near Threatened species (<http://www.iucnredlist.org>), and because of a thriving international illegal trade in leopard parts, the species has been listed in Appendix-I of CITES (www.cites.org/eng/app/appendices.php).

Status of negative interaction

Leopard owing to their adaptable nature, high density of food resource in human use landscapes in the form of domestic animals and the strict laws in India which do not allow the killing of species like leopards, it occur in human use landscapes (Singh, 2005). The behavioural plasticity of the leopard and its wide choice of prey make it adapted to a wide range of habitats altered by humans and capable of tolerating human pressure.

Uttarakhand report large number of human deaths due to leopard attacks with about 50 reported each year. Mumbai used to face large number of attacks on humans a decade ago with an average of 30 attacks on people in areas adjoining Sanjay Gandhi National Park but today there are no more than handful of attacks around Mumbai even though large numbers of leopards are present. Junnar in Maharashtra reported about 25 attacks on people each year for 2001 and 2002 but today, despite leopard presence there is no comparable conflict. Himachal Pradesh reported about 73 attacks in the year 2007 - 2008 which has reduced to about 23 in 2013 - 2014. West Bengal reports large number of attacks but very few deaths with 74 people injured due to leopards, one person killed in 2013 - 2014. However chronic conflict still occurs in Uttarakhand whereas in other sites, the severity of the conflict has decreased. With respect to losses on the other side of this negative interaction, leopards are killed in large numbers. A recent report by

TRAFFIC India (Raza et al., 2012) finds that four leopards have been killed each week for the last ten years.

Reasons for negative interaction

Reduction of prey, fragmentation and degradation of habitats are often stated to be the key reason for the increasing number of conflict cases involving the leopard in India (Chauhan & Goyal, 2000; Edgaonkar & Chellam 1998; Kala & Kothari 2013). However these have not been tested and baseline information on conflict itself is sorely lacking. Furthermore, 100 year old documents such as Gazetteers and/or hunting records by the British also mention leopards visiting settlements to prey on domestic animals at a time when there were more wilderness areas and prey. Increasingly, all over the world, there is a greater understanding about wild carnivores such as bears, wolves, coyotes, foxes, leopards, mountain lions and others do use human use landscapes due to the abundant food resources by way of domestic animals, organic garbage, pet food (Gehrt et al. 2010).

Leopards being an extremely adaptable species, occupies a variety of landscapes across its global range, as well as in India. Leopards are found in croplands, tea gardens, adjoining the metropolis of Mumbai, city of Shimla, Guwahati, Gurgaon. They are found on the rocky areas of Rajasthan and the Aravallis. Their diet includes domestic animals, dogs appear to be preyed upon commonly. Recent information from GPS collars finds that they are largely nocturnal where they share space with humans and that their presence, even in dense human use landscapes does not imply attacks on people (Odden et al. 2014).

Athreya et.al. (2011, 2006) have found that uninformed mitigation strategies such as translocation could also lead to increased attacks on humans. It has been suggested that translocation of straying leopards in areas with other leopards, with human populations and the associated stress and behavioural changes the translocation process could be the reasons for increased human attacks (Athreya et al., 2011). Similar cases have been reported from near protected areas such as Buxa, Gorumara and Jaldapara, resulting from territorial fights and disruption of the socio-biology of leopards (WWF-India 1997).

Management of negative interaction

→ **Current mitigation measures**

- Translocation of “problem” animals to captive facility or other potential habitat has been used by the forest department as the immediate measure for mitigating conflicts (Athreya et al., 2011; Edgaonkar and Chellam, 1998).
- Paying compensation for loss of livestock (Edgaonkar and Chellam, 1998).
- Paying compensation for loss of life or injury to humans.

→ **Mitigation measures suggested**

All the mitigation measures currently in use are reactive. We recommend moving focus of mitigation for livestock depredation from reactive to proactive, incentivising better protection of livestock. Furthermore a survey of all the mitigation measures indicates that traditional proactive methods are the best at reducing losses (Linnell et al. 1996). India has a variety of traditional methods that have been used to deal with predators and it is important that we focus on them from a research and management viewpoint.

- Payment of compensation in case of human death and injury.
- A few researchers have suggested lethal controls for managing conflict. However Indian legislation has banned lethal control since 1972. Moreover, lethal control may even increase the conflict if an individual involved in a conflict is misidentified and if it disrupts the social structure of the population (Karanth & Gopal, 2005).
- Translocation should not be carried out as it could endanger the lives of people living near the release sites. Indian conditions are extremely different than countries in Africa where translocations are carried out because those countries have very low human densities (Weise et al. 2015). Studies across species indicate that translocations are not a management option if there are no large areas devoid of other individuals of the translocated species (Linnell et al. 1997) and in India with high density of humans, such interventions could have disastrous consequences (Athreya et al. 2011).

→ **Existing Policies**

There are no policies for dealing with wildlife outside Protected Areas in India, however following guidelines have been issued by the MOEF and NTCA to deal with the human-leopard negative interaction.

- Standard operating procedures have been formulated by the National Tiger Conservation Authority to deal with straying carnivores in human-dominated landscapes ([http://projecttiger.nic.in/WriteReadData/CMS/Final SOP 11 01 2013.pdf](http://projecttiger.nic.in/WriteReadData/CMS/Final_SOP_11_01_2013.pdf)).
- The Ministry of Environment and Forest has also formulated guidelines for managing the leopard-human conflict (<http://moef.nic.in/downloads/publicinformation/guidelines-human-leopard-conflict-management.pdf>).

Human-Snow Leopard interaction in India

Current population status and distribution of species

The Snow-leopard (*Panthera uncia*) is found in the Trans-Himalayan area of Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Sikkim and Arunachal Pradesh. It inhabits cold arid, semiarid shrub-lands and grasslands habitats (Jackson and Hunter, 1996). India is believed to support a population size of 400-700 snow leopard (Fox et al., 1991; Rodgers & Panwar, 1986). Loss of habitat, prey base depletion, illegal trade for pelt or other body parts and retaliatory killings to reduce livestock depredation are the major threats faced by the species causing its decline. The IUCN has categorized the snow-leopard as 'Endangered'. To put a halt on commercial trade, CITES has listed it in Appendix-I since 1975 to put a halt to the commercial trade in this species (www.iucnredlist.org, www.cites.org). The country's legislation lists the species in Schedule-I of the Wildlife (Protection) Act, 1972 to ensure that it gets the highest degree of legal protection.

Status of negative interaction

Livestock depredation is the major conflict involving the snow leopard, especially where there are people living in areas with underdeveloped economies (Bagchi & Mishra, 2006, Jayapal et.al., Suryawanshi et.al., 2013). The annual livestock loss varies from area to area. For example, in Bhutan, from 2009 to 2011, snow leopards killed 10% of the livestock. This amounted to a monetary loss of \$646 per household. But in Phoo village of Nepal, the corresponding figure was only 4.07% (Gurung & Thapa, 2004). Fox et.al. (1991) reported a 2% annual loss of livestock due to the snow leopard. In Spiti valley, Suryawanshi et.al. (2013) recorded 809 livestock mortalities in 25 villages over two years out of which only 24% (194) was predated by Snow-leopard and feral dogs instead, killed 42% (338) of livestock. Snow leopards have been killed by local herders in retribution. In Zankar, northern India, between 1998 and 2006, a total of 16 snow leopards were reportedly killed (Spearing, 2002), whereas 12 individuals were killed in just a single year in Xinjiang Province, of western China, in 1985–1986. Osborne et al. (1983) reported that 5-10 snow leopards were killed in southern Ladakh from 1978 to 1982 and that in central Ladakh a total of five leopards were killed between 1983 and 1988 (Fox et al., 1991).

Reasons for negative interaction

Fragile snow-leopard habitats are being overstocked with domestic livestock which compete with the wild ungulates for food resources. Local communities also hunt wild prey of snow-leopard. All these factors have led to a decline in the prey base of the snow leopard, leading to predation on domestic livestock (Jackson and Hunter, 1996; McCarthy et al., 2003). In turn, local herders kill snow-leopard in retribution. This has resulted in the increase in conflict cases. It's noteworthy that, it's not only quantum of conflicts that lead to heightened negative attitudes. But also restrictions to access resources, or awareness programs can influence perceptions negatively or positively, respectively as suggested by Bagchi & Mishra (2006).

Management of negative interaction

→ Current mitigation measures

- Livestock insurance schemes initiated in certain parts of India, Pakistan and Bhutan with the help of villagers and local NGOs have proved to be highly successful by reducing the killing of snow leopards and leading to the recovery of their wild prey species (Hussain, 2000; Li et al., 2013; Mishra et al., 2003). These programs also help in inculcating more positive attitudes and tolerance for conservation among the local population.
- In country, compensation for the loss of livestock, human injury and death due to carnivores is in place and have been suggested to reduce the animosity of people towards losses due to large carnivores (Banerjee & Jhala, 2012). However, Bulte and Rondeau (2005) have argued that conventional compensation schemes have failed and had unexpected outcomes in terms of agricultural expansion, inflows of migratory people and changes in land use, with potential negative effects on wildlife.
- In Hemis National Park, Ladakh and Kargil, NGOs are collaborating with the local herder community to build improved corral structures. In return, the local people have promised to protect the snow leopard and its wild prey (Anon, 2004).
- International and national agencies are working in collaboration with local bodies in Hemis National Park, Ladakh, for improving eco-tourism by promoting homestays, nature guiding and a parachute café. All these incentive help offset the economic losses due to unavoidable depredation cases. In Mongolia, efforts have been made to train local

communities to produce handicrafts (Mishra et al 2003). The locals, in turn, sign a contract to stop any hunting or retaliatory killing of the snow leopard (Anon, 2004).

→ **Mitigation measure suggested**

- Improving guarding techniques for livestock by using guard dogs and community-appointed experienced shepherds and stall feeding of calves, sub-adults and lactating females will reduce the vulnerability of individuals to predation and thereby reduce the chances of attacks (Jackson & Hunter, 1996). Guard dogs should be used only for corralled animals and not in wild areas. However, considering the case of Spiti valley (Suryawanshi et.al., 2013) where feral dogs were the major predator of the livestock, guards dogs need to be professionally trained and monitored.
- Improving the animal husbandry techniques used and the veterinary care of the livestock could improve the monetary returns and reduce the pressure on the rangelands, which in turn will reduce the depredation on domestic animals (McCarthy et al., 2003).
- WWF-India has been constructing reasonably priced predator proof corrals in the state of Jammu & Kashmir for past few years that has helped in avoiding conflict. Necessary expertise could be provided by WWF-India in this regard (*pers. comm.* Dipankar Ghose).
- In Phoo village of Nepal, the rate of depredation on small-bodied domestic prey such as sheep and goats was higher than the large-bodied prey such as yaks therefore author suggested that encouraging large bodied domestic livestock would reduce the depredation (Gurung and Thapa, 2004).
- Creating inviolate areas for wild prey and snow leopards devoid of any human activity could help humans and wildlife coexist (Jackson & Hunter, 1996; Karanth & Gopal, 2005; Mishra et al 2003).
- The poor structure of livestock's corrals could be making it easy for snow leopards to prey on domestic livestock. Therefore predator-proof livestock pens and corrals built using stone and mortar, with wire-mesh roofs, built either for individual families or for entire communities, could reduce the attacks on livestock during the night time (Gurung & Thapa 2004; Jackson & Hunter, 1996; Jackson *et. al.*, 1996, Jackson & Wangchuk 2001, 2004; McCarthy et al., 2003).

- Minimizing the high dependence of the local communities on their livestock for their livelihoods can bring down the number of conflict cases. Researchers advocate promotion of eco-tourism (Jackson & Hunter, 1996) and making handicrafts (McCarthy et al., 2003) as alternative livelihood options for the peasant in the snow leopard range.

→ **Existing Policies**

- The Project Snow Leopard is an Indian initiative for strengthening wildlife conservation in the Himalayan high altitudes. One of the objectives of the this project is to find a balance between wildlife conservation and interest of pastoralist (Anon., 2008). The PSL recognizes that since snow leopard is a wide ranging species, where its interface with marginal communities can extend far beyond PAs, effective and proactive conflict mitigation activities need to be put in place at larger spatial scales.
- The snow leopard has been listed in the Appendix-I of the Convention on the Migratory Species of the wild animals since 1985. Five of the twelve snow leopard range States are signatory to CMS and therefore under the oath to protect the species. At the seventh Conference of the Parties to CMS held in September 2002, the Snow Leopard attained the status of a species designated for “concerted and co-operative actions” for its conservation. Recently, the MoEFCC, GoI, has been participating in the Global Snow Leopard Ecosystem Protection (GSLEP) programmes to further strengthen commitment and funds for snow leopard conservation in the country (Y. S. Bhatnagar *pers comm*).

Human-wolf interaction in India

Current population status and distribution of species

Two sub-species of wolf are found in India (Sharma et al., 2004), the Indian wolf (*Canis lupus pallipes*) and the Himalayan wolf (*Canis lupus chanco*). Himalayan wolf is found in the Trans-Himalayan region and recently from Uttarakhand and Sikkim (Bhattacharya and Sathyakumar, 2010; Chanchani et al., 2011; Maheshwari et al., 2013). Indian wolf ranges in the rest of the peninsular India. Indian wolf inhabits arid and semiarid and grassland. Population estimation for Indian wolf done by Shahi (1982) indicate population size of approximately 800 individuals for the entire country. Based on intensive surveys population size in the country was estimated between 2000-3000 individuals (Jhala, 2003; Jhala and Giles, 1991). Himalayan wolf population is very scanty studies and no reliable estimates of the population size or basic ecology exists (Habib et al., 2013). Fox and Chundawat (1995) provides conservative estimates of no more than 350 individual of the Himalayan wolf.

The peninsular Indian wolves as well as the Himalayan wolves are considered endangered and both are kept in the schedule-I of the Wildlife Protection Act 1972 (Jhala, 2003). Indian wolf is categorized in the appendix-I of the CITES which prevents any illegal trade of the species (www.cites.org).

Status of negative interaction

The Himalayan wolf is the top-predator in Ladakh region accounting for more than 60% of the livestock depredation due to wild animals. The predation due to the Himalayan wolf was lower in Himachal Pradesh (16% of all the livestock depredation) and absent in the Uttarakhand state (Habib et al., 2013). This may be related to the low abundance of Himalayan wolf in Himachal Pradesh and Uttarakhand where the mountainous habitat may not provide a suitable terrain to the occurrence of this sub-species.

Conflicts involving Indian wolves have been in the form of (1) livestock depredation, (2) attacks on adult humans and children by rabid wolves (Jhala, 2003; Linnell et al., 2002). Even normal wolves in the absence of availability of wild prey may prey on unprotected children (Johnsingh A.J.T. *pers comm*). A single pack of wolves in Nannaj, Maharashtra killed 70 goats and 24 sheep in 3 years (Kumar & Rahmani, 2000). The published reports indicate a long history of attacks on

children by wolves. In Uttar Pradesh, between March and October 1996, a total of 76 children less than 9 years of age were attacked by wolves, and 50 of these attacks proved to be fatal (Jhala & Sharma, 1997).

Reasons for negative interaction

Studies conducted at national and international level have shown that areas with readily available wild prey experience very few cases of livestock depredation. Shifts in farming agricultural practices from dry to irrigated agriculture with multiple cropping result in the loss of rendezvous and denning sites as well as the loss of wild prey (Jhala, 2003). With reduced prey densities, the level of conflict between humans and wolves increases as the animals kill livestock more frequently (Jhala, 2003). Suryawanshi et al. (2013) expect an increase in conflict levels in the Trans-Himalayan region as the demand for cashmere is leading to increase in an increase in the numbers of livestock. Canine distemper and rabies are the reasons for attacks on humans by wolves (Jhala & Sharma, 1997).

Management of negative interaction

→ Current mitigation measures

- Wolves have been persecuted since the British period in India, mostly involving the payment of bounties. In some areas wolf dens are identified and pups are killed by smoking the dens. In some areas people even use poison to control the wolves. This could be highly detrimental not only for the wolves but for other non-target carnivores (Jhala and Sharma, 1997).

→ Mitigation measures suggested

- Removing a child-lifter is an important measure in keeping conflict levels low. However, it is very difficult to identify a problem animal in a population and sometimes results in killing of non-problem individuals. Jhala and Sharma (1997) provided a detailed account of identifying and controlling the child lifter.
- Compensation due to wolf is available in the state of Maharashtra but public seems to be unaware of the scheme (Krithivasan et al., 2009). However the inherently long process of filing a case and proving the identity of the convict can be really difficult in the case of wolves.

- Replenishing lost or depleted wild prey is expected to reduce livestock depredation and consequently the frequency of conflict cases. Reintroduction of the wild prey is a long-term process, with a lot of effort and funds involved. Moreover, predation on wild prey by co-occurring feral dogs could impede the reintroduction efforts (Krithivasan et al., 2009). Therefore, reintroduction of wild prey should be accompanied with the removal of feral dogs (Jhala and Sharma, 1997).
- Jhala and Sharma (1997) listed a number of preventive measures to avoid attack on children. These measure are very intuitive (children below 9 years of age should sleep indoors, appointing night watchman in affected areas etc.) and are expected to frequency of reduce the conflict cases.

Human-Dhole interaction in India

Current population status and distribution of species

Three subspecies of dhole have been reported from India, *Cuon alpinus laniger*, *Cuon alpinus primaevus* and *Cuon alpinus dukhunensis*. Only *Cuon alpinus dukhunensis*, found south of Ganges, faring better. Historically distributed throughout Indian subcontinent, the Asiatic wild dog or dhole currently exists in fragments of its past distributional range. Presently dholes are found in the Ladakh area of Kashmir, central Indian highlands and peninsular India and North-East India. Recent estimates indicate a population size of no more than 2500 individuals in the wild (<http://www.iucnredlist.org/details/5953/0>). Various threats in the form of prey depletion, persecution, disease and competition with other wild and free-ranging carnivores are responsible for the decline of the species. Recognizing these threats, the IUCN has categorized the species as Endangered (<http://www.iucnredlist.org/details/5953/0>), and CITES has placed dholes in its Appendix-II (www.cites.org). In India, bounties were paid for carcasses until the Wildlife Act (1972) was enacted. Under this act, dholes were given legal protection and classified under Schedule-II.

Status of negative interaction

In Arunachal Pradesh, north-east India, dholes are persecuted for livestock depredation (Mishra et al., 2006). In Kanha-Tiger Reserve of central India, 16 of a pack of 24 were found dead due to strychnine poisoning (<http://www.iucnredlist.org>).

In Nepal, dholes were reported to have killed 14 large-sized prey animals (yaks and cattle) in 2007, which led to retaliatory killing by locals (Khatiwada et al., 2011). In Bhutan, the dhole was the fifth largest predator and accounted for 13% of the total livestock loss (Wang & Macdonald, 2006). Local communities use guns and poison to kill dholes. They also steal their kill and steal pups from dens.

Reasons for negative interaction

Dholes were not found to be in conflict with people in a study conducted across five tiger reserves in southern India (Karanth et al., 2013a). A few studies on the diet and foraging ecology of dholes in southern India indicate that their dependence on domestic prey and livestock is low (Karanth & Sunquist, 1995; Selvan et al., 2013; Madhusudan, 2003). However, occasional

attacks on livestock in the distributional range of the dhole have resulted in retaliatory killings even without proof of depredation. Wild prey densities in most of the dhole's distribution range have declined considerably, especially in north-east India. Therefore, prey depletion in the dhole's habitat could be one of the reasons for livestock depredation. In southern India, the densities of the food resources of dholes are good, which might be responsible for the low conflict level in this region (<http://www.iucnredlist.org/details/5953/0>). On the other hand, conflict rates are higher in North-East India, where the wild prey densities have declined drastically. An increased inflow of livestock in the Kanchenjunga Conservation Area, Nepal was considered to be a reason for increased interaction with dholes and loss of livestock (Khatiwada et al., 2011).

Management of negative interaction

Due to the low frequency of conflicts with the dhole, there are hardly any special mitigation measures adopted by locals. Dholes co-exist with other large carnivores (tigers, leopards, etc.) that are more frequently involved in conflicts. Therefore measures used to protect livestock help reduce the damage caused by dholes as well.

→ Current mitigation measures

- The traditional methods of guarding and fencing were found to be the most effective measure in reducing livestock losses across protected areas in different biogeographic zones (Karanth et al., 2013a). Grazing livestock should be accompanied to keep away dholes which are shy of people.

→ Mitigation measures suggested

- Regulating grazing activities within protected areas and guarding of the herd are expected to lower the livestock depredation cases (Karanth and Gopal, 2005; Karanth et al., 2013a).

→ Existing policies

- State-wise “*ex-gratia*” funds are released by government to provide relief to local people and the funding amount depends upon the intensity of the conflict. However, seldom compensation money is paid for cattle kills.

Human-Bear interaction in India

Current population status and distribution of species

Four of the eight species of bear, namely the Himalayan brown bear (*Ursus arctos isabellinus*), Asiatic black bear (*Ursus thibetanus*), sloth bear (*Melursus ursinus*) and sun bear (*Helarctos malayanus*) are found in India. The distribution of the Himalayan brown bear in India is restricted only to the high altitudes of the northern Himalaya, with there being no more than 300 individuals (Sathyakumar et al., 2012). The Asiatic black bear is distributed in the forested habitats of the Greater Himalaya as well as in the hills of north-east India. Conservative estimates of Asiatic black bear population indicate numbers in the range from 5,400 to 6,750 (Sathyakumar et al., 2012). The sloth bear (*Melursus ursinus*), endemic to the Indian subcontinent, is the only most widely distributed bear species. Its range extends from the Himalayan foothills, in the north, to the Western Ghats, in the south. The total population size in the entire Indian subcontinent has been estimated from a few studies to be approximately 20,000 individuals (Sathyakumar et al., 2012). According to all India tiger monitoring report, forest area occupied by the sloth bear in 17 states of country was 223553 km² (Jhala et al., 2011). The sun bear is the rarest of all the bears and it is patchily distributed in all the north-east Indian states. No reliable population estimates are available for this species.

Three bear species (Himalayan brown bear, sloth bear and sun bear) are listed in the Schedule-I and the Asiatic black bear in schedule-II of the Wildlife (Protection) Act (1972). Illegal trade in bear parts is one of the main reasons for the decline of the populations, and therefore all bear species are listed in Appendix-I of CITES (www.cites.org). Considering the rapid decline of all the bear species, IUCN has listed the four species in the 'Vulnerable' category (www.iucnredlist.org).

Status of negative interaction

The conflict with the Himalayan brown bear is largely in the alpine and sub-alpine regions of the Greater Himalaya and some parts of the Trans-Himalaya. In Zankar Valley, of Ladakh and Jammu and Kashmir, the Himalayan brown bear accounts for a significant proportion of livestock depredation (Sathyakumar et al., 2012). Brown bear accounted for 33% of livestock

depredation cases in Zaskar and about 7% cases in Suru Valley. In both valleys, Sheep and Goats comprised the major domestic prey (52%), followed by Cattle (38%) and Equids (10%). Brown bear killed livestock mostly around villages (54%) and 'Doksa' or summer grazing camp (42%), and largely during summer (64%). Local people reported brown bear sightings on livestock kills (38%) or have confirmed it based on tracks and signs (42%) found near kills (Sathyakumar & Qureshi 2003). In Pakistan, livestock damage due to the Himalayan brown bear was 15% of the total livestock depredation by wildlife (Nawaz, 2007). In the Great Himalayan National Park conservation landscape, from 1989 to 1998, black and brown bears were together involved in 26% of the total livestock loss ascribed to carnivores (Chauhan, 2003). To reduce potential losses to crops and livestock, migratory herders and villagers often kill brown bears. Human- Asiatic black bear interactions are on the rise in the Dachigam landscape, Kashmir (Charoo et al., 2011). Crop- depredation was the major conflict between 2005 and 2007 according to the villagers. Attacks on humans and livestock depredation were also increasing gradually in Dachigam landscape and Kupawara district of Jammu and Kashmir (Charoo et al., 2011; Sanwal and Lone, 2012).

In central and southern India, the number of conflict cases due to sloth bears are increasing. They raid crops, predate livestock and attack humans. From 1989 to 1994, sloth bears were responsible for 67% of the 1094 casualties caused by large mammals (Rajpurohit & Krausman, 2000). Especially in North Bilaspur forest division, where the sloth bear is considered a nuisance, 137 people were attacked between 1998 and 2000 (Bargali et al., 2005).

The sun Bear has been reported to be involved in crop depredation and rarely attacking human in North-Eastern states of India (Sathyakumar et al., 2012).

Reasons for negative interaction

It has been suggested that habitat loss, degradation of remnant forest patches and NTFP collection are the major reasons for the increasing bear-human conflict.

Increased human activities and encroachment into bear habitats have also led to increased human-bear interactions. Unsupervised grazing and poorly constructed night shelters have added to the increased incidents of livestock depredation by brown and black bears. Degradation due to developmental projects and other anthropogenic pressures have led to depletion of bear food

resources (Chauhan, 2003; Nawaz, 2007; Rathore, 2008). In the Dachigam landscape, crop depredation by black bears has increased with changing agricultural practices (Charoo et al., 2011).

The reasons of conflict may also differ depending upon the quality of bear habitat. For example, in Madhya Pradesh, more than 70% of the attacks on humans by sloth bears were reported to have taken place in forests when people were collecting NTFP. However, in North Bilaspur, crop fields were the hotspots of the attacks. The bears were residing there, with forests having been fragmented (Rajpurohit & Krausman, 2000).

Management of negative interaction

→ Current mitigation measures

- Traditional methods such as making noise and lighting fires are used as preventive measures.
- In Jammu and Kashmir, inter-institutional teams consisting of members of forest departments, local NGOs and veterinarians have been constituted to help in case of any emergency (Charoo et al., 2011). Researchers suggest that additional teams should be formed in order to deal with more cases at a given time.

→ Mitigation measures suggested

- The biggest hurdle in mitigating the conflict with bears is the lack of scientific research. Therefore, making country-wide population estimates and gaining an understanding of the behavior of the species is advocated as the first step towards mitigation of the conflict in the long term (Sathyakumar et al., 2012).
- Improvement of guarding techniques (using guard dogs, metal doors, etc.) in houses and husbandry areas has been suggested. These measures have been observed to be efficient in reducing the frequency of conflict cases (Charoo et al., 2011).
- Regulation of livestock pressure and restoring the abundance of wild prey in bear habitats (Rathore, 2008).
- Reducing the dependence of local people on forest resources by training them to adopt alternative livelihood options (Bargali et al., 2005).

- Changing the attitude of local people as well as creating awareness among them about the ecology and behaviour of bears could avoid conflict situations (Bargali et al., 2005).
- Spatio-temporal segregation of food resources shared by bears and humans will reduce the chances of encounters. However, few researchers advocate a complete ban on collection of NTFP during the dry season.
- In highly fragmented forests, bear population management and translocation of remnant populations to suitable habitats have been proposed as mitigation and long-term conservation measures (Rajpurohit & Krausman, 2000). However, the efficacy of these methods is debatable.

→ **Existing policies**

- Almost all states provide compensation for crop loss, damage to property, human and livestock injuries and death caused by wildlife. The compensation amount varies a lot across states, and there is an urgent need to re-structure the schemes as well as the relief amounts.
- All bear range States in India now developed a State Action Plan for Bears through a consultative process but require funds from the Central Government for implementation. Draft Standard Operating Guideline for bears have also been developed by the Wildlife Institute of India (see annexure 3).

Synthesis of Human-Herbivore Negative Interactions



Authors

Monica Kaushik, S. S. Bist, , Ninad Mungi Dhawal Mehta, K. Sankar, , Qamar Qureshi

Reviewers

Dr. Nita Shah, Dr. Diwakar Sharma, Dr. Bibhab Kumar Talukdar, Dr. Parag Nigam and

Dr. S.P.Goyal

Expert panel

Sh. Vinod Rishi, Dr. A.J.T. Johnsingh, Dr. B.K. Mishra, Dr. Bivash Pandav, Dr. S.P. Goyal, Dr. K. Sankar, Sh. Jagdish kishwan

Rapporteur

Dhawal Mehta, Bidyut Bikash, Rahul De, Aisho Sharma, Roshan D Puranik, Harshavardhan, Keshab, Varsha, Neha Awasthi, Sudip Banarjee, Nikunj Jambu

Photo credits: Dhawal Mehta

Photo Credits: Dhawal Mehta

Human-Elephant interactions in India

Current population status and distribution of species

Historically elephants (*Elephas maximus indicus*) were distributed all across India, starting from the southern Himalaya, excluding only the arid tracts in the country. The current distribution is restricted to only the Himalayan foothills in the north, the hills of the Western Ghats in the south, forests of north-eastern states and the forests of east-central India (Baskaran et al., 2011; Sukumar, 2006). Current estimates indicate a countrywide population size of 27,000-28,000 in the wild (www.moef.nic.in). Habitat loss, poaching and other threats in Asia have reduced the elephant population by more than 50% over the last three generation as a result, the elephant have been listed 'Endangered' by the IUCN (www.iucnredlist.org). Elephants have been listed in Schedule-I of the Indian Wildlife (Protection) Act, 1972. The elephant is listed in Appendix-I of CITES which prohibits any form of international trade (www.cites.org).

Status of negative interaction

Statistics indicate that the interactions between humans and elephants are becoming more hostile over the years, leading to loss of human life (> 400 deaths annually), crop-damage (~ 330 km² every year) and elephant deaths (100 annually in retaliation) (MoEF, 2010). Since 1987, 150 elephants died due to train hit (Rangarajan et.al., 2010)

Reasons for negative interaction

Elephant habitats are disappearing, and the quality of the fragmented landscape is deteriorating across the country at an alarming rate. These two factors are being established as the prime reason for the escalating conflict between humans and elephant (Bist, 2002; Choudhury, 2004; Fernando et al., 2008). It has been suggested that infrastructure development leading to fragmentation of elephant habitats is an overriding factor in conflict cases across Asia (Leimgruber et al., 2003). Depletion of food resources directly due to degradation of habitats caused by humans and biomass extraction and indirectly due to spreading of weeds in elephant habitats are resulting in aggravated crop-depredation episodes (Boominathan et al., 2008). Behavioural changes and the associated increased stress levels caused by poaching are a causative agent of damage by elephants in Africa (Ruggiero, 1990).

Management of negative interaction

→ Current mitigation measures

- A variety of short-term strategies are used to mitigate the elephant conflict in the country. Lenin and Sukumar (2008) provide a detailed account of all the mitigation measures used at the national and international levels to alleviate the conflict. Short-term strategies have been used as an immediate tactical strategy to deter elephants: creating a barrier (i.e., electric fencing, boundary wall, ditches etc.), compensation schemes and eliminating “problem” individuals from the population. Elephants have been shown to become habituated to strategies used for conflict management, and therefore these short-term measures should be used to develop strategies that could provide long-term solutions (Lenin & Sukumar, 2008). Additionally, it is important to study (1) the impact of short-term methods on elephant behaviour and (2) their effectiveness at the landscape level, as localized success might result in only shifting the conflict to another location (Lenin & Sukumar, 2008).

→ Mitigation measures suggested

The Elephant Task Force (ETF) appointed by the MoEFCC in 2010 (Rangarajan et al, 2010) and Karnataka Elephant Task Force (KETF) appointed by the Karnataka Forest Department in 2011 in pursuance of directives of the Hon’ble High Court of Karnataka (Sukumar et al, 2012) have examined the issues relating to Human-Elephant Conflict (HEC) in the country in great details and made several suggestions.

1. The KETF has recommended a zone-based approach, combining science and pragmatism, for conserving elephants in the long-term as well as substantially reducing the levels of HEC. Three zones are proposed for this purpose, each with a different set of conservation objectives and goals:

i) Elephant Conservation Zone (ECZ) would encompass the landscapes of larger and more viable populations of wild elephants, with emphasis on maintaining habitat integrity through protection of existing corridors, and mitigation of HEC through containment of elephants within this natural range using barriers such as high-voltage, non-lethal electric fences, elephant-proof trenches and other means. This zone could also include a certain number of

human settlements having hard and clear interface with elephants. In ECZ, conservation of elephants should get the maximum priority.

ii) Human- Elephant Co-existence Zone (HECZ) would include intermediate zones between the larger, integral habitats and small, fragmented forest patches for implementing the co-existence model through negotiated sharing of space between elephants and people. Emphasis in this zone should be on enhancing the social carrying capacity of the people.

iii) Elephant Removal Zone (ERZ) would include regions with small, isolated patches of forests or human-dominated areas with unacceptably high levels of HEC and / or where the viability of the elephant groups is in serious doubt. Elephants would have to be captured from ERZ and either relocated to the first two zones or retained in captivity.

2. ETF has suggested formation of Conflict Management Task Force (CMTF) (consisting of a biologist, animal welfare specialist, wildlife veterinarian, social scientist, elected public representative, representative of Revenue / Civil Department, etc.) in identified areas of high conflict.

3. According to ETF, anti-depredation teams are crucial for drives in high conflict areas, but they cannot be a permanent solution. It has suggested use of short drives to placate people in a crisis situation but not as a routine measure.

4. ETF has opined against **culling elephants** (killing of herds or whole groups of elephants as a technique of population management) as it is ethically unacceptable in the Indian context*. ETF has suggested that **killing of problem elephant** permitted by the Chief Wildlife Warden (CWLW) under S.11 of WPA-1972 should be done under strict supervision, after proper identification of the elephant and after observing due protocols, and all such cases should be reported to the MoEFCC.

5. ETF has recommended serious and sustained research for **reproductive control** of elephant populations in unviable situations.

6. ETF has recommended **translocation of elephant populations** only subject to strict conditions. It has pointed out that translocation will work best if done for whole herds, but in

*Also prohibited under S.12 (bb), Explanation (ii), of WPA-1972.

case of an individual bull, viability of the approach should be carefully examined. ETF has suggested that the translocated animals should be compulsorily monitored through the best possible means (such as telemetry) and Forest Department (FD) should recapture them if they cause conflict elsewhere. KETF has suggested that translocation must be seen as an experimental management tool, and should invariably be accompanied by close monitoring through radio- and GPS-collaring of at least one individual per group to observe its behaviour and movement so that corrective action such as removal into captivity could be taken in the case of continued conflicts.

7. ETF has suggested that **capture of elephants** from the wild as a conflict mitigation strategy should be done only “under the assessment and monitoring by a consortium of research institutes, individuals, other stakeholders and government departments with the requisite capacity”. The captured elephants are to be a government monopoly and not transferred. KETF has suggested that, if dispersing elephants have remained for several years outside their native habitat, it may be best to capture and retain these elephants in captivity. KETF has also provided guidelines for ensuring the welfare of elephants in captivity.

Use of Barriers:

- According to ETF, **fences and trenches** can only work as a part of a large landscape-level intervention. It has suggested moratorium on Elephant-proof Trench (EPT) and sought to discourage expensive electric fences without involvement of community for their maintenance.
- KETF has accepted **physical barriers** (EPT) as one of the main strategies to minimise HEC, particularly in reducing crop losses and recommended creation of such barriers where unbroken interfaces exist between farming and elephant habitats. However, it has cautioned that, in situations where the farm-forest fringe is more dissected /broken, the creation of physical barriers without first understanding patterns of elephant movement may aggravate conflicts as these barriers could impede elephant movement and temporarily restrict them within cultivated areas. KETF has, therefore, recommended a more comprehensive site-specific strategy on physical barriers. It has emphasised upon regular maintenance of these barriers and asked for a system of auditing the effectiveness of these maintenance measures.

- KETF has pointed out that **involving local communities** in the creation and maintenance of barriers is often vital in ensuring its effectiveness and durability and recommended that, wherever possible, the FD should partner with local eco-development committees (EDCs), or even panchayat raj institutions to secure farm landscapes from elephants.
- ETF has suggested that in agricultural areas adjacent to or within elephant range, priority should be given to increase effective protection to farmlands by creating non-lethal barriers. It has suggested that barriers may be raised under PPP model or community-led collective action or public service initiative by the business class. There should be a clear agreement between the FD (or other investors) and the beneficiaries (local communities) about their roles and responsibilities in the creation and maintenance of barriers.

9. ETF has emphasised the role of **crop-guards** and suggested that payments for the work of **crop protection** may be considered under the auspices of the MGNREGS.

10. ETF has recommended holding of **Public hearings** at least twice a year at taluka level (at the start of the kharif and rabi sowing seasons). These must mandatorily require presence of not only the Wildlife Wing and Territorial Wing staff but also the revenue and civil authority and elected people's representatives such as the MLA.

11. ETF has suggested that **transparency of information** (e.g. claims for loss of life, crops or property; loss of lives of people; and elephants captured or killed) should be maintained.

12. KETF has suggested that **toll-free helpline telephones** should be set up at the level of Forest Ranges to provide timely assistance to people who may be injured by elephant attacks, or need help from the anti-depredation squads.

9. **Insurance:**

- Government of Kerala provides insurance support to its tribal population against death and injuries caused by wild animals.
- A few EDCs in Northern West Bengal buy group insurance policies for their members covering death by wild animals. Many tea estates in the same region also buy insurance cover for the labour huts and other properties against damage by wild elephants.

- All efforts made by the MoEFCC and various FDs in the past to persuade Public Sector Insurance Companies to extend insurance cover to farmers against crop damage caused by elephants have been unsuccessful.
- ETF has suggested that, after creation of barriers and finalisation of agreements with the beneficiaries, insurance must become the standard means of offsetting further crop losses. It has further suggested that Modified National Agriculture Insurance Scheme should be adapted and implemented in collaboration with the Agriculture Insurance Company of India in a few sites on a pilot basis. ETF has recommended that the premium must ideally be shared between FD and farmers and payment of insurance should be contingent upon efforts to maintain barriers.

10. *Ex-gratia* relief:

- All elephant range States and Maharashtra have rules for providing ex gratia relief to the victims / their dependents in case of human deaths / injuries / crop damage caused by elephants. Some State Governments (e.g. West Bengal, Uttarakhand and UP) also provide ex gratia relief for damage to huts caused by elephants. MoEFCC also provides financial support to FDs under various Centrally Sponsored Schemes for the purpose of ex gratia relief.
- KETF has recommended that a careful and critical review of the current system of ex gratia relief should be carried out, and, in the interim, the State (Karnataka) Government should speed up disbursement of relief to people. It has suggested that the budget head in the office of the CWLW for payment of ex gratia should be managed on the lines of the Calamity Relief Fund being managed in the office of the District Magistrate and availability of funds in this budget head should be always ensured in order to make quick payments in respect of people killed or injured by elephants. ETF has recommended that a standard guideline for assessment of damage should be developed; compensation claims should be cleared every month; and a transparent verification system involving FD personnel and village representatives should be put in place.
- ETF has recommended that ex gratia relief for loss of human life should not to be less than 3 lakh rupees while for the injured person, full hospital bill including transport;

lodging/boarding charges for the accompanying family member; and cost of treatment and medication post-discharge should be paid for. It has recommended that loss of wages /pay of the victim for the duration of treatment should be compensated.

- ETF has recommended that crop compensation should be available if and only if other methods (barriers) have failed despite being properly put up.
- ETF has proposed schemes like “Grain for Grain” as alternative to crop-compensation.
- ETF has proposed a structured approach to crop compensation to ensure social justice. It has suggested that maximum amount payable to a family should be based on some predetermined percentage (say 80% to 100%) of what the minimum wages a person would earn in a year or the actual crop loss (including labour and input cost) whichever is lower. It has proposed full compensation to people under BPL/SC/ST or anyone holding less than 2 acres of agriculture land; 50% to 70% compensation for people holding 2-5 acres of agriculture land; and 25% compensation to those holding land above 5 acres.

→ **Existing Policies:**

1. Elephant is included in Schedule I of the WPA-1972. Cases of HEC are handled under S.11(1) which stipulates that the CWLW may permit the hunting of an elephant if he is satisfied that it has become dangerous to human life or is so disabled or diseased as to be beyond recovery. The provisions of S.11(1) are subject to the following riders:

- a) No elephant shall be ordered to be killed unless the CWLW is satisfied that such animal cannot be captured, tranquilised or translocated.
- b) No elephant shall be kept in captivity unless the CWLW is satisfied that such elephant cannot be rehabilitated in the wild and records his reasons in writing.
- c) The CWLW cannot delegate his powers under S.11 in respect of elephants to any other authority [Ref. S.5(2)].
- d) Killing or wounding in good faith of any elephant in defence of oneself or any other person is not an offence except when the said person, when such defence becomes necessary, was committing any act in contravention of this Act or any rule or order made thereunder.

e) Provisions of S.11 are not applicable within a National Park or a Wildlife Sanctuary.

2. S.11(1) is applicable only when an elephant poses a direct threat to human life. As a corollary, elephants known to be habitual crop-raiders or habitual house-breakers cannot be dealt with under this Section. This places the forest officers in an awkward position since elephants are the largest destroyers of crop and property among the wild animals (excluding rodents and birds) in the country. The matter needs a serious review.

3. Forest officers sometimes invoke S.12 to deal with elephants which may not be posing a direct threat to human life. S.12 empowers the CWLW to permit, with prior permission of the Central Government, hunting of wild elephants for certain specified purposes which include education, scientific research and scientific management. The expression “Scientific Management” in this Section has been defined as:

— translocation of any wild animal to alternative suitable habitat; or

— population management of wildlife, without killing or poisoning or destroying any wild animal.

4. HEC is showing an upward trend in the country and over-abundance of elephants in some parts of the country is adding to the problem. The option of translocation under Sections 11(1) and 12 is not without limitations. The State may not have a safe and suitable area where the elephants can be relocated. The local people may also resent the translocation of problematic elephants into their neighborhood. Mass translocation of elephants has not been attempted in India for want of necessary expertise as well as doubts about suitability of areas for translocation. In a few attempts with relocation of elephants in ones and twos, they are mostly known to have returned to the original sites. So, translocation of elephants remains a doubtful option. As mentioned earlier, the option of killing an elephant is not available under S.12 while it can be exercised under S.11(1) only after exhausting the options of translocation and capture. The net result of all these legal and technical hassles is that FD in most cases has no option but to capture the problem elephant and retain it in captivity.

5. An important issue in capture of elephant is about its subsequent use and maintenance. Elephants, given their huge size and strength, are not kept in captivity literally. Fortunately,

they can be tamed, trained for certain jobs, handled by mahouts, and kept in restrained conditions. India has an old tradition of capturing and keeping elephants in captivity and using them for a variety of jobs. But the existing policies in India are not conducive to captive elephants as explained below:

- In view of the provisions of the Forest (Conservation) Act, 1980 and various orders of the Hon'ble Supreme Court, logging operations have either been stopped or restricted in various parts of the country. As a result, a large number of elephants used for logging in the North-Eastern India and Andaman & Nicobar Islands have been rendered jobless making it difficult for the owners to find money for taking proper care and upkeep of their elephants and mahouts.
- Commercial dealing in all Schedule-I species including elephants is banned in terms of Sections 44 and 49B. The Act provides that a person can own a captive elephant only on the strength of an ownership certificate issued by the CWLW (Ref. Sections 40, 41 and 42). But an elephant-owner cannot sell his elephant or dispose it off by any other mode of commercial nature because of an amendment carried out in S.43(1) in 2003. Ironically, the said amendment was not specifically meant for elephants. It was intended to prevent trophies of Schedule-I animals like tiger, leopard, rhinoceros, etc., presently in personal collection of various individuals, from entering the market. But, the law-makers overlooked the fact that there were about three thousand captive elephants in private ownership in India which would be affected by the said amendment. The Steering Committee of Project Elephant advised the MoEFCC in December 2003 to amend the WPA-1972 and exempt captive elephants from the restriction imposed under S.43(1). But the proposed amendment has not yet taken place. As stated earlier, owners in the North-East India find it difficult to maintain their elephants. There is a demand for these elephants in other parts of the country for the purpose of eco-tourism, temple duties, and patrol by the forest staff. But the owners cannot sell them legally in view of S.43(1) as it stands now. As a result, even the FDs in need of captive elephants find it difficult to procure them from the legitimate owners. Meanwhile, elephants continue to be sold, albeit illegally, in the North-Eastern India and the famous cattle fair in Sonapur (Bihar).

- In November 2009, the Central Zoo Authority (CZA) issued a directive banning captive elephants from zoos. It has put further restrictions on the use of captive elephants within the country.
- Asian elephant (*Elephas maximus*) is in Appendix-I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and, accordingly, international trade in live elephants and all products derived from them is not allowed. Export Policy of Government of India, therefore, does not permit commercial export of elephants. Meanwhile, elephants from India are allegedly exported to Nepal through the land-borders in violation of the Export Policy and the CITES.
- There is a constant lobbying in the country by the animal right activists against keeping elephants in captivity.

6. In the absence of legal ways for disposing off captured elephants, FD has no option but to retain all the elephants captured under Sections 11 and 12. This in itself is a difficult decision in view of the huge financial implications of maintaining captive elephants.

7. As stated earlier, capture of elephants and their retention in captivity has become a necessary evil as far as management of HEC in India is concerned. But the corresponding legal tools cannot be used effectively without creating adequate room for the use of captured elephants. A few points that need to be considered for this purpose are as follows:

- Most of the FDs in the country can increase their intake of captive elephants by using them for patrolling/ monitoring especially during monsoon seasons.
- The Tourism Policy should encourage use of captive elephants in place of polluting vehicles for eco-tourism activities in National Parks and Sanctuaries and other sensitive zones.
- Export Policy should be reviewed for permitting export of elephants to foreign zoos /tourism facilities and also for elephant-rehabilitation programme in other Asian countries.
- S.43(1) may be revisited in the light of the recommendation made by the Steering Committee of Project Elephant in December 2003.

- The recommendations of ETF and KETF for the welfare of captive elephants should be implemented.

Human-Rhino interaction in India

Current population status and distribution of species

The great one-horned rhino (*Rhinoceros unicornis*), the largest rhinoceros of Asia, was once distributed all along the northern part of the Indian subcontinent. Currently the species exists in few small population in North-East India and Nepal. In the early 1900s, the species was on the brink of extinction as only 200 individuals were left in the wild. However, conservation efforts undertaken in India and Nepal helped the recovery of the species. Population estimates made in 2014 indicated a total population size of 2831 individuals, of which in Kaziranga National Park holds a population of 2329 individual, Orang National Park 100, Pabitora Wildlife Sanctuary 93, Manas National Park 31, Jaldapara National Park 186, Gorumara National Park 43 and Dudhwa National Park 31 (B. Talukdar *pers comm*).

Although the overall population size of the species is increasing, considering the increasing threats jeopardizing the future of the Indian rhino, it has been categorized as ‘Vulnerable’ by the IUCN. Legally the species receives the highest degree of protection in India as it has been placed in Schedule-I of the Wildlife (Protection) Act (1972). It has also been included in Appendix-I of CITES, which prohibits international commercial trade of this animal and all its derivatives.

Status of negative interaction

Crop-damage by the rhino is the major reason for the conflict, and sometimes encounter with rhino leads to injury and death of humans. The incidents of rhinos killing / injuring people mostly take place within forests and the victims include either the forest staff or poachers or trespassers or grazers (S.S. Bist *pers comm*). In Pabitora Wildlife Sanctuary, five people were killed by rhinos between 2000 and 2010 (Bhatta, 2012). The number of incidents that resulted in deaths was high in Royal Chitwan National Park between 1977 and 1988. A total of 78 accidents involving rhinos resulted in 23 deaths and 55 injuries to humans (Jnawali, 1989) in Royal Chitwan National Park. Ghosh (1996) mentions that crop-depredation in Jaldapara National Park, West Bengal is increasing. However, the local people are traditionally tolerant of rhinos.

Reasons for negative interaction

Humans had few negative interactions with rhinos in the past, but increasing habitat loss due to encroachment and silting of *beels* is forcing rhino to venture out of the protected area (Talukdar et al. 2014).

A decrease in the availability of fodder biomass due to an invasion of exotic weeds is another factor contributing to the increasing movements of rhinos outside the protected area in search of food (Talukdar et al. 2014). The area under *Desmodium triflorum*, *Cardiospermum halicacabum*, *Ipomea carnea* and *Argemone mexicana* in Pabitora Wildlife Sanctuary (Bhatta, 2012), and that under *Mikania micarantha* and *Eupatorium* sp. in Nepal are rapidly increasing, and these plants are competing with native fodder species. In West Bengal, *Lantana camara*, *Mikania cordata* and *M. scandens* have infested the grassland habitats severely (Ghosh, 1996).

Expansion of woodlands into grasslands is also leading to a decline in fodder and habitats for the rhino (Bhatta, 2012). Since 1977, in Pabitora Wildlife Sanctuary, the area of woodland habitats has increased by 34%, with a parallel decline in grassland habitats by 68% (Talukdar et al. 2014).

Illegal grazing inside rhino habitats is on the rise, leading to decreased availability of fodder for the rhino. Overgrazing has resulted in degradation of 50% of the grasslands in Pabitora Wildlife Sanctuary.

Management of negative interaction

→ Current mitigation measures

- *Machans*, or guarding platforms, are erected at the boundary or in the middle of crop fields. This was found to be an effective strategy of crop-protection but can be really dangerous if an animal is in a rage and attacks a *machan* (Nepal & Weber, 1995).
- Due to high risks of poaching of rhinos, the forest staff in Assam, West Bengal and UP follow a strict regime of patrolling along the forest boundaries and steps are taken to drive rhinos back to forests as soon as they are detected in the croplands. *Kunki* elephants are used for driving the rhinos whenever required.
- Traditional scaring devices such as bundle of burning thatch grass, creating noise (hitting empty tin, fire crackers and whipping noise through a *Eulalopsis* rope etc.) and scare

crow are being used for a long time in Royal Bardia National Park and Sauraha area in Nepal (Jnawali, 1989; Thapa, 2010).

- Extensive habitat improvement work (e.g. plantation of fodder-grasses, thinning of trees, weed-eradication and digging of wallow-pools) is being carried out in Jaldapara and Gorumara national parks every year to enhance the carrying capacity of the two parks and to prevent rhinos from straying outside for grazing.
- Bio-fences are erected using thorny plant species such as *Ziziphus mauritiana* and *Euphorbia* species in Nepal. Thapa et al. (2010) found that this to be one of the most effective methods of crop protection. Even though it is the cheapest and most effective method of protection, it suffers from two major drawbacks. The first drawback is that *Euphorbia* species take a long to grow into an impenetrable fence. The second is that the roots of aged plants decompose, leading to the collapse of fences.
- In West Bengal (Jaldapara and Gorumara National Parks) and UP (Dudhwa National Park) power fences are used to prevent straying of rhinos outside PAs.
- Deaths caused by rhinos in India are mostly accidental. Jnawali (1989) suggested a few instinctive techniques such as climbing or running around a tree, dropping any personal belongings (piece of cloth or other item) while running away and swimming away to avoid attacks during encounters with rhinos.
- There is a strong Joint Forest Management mechanism in place in Jaldapara and Gorumara National Parks in the form of Eco-development Committees to involve local people in management of human-rhino conflict. West Bengal Forest Department regularly carries out eco-development activities to enhance social-carrying capacity of the fringe-area people.

→ **Mitigation measures suggested**

- Studies conducted by Thapa (2010) and Jnawali (1989) in Nepal focused on the mitigation measures used by farmers to reduce crop damage due to rhinos, and the following suggestions are based largely on these studies. Both studies recommend the use of different combinations of the mitigation measures. Sekhar in India (1998) made similar suggestions for reducing the chances of problem animals getting habituated to the mitigation measures.

- Thapa et al. (2010) suggested the use of electric and mesh-wire fencing to prevent the entry of rhinos into crop-fields. However, the high maintenance costs involved make it less preferred by farmers. Jnawali (1989) suggests that some material could be hung on the fence that creates a noise that alerts the farmer to the animal's presence.
- Digging trenches adjacent to fence walls along crop-fields to restrict the movements of free-roaming rhinos has been suggested by Jnawali (1989). Moreover, this method could reduce fence-damage.
- Limiting the extent of livestock grazing could help reduce the conflict by increasing the food available to rhinos (Jnawali, 1989).
- Cultivation of crops not preferred by rhinos has also been suggested as a mean of reducing crop-damage(Jnawali, 1989; Thapa, 2010). However, the unwillingness of farmers to switch to other crops and a lack of institutional support are the biggest hurdles in the implementation of this technique.
- Wildlife managers should prevent trespass and grazing inside rhino habitats.

→ **Existing policies**

- Rhino is in Schedule I and Human-Rhino Conflict is required to be managed under S.11 (1) (a). It gives rhinos a kind of immunity against crop-raids. In any case, degree of crop-damage by rhinos is seldom severe and local people show great tolerance towards crop damage by rhinos. Rhinos don't indulge in killing livestock. Rhinos are not known to be habitual human-killers. Therefore, in practice, there is no scope for invoking S.11 (1) (a) against rhinos. The main focus of managing human-rhino conflict should, therefore, be on preventing straying of rhinos outside PAs (which is also important as an anti-poaching strategy) and to enhance social carrying capacity of the people (S.S. Bist *pers comm*).

Human-Nilgai interaction in India

Current population status and distribution of species

The nilgai (*Boselaphus tragocamelus*) is endemic to peninsular India. It is widely distributed across the country, from the Himalayan foothills to the southern districts of Andhra Pradesh (Sankar & Goyal, 2004). It inhabits arid areas, scrub and dry deciduous forest but avoids dense forest and desert. Although it has drastically declined in its distribution due to habitat destruction and overhunting, its population size in a few northern and central Indian states ranges between 1,00,000 and 1,50,000 individuals (Sankar & Goyal, 2004). Due to a lack of population studies on the species and its overabundance in a few states, the overall status of the population is assumed to be steady. The IUCN categorized the nilgai as a Least Concern species, and because there is no illegal trade in the species and its parts, CITES does not include it in any of the appendices (www.iucnredlist.org, www.cites.org). The species is listed in Schedule-III of the Wildlife (Protection) Act (1972) in India.

Status of negative interaction

With 60% of the total nilgai population residing in four northern and central states of India (Haryana, Madhya Pradesh, Uttar Pradesh and Rajasthan), the level of conflict is high in these regions (Chauhan, 2011). The reported crop losses due to nilgai are 50% and 73% of the total crop-damage due to wild animals in Sariska and Kumbhalgarh Wildlife Sanctuary, respectively (Chauhan & Singh, 1990; Chhangani et al., 2008; Sekhar, 1998). The nilgai is the top crop-raider in Ranthambore and central Saurashtra and was involved in 70% of the crop-raiding cases (Karanth et al., 2013; Mehta, 2014). Despite of the nilgai being rare in Nepal, it accounted for 8.3% of the total crop-damage caused by wild animals. The number of road mishaps involving vehicular collisions with nilgai are also increasing in states with high densities of the species (Chauhan, 2011).

Reasons for negative interaction

Historical records indicate that the hunting pressure on the species was high during Mughal era (Sankar & Goyal, 2004). However, the present overabundance of the species has been suggested as the proximate reason for the increasing conflict in Indian states. Since the implementation of the Wildlife Protection Act (1972), the overall protection of wildlife has improved. Moreover,

changes in land use practices have resulted in an overabundance of few species such as the nilgai. Hunting of nilgai for crop-protection under Section 11 (1) (b) has been permissible right from the time of the implementation of the Wildlife Protection Act (1972), but few communities (i.e., the Bishnoi) do not allow hunting in their areas. This is another important reason for the increase in the population of the nilgai. The nilgai has a prolonged breeding season, and the loss of potential predators from human-dominated areas has resulted in its overabundance (Chauhan, 2011; Chauhan & Singh, 1990; Sekhar, 1998). Loss of habitat and depletion of food resources as a result of conversion of nilgai habitat to plantations of non-palatable species (*Acacia* sp. and *Prosopis juliflora*) has resulted in increased conflict in Haryana (Chauhan & Singh, 1990). Also, in the cropping season, the animals raid crops in search of richer nutrition compared with what is available in their refuge sites (Mehta, 2014). Nepal had a very small population of nilgai, but the species is still reported to be one of the top crop-raiders due to the depletion of food resources due to livestock grazing (Aryal, 2007).

Management of negative interaction

→ Current mitigation measures

- Crop guarding by humans and physical barriers (stone walls, mud walls and brushwood) are reported to be effective (Mehta, 2014; Sekhar, 1998).
- Night vigils and creating loud noises by beating drums and fire crackers were the most commonly used mitigation methods in central Saurashtra (Mehta, 2014).
- Bio-fencing (thorny bushes and shrubs) and barbed wires (height = 3 m) are being used, but other species involved in conflicts could dig holes to get past these. So they may not be a long-term solution (Sekhar, 1998).

→ Mitigation measures suggested

- Intrusion can be prevented using acoustic (unexpected loud noises, crackers), visual (scarecrows, brightly coloured cloth), olfactory (chilli dung bricks, pepper sprays, tobacco, etc.) and contact deterrents (Chauhan et al., 2010; Kumar, 2012).
- Fencing has proved to be highly effective in reducing the conflict in some protected areas in the country (Karanth et al., 2013). The use of battery-operated electric fencing around farmlands has been proposed a mitigation measure (Mehta, 2014). However, this may interfere with normal animal dispersal and result in shifting the conflict to other, non-

targeted species. Moreover, the associated installation and maintenance costs are generally very high, especially in the case of protected areas with long boundaries (Sekhar, 1998).

- Installing fencing around agricultural areas has also been suggested as a means of reducing the conflict. Farmers of central Saurashtra unanimously perceived government-aided fencing to be one of the top mitigation measures (Mehta, 2014). However, concerns have been raised by a few researchers as this may export the problem to unfenced areas (Chauhan & Singh, 1990).
- Population management and lethal control have been advocated as logical solutions by some researchers. However, Indian law and local communities (especially the Bishnoi and Hindu farmers) do not permures (Chauhan & Singh, 1990).
- Although compensation is provided for crop- losses due to wildlife, there are challenges involved in availing oneself of the funds, and the delays involved often discourage farmers from reporting cases. To reduce the conflict levels, it is imperative to restructure the systems and the compensation schemes (Karanth et al., 2013; Madhusudan, 2003; Sekhar, 1998).
- Improving the habitat in nilgai refuge areas by preventing livestock grazing and by planting various nutritive forage species could reduce the number of crop-raiding cases (Mehta, 2014).

→ Existing policies

- All Indian states hold the power to use the legal option available under Section 11(1) (b) of the Wildlife Protection Act (1972), which empowers the Chief Wildlife Warden or an authorized officer to permit any person to hunt a wild animal or a group of animals (specified within Schedule II to Schedule IV) causing damage to standing crop. So far the state governments of Uttar Pradesh, Uttarakhand, Haryana, Madhya Pradesh and Gujarat have exercised this legal option to manage conflict due to nilgai in agricultural areas (Chauhan et al., 2010). Though there is a provision for lethal control of Nilgai but this policy is not effective due to the religious belief and the carcass of the individuals is not allowed to be taken by hunter.

Human-Wild Pig interaction in India

Current population status and distribution of species

The wild pig (*Sus scrofa*) is one of the most widely distributed terrestrial mammals amongst all Suiformes. This range has been greatly expanded by humans (IUCN 2008). It is common throughout India except Jammu and Kashmir, upper Himalayas and desert, (Chauhan 2004). The wild pig (*Sus scrofa*) is Schedule-III species of Wildlife (Protection) Act, 1972. This species is abundant in many parts of its range, though populations can be depressed in places where hunting intensity is high (for example in eastern and southeastern Asia).

Status of negative interaction

Wild pigs invade human habitations and agricultural and horticultural farms and feed on different crops. Wild pigs were reported to cause 46% of the damage to crops in central Saurashtra (Mehta, 2014). Damage caused by wild pigs to *Triticum vulgare*, *Oryza sativa*, *Zea mays*, *Pennisetum typhoides*, *Saccharum officinarum*, *Arachis hypogea*, *Cicer arietinum*, *Hordeum vulgare*, *Sorghum vulgare* and *Brassica campestris* was 5% to 20% in north and central India (Chauhan, 2011). *Eleusine coracona*, *Vigna radiata*, *Glycine max*, *Sesamum indicum*, *Lens esculenta*, *Ipomoea batatas* and *Lythyrus sativus* showed damage to varying extent (5% to 10%) and in some areas, pulses and vegetables were damaged to an extent of 5% to 25% (Chauhan, 2011b). Dave (2010) reported the damage in terms of percentage of agriculture field area affected near the Little Rann of Kachchh to be between 10% and 25% for cash crops (cotton and cumin), millet and pulses and oil seeds.

Occasionally wild pigs attack people and injure them. Human casualties are caused by wild pigs in different parts of the country (Chauhan, 2004). A survey conducted in Madhya Pradesh revealed that 58 human casualties were caused by wild pigs in and around 12 protected areas and forest divisions between 1989 and 2000 (Chauhan et al., 2009). Most of these cases occurred inside forests and resulted in severe injuries. Seven and five human casualties were recorded in Noradehi Wildlife Sanctuary and Chindwara West Forest Division, respectively. During 1991–1992, two human casualties caused by wild pigs were recorded in Almora Forest Division, Uttaranchal. Sporadic wild pig attacks were reported from different states (Chauhan, 2004).

Reasons for negative interaction

Prater (1971) reported that there is no animal more destructive to crops than the wild pig. It causes extensive damage to agricultural crops and utilizes agro-ecosystems for food resources and shelter. Presently wild pig populations are fragmented and relatively isolated all over the range. Some of these isolated populations have become locally overabundant and depend upon agricultural crops, especially in and around protected areas or managed forests, for a major part of their food requirements. Besides agricultural crops, they cause damage to orchards and forest plantations and possibly act as carriers of some infectious diseases. According to Mackin (1970), Andrzejewski & Jeziarski (1978) and Genov (1981), the damage caused to crops by wild pigs increases when there is less natural food available in forests.

Management of negative interaction

→ Current mitigation measures

- Farmers manually guard their farms, create noise, fire crackers and even guns, to scare away wild pigs from farms (Ahmed 1991, Mehta 2104). Wild pigs are killed in many places using local-made guns. At times pig bombs are also employed illegally to eliminate wild pigs.
- The forest department helps with crop protection by deputing crop watch guards in highly impacted areas and providing torches and fire crackers to farmers in a few places to scare away wild animals (Chauhan, 2004).
- Barbed wire fences are also used to contain the damage done to crops by wild pigs. Farms around Bandhavgarh National Park are guarded using electric fencing (Chauhan, 2004).
- Crop protection trenches are reported to be used in Nepal (Thapa, 2010).

→ Mitigation measures suggested

- Contraception and cost-effective barriers have a wide scope and seem to have the potential to develop as effective management tool.

→ **Existing law & policies**

- Almost all states have compensation for loss of crop, damage to property, human and livestock injuries as well as death due to wildlife. Compensation amount vary a lot across states and there is an urgent need to re-structure the schemes as well as the relief amount.

Human-Blackbuck interactions in India

Current population status and distribution of species

The blackbuck (*Antelope cervicapra*) is native to the Indian subcontinent (Lydekker, 1907). It is found in a wide range of habitats, from semi-arid grasslands and scrub to open forest (Isvaran, 2005; Mungall et al., 1981; Prasad, 1981). They reach their highest densities in semi-arid, open and short-grass plains. Blackbuck historically ranged from near Peshawar (in Pakistan), in the northwest, through the Indo-Gangetic plains, up to the plains of western Assam, in the east; centrally, in the Deccan; in open plains areas along the western coast of the peninsula; and along the eastern coastal plains up to southern Tamil Nadu (Lydekker, 1907). Within India, they are found throughout a large part of their former range. However, their populations, previously large and contiguous, are now small, scattered and relatively isolated. The most recent survey of blackbuck populations in the country, based on observations made between 1981 and 1988, arrived at an estimate of 29,000–38,000 individuals (Rahmani, 1991). This estimate includes populations both within and outside protected areas. Rajasthan, Punjab, Gujarat and Maharashtra had the largest state-wise population estimates (Rahmani, 1991). Velavadar, in Gujarat, Tal Chappar, in Rajasthan, Nannaj, in Maharashtra, Rollapadu, in Andhra Pradesh, Ranebennur, in Karnataka, and Point Calimere, in Tamil Nadu, currently hold some of the largest concentrations of blackbuck within protected areas (Isvaran, 2003; Jhala, 1993a; Rahmani, 1991; Ranjitsinh, 1989).

Status of negative interaction

Chauhan & Singh (1990) reported losses incurred by farmers due to crop depredation in Haryana. Blackbuck feed on crops, such as groundnut, wheat, barley, millet, and black gram (Jhala, 1993b; Manakadan & Rahmani, 1998; Prasad, 1981), in areas where croplands are easily accessible (Isvaran, 2004).

Reasons for negative interaction

Blackbuck thrive in protected areas as a result of their high fecundity and their ability to survive well in diverse habitats (Isvaran, 2004). However, this tendency of blackbuck populations to grow rapidly often brings them into conflict with local communities. In most protected areas with healthy populations of blackbuck, individuals regularly feed in adjoining crop fields. Some

factors thought to be responsible for this movement are the relatively small sizes of many protected areas with blackbuck and the greater nutritional value of many crops compared with natural forage, particularly in the dry season (Jhala, 1993b; Manakadan & Rahmani, 1998).

Management of negative interaction

→ Current mitigation measures

- Brushwood fences are used in some places (Chauhan & Singh, 1990)
- The most common protection strategy for farmers in Haryana is to guard their fields by remaining vigilant during the crop season (Chauhan & Singh, 1990) .

→ Mitigation measures suggested

- Selective reduction of the population by translocation in areas with high loss has been suggested (Chauhan & Singh, 1990) .
- Other recommendations include implementing various crop protection measures and compensation schemes and growing non-palatable species in fields close to sanctuaries (Manakadan & Rahmani, 1998). The effectiveness of these various recommendations has not yet been systematically studied.

→ Existing law & policies

- Almost all states have compensation for loss of crop, damage to property, human and livestock injuries as well as death due to wildlife. Compensation amount vary a lot across states and there is an urgent need to re-structure the schemes as well as the relief amount.

Human-Wild Ass interaction in India

Current population status and distribution of species

Two species of wild ass are found in India, the khur (*Equus hemionus khur*) and the kiang (*Equus Kiang*). The range of the khur or Indian wild ass was probably always restricted to the deserts of north-western India. In the 20th century, the Indian wild ass had a fairly wide distribution in the dry regions of north-west India and south Pakistan. It was found as far north as Jaisalmer and Bikaner, in Rajasthan, and westward in Sind and Baluchistan (Gee, 1963). The former distribution of this sub-species was in Baluchistan, around Balgajar, in central Makran, and in Sohtagan, in the extreme western part of Kharan District. A small population survived in the Great Rann of Kutch, on the border between Chacro and Nagar-Parkar tehsils, of Tharparkar District, in Sindh, until the late 1960s (Feh et al 2002). The only remaining population of khur in the world today is in the Wild Ass Sanctuary, the Little Rann of Kutch, and its surrounding landscape in Gujarat (Groves, 1974; Shah, 1993, 2004). An increasing trend has been observed for the khur population in Rann of Kutch since 1970's. The wild ass population has gradually increased from less than 400 in the late 1960s to about 4000 in 2014 (Shah, 1993, Shah 2015, Moehlman et al 2008).

Kiang is restricted to the high altitude cold desert, on the Tibetan Plateau, between 2700 and 5400. msl. About 90% of kiang distribution is in West China, and 10% population is along borders of Pakistan, India, Nepal and possibly Bhutan (Shah, 2002, Shah et al 2008). Within this broad range, the distribution of the kiang has become increasingly fragmented, and at present, most of the populations are found in protected areas or in areas under army jurisdiction (Shah, 2002). In India, the kiang occurs in the Trans Himalayan areas of Ladakh (Jammu and Kashmir), Uttarakhand and in north Sikkim. The total population of the kiang in India is estimated to be above 3500 to 4000 (Shah & Qureshi 2002, Shah, 2015, shah et al 2008).

Status of negative interaction

The wild ass were found to feed on six species of crops based on village surveys for perception on wildlife conflict (~400 villages) around the Rann. The study indicated that the damage by khur was minimal i.e., ranked lowest in comparison to Wild pig, Cranes and Nilgai, jackals, mynas in the descending order. (Shah 1993, 1999). Wild ass mostly raid crop fields during night,

travelling couple of kilometres, more incidents occurred during summer for food and water (Shah 1993). Damage caused by wild ass was reported between 15 to 25 % of the crop land in the area for all different crop types (Cash crops, millet, pulses & oil seeds) and damage up to 1 km from the fringes of the sanctuary was evident in Northern Little Rann of Kutch (Dave 2010). Almost 80% farmers in Northern part of Little Rann of Kutch believed that the conflict can be avoided if proper mitigation steps are taken (Dave 2010). The attitude toward conflict has changed over time, with people becoming more intolerant with increase in irrigable land and cash crops (Shah 1993, 1999 & 2004).

Reasons for negative interaction

Increases in the wild herbivore populations following better protection with management and changes in land use patterns and intense farming practices because of the water supply from Narmada canal have resulted in severe rise in crop raiding by wild herbivores (nilgai, wild pig, blackbuck) including the khur (Shah, 1999). Agricultural activities have become more intense with better irrigation facilities, thus changing the land use patterns. Prior to the Narmada canal, khur and other herbivores used to move between the PA and the agro-landscapes, with the functioning of the Narmada canal many herds of khur have become resident herds in and around the croplands outside the PA as they could not get back to the Rann. The canal forms the barrier for movement of khur between the sanctuary and the agro-landscapes. In high conflict zones, the agro-systems at the interface of the Rann are the areas most affected (Qureshi & Shah 2013, Shah & Qureshi 2007). Moreover, wild asses are active during the night to maximize the intake of resources at the natural vegetation–agriculture interface (Shah, 1993, 1998, 1999).

Kiang

In the Trans-Himalayan region of Ladakh and Sikkim, the wild equids have been reported by the locals as competitors with the local livestock over the limited resources. The pastoralists tend to maintain large sheep /goat herd sizes in order to compensate over the high incidences of mortality due to harsh environmental conditions. Larger the herd sizes more the resources required; in the high altitude pastures resources are naturally limited with short vegetation growth phase. The kiang-livestock overlap of pasture use therefore would lead to conflicting

situations (Shah et al 2008). In Sikkim despite the kiang population being very small, the local herders perceive that kiang deplete the resources (Shah 1994).

There is an increased pressure on the pastureland due to the increasing population of livestock in Ladakh. The Jammu & Kashmir Government provide incentives to nomads to keep pashmina goats for production of wool (Shah, 1996, 2006; Bhatnagar, 2006). In this context, kiang are increasingly perceived as serious competitors by pastoralists and the local administration (Shah, 1996, 1997). The conflict with kiang has arisen mostly due to a misplaced notion of preserving pastures for livestock grazing. Many pastures are fenced to keep kiang away to maintain resources for pashmina goats (Shah, 1996 & 1997). Temporal use of winter pasture by kiang which were protected for the winter livestock grazing was one of the reasons for the herders' prejudice towards the kiang (Shah & Qureshi 2003). As a consequence, there is a decrease in tolerance towards kiang due to changes in socio-economic conditions.

Overgrazing has reduced the cover in the high land pastures. The complex system of rotational grazing, which has maintained the rangelands, is being modified. Nomad groups now fenced winter pastures and some had built long fences across valleys and hills to keep wildlife out, which will affect the kiang and other wildlife populations (Miller & Schaller 1997, Shah & Huibin 2000, Shah & Gruisen 2000). There are demands from herders to control kiang populations (Miller & Schaller 1997, Shah 1996, Marc Foggin *in litteris*).

Management of negative interaction

The Rann fringe of the Sanctuary and its landscape with a mix of human development experience the major conflict. Human-wildlife conflict often leads to destruction of species and their habitat or political clashes over biodiversity protection which nearly got the Wild Ass Sanctuary on verge of denotification. Outside groups often become involved and proposed solutions multiply and traditional mitigation methods may be forgotten. The risk in such cases is that traditional coping methods are often more understandable, sustainable, and cost-effective for affected communities than are novel solutions advocated by stakeholders who are less directly affected by the conflict. Moreover, the affected communities are sometimes completely marginalized if Sanctuary authorities and outsiders step in to control negative interaction.

→ **Current mitigation measures**

- Efforts to reduce damage has been applied by locals directly or indirectly as follows in the khur and kiang landscapes (Shah & Qureshi 2002):

Direct methods reduce the severity or frequency of wildlife damage:

- Barriers (fences, trenches, walls, buffer zones, etc.)
- Guards (human or animal) Changing the type, timing or location of human activities
- Repellents (Baits, lures, chemical, auditory or visual aversive stimuli)
- Removal of wildlife (illegal killing,) e.g . poisoning

Indirect methods raise people's tolerance for conflicts with wildlife:

- Compensation and incentives (comprehensive crop/livestock insurance policy)
- Participation
- Research and environmental education /Awareness
- In Kutch, farmers manually guard their farms, use ingenious noise-making systems and firecrackers by the night and use various forms of fencing (tape strings, sarees, and plastics) use of *Euphorbia* *sps.* as a fence to keep herbivores and birds away.
- Some pastures in Ladakh are protected from kiang by fencing. However, it is a bad practice as it prevents other species from using the pastures.
- The khur and kiang landscapes protection of cropland and pastures respectively are done by paid horsemen who chase the wild equid away (Shah & Qureshi 2002, Shah 2015).

→ **Mitigation measures suggested,**

Equus hemionus khur

- A compensation scheme needs to be devised and implemented to address the losses incurred by farmers (Dave 2010).
- The efficacy of various fencing designs against large herbivores must be tested (Dave 2010).

Equus kiang

- There is no practice in vogue for the collection of pasture grass seeds and re-seeding among the changpas. This has to be introduced by offering remunerative price for seeds of promising, time-tested native grasses and reseeded them (Prof. Mir *pers.comm*). Need for a network of fodder producing farms with fodder depots (Prof. Mir *pers.comm*) in Changthang can tide over the unfavorable period and thus benefit the pastoralists and wild species. Any alternative for fodder security for livestock during winter should be linked with summer livestock stocking density in the pastures. By increasing survival rates of livestock without any restrictive policy on livestock holding in a given pasture will prove disastrous in a long run for both wildlife and pastoral economy (Shah&Qureshi 2002, Shah et al 2008).
- Protection of pasture especially by fencing and driving away the kiang on horseback was in high demand by pastoralists. Watchman to be provided by Wildlife Department to protect crop field and pasture was also suggested although the community do elect people to guard the pastures and the crop fields. During harsh winter people demanded that government should increase the quota of food supply and fodder (Shah & Qureshi 2002, Shah et al 2008). Stall feeding for livestock would reduce the pressure on the pastures and also decline the incidences of predation by carnivores.
- Inter-sectoral planning and education of herders are critical for addressing the conflict related to the kiang in Ladakh (Shah & Qureshi 2002, shah et al 2008).Comprehensive pasture management policy should be drafted by involving people, and various governmental bodies like Wildlife Departments, Animal Health Department, Soil Development Board and Ladakh Hill Council.

→ **Existing law & policies**

- Both the khur and kiang are given the highest level of protection (Schedule-I) by the Wildlife Protection Act (1972). The khur is categorized as Endangered and the kiang as Least Concern by IUCN, and CITES has listed both species in Appendix-II.
- Wild Ass Sanctuary – the name has victimized the species despite the khur attributes to a minimal level of damage in comparison to Nilgai and Wild Pig. The PAs must not be named by a species (N. Shah *pers comm*).

Synthesis of Human-Macaque Interactions



Authors

S.S. Bist, Monica Kaushik, Ninad Mungi, & Qamar Qureshi

Human -Non-human primate interaction in India

Current population status and distribution of species

Non - human primates, whose natural habitats have drastically reduced due to habitat loss and modification (Chapman and Peres 2001), particularly Rhesus macaques (*Macaca mulatta*), Bonnet macaques (*Macaca radiata*) and Hanuman Langur (*Semnopithecus entellus*) utilize anthropogenic environments to their advantage (Priston & McLennan 2012). Rhesus macaque distribution in India extends over much of northern, central (except for northern Kashmir, high altitudes of Himalaya, Great Indian Desert and west-central India) and east whereas, the southern geographical limit has extended beyond river Krishna in the last few decades (Fooden 2000). Estimated population is 500,000, with 50%-60% of the rhesus living in “urban areas” (Soloman 2013). Rhesus macaque population in Himachal Pradesh reported to be 3, 19,168 in July 2004 and 2, 26,086 in June, 2013 (Anon, 2014). The geographic range of the bonnet macaque extends across peninsular India with population estimate around 170,000 individuals (Kurup, 1981), however reduction in population and local extinction is observed within the range (Singh et al, 2011). Hanuman langurs are distributed throughout the parts forests of tropical Indian subcontinent. Its estimated population is approximately 300000 individuals in India (Mukherjee, 2001). India exported 60-70 thousands monkeys per year for biomedical research (Southwick & Siddiqi, 2001), however it was banned in 1978.

Status of negative interaction

In Himachal Pradesh, approximately 53% of all crop damage in the state was attributed to rhesus macaques (Singh & Thakur 2012). In addition, more than 1500 cases of biting are reported by the forest department (HPFD). As informed by the Agriculture Minister in J&K Assembly, monkeys damage 15596 ha of agriculture crops worth ₹ 32.93 Cr and 9426 tonnes of fruits worth ₹ 4.72 Cr annually in Jammu Division (Business line, 4.4.2013). 27 cases of bite and 49 cases of aggressive threats by rhesus macaque were reported from Gauhati University Campus from June 2004 to May 2005 (Devi. S. O & Saikia, P.K., 2008).

Langurs caused annual loss of ₹1.4 lakhs to 1.9 lakhs for studied 12 farms near Kumbhalgarh Wildlife Sanctuary (Changgani et al 2004).

Bonnet macaque enters the houses and hence perceived to be nuisance. The people in the villages bordering the Mollem National Park and Bhagwan Mahaveer Wildlife Sanctuary (Goa) reported it to be the feared, most destructive and most frequent of the crop depredating species (Sengupta & Radhakrishnan 2013).

Reasons for negative interaction

In India, due to agricultural expansion and deforestation resulting in contraction of natural habitats, few primates have colonized rural and urban environments in large numbers (Southwick and Siddiqui 2011).

Their ability of benefitting from human-disposed food is the precursors of conflict with humans (Singh & Thakur 2012). Devotees and animal lovers feel gratified in feeding monkeys in temples, highways or roof tops and consider it a religious deed. As a result, monkeys have become habitual of snatching food from people, attacking them, in extreme cases causing death (Singh & Thakur 2012).

Management of negative interaction

→ Current mitigation measures

- The prevalent management strategy to reduce such conflicts is by translocating macaques to forest patches (Fooden 2000). However, such translocations, if not done carefully, may lead to transfer of conflict to new area or to spread of zoonotic diseases. Also, most of the Forest Departments in India engage professional trappers to capture monkeys from problem areas and release them in remote areas. Animal Right Groups have often blamed the trappers of using cruel methods.
- Capture and translocation of problem monkeys in Delhi has been going on since 1990s. In June 2004, 250 monkeys were translocated from Delhi to Kuno Sanctuary in MP. Monkeys are being released in Asola Bhatti Sanctuary in Delhi in accordance with Delhi High Court's order dated 14.3.2007 and 17138 monkeys had been released till 28.2.2014. Ten million rupees a year are spent on feeding these captured monkeys (Soloman 2013).

- In some instances, Hanuman langurs (*Semnopethicus entellus*) are used to terrorize and displace rhesus macaque (Fooden 2000). However, in areas where these species distributions overlap, agonistic interactions are common, wherein the rhesus macaque has been found to be more aggressive and successful in displacing the Hanuman langur (Fooden 2000). Illegal hiring of langur for chasing away rhesus monkeys from official buildings in Delhi has been prohibited vide WCCB's advisory dated 15.10.2012 (S.S.Bist *pers comm*).
- In other instances, rhesus macaque males have been sterilized to reduce population recruitment and growth (Fooden 2000).
- Tubectomy and vasectomy at large scale was carried in Himachal Pradesh. Till this date more than 84,000 individuals have been sterilized in seven sterilization centers and released back near the capture sites.
- Non-invasive female contraception, can be a viable solution, but not so widely practiced and developed.
- For avoiding the loss by langurs and monkeys in Himachal Pradesh and Uttarakhand, farmers patrol the fields, throw stones with "gophan", keep dogs, fence with thorny twigs, use potash bomb etc. (Chhangani et al, 2004).

→ **Mitigation measures suggested**

- Methods such as oral administration of contraceptives, intra-uterine devices, and blockade of tubal patency following trans-cervical administration of polidocanol foam (Jensen et al.2013) are suggested. However, there is a serious need to carry out field trial to assess the efficacies and impacts on monkey's population, of these different sterilization techniques.
- Risk-potential locations can be reduced by using macaque deterrents like security guards, dogs and/or negative reinforcements on key troop members, alongside management of the critical resources (Soloman 2013). Trained langur can be used as guard animal only after proper permission from the CWLW.

- Solid waste management and proper disposal of rural organic waste as well as prohibition on feeding of monkeys in public places could reduce the conflict cases in long run by stabilizing their population.
- Translocation of problem monkeys from high-conflict zone can be tried provided habitats for translocation are chosen with care and the population to be translocated has been screened against zoonotic diseases.
- Scientists of YS Parmar University of Agriculture, Horticulture and Forestry (HP) have suggested cultivation of Marigold and some varieties of wheat as alternative to crops damaged by monkeys (Amar Ujala, 15.12.2013).

→ **Existing policies**

- All three primates are protected by Schedule II (Part I) of Wildlife Protection Act (1972).
- After the taxonomic revision of Cercopithecidae, some of the populations of common langur (e.g. *Semnopithecus entellus ajax* found in HP) have been categorized as ‘Endangered’ as per IUCN Red List Criteria. It has been suggested that a differential, species-specific approach should be followed while dealing with non-human primates involved in conflict with humans (Singh et. al. 2005).
- Government of Himachal Pradesh and Uttarakhand declared primates as vermin so that they can be killed by farmers and ordinary citizens (Letter No. 1953/25-28, dated 15th January, 2007 from the Additional PCCF (Wildlife) cum Chief Wildlife Warden, Uttarakhand).
- HPFD has authorized Forest Rangers under S.11 (1) (b) to permit hunting of monkeys (which includes shooting) but HP High Court has stayed shooting of monkeys on 6.1.2011 asking HPFD to try alternative methods.
- HP Government amended the Municipal Corporation Act-1994, in 2004, making feeding of monkeys in public places an offence.
- Despite high incidents of crop damage by non-human primates, HP Government does not give *ex-gratia* relief in such cases.
- Illegal hiring of langur for chasing away rhesus monkeys from official buildings in Delhi has been prohibited vide WCCB’s advisory dated 15.10.2012. Considering the usefulness of trained langurs in keeping problem monkeys at bay, particularly in strategic locations

like hospitals, schools, offices, etc. there is need to revisit legal restrictions on ownership and use of langurs.

- Govt of India has banned commercial export of monkeys from India w.e.f 1.4.1978. (Common Langur is also included in Appendix I of CITES while Rhesus Macaque and Bonnet Macaque are in Appendix II of CITES).
- Use of monkeys in circus has also been banned by Govt of India in 1998.

Synthesis of Invasive Species Management



Authors

Ninad Mungi, Monica Kasuhik, J.A. Johnson & Qamar Qureshi

Reviewers

Dr. Gyan Prakash Sharma & Dr. G.S.Rawat

Lantana camara in India

Current distribution and status of species

Lantana camara (hereafter lantana) is a pan-tropical weed. It occurs in diverse habitats and on a variety of soil types. Is a low erect or sub-scandent, vigorous shrub with stout recurved prickles and a strong odor of black currants; it grows to 1.2-2.4 meters (or even more); its root system is very strong, and it gives out a new flush of shoots even after repeated cuttings; Leaf ovate-oblong, sub-acute, crenate-serrate; flower small, usually varying from white to red in various shades and blooms throughout the year; fruit small, blackish, drupaceous, almost throughout the year, dispersed by birds (Sastry et al., 1990). *Lantana* also occurs as Liana in many parts where it climbs tall trees and spreads over the canopy. *Lantana* is native to the tropical and sub-tropical regions of Central and South America. In India, it was first introduced in the early eighteenth century as an ornamental plant (Thakur et al., 1992) in Coorg, Dehradun and Kolkata. Since then it has invaded almost all the tropical India and encroaches 13.2 million hectares besides forest and fallow land. Its management cost around US\$ 70 per hectare (Bhagwat et al., 2011).

Reasons for concern

Impacts: *Lantana* aggressively proliferates and forms a dense mesh of bushes. This happens excessively at the edges of the forests with sparse canopy. It is known to produce allelochemicals that restricts the growth of other species under its canopy (Achhireddy & Singh, 1984). Hence, it replaces native flora, resulting in homogenous vegetation (Lamb 1991). Dense invasion of lantana was reported to related with decline in the diversity of birds (Arvind et al. 2010) and habitat of elephants (Wilson et al. 2013). *Lantana* can alter fire regimes in natural systems (Humphries & Stanton 1992). Consumption of its leaves has caused poisoning to cattle, buffalo, sheep & goats (Sharma et al. 1988). Over consumption of lantana leaves and shoots by wild herbivores has also been reported to be fatal for their health. Malarial mosquitoes have shown to be breeding in its dense thickets (Gujral & Vasudevan 1983). Different varieties of ecosystem services have been altered by *Lantana*.

Success of Invasion: Different populations of lantana were introduced in India, mixing of which, in addition to escape from predators, resulted in enhanced vigorous genotype (Ray & Ray 2014).

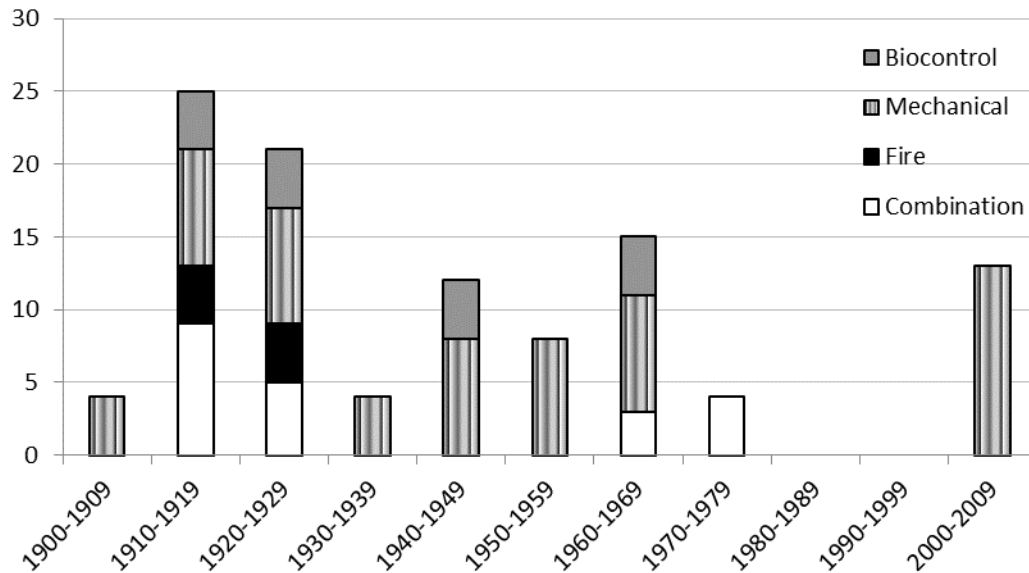
Owing to its high fitness homeostasis and phenotypic plasticity, *Lantana* has invaded in nutrient poor soil, areas with high native cover, and extreme climatic conditions. Allelopathic characters (aromatic, alkaloids and phenolics) present in plant suppress regeneration and growth of other vegetation, thus getting rid of the competitors for resource utilization. *Lantana* also reproduces vegetatively, that makes the eradication complex; as during its removal, nodes of the main stem are dispersed causing dispersal of plant. Moreover fire has been reported to break the seed dormancy of *lantana*, causing high flash of invasion after fire treatment that is commonly used by forest department to restore the grasslands (Sharma et al., 2005). As *lantana* provides green cover and has associated dependencies of species belonging to various taxa, popularly it is perceived as beneficial; thus, impeding the focused restoration of native ecosystem which is already damaged.

Management Interventions

Manual uprooting followed by replanting the native flora is the most preferred technique till now. Though not much success is achieved in the process, resources are spent each year by forest department for *Lantana* management. Bhagwat et. al. (2011) provides an interesting account of techniques so far used for *lantana* management in India (see figure 1). Popular methods are discussed below:

a. Fire. This method is used for burning *Lantana* cover in grasslands and fallow lands. It is the most cost – effective technique in terms of efforts invested. However, many times native flora, nest of birds and shelter of other dependent fauna using the *Lantana* cover and other small animals are lost in the process. Moreover fire induces *Lantana* seed dormancy and hence high invasion *Lantana* is observed post fire (Hiremath and Sunderam, 2005).

Figure 1. History of managing Lantana in India (Bhagwat et. al. 2011).



b. Manual uprooting. *Lantana* thickets along the roadside and in understory are manually removed. Presently, it is the only method practiced for clearing the understory invasion. However this method cannot be used at large scale owing to the intensive efforts and repeated treatment needed each year.

c. Chemical. It involves the use of inorganic/organic herbicides. However the usage is limited by high cost of such programs. Moreover a detailed study on effects of such chemicals on components of biodiversity is needed before implementing such studies (Sharma et al.,2005).

d. Bio-control. In India, *Teleonemia scrupulosa* Stal. was introduced for bio-control of *Lantana*. But, control agent could not cope with the vigorous regrowth of *Lantana* at the onset of the monsoon rains; the control agent itself suffered heavy mortality during the winter months. Moreover a detailed study of effects of such agents on other organism is needed before implementing it to other regions (Sharma, 1988).

e. Restoration. Native plants are planted in the invaded patches (mostly after removing the major cover). However, desired result was not achieved. E.g. *Ficus* sp. and castoroil plant was planted to compete with *Lantana*, without much success (Troupe, 1921).

f. Harvesting. Few non-governmental organizations started experimenting with lantana to make furniture, pulp extraction of aromatic oils, etc. However, the scale of such usage is very small compared to the current extensive *Lantana* cover (Troupe, 1921).

g. Adaptive eradication. One of the most preferred technique followed in the recent past was established by Babu et al (2009). The procedure is; 1. cut below the root-stem transition zone 2. burn dried clumps 3. weed out *Lantana* saplings beneath the trees and from the surface of drainage channels originating from the invaded and uprooted area 4.restore grasslands and mixed woodlands.

None of the present methods promises complete spatial or permanent eradication of lantana.

Existing Policies

Lantana colonized variety of habitats and even the protected areas. Every year a considerable amount of overall budget of PA's management have been spent for managing *Lantana* invasion. Recently introduced operational guidelines of the 'intensification of forest management scheme' of the Ministry of Environment Forest and Climate Change (MOEFCC) emphasizes the need for control and eradication of forest invasive species and providing assistance to state-owned or supported research institutions to carry out research for management of invasive like *Lantana*. Kannan et al. (2013) has reviewed the legislative gaps and needs for managing invasive species in India.

Prosopis juliflora in India

Current distribution and status of species

Prosopis juliflora (hereafter 'Prosopis'), commonly known as *Kabuli Kikar* or Honey Mesquite of Mimosaceae family, is a fast growing shrub, sometimes attaining form of a small evergreen tree in semi-arid and arid tracts (Burkart, 1976). This is the only invasive species amongst many other species of the genus (Pasicznik, 1999). The foliage ranges from light to dark green. The spines range in length from 4 mm to 9 mm and form impenetrable barriers for herbivores. All members of the genus *Prosopis* are phreatophytes with deep tap roots (Pasicznik, 1999). *Prosopis* flowers are produced in large number on spike-like racemes, and are primarily pollinated by insects. Pods are linear, compressed, 10-15 cm long with 20-25 seeds. Seeds can remain viable up to 20–50 years.

Prosopis has its origins in frost-free *tropical* regions of Central America and Mexico. In many areas within its native range, *Prosopis* sometimes occurs as a noxious weed. Luna (1996) dates the introduction of *Prosopis* to the Sindh part of India to 1857. Lt. Col. R.H. Beddome, the Conservator of Forests of Northern Circle (Madras) introduced this species in Camalpur, Cuddaph district of Andhra Pradesh in 1876 from where it naturalized in other parts of south India (Reddy, 1978). There was a second introduction of material from Mexico in 1912. *Prosopis* was introduced in Rajasthan in 1913 (Muthana & Arora, 1983), and seeds were supplied to neighboring states. In 1915–1916, seeds were introduced at a number of locations (Dubey, 1998). Most of the plantation was done for raising green cover in the arid and semi-arid landscape.

Reasons for concern

Impacts *Prosopis* was originally considered a wonder plant for afforestation in semi-arid tracts especially to meet the fuel wood requirement of the local communities. However, once it invades the grasslands, it leads to rapid loss of wildlife habitat. Many threatened grassland birds and mammals have known to suffer greatly due to invasion by this species. It exacerbates and accelerates soil erosion (Kaur et al., 2012). The United States experiences production losses of US\$200–500 million per year because of *Prosopis* infestations (Pasicznik & Felker, 2001).

Success of invasion. This species produces copious amount of flowers and fruits. Each pod may contain 20 – 25 seeds which have very high germination rate. Pods are eaten by cattle and wild ungulates. Seeds that pass through the guts of ungulates germinate even faster and establish very easily. This life-history trait makes this species very successful invader. Extracts from parts of the plant contain various chemicals including tannins, flavonoids, steroids, hydrocarbons, waxes and alkaloids that prevent the germination and growth of almost all plants tested in several studies. The roots are better adapted to an arid climate than native species. It has formed hybrids and complexes with many other congeneric species (Pasiiecznik & Felker, 2001).

Management Interventions

Manual removal was the first method used to deal with *Prosopis*. It remains practical only for small land holdings of high value, such as agricultural lands, or where labor is relatively cheap.

Hand clearing can also be used in conjunction with some mechanical or chemical methods, such as chemical stump treatment. Mechanical site clearance involves tractor operations developed for removing trees, in which roots have to be severed below the ground level to ensure that trees are killed. These operations include root ploughing and chaining and are often the most effective mechanical means.

Several biological control programmes have been developed and implemented that use species of seed-feeding bruchid beetles. In their native range, bruchid beetles can destroy substantial amounts of seeds. Twig girdlers and psyllids have also been suggested as possible biological control agents. Psyllids are known to severely affect the growth of *Prosopis* (Hodkinson, 1991) and have been suggested for use in controlling invasions.

In India, Keoladeo Ghana and Ranthambhore National Parks had provided permits for cutting *Prosopis* trees in specified areas for eco-development and management so that *Prosopis* does not spread further, in non-invaded parts of the parks. Local communities are allowed to extract the *Prosopis* for domestic usage under the Mahatma Gandhi Rural Employment Guarantee Scheme (Hiremath & Sundaram, 2013).

In Kachch, the forest department noted that, if scientifically managed, each of the five vehicles falling under *Prosopis* areas in Kachch can yield 10 lakh bags of charcoal each year at an estimated value of Rs.10 crore. The income generated could be used for paying wages for

labourers or could be transferred to government funds. Thus this harvesting could be beneficial for the ecology and economy. However, after the initiation of the programme, native trees were also cut down illegally by people, resulting in a reduction in the green cover to less than 10% in 2004. As a consequence, in 2008 the Gujarat state government stopped the programme.

***Mikania micrantha* in India**

Current distribution and legal status of species

Mikania micrantha (hereafter mikania) is native to tropical and subtropical zones of north, Central and South America. It was introduced to India during the Second World War (1940's) to camouflage airfields and since then is a major weed, especially in north-east and south-west India. The species has drastically spread over the natural and maintained vegetation in the invaded area (Reddy, 2008). It is currently known to occur in the states of Assam, West Bengal, Tripura, Manipur, Kerala, Arunachal Pradesh, Orissa and the Union Territory of Andaman and Nicobar Islands. It is a perennial twining herb with 5-ribbed branches, pubescent or glabrous; internodes are 7.5 - 21.5 cm long. Leaves are opposite, ovate-deltoid, margins are coarsely dentate, crenate or sub-entire, glabrous on both sides; the petiole is 3 - 7 cm long. The inflorescence is axillary paniced corymb. Individual florets are white to greenish-white. The seed is black, linear-oblong and about 2 mm long. Each seed has a terminal pappus of white bristles that facilitates dispersal by wind or on the hair of animals. In south -west India, flowering starts in August and continues up to January. Fruiting season is between September and February, initiates 17 - 21 days after flowering (Sankaran, et.al., 2001).

Reasons for concern

Mikania reduces the growth and productivity of several crop plants, plantations and forest species. Infestation by the weed in the forests of north-eastern India caused habitat homogenization, new microsite formation and a reduction in plant richness (Poudel et al., 2004). The allelopathic chemical affects the native flora. *Mikania* is one of the three worst weeds for tea in India and Indonesia and for rubber in Sri Lanka and Malaysia. Young teak suffers from its infestation. Infestations of *Mikania* make harvesting of non-wood products such as bamboo and reeds an onerous task in the Western Ghats (Sankaran et al, 2001). Crops affected by *Mikania* include banana, coconut, coffee, cocoa, cassava, pineapple, ginger and teak. Intensive weeding of *Mikania* has become necessary to reduce its effect on productivity, and this has resulted in escalation of cost of production of many crop plants (Palit, 1981). *Mikania* infestation in natural moist deciduous forests has affected the livelihood of tribal community in Vazhachal forests in

Kerala. It was possible to collect six bundles of reed (one bundle consisted of 20 numbers) in one day before the infestation of mikania but after infestation they are able to collect only three or four bundles in a day due to twining and creeping habit of the weed on natural growth of reeds.

Success of invasion. A single stalk of *Mikania* can produce 20,000–40,000 mature seeds in one season. The growth of young plants is extremely fast (highest could be 8–9 cm in 24 hours), and using trees as supports, the weed rapidly forms a dense cover. *Mikania* can produce roots from each node and it thus helps easy vegetative propagation. The plant produces phenolic and flavonoids compounds that can kill or retard growth of competitors. The stolons of *Mikania* enable the plant to spread rapidly in young fallows and place it at high levels in the canopy through rapid vertical growth. Since fire is a common phenomenon in slash-and-burn agriculture, it seems that the weeds follow fire-burnt plots because of its tolerance to fire (Murphy et al., 2013; Subedi et.al., 2012).

Management Interventions

The Global Invasive Species Database compiled by the IUCN/SSC Invasive Species Specialist Group provides the following management information on this species,

Biological: A number of very promising (and probably specific) natural enemies are known in Central and South America. Of these, a thrips, *Liothrips mikaniae* appears to be specific and to have considerable potential as a biological control organism (Waterhouse, 1997). *Liothrips mikaniae* was introduced into the Solomon Islands in 1988, but it failed to establish. Fungal pathogens have also been investigated in India for use in potential biological control methods. As part of an integrated approach to controlling *Mikania* in Kerala, a number of fungal pathogens were tried. Only *Myrothecium roridum*, *Corynespora cassiicola*, *Ascochyata* sp. and *Phoma* sp. produced symptoms on both unwounded and wounded leaves. However, none of them caused any serious damage to the host. Their virulence may be low because they have not co-evolved with *Mikania* (Ellison, 2001). A world list of 55 fungal pathogens was prepared based on Barreto and Evans (1995). However, most of the aggressive pathogens are restricted to the native range of the weed (Neotropics). Classical biological control using insects started in 1987 (Cock, 1982) in the Solomon Islands and west Malaysia. In the Western Ghats, none of the insects used for bio-control caused any damage to *Mikania*.

According to Sankaran and Suresh (2013), a rust fungus, *Puccinia spegazzinii*, which attacks the weed in its native range, was imported to India after completing host specificity tests in CABI, U.K. Studies conducted in India showed that the fungus is specific to *Mikania micrantha* and is highly damaging to the plant (infecting leaf, petiole and stem leading to cankering and death) and has a broad environmental tolerance. The pathogen was released in Assam and Kerala in 2005-2006. The releases were successful in the sense that the rust had spread to the large span of mikania distribution at all sites within one week of release. However, the rust could not persist on the field population of mikania beyond 3-4 months especially when the environmental conditions at the release sites became unsuitable (high temperature and low humidity) for disease spread. Low inoculum load and inappropriate time of release are considered to be the main reasons for failure in survival of the rust in the field. However, successful control of mikania using *P. spegazzinii* has been reported from Papua New Guinea and Fiji and trials are underway to release the fungus in Guam and Northern Mariana Islands (Day *et al.*, 2011b; Day *et al.*, 2013; Univ. of Guam, 2012).

Chemical. Controlling *Mikania* is difficult because of its high output of viable seeds and vigorous asexual reproduction. Spraying a combination of the herbicides triclopyr and picloram (1.75 l per hectare) was tried. This yielded good results as the biomass of the weed decreased by 95% in one month. Similarly, application of glyphosate at the rate of 2.5 - 5 liters per hectare is also effective (Sankaran and Pandalai, 2004). These herbicides are relatively less toxic and degrade easily in soil (Ellison, 2001).

Physical removal: In one study, it was found that complete weeding (uprooting and removal) was effective in reed growing areas and forest plantations. As the economics of forest dependent communities was affected by mikania infestation, encouraging local communities in the eradication of *Mikania micrantha* was thought to be considered as an option (Sankaran *et al.*, 2001). Rai and Subedi (2012) have used fire and manual removal at Chitwan National Park, Nepal.

Parthenium hysterophorus in India

Current distribution and status of species

Parthenium hysterophorus (hereafter Parthenium), commonly known as ‘Congress weed’ or Gajar ghas, (Family Compositae) is an erect herb attaining a height of upto 150 cm. Leaves finely lobed. Young plants form a basal rosette of leaves that are up to 30cm in length. An average plant can produce 15,000 seeds and large plants are known to produce 100,000 seeds. Seeds are dispersed by wind, water runoff, transport of grains and vegetables, garden waste etc. Germination temperatures for Parthenium occur between the 8 to 30° C range with the optimum germination temperature being 22 to 25° C. Seed of Parthenium remain viable for 20 years (Parsons & Cuthbertson, 2001).

Parthenium is native to the tropical and sub-tropical regions of Mexico, Central and South America. It probably entered India before 1910 (through contaminated cereal grain), but went unrecorded until 1956. It was first recorded as weed near Pune in Maharashtra State in 1951. By 1972 it had spread into the majority of the western states from Kashmir to Kerala. It is presently distributed almost throughout the subcontinent and occupies over 5 million ha of land in the country. The impact of this weed in the Indian subcontinent has been summarized by Parsons and Cuthbertson (2001). This study highlighted the need of using different bio-control agents for managing Parthenium in the agricultural areas, it also emphasized on early eradication of the seedlings before the species flowers.

Reasons for concern

Impacts: Colonization of stream and ditch banks, open areas and fallow fields by this aggressive species leads to loss of natural habitats, loss in forage production and decline in biodiversity. Once this species takes over in an area, native grass and herbs cannot compete for light and nutrients. Parthenium was reported to cause a yield loss of up to 40% in several crops (Khosla & Sobti, 1980) and a reduction in forage production of up to 90% (Nath, 1981). It is toxic to livestock (Tudor et.al.,1982). It is considered to be one of the greatest source of dermatitis, asthma and nasal, dermal and naso-bronchial diseases. Parthenium toxicity in buffalo calves was

reported to cause the onset of diarrhoea, anorexia, pruritus, alopecia, dermatitis, etc. (Kadhane et al., 1992).

Success of invasion. This species has ability to flower twice in a year producing enormous quantity of seeds which germinate very fast. Seed dispersal is through wind, water, animals as well as vehicles. These are the primary reasons for its successful invisibility.

Management Interventions

Chemical control. A vast array of herbicides including 2,4-D, glyphosate, MSMA (monosodium methanearsonate), bromacil, atrazine, paraquat, diquat, sodium chloride and many other such chemicals are in use against *Parthenium* especially in agricultural fields (Krishnamurthy et al., 1977). However, chemical control is not advisable anymore.

Mechanical removal: Ploughing the weed infested fields before the plants reach the flowering stage and then sowing seeds of desired forage / food grain may be effective.

Bio-control The Mexican beetle *Zygogramma bicolorata* Pallister was imported into India after confirming its host-specificity (Jayanth & Nagarkatti, 1987). The beetle has been reported to disperse over more than 2,00,000 km² in Karnataka, Tamil Nadu and Andhra Pradesh and in Jammu, Punjab, Haryana and Madhya Pradesh (Jayanth et al., 1997). This beetle has recently been reported to feed on sunflower (Chakravarthy & Bhat, 1994). Other bio-control insects are *Glomerella cingulata*, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Fusarium pallidoroseum*, *Bremia domingensis*, *Erysiphe cichoracearum* var. *cichocearu*, *A. protenta*, *A. zinnia*, *Cercospora parthenii*, *Entyloma compositarum*. These insects infest parts of *P. hysterophorus* or the entire plant.

STATUS OF AQUATIC INVASIVE SPECIES IN INDIA

Aquatic ecosystems of India have suffered from intense human intervention that resulted in habitat degradation and habitat loss. As a consequence many fresh water fish species have become heavily endangered, particular in inland aquatic systems. This was coupled with irreversible changes in natural population by introduction of invasive species in order to improve aquaculture production. During last 100 years or so, several exotic aquatic species have been brought to India for experimental studies and many of them have been introduced into inland water bodies for improving fisheries production, promote recreational fishing, control pests etc. There were about 324 fish species have been introduced in India, which includes 291 ornamental fishes, 31 cultivable fishes and 2 larvicidal fishes (Mandal 2011). Among these invasive species, brown trout (*Salmo trutto*), rainbow trout (*Oncorhynchus mykiss*), Common carp (*Cyprinus carpio*), Mozambique tilapia (*Oreochromis mossambucus*) and Mosquito fish (*Gambusia affinis*) were also listed as worst invasive fish species in the world (Lowe et al. 2000). In addition to that the presence of African cat fish, *Calarias guirepinus* and Pacu-Piranha in Indian river systems is another setback for fish conservation in India (Krishnakumar *et al.*, 2011; Johnson *et al.*, 2014). A general plan and guidelines have been developed to regulate fish introduction in India by National Bureau of Fish Genetic Resources (Lakra *et al.*, 2006), but it is not properly implemented by neither by Fisheries Department nor by fish farmers. Similarly several exotic species have been introduced in marine water. In addition to that maritime trade has also been identified as an important factor for spread of marine invasive species through the ballast water. There exists limited understanding on marine invasive species, their distribution, probable impacts on marine ecosystem functioning in India. One of such worst invasive marine species is *Kappaphycus*, a sea alga wildy cultured species in south Indian coast. In this section, we are highlighting the status, issue and different management intervention adopted to manage three important freshwater invasive species (namely, *Calarias guirepinus*, *Oreochromis mossambucus* and *Salmo trutto fario* and a major marine invasive species *Kappaphycus*.

Calarias guirepinus (African catfish) in India

Current distribution and legal status of species

Calarias guirepinus is native to Africa, most of Pan-Africa, except the upper and lower Guinea and the Cape Province and widely introduced in other parts of Africa, Europe and Asia, established itself in the wild in many countries, often outcompeting local species and several countries report adverse ecological impact after introduction (fishbase.org; Krishnakumar *et al.*, 2011). Adults mainly live in quiet waters, lakes and ponds and prefer shallow and swampy area of the water bodies (Seegers, 2008).

In India, *Calarias guirepinus* was brought from Bangladesh and cultured initially in many parts of the country (Thakur 1998). It is believed that the first consignment of this catfish was brought from Bangladesh through Andhra Pradesh and reached southern India in early 1994 (Middendorp, 1998; Krishnakumar *et al.*, 2011). Throughout India this species has been cultured in inland waters and it also entered into rivers like Cauvery, Yamuna and Ganga (Singh and Lakra, 2011). Recently, it was reported that the African catfish *Calarias guirepinus*, are spreading rapidly across various drainages in Western Ghats and natural water bodies of Rajasthan (Krishnakumar *et al.*, 2011; Anoop *et al.*, 2009).

Reasons for concern

Impacts. As it is a predatory fish, it preys on many native species. Recent reports indicate, even it preys on small terrestrial birds, aquatic birds and turtles in Bharatpur National Park, Rajasthan (Anoop *et al.*, 2009). Further, it grows very faster than native carps and has high rate of reproductive success. Decline and localized extinction of native fish diversity by predatory behaviour of African catfish have been well reported in many countries, including India (Rabin *et al.*, 1991; Krishnakumar *et al.*, 2011; Anoop *et al.*, 2009). It is also observed that presence of African Catfish in Periyar Lake in Kerala, has drastically reduced many native and endemic fishes (*Lepidopygopsis typus*, *Nemacheilus menoni*, *Crossocheilus periyarensis*, *Hypselobarbus periyarensis*, *Garra periyarensis*, *Nemacheilus periyarensis*) of Periyar Lake (Periyar Foundation, 2006; Sudhi, 2009).

Success of invasion. Highly tolerant to extreme environmental condition, bears an accessory respiratory organ, which enable this species survive in oxygen depleted condition (de Moor and Bruton, 1988). Omnivorous in feeding habits, feeds largely of fish, insects and crustaceans, known to attack healthy animals and also influences distribution and feeding of other fish, even large water birds and terrestrial birds (Teugels, 1986; Anoop *et al.*, 2009). It can easily crawl over ground and reach nearby water bodies, especially during monsoon, this behaviour can lead to escape of culture stock into natural water bodies.

Management Interventions

The National Committee constituted under the chairmanship of the Joint Secretary (Fisheries), Government of India, to oversee and regulate the introduction of exotic aquatic organisms in Indian waters, at its first meeting on December 19, 1997, had directed State governments and Union Territories to 'take immediate steps to destroy the existing stocks of exotic African catfish and big head fish which had been introduced without official sanction in the country' (The Hindu, 2014). Though, this species has been banned for aquaculture, culturing of this species is going on every local and corner of the country. So far no management intervention has been implemented for removal and further extension of aquatic invasive species in natural habitat like rivers and lakes. Few attempts have been taken to remove this species manually from Bharatpur National Park in Rajasthan and Periyar Lake in Kerala, but there is no long time solution. The major intervention needed, is to raise public awareness towards the impact of this on native aquatic biodiversity.

Oreochromis mossambicus (Mozambique tilapia) in India

Current distribution and legal status of species

Adult *Oreochromis mossambicus* inhabits reservoirs, river, creeks, swamps, tidal creeks, estuaries and coastal lakes (Blaber, 1997; Allen et al., 2002). This species has origin in East Africa, distributed in Lower Zambezi river and coastal plains from Zambezi delta to Algoa Bay. Occurs southwards to the Brak River and in the Transvaal in the Limpopo system in South Africa (de Moor and Bruton, 1988). Widely introduced for aquaculture, but established itself in the wild in many countries, often outcompeting local species and several countries report adverse ecological impact after introduction (Kottelat and Whitten, 1996).

In India, Mozambique tilapia was introduced in south Indian reservoirs in 1952 to improve reservoir fishery production (De Silva et al. 2004). Now it has been well established in rivers, canals, irrigation tanks and even inside the protected areas like Moyar river in Mudumalai, Periyar lake in Periyar Tiger Reserve, Thenmala river in Senthurani Wildlife Sanctuary, Papikondan National Park (Godavari river) and Coringa Wildlife Sanctuary in southern India.

Reasons for concern

Impacts. Since it is a hardy and well adopted species, it competes with native fishes by occupying their ecological niches. It also interfere feeding and breeding habitat of many native species by making sand nest on the ground. Decline and localized extinction of native fish diversity by competitive nature of Mozambique tilapia have been well reported in South America, Australia, Sri Lanka and India (Starling et al. 2002; Attayde et al. 2011; Dupe & Burrows 2008; Pethiyagoda 1994).

Success of invasion. They can able to survey extreme reduction of dissolved oxygen, adopted to take atmospheric oxygen, tolerate high water temperature and wide range of salinity (de Moor and Bruton, 1988). Omnivorous in feeding habits, feed mostly algae, detritus, worms, insects larvae, shrimps etc., large individuals are reported to prey on small fishes (de Moor and Bruton, 1988; Skelton, 1993). It grows and reproduces in fresh, brackish and even in seawaters. It attains sexual maturity at 15 cm length, but stunted fish may breed at 6-7 cm at an age of over 2 months. Fecundity is high, female deposits 100 – 1700 eggs and well developed parental care mechanism.

Female collect fertilized eggs into mouth and fry catches from the mouth (Allen *et al.*, 2002; Lampoj, 2004).

Management Interventions

So far no management intervention has been implemented for removal and further extension of aquatic invasive species in Indian waters. The major intervention needed, is to raise public awareness towards the impact of *Tilapia* on native aquatic biodiversity. Ground level intervention also requires eradicating this pest fish, especially inside the Protected Areas. It is also necessary to establish a database on the distribution of pest species in the wild.

Salmo trutta fario (Brown trout) in India

Current distribution and legal status of species

Native of Europe, distributed from Spain to Chosha Bay in Russia, Iceland and northernmost rivers of Great Britain and Scandinavia (www.fishbase.org). It was introduced in many parts of the world including India and Pakistan. Although this species is well known for its utility in angling sports, it is now considered as one of worst invasive species in the river wherever it got introduced (Lowe *et al.*, 2000). Brown trout was introduced in head waters of Himalayan rivers and coldwater lakes in Nilgiri from 1899 and 1901 for recreational purpose as well as for food (Talwar and Jhningran, 1991). Well functional trout hatcheries were established by State Fisheries Department of Jammu & Kashmir, Himachal and Uttarakhand to produce seeds for stocking. Currently this species has been established in streams/ rivers of Indus, Yamuna and Ganga (Rajvenshi, 2012)

Reasons for concern

Impacts. Being a carnivore, it is known to survive on fry and juveniles of native fish species. Wherever this species introduced, the native snow trout population in Himalayan water has been declined.

Success of invasion. Thrive well in cold waters, range extension increased in Himalayan rivers. Recent report says, it is recorded in Bhagirathi river till Harsil, Pidar river and Ashi Ganga (Rajvenshi, 2012). It breeds in streams and rivers of Himalayas, even in high altitude lake habitats. In addition to that the State Fisheries Departments have periodically been stocking this species in Himalayan waters as part of promoting Trout fishery.

Management Interventions

So far no management intervention has been made to eradicate or stop the introduction of Brown trout in Indian waters. As Trout fishery and Angling sports are very popular in many Hill states, no active management intervention has been thought.

Marine invasive species: *Kappaphycus alvarezii* in India

Current distribution and status of species

Kappaphycus alvarezii is a marine brown algae (Rhodophyta: Solieriaceae), native of Creagh Reef, Malaysia. Growing attached to calcareous solid materials of detrital origin near the channel west of Karindingan Island on Creagh Reef. It also has distribution records in Philippines, Taiwan and Indonesia (Silva et al., 1996). This alga grows to two meters long and is brown or yellow in color (It is one of many seaweeds being intentionally introduced for the production of kappa carrageenan worldwide. The culture of *Kappaphycus* was initiated in the Philippines during 1960s with local varieties of its wild populations Since then, countries like Japan, Indonesia, Tanzania, Fiji, Kiripati, Hawaii and South Africa have been cultivating this species on a large scale (Johnson and Gopakumar, 2011).

In India, this alga was introduced in open sea in confined condition – employing net bag techniques initially in Gujarat coast and later in Mandapam, Tamil Nadu coast during 1995–1997. Late bamboo raft technique was emerged as most suitable commercial farming. At present, commercial cultivation of *Kappaphycus* is carried out in five coastal districts of Tamil Nadu namely Ramanathapuram, Pudukottai, Thoothukudi, Thanjavur and Kanyakumari (Johnson and Gopakumar, 2011). Now this species has been reported as one of the invasive species in India and other countries (Conklin et al., 2005; Periera and Verlecar, 2005; Anon, 2008; Bagla, 2008; Chandrasekaran et al., 2008; Kamalakannan et al., 2010).

Reasons for concern

Impacts. Being fast growth and vegetative propagation potential, *Kappaphycus* poses major threats to coral reefs. The vegetative part of this species easily attached with coral and start growing on coral reefs. This overgrowing on reef habitats leads to killing corals and bleaching (Conklin et al., 2005).

Success of invasion. It is very fast-growing, known to double its biomass in 15 days (Conklin et al., 2005). *Kappaphycus* is posing sever threat to reefs in Gulf of Mannar, because the vegetative propagules are the primary means of reproduction, which is easily attach and grow

over any hard substratum. As forming of this species has been practiced in Palk Pay region of Ramanathapuram and Tuticorin coasts, during wind and tidal force the vegetative propagules are entering in to the Gulf of Mannar National Park and it started growing on coral reefs. Several studies have confirmed the impact of this species on coral reef ecosystem (Conklin et al., 2005; Anon, 2008; Bagla, 2008; Chandrasekaran et al., 2008; Kamalakannan et al., 2010).

Management Interventions

The commercial cultivation of *Kappaphycus* in India was strongly opposed due to the prediction of its likely invasiveness, as it is exotic to Indian marine environments. However, some environmental impact assessments showed no harmful effects from this alga (Tewari 2006) and thus the cultivation of this species initiated in Indian water by the leading Fisheries Institution in Palk Pay. Later many studies had had found out occurrence of this species in live corals in Kurusadai Island of the Gulf of Mannar National Park and subsequently the invasion of *Kappaphycus* on corals were reported (Anon, 2008; Bagla, 2008; Chandrasekaran et al., 2008; Kamalakannan et al., 2010). Control of *Kappaphycus* in invaded communities has been carried out by either physical method. An underwater vacuuming system, Super Sucker, has been used as a physical method to eradicate *Kappaphycus* in Hawaii Bay and also, native collector urchins (*Tripneustes gratilla*) were used to control *Kappaphycus*, which clear them through grazing (Conklin et al., 2005). However, in Kurusadai Island, the Forest Department adopted manual removal method, but the success rate was very less.

Proceedings of
“Human-Wildlife Interactions
and Management of Invasive
Species”

DAY 1

TECHNICAL SESSION

HUMAN-CARNIVORE

Chair: Sh. Vinod Rishi

Co-Chair: Dr. Vinay Sinha

Sh. Vinod Rishi, Former Additional Director General of Forests, highlighted the need to study the often less-explored human aspect of human- wildlife interaction. Sh. Rishi emphasized the need to estimate the social carrying capacity of a landscape harboring large carnivores. He mentioned the need for dynamic strategies to incorporate temporal changes in the attitude of local people sharing resources with wild animals.

Sh. A.K. Singh, Chief Wildlife Warden from the Jammu and Kashmir Forest Department, shared a news clip about a recent experiment with a metallic suit that can be used by members of rescue team during wildlife rescue operation to prevent injuries to humans. He discussed the efforts of the Jammu and Kashmir Forest Department to bring down the level of the human-bear and human-leopard conflict. Adopted strategies by the Jammu and Kashmir Forest Department such as forming a conflict- control room, working with media and NGOs to create public awareness and providing immediate compensation to victims have resulted in a decline of the number of conflict cases.

Dr. Vidya Athreya, Senior Scientist, Wildlife Conservation Society, indicated that the cultural tolerance of Indian society could be one of the reasons for the country retaining a large proportion of the world's carnivore species despite high human density. She touched upon the serious issue of the presence of wild animals in human use landscapes and increasing conflicts due to ill-informed translocation. According to Dr. Athreya, there exists a huge knowledge gap regarding wildlife in human use areas, and to reduce conflict, it is important to find answers for the following important questions through research and dialogue among stakeholders: (1) requirement to better understand ecology of wildlife outside Protected Areas (2) the role of compensation in increasing human tolerance towards damage caused by wildlife, (3) the role of traditional knowledge, (4) the use of social sciences to understand the human dimension of the problem and (5) adequate information sharing and co-operation among all the stakeholders for resolving conflict

Dr. Vinay Sinha, Additional Principal Chief Conservator of Forests, Maharashtra, commended Dr. Athreya's work and suggested developing site-specific mitigation measures.

Questions and Suggestions:

Dr. R.N. Mehrotra suggested that the capacity of the forest staff be built for handling of conflict situations better and that well-equipped rapid response teams be formed. *Ex-gratia* and other compensations emerged as the important mitigation measures. Dr. R.N. Mehrotra mentioned about the judicious utilization of the CAMPA (Compensatory Afforestation *Fund* Management and Planning Authority) fund for compensation and Dr. R.B.S Rawat proposed an idea of allocating compensation money through centrally sponsored schemes of the MoEFCC. Sh. S.K. Mukharjee emphasized the importance of a fair and transparent compensation process with mandatory validation of damage. Dr. Ruchi Badola mentioned the importance of social and psychological compensation in addition to monetary compensation. Mr. Raisaily expressed his concerns about the carnivore-attack-proof suit, which might injure animals (canine loss), disabling them and preventing them from hunting wild prey.

DAY 2

WORKING GROUP DISCUSSION

Reducing negative interactions while increasing positive interactions with carnivores was identified as the way forward for mitigating the human–carnivore conflict. Considering the urgent need to address the increasing conflict due to a few species, the working group decided to rank the carnivores on the bases of the distribution and magnitude of the conflict. One important suggestion came from the group regarding the criteria for valuation of a conflict's magnitude. According to these criteria, a species involved in human deaths should be given a high conflict value compared with one causing livestock depredation. The group came up with a list of nine species (group of species) for which negative human–wildlife interaction should be minimized: (1) leopard, (2) Asiatic black bear and sloth bear, (3) tiger, (4) lion, (5) wolf, (6) snow leopard, (7) wild dog and hyaena, (8) jackal and (9) other small carnivores. Mitigation strategies adopted to address the conflict due to a particular species could help other cohabiting carnivores as well. Mitigation practices were identified by the group for the top three carnivores (Table 1).

Ex-gratia, an important yet somewhat controversial, management practice was discussed exhaustively during the session. The group had a brainstorming session on two important issues that need to be addressed to strengthen the *ex- gratia* payment process: (1) the inequality in compensation money across various states and (2) the lack of quantification of ‘lost opportunity cost’ (opportunity to earn in the years to come from livestock that had been preyed upon, had these animals not been killed). According to the group, compensation can be strengthened by addressing these two limitations. Research findings of Y. V. Jhala and Kausik Banerjee (WII) also support the economic compensation that could minimize the negative attitude of local communities towards wildlife damage. For further strengthening the compensation, Ruchi Badola (WII) suggested on incorporating the social compensation in addition to economic one. S. S. Bist (WII) elaborated on the alternatives of economic compensation through subsidies for growing alternative crops, insurance for life and property, support for setting up wildlife-proof barriers, categorizing wildlife-depredation as ‘natural calamity’ and compensation by district administration. It was realized that the conflict mitigation guidelines and standard operating procedures (SOPs) formulated should be species- and site-specific to account for the immense diversity in economic status, tolerance levels and attitudes of local inhabitants towards wild animals. Experts in the working group quoted various studies and their personal experiences with the use of simple measures (barrier construction, improvement of infrastructure to safeguard livestock and humans) to effectively reduce negative human–wildlife interactions. The first step of the road map prepared by the group for alleviation of negative interactions was prioritizing sites on the basis of conflict level. The second step is the identification of stakeholders and their involvement at all stages of mitigation and management. Next steps are promotion of inter-agency co-operation and advising the media to play a positive role in educating and sensitizing the public. A special task force should be formed and sustained using appropriate funds (from CAMPA or corpus bodies) to deal with emergency situations. Most importantly, perpetuating thoughts about conservation is an important step for reducing negative interactions.

Table 1. Mitigation strategies for reducing the negative interaction for the selected carnivores

Mitigation measures	Leopard	Bear	Tiger
Awareness (do's and don'ts)	✓	✓	✓
Better livestock husbandry practices and other proactive measures of reducing losses	✓		✓
Using precautionary measures	✓	✓	✓
Research (Identify gaps) in both ecological and human dimensions aspects.	✓	✓	✓
Compensation	✓	✓	✓
Habitat management	✓		✓
Prevention of unnecessary translocation	✓	✓	✓
Management of free ranging dogs	✓		
NTFP collection	✓	✓	✓
Change in cropping patterns	✓		✓

DAY 1

TECHNICAL SESSION

HUMAN-HERBIVORE INTERACTIONS

Chair: Sh. Anmol Kumar

Co-chair: Dr. A. J. T. Johnsingh

Sh. Anmol Kumar, Director General, Forest Survey of India, raised important questions regarding the cause of conflict and strategies of management. He emphasized the importance of wildlife-friendly developmental activities around protected areas and an urgent reconsideration of policies and acts for better management of certain species influenced in conflicts and of the compensation schemes across the country.

Dr. N.V.K. Ashraf, an expert from the Wildlife Trust of India, highlighted the five aspects of mitigation strategies: (1) understanding the dynamics of the conflict, (2) controlling damage, (3) providing *ex gratia* payments and compensation, (4) management of conflict animal and (5) defining the roles of stakeholders. Dr. Ashraf mentioned the differences in the tolerance levels of local communities towards wild animals and the changes in their attitudes with time. He underscored the need to form dedicated conflict management teams and work constantly on building the capacity of forest department personnel to improve the management of conflict cases.

Dr. A. J.T. Johnsingh, an eminent scientist and former Dean of Wildlife Institute of India, provided the species-specific account of the various herbivores involved in conflicts and their current population status. Dr. Johnsingh pointed out towards the degrading quality of the various large herbivore's habitat due to anthropogenic pressure and due to invasion of exotic inedible species such as *Lantana camara* that leading to straying out of wild animals. According to him carrying capacity of an area should be taken into consideration in making decision for maintaining the numbers of mega-herbivores

Dr. S.P. Goyal, senior scientist from Wildlife Institute of India, discussed the need for more specific information on the spatial and temporal locations of human-wildlife interactions to find site-specific solutions. He also mentioned the need to improve and restore habitats in protected areas to minimize the number of conflict cases.

Sh. Qamar Qureshi, senior scientist from Wildlife Institute of India, explained the role of changing land-use patterns and the increases resources in post green revolution period as the casues of increase in the population sizes of a few herbivore species, such as the nilgai, wild ass and blackbuck, in India. He also pointed out the drawbacks associated with the use of translocation as a mitigation tool. This has resulted in mortality of the concerned individual/population and transferred the problem to other areas. Any attempt of translocation should be done with the proper strategy and planning.

Questions and Suggestion:

Suggestion were provided by the experts on the idea of amending the policies and acts, after which the session was opened for discussion. One of the suggestions from Dr. Jhala was to adopt a precautionary approach and use scientific information relating to a species while deciding its placement in Wildlife (Protection) Act schedules. Sh. R.N. Mehrotra cautioned the house about taking any hasty decisions regarding modification of the existing policies. Dr. R.B.S Rawat raised concerns about the issue of crop-depredation by wild animals, which has resulted in farmers abandoning cultivation, especially in the higher Himalaya. He also requested Wildlife Institute of India to develop relevant projects that could help to formulate SOPs and guidelines to address conflict issues. The use of lethal control to curb some overabundant wild animals such as the nilgai and macaque was also discussed. Mr. Satpal Dhiman, DFO, Himachal Forest Department, pointed out that in the absence of any sound ecological backing, such measures have faced strong opposition.

DAY 2

WORKING GROUP SESSION

Using the criteria of distribution, magnitude of conflict and involvement in human mortality, this group identified two sets of species: (1) major conflict species and (2) moderate conflict species. The elephant, wild pig, blackbuck and nilgai were categorized in the first group, and the wild ass, chinkara and gaur were placed in the second group. Experts, researchers and students identified the states facing high levels of conflict due to selected herbivore species and then jointly prepared species-specific mitigation and management strategies. A number of traditional and mitigation measures used to keep the animals away from human habitations and crop lands were

discussed. It was realized that traditional preventive measures such as night vigils, the use of noise (drums, fire crackers, etc.) and erecting barriers (electric fencing, concrete walls, chilli fencing and bee hives near crop lands) could help reduce damage caused by wild animals considerably. Long-term mitigation measures such as habitat restoration, invasive species management and corridor management were also thoroughly discussed. The group also touched upon the important dimension of negative impacts on wild animals due to humans. The increasing elephant mortality due to speeding trains is one example. The group suggested that installing sensor networks to inform train drivers about the presence of elephants near railway tracks or altering the routes of trains near forests or important corridors would bring down the mortality rate. According to the group, crop insurance or providing incentives to farmers, especially in areas with high levels of conflict, could help in increasing the tolerance of local communities towards damage caused by wildlife. Controlling the populations of overabundant species in areas with high levels of conflict as a last resort was also discussed. However, the group advised that the population status of the species in question be ascertained to avoid its local extirpation.

DAY 1

TECHNICAL SESSION

HUMAN-MACAQUE INTERACTIONS

Chair: Sh. R.N. Mehrotra

Co-Chair: Sh. A. K. Wahal

Sh. R.N. Mehrotra, Former PCCF & Head of Forest Force, Government of Rajasthan, mentioned about the increasing conflict in certain states due to three species of the primates namely, Hanuman langur, Rhesus and Bonnet macaque. These population are no more dependent on forest and are part of urban fauna. He further mentioned about attachment of religious sentiments of the public with primates which makes it difficult to implement population control strategies.

Sh. A.K. Wahal, Former PCCF & Head of Forest Force, Government of Arunachal Pradesh, stressed on finding the long-term solutions (i.e., social forestry) to resolve negative human-macaque interactions. He also mentioned about accounting for human-socio- religious relationship with macaque while dealing with this problem to ensure success of the implemented mitigative strategy.

Sh. S.S. Bist, discussed about the problem of solid waste management in urban areas which is one of the important reasons for increasing macaque population. Sh. Bist provided instances from Uttar Pradesh, Uttarakhand, Delhi, Himachal Pradesh and other states that are facing problems due to increasing damages to crops and attacks on humans by macaques. He gave a detailed account of the preventive and mitigative strategies used by different states as well as their success rate. He emphasized on taking help from research institutes to provide the reliable population estimates and non-governmental agencies for increasing tolerance of local communities by creating awareness about this issue.

Dr. Y. V. Jhala reiterated the availability of superabundant resources in urban areas in the form of food from dumpsters and roosting habitats on buildings and trees leading to increase in macaque population. He opined that instead of complete wipe out macaques should be managed at the levels acceptable by the society. He suggested that while using population control

measures ecological and behavioural aspects of the macaques should be taken into considerations.

Questions and Suggestions:

Sh. Satpal Dhiman shared information about the Himachal Pradesh forest department effort for macaque population control. He provided a detailed account of the sterilization technique used by the department as well as other associated important aspects. Details of the process can be found at the HPFD website (hpforest.nic.in/pages/display/monkey-sterilization-programme). High cost-involvement in establishing sterilization centers, decline in capture rate of macaque at subsequent efforts and post-release monitoring are some important facets of this strategy. Mr. Dhiman suggested that these aspects should be considered well in advance by the states which might use this strategy.

Sh. Suresh shared his observation from North-East India where only the alpha male was removed by the local community to destabilize the social structure of the troops and consequently reduces the conflict.

Participants also suggested about the use of watch dogs to reduce crop-damage by macaques and plantation of fodder trees in the buffer areas of macaque habitats.

DAY 2

WORKING GROUP DISCUSSION

During the early part of the discussion among the group members, concerns were raised about the lack of basic information about three primate species in conflict, namely Rhesus macaque, bonnet macaque and Hanuman Langur. Group members decided that population estimation should be the first step in resolving the increasing human-macaque interaction. Depending on conflict level and dependency on the human habitation primate populations can be categorized in three groups 1) commensal 2) non-commensal and 3) semi-commensal. All these populations in wilderness as well as in human-dominated landscape should be estimated separately. The stakeholders were identified to assist in conflict mitigation based on the population categories of

macaques like highway stakeholder, rural/cropland, urban/semi-urban, temple monuments/tourist spots and forest area

Prevention of crop damages by deterrence (trained dogs, fire cracker, catapults etc.) and revival of traditional knowledge were stressed to be the very important procedure for addressing macaque –human conflict mitigation.

For managing the increasing negative interaction between human and macaques, group discussed about population control method adopted by Himachal Forest Department. For developing standard protocol for management, all the transitional steps such as capturing techniques, transportation and post monitoring of sterilized animal etc. were discussed. Group also emphasized on the efficacy evaluation of anti-fertility drugs for population control (pZP).

Group discussed about the nitty-gritties of the legislation for declaring the species as a vermin and controlling the population growth by legal ban on feeding of macaques.

The research and advisory group was decided to include following agencies: WII - Nodal Agency, Forest department (PCCF & CWLW), National and international NGOs, Experts – scientist/veterinarian/ex forester, ICAR, IVRI and representative of universities and institutes, NEERI. Whereas the implementing agencies were Ministry of Environment, Forest & Climate change, State forest Department, Local bodies (panchayats, municipalities, resident welfare association, etc.), other stakeholders (Temple authority, tourism Deptt.), Veterinary Department and Agriculture & Horticulture. For carrying out the research funding agencies identified were CAMPA,EAPs, Panchayats, Corporate houses (Maharatan etc), Municipality, Government of India (MoRD) and NGOs.

Day 1

TECHNICAL SESSION

MANAGEMENT OF INVASIVE SPECIES

Chair: Dr. Srikant Chandola

Co-chair: Dr. G. S. Goraya

Dr. G.S. Goraya, Deputy Director General, Indian Council for Forestry Research and Education (ICFRE) Dehra Dun, provided details of the invasive species management efforts undertaken by Forest Department in Himachal Pradesh. He appreciated the participatory role of communities in successful management of invasive plants.

Sh. Rajiv Bhartari, Head of Ecotourism Wing, Uttarakhand Forest Department, shared the success story of *Lantana* removal in Corbett National Park under the supervision of Professor C.R. Babu, University of Delhi. He emphasized the need for immediate action for management of *Lantana*. *Lantana* affects the growth and regeneration of native plant species as well as the natural fire cycle. In addition to providing technical details of the removal method, he underscored the necessity of restoration as a subsequent step for preventing further invasion through seed bank germination.

Dr. A.J.T. Johnsingh shared his personal experience with invasive species in Mudumalai Tiger Reserve, southern India, where the present management actions are failing to manage *Lantana* and *Opuntia*. These species have deleterious impacts on the native ecosystem. Dr. Johnsingh added that it is important to understand key biological processes such as animal-mediated seed dispersal to prevent the introduction and spread of invasive plants in novel areas. He emphasized that public participation can make the management of invasive species easy and effective.

Mr. Ninad Mungi, researcher from Wildlife Institute of India, stressed the need for scientific research to answer important questions regarding biological invasions for better management. Mr. Mungi highlighted the opportunity for generating employment for efficient eradication of invasive species such as *Lantana*, which is used for making furniture, water hyacinth, which is used as fodder and a fertilizer, and *Prosopis juliflora*, which is being used for energy production.

Dr. Srikant Chandola, former Principal Chief Conservator of Forests (Wildlife) and Chief Wildlife Warden, Uttarakhand, highlighted the cases of lesser known exotic species in Uttarakhand that need immediate attention from the research community before the problem becomes unmanageable.

Questions and Suggestions:

Prof. Qamar Qureshi expressed his concerns about using bio-control agents in Indian forests without adequate field trials, which could result in invasions of additional species in the ecosystem. He also suggested that precautionary measures be taken during restoration activities to prevent the invasion of weedy and exotic species in protected areas. Dr. R.B.S. Rawat suggested that the huge amount of biomass generated as a result of management of invasive species be used for power generation and for making useful items such as furniture.

DAY 2

WORKING GROUP DISCUSSION

After an initial discussion, the group members agreed unanimously that identification of the invasive species of national concern should be the priority for reducing their spread and subsequent damage to the natural ecosystems. To fill the knowledge gap and disseminate scientific information on the invasive species scientific research, experts' opinions and web portals could be utilized. The group also suggested actions and institutions that could help address the gaps in information through research. It was reiterated that efforts should be invested in identifying invasive species in major ecosystems such as terrestrial, marine, island and freshwater ecosystems. A tentative list of the major invasive species in the above-mentioned four major ecosystems was prepared by the group during the discussion. According to the working group, the Ministry of Environment, Forest and Climate Change should, in the interest of national biosecurity, direct the agencies and departments of all the ministries involved to conduct brainstorming sessions about the issue of invasive species as it is among the objectives of the Aichi targets. The group also suggested that a task force be established for each ecosystem. The roles and potential institutes are listed in table 1. According to the discussion, a task force should be provided with clear and achievable directives. The mandate of a task force should direct it

regarding the prioritized invasive species, sites and pathways of their introduction and their movement. The mandate should direct the authorities to cease the use of management practices such as fire and biological control that are not validated through research. Important responsibilities identified for the task force were education and outreach programmes for stakeholders, training programmes for utilizing eradicated plant material, research and timely meetings with the members and stakeholders. Considering the high cost involved in achieving all the tasks, potential funding agencies were also identified by the working group. The governmental funding agencies identified were CAMPA, Green India Mission, MNREGA and DST. The group suggested that using corporate social responsibility funds could also be explored. A tentative time frame was also chalked out by the group spanning all the stages from the release of an order by the MOEFCC to the formation of task forces, identification of research priorities and other subsequent steps.

The AIS of national concern were decided for different ecosystems based on the experience and research. But further investigations regarding environmental damage caused by them have to be researched.

Terrestrial Ecosystem: *Lantana camara*, *Mikania micrantha*, *Parthenium hysterophorus*, *Prosopis juliflora* (socially important), *Leucaena leucocephala*, *Chromolaena spp.*, *Ageratum spp.*, *Cassia tora* (investigation needed), *Xanthium strumarium* and *Achatina fulica* (Giant African Snail).

Islands Ecosystem (Andaman and Nicobar): *Axis axis* (Spotted deer) and *Hoplobatrachus tigerinus* (Indian Bullfrog) (investigation needed).

Fresh water Ecosystem: *Eichhornia crassipes* (plant), *Ipomea carnea* (plant), *Tilapia* (Fish) and *Clarias gariepinus* (African Magur) (Fish).

Marine Ecosystem: *Kappaphycus alvarezii* (Sea Weed)

Table 2. Institutionalizing the invasive species (IS) management plan for different ecosystem

Targets	Potential Institutions
<ol style="list-style-type: none"> 1. Identifying status of IS of national concern for all the landscapes involved. 2. Experiment with management practices, review the standard operating procedure (SOP) and guidelines for IS management. 	Wildlife Institute of India (WII) (PA's); Indian Council of Forestry Research and Education (ICFRE), Fishery Survey of India (FSI) , The Centre for Marine Living Resources & Ecology (CMLRE),
<ol style="list-style-type: none"> 1. Review the practices and status. 2. Developing SOP for every IS of national concern 3. Develop site-specific guidelines for restoration of the native ecosystem. 4. Monitoring the restoration process and producing timely reports 	Indian Council of Forestry Research and Education (ICFRE), Forest Research Institute (FRI) , Central Institute of Freshwater Aquaculture (CIFA); ICAR ; Directorate of Weed Science Research (DWSR)
<ol style="list-style-type: none"> 1. Prioritize the areas for managing every IS based on the status developed 2. Implementing the species specific SOP's guidelines for restoring the native ecosystem 3. Allocate the funds and conduct timely audits for implementation. 4. Produce yearly report on the progress in managing IS. 	State biodiversity board (SBB), State fishery department & State Agricultural department , Minister of Water Resources, River Development and Ganga Rejuvenation
<ol style="list-style-type: none"> 1. Implement the directed management recommendations. 2. Identify means of involvement of local communities 3. Conduct patrolling to stop the harm caused to native species while managing IS. 4. Submit the report containing information about area targeted, economics, efforts, time and restoration. 	State forest department (for area under their responsibility), State revenue department (Revenue land, plantation), Coastal protection and development Advisory Committee (Marin ecosystem), State Agricultural department , State revenue department (Revenue land, plantation)
<ol style="list-style-type: none"> 1. Identify pathways of invasion 2. Make the import and export of biological material stricter and fix the norms for biological transport based on rigorous research 	Directorate of Plant Protection, Quarantine and Storage
<ol style="list-style-type: none"> 1. Promote awareness in society through outreach. 2. Workshops for reusing the extracted IS parts and promoting the economic usage of it 	NGO's, panchayat, Gram sabhas, Horticulture dept, Animal husbandry.

Chair: Sh. S. K. Mukharjee

Co-Chair: Dr. A. K. Bhardwaj

Sh. S.S. Bist provided an elaborate account of the available acts and sections in Indian legislation to handle conflict situations and problem animals. At the same time, he mentioned the challenges and gaps associated with each act, which make it difficult for the forest department to utilize them for conflict management. Sh. Bist also mentioned several facets of *ex-gratia* payments for mitigation of damages caused by wild animals. He added that subsidies for crops, livestock insurance, designating damage caused by wildlife as natural calamities and providing incentives through developmental funds should be utilized by the government as alternatives to *ex gratia* payments. He emphasized that the available policies (National Livestock Policy, National Mining Policy, National Agriculture Policy National Policy for Farmers, etc.) should be used efficiently and co-operation among the concerned departments should be improved for better management of human–wildlife interactions.

Dr. Dipankar Ghose, Director, Species Landscape Programme, WWF-India, highlighted the high tolerance level of communities and culture of conservation as being responsible for a long co-existence of humans and wildlife. Our constitution provides a right to each and every citizen to have a healthy environment, and it also provides a right to protect and improve the same. Dr. Ghose provided suggestions to be incorporated into the legal framework for improving the management of human–wildlife interactions in the country. Deployment of tracking squads, using camera traps for correctly identifying conflict individuals, providing early warning systems, forming an advisory committee consisting of representatives of all concerned stakeholders, etc. were some of the suggestions provided by Dr. Ghose. According to Dr. Ghose, wildlife conservation in India follows a protected area-centric approach. However, the degraded quality of most of protected areas is the one of the most important causes of the increasing number of conflict cases. Therefore, improving the habitat to ensure that resources are available for wildlife is the first step for ensuring the peaceful co-existence of humans and wildlife. He then mentioned the discrepancies in the *ex gratia* compensation across the country and advised that there should be one country-wide policy.

He stressed the need for conducting long-term scientific research to help policy makers formulate guidelines.

Sh. Samir Sinha, Field Director, Corbett Tiger Reserve, discussed the gaps in policies and law as well as the conflicts among multiple acts.

Sh. S.K. Mukharjee, former Director, Wildlife Institute of India, provided his views on the existing policies and action plans. Differences between the state and central government legal administration serve as a hurdle to the implantation of action plans. Like other experts, Sh. Mukharjee emphasized the role of long-term research in guiding policy makers. He suggested that premier research institutes such as Wildlife institute of India should be given charge of capacity building in the ecological research arena in the country.

Questions and Suggestions:

Dr. Abhijit Das drew the group's attention towards the serious issue of the lack of a law to deal with a Schedule-I species (the elephant) being feral and invasive on the Andaman and Nicobar Islands.

Draft Guidelines for the Management of Human-Wildlife Negative Interactions and Invasive Species

**MODEL OPERATING GUIDELINES (M.O.G.) FOR DEALING
WITH HUMAN-WILDLIFE NEGATIVE INTERACTIONS AND
ALLIED MATTERS**

DRAFT REPORT PREPARED BY

S.S. BIST, IFS (Retd)

EMERITUS SCIENTIST

Section-1

MODEL SETUP FOR MANAGEMENT OF HUMAN-WILDLIFE NEGATIVE INTERACTIONS

As envisaged in the Wildlife (Protection) Act, 1972 (WPA-1972), the Forest Department (FD) in each State* of the country has a Wildlife Wing, headed by the Chief Wildlife Warden (CWLW), for looking after all matters relating to protection and management of wildlife. But considering that Human-Wildlife Conflict (HWC) takes place largely in non-forest (rural, semi-urban and urban) landscapes; affects a large cross-section of stakeholders; involves political, social, financial, technical, legal and administrative issues; and calls for coordinated efforts by a number of agencies—a specially designed setup for effective management and monitoring of HWC is called for. The organisational requirements of a particular State may depend upon the extent and seriousness of conflict and also on the kind of wild animals involved, but by and large, a model setup can be planned on the following lines.

1. SETUP AT THE STATE LEVEL

1.1. Advisory and Monitoring Role

1.1.1. **State Board for Wildlife:** The existing State Board for Wildlife (SBWL), under the chairmanship of the Chief Minister/Administrator, should take up the advisory and monitoring role on all matters relating to HWC at the State level. The State Government may assign to the SBWL the duty of advising on matters relating to HWC in accordance with Section 8(d).

1.1.2. **Sub-Committee:** For a much vigorous monitoring of the HWC issues, the SBWL should set up a sub-committee headed by the Minister-in-Charge of the Forests and Wildlife. The sub-committee may invite to its meetings such officers, experts, scientists, representatives of the stakeholders and representatives of the major relief / philanthropic organisations as it may think necessary.

* The term 'State' is also intended to include Union Territory (U.T.) in this document.

1.1.3. The sub-committee should meet as frequently as required. In particular, it must meet before the major HWC season to take stock of the preparations. It must also meet whenever an emergency occurs.

1.1.4. The CWLW should submit an annual report on the status of HWC in the State to the SBWL.

1.2. Executive Role

1.2.1. **State Level Coordinator:** The CWLW should remain overall in-charge of HWC management in the State. But given the multifarious and demanding functions of a CWLW in most of the States, the FD may designate another forest officer of sufficient seniority (say, Additional CWLW) at the headquarters of the Wildlife Wing as the **State Level Coordinator (SLC)** for management of HWC. He should be provided with the requisite office support.

1.2.2. The name and contact address of the SLC should be duly publicised from time to time through the official channels.

1.2.3. Suggested duty-list of the State Level Coordinator

1. To ensure quick and effective communication between the CWLW and the district level forest officials dealing with HWC, particularly in respect of permission sought from the CWLW under Sections 11 and 12.
2. To coordinate with other government departments, researchers, NGOs, media and relief / philanthropic agencies at the State level.
3. To organise training / capacity building programmes relating to HWC within the State.
4. To procure darting guns and drugs for chemical immobilisation of wild animals. Also, to procure the services of chemical immobilization experts, trained elephants, hunters and trappers.
5. To maintain a list of recognised wildlife corridors in the State and ensure their protection and effectiveness.
6. To maintain records and statistics related to HWC and ex-gratia relief in the State and display / update such statistics on the website of the FD.
7. To prepare replies to parliamentary / assembly questions as well as queries from the State Government / Central Government in respect of HWC.
8. To prepare an annual report on the status of HWC in the State for submission to the SBWL (Ref. Para 1.1.4).

2. SETUP AT THE DISTRICT LEVEL

2.1. Advisory and Monitoring Role

2.1.1. District Level Advisory and Monitoring Committee: In all such districts as are sensitive from the point of view of HWC, the FD should set up District Level Advisory and Monitoring Committee (DLAMC). The DLAMC should preferably be chaired by the Minister-in-Charge of the district. It should include the District Level Coordinator (Ref. Para 2.2.1) and other territorial DFOs / PA managers within the district, District Magistrate, District Superintendent of Police, Chairperson (Sabhadhipati) of the District Board (Zila Panchayat Samity), local MPs and MLAs, Chief Medical Officer, District Veterinary Officer, District Agriculture Officer, all Honorary Wildlife Wardens in the district, non-official members of the SBWL from the district, major environmental NGOs in the district, representatives of the major stakeholder groups in the district (e.g. railways, tea / coffee planters, army, mining companies, electricity board, etc.), representatives of Joint Forest Management Committees (JFMCs), representatives of local relief / philanthropic organisations, representatives of local scientific institutes working on HWC issues, etc. The District Level Coordinator may serve as the member-convenor of the DLAMC. The DLAMC should meet as frequently as required. In particular, it must meet before the major HWC season to take stock of the preparations. It must also meet whenever an emergency occurs.

2.1.2. PA Level Advisory and Monitoring Committees: The WPA-1972 envisages establishment of Advisory Committees for Sanctuaries (S.33B) and Management Committees for Conservation Reserves (S.36B) and Community Reserves (S.36D). The Central Government has also notified Eco-sensitive Zones (ESZs) around a number of PAs and set up Monitoring Committees for each ESZ under S.3 of the Environmental (Protection) Act, 1986 (EPA-1986). The FD should actively consult and involve these Committees in all such matters as may impact HWC management in the region.

2.2. Executive Role

2.2.1. District Level Coordinator: Usually the respective territorial DFOs and PA managers manage the HWC in a district in and around their respective jurisdiction. But in districts having more than one DFO / PA manager, there may often be problems of coordination between different forest officers or between forest officers and the civil authorities and public representatives. The FD may, therefore, designate one of the forest officers in a district as the **District Level Coordinator** (DLC) for looking after matters relating to HWC in the district. It

will be advisable to appoint the senior-most forest officer present in the district as the DLC. He should be provided with the requisite office support.

2.2.2. The CWLW may, in accordance with S.5(2), delegate some or all of his powers under S. 11(1)(b) to the DLC with suitable conditions (Ref. Para 3.1).

2.2.3. The FD may authorise the DLC to requisition staff, vehicles, trained elephants, RT sets, equipment and other logistic support from various Forest Divisions (Territorial or Functional), PAs and zoological park within the district or from the adjoining districts **during any emergency relating to HWC.**¹

2.2.4. The name and contact details of the DLC should be duly publicised from time to time through official channels.

2.2.5. Suggested Duty-List of the District Level Coordinator

1. To prepare a conflict management strategy for the district on the basis of the past conflict records, in consultation with the local forest officers and the district administration, and in accordance with the guidelines given by the CWLW and the State Government.
2. To scrutinise and forward all schemes for HWC management under the Centrally Sponsored Schemes or State Plan for the district to the CWLW and oversee the implementation of the sanctioned schemes in the field.
3. To cause inquiry into death of human-beings by wild animals and submit the same to the CWLW promptly.
4. To cause inquiry into death of Schedule-I animals and submit the same to the CWLW promptly.
5. To maintain dossier of problem animals involved in human deaths/injuries in the district (Ref. Sec. 4 /Para 4.3)
6. To forward all proposals relating to translocation/ capture / elimination of problem animals specified in Sch.I to the CWLW for proclamation under S.11 (1)(a) and ensure the implementation of such a proclamation.
7. To forward all proposals relating to translocation/ capture / elimination of problem animals belonging to Sch.II/Sch.III/Sch.IV for permission to the Authorised Officer under S.11(1)(b) [or issue the permission himself if such a power has been delegated to him as suggested in Para 2.2.2. and Para 3.1] and ensure the implementation of such a permission.

¹ The PCCF (West Bengal) issued a directive in 1991 directing the staff of the non-territorial forest divisions in North Bengal to help the Wildlife Divisions in cases relating to HWC.

8. To maintain a list of recognised wildlife corridors in the district; ensure their protection and effectiveness; and submit a report on their status to the SLC on half-yearly basis.
9. To maintain records and statistics related to HWC and ex-gratia relief in the district and share the same with the SLC once in a quarter.
10. To assist the SLC in preparation of replies to parliamentary questions / assembly questions relating to HWC.
11. To prepare an annual report on the status of HWC in the district to the CWLW.
12. To deal with complaints and grievances relating to HWC management including payment of ex-gratia relief in the district.
13. To coordinate with the other government departments, researchers, NGOs, media and relief / philanthropic agencies at the district level.
14. To oversee the performance of the Anti-Depredation Squads (Ref. Para 2.4) and Honorary Wildlife Wardens (Ref. Para 2.3) in the district.
15. To appoint hunter / trapper for dealing with HWC whenever required.
16. To organise training / capacity building programmes relating to HWC within the district.
17. To convene the meetings of the DLAMC.

2.3. Honorary Wildlife Wardens

2.3.1. In all districts sensitive from the viewpoint of HWC, the State Government may, in accordance with S.4(1)(bb), appoint adequate number of Honorary Wildlife Wardens (HWLW). The HWLWs should be selected keeping in view their expertise in dealing with wild animals; their potential to control the crowd (Ref. Sec. 8 /Para 2) and help the forest staff in the field; and their capability to arrange relief for the people affected by HWC. Retired but experienced veterinarians may also be engaged as HWLWs (Ref. Para 3.2.2). It may be advisable in certain cases (e.g. for dealing with conflict with wild animals existing in non-forest areas) to designate authorities of the district administration or local bodies (Panchayat, Municipalities, etc.) as HWLWs (Ref. Paragraph 3.1.5).

2.3.2. In deserving cases, the CWLW may, in accordance with S.5(2), delegate some of his powers under S. 11(1)(b) to the HWLWs with suitable conditions (Ref. Para 3.1).

2.3.3. In deserving cases, the HWLW may be given the responsibility to supervise the Local Wildlife Squads (Ref. Para 2.5); oversee the working and maintenance of barriers, fences and other devices meant for controlling HWC; and help in verification of applications for ex-gratia relief. They will submit their reports to the DLC.

2.3.4. All the HWLWs in a district should be included in the DLAMC.

2.3.5. The name and contact details of the HWLWs should be duly publicised from time to time through official channels.

2.4. Anti-Depredation Squad²

2.4.1. The FD should set up an Anti-Depredation Squad (ADS) in each district having HWC. The ADS should act like fire brigade to rush to the problem spots and help the people. More than one ADS may be set up in a district depending upon its area, geographical distribution of conflict areas and seriousness of conflict. In many cases, it may be sufficient to have one permanent ADS and set up a few temporary ADS during the major conflict seasons (e.g. crop-harvesting season, elephant- migratory season, etc.) or during an emergency by pooling up staff and resources from various forest divisions.

2.4.2. The ADS should be headed by a Forest Ranger / Senior Deputy Ranger and comprise 10-12 permanent / contractual staff with a provision for leave vacancies. The ADS may work under the administrative control of the DLC or one of the local DFOs as may be convenient.

2.4.3. **Jurisdiction:** In case of more than one ADS in a district, their jurisdiction should be fixed as clearly as possible to avoid any confusion. The headquarters of the ADS should be fixed keeping in view the major zones of conflict. The ADS should be geared up to camp within a conflict zone in emergency.

2.4.4. The contact details (address, phone / fax/ mobile number and/or email ID) and jurisdiction of the ADS should be duly publicised from time to time through the official channels.

2.4.5. **Tools and Equipment:** The ADS should be properly equipped keeping in view the kind of wild animals likely to be faced, nature of depredation, and the terrain.

2.4.5.1. The NTCA's SOP (2013) has recommended the following tools / equipment for ADS dealing with tigers and leopards:

² Referred to as '**Emergency Response Team**' in 'Guideline for Human-Leopard Conflict Management' (MoEFCC, 2011) and as '**Rapid Response Team**' in 'Standard Operating Procedure To Deal With Emergency Arising Due To Straying Of Tigers In Human Dominated Landscapes' (NTCA, 2013). The latter deals with tigers and leopards and was issued vide NTCA's Letter No. 15-37/2012-NTCA dated 30.1.2013.

- I. A field van/mini-truck with built in rails for accommodating a trap cage, with space for equipment, attendants and staff.
- II. A tranquilization kit with drugs for chemical immobilization.
- III. Taser gun for instant immobilization of the animal.
- IV. 2 mobile phones for continued communication with the authorities.
- V. 4 wireless handsets.
- VI. 2 GPS sets.
- VII. 1 long ranging night vision for seeing objects in the dark.
- VIII. A digital camera.
- IX. 4 trap cages (2 for tiger and 2 for leopard).
- X. 1 mini-tractor for transporting the cage in rugged terrain.
- XI. 2 search lights.
- XII. 2 radio collars with receiver and antenna.
- XIII. 2 portable tents.
- XIV. Portable hides – which can be set up fast, to be used for persons with tranquilizers
- XV. 2 folding chairs with table.
- XVI. Hand held audio system.
- XVII. Rope and net.
- XVIII. First aid kits

2.4.5.2. In certain areas (e.g. islands, mangroves etc.) or for certain species (e.g. crocodile), the ADS may need motorboat or a suitable watercraft.

2.4.5.3. The ADS should carry a stretcher for moving chemically immobilized animals.

2.4.5.4. The ADS should also carry suitable guns / rifles and sufficient stock of crackers / rocket bombs. Air guns /rubber-bullet guns are useful for dealing with monkeys and small mammals. Flare guns or light-producing bottle-rockets are useful for locating wild animals in the dark. A hooter /siren may often be useful in scaring away wild animals. Camera traps are useful for monitoring / tracking of a problem animal. A portable public address system is useful for warning people.

2.4.6. Uniform and Protective Gear: The ADS staff should be provided with special uniform to make them identifiable during the operation. The ADS staff should also carry special protective gear in case they are likely to deal with big carnivores.³

2.4.7. Insurance Cover: The FD should arrange insurance cover for each member (permanent or contractual) of the ADS against death or injury.

2.4.8. Suggested Duty List of the Anti-Depredation Squad

1. To remove the problem animals from human habitations, croplands and other sensitive areas by managing the local people, or by driving/ scaring the animal away, or by capturing/ trapping/ translocating/ eliminating the animal—in accordance with the merit of the individual case and in keeping with the provisions of law.
2. To rescue wild animals stranded in human habitations.
3. To identify wild animals indulging habitually in human-killing/ crop-raiding/ cattle-killing/ house-breaking; maintain their dossiers; and submit proposals to the DFO / DLC for hunting them under S.11(1).
4. To help the authorised hunter / trapper /chemical immobilization expert in tracking and locating the problem animals proclaimed by the CWLW / AO under S.11(1).
5. To help the victims of wildlife depredation in getting ex-gratia relief from the competent authority.
6. To provide first aid to the persons injured by wild animals and help them in receiving medical care.
7. To conduct inquiry in each case of human-death caused by a wild animal and submit a report to the DFO / DLC.
8. To conduct inquiry in each case of wild animal killed during conflict and submit a report to the DFO / DLC.
9. To supervise fences, trenches and other barriers set up to prevent HWC and inform the appropriate authority about their maintenance.
10. To oversee the status of the recognised wildlife corridors once in a quarter and submit a report to the DLC.
11. To provide training in conflict-management techniques to temporary ADS, Local Wildlife Squads (Ref. Para 2.5) and other stakeholders.

2.4.9. The CWLW may, in accordance with S.5(2), delegate some of his powers under S. 11(1)(b) for animals listed in Sch.II/Sch.III/Sch.IV to the Officer-in-Charge of the ADS with suitable conditions (Ref. Para 3.1).

³The FDs in West Bengal and Jammu & Kashmir have developed protective gears for leopards. The West Bengal FD has also developed 'human-face masks' for use by the field staff and workers entering the tiger- infested forests in the Sundarbans.

2.4.10. **Training:** All staff of the ADS should be provided with training with due regard to the suggested duty list and the tools and equipment supplied to them. They should be given basic information about the biology, nature and ecological needs of the wild animals that they are likely to handle. They should also be educated about their duties and powers under the WPA-1972 and the Prevention of Cruelty to Animals Act, 1960 (PCA-1960) and rules made thereunder.

2.5. Local Wildlife Squad⁴

2.5.1. The FD should encourage the local community in a conflict area to form Local Wildlife Squad (LWS). The purpose of a LWS is to manage minor cases of HWC (e.g. chasing and driving of wild animals or guarding of crop) or to manage the situation until the arrival of the ADS. LWS may provide necessary support to the ADS, particularly with regard to the crowd control and monitoring of problem animals. The ADS may also take help from LWS in setting up traps for capturing of problem animals and protecting them.

2.5.2. The FD should, in particular, insist upon formation of LWS in a locality before undertaking construction of a barrier (e.g. power-fencing or trench) and entrust the monitoring and maintenance of the barrier to such LWS.

2.5.3. The FD should preferably undertake the distribution of crackers, search-lights and other material in the conflict area for managing HWC through the LWS.

2.5.4. The LWS may take many shapes depending upon the local circumstances. It may consist of volunteers provided by the local JFMCs, Panchayat or a local NGO. The organised stakeholders (e.g. Tea / Coffee Estates, Public Undertakings, Companies, Army Units, Farm Houses, etc.) may be persuaded to set up LWS by engaging their own workers. In emergency situation, the FD may have to set up a LWS for a certain period by paying wages or honorarium to its members.

⁴ Referred to as 'Primary Response Team' in the MoEFCC's Guideline (2011). It finds no mention in the NTCA's SOP (2013) which, however, suggests setting up 'Monitoring Team' consisting of locals'.

2.5.5. In some cases, it may be useful to set up a Joint Wildlife Squad comprising of forest staff and local volunteers. This may, in particular, be needed while dealing with wild animals known to be human-killers—in which case some armed forest staff may be deployed with a LWS.⁵

2.5.6. The ADS should have a list of all LWSs under its jurisdiction and arrange for their training. It may oversee the selection of members of LWS. Old, sick and alcoholic persons should not be included in LWS. The ex-servicemen and the persons possessing licenced guns may be preferred if otherwise fit.

2.5.7. The FD should arrange insurance cover for each member (paid or volunteer) of the LWS against death or injury.

3. ANCILLARY MATTERS

3.1. Authorised Officers:

3.1.1. Most of the tools meant for HWC management, such as killing, capturing, tranquillising, snaring, trapping, driving, baiting etc., come under the definition of hunting and require permission from the CWLW for animals listed in Sch. I [S.11(1)(a)] and from either the CWLW or the Authorised Officer (AO) for animals covered by Sch.II /Sch.III/Sch.IV [S.11(1)(b)]. AOs may be appointed under S.5(2) which empowers the CWLW to delegate his powers under S. 11(1)(b) to any subordinate officer with the approval of the State Government. The State Governments may also appoint AOs under S.4(1)(c).

3.1.2. HWC management usually requires quick decisions in the field and it is not practical to obtain prior permission from the CWLW in each and every case, particularly for routine operations like chasing or scaring wild animal. Therefore, it is necessary to designate adequate number of AOs in the field.

3.1.3. The CWLW cannot designate AOs in respect of the animals covered by Sch.I. He may, however, grant a general permission in favour of the ADS, LWS, HWLWs, and the local forest staff for undertaking simple anti-depredation measures such as chasing and driving wild animals

⁵ The Gujarat FD has set up mixed teams of forest staff and volunteers to manage human-crocodile conflict along Vishwamitri river, Vadodara (August 2014).

from human habitations; and rescuing injured wild animals or abandoned cubs / calves found outside their natural habitats. He may also issue a general permission in favour of the DLC, local DFOs, ADS and some selected HWLWS for capturing (trapping / chemical immobilisation) of wild animals of Sch.I posing threat to human life and releasing them immediately within their home range subject to the condition that all such cases should be immediately reported to him. But no action should be taken for translocating a Sch.I animal outside its home range or putting it under permanent captivity or killing it, without a specific permission of the CWLW in writing. The cases of killing or wounding of Sch.I animal in defence of oneself or of any other persons under the provisions of S.11 (2) should also be reported to the CWLW as soon as possible.

3.1.4. The CWLW should designate adequate number of AOs for exercising powers under S.11 (1)(b) in respect of animals listed in Sch.II/Sch.III/Sch.IV. He may, grant a general permission in favour of the ADS, LWS, HWLWs, and the local forest staff for undertaking simple anti-depredation measures such as chasing and driving wild animals from human habitations; and rescuing injured wild animals or abandoned cubs / calves found outside their natural habitats. He may designate the DLC, local DFOs, Officer-in-Charge of ADS, and some selected HWLWS as AOs for permitting capture (trapping / chemical immobilisation) of problem animals and releasing them immediately within their home range. However, for decisions involving large financial or scientific implications, such as translocating a wild animal outside its home range or putting it under permanent captivity or killing it, should not be left to a junior-level officer and only the DLC or a higher-ranking forest officer should be entrusted with this responsibility. The cases of killing or wounding of animals listed in Sch.II/Sch.III/Sch.IV in defence of oneself or of any other persons under the provisions of S.11 (2) should also be reported to the DLC as soon as possible.

3.1.5. It may be advisable in certain cases (e.g. for wild animals existing in non-forest areas) to designate authorities of the district administration or local bodies (Panchayat, Municipalities, etc.) as AO. S.5(2) stipulates that the CWLW may delegate his powers only to an officer subordinate to him and subject to such conditions as he may specify. In such cases, the State Government should first appoint the authority in question as an HWLW under S.4(1)(bb) and, thereafter, the CWLW should delegate the required powers to him subject to the condition that he will endorse copies of all his orders under S.11(1)(b) to the DLC and also submit a report on the action taken on such orders as soon as possible.⁶ The State Government may also appoint

⁶ As an example, the Government of Gujarat appointed a number of village-heads (Sarpanch) as HWLWs under S. 4(1)(bb) during 2006-07 and permitted the CWLW under S. 5(2) to delegate them with powers under S.11(1)(b) for hunting Blue Bulls involved in crop-raiding.

AOs from outside the FD under S.4(1)(c).⁷ But it is important to ensure that they work under the supervisory control of the CWLW and submit regular reports to him.

3.1.6. The CWLW / SLC should review the working of the AOs from time to time and issue suitable guidelines to them. Training programmes should be organised for the AOs from outside the FD to help them understand the ecology and behaviour of wild animals involved in conflict so that they may take responsible decisions.

3.2. **Veterinary Support:**

3.2.1. Support from knowledgeable and experienced veterinarians is essential for chemical immobilization and transportation of wild animals; putting radio-collars and identification marks on them; treating sick and injured wild animals in the field and at the Rescue Centres / Transit Facilities; and screening the captured animals for zoonotic diseases before releasing them in the wild. The FD, in collaboration with the Veterinary Department, should identify the veterinarians with experience in dealing with wild animals, particularly those working in the Zoos and PAs, and make the list available to the DLCs. Suitable training programmes and refresher courses in handling wild animals should be organised for the selected veterinarians with the help of the WII, Indian Veterinary Research Institute, Kerala Agricultural University and Assam Agricultural University. Short term orientation programmes for the district veterinarians can also be arranged with the help of the experienced Zoo Veterinarians. The target should be to have at least two trained wildlife veterinarians in each district and equip them with vehicle, necessary instruments and medicines.

3.2.2. In view of the limited number of experienced and trained wildlife veterinarians in the country at present, it will be a good idea to retain the services of such veterinarians even after their superannuation on voluntary or contractual basis. Well-known wildlife veterinarians may also be engaged as HWLWs.

3.2.3. The FD should help the Veterinary Department or a Veterinary College to set up a pathological and diagnostic centre for wild animals.⁸

⁷ As an example, the Government of Uttar Pradesh has appointed District Magistrates under S.4(1)(c) as AO for exercising powers under S.11(1)(b) vide GO No. 736-14-4-94-854/92 dated 9.3.1994. This order is presently also applicable in Uttarakhand.

⁸The FD in West Bengal has established a Wildlife Diseases Investigation & Diagnostic Centre in Kolkata in collaboration with the State Animal Resources Department and the CZA.

3.2.4. The FDs in the States having chronic conflict problems on account of over-abundance of wild animals like rhesus monkeys, blue bulls, axis deer, etc. may also set up Wildlife Sterilization Centres in collaboration with the Veterinary Department or a Veterinary College.⁹

3.3. Chemical Immobilization Team

3.3.1. Chemical immobilisation has now become a *sine qua non* for managing HWC. Chemical immobilisation provides a safe, fast and the least traumatic technique for capturing and transporting problem animals; putting radio-collars and identification marks on them; and treating sick and injured wild animals. Only a few FDs and institutes (e.g. Wildlife Institute of India) in the country at present possess the experts and equipment for chemical immobilisation. These FDs and institutes may not always be in a position to spare their immobilization team for other States, particularly at a short notice. Other FDs should, therefore, also strive to set up their own chemical immobilisation teams as soon as possible. A trained veterinarian should always be a part of the immobilisation team.

3.3.2. The list of trained and experienced immobilisation experts should be available with the SLC and the DLCs. If, however, the FD does not have in-house expertise with chemical immobilisation, it may work out an understanding in advance with other FDs, NGOs or Research Organisations to provide the services of their experts as and when required. The contacts of the identified experts and the terms of their engagements should be made available to the DLCs.

3.3.3. The SLC and DLCs should have a complete list of the darting equipment, drugs and antidotes available with the FD, zoological parks, research organisations and other agencies within their jurisdiction. The equipment should be checked periodically and repaired or replaced. Additional equipment should be procured well in time. Procurement of certain drugs and antidotes is often a tedious and time-consuming exercise. Therefore, the SLC should work out the additional requirement of drugs and antidotes in consultation with the DLCs and initiate the procurement process well in advance. The equipment with drugs and antidotes should be allotted to an ADS if it has an immobilisation expert or kept in a zoo or in the custody of the DLC so that the same is readily available whenever needed. The rules and the guidelines prescribed by the Narcotics Bureau and Controller of Drugs for safety and upkeep of the drugs should be strictly followed.

3.4. Kunki Squad

⁹ The FD in Himachal Pradesh has set up a number of Monkey Sterilization Centres.

3.4.1. Trained elephants (*Kunkis*) and mahouts are very useful in dealing with a number of conflict situations involving wild elephant, tiger, leopard, gaur and rhinoceros. *Kunki* elephants are useful for:

1. Tracking, monitoring, chasing and driving of problem animals.
2. Screening of forests to locate proclaimed wild animals and injured wild animals or their carcasses.
3. Capture of wild elephants by *Mela-shikar*.
4. Training and handling of captured elephants and rescued elephant calves.
5. Assisting experts in chemical immobilisation and translocation of wild animals.
6. Assisting hunter in hunting down the proclaimed wild animal.

3.4.2. FDs of Karnataka, Tamilnadu, Madhya Pradesh, West Bengal and Assam have their own fleets of *kunki* elephants and experienced mahouts.¹⁰ These FDs may not always be in a position to spare their *kunkis* for other States, particularly at a short notice. Some FDs also hire *kunkis* from the private owners in Assam. Depending upon the level of conflict and its past experience, the FD may decide whether or not to set up a permanent *kunki* squad of its own.

3.4.3. The FD may build up a permanent *kunki* squad either by procuring surplus trained elephants from the aforesaid States or by capturing suitable wild elephants from its own forests (under S.11 or S.12 of the WPA-1972) and getting these elephants and prospective mahouts trained with the help of *kunkis* and mahouts from other States.

3.4.4. A squad comprising 4-6 number of *kunki* elephants (including two bulls) of height 8 feet and above should be sufficient for dealing with most of the cases of conflict. *Kunkis* should be trained enough to withstand the sound of gun-fire and ride into a truck so that they can be transported speedily from one problem area to another. They must not be shy of cattle or given to the habit of jerking off their riders.

3.4.5. Selection of mahout and grass-cutter for each *kunki* is very important. They should be physically fit and free from alcoholism; able to handle their elephant in different situations—particularly in the presence of big carnivores and mega-herbivores; skilled in preparing ropes and other accoutrement for their own elephant and the captured elephants; and experienced in providing at least preliminary training to the captured elephants.

¹⁰ FDs of U.P., Odisha and Kerala are presently building up their *kunki* squads. FDs of Uttarakhand and Andaman & Nicobar possess a number of domesticated elephants and mahouts which need training before being used as *kunki* squads.

3.4.6. The *kunki* squad should be camped at a place reasonably close to the potential conflict areas; having plentiful supply of fodder and running water (for bathing and drinking) and accessible to a veterinarian. It's a good idea to plant quick-growing fodder species (e.g. Ficus, Bamboo, hybrid Napier grass, etc.) in the forest offices in and around the conflict areas to take care of the feeding requirements of *kunki* elephants in emergency.

3.5. Trappers, Catchers and Hunters:

3.5.1. The FDs in some States may not have the in-house expertise for trapping and capture of certain species of wild animals (e.g. elephants, monkeys and crocodiles) and may need help from the professional trappers /catchers. The FD may also require skilled hunters having suitable weapons for tracking and killing problem animals proclaimed by the CWLW /AO under S.11(1). A skilled hunter may also be needed to provide a backup to the chemical immobilization team engaged in handling dangerous animals like tigers, leopards, elephants, etc. The SLC should complete the process of selection of trappers, catchers and hunters before the conflict season sets in instead of leaving the matter to be dealt with at the eleventh hour by the district-level officers.

3.5.2. In most of the cases, the trappers /catchers are illiterate / semi-literate and may not respond to the usual system of bidding through tenders and quotations. In such cases, the State Government may appoint and authorise a committee of officials (with representation of the Finance Department) and non-officials with relevant experience to negotiate with the known experts and finalise the deal. It may be useful to prepare a panel of approved experts instead of selecting a single expert so that there is always an alternative when the first one in the panel defaults.

3.5.3. During selection, due weightage should be given to skills, experience and past performance of the expert and his team. Persons with bad reputation should not be selected and a background check should be carried out with the local Police and the local DFO.

3.5.4. It should be ensured that the expert and his team are well-versed with the modern concepts of animal welfare and corresponding legal provisions.

3.5.5. For an operation involving driving, capturing and translocation of wild elephants, the expert may be called upon to provide services of 4-6 number of *kunki* elephants (including two bulls) of height 8 feet and above. The *kunki* elephants should be duly covered by ownership

certificate issued by a CWLW and health certificate issued by a registered veterinarian. The *kunki* elephants and their handlers should meet the requirements indicated in Paragraphs 3.4.4 and 3.4.5 above.

3.5.6. Similarly, for an operation involving driving /scaring of monkeys with the help of trained langurs, it should be ensured that the langurs are healthy and have been procured legally.

3.5.7. The hunters should not be engaged from the open market. The NTCA (2013) recommends that no award / reward should be announced for destruction of human-eating tigers / leopards and some skilled departmental personnel should be engaged for eliminating them. A similar policy may be adopted in respect of other wild animals. But the FDs often lack competent hunters or the appropriate weapons (.375 Magnum and above for tiger and leopard; and .450 and above with hard-nosed ammunition for elephants, rhinos and gaur). It is, therefore, essential to identify expert hunters possessing appropriate gun and ammunition from other sources, particularly the army and police, or from the neighbouring States.

3.5.8. The list of approved trappers, catchers and hunters should be provided to the DLCs so that they may straightway requisition their services without wasting time in formalities.

3.6. Rescue Centres and Transit Facilities:

3.6.1. Rescue Centres are required for sheltering the problem animals captured from the field or the stranded wild animals (including cubs / calves of wild animals) rescued by the ADS and LWS which cannot be released back in their natural habitats due to sickness / injury, or their habit of straying back into human habitations, or their propensity to cause harm to the life or property of the people, or their inability to survive on their own in the wild. In many cases, the captured wild animal needs to be kept temporarily at a Transit Facility temporarily for treatment or investigation, or while awaiting a decision by the competent authority about its disposal.

3.6.2. The number and location of Rescue Centres / Transit Facilities would depend upon the extent and distribution of HWC within the State and experience from the past. Ideally, the Rescue Centre / Transit Facility should be close to a conflict zone as well as a veterinary unit.

3.6.3. A Rescue Centre, by virtue of S.2(39), is a Zoo and, therefore, governed by the provisions of the Chapter IVA of the WPA-1972 and various rules and guidelines issued by the Central Zoo

Authority (CZA) from time to time. An existing Zoo in a district may be used as a Rescue Centre by adding suitable facilities to it.

3.6.4. A Transit Facility does not need any permission from the CZA, though it is advisable to follow the norms and standards prescribed by the CZA for Rescue Centres. A Transit Facility may be set up as an adjunct to an existing Zoo / Rescue Centre or an independent unit near a forest beat office or a veterinary centre. The captured wild animal should not be kept inside the trap cage for more than a week and should be shifted to a larger enclosure as per specifications fixed by the CZA.

3.6.5. Captured elephants and rescued elephant calves need special care of experienced mahouts and trained elephants. Therefore, a Rescue Centre / Transit Facility for them should either be set up close to an existing elephant camp or services of experienced mahouts and trained elephants should be requisitioned at the existing Rescue Centre / Transit Facility.

3.6.6. Some NGOs also run Rescue Centres approved by the CZA in various parts of the country specialising in the care and handling of one or more species of wild animals. The SLC / DLC may tie up with the concerned NGOs for providing help to capture and manage the animals involved in HWC.¹¹

3.6.7. The ADS and LWS should be informed well in advance about the Rescue Centre / Transit Facility where a captured wild animal has to be shifted.

3.7. Inter-State Coordination:

3.7.1. Wild animals know no state boundaries and, as a corollary, people living on two sides of the inter-state border may be suffering on account of the same animal or same group of animals. The FDs of the neighbouring States should, therefore, cooperate with each other and follow uniform policies as regards HWC management.

¹¹ For example, the Wildlife SOS-India runs rescue centres for bears at Agra (U.P.), Bannerghatta (Karnataka), Van Vihar (M.P.) and Purulia (W.B.) and for elephants at Agra (U.P.) and Yamuna Nagar (Haryana). The Wildlife Trust of India runs rescue centres for bears in Pakke Tiger Reserve (Arunachal Pradesh) and for rhinos, elephants and other wild animals in Kaziranga National Park (Assam).

3.7.2. The SLCs and DLCs of the neighbouring States should frequently interact to exchange information and sort out problems, if any. In particular, information about the human-killing animals should be shared and joint efforts should be made to track and capture / kill the same. Information should also be shared in respect of injured animals, translocated animals and those following seasonal pattern of movement (e.g. elephants). Cooperation is also needed for monitoring and protection of inter-state wildlife corridors.

3.7.3. The FDs of the neighbouring States should also organise joint training programmes for their ADS, LWS and JFMC members to boost up mutual trust and cooperation.

3.7.4. As far as possible, the FDs of the neighbouring States should follow similar rates in respect of ex-gratia relief to the victims of HWC.

Section-2

Conflict Management Strategies

1. **General Guidelines:** Strategies for dealing with wild animals in different conflict scenarios should be planned in accordance with the following guidelines:

1.1. In general, a wild animal should either be left undisturbed or permitted to escape to its natural habitat unless there is reason to believe that it has become (or may become) a threat to the safety of humans and their properties (viz. livestock, crop, houses, etc.).

1.2. Intervention, if necessary, should be minimal and commensurate with the level of threat posed by the animal and the level of tolerance exhibited by the stakeholders towards it. So, whereas an animal involved in human-killing just by accident, may be permitted to return to its natural habitat on its own, there should be no hesitation in eliminating an animal indulging habitually in human-killing. Similarly, a distinction needs to be made between the animals involved in crop-raiding and livestock-killing opportunistically and those indulging habitually—the former should be handled through barriers, scaring tactics and precautionary measures, while the latter should be handled through capture, translocation and—if situation so demands—killing.

1.3. The WPA-1972 [S.11(1)(b)] provides no legal strategies for dealing with Sch.I animals posing threat to crops, livestock and other properties. It also puts some riders on the strategies for dealing with Sch.I animals posing threat to human life and limits the choice to the following options:

Option-1: Capture and rehabilitate it in the wild (i.e., release it in its original habitat or translocate it to an alternative habitat).

Option-2: Capture and retain it in captivity, if the CWLW has reasons to believe that Option-1 is not viable.

Option-3: Kill it, if the CWLW has reasons to believe that Options-1 and 2 are not viable.

1.4. The WPA-1972 [S.11(1)(b)] does not put any riders on the strategies for dealing with animals belonging to Sch.II/Sch.III/Sch.IV posing threat to human life or indulging in destruction of crops, livestock, houses, etc. It is, however, advisable to follow the options meant for Sch.I animals as cited above.

1.5. The NTCA's SOP (2013) recommends that a tiger/leopard involved in attack on humans (including human-eaters) should not be released in the wild but sent to the nearest recognized zoo. It recommends killing of a human-eating tiger/leopard only after exhausting the option of capturing it alive. The MoEFCC's Guidelines (2011) stipulate that no leopard captured after a deliberate attack on a human (including human-eaters) should be released into the wild. It goes

on to recommend euthanizing a human-eating leopard even when captured. For other animals, the following approach may be considered:

A. No animal involved in deliberate attack on humans (including human-eaters) should be considered for Option-1 (capture and rehabilitate).

B. An animal should be considered for Option-2 (capture and retain) if involved in a single incident of deliberate attack on humans and for Option-3 (kill) if involved in multiple incidents of deliberate attack on humans.

1.6. Option-3 (kill) may be exercised straightway for any wild animal (irrespective of the schedule) in the following cases:

1.6.1. S.11(2) permits killing / injuring of any wild animal in defence of oneself or any other person. This is particularly the case when a wild animal is suspected to be rabid or when it is on a killing-spree and immediate trapping / immobilization of the animal is not possible.

1.6.2. S.11(1) permits killing of any wild animal when it is so disabled or diseased as to be beyond recovery.

1.7. The wild animals listed under Sch.II /Sch.III /Sch.IV involved in destroying crops or killing livestock should first be considered for Option-1 (capture and rehabilitate) and then for Option-2 (capture and retain). Though S.11(1)(b) also permits Option-3 (kill) in such cases, yet this option should be exercised only sparingly and not until the CWLW /AO has caused an enquiry and come to the conclusion that all reasonable alternative options to protect crops / livestock have been exhausted. The permission in such cases should be given only for killing a limited number of animals for a limited period of time and hunting should be carried out by the hunters engaged by the FD. As far as practicable, only the animals known to be habitual crop-raiders / livestock-killers should be targeted for killing. Option-3 (kill) should not be exercised in respect of wild animals categorised as 'Threatened' in the IUCN Red List for involvement in crop-raiding / cattle-killing.

1.8. Before exercising Options-1 (capture and rehabilitate) and 2 (capture and retain), a veterinarian must examine the animal and certify its fitness. The animal should be given treatment for the wounds, if any, suffered during capture. If, however, the animal suffers from zoonotic diseases or wounds which cannot be healed, it should be subjected to Option-3 (kill) through euthanasia. The NTCA's SOP (2013) stipulates that an injured / incapacitated tiger should not be released back, and the same should be sent to a recognized zoo.

1.9. Abandoned wild cubs /calves which cannot be reunited with their mother should straightway be considered for Option-2 (capture and retain) and sent to a designated Rescue Centre.

1.10. Option-1 (capture and rehabilitate) provides a choice between releasing the animal in its original habitat and translocating it to an alternative habitat. The MoEFCC's guidelines (2011) recommend that a captured leopard should be released into its home range. A similar policy should normally be followed in respect of all other wild animals.

1.10.1. In some cases (e.g. bull elephants straying long distance from their home range), it may not be possible to ascertain the original habitat of the animal which should, therefore, be translocated to any appropriate habitat.

1.10.2. In some cases, the tolerance level of the local public for an animal may be very low, and there may be no choice but to translocate the animal to a new habitat.

1.10.3. If, after local rehabilitation, the animal does not settle down peacefully in its original habitat and continues to come into conflict with the humans, it should be recaptured and translocated to an alternative habitat—subject to its fitness from veterinary angle.

1.11. If suitable area for translocation is not available (Ref. Para 3.7.6), the animal should be considered for Option-2 (capture and retain).

1.12. If adequate logistics for translocation are not available (for example, translocation of a big groups of elephants and blue bulls), animals may be considered partly for translocation and partly for retention in captivity. However, as far as practicable, entire family groups / social groups should be selected for translocation.

1.13. If, after translocation, the animal does not settle down peacefully in its new habitat, returns to its original habitat, or continues to indulge in conflict with the humans, it should be recaptured and considered for Option-2 (capture and retain).

1.14. Disposal of animals captured under Option-2 (capture and retain) is an important matter and should, preferably be decided by the CWLW in advance.

1.14.1 A captured animal should be kept provisionally in a designated Transit Facility till suitable instructions from the CWLW for its final disposal are received.

1.14.2. In case of an elephant, if it is amenable to training, it should be trained and put to departmental use.

1.14.3. If the animal is in demand by a recognised zoo, it may be sent there with the approval of the CWLW and the CZA. The NTCA's SOP (2013) stipulates that a tiger involved in attack on humans (including human-eaters) should be sent to the nearest recognized zoo.

1.14.4. In other cases, the animal will have to be kept in a designated Rescue Centre for life.

1.14. Along with managing the problem animals, the FD should also try to address the factors which lead to HWC and strive to enhance the tolerance level of the people towards wild animals.

2. Barriers and Watch Towers

2.1. Barriers and watch towers may be constructed either by the FD or by the stakeholders themselves. The DLC and ADS should keep a tab on all barriers being constructed by the FD or any other agencies to ensure that the same do not obstruct a wildlife corridor or divert the conflict to new areas. It may be enough to put a barrier around only the sensitive sectors, labour colonies and hamlets rather than enclosing the entire forests. Moreover, razor-wire fences are harmful to wild animals and should be discouraged.

2.2. All new barriers (trench/ wall /fence/power-fence) and watch towers should be planned with due regard to the seriousness of the conflict; nature of the wild animal; and soil and weather conditions. Power fences should be designed in accordance with the WII's 'Manual on Power Fencing for Wild Animals' (Chauhan, 2010). Guidelines for designing trenches and rubble walls are also available in the WII's 'Manual of Wildlife Techniques for India' [Sale & Berkmuller (eds), 1988]. Designs for construction of Crocodile Exclusion Enclosures are available on the website of the IUCN /SSC Crocodile Specialist Group (<http://www.iucnscg.org>).

2.3. The site and the design of the barrier being constructed departmentally should be approved by an officer not below the rank of a DFO (or an ACF holding post-graduate diploma from the WII). A cost-benefit analysis should be carried out before initiating the construction to ensure that the estimated expenditure on the barrier is commensurate with the financial losses it is meant to curtail. In many cases, regular payment of ex-gratia relief to the victims of conflict may be a cheaper option than to invest heavily on a barrier.

2.4. It is extremely important to protect and maintain the barriers to take their full and sustained advantage for containing HWC.

2.4.1. The concerned stakeholders should be taken into confidence before undertaking the construction of a barrier/watch tower departmentally. They should be encouraged to form a LWS for protection and maintenance of the barrier/watch-tower before the construction starts.

2.4.2. If the financial rules so permit, the construction work (at least the labour component) should be done by engaging the stakeholders. This is to give them a sense of belonging to the barrier /watch tower.

2.4.3. The power fences should preferably be constructed by using local resources and the LWS should be given training and equipment for monitoring the voltage and carrying out minor repairs.

2.4.4. While designing barriers, suitable number of inlets may be provided for meeting the bonafide requirements of the stakeholders.

2.4.5. The ADS and LWS should visit the old barriers and watch towers before the conflict season and get them into working condition. Thereafter, the LWS should look after the barrier / watch tower and try to maintain their efficacy.

2.5. Owners of commercial farms and tea / coffee estates should be persuaded to erect their own power-fences. Wherever possible, small and poor cultivators having adjacent lands should be encouraged to form a co-operative. The FD / district administration should supply energiser and other essential materials to the co-operative and also arrange training for erecting the fence. The co-operative should be asked to provide labour and undertake maintenance works. This will bring down the cost and also encourage the farmers to have a stake in the upkeep of such fences. The fences can be erected before the crop attains maturity and dismantled once the crop has been harvested and removed from the field.

3. Capture of Wild Animals

3.1. General:

3.1.1. Capture of wild animals for the purpose of conflict management by trapping /netting or chemical immobilization should preferably be carried out by the ADS, forest staff or by the experts engaged by the FD. In case, any other agency (e.g. Municipal Corporation, Panchayat, NGO or any other stakeholder) has been permitted by the CWLW /AO to capture problem animals, it must be ensured that the said agency has the experts capable of carrying out capture operations safely and in accordance with the provisions of law.

3.1.2. Whatever be the method selected for capture of a wild animal, all possible care should be taken to ensure the safety and welfare of the animal and avoid all unnecessary cruelty. The term 'cruelty' has not been defined in the PCA-1960, but S.11(1) of the said Act describes certain acts of omissions and commissions in respect of animals which are punishable under the Act. These include:

- Subjecting any animal to beating, kicking, and torturing.
- Depriving any animal of sufficient food, water or shelter.

- Confining any animal to a cage which does not permit it a reasonable opportunity of movement.
- Keeping any animal chained or tethered for an unreasonable time or in unreasonable manner.
- Conveying or carrying any animal in such a manner as to subject it to unnecessary suffering.
- Wilfully and unreasonably administering an injurious substance to any animal.

3.1.3. Prevention of Cruelty (Capture of Animals) Rules, 1972 also prohibits capture of animals except by ‘Sack & Loop method’, tranquilliser guns or any other method which renders the animal insensible to pain before capture.

3.1.4. As far as practicable, entire family group / social group of animals should be selected for capture.

3.1.5. To take maximum advantage of capture, the animals known to be indulging habitually in HWC or those playing a major role in HWC (e.g. unattached elephant bulls, alpha-monkeys, etc.) should form the main targets of capture.

3.1.6. Capture of wild animals from an area may often lead to influx of new set of individuals to occupy the vacant territory— thus restoring the conflict level. There should be a supplementary strategy in place to prevent this influx by suitable means (e.g. putting barriers strategically; engaging watchers to keep the intruders away; capturing the animals both from the source and the sink populations, etc.). Help of an experienced wildlife biologist may be taken to address this issue while planning the capture operation.

3.2. Trapping and Netting:

3.2.1. Wild animals (except mega-herbivores like elephants, gaurs and rhinos) can be captured by using traps or nets.

3.2.2. Help of professional trappers may be necessary for capture of certain wild animals (e.g. monkeys, crocodiles, etc.) if in-house expertise is not available.

3.2.3. Trap cages should be properly designed keeping the target animal in mind. Cages should be strong and lightweight so as to cause minimum injury to the animal and facilitate transportation of the captured animal. Fiber-glass cages with holes for ventilation are ideal.

3.2.4. For trapping carnivores, thick chain-links should be preferred to iron rods to minimize the risk of the animal damaging its canines. Cages with rusty iron rods should be avoided. Trap cage should not have any artificial padding made of rubber or any synthetic material which the animal may rip off and eat.

3.2.5. Some allurements may be necessary for trapping wild animals. Baiting in the form of goats, dogs, domestic fowl, etc. is useful for alluring a carnivore to the trap.¹² Similarly, bananas, maize or grams may be used for alluring monkeys to the trap cage.

3.2.6. Cases of local people killing or injuring trapped animals in anger are not uncommon. Therefore, a LWS or ADS or any other reliable agency should take the responsibility of monitoring the trap and protect the trapped animal.

3.3. ***Mela-Shikar***: *Mela-Shikar* method can be used for capturing wild elephants if experienced *phandis* and trained *kunki* elephants are available and the objective is to scare away wild elephants from a given area for a long period. A variant of *Mela-Shikar* involves chasing a herd without any capture. Another variant involves capturing a calf/sub-adult elephant temporarily and releasing it at a safe distance. *Mela-Shikar* can also be used for capturing wild elephants in combination with chemical immobilization when only Xylazine is available as a drug.

3.4. **Chemical Immobilization:**

3.4.1. Chemical immobilization is a convenient way to capture almost all kinds of wild animals on land and should be preferred whenever a team of experts with appropriate drugs is available. In particular, presence of a qualified veterinarian and availability of the antidotes in adequate quantity must be ensured before undertaking a chemical immobilization exercise. General guidelines for chemical immobilization of wild animals are available in the WII's 'A Guide to

¹²Some forest staff and animal activists wrongly believe that baiting of live animals is prohibited under the PCA-1960. S.11(1)(m) of the PCA-1960 prohibits baiting for the purpose of entertainment and not for managing the HWC.

the Chemical Restraint of Wild Animals [Chowdhury & Malik, 1992]. Specific protocol for chemical immobilization of tigers has been prescribed by the NTCA (2013).

3.4.2. Chemical immobilization may be used along with traps to capture an entire group of monkeys, Chital or Nilgai.

3.4.3. If the *kunki* elephants are available and the terrain is favourable, they should be used for darting of large carnivores (e.g. leopards and tigers) and mega-herbivores (e.g. elephants, gaurs and rhinos). *Kunki* elephants should also be used for restraining and shifting a wild elephant after chemical immobilization.

3.4.4. MoEFCC's guidelines (2011) advise against chemical immobilization of leopards in the open since a darted animal in the open can retaliate and injure people. A similar precaution may be taken in respect of other carnivore species.

3.4.5. While carrying out chemical immobilization of dangerous animals like elephants, tigers, leopards, etc., hunters carrying suitable firearms should be engaged to provide protection and backup support to the immobilization team.

3.4.6. Wherever possible, chemical immobilization should be preferred over shooting to kill a proclaimed wild animal.

3.5. Handling Captured Animals:

3.5.1. The captured animals should not be put on display and no one should be permitted to tease or disturb them. The cage should be covered with tarpaulin with suitable provision for ventilation. The chemically immobilized animal should also be shifted to a cage and covered.

3.5.2. The animal should be treated for injuries in the field itself if a veterinarian is at hand (which must be the case for a chemically immobilized animal) or shifted immediately to a designated Rescue Centre / Transit Facility and examined by a veterinarian. The animal should be photographed. Its morphometric parameters should be recorded and it should be fitted with identity marks (e.g. microchip, ear-tag, colour-coded collars, etc.).

3.5.3. The animal intended to be treated under Option-1 (capture and rehabilitate) should be housed in a designated Transit Facility with minimum exposure to humans. The MoEFCC's guidelines (2011) recommend that if a leopard has been kept in captivity for more than a month, it should not be released back into the wild. A similar policy may be adopted for other carnivore species.

3.5.4. The animal should also be screened for zoonotic diseases. The animal should be released in the wild only if the veterinary doctor is satisfied that it is medically fit and does not suffer from any zoonotic disease. If, however, the animal is found to be suffering from a contagious disease or a disabling wound which cannot be healed, it should be considered for euthanasia in accordance with S.11(1). The animal intended to be treated under Option-3 (kill) should straightway be subjected to euthanasia.

3.5.5. The animal meant to be treated under Option-2 (capture and retain) should be sent to a designated Rescue Centre (or to an elephant camp if the captured animal is an elephant).

3.5.6. The captured animal at the Transit Facility / Rescue Centre should not be kept inside the trap cage for more than a week and should be shifted to a larger enclosure as per specifications fixed by the CZA.

3.6. Transport of Captured Animals:

3.6.1. A captured animal may be transported over a short distance in the trap cage itself. However, for transporting animals over long distances, guidelines given in the CZA's 'Protocols for Transportation of Wild Animals' [Bonal et al (eds), 2012] should be followed. Attention should also be paid to Rules 15-45 of the Transport of Animals Rules, 1978 relating to the transport of monkeys.

3.6.2. The animal should be transported in a stress-free environment without exposure to public. The transport vehicle should be sanitised before and after shipment. The animal should not be exposed to direct sunlight or cold wind during transportation. The persons handling the animal during transit should strictly observe personal hygiene.

3.6.3. A registered veterinarian should accompany the animal being transported over long distance. The animal's health condition should be frequently checked during transit and it should

be immediately treated for sickness or injury, if any. The animal may be sedated during the journey if so advised by the veterinarian.

3.6.4. Safety of the animal and human-beings during transportation should be given utmost importance.

4. Rehabilitation and Translocation:

4.1. Release of a captured wild animal in its original habitat should generally be the rule, but there may be exceptional cases when either the captured animal should not be released at all (Ref. Paragraphs 1.5, 1.8, 1.9, 1.11 and 1.13) or it should be translocated to a new habitat (Ref. Paragraphs 1.10.1, 1.10.2 and 1.10.3).

4.2. As far as practicable, entire family group /social group should be selected for translocation.

4.3. Physical fitness and freedom from zoonotic diseases should be the prerequisite of any rehabilitation programme for any wild animal whether in its original habitat or at a new habitat.

4.4. Rehabilitation of wild animals captured by other agencies (e.g. Municipal Corporation, Panchayat, NGO or any other stakeholder), should only be carried out at a site and in a manner approved by the DLC.

4.5. Photographic / Videographic evidence of the release of the animal should be kept.

4.6. Site selection for Translocation:

4.6.1. Translocation of problem animals often fails inasmuch as the released animals tend to return to their original habitats or add to the conflict at the new site. Selection of site for

translocation of different wildlife species is, therefore, very important and should be carried out by a technical committee comprising experienced forest officers and wildlife biologists with a provision for co-opting representatives of the local stakeholders. The committee should also recommend the maximum number of animals of a particular species that may be released in a potential site.

4.6.2. The following considerations will be helpful in selecting the translocation sites:

- A. The release site must be at a suitable distance from the capture site to minimize the probability of the animal returning to the capture site. In case of elephants, it has been suggested that the relocation site should be '3-4 times the Home Range' distance away from the capture site.¹³
- B. Some assessment of the carrying capacity of the potential site is necessary. Translocation should not lead to overpopulating the site, resource-crunch and intra-specific competition. Some indication of the carrying capacity of the potential site can be had from the current size of the resident population of the animal in question, current level of dispersal (straying), current level of conflict of the animal with humans in the surrounding areas, body condition of the resident animals, and signs of habitat deterioration, if any.
- C. The NTCA (2013) recommends that a healthy tiger in prime or young age without any incapacitation may be released after radio collaring in a 'suitable habitat with adequate prey base, away from the territory of a resident male tiger (if any) or human settlements', under intimation to the NTCA. It also recommends release of an encumbered tigress release in 'low density area of a nearby tiger reserve/PA'. Similar precautions need to be taken in respect of other animals showing territorial behaviour.
- D. The level of threat to the translocated animal at the release site on account of poaching, poisoning, electrocution, train/vehicular traffic, etc. should also be assessed in advance. An area with a previous history of poaching or retaliatory killing of the wild animal in question does not make an ideal site for translocation.
- E. It should be assessed if translocation will lead to significant escalation of HWC in the region, and, if so, whether resources will be available to neutralise this escalation.
- F. It should be ensured that translocation does not lead to spread of communicable diseases among the resident population.
- G. Genetic compatibility between the translocated and the resident population of the animal should be ensured.
- H. It is important to assess the current level of tolerance of the local people towards the animal in question; how the translocation will impact this level; and whether resources will be available to offset any negative impact.
- I. Capacity of the local forest staff to protect, manage and monitor the translocated animal is an important factor.

¹³ Ajay Desai (pers. Comm.)

4.6.3 The potential sites for translocation should be selected much before the conflict season and made known to the DLC and ADS.

4.7. Monitoring:

4.7.1. Monitoring of the translocated animal is very essential to judge the success of rehabilitation. Frequent straying of the animal or increase in the levels of HWC at the rehabilitation site should serve as a notice for the FD to review its translocation strategy.

4.7.2. The animals should be fitted with identity marks (microchips, ear-tags, colour-coded collars, etc.). NTCA (2013) has recommended radio-collaring of tigers before release. MoEFCC (2011) has recommended that radio-collars should be put on a sub-set of the released leopards to monitor post-release movements and survival. It has also recommended involvement of scientists and experts in the radio-tracking of the released leopards. A similar policy should be adopted for all other Sch.I animals.

5. Population Management:

5.1. Overabundance of certain species in some localities may add to the HWC levels. Population management in such areas may be regarded as a tool for HWC management. The WPA-1972 provides two legal tools for population management of a particular species of animal: by declaring it to be vermin (S.62) or by permitting its hunting for the purpose of scientific management (S.12).

5.2. **Declaration of the wild animal as vermin:** Under S.62, the Central Government may declare a wild animal belonging to Sch.II (Part-I), Sch.III and Sch.IV as vermin (i.e. a species under Sch.V) for a specified area and for a specified period. Declaring a wild animal as vermin is a drastic measure as it withdraws all legal protection to the animal in question (except inside PAs) and gives a blanket permit to the public at large to destroy the animal. Before submitting a proposal to the Central Government under S.62, the CWLW should get the matter examined by a technical committee comprising experienced forest officers and eminent wildlife biologists and also seek approval from the SBWL in accordance with S.8(c). The CWLW should also ensure that all reasonable alternative tools available with the FD for mitigating the HWC have been tried and exhausted before mooted the proposal. An extra care should be taken while submitting a proposal under S.62 for a wild animal categorised as ‘Threatened’ in the IUCN Red List.

5.3. Scientific Management:

5.3.1. Under S.12, CWLW may permit hunting of a wild animal listed in Sch.I (with the previous permission of the Central Government) and Sch.II/Sch.III/Sch.IV (with the previous permission of the State Government) for scientific management. Scientific management includes translocation of any wild animal to an alternative suitable habitat and also population management (without killing or poisoning the wild animals).

5.3.2. S.12 precludes the use of Option-3 (kill) but permits the use of Option-1 (capture and translocate) and Option-2 (capture and retain) for scientific management. It provides the scope for exercising yet another option, viz. fertility control of the wild animal population (Option-4).

5.3.3. S.12 permits the use of Option-1 (capture and translocate), Option-2 (capture and retain) and Option-4 (fertility control) for dealing with Sch.I animals indulging in crop-raiding or cattle-killing which is not possible under S.11(1)(a). S.12 also provides a convenient alternative to S.62 for dealing with Sch.II/Sch.III/Sch.IV animals indulging in depredation inasmuch as the permission of the Central Government is not required and no blank permit for hunting needs to be given to the public at large.

5.3.4. Although S.12 authorises the CWLW to permit hunting for scientific management to any person, yet it is advisable that only the FD or the experts engaged by it carry out the desired operations.

5.3.5. This being an exercise meant for scientific management, the CWLW should get the matter examined by a technical committee comprising experienced forest officers and eminent wildlife biologists. The committee, in particular, should address the following points:

A. It should establish that there is an 'overabundance' of the wild animal in question which needs to be managed.

B. It should establish that overabundance is leading to HWC which cannot be addressed only by the existing tools available with the FD.

C. It should provide justification for the number of animals proposed to be captured/translocated/brought under fertility control and the projected impact on the population.

D. It should justify the choice of Options-1, 2 or 4 proposed to be used for scientific management. If Option-1 (capture and translocate) is proposed to be used, the suitability of the alternative habitat should be established (Ref. Para 3.7.6)

5.3.6. Fertility control in free-ranging wild animals is still an evolving subject in India. The FD in Himachal Pradesh has set up Monkey Sterilization Centres for fertility control in rhesus macaque— results of which are not officially known. Zoos usually practise fertility control in captive animals by segregating the male and female populations or by castrating the males. It is advisable to take up a fertility control programme in collaboration with the Veterinary Department and /or a reputed scientific institute.

5.3.7. The FD should have support from the chemical immobilisation team and veterinarians for implementing the programme. Availability of *kunki* elephants and experienced mahouts is necessary if wild elephant is the target animal. Involvement of scientists and experts is advisable for carrying out translocation and subsequent tracking of animals.

5.3.8. The CWLW should take approval from the Central Government / State Government before going ahead with the programme.

Section-3

Dealing with Different Conflict Scenarios

1. Wild Animals Living Within Human Settlements

It is not unusual for some wild animals (e.g. Rhesus Monkeys, Common Langurs, Jackals, Common Civets, Rock Pythons, etc.) to be living within human settlements. The management of these animals would depend upon their potential to cause harm vis-à-vis existing levels of conflict and the threat perceptions of various stakeholders.

1.1. Ordinary Complaints: In ordinary cases (e.g. mere sighting of a wild animal, killing of pets or poultry by a wild animal, etc.) the following action by the FD should be sufficient:

1.1.1. The DLC should take action to monitor the population and distribution of such wild animals from time to time and submit a proposal to the CWLW for population management under S.12 if their overabundance becomes a cause of concern (Ref. Sec. 2, Para-3.8).

1.1.2. The DLC should initiate suitable education and awareness programme based on periodic meetings and publicity material aiming at diluting the threat perception of the stakeholders and also to persuade the concerned authorities and stakeholders for undertaking precautionary measures, particularly in respect of protecting poultry, fruit trees and other assets; and proper disposal of garbage and left-over food.

1.1.3. A Sch.I animal like Rock Python needs to be protected against harm and should be considered for Option-1 (capture and translocate) or Option-2 (capture and retain) depending upon the advice of the veterinarian.

1.2. Wild Animals Causing Nuisance Within Sensitive Locations: Wild animals sometimes cause disruptions within Airport runways, army depots, hospitals, schools, office buildings, ration-shops / food godowns, etc. The following sequence of action may be followed for dealing with such complaints:

A. The DLC should arrange for a safety audit of the location by a team of experts / experienced officers to advise the stakeholders suitably. Quite often the problem can be addressed by advising the stakeholders to adopt either one or a combination of the following measures:

1. Plugging the entry points of the wild animal.¹⁴
2. Using properly designed barrier (trench or wall) or fence (including power fence)¹⁵ or a combination of the two to prevent the incursion of wild animals into a sensitive area.¹⁶

¹⁴For example, use of wire-nets on windows and ventilators of houses for denying entry to civets.

3. Preventing access of wild animals to garbage and other sources of food.
4. Using ultrasonic-sound devices to repel the wild animals.
5. Engaging guards with simple scaring devices (e.g. catapult, crackers, airguns, etc)¹⁷.

B. If, however, the problem persists despite all reasonable steps having been taken by the stakeholders, the ADS should be engaged for removing the problem animals from the scene, by using the following measures:

1. Locating the burrows / dens inhabited by the animals in question and closing them down.
2. Chasing / driving away the group of animals in question aggressively and regularly for some days (say a week) until they are discouraged from coming back.

C. If, however, the ADS is unable to control the problem by the above means, the animals in question should be considered for Option-1 (capture and translocate) or Option-2 (capture and retain) depending upon the advice of a veterinarian and with due permission from the CWLW /AO.

1.3. Wild Animals Causing Physical Harm To Humans: In case of wild animals attacking/injuring / killing human-beings, detailed guidelines given in Section- 4 should be followed.

2. Wild Animals Straying Out From Their Natural Habitats¹⁸

2.1. General Observations:

2.1.1. Wild animals do stray out of their natural habitats for various reasons and often get stranded. Some animals (e.g. leopards and elephants) are known to stray much more than the others. Mere sighting of a wild animal outside forests does not necessarily mean that it should be captured. But straying of wild animals cannot be ignored altogether because it may cause accidental encounters with people and also lead to panic in some areas.

2.1.2. Action in the matter depends on the following factors: whether the animal is involved in attack on humans; whether it can return to its habitat on its own; whether it has a record of straying frequently; the degree of threat to its safety outside its habitat; and degree of threat it poses to humans outside its habitat.

2.1.3. A common element in all the strategies discussed in the following paragraphs to deal with strayed wild animals is the crowd management (Ref.Sec.8, Para 2)) and safety of the local people. The effort of the ADS and LWS should be to keep the people and dogs at a safe distance from the site and to forewarn the people living on the expected escape route of the animal.

¹⁵ Razor-wire fences are harmful to wild animals and should not be recommended. Chain-link fences or woven-wire fences are usually safe and effective.

¹⁶ Suitably designed Crocodile Exclusion Enclosures can be used to keep crocodiles off from bathing/washing ghats along banks of rivers / lakes.

¹⁷Trained langurs may often help in keeping problem monkeys at bay from strategic locations.

¹⁸NTCA's SOP (2013) deals exclusively with straying of tigers and leopards and MoEFCC's Guidelines (2011) deal exclusively with straying of leopards.

Armed Policemen and forest staff should be deployed at strategic points. Nets made of Nylon or Jute should be used as a shield to protect people from sudden bursts from the carnivores. A row of volunteers holding *mashaal* (lighted torches) can provide an effective shield for the people and also prevent the animal from taking a wrong route.

2.2. Wild Animals Stranded in Open Areas

2.2.1. The first priority in respect of wild animals stranded in open areas (e.g. agricultural fields, tea gardens, orchards, open streets, etc.), not far away from their natural range, should be to let them escape on their own. As stated above, the ADS and LWS should keep the people and dogs at a safe distance from the site, prevent all disturbances to the wild animals, and keep a safe passage open for them towards the forests. In most cases, the animals in question would retreat under the cover of darkness. Sometimes, a little prodding from the squad may also be needed.

2.2.2. Services of *kunki* elephants should be used, if available, to drive wild elephants, gaurs and rhinos to safety. Experienced mahouts can also use *kunki* elephants for chasing away tigers and leopards from open areas adjoining forests. In South West Bengal, professional teams of elephant-chasers (locally known as *Hulla*-parties) often help the FD. These teams are also sometimes invited by the FDs of Jharkhand and Odisha.

2.2.3. If, however, local circumstances do not permit safe passage to the wild animal in question, it should be considered for Option-1 (capture and rehabilitate) or Option-2 (capture and retain) depending upon the veterinary advice with due permission from the CWLW /AO.

2.2.4. Some deer /antelopes may stray too far away to return on their own and may also face danger from country dogs and unscrupulous people. Such animals should be considered for Option-1 (capture and relocate) or Option-2 (capture and retain) depending upon the veterinary advice.

2.2.5. Crocodiles are known to stray into village ponds and agricultural fields and pose great threat to humans and livestock. They should be considered for Option-1 (capture and rehabilitate) or Option-2 (capture and retain) depending upon the veterinary advice.

2.3. Wild Animals Stranded in Closed Areas, Wells, Pits etc.

2.3.1. If a wild animal is stranded in closed areas (e.g. house, garage, factory, cattle-pan, etc.) and not likely to escape in the night, it should be considered for Option-1 (capture and rehabilitate) or Option-2 (capture and retain) depending upon the veterinary advice.

2.3.2. Wild animals often fall into wells, pits or ponds and cannot come out. The animals can be rescued and allowed to escape by draining out water and levelling out the walls with the help of JCB machines.

2.3.3. The MoEFCC's guidelines (2011) recommend the use of ladder in dry wells to help leopards climb out. In Gujarat, a trained forest staff is lowered into the dry well inside a cage with equipment to tranquillise the leopard and bring it out.

2.4. Wild Animals On Roads

2.4.1. It is not unusual for wild animals to come on public roads passing through or close to forests. The wild animals are susceptible to being run over by fast moving vehicles. Some of the wild animals (e.g. elephants, gaurs, leopards, tigers, etc.) also pose threat to the safety of pedestrians, cyclists, motor-cycle riders and even the persons travelling by light and heavy vehicles, leading sometimes to a panic situation.

2.4.2. The management of HWC on roads is guided by the principle that 'The wild animals have the first right of way'. The conflict should be managed by identifying the sensitive section of the road and regulating the movement of people and vehicles—the degree of regulation being determined by the kind of wild animals involved, seasonality of conflict and the seriousness of the problem as indicated by the past records. The regulatory measures may include one or more of the following:

1. Putting warning signs at appropriate points.
2. Putting a ban on pedestrians, cyclists and riders of scooters / motor-cycles except during the day time.
3. Putting a speed limit on vehicles.
4. Providing speed-breakers at appropriate points on the road.
5. Prohibiting night-time vehicular movement during certain months of the year.
6. Allowing night-time vehicular movement in convoys only escorted by the armed police/ forest-staff.
7. Prohibiting people from feeding wild animals on the road.

2.4.3. Reducing the height of the lane-dividers and illuminating the sensitive stretch of the road with strong halogen lamp-posts may also be helpful in reducing the level of conflict.

2.4.4. It is necessary to seek permission and cooperation from the district administration and the Police for enforcing the requisite regulations on a public road. It is also necessary to seek public cooperation through educational and awareness programmes.

2.5. Pregnant Animals

2.5.1. Wild animals (e.g. leopards and tigers) sometimes take shelter in tea / coffee estates, sugar-cane fields or some other bushy areas outside forests during their breeding period. Usually there is a past history of such incidents and the concerned stakeholders should be forewarned before the breeding season and advised to exercise due precautions. They should be advised to remove stray dogs and loose livestock and ensure proper disposal of garbage and left-over food to deny easy availability of food to the animal.

2.5.2. Attempts to send a pregnant female animal back to forest may be made by the ADS or *kunki* squad as long as she has not delivered. But a mother animal with cubs / calves should not be disturbed. The LWS should be engaged to secure the area and monitor the animal till she has left the place on her own.

2.6. Abandoned Wild Cubs / Calves

2.6.1. The people / forest staff should be discouraged from 'rescuing' wild cubs / calves found in the vicinity of forests without mother. All such 'rescued cubs / calves' should be released back immediately at the same site from where they were picked up. An elephant calf should be released in the close vicinity of the nearest elephant herd. A reasonable opportunity should be given to the mother to reclaim her cubs / calves. The LWS should be engaged to secure the area and monitor the cubs / calves from a safe distance. A camera trap, if available, should be placed near the release site for conforming the reunion of the mother and her cubs / calves.

2.6.2. If, however, the reunion does not take place within a reasonable period (say, one night), the cubs / calves should be captured and immediately removed to a designated Rescue Centre.

2.7. Injured Wild Animals

Any stranded wild animal found to be carrying serious injuries should be captured (trapped / immobilised) and removed to a designated Transit Facility for treatment. It may be released back in the wild depending upon the veterinary advice. However, carnivores kept in a Transit Facility / Rescue Centre for more than 30 days should not be released. (Ref. Sec. 2, Para 3.5.3)

2.8. Wild animals involved in attack on humans

Guidelines given in Section-4 should be followed in such cases.

2.9. Wild Animals in the Habit of Straying

If the records of the ADS reveal that a particular wild animal released in a nearby habitat has been straying frequently, it should be considered for Option-1 (capture and translocate) or Option-2 (capture and retain) depending upon the veterinary advice.

2.10. Preventing Straying of Wild Animals

2.10.1. Suitably designed barrier (trench/wall) or fence (including power fence) or a combination of the two should be recommended to the stakeholders for preventing the straying of wild animals into strategic locations (e.g. army camps, schools, electric sub-stations, FCI godowns, etc.) situated on the fringe of forests. Strong halogen lamp-posts along the periphery with the forests are also useful to deter most of the wild animals. Arrangement should also be made for suitable disposal of garbage and left-over food

2.10.2. The FD may have to take similar measures as above for preventing the incursion of wild animals into villages suffering high levels of depredation involving loss to human life and livestock. In the Sundarbans, FD has been using Nylon-net fences to prevent straying of tigers into villages.

2.10.3. Guidelines given in Section 2 (Para 2) for barriers and fences should be followed.

Section-4

Dealing with Human Deaths and Injuries

1. **Quick Response:** As soon as information about a wild animal attacking and injuring / killing human-beings is received, the ADS and HWLW should rush to the spot.

2. **Medical Help and Post-Mortem:** The injured persons should be provided with immediate medical help. Arrangements should be made with the help of the Police for post-mortem of the dead.

3. **Relief to the Victims:** Necessary help should be provided to the injured persons / dependents of the dead persons for claiming ex-gratia relief from the competent DFO. Where the rules so permit, part of the ex-gratia relief should be made available to the victims or their dependents immediately without waiting for the official formalities. In deserving cases, additional relief in the form of livelihood support, food-grains, camping material, tools and implements, etc. should be arranged for the victim or his family with the help of the district administration and philanthropic organisations.

4. **Inquiry:** The ADS should conduct an inquiry to establish the identity of the animal in question and to ascertain the circumstances of the conflict.

4.1. **Identification of the Problem Animal:** Since only a few of the locally occurring species of wild animals may be capable of attacking humans, it may not be a problem to find out which species is involved in a particular incident. But pinpointing a particular individual responsible for the attack may not be an easy task and need some investigative skills.

A. The footprints left by the animal at the place of occurrence are usually helpful. It is useful to make plaster-casts / tracings of the pugmarks left by a carnivore in the field and record such parameters as the length and breadth of the pugmark and stride of the animal. The presence of small pugmarks along with large pugmarks may be suggestive of a mother animal with cub. The footprints of an elephant can give an idea about the height of the animal.¹⁹ The eye-witnesses may provide some additional details about the size and shape of the tusks of the elephant and any other peculiarity on its body (e.g. a cut-tail, broken-tusk, injury mark, etc.).

B. Samples of scat / dung, blood, hair or any other body part of the animal, if found in the field, should be sent to a suitable research laboratory for DNA profiling of the animal which is a fairly reliable way of ascertaining the identity of the animal.

C. A comparison of the pugmarks of a tiger / leopard collected from the place of occurrence with the records of the previous census may also give some idea about the identity of the animal.

¹⁹ Double the circumference of the front foot of an elephant will give its approximate height.

D. The NTCA's SOP (2013) has recommended fixing camera traps near the site of incident to get photographs of the tigers active in the area and to compare it with the National Repository of Camera Trap Photographs of Tigers (NRCTPT) or the database of the nearby Tiger Reserve to establish the identity of the tiger and find out the source area of the animal.

4.2. Circumstances of the Conflict: The circumstances of the conflict may be ascertained by recording the evidence of the witnesses, observing the injuries / condition of the corpse, and inspecting the place of occurrence. The objective is to find out whether the alleged attack by the animal in question was accidental or deliberate.

4.2.1. Some Indicators of a Deliberate Attack: Any one of the following actions may be an indicator of a deliberate attack by a wild animal:

- A. The animal (a carnivore) stalked the victim before attacking him.
- B. The animal (a carnivore) lifted and carried away the victim from the place of attack.
- C. The animal (a carnivore) attacked persons sleeping outside their houses.
- D. The animal (a carnivore) ate away a part of the corpse.
- E. The animal (an elephant) chased the victim over a considerable distance before attacking him.
- F. The animal (an elephant) tore apart the corpse and threw the pieces over a large area.
- G. Same animal (a carnivore /an elephant) chased/attacked two or more persons in nearby locations within a short span of time (same day /same week).

4.2.2. Some Examples of Accidental Attack:

- A. A wild animal may attack a person while being chased / driven.
- B. People walking through forests or collecting NTFPs may also have chance encounters with wild animals.
- C. A leopard (usually a pregnant leopardess) often takes shelter in the drains in the tea gardens and may attack a party of labourers plucking tea-leaves and advancing towards it. Similar encounters may take place between farmers and tigers in sugar-cane fields close to forests.
- D. A wild elephant may break into a house in search of food-grains / country-liquor and the residents may be crushed under a wall or roof. People often get injured while running helter-skelter in nervousness when a wild elephant is around. A bull elephant in *musth* may also behave erratically and chase people and cattle.
- E. Photographers often get killed / injured while trying to approach a wild animal close enough to take a good shot.
- F. An intoxicated person is often unable to steer clear of an approaching wild animal and get injured / killed in the process.

4.3. Dossier: ADS/DLC should maintain a dossier of animals involved in attack (both deliberate and accidental) on humans containing all available information about the animal and its victims. Whenever a fresh incident takes place, the information collected about the animal should be compared with that in the dossier to ascertain whether the same animal is involved in more than

one incident and, therefore, a habitual offender. This information can be of great help in deciding whether the animal needs to be proclaimed under S.11(1).

5. Proclamation under S.11 (1):

5.1. If the inquiry hints at deliberate attack by a wild animal, permission should be sought from the CWLW under S.11(1)(a) [for Sch.I animals] or from the AO under S.11(1)(b) [for Sch.II / Sch. III/Sch. IV animals] for exercising Option-2 (capture and retain). If the dossier reveals that the animal in question (other than tigers) is a habitual human-killer, Option-3 (Kill) should be exercised. Wild animals involved in deliberate attack on humans should not be released back in the wild (Ref. Sec.2, Para 1.5).

5.2. If the inquiry hints at an accidental encounter, no proclamation is required. Action should be taken, if necessary, to chase / drive the animal back to its natural habitat. If, however, the dossier reveals that the animal is in the habit of straying out of forests and has been involved in more than one accidental encounter with humans, permission of the CWLW/AO should be sought for exercising Option-1(capture and translocate).

5.3. The proclamation issued by the CWLW/AO should provide as many clues about the identity of the animal and its home range as possible. The proclamation should specify the area over which the animal can be hunted and PAs should be kept out of it. The proclamation should clearly indicate whether the permission for hunting is for Option-1 (capture and translocate), Option-2 (capture and retain) or Option-3 (Kill). It should specify the period (not exceeding three months) after which the proclamation will cease to be in force. The proclamation may be renewed further if there is evidence that the animal in question is still engaged in attacks on humans.

6. Tracking and Monitoring: Adequate number of LWSs comprising of armed forest staff and local volunteers should immediately be deployed over the known range of the animal to locate it and monitor its movements. The NTCA (2013) has recommended laying out a series of 'Pressure Impression Pads' in an area where a human-tiger/leopard conflict has taken place to ascertain the daily movement of the animal and plot the same on a map (1:50,000 scale). *Kunki* elephants, if available, should also be pressed into service in tracking and monitoring the proclaimed animal.

7. Engagement of Experts: Adequate number of traps with appropriate baits should be laid out at strategic points. The chemical immobilisation team and approved trappers should also be pressed into service immediately. If the proclamation is for Option-3 (Kill), the approved hunters should also be summoned.

8. Precautionary Measures:

8.1. Adequate publicity should be given in the region about the wild animal posing threat to human life which has been proclaimed under S.11(1) and the people should be informed about the precautions to be taken.

8.2. Information about the proclaimed animal should also be shared with the SLC / DLC of the adjoining State if the range of the animal extends across the inter-state borders.

9. Action after Capture:

9.1. After the animal has been captured (trapped / immobilised), it should be provided with veterinary care as soon as possible. A report should immediately be submitted to the CWLW/AO /SLC/ DLC.

9.2. The animal should be examined by a team of officers (including the local HWLW and a veterinarian) led by the DLC to conform its identity vis-à-vis the order of proclamation.²⁰

9.2.1. If the team is satisfied that the right animal has been captured, further action should be taken as per proclamation.

A. The animal ordered for translocation may be shifted to a designated Transit Facility if it is not possible to translocate it immediately.

B. The animal ordered for retention in captivity may be shifted to a designated Rescue Centre. A captured elephant may be shifted to an elephant camp for training.

C. The animal ordered for killing may be euthanized.

9.2.2. If the team is satisfied that a wrong animal has been captured, it should be immediately released back into its original habitat. If the animal needs further treatment, it should be shifted to a designated Transit Facility. The field operations to capture the right animal should be continued.

9.3. A report should be submitted to the CWLW/AO/SLC immediately.

10. Action after Killing:

10.1. If the animal has been killed by a hunter in accordance with the proclamation, a report should immediately be submitted to the CWLW/AO/SLC/ DLC.

10.2. The carcass should be examined by a team of officers (including the local HWLW and a veterinarian) led by the DLC to conform its identity vis-à-vis the order of proclamation.

10.2.1. If the team is satisfied that the right animal has been killed, a report should be submitted to the CWLW/AO/SLC.

10.2.2. If the team is satisfied that a wrong animal has been captured, it should inform the CWLW/AO/SLC immediately. The field operations to capture / kill the right animal should be continued.

²⁰ The NTCA's SOP (2013) has prescribed a special team for technical guidance and monitoring for dealing with cases involving tigers and leopards.

11. Expiry of the Proclamation:

11.1. If the proclamation issued by the CWLW/AO lapses before the animal is captured / killed, the operation may be stopped and a report submitted to the CWLW/AO/SLC. However, the ADS and LWS should continue to monitor the activities of the animal.

11.2. If, however, there is evidence that the animal in question is still engaged in attacks on humans, a proposal should be submitted to the CWLW/AO for reviving the proclamation.

12. Action in Emergency Situations:

12.1. When the animal is suspected to be rabid or when the animal is on a killing spree and immediate capture (trapping/immobilization) of the animal is not possible, the ADS should take steps for killing it in accordance with S.11(2).

12.2. An inquiry should be conducted by the DLC and a report submitted to the CWLW/AO/SLC.

13. Disposal of Carcass:

13.1. As stipulated in S.39(1), all wild animals killed under the provisions of S.11 are government property. The ADS and LWS should protect the carcass and prevent its misuse by unscrupulous persons.

13.2. As stipulated by the NTCA, carcasses of tigers/leopards should be incinerated in the presence of the Field Director / CF and the whole process should be photographed / videographed.²¹ A similar practice may be followed in respect of other species of wild animals. Special care should be taken to ensure that the parts of the carcass in demand in the illegal market (e.g. tusks of bull elephants, horns of rhinos, gall-bladders of bears, etc.) are destroyed fully.

13.3. There are other bonafide ways of disposing off the carcass or its parts which may be followed with permission from the CWLW. These include:

²¹ SOP for disposal of carcasses of tiger and leopard issued vide NTCA's Notification No. 15-37/2012-NTCA dated 18.3.2013.

1. Handing over the carcass to a recognised zoo / Vulture Conservation & Breeding Centre for consumption by wild animals.
2. Handing over the carcass to a Natural History Museum for display or record.
3. Providing samples to the research institutes / forensic laboratories for legitimate research / studies.

13.4. A report should be submitted to the CWLW/AO/SLC immediately after the disposal of the carcass.

14. A Parallel Strategy for Preventing Accidental Human Deaths and Injuries:

14.1. The fact remains that most of the cases of death or injuries of human-beings are circumstantial or accidental in nature and influenced by local factors including life-styles of the people. These issues can be handled only through awareness and educational programmes targeting the concerned stakeholders and by seeking help from the concerned governmental and non-governmental agencies. For example:

1. Many cases of deaths / injuries of humans are on account of roof / wall crashing on the victim when pushed by an elephant looking for some food-item. Strategies for dealing with the problem of house damage have been discussed in Section 7.
2. Many deaths / injuries take place when the victim is highly intoxicated and unable to protect himself against the wild animal. This is a social problem which needs to be addressed with active support from the community leaders, Panchayat, district administration, JFMCs and NGOs.
3. The villagers entering forests for collecting fodder, firewood, honey and other NTFPs run a great risk of being attacked by wild animals. Suitable restrictions in terms of time and area of collection of NTFPs should be enforced to minimise human-wild animal encounters. If need be, an armed forest staff can be assigned to accompany a group of NTFP collectors. Entry of persons, who are alone, sick, aged or otherwise unable to protect themselves, inside forests also needs to be regulated. The FD should also take strict measures against trespassers.
4. Certain categories of visitors to forests are particularly vulnerable to physical harm by wild animals. These include tourists, pilgrims, news reporters and photographers, researchers, workers of a project within the forest, army personnel carrying out field practice, etc. They should be adequately cautioned; advised to stick to a prescribed route, area, time-schedule

and camping site; or provided with trained guides. In special cases, armed forest staff may be assigned to accompany a group of visitors.

5. Many villagers do not have toilet facilities and visit nearby forests to relieve themselves where they face the risk of running into wild animals. Panchayat and the district administration should be advised to give priority to the villages reporting high levels of HWC for the purpose of setting up community latrines.
6. Street-lighting in the localities adjoining forests can reduce such human-wild animal encounters significantly. In areas where electricity is not available, solar light-posts can be provided. Panchayat and the district administration should be advised to give priority to the villages and tea / coffee estates reporting high levels of HWC under rural electrification schemes.
7. Proper disposal of garbage including left over foods and control over stray dogs and livestock is very essential to keep wild animals away from human localities.
8. Very often, a person gets trampled while chasing away wild animals rather carelessly. Aged and otherwise infirm persons as well as children must not be involved in anti-depredation works. The villages prone to HWC should be encouraged to set up a LWS comprising of volunteers who are physically fit. The LWS should be properly trained and equipped by the FD to deal with wild animals.

14.2. JFMCs and Tea / Coffee Estates should be encouraged to obtain group insurance cover against death / injury of their members / labourers.

Section-5

Dealing with Crop Depredation

1. General:

Wild herbivores have acquired the habit of feeding on a large number of crops ever-since the humans started practicing cultivation. Wild herbivores develop a definite bias towards the agricultural crops in view of their nutritional superiority over the wild fodder and the convenience of feeding. It is, therefore, unrealistic to think that abundance of wild fodder alone can contain wild animals within forests. But conversely, shortage of fodder within forests will definitely induce wild animals to raid the nearby agricultural fields. Thus, the desired strategy should be to take drastic measures for making it inconvenient and un-profitable option for wild herbivores to go after crops and, simultaneously, to make concerted efforts for protecting and improving the habitat within the forests.

2. Action before the conflict:

2.1. ADS should identify the potential conflict areas on the basis of past records and visit them before the conflict season to assess their preparedness. Condition of the equipment (e.g. searchlights) supplied to the farmers / LWS during the previous season as well as old barriers and watch towers built in the area should be checked and action should be taken to get them unto working condition.

2.2. ADS should arrange training for the farmers in anti-depredation techniques; help them in setting up a temporary LWS for the ensuing harvesting season and equip it with searchlights and crackers.

3. Action during the conflict:

3.1. ADS should visit the conflict site when the farmers / LWS are unable to manage the situation or when a dangerous animal (e.g. elephant, gaur, black bear/ sloth bear) or an endangered animal (e.g. rhino) is involved. Attempts should be made to scare and drive the animals away from the crop-field.

3.2. Services of *kunki* elephants and / or a professional team of chasers (Ref.Sec.3, Para 2.2.2) should be used, if available, to drive wild elephants, gaurs and rhinos to safe locations.

3.3. ADS, with the help of the LWS, should try to identify the problem animals (individual / groups) which are particularly aggressive or appear to be habitual crop-raiders. This information should be recorded in a dossier.

4. Strong Measures:

4.1. It may sometimes be necessary to create fear within a particularly desperate group of wild animals (e.g. monkeys, wild boars and blue bulls). Permission of the CWLW /AO may be obtained for Option-1 (capture and release) under S.11(1)(b). The objective should be to capture (trap / immobilise) a few animals while in the act of crop-raiding and release them in a nearby habitat after some time (say 12-24 hours). Preference should be given to capture of alpha-males, or animals known to be aggressive, or animals known to be habitual crop-raiders. The operation should be carried out with the help of the ADS and the chemical immobilization team / approved trappers. Option-1 (capture and release) is not permissible for the Sch.I animals indulging in crop-raiding.

4.2. If temporary capture proposed in Para 4.1 does not bring down the levels of crop-damage, permission may be sought from the CWLW/AO for exercising Option-1 (capture and translocate) for the problem animals (except those listed under Sch.I). The guidelines given in Section 2 for capture (Para 3) and translocation (Para 4) should be followed.

4.3. If the translocation proposed in Para 4.2 is either not possible or the translocated animals continue to indulge in serious crop-raiding, Option-2 (capture and retain) should be exercised with permission from the CWLW/AO. Preference should be given to capture of alpha-males, or animals known to be aggressive, or animals known to be habitual crop-raiders. The guidelines given in Section 2 for capture of wild animals (Para 3) should be followed. Option-2 (capture and retain) is not permissible for the Sch.I animals indulging in crop-raiding.

5. Extreme Measures: S.11(1)(b) permits killing of wild animals listed under Sch.II /Sch.III /Sch.IV for destroying crops. But this option should be exercised only sparingly and not until the CWLW/AO has caused an enquiry and come to the conclusion that all reasonable alternative options to protect crops have been exhausted. The permission in such cases should be given only

for killing a limited number of animals for a limited period of time and hunting should be carried out by the hunters engaged by the FD. As far as practicable, only the animals known to be habitual crop-raiders should be targeted for killing. Wild animals categorised as ‘Threatened’ in the IUCN Red List should not be killed for involvement in crop-raiding. Killing of Sch.I animals for destroying crops is not permissible under S.11(1)(a).

6. Relief to the Victims

6.1. Local forest staff, ADS and HWLW should help the victims of crop-depredation in claiming ex-gratia relief from the competent DFO. HWLW and DLC should also pursue the pending applications for ex-gratia relief with the concerned DFO to ensure quick settlement of claims.

6.2 Local forest staff, ADS and HWLW should also identify the poor and destitute among the victims who require support in the form of food grains to sustain themselves or in the form of seeds and implements to re-cultivate their land, and try to arrange help for them with the help of the district administration, NGOs or philanthropic agencies.

7. **Barriers and Watch-Towers:** The FD may plan for construction of watch-towers, trench, wall or fence (including power fence) for preventing incursion of wild animals in cropland in localities suffering very high levels of crop-depredation and where the beneficiaries are willing to set up LWS for protection and maintenance of watch-tower /barrier. Guidelines given in Section 2 (Para 2) for barriers and watch-towers should be followed.

8. A Parallel Strategy for Preventing Crop Depredation

8.1. **Alternative Cropping:** The fields located within or adjacent to forests as well as those situated along the known wildlife corridors are particularly vulnerable to depredation. It makes sense to encourage the farmers to change their agricultural practices in such areas and grow such crops as are profitable, but not favoured by wild animals. Help from the agricultural experts and NGOs, and suitable incentives from the government agencies can go a long way in facilitating the change. FD should also try to promote alternative cropping in identified areas through its eco-development schemes as well as awareness and educational programmes.

8.2. Commercial Farms and Plantations:

8.2.1. The DLC should arrange for a safety audit of large agricultural farms, sugar-cane fields, rubber and banana plantations, fodder farms, orchards, tea / coffee estates, etc. situated on the fringe of forests by a team of experts / experienced officers. Quite often the problem can be addressed by advising the stakeholders to adopt the following measures:

1. Engaging crop-guards / LWS equipped with simple scaring devices (e.g. catapult, crackers, search-lights, airguns, etc.).

2. Using properly designed barrier (trench or wall) or fence (including power fence)²² or a combination of the two.
3. Using ultrasonic-sound devices to repel the wild animals.
4. Using strong halogen lamp-posts along the periphery with the forests.
5. Seeking insurance cover.

8.2.2. Usually the wild animals do not harm the tea / coffee bushes except trampling the nursery or young crop. Therefore, it may be enough to put a barrier or fence around only the sensitive sectors and labour colonies rather than enclosing the entire estate. This is particularly important in case of tea / coffee estates being used as a corridor by wild animals.

8.2.3. The FD should, with the help of Panchayat / district administration, discourage the prospective planters from cultivating sugarcane, rubber, banana or any other plant on the fringe of forests which may allure wild animals unless they promise to set up their own barriers.

8.3. **Discourage Illegal Measures:** The farmers sometimes indulge in illegal measures for protecting their crops, such as shooting at the wild animals, using poison or explosives concealed in food items, and setting up electrified fences. The FD should identify such areas on the basis of past records and deal with this problem through awareness and publicity programmes as well as legal action. In particular, farmers should be encouraged to use safe and innocuous power-fences operated by solar-power or rechargeable batteries instead of tapping electricity illegally. Similarly, in case of cultivation over encroached government lands, emphasis of the government agencies should be on removing encroachment and protecting wild animals rather than chasing wild animals.

Section-6

Dealing with Livestock Depredation

1. General:

1.1. It is mainly the wild carnivores who indulge in killing livestock for their food, though reports of wild elephants killing cattle are also sometimes received.

1.2. Wild carnivores have been preying upon the livestock ever-since the humans started practicing animal-husbandry. This may be either due to the shortage of the wild prey or the relative ease of hunting the livestock vis-a-vis the wild prey. Thus, the desired strategy should be to take drastic measures for making it inconvenient and un-profitable option for wild carnivores to go after the livestock, and simultaneously, making concerted efforts for protecting for improving the prey-base within the forests.

²² Razor-wire fences are harmful to wild animals and should not be recommended. Chain-link fences or woven-wire fences are usually safe and effective.

2. Action before the Conflict:

2.1. ADS should identify the potential conflict areas on the basis of past records and visit them before the conflict season to assess their preparedness. Condition of the equipment (e.g. searchlights) supplied to the villagers / LWS during the previous season as well as old barriers and watch towers built in the area should be checked and action should be taken to get them into working condition.

2.2. ADS should arrange training for the livestock-owners and herders in anti-depredation techniques; help them in setting up a LWS and equip it with searchlights and crackers.

3. Action during the Conflict:

3.1. Initial responsibility for managing livestock-killing by wild animals should be taken by the regular forest staff of the PAs / Forest Divisions and the LWS. ADS should visit the conflict site when the villagers / LWS / local staff are unable to manage the situation or when a dangerous animal (e.g. tiger, leopard) is involved. Efforts should be made to remove the animal away from the conflict area by an appropriate strategy described in Section 3.

3.2. ADS, with the help of the LWS /local staff, should try to identify the wild carnivores habitually sneaking into human habitations for killing livestock. This information should be recorded in a dossier.

3.3. The forest staff should monitor the incidents of killing of livestock whether inside forests or in the neighbouring locations. They should particularly keep watch on areas with a past history of retaliatory killing of wild animals and address the problem through awareness and publicity programmes as well as legal action.

3.4. The forest staff should also pay due attention to the disposal of the carcass of the killed livestock so as to prevent its misuse for killing the predator either by poisoning it or using it as a bait. If the kill lies inside forest or very close to it and its safety can be ensured, it should be left to be devoured by wild animals. It may be useful to put up a camera-trap, if available, to photograph the wild animal in question. In all other cases, arrangement should be made to bury / burn the carcass.

4. Strong Measures:

4.1. In case the level of conflict is more than the tolerance level of the stakeholders, permission of the CWLW/AO may be obtained under S.11(1)(b) for exercising Option-1 (capture and translocate) against the habitual livestock-killers. The operation should be carried out with the help of the ADS and the chemical immobilization team / approved trappers. The guidelines given in Section 2 for capture (Para 3) and translocation (Para 4) should be followed. Option-1 (capture and translocate) is not permissible for the Sch.I animals indulging in livestock-killing.

4.2. If the translocation proposed in Para 4.1 is either not possible or the translocated animal returns and indulge in livestock-killing, permission of the CWLW/AO may be obtained under S.11(1)(b) for exercising Option-2 (capture and retain) against the habitual livestock-killer. The guidelines given in Section 2 (Para 3) for capture of wild animals should be followed. Option-2 (capture and retain) is not permissible for the Sch.I animals indulging in livestock-killing.

5. Extreme Measures: S.11(1)(b) permits killing of wild animals listed under Sch.II /Sch.III /Sch.IV indulging in livestock-killing. But this option should be exercised only sparingly and not until the CWLW /AO has caused an enquiry and come to the conclusion that all reasonable alternative options to protect livestock have been exhausted. The permission in such cases should be given only for killing a limited number of animals for a limited period of time and hunting should be carried out by the hunters engaged by the FD. As far as practicable, only the animals known to be habitual livestock-killers should be targeted for killing. Wild animals categorised as 'Threatened' in the IUCN Red List should not be killed for involvement in cattle-killing. Killing of Sch.I animals for killing livestock is not permissible under S.11(1)(a) .

6. Relief to the Victims

6.1. Local forest staff, ADS and HWLW should help the victims of livestock-depredation in claiming ex-gratia relief from the competent DFO. HWLW and DLC should also pursue the pending applications for ex-gratia relief with the concerned DFO to ensure quick settlement of claims.

6.2 Local forest staff, ADS and HWLW should also identify the poor and destitute among the victims who require livelihood support or any other relief and try to arrange help for them with the help of the district administration, NGOs or philanthropic agencies.

7. Barriers and Watch-Towers: The FD may plan for construction of watch-towers, trench, wall or fence (including power fence) for preventing incursion of wild animals in in localities adjoining forests suffering very high levels of livestock-depredation and where the beneficiaries are willing to set up LWS for protection and maintenance of watch-tower /barrier. In the Sundarbans, FD has been using Nylon-net fences to prevent straying of tigers into villages. Guidelines given in Section 2 (Para 2) for barriers and watch-towers should be followed.

8. A Parallel Strategy for Preventing Livestock-Killing:

4.1. Effective control of livestock depredation is not possible without regulating the animal-husbandry practices like sending the cattle, particularly the unproductive ones, for grazing inside forests without an attendant. In forest areas where grazing is allowed, the FD should impose suitable restrictions in terms of time and area of grazing to minimise livestock-wild animal encounters. Yet another practice that needs to be encouraged among the keepers through awareness programmes is that of stall-feeding of livestock.

4.2. The problem may also be addressed by the FD, where possible, through eco-development schemes for promoting fodder reserves on community lands outside forests— thereby reducing livestock movement inside forests. The FD may also build up community livestock-sheds; set up artificial insemination centres; and undertake vaccination programme in collaboration with the Veterinary Department in the conflict-affected villages to earn the goodwill of the people.

4.3. There is also a need to motivate the livestock-owners through JFMCs, Panchayat and district administration to build strong, robust and properly designed livestock-sheds / poultry farms for keeping the carnivores out.

4.4. The organised and resourceful stakeholders maintaining dairy-farm, poultry, piggery, etc. should be advised to invest in properly designed wildlife-proof cattle sheds. They may also be advised to set up properly designed barriers (trench/wall) or fences (including power fence) or a combination of the two for preventing the straying of wild animals into strategic locations. Designs of such barriers are available with the CZA. Strong halogen lamp-posts along the periphery with the forests are also useful to deter most of the wild animals. Arrangement should also be made for suitable disposal of garbage and left-over food

4.5. JFMCs and Tea / Coffee Estates should be encouraged to obtain insurance cover against loss of livestock by their members / labourers.

Section-7

Dealing with House Damage

1. General:

Almost all cases of house damages in the country can be attributed to elephants. This is quite a serious issue– not only because many poor villagers are put to great hardships, but also because a large number of cases of human deaths and injuries take place in the process.

2. Action before and during the Conflict:

Cases of house damage in many areas usually peak either during or immediately after the harvesting season and measures suggested for dealing with crop-depredation in Section 5 (Paragraphs 2 and 3) are applicable in such cases as well.

3. Strong Measures:

3.1. Some individual elephants may develop a habit of targeting and damaging houses throughout the year. ADS/forest staff should inquire into the cases of house-breaking by elephants and try to identify elephants repeatedly indulging in such incidents (Ref. Sec.4, Para 4). Permission of the CWLW may be obtained for exercising Option-1 (capture and translocate) against the habitual house-breakers under S.11(1)(a) since these elephants do pose threat to human life. The operation should be carried out with the help of the ADS and the chemical immobilization team / *kunki* squad. The guidelines given in Section 2 for capture (Para 3) and translocation (Para 4) of wild animals should be followed.

3.2. If the translocation proposed in Para 3.1 is either not possible or the translocated animal returns and continues to indulge in depredation, permission of the CWLW should be obtained for exercising Option-2 (capture and retain) against the animal under S.11(1)(a). The guidelines given in Section 2 (Para 3) for capture of wild animals should be followed.

4. Relief to the Victims

4.1. Local forest staff, ADS and HWLW should help the victims of house-damage in claiming ex-gratia relief from the competent DFO, if eligible.²³ HWLW and DLC should also pursue the pending applications for ex-gratia relief with the concerned DFO for quick settlement of the claims.

4.2. Local forest staff, ADS and HWLW should also identify the poor and destitute among the victims who require support for the repairs or reconstruction of their huts or any other relief and

²³Only a few state governments provide ex-gratia relief for damage to houses and property by wild animals.

try to arrange help for them with the help of district administration, NGOs or philanthropic agencies.

5. **Barriers:** The FD may plan for construction of Elephant-Proof Trenches (EPTs), walls, or power fences for preventing the incursion of wild elephants in localities adjoining forests suffering very high levels of depredation and where the beneficiaries are willing to set up LWS for protection and maintenance of the barrier / fence. The FD may also take similar measures to protect forest villages/ beat offices /timber depots / rest houses against elephants. Guidelines have been given in Section 2 (Para 2) for trenches and power-fences.

6. **A Parallel Strategy for Preventing House Damage:** Quite often, the house damage may be circumstantial or accidental in nature and influenced by local factors. These issues can be handled only through awareness and educational programmes targeting the concerned stakeholders. For example:

1. Elephants are known to be attracted to a house by the smell of country-liquor. The villagers should be cautioned against storing country-liquor in their houses. The district administration should arrange special drives from time to time in villages situated within or adjacent to forests to discourage brewing of country liquor.
2. An elephant may venture dangerously close to a house lured by a banana plant or a jackfruit tree growing in the compound or pumpkins growing on the wall of the house. The villagers should be cautioned about the dangers of growing all such plants close to their houses as may attract elephants.
3. An elephant may be attracted to a house by the smell of salt or paddy or any other eatable. The villagers should be advised to store salt, paddy and other edibles in a place away from the direction from which an elephant is likely to approach. A useful way to suppress the smell of food-items and to distract elephants is to spray a dilute solution of phenyl or some other foul-smelling (but non-poisonous) substance on the outer walls from time to time.
4. Elephants are also known to target granaries after the crop has been harvested. The villagers should be advised to set up granaries far from the fields and away from the usual routes of elephants. As far as possible, granary should not be a part of the main house. If it is not possible, granary should be set up on the roof of the house at a height beyond the reach of an elephant's trunk.²⁴
5. Observations reveal that the electrified houses are less prone to damage by elephants than those without electricity. District administration / Panchayat should be persuaded to take up electrification projects in the conflict zones on a priority basis.
6. FD should discourage construction of buildings and other structures on known elephant routes and corridors.
7. The organised and resourceful stakeholders (e.g. Tour Operators ,Tea / Coffee Estates, Army, etc.) should be advised to invest in properly designed EPTs, walls, or power fences to protect their residential areas / critical assets located in or around forests. Strong halogen lamp-posts along the periphery with the forests are also useful to deter most of the wild elephants.

²⁴In some parts of Odisha, farmers keep paddy in under-ground storage (known as *khani-dhaan*) to protect it from elephants. The Central Rice Research Institute, Cuttack, has also designed elephant-proof storage bins for protecting paddy against elephant.

8. JFMCs and Tea / Coffee Estates should be encouraged to obtain insurance cover against damage to houses of their members / labourers. Some tea gardens in the Northern West Bengal have insured their labour huts against damage by wild elephants.

Section-8

Managing People

1. Ex-gratia Relief and Other Support:

1.1. The purpose of ex-gratia relief is to help the people overcome the effects of damage inflicted on them by the wild animals and to sustain their sympathy for the wild animals. But it does not serve the desired purpose when the people feel that the relief being paid is unjust and unfair, and get disgusted with the hassles, delays and malpractices in receiving their dues. Ex-gratia relief is an important tool for managing the people and forest officials should strive to take the maximum benefit from it.

1.2. The FDs should review the rules and procedures for payment of ex-gratia relief to make it fast, hassle-free and transparent. It can generally be done by delegating the responsibility of inquiry and disbursement of ex-gratia relief to the JFMCs/panchayat and prescribing a time-limit for the same. FDs in some States have authorised the DFOs to disburse a part of the ex-gratia relief within 24 hours in the event of human deaths / injuries pending final inquiry.

1.3. ADS, LWS and HWLWs should help the victims with the submission of their claims immediately after the incident and also pursue the matter with the appropriate authorities. This is particularly important in conflict situations leading to injury / death when the injured person / dependants of the deceased need immediate financial support. Where the rules so permit, part of the ex-gratia-relief should be made available to the victims or their dependents urgently without waiting for official formalities.

1.4. The DLC should also review the status of settlement of claims periodically and look into complaints and grievances brought to his notice. It is a common experience that the ADS / forest staff face a hostile atmosphere in an area having a multitude of unsettled claims. The DLC should, therefore, ensure that all pending claims from the previous conflict season get settled before the next conflict season sets in.

1.5. The biggest hassle in the payment of ex-gratia relief in many States is often the shortage of funds and delays in budgetary allocations to DFOs. Some FDs have overcome this problem by placing special non-lapsable funds at the disposal of DFOs. Innovative efforts have been made in some States for augmentation of funds from other sources for ex-gratia relief.²⁵

1.6. As far as possible, the FDs of the adjoining States should follow similar rates in respect of ex-gratia relief to the victims of HWC.

1.7. **Supplementary Relief:** It is possible to go beyond what is prescribed in the ex-gratia rules to help the sufferers and earn their goodwill. ADS and HWLW may identify the poor and destitute among the victims who require support in the form of livelihood support, food- grains, seeds, tools and implements, camping material, etc. to recover from their losses and try to arrange help with the help of the district administration, NGOs or philanthropic agencies.

1.8. **Medical Support:**

1.8.1. Care of the persons injured in HWC is an issue that should get serious attention of the FD and the matter should not end with the payment of ex-gratia relief. ADS and HWLW may also arrange transport and medical support for the injured persons. The FD may directly pick up the bill for medical expenses instead of expecting the injured person to make payment and then apply for reimbursement.

1.8.2. Injuries caused by wild animals may often be very serious and need special care. For example, a person trampled by an elephant may need prosthetic limbs or a wheelchair and a woman whose face has been mauled by a bear may need plastic-surgery. The SLC/DLC may make arrangement with the Health Department, Chief Medical Officer, hospitals, NGOs and philanthropic organisations before the conflict season for providing quality medical aid on priority basis to the injured persons.

²⁵ Uttarakhand FD has set up 'Human-Wildlife Conflict Relief Disbursement Fund' vide its GO dated 10.12.2012 with seed money of Rs. 4 Cr from the Uttarakhand CAMPA and Rs. 3 Cr from the Uttarakhand Forest Development Corporation. The funds provided by the State Government, Central Government and other agencies including private donors for the purpose of ex-gratia relief are deposited into this fund. The DFOs get an advance of Rs. 20 lakh into their accounts for payment of ex-gratia relief and the expenditure is refunded within 48 hours of the receipt of sanction orders from the DFO. So, a DFO always has an amount of Rs. 20 Lakh available in his account.

1.9. Insurance Cover:

1.9.1. Insurance as a tool for providing relief to the victims of accidents and unforeseen events has many advantages over ex-gratia which is often inadequate and does not cover all kinds of losses suffered by the people. Attempts should be made to take advantage of the existing insurance schemes.

1.9.2. Insurance companies provide group insurance schemes to cover death and injuries. They also have policies to cover houses and livestock. Insurance companies are generally reluctant to provide cover for crop damage in view of complications of verifying claims and assessing damage, and also because they do not consider it a lucrative venture.

1.9.3. The State Government in Kerala has provided life insurance coverage to the tribal population inhabiting forests. Some JFMCs in the Northern West Bengal are covered by the Janata Personal Accident Insurance Policy of the New India Assurance Company. Some tea gardens in the Northern West Bengal have insured their labour huts against damage by wild elephants.

1.9.4. The Ministry of Agriculture, Government of India, has introduced 'National Crop Insurance Project' in the country during the 12th Plan through Agriculture Insurance Company of India and some public sector insurance companies. This is meant to cover food crops, oil seeds and annual commercial / horticultural crops against pests and natural calamities. The scheme has a well laid out procedure for assessment of crop damage and settlement of claims. The premium is jointly subsidised by the Central Government and the State Government to the tune of 40% to 70%. The Ministry of Agriculture has also been implementing a Livestock Insurance Scheme in 300 districts of the country through the State Livestock Development Boards in which 50% of the premium is paid by Government of India as subsidy. It will be appropriate to bring damage to crops and livestock by wild animals under the ambit of the aforesaid schemes.

1.9.5. Commercial farms, Tea /Coffee Estates and JFMCs should be encouraged to obtain insurance cover for their workers / members against death / injury of humans, damage to crops / houses and loss of livestock caused by wild animals. JFMCs, in particular, should be persuaded to spend a part of their income from NTFPs in buying insurance cover for their members.

2. Crowd management:

2.1. Crowd management is a formidable issue for the managers of HWC all over the country. People often react in an irrational manner when a wild animal strays into their locality. In its simplest form, they may get curious, get dangerously close to the animal, ignore warning issued by the forest staff, and make the escape difficult for the animal. In its worst form, the crowd may get violent, obstruct the forest staff from rescuing the animal, chase the animal indiscriminately and harass it — leading to injuries and even fatalities of humans and / or the animal in question. There have been incidents of the unruly crowd assaulting the forest staff and killing the trapped animal. It is, therefore, necessary for the ADS, chemical immobilisation team, *kunki* squad, trappers/hunters and the general forest staff to anticipate crowd behaviour and prepare for it before executing any capture / driving operation.

2.2. Crowd management essentially means ensuring the safety of the animal, the forest staff, and, of course, the crowd itself. It is basically a law and order situation and involves the district administration and the police. In Kerala, the DGP has issued standing instruction to the district police to provide escort to the forest staff engaged in capture or driving of wild animals. In some States, the District Magistrates invoke Section 144 of the Cr PC to bring the crowd under control. The local politicians sometimes come to the rescue of the forest officers and persuaded the crowd to cooperate.

2.3. The DLC and ADS should make advance preparations for crowd management. They should identify the sensitive areas on the basis of past records and solicit police help before visiting these areas. They should carry out publicity and awareness programmes in these areas and educate the people about the dangers of unruly crowd behaviour. They should identify the influential community leaders and request them to accompany the ADS in the field. A deserving community leader may also be appointed as HWLW and made a part of the HWC management team. Help should also be taken from the local panchayat and NGOs to manage the crowd. Forest staff from the neighbouring forest divisions and members from the local JFMCs may be requisitioned to strengthen the ADS.

2.4. The effort of the ADS and LWS should be to keep the people at a safe distance from the animal and to forewarn the people living on the expected escape route of the animal. Armed Policemen and forest staff should be deployed at strategic points. Nets made of Nylon or Jute should be used as a shield to protect people from sudden bursts from the carnivores. A row of volunteers holding *mashaal* (lighted torches) can provide an effective shield for the people and also prevent the animal from taking a wrong route.

3. Publicity and Awareness Programme:

3.1. FDs routinely conduct Publicity and Awareness Programmes (PAPs) during the Forest Festival (July) and Wildlife Week (October) every year. JFMCs also provide a platform to the forest officers and staff to have regular interactions with the people living on the fringe of forests and PAs. Many NGOs also carry out PAPs relating to wildlife and environment.

3.2. PAPs relating to HWC are expected to be different from the routine programmes inasmuch as these aim at enhancing/sustaining the tolerance level of various stakeholders towards wild animals; addressing the behaviour and life-styles of the people which contribute towards the conflict; and also ensuring their active participation in the management of conflict.

3.3. PAPs can be conducted through meetings, workshops, radio/TV talks, press-releases /advertisement in newspapers, posters, hand-bills, calendars, endorsement by celebrities, etc. But best and lasting results are obtained through personal contacts and one-on-one interactions between the stakeholders and the forest officials.

3.4. ADS and the field staff come into maximum contact with the stakeholders and also serve as unofficial spokespersons of the FD. Therefore, it is extremely important to initiate the PAP with the field level officers and staff to make them aware of the theory and practice of HWC management and help them build a positive and liberal attitude both for the people and the wild animals. Motivated and well-informed forest officers and staff serve as the most effective agents for PAP.

3.5. The next in terms of effectiveness are the enlightened and pragmatic lot from among the local communities who understand the intricacies of the HWC and hold influence over their community. The DLC and ADS should identify these persons; invite them to the PAPs as resource persons; involve them in LWS; use them for crowd-management in the field; and get some of them appointed as HWLWs (Ref. S.1, P.2.3) or members of DLAMC (Ref. S.1, P.2.1.1) or PA Level Advisory and Monitoring Committees (Ref. S.1, P.2.1.2).

3.6. The DLC and ADS should carefully identify various stakeholders and their stakes and also list mutual expectations of each stakeholder with the FD and then plan a PAP for them accordingly. Stakeholders may include district administration, police, municipality / panchayat, JFMCs, politicians / public representatives, army, railways, veterinary department, agriculture department, health department, development agencies, mining industry, tourism industry, big farms / tea estates / coffee estates, small farmers, livestock-herders, fishermen, NTFP collectors, schools / colleges, and many more. The contents and strategy for PAP should be tailor-made for each stakeholder, his stake and tolerance level, and mutual expectation with the FD. For example, stakes of big planters are different from the small farmers and livestock-herders and mutual expectations of each group with the FD are also different. Media, NGOs, research organisations, doctors, and relief/philanthropic organisations are some of the groups which the FD should cultivate in order to get support for HWC management.

3.7. Some suggestions about the issues which should be addressed through PAP are given below.

3.7.1. Enhancing Tolerance Level of the Stakeholders:

1. Educate stakeholders about wild animals — their nature, home-range / territoriality, intra-specific competition, breeding habits, food preference, reasons for straying out into tea gardens / sugarcane fields, reasons for crop-raiding / cattle-killing, etc.
2. Educate stakeholders about the livelihood and development requirements of the people impacting wildlife habitats and consequential conflict with wild animals.
3. Remind stakeholders about the positive ecological, economic and cultural values of the wild animals.
4. Deal with stakeholders' threat-perception of the wild animals by addressing misconceptions and rumours, sharing statistics of conflict level, and highlighting the accidental nature of majority of human deaths / injuries.
5. Motivate the media to report objectively and help in spreading awareness about HWC, and desist from sensational reporting which may lower the tolerance level of the stakeholders.
6. Inform stakeholders about the preparedness of the FD to deal with HWC and action taken against the problem animals in the past.
7. Inform stakeholders about the ex-gratia scheme and other support available for the victims of HWC.
8. Inform stakeholders about the benefits derived by the community through eco-development works and other forestry works vis-à-vis the loss suffered due to HWC.
9. Show appreciation to the stakeholders for their cooperation / good work.
10. Identify the opinion-makers among stakeholders and arrange a separate one-on-one interaction with them.
11. Arrange training for the stakeholders in anti-depredation techniques.
12. Publicise contact details of the ADS, DLC, SLC and CWLW among the stakeholders and inform them about the grievance-redressal system.

3.7.2. Addressing Behaviour and Lifestyles of the Stakeholders:

1. Inform forest-fringe dwellers about the fallout of unregulated grazing and collection of firewood/firewood/NTFPs, forest fires, trespass and encroachment vis-à-vis HWC.
2. Inform livestock owners about the perils of keeping stray dogs and loose cattle, and virtues of stall-feeding of livestock, wildlife-proof livestock-pans and Livestock Insurance Schemes.
3. Educate tourists about the threats associated with feeding of wild animals and throwing garbage and left-over food around.
4. Caution forest-fringe dwellers about the perils of storing country-liquor in their homes and moving around in intoxicated condition.
5. Inform forest-fringe dwellers about the perils of going to the forests for relieving them and about the government schemes to provide them indoor toilets.

6. Inform development agencies about the fall out of blocking wildlife corridors.
7. Educate farmers about alternative cropping for avoiding crop-raiding by wild animals.
8. Inform forest-fringe dwellers about the virtue of having electricity in their houses and streets vis-à-vis HWC.
9. Caution farmers/livestock-herders about shooting at the wild animals; poisoning the livestock-carcass for killing the predators; or setting up electrified fences to protect their crops, and educate them about safe and legal ways of protecting their crops and livestock.
10. Inform forest-fringe dwellers about the futility of ‘rescuing’ wild cubs /calves seen without mother in the vicinity of forests.
11. Caution big farmers / plantation companies against cultivating sugarcane, rubber, banana or any other plants alluring wild animals without making a provision for a barrier or power fence.

3.7.3. Ensuring Participation of Stakeholders in HWC Management:

1. Motivate villagers / JFMCs to form LWS.
2. Encourage resourceful and privileged stakeholders to set up their own LWS and barriers/fences, and underprivileged stakeholders to help in protecting / maintaining the barriers / fences set up by the FD.
3. Educate stakeholders about precautionary measures to minimise the impact of HWC.
4. Educate stakeholders about the limitations of various anti-depredation measures like capture, translocation, barriers, etc. to help them appreciate the decisions taken by the wildlife authorities.
5. Caution stakeholders about the ensuing breeding season / conflict season of a wild animal and educate them about the precautions to be taken.
6. Caution stakeholders about the wild animals proclaimed under S.11(1) for posing threat to human life and educate them about the precautions to be taken.
7. Motivate resourceful and privileged stakeholders to procure insurance cover for their workers / members against any damage due to HWC.
8. Gather information about effective traditional practices of protecting crops and livestock from wild animals and disseminate the same among other communities..
9. Motivate the residents of a hamlet situated inside a high conflict zone or blocking a wildlife corridor to relocate to a safe area.
10. Persuade district administration, hospitals, NGOs and philanthropic organisations to help the victims of HWC with relief and medical support.
11. Urge stakeholders to help in crowd-management.
12. Seek help from politicians and public representatives to get adequate funds for managing HWC and help in spreading awareness among the stakeholders.
13. Urge Public Sector Undertakings / Companies to support anti-depredation measures and eco-development works under their Corporate Social Responsibility Projects.

4. Joint Forest Management Committees

4.1. A large number of Joint Forest Management Committees (JFMCs)²⁶ have already been set up by FDs for involving local people in the management and protection of forests including PAs. FDs should make a concerted effort to bring all the forest-fringe areas prone to HWC under the ambit of JFMCs and involve them actively in the management of HWC.

4.2. Management of HWC and corresponding duties and obligations of the JFMC members should find a place in the micro-plans of the JFMCs.

4.3. JFMCs should, in particular, be involved in providing volunteers for LWS and ADS; constructing and maintaining barriers and watch-towers; preventing retaliatory killing of wild animals; and verifying applications for ex-gratia relief. Distribution of crackers, search-lights and other materials for conflict management should preferably be done through JFMCs only.

4.4. As an incentive, FDs may reward the JFMCs actively co-operating in the HWC management with liberal financial help for eco-development works. JFMCs may also be brought under group insurance schemes covering human life / injuries, livestock and houses.

4.5. JFMCs having substantial income from forests (e.g. from sale of NTFPs or from eco-tourism) may be encouraged to spend a part of their income on maintenance of barriers, engagement of crop-guards and payment of premium for group-insurance policies.

5. Eco-development

5.1. A number of Centrally Sponsored Schemes in the Wildlife Sector provide financial assistance for carrying out eco-development works in and around PAs. Some schemes including Project Elephant and some Externally-Aided Projects also provide financial assistance for undertaking eco-development works in forest areas other than PAs. Eco-development should be used as a tool for addressing HWC.

5.2. Eco-development activities should be planned for reducing the dependence of the local people on forest resources (e.g. collection of fodder and firewood from forests).

²⁶Also referred to as Forest Protection Committees (FPCs) and Eco-development Committees (EDCs).

5.3. Eco-development activities may also be planned for reducing the impact of HWC (e.g. construction of barriers and watch-towers; promotion of alternative crops; construction of community granaries and livestock-pans, provision of community-latrines; etc.).

5.4. Eco-development activities should also be planned as a means for indirectly compensating the community against damage caused by wild animals and sustaining their tolerance level (e.g. promotion of eco-tourism facilities; construction and repair of community centres, schools and dispensaries; repair of village roads; provision of minor irrigation facilities; provision of solar streetlights; etc.). It should be made clear to the beneficiaries of these activities that they have been receiving various benefits as a reward for their cooperation for protecting wild animals.

5.5. Eco-development works for a particular area should be based on micro-planning of the concerned JFMC if there is one or in detailed consultation with the concerned stakeholders. Eco-development works should not be stereotypes but based on proper assessment of the mutual impact of the people and the wild animals.

5.6. Public Sector Undertakings / Companies should be urged to sponsor eco-development works in high HWC zones under their Corporate Social Responsibility Projects.

6. Relocation of Human Settlements

6.1. Relocation of a human settlement as a strategy for mitigating HWC should be considered as an option in the following cases:

A. When the settlement has been witnessing very high level of conflict on a regular basis and all possible strategies for bringing the conflict under control have been tried and found to be ineffective.

B. When the settlement is known to be obstructing an important and recognised wildlife corridor.

6.2. A relocation proposal should meet the following criteria:

A. It should be based on the willingness of the people involved.

B. It should be compatible with the existing laws, in particular IFA-1927, WPA-1972, EPA-1980, FCA-1980 and the Scheduled Tribes and Other Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA-2006), and the National Rehabilitation and Resettlement Policy, 2007.

C. It should be approved by the DLAMC and SBWL.

6.3. A detailed guidelines/protocol for relocation of villages from Tiger Reserves has been prepared by the NTCA (http://www.ntcavillagerelocation.nic.in/about_us.aspx#) which can be suitably adapted for use in other areas as well.

ABBREVIATIONS

ADS	Anti-Depredation Squad
AO	Authorised Officer
Cr PC	Criminal Procedure Code
CWLW	Chief Wildlife Warden
CZA	Central Zoo Authority
DFO	Divisional Forest Officer
DGP	Director General of Police
DLC	District Level Coordinator
DLMAC	District Level Advisory and Monitoring Committees
EPA-1980	Environment (Protection) Act, 1980
EPT	Elephant-Proof Trench
ESZ	Eco-Sensitive Zone
FCA-1980	Forest Conservation Act, 1980
FD	Forest Department
FRA-2006	Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Rights) Act, 2006
HWC	Human Wildlife Conflict
HWLW	Honorary Wildlife Warden
IFA-1927	Indian Forest Act, 1927
LWS	Local Wildlife Squad
MoEFCC	Ministry of Environment, Forests and Climate Change
MLA	Member of Legislative Assembly
MP	Member of Parliament
NGO	Non-Governmental Organisation
NTCA	National Tiger Conservation Authority
PA	Protected Area
PAP	Publicity and Awareness Programme
PCA-1960	Prevention of Cruelty to Animals Act, 1960
S.	Section
SBWL	State Board for Wildlife
Sch.	Schedule
SLC	State Level Coordinator
SOP	Standard Operating Protocol
WII	Wildlife Institute of India
WPA-1972	Wildlife (Protection) Act, 1972

Management of Human-carnivore conflict

On the basis of the expert opinion and discussions during the workshop “Human-wildlife interactions and management of invasive species” conducted by the Wildlife Institute of India, a team of scientists and researcher designed these draft guidelines to manage the human-carnivore conflict in the country. Team also conducted a post-workshop intensive literature survey for preparing these decision making flow-charts. The first flowchart (figure 2) provides a decision-making framework for managers to resolve carnivore conflicts using the existing spatial and temporal information related to conflict cases. The second flowchart (figure 3) provides the steps to be followed in the case of an attack by a carnivore on humans. Subject matter with superscript has been explained in detailed in the following text.

The primary task of the park manager, in case of human-carnivore conflict, is to understand the spatial and temporal distribution of the conflict in the forested area. This understanding can be gained by mapping the existing information relating to the compensation paid to villagers for damage to property, livestock loss and attacks on humans across the years. The method of identifying the present and potential hotspots is described in the following:

IDENTIFY AND CATEGORIZE HOTSPOTS OF CONFLICT

Present hotspots. These are the areas (forest beats, villages, etc.) that have witnessed maximum conflict cases. In the case of a carnivore conflict, villages should be mapped for the frequency and intensity of the conflict (nature of each conflict event-encounter, injury, fatal attacks). All India tiger monitoring guide could be used as a model for required data collection. Frequency and intensity of the conflict can be quantified using the information relating to the compensation offered by the forest department and the number of reported cases. The priority should be; **human injury/attack > Livestock depredation> crop + property damage > property damage > crop damage > perceived conflict.** An area with a high frequency of damage under any of these categories could be further classified on the basis of conflict at the micro-scale (beat or range level). Considering the social attitude when mapping the conflict hotspots is crucial as sometimes even communities with low levels of conflict could react violently to damage caused by wildlife if the tolerance level is low. Regular meetings and discussions are needed to understand the attitudes of different communities (see the section ‘Social Capacity’).

Figure 2. Proposed decision making chart for managing the carnivore-human conflict.

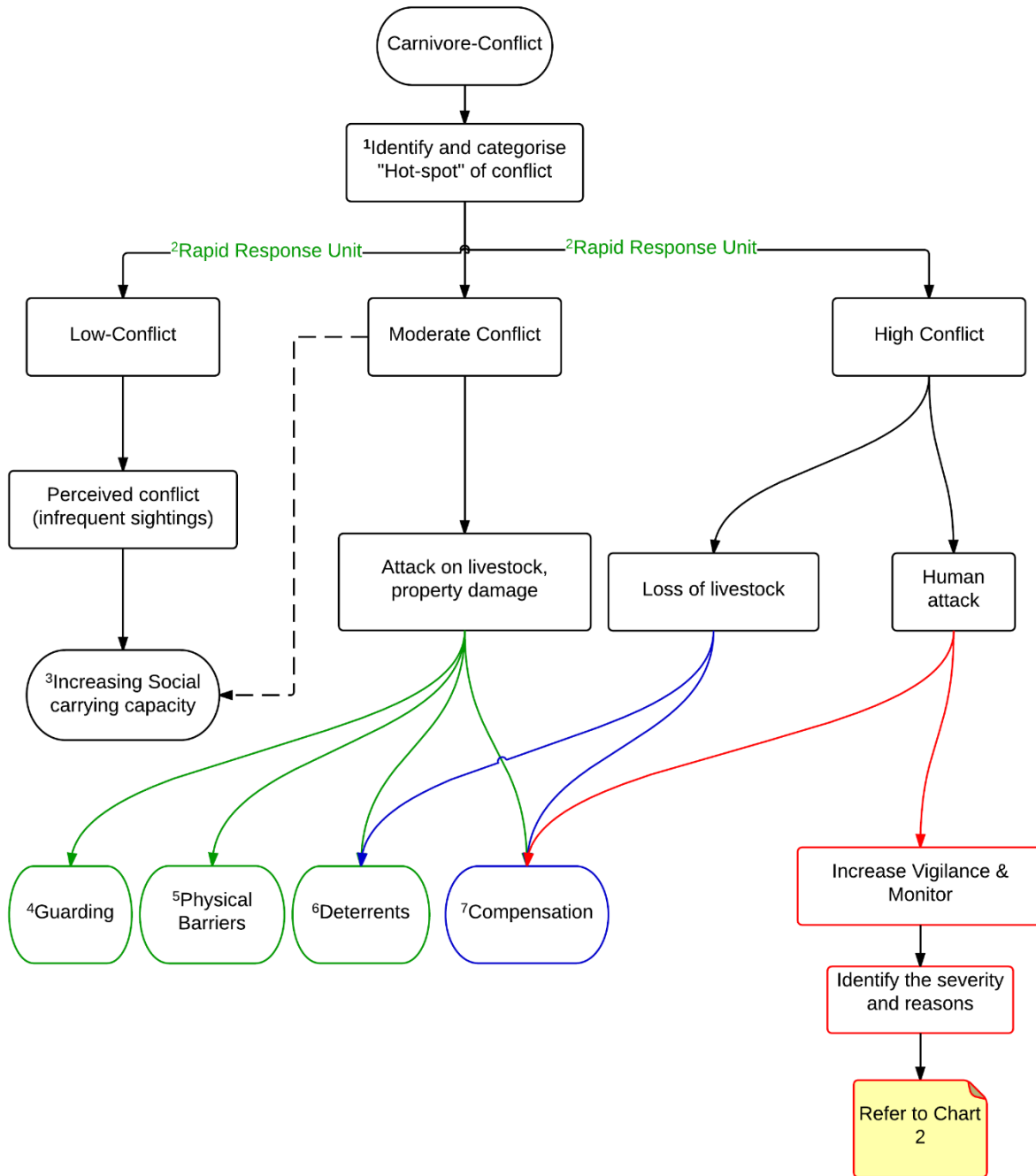
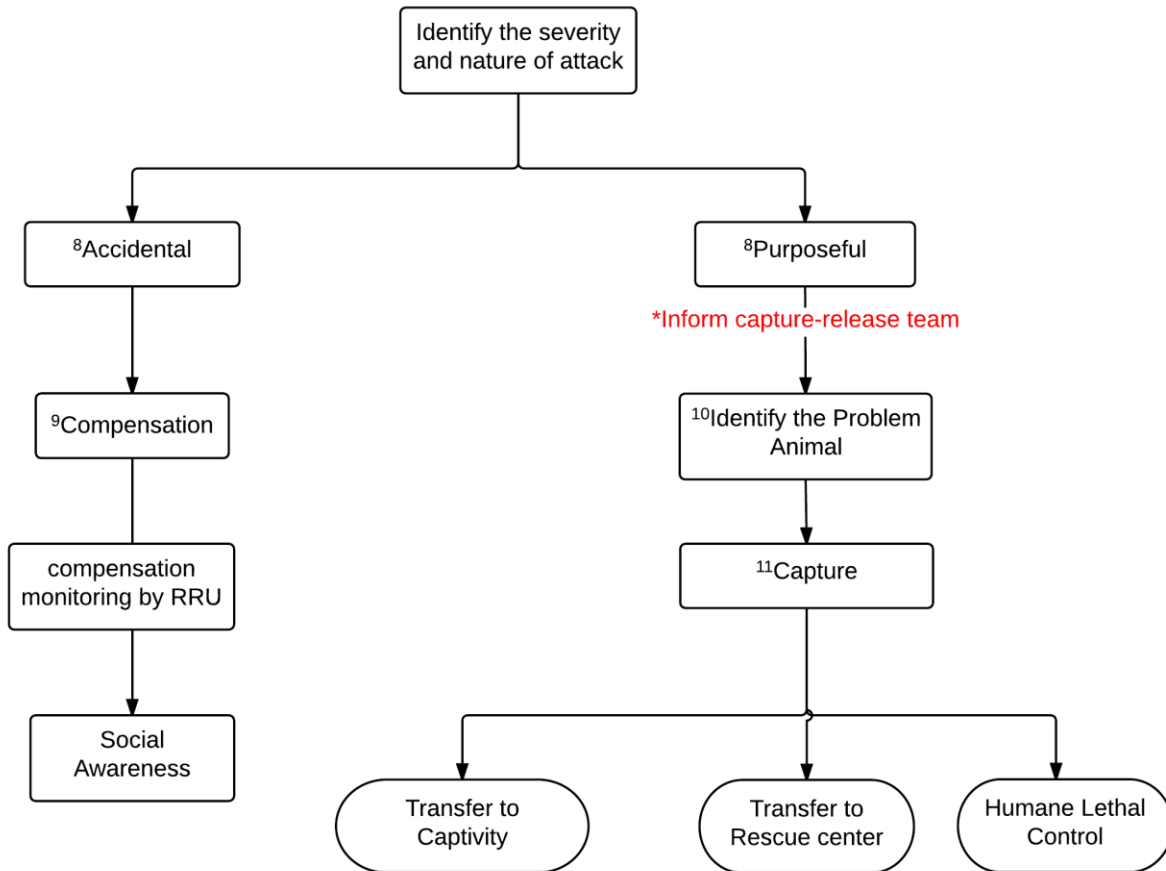


Figure 3. Proposed decision making chart in case of attack on human by carnivore.



Potential hotspots. These are the areas (forest beats, villages, etc.) that could witness an increase in the number of conflict cases in the near future. The hotspots can be in space (village, pasture, forest block) or time (eg. winter season, dawn-dusk period). Spatial hotspots may be so, due to some drivers that make them vulnerable (eg. near forest, near cliffs from where snow leopard can easily attack a corral, remote unattended field where herbivores can damage, etc). Information on the populations of animals and human activity around the forest is required for identifying such hotspots. However, if adequate steps are taken in a timely manner (such as providing fencing, creating social awareness and translocating the increased population to other suitable habitats) potential conflict can be prevented.

UNDERSTAND THE PERCEIVED CONFLICT

After categorizing the surrounding areas into conflict zones broadly, it is essential for the managers to understand the attitude of the villagers towards wildlife. Researchers have started exploring the complex issue of human attitudes towards wildlife (Dickman, 2010; Siex and Struhsaker, 1999; Suryawanshi et al., 2013). In most cases wild species are perceived to be a threat to human life and resources; however, systematic studies have not found a strong basis in support of such perceptions (Siex & Struhsaker, 1999; Suryawanshi et al., 2014). Infrequent sightings of predators and a lack of evidence to prove the involvement of a carnivore in loss of cattle/injury indicates negative human perception. In such situations, it becomes important for authorities to make informed decisions before planning any management.

INCREASE SOCIAL CARRYING CAPACITY

Previously, local communities had more tolerant attitudes towards wild animals because of religious reasons and their long-term attachment with areas (Gadgil & Guha, 1993). However, with the increasing frequency of conflict cases over the years, communities are becoming less tolerant towards wildlife (Dickman, 2010) which might also be exacerbated by the way media reports such incidences in the papers and television. Creating awareness among media, as well as public and policy makers at various scales (local, regional and national) about the unique nature of shared spaces in India which has been part of our history and culture could lead to decreased perception of conflict among people who can change the way public view this issue. Simple

measures adopted by local communities could reduce not only the number instances of in which wild animals are encountered but also the chances of these encounters leading to conflicts. These simple precautionary practices have been described well in various reports and papers. For example, Athreya and Belsare (2007) provide a list of do's and don'ts to avoid being attacked by a leopard, and Charoo et al. (2011) mention precautionary measures for reducing chances of bear attacks on livestock during grazing and at night in pens.

LIVESTOCK GUARDING

Guarding grazing herds can considerably reduce the frequency of attacks on livestock as herdsman with knowledge of carnivore presence in the landscape would avoid the predation hotspots (Karanth et al., 2013). The effectiveness of guarding varies with the number of people involved and the size of the property/herd/farm. There are numerous traditional methods of livestock husbandry in India that takes into account the presence of predators. It is important to study these and use it in for proactive mitigation.

Community guarding. Involving more people in guarding property (farms and livestock corrals) will reduce the number of attacks as well as the number of vigil days per family/individual.

Using livestock guarding animals. In Asia, the use of livestock guarding dogs started some 5000 year ago (Olsen, 1985). It has also been suggested that dogs are the cheapest guarding option both during the day, during grazing, and at night, in livestock corrals. However, the effectiveness of guarding dogs varies according to the breed, terrain of the grazing area, type and density of the predator and the number of guarding dogs (Green et al., 1994). The use of dogs in wilderness as grazing areas should be discouraged as it will affect the wildlife existing in these areas.

Employing local people as guards. In areas where the conflict is very high and unmanageable by the above means, the forest department can employ local people from the villages as night watchmen. This would ensure giving them a source of income and betterment of their livelihoods.

PROVIDE COMPENSATION

Ex-gratia. In the case of the injury or death of a human being as well or livestock, crop-depredation and damage to property due to wildlife, state governments and a few non-governmental organizations provide *ex-gratia* payments in order to reduce the animosity of the

communities cohabiting with the wild animals (Krithivasan et al., 2009; Lenin and Sukumar, 2008; Madhusudan, 2003; Mishra et al., 2003). *Ex-gratia* and compensation in other forms (jobs, subsidies, etc.) have been viewed as an essential mitigation tool in increasing the tolerance of local communities of wild animals (Banerjee et al., 2013).

Innovative insurance schemes. An incentive programme started by the Nature Conservation Foundation (NCF) in Spiti valley to deal with livestock depredation by snow leopards is an excellent example of the use of insurance schemes to reduce human–wildlife conflict. Under this scheme, villagers pay a monthly premium for their livestock, and non-governmental organizations (NCF and International Snow-Leopard Trust) are helping the programme till it becomes self-sustaining. Villagers also receive biannual monetary rewards for better anti-predator herding. The funds generated are used for developmental activities within the village. The villagers have agreed to set aside 500 ha of the area, free of grazing pressure, and thereby provide a chance for the density of the wild prey of the snow leopard to increase.

Similarly, a programme has been started in Pakistan with the help of Project Snow Leopard and a village insurance committee. In this programme, claims are verified by the committee, thereby reducing the chances of fraudulent claims. Unlike the Spiti model, the programme has a two-tier system in which the money is deposited in the insurance fund by the livestock owner as well as the village committee, which receives money through ecotourism activities. In case the loss of a farmer exceeds the money paid by him in the form of premium, the village committee can provide him money from their fund. These could be used in low human density areas, but innovative methods need to be devised for other parts with high density of people.

PHYSICAL BARRIERS

Different physical barriers can be used to prevent entry of carnivore in livestock stocking area, depending upon the situation. In India, barriers are largely prepared to keep the livestock within pens during the night and rarely for providing predator–proof grazing areas. Conventionally fences are made from natural products (thorny bushes, plant poles, rocks, etc.). Different types of physical barriers used in the country are as follows:

Barbed wire fencing. This is a type of steel fencing wire constructed with sharp edges or points arranged at intervals along the strand(s). This form of fencing is used for protecting night pens in India and *bomas* in Africa (Vijayan & Pati, 2002; Sekhar, 1998; Kolowski & Holekamp, 2006).

Chain link fencing. This is a type of woven fence, usually made from galvanized steel wire. It is not used very commonly, mainly owing to its cost. This fencing has been put up on the eastern boundary of Gir National Park to prevent the lions and leopards from straying out as well as to reduce illegal grazing (Vijayan & Pati, 2002). However, considering the cost involved and low effectiveness, this fencing is not used for entire park boundaries (Vijayan & Pati, 2002).

Stone/rubble wall. Construction of rubble walls is limited by the availability of stones. They are expensive to make and elephants can push over unless these are bound with chain-link nets (Sukumar, 2003). Again the height of the wall is an important factor in preventing the entry of animals-

Concrete fencing. This type of fencing involves the use of slabs of concrete or building a wall of sufficient height with a foundation in the ground so that animals do not dig their way in. The efficacy, again, has not been reported, but a few studies mention that this fencing is quite effective (Mehta, 2014).

Nylon mesh. In the Sundarbans, a nylon mesh was erected along the boundary of the park to prevent straying of tigers into villages. This measure has been claimed to be highly effective (Das, 2005).

Physical barriers could restrict natural migratory movement of animal therefore one essential regulation while fencing the forest parts should be done strategically to avoid any resistance to animal movements in corridors.

Rapid Response Units or RRU. These units are currently present only in protected areas and more teams are required all across the country. The unit should have forest department officials, representatives of local NGOs, researchers (environmental science or social science), pradhans/heads of the villages involved and villagers (preferably farmers, teachers). In case of a conflict, the RRU should act to resolve the societal negative attitude by taking adequate

measures as broadly discussed here, but these measures could be tailored to suite the local requirements.

Decision making framework to deal with the situation of attack on humans include two major component 1) confirmation of carnivore involved in attack and 2) strategy to deal with the animal. In case of attack on human being (lethal or non-lethal), situations should be immediately assessed by concerned authorities and cautiously managed. Standard operating procedure and guidelines issued by the MoEFCC and NTCA provide directions to manage human-leopard conflict and situation of carnivores straying in human dominated landscapes (tiger/ leopard). Guidelines to deal with straying bears have also been prepared by the Wildlife Institute of India (see Annexure IV). To differentiate the attack from accidental to purposeful has been described aptly in guidelines issued by Maharashtra forest department to deal with human leopard conflict (Athreya & Belsare 2007). Details about identification, capture and translocation of problem animal have been described in SOPs issued by MoEF & NTCA for tiger ([http://projecttiger.nic.in/Write Read Data/CMS/Final_SOP_11_01_2013.pdf](http://projecttiger.nic.in/Write_Read_Data/CMS/Final_SOP_11_01_2013.pdf)) and human-leopard conflict management (<http://envfor.nic.in/sites/default/files/moef-guidelines-2011-human-leopard-conflict-management.pdf>) & (<http://environmentportal.in/files/Conflict%20management%20manual.pdf>).

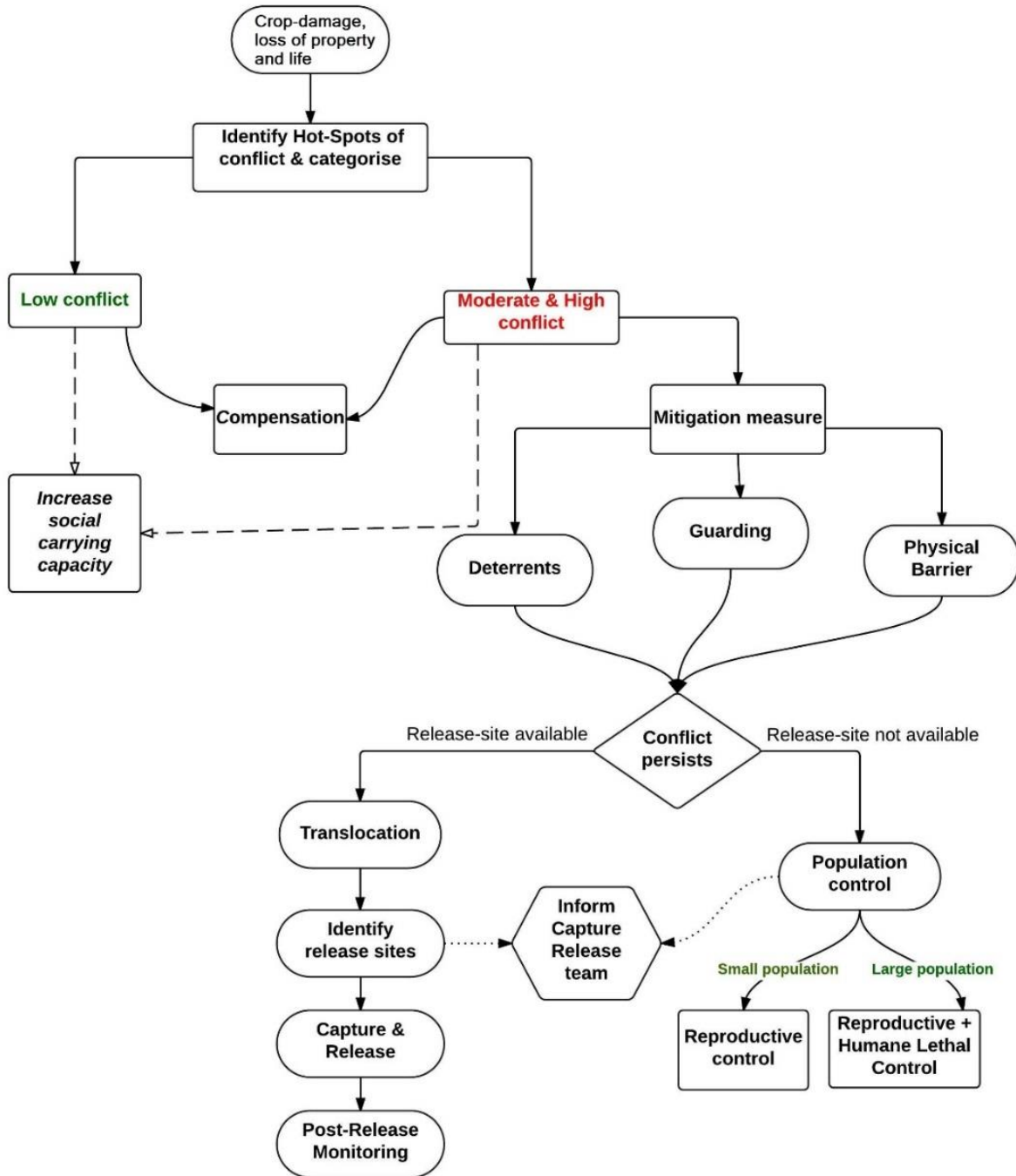
Management of Human-Herbivore Interactions

On the basis of the expert opinion and discussions during the workshop “Human-wildlife interactions and management of invasive species” conducted by the Wildlife Institute of India, a team of scientists and researchers drafted guidelines to manage the human-herbivore conflict in the country. The team also conducted a post-workshop intensive literature survey for preparing decision making flow-charts. The first flowchart (figure 4) provides a decision-making framework for managers to resolve conflict cases using the existing spatial and temporal information related to conflict cases. The second flowchart (figure 5) provides structure of capture and release team for translocation of animals.

Present hotspots. These are the areas (forest beat, village, etc.) that witness relatively high numbers of conflict cases. These hotspots could be different for different types of conflict. Hence in the case of an herbivore interaction, the hotspot could be ranked on the basis of human injury (lethal and non-lethal), crop damage, property damage, loss of life and perceived conflict. Hotspots should be mapped for every conflict on the basis of the frequency of damage and the compensation offered by the forest department. The priority should be: Human death > Human injury + crop/property damage > human injury > property damage > crop damage > perceived conflict. The areas with high frequencies of damage could be further classified for conflict at the micro-scale. Consideration of the social attitudes while mapping the conflict hotspots is crucial as some times areas with the least conflict could react violently and threaten animals and society. This can only be achieved by understanding the attitudes of different villages through regular meetings and campaigns (see section ‘Social Carrying Capacity). The forest department needs to carry out mapping of conflict cases on a yearly basis.

Potential hotspots. These are the areas (forest beat, village, etc.) that could witness increases in the numbers of conflict cases in the near future. This could be due to human encroachment into the forest, increases in the populations of conflict species, etc. To identify such hotspots, precise information about the population of animals and human activity around the forest is required (quantification of these variables could be done according to the scheme of the All India Tiger Monitoring Project 2014).

Figure 4. Decision Making Chart for managing Human-Herbivore Conflict



MANAGING CONFLICTS

If adequate steps are taken (like fencing, social awareness, diverging the increased population to other suitable habitats) in a timely manner, conflict could be mitigated most successfully.

After collecting information on the different criteria (intensity, frequency, tolerance of human communities) related to the conflict, these criteria could be grouped into a single index and partitioned into a scale of 'high', 'moderate' and 'low'. In the meanwhile, any conflict case should be addressed immediately to reduce animosity as well as the grief of the victim.

COMPENSATION

Appropriate and timely compensation could reduce the tension between the forest department and the community. The following are the existing and potential compensation schemes:

Ex gratia payments. In the case of injury or death of human beings as well as of livestock, crop-depredation and property damage due to wildlife, state governments and a few non-governmental organizations provide *ex gratia* payments in order to reduce the animosity of the communities towards wildlife (Madhusudan, 2003; Mishra et al., 2003; Krithivasan et al., 2009; Lenin & Sukumar, 2008). Compensation has been viewed as an essential mitigation tool in increasing the tolerance of local communities of dangerous and endangered animals (Banerjee et al., 2013).

Sharing benefits of ecosystem services. An alternative approach of increasing tolerance among communities living close to forested areas is by allowing them to reap the benefits of ecosystem services. Sharing profits generated through ecotourism and economic evaluation of the forest products extracted by communities will instill a sense of ownership among them (Sekhar, 1998). This way, wildlife becomes a valuable resource rather than a liability.

Innovative insurance schemes. A few innovative insurance schemes have been started in India by non-governmental organizations to provide insurance cover to livestock against carnivore attacks. These schemes work well to conserve these predators as well (Mishra et al., 2003). However, so far there have been no such schemes for crop-depredation by wildlife in India.

Challenges. *Ex gratia* payment schemes have loopholes at every level, from verification and estimation of loss due to wildlife to the time of payment (Nyhus et al., 2005).

Precautionary mitigative measures can be adopted by local communities to reduce the chances of conflict. Using deterrents, guarding and installing physical barriers are three major mitigation measures used for preventing entry of herbivores into properties and crop lands. All these methods are discussed in the following.

DETERRENTS

Deterrents are harmless precautionary measures used to prevent animals from gaining access to any kind of targeted source or repelling them from it. Deterrents can be classified into four categories, depending upon the sense organ they target: acoustic (hearing), visual (vision), olfactory (smell) and tactile (touch).

Acoustic deterrents. These deterrents target the hearing sense of the intruding wild animal. Traditional acoustic deterrents used by the farmers against crop-raiding animals were shouting, beating drums, bursting firecrackers, tin-hitting and noise from the whipping rope made from *Eulalopsis* grass. In some parts of the country, guns are also used for creating a sudden noise and scaring away the individual or the group. Playing audio recordings of the predators such as tiger have been used as a deterrent for elephant in southern India but its efficacy is not been reported yet.

Visual deterrents. Scarecrows, coloured cloth strung on fences along fields and fires maintained at corners of crop-fields are age-old visual deterrents used by farmers.

Chemical deterrents. One commonly used olfactory deterrent is chilli. This is mixed with engine oil or grease and applied on fences or ropes all along the perimeters of crop-fields or properties. Chilli smoke and sprays are also used as deterrents. In north-east India, the Assam Haathi Project is experimenting with chilli-based deterrents, especially using the Tezpur chilli (*bhut jholakia*). Tobacco is also efficient as a deterrent, either in conjunction with chilli or alone. These fences have been shown to be more effective in areas with low rainfall in a comparative study conducted in southern India. Pesticides (forite and furadon) have also been shown to deter small animals. In southern India, kerosene and waste oil are poured on potential entry routes for deterring small-bodied animals such as of black-naped hares, mouse deer and porcupines.

Tactile deterrents. Burning sticks and rocks are tactile deterrents used against crop-raiding individuals or groups. Placing of beehives all along crop-fields to prevent the entry of elephants in Nepal and Maharashtra, India has been reported. This method is also claimed to be effective against small herbivores. However, the efficacy of this method needs to be tested. Some deterrents (burning sticks and rocks) could injure the animals and consequently increase the chances of more damage to crop and human life by furious animals. Therefore the use of such deterrents should be discouraged.

Challenges. The major limitation of all these deterrents is their short-term effectiveness against the target animals as most of the animals soon get habituated and start ignoring the deterrents. Another major problem associated with all the deterrents is that they do not really solve the problem and merely shift it from one location to another.

GUARDING

Guarding is the most common form of preventing wildlife from entering farms. Night vigils are kept by almost all the farmers in the country. However, the effectiveness varies with the number of people deployed and the size of the farm. Also, fatigue plays an important role as people have to stay up all night to ensure that wild animals does not enter the farm. The economics of this activity is also seldom understood—the people engaged in night guarding lose a lot of opportunities that they would otherwise have during the daytime. Many of the problems of guarding (e.g. fatigue and scarcity of manpower) can be addressed by combining guarding with other measures such as barriers and deterrents.

Community guarding. Farms are usually situated in a continuous stretch of land and are not very scattered. The owners of all the farmlands and the community can collectively guard all the farms, irrespective of ownership. This can develop unity among the farming community and local villagers as they participate in the same activity and this will lead to better protection in a selfless manner.

Using dogs. Dogs are great pets to keep and are successful most often in keeping ungulates at bay. The number of dogs on a farm depends on its size. Dogs can be kept at all strategic locations in a farm, and being nocturnal, they can easily patrol the farm and deter wildlife.

However, the use of dogs in forests as grazing areas should be discouraged as it will affect the wildlife existing in these areas.

Employing locals as guards. In areas where the level of conflict is very high and is not manageable using the previously described methods, the forest department can employ some unemployed locals from the villages as night watchmen. This will give them a source of income and improve their livelihoods.

PHYSICAL BARRIERS

Barriers are popular wherever conflict is severe as they separate people and animals. The efficacy of these barriers also varies.

Barbed wire fencing. This is a type of intertwined galvanized steel wire fencing has pieces of wires with sharp edges or points arranged at regular intervals along strand(s). Any animal trying to pass through or over the barbed wire will suffer discomfort and possibly get injured. This form of fencing is commonly used all over the country. However, its efficacy and cost effectiveness are questionable. Animals such as wild pigs dig below them, making passages to enter fields. Sturdy animals such as the nilgai have been known to break this fencing by damaging the posts that hold the fence or even jump above the fences if the height is not adequate.

Chain link fencing. This type of woven fence is usually made from galvanized steel wire. Its use is not common mainly due to its cost. The efficacy of this type of fence is seldom reported. Also, it has the similar limitations as those of barbed wire fencing.

Stone/rubble wall. Construction of rubble walls is limited by the availability of stones. They are expensive to make and can be easily pushed over by elephants unless they are cemented or are bound with chain link nets (Sukumar, 2003). Again, the height of the wall is an important factor in preventing animals from entering

Concrete fencing. This type of fencing involves using slabs of concrete to create a wall of sufficient height that has a foundation in the ground so that the animals do not dig their way in. The efficacy of concrete fencing, again, has not been reported yet, but a few studies mention that they are quite successful (Mehta, 2014).

Bio-fencing. This form of fencing involves planting non-palatable and hardy species to hold back intruding herbivores. Plants commonly planted along the boundaries are thorny plants such as Euphorbia (cactii) and *Agave*. At times, non-preferred crop species such as chilli are grown along the boundaries of farms. Currently this technique is under experimentation, and its effectiveness needs to be assessed.

Electric fencing. This form of fencing uses an electric shock to prevent animals from entering farms. The shock is mild and keeps the animals at bay. It is advocated frequently, but has issues related to cost-effectiveness and maintenance.

Trenches. Trenches are used in areas where there is human–elephant conflict. Also, tea garden owners and farmers with large land areas often dig cattle-proof trenches to keep cattle/deer away from their plantations. The trenches should be wide and deep enough to prevent animals from crossing over (Fernando et al., 2008). The trenches work well in combination with electric fences (Desai, 2002; Kulkarni et al., 2007; Parker et al., 2007). The problem with trenches is that animals such as elephants are known to kick the earth into the trenches they can cross. This also leads to gully-erosion in high-rainfall areas.

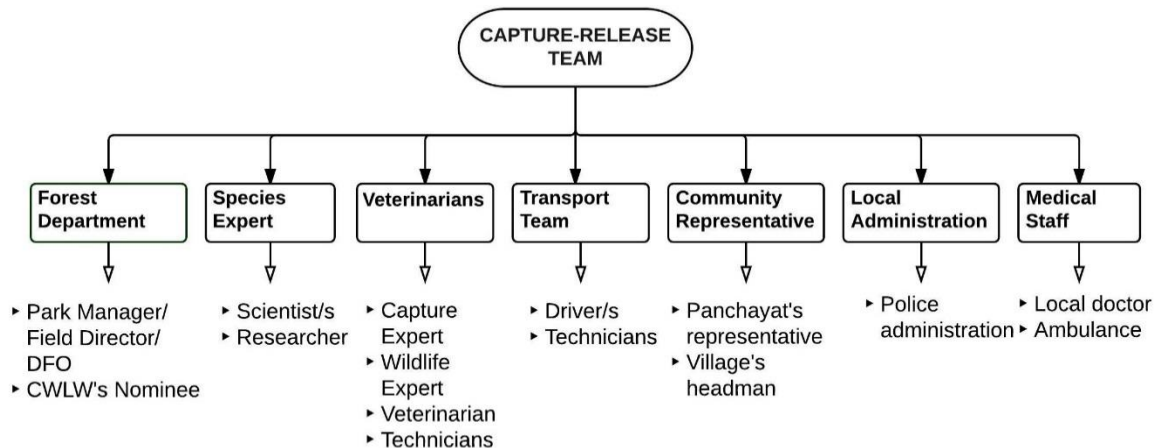
Construction and maintenance of fences by the government is unsustainable. Therefore, fencing should be done on a participatory basis. When the community is involved in either erecting or maintaining a fence, there is a better chance of success. The other option is subsidizing construction of fences for farmers. This way they maintain the fences as their own, and hence these will be more effective as barriers.

MEASURES INVOLVING TRANSLOCATION/POPULATION CONTROL OF WILDLIFE

In case mitigative measures fail to reduce the number of conflicts the options to control the population of the wildlife scientific manner need to be used. This will reduce the antagonism of the community towards the animals as well as against the authorities. Translocation and population control are the two methods used to reduce the number of individuals in a given area. Translocation of animals can be done depending on the availability of free and/or less populated potential habitats. In case potential habitats are available, the authorities can translocate animals. It has been observed that animals translocated to new areas become disturbed due to new territory and therefore come in conflicting situations again (A. Desai *pers comm*). The methods

of translocation are species-specific. If translocation is selected, a capture–release team should be prepared for execution of the process (see figure 5).

Figure 5. Members of *Capture-Release* team for capture, translocation and release.



If habitats are not available, population control remains the only viable solution for conflict management. In case of non-availability of potential habitat/s, managers could decide to control population through either reproductive control, humane lethal control or a combination of both.

REPRODUCTIVE CONTROL

According to Garrott (1995), most ungulate species that present problems of local overabundance are medium-to-large mammals with polygamous mating systems where dominant males mate with many females and limit breeding opportunities of subordinate males. In polygamous system reproductive control is most important as even few males can potentially serve the reproductive needs. Any management program designed to control population growth by inhibiting reproduction must evaluate the proportion of the population that must be treated to obtain a desired effect (Garrott 1995). The success of many contraceptive programs depends on costs and ease with which animals can be effectively treated. Three factors limit the level of treatment attainable in the field: (1) the proportion of animals that can be detected, (2) the proportion of animals detected that can be successfully treated, and (3) the efficacy of the contraceptive agent (Garrott 1995).

A relatively high proportion of animals must be treated to significantly reduce reproduction in most situations (Garrott 1995). A highly optimistic scenario would be that if from 90% of the target, 90% animals are treated successfully, and the contraceptive has a 95% efficacy. In such scenario, the level of treatment realized would be $0.95 \times 0.90 \times 0.90 = 0.77$. Thus, under a best-case scenario, nearly 25% of the population remains reproductively active after initial treatment. A more realistic scenario for many wildlife populations may be treated 75% to 80% with a contraceptive 90% effect. This would result in an effective treatment of more than 60% of the targeted population. Several studies suggest that rapidly growing populations may not be stabilized or reduced unless 60-80% of the animals in the population are effectively treated (Garrott 1991, Garrott *et al.* 1992, Hone 1992). In the U.S., feral horse mares and female white tailed deer were injected with contraceptives in a non-operative manner and these contraceptives were recorded to have an efficacy as high as 90% (Kirkpatrick *et al.* 1990, 1992, 1995; Turner and Kirkpatrick 2002, Kirkpatrick and Turner 2008). And these vaccines can produce the desired effects on a wide range of species, especially ungulates.

SOCIAL CARRYING CAPACITY

Understanding and addressing the human-wildlife conflict is incomplete without addressing an aspect -the social component. Human-wildlife conflict cases have increased globally and expected to rise further in future. In such situation it becomes important for the authorities to use not only the biological tools for deterring, restricting and controlling wild animals but also the social tools for increasing the social carrying capacity of the humans sharing space with wildlife. Following text incorporates few methods of raising the social capacity of local community

Social carrying capacity forms an integral part of every aspect of the decision making in managing conflicts. The economic loss of a conflict can be resolved through economic compensation. However, the stigma attached to the wildlife remains in society after every conflict case. Social mitigation needs to be focused on by mitigating the negativity of interactions. The societal attitude that animals are the property of the forest department needs to be changed. This can only be achieved through experiments with social capacity and the involvement of the public in solving the conflict. Hence we propose that the formation of more rapid response units (RRUs) is essential for all protected areas as well as other conflict areas.

RRUs are currently present only in protected areas and more teams are required all across the country.

Team: The team should have forest department officials, representatives of local NGOs, researchers (environmental science or social science), pradhans/heads of the villages involved and villagers (preferably farmers, teachers). In case of a conflict, the team should act to resolve the societal negative attitude by taking adequate measures as broadly discussed here, but these measures could be tailored to suite the local requirements.

If any villager is lost due to an attack by a wild animal

1. Appropriate economic compensation in accordance to the state rules should be provided as soon as possible.

If any villager is injured due to attack of wild animal.

1. He should be moved to the closest hospital by the RRU ambulance while providing first aid treatment.
2. Creative insurance policies should be encouraged that considers the medical necessity of such victims.

In case of damage to property.

1. In case the only available house to the family is lost, they should be provided with alternative shelter in the same village.
2. In case, a commercial property was damaged, innovative subsidies should be encouraged that guarantees the economic compensation of such loss.

In case of damage to crop.

1. The owner should be compensated as per the clause of state.
2. In case of conflict prone areas, the villages should be recommended for common big fencing on basis of innovative subsidies as it reduced per head cost and is comparatively cheaper.

3. For high conflict zone, a chowkidar should be provided for surveillance. The guard needs to regularly interact with the villagers to form a team of volunteer who in the time of conflict could be called for channelizing the animals back to the forest.

The team should possibly undertake following measures to increase social capacity.

1. The team has to hold timely meetings with villagers of the area that suffers conflict. The team needs to learn the problems of villagers regarding any conflict and needs to ask for the legal solution.
2. Primary health center should be made available and equipped with the kind of injuries expected in the park area. RRU should also have an ambulance to be used in case of any emergency, and toll free number for calling ambulance should be displayed on the important areas of the village.
3. The team should also hold timely discussions and lectures in the schools of conflict areas. In case of colleges and university, the team needs to conduct for workshops for skill development of youth who could provide innovative ideas to manage the conflict case.
4. The display board of 'do's and don'ts' should be placed at all important places in village that illustrates about avoiding conflict and acting smartly in the time of conflict.

Management of Human-Macaque Interaction

On the basis of the expert opinion and discussions during the workshop “Human-wildlife interactions and management of invasive species” conducted by the Wildlife Institute of India, a team of scientists and researcher designed these draft guidelines to manage the human-macaque conflict in the country. Team also conducted a post-workshop intensive literature survey for preparing these decision making flow-chart. The following flowchart (figure 6) provides a decision-making framework for managers to resolve conflict cases using the existing spatial and temporal information related to conflict cases.

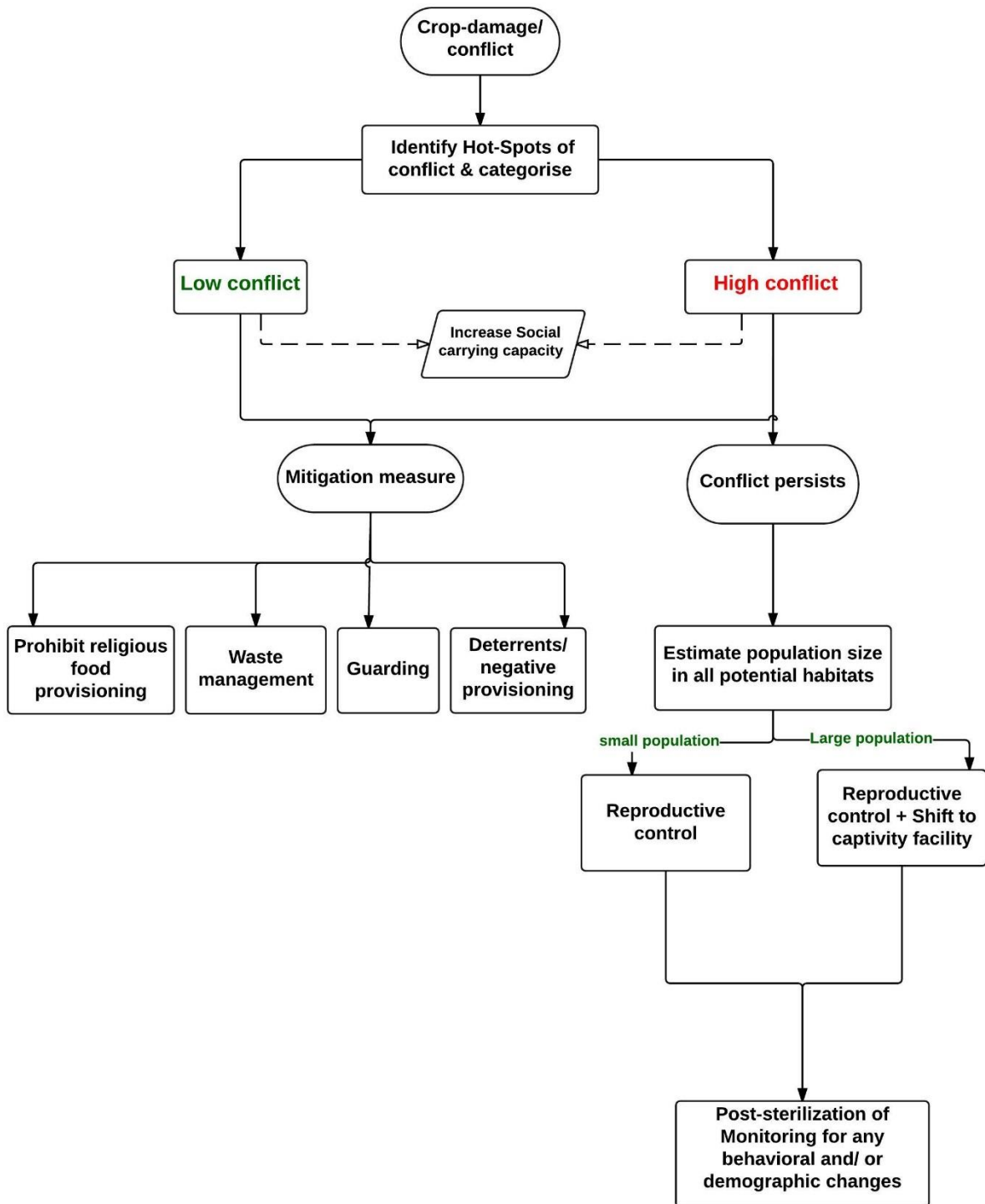
IDENTIFY CONFLICT HOTSPOT

Based on the loss caused by crop damage and direct attacks by non – human primates, the conflict may be classified into low conflict and high conflict zone. Mean a daily range of rhesus macaque is ~1.2 km in human habitats and ~1.9 km in forest habitats (Wada 1984), which implies that managing habitat at the level of village is not sufficient to curb conflict. Accurate information on ranging scale of macaque and spatial interaction between troops can inform us on the zone of influence, where management actions has to be targeted. Understanding ranging patterns of macaques in relation to resource availability can be applied to map the areas with high probability of human macaque interaction (human–macaque interfaces).

INCREASE SOCIAL CARRYING CAPACITY

In the conflict area, awareness programs that intend to increase the social carrying capacity should be stressed. Such programs can highlight the need of proper waste management, prohibiting animal feeding and use of deterrents in case of attacks by the animals. Particularly around the religious constructions where many macaques are fed, it is essential to put a notice board pointing the prohibition on feeding animals. In case of areas with moderate to high conflict, one needs to use combination of action and prevention. Social carrying capacity can also be increased by strengthening JFM, initiating eco-development programmes and ensuring an efficient system for payment of *ex-gratia* relief to the victims.

Figure 6. Decision support chart for managing non-human primate conflict in India



SOLID WASTE MANAGEMENT

It is one of the main reasons for increasing the negative interaction with these species. In the areas with high to moderate conflict, large scale solid waste management should be addressed for which the involvement of communities, panchayats/municipal corporations, forest department and NGO's is essential. An awareness campaign should be held in such areas for proper waste management, the dump yards should be covered and regularly cleared. Food waste from the sub urban areas and villages contribute to the large portion of the diet of these species. Hence, it should be converted to compost by filling in the compost dig and covering it with layer of cattle dung and mud.

GUARDING

People are often charged and food is snatch relatively more is few hotspots of the village or settlement. Such places need a guard who could drive away such problem individual and rescue the victim. The guard may keep dogs that help to drive away the problem individual. Considering their usefulness in keeping problem monkeys at bay, particularly in strategic locations like hospitals, schools, offices, etc. trained langurs may also be used as guard animals with due permission from the CWLW.

DETERRENTS AND NEGATIVE PROVISIONING

Catapults are used by people to scare the macaque that induce negative provisioning. Electronic sound modulator that makes ultrasonic sounds causing discomfort to monkeys present there in residential areas are suggested particularly for the agricultural store houses and poultry safeguards. These high intensity ultrasonic sound waves (10-65 KHz) are out of the range of hearing of humans and most household pets. Barbed wires, monkey snares and metal spokes are often used for repelling the macaque menace around the settlements. However there is no scientific study on the efficiency and long-term consequences of such product on macaque behavior.

POPULATION STATUS ESTIMATE

Before investing the efforts for controlling the population of macaque it is essential to know their population status. For estimating the population, one may stratify the area into equal sized grids. In each of these grids, total count using area search method and mark resight sampling should be conducted. The number of individuals, their age sex composition and habitat covariates should be recorded. From this information, age sex specific and overall macaque densities can be estimated and their population trend and growth rates can be monitored to assess management effectiveness.

Based on the population size and conflict cases one may opt for: Reproductive control (in case of small population, less frequent conflict) and Removal of individual combined with reproductive control (in case of large population and frequent conflict).

REPRODUCTIVE CONTROL

Rhesus macaque males have been sterilized to reduce population recruitment and growth (Fooden 2000). But with a promiscuous mating system (45% of offspring sired by sneak mating) (Berardet *al.* 1994), few fertile males can still sire offsprings of multiple females. Therefore, male sterilization may reduce but not stop population growth. Female contraception, on the other hand, can be a viable solution, but not so widely practiced and developed. Hence, female rhesus macaques should be sterilized preferably with non-surgical techniques used for primates. Methods such as oral administrative contraceptives, intra-uterine devices, and blockade of tubal patency following transcervical administration of polidocanol foam (Jensen *et al.* 2013) should be used. The sterilization should be done in such a manner that the population reduces but remains at a stable size so that troops from outside will have minimum chance of displacing the resident troops. Scientific expertise and facilities for this program need to be developed in consultation with organizations having similar experience, expertise and agenda (Indian Veterinary Research Institute, Institute of Animal Health and Veterinary Biologicals, Uttarakhand Forest Department etc.).

REMOVAL OF PROBLEM INDIVIDUAL

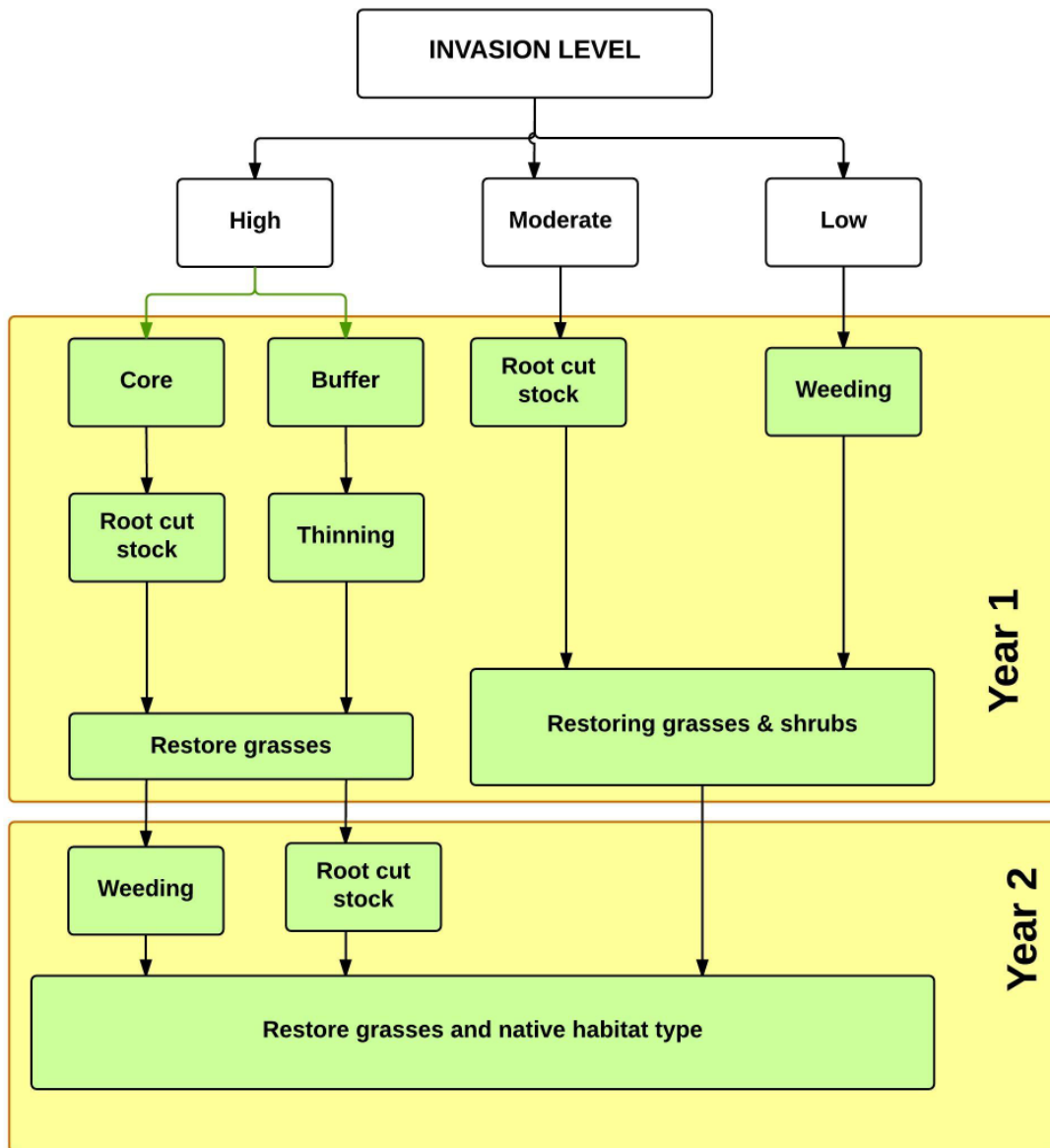
Removal of specific macaque individuals that show persistent aggressive behavior or learnt raiding behavior should be implemented. These few individuals are responsible for most of the

negative interactions with humans. Their targeted removal to rehabilitation centres (captive enclosures) or reducing aggressive behavior by hormonal control/ therapy should be resorted. The cost of rearing such captured individual is high, however as the society bears an emotional attachment with the species, keeping such individuals in captivity is the only solution.

The reproductive control and capturing of animal should always accompany pre – action and post – action population status and the behavioral response of the animals. Rigorous ecological surveys are hence continuously needed during the proper management of this negative interaction.

The current guidelines (Figure 7) have been formulated for lantana management in forested areas on the basis of experts' knowledge and published information. The present strategy is adapted from Ramaswami et al. (2014) and Love et al. (2009).

Figure 7. Decision support chart for *lantana* management in forested areas.



1. Invasion level

Before proceeding with any management plan, the manager needs to understand the distribution of lantana and the level of invasion in and around the park. This assessment of the invasion level could be carried out using the vegetation sampling protocol of the All India Tiger Monitoring Project (Jhala et.al., 2013). According to this protocol, a 2 km transect is to be laid in every beat (an area of 25 km² should have at least three transects). On each transect, circular plots of radius 15 m are to be established at every 400 m to quantify the abundance of native and invasive plants. After collecting data from these transects, the manager needs to map the abundance of lantana within that area. Such monitoring provides baseline data on the level and stage of invasion. It also helps identify other problematic invasive or exotic species that may turn invasive in the future.

2. Conservation prioritization

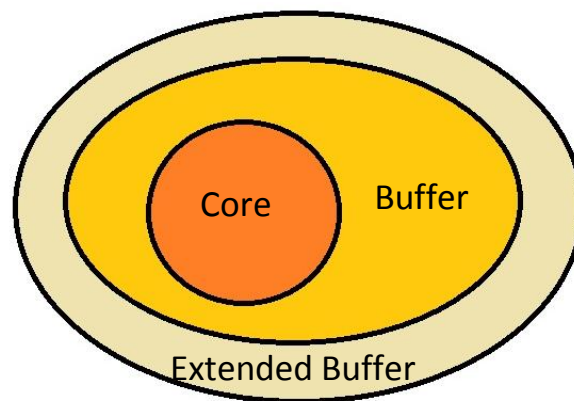
The management strategy needs to be shifted from complete eradication of lantana to restoration of key habitats. These key habitats should be identified on the basis of the ecological value of the patch. In general, lantana should not be allowed to establish itself inside protected areas. In buffer and revenue forests, the invasion level should be kept low until and unless a complete restoration plan is prepared. Grasslands (e.g., *bhabhar*), savannas (e.g., Kachch, Keladevi), sparse canopies, grass-dominated understory vegetation and riverine patches are highly susceptible to dense lantana invasions (Ramaswami & Sukumar, 2013). All such areas should be priority areas for yearly management and should be mapped for prioritization. Sometimes even a small sparsely invaded patch or a few plants in a grassland or meadow (e.g., Kanha meadows) that serves ungulates in a forest or rare habitat (e.g., shola grassland) could result in ecological damage if left untreated and hence should be given similar priority.

3. High-priority highly invaded areas

Once priority areas are identified and assessed, a systematic removal programme should be undertaken for different levels of invasion and conservation priority. As mentioned in Ramaswami et.al. (2014) most of the highly invaded patches have dense thickets of lantana which are surrounded by the buffer of sparsely distributed lantana. In the first management effort

(Year 1), the dense thicket core (core, figure 6) is cleared using root cutstock method (section 4). Simultaneously areas surrounding the first effort are thinned (section 5) (buffer, figure 1). Active grassland restoration is done in the core while grasses and shrubs are restored in the buffer. In the second year, weeding is carried out in the core, and active management can be undertaken for the buffer using the root cut stock method or weeding, depending upon the density of the lantana. The treated area is actively restored and a further, extended buffer is identified that can be managed in the next year. Gradually increasing the size of the buffer in subsequent managements will reduce the dispersal of lantana seeds into the priority area.

Figure 8. Phased management plan for “High-Priority” and highly invaded area. The central core represent high density patch of lantana which is managed in the 1st year followed by buffer in the 2nd year which is later followed by extended buffer.



4. Thinning

In a moderately dense patch of lantana, few plants should be removed to reduce the overall density and make the plants highly separated so that they can be manually removed in the next season. A mechanical crane could be used if the patch is large and approachable; else an axe can be used. The rest of the standing plants in the plot are usually thinned by cutting their branches and shoots.

5. Weeding

Sparse lantana plants or young plants should be manually uprooted by laborers. Usually an axe is used by people cutting the plant. The plant should be removed in the same way as in the root cutstock method.

6. Restoration

For any active restoration programme, native grasses should be planted in the first year as they can provide competition to the invasive species in recolonizing the site. Seedlings and seeds of grasses from nurseries should be planted in the first year. While purchasing the seedlings and seeds, one needs to ensure the quality of seeds so that no plant (native or exotic) is introduced other than the desired one. In case the area is heavily used by ungulates/livestock, it needs to be fenced. Though fencing bigger areas is costly affair, it is crucial as browsing by ungulates can nullify all the efforts undertaken for restoration. However, portable fences, biological fences, etc. could be useful in reducing the costs and hence should be given due priority in the management plan. In the subsequent years, if needed, active restoration can be undertaken by planting species belonging to the native habitat. For example, in case the native habitat type is sal forest, sal saplings should be planted. For passive restoration, see section 5.

7. Utilization of removed plant material

The eradicated plant material should be used rather than being burnt or abandoned in the forest as burning may contribute to liberation of fixed carbon. The eradicated lantana can be utilized for furniture production, paper production, etc. it is recommended that the communities around the forest be involved in this production as it can uplift the economic status of the communities and gradually lessen their dependence on the forest. The potential utility is described by Thekaekara et al. (2013) and Patel (2011). Training for furniture production is provided by the Women Empowerment through Lantana Furniture and Artefacts and Restoration of Environment (WELFARE) project in Corbett, Lantana Craft Centre, Ashoka Trust for Research in Ecology and the Environment (ATREE) in Bangalore and a Dehradun-based NGO named Himalayan Environmental Studies & Conservation Organization (HESCO).

8. Post-management monitoring and follow-up management

In case the habitat is moderately or less prioritized, i.e. it is out of the protected area and has low ecological value, and the invasion level is less, active restoration may be monetarily challenging. Hence, continuous monitoring of the site is advised for quick removal of any regenerating individuals. Weeding should be continued as soon as any young plants are detected. Managed patches should be monitored for at least 5–10 years as Ramaswamy et al. (2014) found that plants regenerate even after 2 years of continuous management. The reinvasion of that site can be prevented by managing the nearby sites, thus increasing the buffer of all the managed areas. A manager must keep in mind that none of these methods is likely to result in complete eradication as seed sources are often located in the surrounding agricultural, urban and forest areas as well. Therefore, subsequent monitoring will help with early detection and reduce the probability of reinvasion.

***Prosopis juliflora* (Prosopis) management**

The management strategy for *Prosopis* is similar to that of lantana management. However, the root cutstock method is applicable for *Prosopis* shrubs and not for trees. In the case of trees, it has to be manually cut, which can be achieved by involving local communities. As it was found in Kachch, where the native flora was illegally disturbed and the public participated in management, a team of guards should patrol the ongoing management site for safeguarding the native flora. This management should be done before the monsoon, and the native grasses should be planted with the first shower of the season. The utility of eradicated *prosopis* is attached in the appendix 6. Continuous monitoring of the area should be done and any regenerating *Prosopis* plant should be uprooted.

'*Prosopis* society (of India)' was established at CAZRI in 1993 that intended harvesting *prosopis* for sustenance of natural systems, grazing pastures and community economics. It developed a detail technical manual regarding the *Prosopis* management; partially for Rajasthan, Gujarat, Madhya Pradesh and Tamil Nadu (2000).

- State Governments to purchase *prosopis* pod flour as subsidized livestock fodder in drought; *prosopis* is cheaper and more nutritious than the alternatives, and is locally available thus improving rural economy and employment generation.
- Joint management of roadside trees, Forestry Department paying villagers day rates to thin, single and prune, generating employment and training villagers.
- Encourage State Forestry Departments and State Forest Development Corporations (SFDC) to promote and market *prosopis* tree products, and establish a SFDC for Rajasthan.
- Establish independent funds for commercial processing, as lending institutions appear unwilling to provide credit to *prosopis* -based business.
- Promote assured markets for *prosopis* products through government intervention, positive 'press' and pressure on private enterprise to establish industries for tree product processing.
- Guarantee a market price for an initial period to stimulate management, production and processing of new products such as *prosopis* timber or pods.
- Record the area under *prosopis*, available from village accounts and annual seasons and crop reports.

- Detail the quantities of charcoal exported from state to state, derived from ‘certificate of origin’ issued by State Forest Departments and also for pods and other tree products.
- Demonstrate cheap, simple improved kilns for charcoal production and small scale pod processors, and prosopis for furniture making.

***Mikania micrantha* (Mikania) management**

Presently experimentation is required for managing Mikania. However in case of managing the priority area one can use the traditional method in which Mikania is mechanically removed and the shoots are burnt. Mikania vines should be cut near the ground once a month for three consecutive months in summer and autumn and then in winter and spring. This method was tried in china and 90% of the plants can be eliminated (Zhang et.al., 2004). Manual control in newly infested crop areas have been carried out by rolling, drying and burning the plants but this proved to be unsustainable.

***Parthenium hysterophorus* (Parthenium) management**

Ploughing the weed before the plants reach the flowering stage and then establishing pastures may be effective in the agricultural areas and other approachable areas. In the case of a forest, the soils should be loosened by ploughing and then the plant should be uprooted. However, *Parthenium* has been reported to cause respiratory and skin problems in humans (Sharma, Verma, & others, 2012; Towers & Mitchell, 1983). Hence the labourers involved should be provided with masks and safety costumes. Management should be followed by active restoration of grasses.

Chemical and biological control strategies have been provided in the following. However, all these strategies have not been tested for their effects on the environment and hence have no utility in Indian forests. Their effects on all the environmental cycles and different trophic levels should be determined through experimentation. These experiments will require a scientific advisory. Moreover, the use of any pesticide or herbicide is prohibited in any protected area.

Bio-control by introducing a foreign agent should be avoided as it can have detrimental effects on the native flora and fauna as testing sensitivity of every native species is not feasible.

Review of Policy and Legal Instruments for Management of Invasive Species (IS) in India

1. Policy documents having implications for management of IS

1.1. Forest and Wildlife

1.1.1. Forest Policies:

- I. Forests under the control of the Government in India are required to be managed on the basis of silvicultural principles which stress upon control of weeds and pests. IS have been engaging the attention of the foresters for over 120 years now²⁷. But, neither the National Forest Policy-1988 nor most of the existing State Forest Policies make a direct reference to IS. An exception is made by the Jammu & Kashmir State Forest Policy-2010 which admits that invasive weeds contribute toward failure of regeneration (Para 2.3). It stipulates that forest areas heavily infested with invasive weeds will be systematically treated to restore the natural mix of vegetation in order to augment the supply of fodder, firewood, timber and other forest produce [Para 4.3 (g)]. The Madhya Pradesh State Forest Policy-2005 makes an indirect reference to IS while stating that an appropriate system of forest management shall be developed for protection from various kinds of diseases and destructive forest-pests (Para 3.3.6).
- II. Most of the Forest Policies caution against introduction of exotic species. The National Forest Policy-1988 stipulates that exotic species should not be introduced in forests through public or private sources, unless long-term scientific trials undertaken by specialists in ecology, forestry and agriculture have established that they are suitable and have no adverse impact on native vegetation and environment (Para 4.3.3). This point is reiterated by the Chattisgarh State Forest Policy-2001 (Para 4.2.3), Assam State Forest Policy-2004 (Para 4.2.4) and Maharashtra State Forest Policy-2008 (Para 3.3.9).
- III. Some State Governments show reservations about prohibiting exotic species and IS:
 - a) The Haryana State Forest Policy-2006 stipulates that only the suitable indigenous species should be used for plantation in wildlife sanctuaries (Para 4.4.2), but it goes on to say that block forests like that of Shiwaliks should *gradually* be planted with lesser known (?) indigenous species *to the extent possible* (Para 4.4.6)—thereby providing a ruse for use of exotic species.
 - b) The Rajasthan State Forest Policy-2010 does not appear to have any serious issue with the IS or exotic species. It states that: “Though damage to forest due to pest and disease is rarely seen in forest areas of the State, it can be controlled by taking collaborative support from research institutes as and when required” (Para 5.3.12). The Policy stipulates that plantation in the desert areas should be taken up with indigenous xerophytic species but *exotic species can be used in lesser quantity depending upon locality factors* (Para 5.8.4). There is an obvious dilemma as how to

²⁷ For example, refer to Inspector General of Forest's note titled “Is the Lantana a friend or an enemy?” in the Indian Forester, December 1895.

- deal with *Prosopis juliflora*—a known IS. It is contended that *Prosopis juliflora*, which has extensively spread on all kinds of wastelands, is being used by the people as firewood and charcoal—thereby helping in reducing illicit felling of trees in natural forests, and therefore, a ‘careful review of the policy directives from time to time’ has been suggested (Para 5.5.3).
- c) The Uttarakhand State Forest Policy, which is otherwise silent on IS, calls for research to promote utilisation of Lantana (Para 4.7) and seeks to encourage industries based on forest products including Lantana(Para 4.8).
- IV. Interestingly, the Chattisgarh State Forest Policy-2001 is the only policy document which specifically prohibits introduction of exotic faunal species into the forests (Para 4.9.1).

1.1.2. National Working Plan Code-2014:

- I. If there is anything wanting in the National and the State Forest Policies as regards management of IS, the same has been amply compensated by the National Working Plan Code-2014. Working Plans form the cornerstone of forest management in the country. National Forest Policy-1988 stipulates that no forest should be permitted to be worked without the Government having approved the management plan, which should be in a prescribed format and in keeping with the National Forest Policy (Para 4.3.2). The Supreme Court of India, in its orders dated 12.12.1996 and 12.5.2001 in the Godavarman case [WP (Civil) No. 202 of 1995], has directed that no forests will be harvested unless in accordance with a Working Plan duly approved by the Central Government. The MoEF&CC has prescribed National Working Plan Code-2014 for preparation of Working Plans by State Forest Departments.
- II. The Code emphasizes upon the management of pests and weeds to maintain forest health (Para 13). It recommends assessment of area infested by invasive weed species in forests (Para 68).The Code prescribes that there should be provision in the Working Plan for exclusive or overlapping mandatory working circles related to various issues including management of invasive species and weeds (Para 89). It prescribes that the compartment description should classify the area for presence of weeds as very dense, dense, moderate, scanty and absent (Para 110). The Code also prescribes the maintenance of a register for keeping record of eradication of Lantana and other invasive species (Para 134).

1.1.3. National Wildlife Action Plan (2002-16):

- I. The NWAP (2002-16), framed by the MoEF&CC, can be treated as a supplementary policy statement by Government of India, and leaves no doubt that management of IS within or outside the Protected Areas (PAs) needs to be taken seriously.
- II. The NWAP calls for technical assistance to each PA for control and eradication of exotic invasive species (Chapter-II, Para 5.1).It calls for preventive action against the introduction of related species which may cause interbreeding among taxa and

hybridisation, and also ordains against ‘further introduction of floral and faunal species exotic to the locality’ in PAs or in areas from where they are likely to invade PAs (Chapter-III, Para 3.3).

1.1.4. Centrally Sponsored Schemes:

- I. The Central Government has been re-enforcing its policy towards control of IS in forest areas by providing financial support to the State Governments under various Centrally Sponsored Schemes (CSS).
- II. The Central Government has since long been providing financial support under some CSS, viz. Project Tiger, Project Elephant and Integrated Development of Wildlife Habitats, for improvement of wildlife habitats within and outside PAs. Management of IS in accordance with Management Plans is a permissible activity under the said schemes. The Central Government also provides financial support for removal of IS, particularly water hyacinth (*Eichornia crassipes*), from selected Wetlands.
- III. The Central Government has been providing financial support for eradication of IS from general forests under the CSS named ‘Intensification of Forest Management’ during the 12th Five Year Plan.
- IV. Many State Governments also provide funds to their Forest Departments for control of IS from wildlife habitats and forest plantations.

1.2. Agriculture and Livestock

1.2.1. National Agriculture Policy-2000:

The Policy seeks to give particular attention to quarantine, both of exports and imports, so that Indian agriculture is protected from the ingress of exotic pests and diseases.

1.2.2. National Policy for Farmers-2007:

The Policy (Para 5.2.1) acknowledges the importance of agricultural bio-security covering crops, trees and farm and aquatic animals since it relates to both the work and income security of a majority of the population and the food and trade security of the nation. It proposes to establish an integrated National Agricultural Biosecurity System (NABS) covering crops, animal husbandry, fisheries, forestry and agriculturally relevant micro-organisms. The objectives of NABS, *inter alia*, include organisation of an integrated national agricultural biosecurity programme on a hub-and-spoke model, with effective home and regional quarantine facilities capable of insulating the major agro- ecological and farming system zones of the country from invasive species of pests, pathogens and weeds as well as from the introduction and release of Genetically Modified Organisms (GMOs)’.

1.2.3. National Agroforestry Policy-2014:

The Policy, though silent on the use of exotic species in agroforestry, does seek to encourage agroforestry research, both in government and private sector, particularly for multipurpose

indigenous species with higher nitrogen-fixing ability, so as to meet the local needs for fuel, fodder and timber as well as improving the soil health (Para 6).

1.2.4. National Livestock Policy-2013:

- I. The Policy seeks to strengthen quarantine facilities to prevent the ingress of exotic diseases and synchronisation of the system of sanitary certification for export with global standards to promote export (Para 13.4).
- II. The Policy (Para 13.8) seeks to put in place a national institutional mechanism, in collaboration with the ICAR and other institutions, to deal with the issue of biosecurity in the livestock sector. It proposes necessary legislative back-up for enforcement of biosecurity along with strong quarantine facility, appropriate risk analysis and risk mitigation. It also proposes to regulate import of livestock, their products, vaccines and diagnostics to prevent ingress of exotic diseases.

1.3. Environment and Biodiversity

1.3.1. National Environment Policy-2006:

Despite the fact that the IS pose tremendous environmental hazards, they don't get any direct reference in the NEP-2006. But the NEP does reinforce the concerns raised by the agricultural policies about the negative fallouts of genetic-engineering and by the forest policies about the exotic species, as we can see below:

- I. The NEP [Para 5.1.1 (3)] recognises that the Living Modified Organisms (LMOs) may pose significant risks to ecological resources, and perhaps, human and animal health. It proposes the following actions:
 - a) Review the regulatory processes for LMOs so that all relevant scientific knowledge is taken into account, and ecological, health, and economic concerns are adequately addressed.
 - b) Periodically review the National Bio-safety Guidelines, and Bio-safety Operations Manual to ensure that these are based on current scientific knowledge.
 - c) Ensure the conservation of biodiversity and human health when dealing with LMOs in transboundary movement in a manner consistent with the multilateral Bio-safety Protocol.
- II. The NEP [Para 5.2.3 (i)] also seeks to promote plantation of only such species as are conducive to the conservation and sustainability of given ecosystems.

1.3.2. National Biodiversity Action Plan-2008 (amended in 2014):

The NBAP-2008 (amended in 2014), framed by the MoEF&CC, can be treated as supplementary to the National Environmental Policy-2006 and provides an exhaustive frame-work for managing IS in the country.

- I. The NBAP-2008 (Chapter-III, Para 3.3) recognises IS as a major threat to native plants, and animals (and their habitats)—second only to habitat loss. It welcomes the legislative and administrative measures adopted by some States for eradicating / containing IS but calls for more effective steps at the ground level.
- II. The NBAP (Chapter-4, Para 4.3) sets the following objectives in respect of regulation and management of IS:
 - To develop unified national system for regulation of all introductions including their quarantine check, assessment and release.
 - To improve management of IS and restore the adversely affected ecosystems.
- III. The NBAP (Chapter-5, Para 5.3) stipulates the following action points:
 - a. Develop a unified national system for regulation of all introductions and carrying out rigorous quarantine checks.
 - b. Strengthen domestic quarantine measures to contain the spread of invasive species to neighbouring areas.
 - c. Promote inter-sectoral linkages to check unintended introductions and contain and manage the spread of IS.
 - d. Develop a national database on IS reported in India.
 - e. Develop appropriate early warning and awareness system in response to new sightings of IS.
 - f. Provide priority funding to basic research on managing IS.
 - g. Support capacity building for managing IS at different levels with priority on local area activities.
 - h. Promote restorative measures of degraded ecosystems using preferably locally adapted native species for this purpose.
 - i. Promote regional cooperation in adoption of uniform quarantine measures and containment of invasive exotics.
- IV. The amendment in the NBAP in 2014, *inter alia*, seeks to integrate National Biodiversity Target No.4 which stipulates identification of IS and pathways and development of strategies to manage them by 2020 so that populations of prioritized IS are managed. The responsibility has been entrusted to the State Forest Departments, DoS, Wetlands International-South Asia, SACON, ICFRE (Forest Invasive Species Cell), WII, CMLRE, National Institute of Oceanography (NIO), Annamalai University (Faculty of Marine Sciences), and CABI South Asia. The following indicators have been set up for the target:
 - i. Number and coverage of management plans developed for prioritized invasive species and integration with PA management plans and wetland management plans
 - ii. Change in area affected by invasive species

As part of the updating of NBAP 2008, national biodiversity targets were developed in harmony with global strategic plan for biodiversity 2011-2020 and the Aichi Biodiversity

Targets. Recognising the crucial need to address invasive species threats, India formulated **National Biodiversity Target 4:**

- iii. *By 2020, invasive species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive species are managed.*
- iv. India has established 'Forest Invasive Species Cell' in the Indian Council of Forest Research and Education, Dehradun. The major objectives of this cell are to establish database on forest invasive species in India, networking and capacity building towards management of invasive species and development of better technology to eradicate invasive species.

1.4. Foreign Trade Policy (Import-Export Policy)

- I. The Foreign Trade Policy (FTP), notified periodically by Director General of Foreign Trade (DGFT) under the provisions of Foreign Trade (Development and Regulation) Act, 1992, is a major tool for regulating import and export of plants and animals of all descriptions including IS. The item-wise export and import policy is specified in ITC (HS)²⁸ notified by DGFT, as amended from time to time.
- II. The Policy (Chapter-2, Para 2.2) stipulates that all imported goods shall be subject to domestic Laws, Rules, Orders, Regulations, technical specifications, environmental and safety norms as applicable to domestically produced goods. In particular, the ITC (HS), 2012 makes the following stipulations:
 - a) Import and export of all wild animals covered by WPA-1972 and their derivatives is prohibited.
 - b) Compliance with CITES is mandatory.
 - c) Export of wild animals covered by WPA-1972 for research and education purpose is permissible on recommendation from the MoEF&CC.
 - d) Export of exotic birds except 6 species [Ref. Chapter I of Sch.2 of ITC (HS), 2012] is also prohibited. Export of 39 taxa of plants [Ref. Chapter III of Sch.2 of ITC (HS), 2012] is also banned.
 - e) Import of live animals (not covered by WPA-1972) by research institutions, zoos, circuses and private individuals is permitted on the recommendation of the CWLW. For import by research institutions, approval is also needed from the Committee for the purpose of Control and Supervision of Experiments on Animals (CPCSEA).
 - f) Import of live cattle, swine and poultry requires recommendation of the Department of Agriculture and Cooperation, Government of India and compliance with quarantine regulations. Import of all livestock products is subject to a sanitary import permit to be issued by Department of Animal Husbandry, Dairying & Fisheries, Government of India, as per S.3A of Livestock Importation Act, 1898 as amended from time to time.

²⁸Indian Trade Classification (Harmonized System) Classification of Export & Import Items

- g) Import of plants is permitted subject to the Plant Quarantine (Regulation of Import into India) Order 2003. All imported plant consignments should be accompanied by the documents / certificates prescribed in the said Order. All imported materials are inspected and, if necessary, fumigated or otherwise disinfected at the port of entry by the Plant Quarantine Officer.
- III. The Policy [Chapter-2, Para 2.6 (b)] also empowers the DGFT to adopt and enforce any measure necessary for protection of human, animal or plant life or health.

1.5. International Conventions

India is a party to International Plant Protection Convention (IPPC-1951), Convention on Conservation of Migratory Species of Wild Animals (CMS-1979) and Convention on Biological Diversity (CBD-1992) and is, therefore, under obligation to take legislative and administrative measures required for regulating IS within the country and also their import and export. These conventions also provide a medium for seeking cooperation from the other countries.

- I. IPPC is fully dedicated to securing coordinated and effective international action to prevent and to control the introduction and spread of pests (including weeds) of plants (natural and cultivated) and plant products. The Convention also covers research materials, biological control organisms, germplasm banks, containment facilities, food aid, emergency aid and anything else that can act as a vector for the spread of plant pests – for example, containers, packaging materials, soil, vehicles, vessels and machinery. The Convention is recognized by the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) as the only international standard setting body for plant health.
- II. CMS aims at conserving terrestrial, marine and avian migratory species throughout their range. Article III. 4 (c) of the Convention says that Parties that are Range States of a migratory species listed in Appendix I shall endeavour to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species.
- III. CBD is a comprehensive treaty which aims at conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits from the use of genetic resources. Article 8 (h) says that each Contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those species which threaten ecosystems, habitats or species. The Cartagena Protocol on Biosafety (2000) to the CBD is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health.

2. Legal instruments for dealing with IS

2.1. India Forest Act-1927 and State Forest Acts:

Forest officers have the authority to undertake management of weeds and IS in Reserved Forests and Protected Forests in accordance with Sections 26 (2) and 34 respectively of the IFA-1927 (or relevant Sections of the State Forest Acts). As stated earlier, they carry out required operations in accordance with the approved Working Plans.

2.2. Wildlife (Protection) Act-1972:

- I. S.33(c) and S.35(8) of WPA-1972 authorise the CWLW to undertake habitat improvement works (which include management of plant-based IS) in Sanctuaries and National Parks respectively.
- II. The Supreme Court issued an order on 14.2.2000 in IA No. 548 in the *Godavarman* case [WP (Civil) No. 202 of 1995] restraining the State Governments “from ordering the removal of dead, diseased, dying or wind-fallen trees, drift wood and grasses, etc. from any National Park or Game Sanctuary or forest.” On 28.2.2000, the Court modified the above instruction and dropped the word ‘forest’ from its order. The Court issued further instructions in IA No. 548 on 25.11.2005 and clarified that its order dated 14.2.2000 would not apply to certain activities in the PAs relating to habitat improvement, fire protection, management of grassland habitat, improvement of communication and protection in the PAs, and anti-poaching initiatives—provided the same are in accordance with the approved Management Plans; consistent with the WPA-1972, NWAP and other relevant guidelines.
- III. WPA-1972 also provide for management of invasive animal species (whether listed under the schedules of the WPA-1972 or not). S.12 authorises the CWLW to permit hunting of any scheduled wild animal for scientific management (which includes population management) with prior approval of the Central Government in respect of Schedule I animals and State Government in respect of animals covered in Schedules II, III and IV. However, S.12 does not permit killing or poisoning of wild animals for the purpose of population management, which restricts the choice of hunting to capture, translocation and fertility control. S.62 provides an alternative way in respect of animals covered in Schedules II (Part-I), III and IV which can be declared vermin with the permission of the Central Government for a specified period and then culled. There is no problem with the culling of animals already listed in Schedule V (vermins) or those not listed in any of the schedules.
- IV. However, all wildlife (which include vermins and non-scheduled animals) enjoy protection within Sanctuaries and National Parks under S.29 and S.35(6) respectively and the CWLW would need prior permission of the State Government before ordering destruction or removal of such wildlife—with an additional rider that the State

Government would consult SBWL in respect of a Sanctuary and NBWL in respect of a National Park before granting its permission.

- V. There are no legal problems in removing Elephants (Schedule I) and Chital (Schedule III) from the A&N Islands in case they are considered to be invasive species, but there are obvious logistic and financial problems.

2.3. Environment (Protection) Act-1986

- I. The preamble of the EPA-1986 suggests that it is meant for prevention of hazards to human beings, other living creatures, plants and property. S.3(1) of the EPA-1986 empowers the Central Government to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of environment.
- II. The Central Government has framed 'Manufacture, Use, Import-Export and Storage of Hazardous Micro-organism, Genetically Engineered Organisms or Cells Rules-1989'.

2.4. Biological Diversity Act-2002

- I. Management and control of IS is obviously related to conservation of biodiversity. S.18(3)(a) stipulates that the National Biodiversity Authority (NBA) may advise the Central Government on matters relating to the conservation of biodiversity. Similarly, S.23 (a) enjoins upon the State Biodiversity Board to advise the State Government on matters relating to the conservation of biodiversity.
- II. S.36(1) mandates the Central Government to develop national strategies, plans and programmes for the conservation, promotion and sustainable use of biological diversity. S.36(2) empowers the Central Government to issue suitable directives to the concerned State Government if it has reason to believe that any area rich in biological diversity, biological resources and their habitats is being threatened by overuse, abuse or neglect.
- III. S.36(4)(ii) mandates the Central Government to take measures to regulate, manage or control the risks associated with the use and release of LMOs likely to have adverse impact on the conservation and sustainable use of biological diversity and human health.
- IV. S.40 empowers the Central Government to declare, in consultation with the NBA, by notification in the Official Gazette, that the provisions of this Act shall not apply to an IS which also happens to be a 'biological resource'.

2.5. Prevention and Control of Infections and Contagious Diseases in Animals Act, 2009

This Act authorises the competent authorities of the Central and State Governments to prohibit or restrict the movement of animals suffering from specified diseases like Anthrax, Avian Flu, Swine Flu, etc. and carry out culling of the diseased animals if so required.

2.6. Criminal Procedure Code-1973

S.133 of Cr.P.C. empowers the District Magistrate or any other authorised Executive Magistrate to permit the destruction or confinement of any dangerous animal. S.47 of IPC-1860 defines

"animal" as any living creature, other than a human being. District Magistrates have sometimes been using S.133 of Cr. P.C. to order destruction of birds suspected to be carrying pathogens of Avian Flu.

2.7. Livestock Importation Act-1898

This Act empowers the Central Government to regulate, restrict or prohibit the import into India or any specified place therein, of any livestock which may be liable to be affected by infectious or contagious disorders.

- I. As defined in the Act, Livestock includes horses, kine, camels, sheep and any other animal which may be notified by the Central Government in the Official Gazette. Through a notification dated 26.6.1950, the Central Government included mules, asses, bulls, calves, bullocks, buffaloes, goats, swine, dogs, cats, poultry, parrots, pigeons, canaries and finches in the list of livestock.
- II. The Ministry of Agriculture has appointed Animal Quarantine officers at Delhi, Mumbai, Chennai and Kolkata to verify the health of animals and birds before export and after import and to issue Quarantine Clearance Certificates. The Animal Quarantine Officer may, if needed, cause for the detention of any animal or bird to be imported at a quarantine station for observation and prevent the entry of such birds and animals as are diseased.
- III. The Act was extended through an amendment in 2001 to import of livestock products.

2.8. Destructive Insects and Pests Act, 1914

This Act seeks to prevent the import into India and the transport from one state to another in India of any insects, fungus or other pest which is or may be destructive to crops.

- I. A comprehensive set of regulations under the said Act was issued in 2003 under the title 'Plant Quarantine (Regulation of Import into India) Order 2003' (PQO-2003) which has since undergone a large number of amendments. The PQO-2003 contains many schedules, such as:
 - 1) Schedules I to III: Points of Entry / Inland Container Depots / Foreign Post Offices for imports of plants/ planting materials
 - 2) Schedule IV: List of plants/ planting materials prohibited for import and countries from where import is prohibited
 - 3) Schedule V: List of plants/ planting materials imports of which are restricted and permissible only by authorized institutions with additional declarations and subject to special conditions
 - 4) Schedule VI: List of plants/ planting materials permitted for import with additional declarations and special conditions
- 5) Schedule VII: List of plants/ planting materials permissible for import on the basis of phytosanitary certificate issued by the exporting country, the inspection conducted by Inspection Authority and fumigation, if required, including all other general conditions

6) Schedule VIII: List of Quarantine Weed Species

- II. As per S.3(14) of the PQO-2003, all consignment of seeds and plants for propagation and regulated articles such as live insects, microbial cultures, bio-control agents and soil shall only be imported into India through regional plant quarantine stations of Amritsar, Chennai, Kolkata, Mumbai or New Delhi or through any other points of entry as may be notified from time to time for this purpose, provided that no import of germplasm/ transgenic plant material and Genetically Modified Organisms (GMOs) shall be permitted through New Delhi Airport.
- III. As per S. 6(1) of the PQO-2003, no consignment of germplasm/ transgenics/ GMOs shall be imported into India for experimental purpose without valid permit issued by the Director, National Bureau of Plant Genetic Resources.

2.9. State Acts to deal with IS

- I. Bengal Water Hyacinth Act-1936 (amended in 1941) seeks to prohibit introduction and propagation of Water Hyacinth (*Eichornia crassipes*) in West Bengal.
- II. Some examples of State Acts dealing with agricultural pests and diseases are: Madras Agricultural Pests and Diseases Act-1919, Travancore Plant Pests and Plant Diseases Regulation-1919, Coorg Agricultural Pests and Diseases Act-1914 (came into force in 1933), Patiala Destructive Insects and Pests Act-1943, Bombay Agricultural Pests and Diseases Act-1947, Rewa State Agricultural Pests and Diseases Act-1947, East Punjab Agricultural Pests, Diseases and Noxious Weeds Act-1949, (also extended to Himachal Pradesh in 1949) and Assam Agricultural Pests and Diseases Act-1950.

2.10. Customs Act-1962

- I. All cases of violations of the Foreign Trade Policy are deemed to be an offence under the Customs Act and processed accordingly.
- II. S.11 of the Customs Act empowers the Central Government to prohibit or regulate, by a gazette notification, the import or export of goods of any specified description for the purpose of, *inter alia*, protection of human, animal or plant life or health.

3. Some observations on the Policies and Laws relating to IS in India

- i. The concept of IS is still evolving in India. It is, therefore, not surprising that one finds either no reference or only a passing reference to IS in old policy documents, such as the National Forest Policy-1988, National Agriculture Policy-2000, etc. But the newer policy documents like the National Policy for Farmers-2007, National Biodiversity Action Plan-2008 (amended in 2014) and National Working Plan Code-2014 are quite vocal about IS and together present a fairly comprehensive policy statement. It is, however, desirable that different ministries revise and update their policies and action plans with regard to IS.

- ii. National Biodiversity Action Plan has rightly pointed out that “There is, however, a need to develop a unified national system for regulation of introduction and management of all invasive species across jurisdiction of all concerned Ministries and relevant sectors.” (Para 5.3).
- iii. The paper by Kannan *et al* (2013), said to be based on interview with some retired forest officers and interaction with a few Park Managers, gives an inaccurate picture about inadequacy of policy and law for management of IS in PAs. As explained earlier, NWAP (2002-16) provides a clear policy statement on control of IS in PAs; Central Government provides financial support for this purpose under various CSS; and WPA-1972 provides the enabling legislation. A large number of PAs in India routinely carry out habitat improvement works by way of removal of IS and replacement of monocultures of exotic species with a mixture of indigenous fodder or fruit-bearing species. Removal of IS is usually done by uprooting or burning followed by plantation with bamboo or other fodder species. The results are not always encouraging. That is why the NWAP calls upon research institutes to provide technical assistance to the PA managers for control and eradication of IS (Chapter-II, Para 5.1).
- iv. The forest based IS are still in the process of identification and there is no final or authentic list for forest officers to act upon. Forest officers in India have been using exotic species for over 150 years either for increasing the productivity of forests or for afforestation of degraded lands. Most of these species were tried and recommended by the scientists of the FRI (now ICFRE) or the State Silviculturist. The recommended species were often included in the Working Plan prescriptions. One can understand the dilemma of the forest officers if some of such species were now to be dealt with as IS. An example is provided by *Leucaena leucocephala* (commonly known as Subabul)—a fast-growing tree species recommended during the mid-1970s by the FRI Scientists and the agricultural scientists as an excellent source of fuelwood and cattle-fodder, which has now been listed as IS for India²⁹. Two grass species listed as IS, viz. *Saccharum spontaneum* and *Imperata cylindrica*, are ironically also being planted by the West Bengal Forest Department (WBFD) for improving the rhino-habitat in Jaldapara National Park since 1980s. The success of these plantations is reflected in the increase in rhino population in Jaldapara from 14 in 1985 to 186 in 2013. *Imperata cylindrica* is also a source of thatch for the members of EDCs of Jaldapara NP helping the forest staff in protection of rhinos. It will be unrealistic to expect WBFD to change its management practice in Jaldapara NP overnight. A similar dilemma presented in the State Forest Policy of Rajasthan in respect of *Prosopis juliflora* has been discussed earlier. It is advisable that the MoEF&CC finalises its list of IS and corresponding management strategy in consultation with the State Forest Departments.

²⁹ Ref. Status of Forest Invasive Species in India—Country Report. Asia-Pacific Forest Invasive Species Network (www.apfisn.net)

- v. Management of IS is likely to involve clashes with policies and laws of other Ministries and Departments. Many of the plants identified as IS (e.g. *Ageratum conyzoides*, *Cassia tora*, *Dioscorea deltoidea*, *Tridax procumbens*, *Vitex negundo*, etc.)³⁰ are also known to be medicinal plants used in traditional medicinal system and being promoted by various government agencies (perhaps also National and State Medicinal Plant Boards), industries and NGOs and it will be unreasonable to take unilateral decisions about management of these species as IS. Likewise, many of the plant species identified as IS are also likely to be categorised as NTFPs collected by the members of the JFM Committees in accordance with the policies of the State Governments or reserved for use by the tribal people in accordance with PESA-1996. Many IS may also qualify to be called ‘Biological Resource’ and included in PBR in accordance with Biological Diversity Act-2002 with altogether different set of policies and legal provisions. It is, therefore, advisable that the list of IS and corresponding management strategy is finalised in consultation with all stakeholders.
- vi. Theoretically, PQO-2003 and the Foreign Trade Policy provide strong legal tools to check import of plant-based IS. But a large volume of plants and plant-products is known to move across the international land-borders and it is doubtful whether there are adequate plant quarantine stations to detect and take care of this movement.
- vii. Destructive Insects and Pests Act, 1914 also seek to regulate movement of insects, fungus or other pests from one state to another but PQO-2003 is not built to regulate inter-state movement of plant-based IS. Some of the States have their own Acts for this purpose but the efficacy of these Acts and corresponding enforcement machinery is doubtful.
- viii. The Foreign Trade Policy is effective against the import of only those animal-based IS which are specifically restricted or prohibited in the ITC (HS)—the other species, by implication, are permitted for free import. Presently, ITC (HS) covers wild animals as defined in the WPA-1972 (i.e. species listed in Schedules I to IV); species listed in the appendices of CITES; animals as covered by the Livestock Importation Act-1898, and a few more species listed in ITC (HS)-2012. A large number of animals, particularly, fish, crustaceans and invertebrates, are not covered by the restricted / prohibited list and their entry within the country is dependent on the discretion of the inspecting officers or the alertness of the Animal Quarantine Officers. It is advisable to develop regulations for import of animals on the lines of PQO-2003.
- ix. As in the case of plant-based IS, legislation and infrastructure for inter-state movement of animal-based IS is inadequate.
- x. IS are widely reckoned as environmental hazards but the definition of “Hazardous Substance” as provided in the EPA-1986 does not appear to cover IS³¹. It may be

³⁰ Ref. *ibid*.

³¹ According to S.2(c) of the EPA-1986, “Hazardous Substance” means any substance or preparation which, by reason of its chemical or physic-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment.

examined whether the definition should be amended suitably to bring the management and control of IS under the ambit of a strong Act like EPA-1986.

References

- Allen, G.R., S.H. Midgley and M. Allen, 2002. Field guide to the freshwater fishes of Australia. Western Australian Museum, Perth, Western Australia. 394 p.
- Ali Nawaz, M. (2007). Status of the brown bear in Pakistan. *Ursus*, 18(1), 89–100.
- Andelt, W. F. (2004). Livestock guard dogs, llamas, and donkeys.
- Andrzejewski, R., & Jezierski, W. (1978). Management of a wild boar population and its effects on commercial land. *Acta Theriologica*, 23(19-3), 309–339.
- Anon. (2004). Solving conflicts between Asian big cats and humans: A Portfolio of conservation action.
- Anon. (2008). The Project Snow Leopard. Ministry of Environment & Forests, Government of India, New Delhi.
- Anon (2014). Summary of Discussion, National Workshop on Developing Strategies for Mitigation of Human Wildlife Conflicts organized by MoEFCC at India Habitat Centre, New Delhi on 20.8.2013.
- Anoop, K., K.S., Gopi Sundar, B.A. Khan & Lal (2009). Common moorhen *Gallinula chloropus* in the diet of the African catfish *Clarias gariepinus* in Keoladeo Ghana National Park, India. *Indian Birds*, 5(1): 22-23.
- Achhireddy, N. R., & Singh, M. (1984). Allelopathic effects of lantana (*Lantana camara*) on milkweedvine (*Morrenia odorata*). *Weed Science*, 757–761.
- Aryal, A. (2007). Blue bull (*Boselaphus tragocamelus*) in Lumbini-A world heritage site of Nepal. *Tiger Paper*, 34, 4–9.
- Athreya, V., & Belsare, A. V. (2007). Human-leopard conflict management guidelines. Kaati Trust, Pune, India.
- Athreya, V., Odden, M., Linnell, J. D., & Karanth, K. U. (2011). Translocation as a Tool for Mitigating Conflict with Leopards in Human-Dominated Landscapes of India. *Conservation Biology*, 25(1), 133–141.
- Athreya, V., Thakur, S., Chaudhuri, S., & Belsare, A. (2006). Is relocation a viable management option for unwanted animals?-The case of the leopard in India. *Conservation and Society*, 4(3), 419.
- Attayde, J.L., J. Brasil & R.A. Menescal (2011). Impacts of introducing Nile tilapia on the fisheries of a tropical reservoir in north-eastern Brazil. *Fisheries Management and Ecology*, 18: 437–443.
- Babu, S., Love, A., & Babu, C. R. (2009). Ecological restoration of lantana-invaded landscapes in Corbett Tiger Reserve, India. *Ecological Restoration*, 27(4), 467–477.
- Bagchi, S., & Mishra, C. (2006). Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology*, 268(3), 217–224.
- Banerjee, K., & Jhala, Y.V. (2012). Demographic parameters of endangered Asiatic lions (*Panthera leo persica*) in Gir forests, India. *Journal of Mammalogy*, 93(6), 1420-1430.

- Banerjee, K., Jhala, Y.V., Chauhan, K.S., & Dave, C.V. (2013). Living with lions: the economics of coexistence in the Gir forests, India. *PLoS ONE*, 8(1), e49457.
- Bargali, H. S., Akhtar, N., & Chauhan, N. P. S. (2005). Characteristics of sloth bear attacks and human casualties in North Bilaspur Forest Division, Chhattisgarh, India. *Ursus*, 16(2), 263–267.
- Barreto, R. W., & Evans, H. C. (1995). The mycobiota of the weed *Mikania micrantha* in southern Brazil with particular reference to fungal pathogens for biological control. *Mycological Research*, 99(3), 343–352.
- Baskaran, N., Varma, S., Sar, C. K., & Sukumar, R. (2011). Current status of Asian elephants in India. *Gajah*, 35, 47–54.
- Berard, J. D., Nurnberg, P., Epplen, J. T., & Schmidtke, J. (1994). Alternative reproductive tactics and reproductive success in male rhesus macaques. *Behaviour*, 177–201.
- Bhagwat, S. A., Breman, E., Thekaekara, T., Thornton, T. F., & Willis, K. J. (2012). A battle lost? Report on two centuries of invasion and management of *Lantana camara* L. in Australia, India and South Africa. *PloS One*, 7(3), e32407.
- Bhatta, R. (2012). Ecology and Conservation of Great Indian One horned Rhino *Rhinoceros unicornis* in Pobitora Wildlife Sanctuary Assam India.
- Bist, S. S. (2002). An overview of elephant conservation in India. *Indian Forester*, 128(2), 121–136.
- Blaber, S.J.M., 1997. Fish and fisheries of tropical estuaries. Fish and Fisheries Ser. 22, Chapman and Hall, London. 367 p.
- Boominathan, D., Mohanraj, N., Aziz, T., & Desai, A. (2008). Management of the Asian elephant in the Nilgris and Eastern Ghats: human-elephant conflict in Somwarpet Subdivision (Madikeri Forest Division). WWF AREAS.
- Bulte, E. H., & Rondeau, D. (2005). Research and management viewpoint: why compensating wildlife damages may be bad for conservation. *Journal of Wildlife Management*, 69(1), 14–19.
- Burkart, A. (1976). A monograph of the genus *Prosopis* (*Leguminosae subfam. Mimosoideae*). [Part 1.]. *Journal of the Arnold Arboretum*, 57(3), 219–249.
- Chakravarthy, A. K., & Bhat, N. S. (1994). The beetle (*Zygogramma conjuncta* Rogers), an agent for the biological control of weed, *Parthenium hysterophorus* L. in India feeds on sunflower (*Helianthus annuus* L.). *Journal of Oilseeds Research*, 11, 122–125.
- Chakravarthy, A. K., Bhat, N. S., & Sridhar, S. (1994). The beetle *Zygogramma conjuncta* (Rogers), a bioagent for the control of the weed, *Parthenium hysterophorus* L. is oligophagous. *Science and Culture*, 60, 61–62.
- Chapman, C. A., & Peres, C. A. (2001). Primate conservation in the new millennium: The role of scientists. *Evolutionary Anthropology: Issues, News, and Reviews*, 10(1), 16–33.
- Charoo, S. A., Sharma, L. K., & Sathyakumar, S. (2011). Asiatic black bear-human interactions around Dachigam National Park, Kashmir, India. *Ursus*, 22(2), 106–113.

- Chauhan, D. S., & Goyal, S. P. (2000). A study on distribution, relative abundance and food habits of leopard (*Panthera pardus*) in Garhwal Himalayas. Report of the Wildlife Institute of India, Dehradun.
- Chauhan, N. P. S. (2003). Human casualties and livestock depredation by black and brown bears in the Indian Himalaya, 1989-98. *Ursus*, 84–87.
- Chauhan, N. P. S. (2004). Wild Pig. Ungulates of India. ENVIS Bulletin: Wildlife and Protected Areas, Wildlife Institute of India, Dehradun, 203–218.
- Chauhan, N. P. S. (2011a). Agricultural crop depredation by nilgai antelope (*Boselaphus tragocamelus*) and mitigation strategies: challenges in India. *Julius-Kühn-Archiv*, (432), 190.
- Chauhan, N. P. S. (2011b). Human casualties and agricultural crop raiding by wild pigs and mitigation strategies in India. *Julius-Kühn-Archiv*, (432), 192.
- Chauhan, N. P. S., Barwal, K. S., Kumar, D., & Náhlik, A. (2009). Human–wild pig conflict in selected states in India and mitigation strategies. *Acta Silvatica & Lignaria Hungarica*, 5, 189–197.
- Chauhan, N. P. S., & Singh, R. (1990). Crop damage by overabundant populations of nilgai and blackbuck in Haryana (India) and its management. *Proceedings of the Fourteenth Vertebrate Pest Conference*. Paper 13.
- Chauhan, N. P. S., Sushant, C., Qureshi, Q., Malik, P. K., Nigam, P., & Sinha, P. R. (2010). Managing Blue Bull (*Boselaphus tragocamelus*) in Human and Agriculture Dominated Landscape: Challenges & Options for Mitigation. Wildlife Institute of India.
- Chellam, R., (1993). Ecology of the Asiatic lion (*Panthera leo persica*). Ph.D Thesis, Saurashtra University, Rajkot, India, 170 pp.
- Chhangani, A. K., Robbins, P., & Mohnot, S. M. (2008). Crop raiding and livestock predation at Kumbhalgarh Wildlife Sanctuary, Rajasthan India. *Human Dimensions of Wildlife*, 13(5), 305–316.
- Chhangani, A. K., & Mohnot, S. M. (2004). Crop raid by hanuman langur *Semnopithecus entellus* in and around aravallis (India) and its management. *Primate Report*, 35–48.
- Choudhury, A. (2004). Human–elephant conflicts in Northeast India. *Human Dimensions of Wildlife*, 9(4), 261–270.
- Cock, M. J. W. (1982). Potential biological control agents for *Mikania micrantha* HBK from the neotropical region. *International Journal of Pest Management*, 28(3), 242–254.
- Conklin, E. J. and J. E. Smith. (2005). Abundance and spread of the invasive red algae, *Kappaphycus* spp., in Kane'ohe Bay, Hawai'i and an experimental assessment of management options. *Biological Invasions* 7(6), 1029-39.
- Corbett, J. (1991). The Jim Corbett Omnibus (Vol. 1). Oxford University Press India.
- Das, C.S. (2012). Tiger straying incidents in Indian Sundarban: statistical analysis of case studies as well as depredation caused by conflict. *Eurasian Journal of Wildlife Research*. 58, 205–214.

- Dave, C. V. (2010). Understanding conflicts and conservation of Indian wild ass around Little Rann of Kachchh, Gujarat. India.
- De Moor, I.J. and M.N. Bruton, 1988. Atlas of and translocated indigenous aquatic animals in southern Africa. A report of the Committee for Nature Conservation Research National Programme for Ecosystem Research. South African Scientific Programmes Report No. 144. 310 p. Port Elizabeth, South Africa.
- Desai, A. A. (2002). Design of human-elephant conflict mitigation strategy for the proposed Tesso Nilo Protected Area, and possible expansion of such strategy into the Tesso Nilo Conservation Landscape, and the Province of Riau. Draft, Jakarta, Indonesia, WWF-Indonesia.
- De Silva, S.S., R.P. Subasinghe, D.M. Bartley & A. Lowther (2004). Tilapias as aquatics in Asia and the Pacific: a review. FAO Fisheries Technical Paper. No. 453. Rome, FAO. 2004. 65p.
- Devi, Oinam Sunanda, and P. K. Saikia. 2008. Human-Monkey Conflict: A Case Study at Gauhati University Campus, Jalukbari, Kamrup, Assam. *Zoos' Print* 23 (2): 15–18.
- Dhanwatey, H. S., Crawford, J. C., Abade, L. A., Dhanwatey, P. H., Nielsen, C. K., & Sillero-Zubiri, C. (2013). Large carnivore attacks on humans in central India: a case study from the Tadoba-Andhari Tiger Reserve. *Oryx*, 47(02), 221–227.
- Di Fonzo, M. M. (2007). Determining correlates of Human–elephant conflict reports within fringe villages of Kaziranga National Park, Assam. Master's Dissertation. University of London.
- Dickman, A. J. (2010). Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation*, 13(5), 458–466.
- Doupe, R.G. & D.W. Burrows (2008). Thirty years later, should we be more concerned for the ongoing invasion of Mozambique tilapia in Australia? *Pacific Conservation Biology*, 14: 235–238.
- Edgaonkar, A., & Chellam, R. (1998). A preliminary study on the ecology of the leopard (*Panthera pardus fusca*). Sanjay Gandhi National Park, Maharashtra.
- Ellison, C. A. (2001). Classical biological control of *Mikania micrantha*. Weeds in Moist Tropical Zones, Banes and Benefits (eds KV Sankaran, ST Murphy & HC Evans), 131–138.
- Feh, C., Shah, N., Rowen, M., Reading, R. P., & Goyal, S. P. (2002). Status and action plan for the Asiatic wild ass (*Equus hemionus*). *Equids: Zebras, Asses and Horses*. Cambridge, UK: IUCN Publication Services Unit.
- Fernando, P., Kumar, M. A., Williams, A. C., Wikramanayake, E., Aziz, T., & Singh, S. M. (2008). Review of human-elephant conflict mitigation measures practiced in South Asia. AREAS Technical Support Document Submitted to World Bank. WWF–World Wide Fund for Nature.
- Fooden, J. (2000). Systematic review of the rhesus macaque, *Macaca mulatta* (Zimmermann, 1780).

- Fox, J. L., & Chundawat, R. S. (1995). Wolves in the Transhimalayan region of India; the continued survival of a low-density population. *Ecology and Conservation of Wolves in a Changing World*, 95–103.
- Fox, J. L., Sinha, S. P., Chundawat, R. S., & Das, P. K. (1991). Status of the snow leopard *Panthera uncia* in Northwest India. *Biological Conservation*, 55(3), 283–298.
- Gadgil, M., & Guha, R. (1993). *This fissured land: an ecological history of India*. University of California Press.
- Gee, E. P. (1963). The Indian Wild Ass. *Oryx*, 7(01), 9–21.
- Gehrt, Stanley D., Seth PD Riley, and Brian L. Cypher. 2010. *Urban Carnivores: Ecology, Conflict, and Conservation*. JHU Press.
- Genov, P. (1981). Food composition of wild boar in Northeastern and Western Poland. *Acta Theriologica*, 26(8-15), 185–205.
- Ghosh, D. K. (1996). Crop depredation around Jaldapara sanctuary by *Rhinoceros unicornis* an indicative trend. *Indian Forester*, 122, 884–896.
- Gubbi, S. (2012). Patterns and correlates of human–elephant conflict around a south Indian reserve. *Biological Conservation*, 148(1), 88–95.
- Green, J. S., Woodruff, R. A., & Andelt, W. F. (1994). Do livestock guarding dogs lose their effectiveness over time? *Proceedings of Vertebrate Pest Conference*. 16:41–44.
- Gujral, S. S., & Vasudevan, P. (1983). *Lantana camara* L., a problem weed. *Journal of Scientific & Industrial Research*, 42(5), 281–286.
- Gupta, A. (2001). Non-human primates of India—an introduction. *ENVIS Bulletin, Wildlife Protected Areas*, 1–29.
- Gurung, G., & Thapa, K. (2004). Snow Leopard (*Uncia uncia*) and Human Interaction in Phoo Village in the Annapurna Conservation Area, Nepal. Report Submitted to International Snow Leopard Trust, USA.
- Habib, B., Shotriya, S., & Jhala, Y. V. (2013). Ecology and Conservation of Himalayan Wolf. Wildlife Institute of India – Technical Report No. TR – 2013/01, Pp 46.
- Harihar, A., Ghosh-Harihar, M., & MacMillan, D. C. (2014). Human resettlement and tiger conservation–Socio-economic assessment of pastoralists reveals a rare conservation opportunity in a human-dominated landscape. *Biological Conservation*, 169, 167–175.
- Hiremath, A. J., & Sundaram, B. (2005). The fire-lantana cycle hypothesis in Indian forests. *Conservation and Society*, 3(1), 26.
- Hiremath, A. J., & Sundaram, B. (2013). Invasive Plant Species in Indian Protected Areas: Conserving Biodiversity in Cultural Landscapes. *In Plant Invasions in Protected Areas* (pp. 241–266). Springer.
- Hoare, R. E. (2001). A decision support system for managing human–elephant conflict situations in Africa. IUCN/SSC African Elephant Specialist Group, Nairobi, 105.
- Hodkinson, I. D. (1991). New World legume-feeding psyllids of the genus *Aphalaroida* Crawford (Insecta: Homoptera: Psylloidea). *Journal of Natural History*, 25(5), 1281–1296.

- Humphries, S. E., & Stanton, J. P. (1992). *Lantana camara* (lantana). Weed Assessment in the Wet Tropics World Heritage Area of North Queensland', Eds SE Humphries and JP Stanton.(Wet Tropics Management Agency, Cairns).
- Hussain, S. (2000). Protecting the snow leopard and enhancing farmers' livelihoods: a pilot insurance scheme in Baltistan. *Mountain Research and Development*, 20(3), 226–231.
- Isvaran, K. (2003). The evolution of lekking: Insights from a species with a flexible mating system. University of Florida.
- Isvaran, K. (2004). Indian Antelope or Blackbuck (*Antilope cervicapra* Linn. 1758). In: Sankar K, Goyal SP (eds) Ungulates of India. ENVIS bulletin: wildlife and protected areas, vol 71. Wildlife Institute of India, Dehradun, India. Pp. 120–143.
- Isvaran, K. (2005). Variation in male mating behaviour within ungulate populations: patterns and processes. *Current Science*, 89(7), 1192–1199.
- Jackson, R. M., & Hunter, D. O. (1996). Snow leopard survey and conservation handbook. International Snow Leopard Trust.
- Jackson, Rodney, and Rinchen Wangchuk. 2001. "Linking Snow Leopard Conservation and People-Wildlife Conflict Resolution: Grassroots Measures to Protect the Endangered Snow Leopard from Herder Retribution." *Endangered Species Update* 18 (4): 138–41.
- Jackson, Rodney M., and Rinchen Wangchuk. 2004. "A Community-Based Approach to Mitigating Livestock Depredation by Snow Leopards." *Human Dimensions of Wildlife* 9 (4): 1–16.
- Jayanth, K. P., & Nagarkatti, S. (1987). Investigations on the host-specificity and damage potential of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) introduced into India for the biological control of *Parthenium hysterophorus*. *Entomon*, 12(2), 141–145.
- Jensen, J. T., Hanna, C., Yao, S., Micks, E., Edelman, A., Holden, L., & Slayden, O. D. (2014). Blockade of tubal patency following transcervical administration of polidocanol foam: initial studies in rhesus macaques. *Contraception*, 89(6), 540–549.
- Jhala, Y. V. (1993). Damage to Sorghum crop by blackbuck. *International Journal of Pest Management*, 39(1), 23–27.
- Jhala, Y. V. (1993). Predation on blackbuck by wolves in Velavadar National Park, Gujarat, India. *Conservation Biology*, 7(4), 874–881.
- Jhala, Y. V. (2003). Status, ecology and conservation of the Indian wolf *Canis lupus pallipes* Sykes. *Journal of Bombay Natural History Society*. 100(2), 3.
- Jhala, Y. V., & Giles, R. H. (1991). The status and conservation of the wolf in Gujarat and Rajasthan, India. *Conservation Biology*, 5(4), 476–483.
- Jhala, Y. V., Qureshi, Q., Gopal, R., & Sinha, P. R. (2011). Status of the Tigers, Co-predators, and Prey in India, 2010. National Tiger Conservation Authority, Govt. of India, New Delhi, and Wildlife Institute of India, Dehradun. TR 2011/003 pp-302.
- Jhala, Y. V., & Sharma, D. K. (1997). Child-lifting by wolves in eastern Uttar Pradesh, India. Boguslaw Bobek.

- Jhala, Y.V., Qureshi, Q., Gopal, R., Amin, R. (2013). Field guide: Monitoring tigers, co-predators, prey and their habitat. Third edition. Technical publication of National Tiger Conservation Authority, New Delhi and Wildlife Institute of India, Dehradun.
- Jnawali, S. R. (1989). Park-people conflict: assessment of crop damage and human harassment by rhinoceros (*Rhinoceros unicornis*) in Sauraha Area adjacent to the Royal Chitwan National Park, Nepal.
- Johnsingh, A. J. T., Panwar, H. S., & Rodgers, W. A. (1990). Ecology and conservation of large felids in India. In Wildlife conservation: present trends and perspectives for the 21st century. Proceedings of the International Symposium on wildlife conservation in Tsukuba and Yokohama, Japan (pp. 21–25).
- Johnsingh, A.J.T., Chellam, R., & Sharma, D. (1998). Prospects for conservation of Asiatic lions in India. *Biosphere Conservation*, 1, 81-89.
- Johnson, A., Vongkhamheng, C., Hedemark, M., & Saithongdam, T. (2006). Effects of human–carnivore conflict on tiger (*Panthera tigris*) and prey populations in Lao PDR. *Animal Conservation*, 9(4), 421–430.
- Johnson, B and G. Gopakumar, 2011. Farming of the seaweed *Kappaphycus alvarezii* in Tamil Nadu coast - status and constraints, *Marine Fisheries Information Service T&E Ser.*, No. 208, 1-5.
- Johnson, J.A. Paromita, R. and K. Sivakumar (2014). Report of new invasive fish, Red-bellied Piranha *Pygocentrus nattereri* in Godavari River, Andhra Pradesh, Min, 2: 8-10.
- Joslin, P. (1973). The Asiatic lion: a study of ecology and behavior. PhD thesis, Department of Forestry and Natural Resources, University of Edinburgh, UK, 249 pp.
- Kadhane, D. L., Jangde, C. R., Sadekar, R. D., & Joshirao, M. K. (1992). Parthenium toxicity in buffalo calves. *Journal of Soils and Crops*, 21(1R), 69–71.
- Kala, C. P., & Kothari, K. K. (2013). Livestock predation by common leopard in Binsar Wildlife Sanctuary, India: human–wildlife conflicts and conservation issues. *Human-Wildlife Interactions*, 7(2).
- Kanchan, S. D. (1980). Allelopathic effects of *Parthenium hysterophorus* L. *Plant and Soil*, 55(1), 67–75.
- Kannan, R., Shackleton, C. M., & Uma Shaanker, R. (2013). Playing with the forest: invasive plants, policy and protected areas in India. *Current Science*, 104(9), 1159–1165.
- Karant, K. K., Gopaldaswamy, A. M., Prasad, P. K., & Dasgupta, S. (2013). Patterns of human–wildlife conflicts and compensation: Insights from Western Ghats protected areas. *Biological Conservation*, 166, 175–185.
- Karant, K. K., Naughton-Treves, L., DeFries, R., & Gopaldaswamy, A. M. (2013). Living with wildlife and mitigating conflicts around Three Indian Protected Areas. *Environmental Management*, 52(6), 1320–1332.
- Karant, K. U., & Gopal, R. (2005). An ecology-based policy framework for human-tiger coexistence in India. *Conservation Biology Series-Cambridge*, 9, 373.

- Karanth, K. U., & Stith, B. M. (1999). Prey depletion as a critical determinant of tiger population viability. *Riding the Tiger: Tiger Conservation in Human Dominated Landscapes*. Cambridge University Press. 383pp.
- Karanth, K. U., & Sunquist, M. E. (1995). Prey selection by tiger, leopard and dhole in tropical forests. *Journal of Animal Ecology*, 439–450.
- Kaur, R., Gonzales, W. L., Llambi, L. D., Soriano, P. J., Callaway, R. M., Rout, M. E., ... others. (2012). Community impacts of *Prosopis juliflora* invasion: biogeographic and congeneric comparisons. *PLoS One*, 7(9), e44966.
- Khan, M. R. (1986). The status and distribution of the cats in Bangladesh. *Cats of the world*. National Wildlife Federation, USA, 43–49.
- Khatiwada, A. P., Awasthi, K. D., Gautam, N. P., Jnawali, S. R., Subedi, N., & Aryal, A. (2011). The pack hunter (dhole): Received little scientific attention. *The Initiation*, 4, 8–13.
- Khosla, S. N., & Sobti, S. N. (1980). Parthenium—a national health hazard, its control and utility—a review. *Herba Hungarica*.
- Kolowski, J. M., & Holekamp, K. E. (2006). Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along a Kenyan reserve border. *Biological Conservation*, 128(4), 529–541.
- Kottelat, M. and T. Whitten, 1996. Freshwater biodiversity in Asia, with special reference to fish. World Bank Tech. Pap. 343:59 p.
- Krishnamurthy, K., Ramachandraprasad, T. V., Muniyappa, T. V., & Venkata Rao, B. V. (1977). Parthenium, a new pernicious weed in India. UAS Technical Series, 17.
- Krishnakumar, K., A. Ali., B. Perieria & R. Raghavan (2011). Unregulated aquaculture and Invasive alien species: case of the exotic African catfish, *Clarias gariepinus* in Vembanad Lake (Ramsar wetland), Kerala, India. *Journal of Threatened Taxa*, 3(5): 1737-1744.
- Krithivasan, R., Athreya, V., & Odden, M. (2009). Human-Wolf Conflict in human dominated landscapes of Ahmednagar District, Maharashtra. Submitted to the Rufford Small Grants Foundation.
- Kulkarni, J., Mehta, P., Boominathan, D., & Chaudhuri, S. (2007). A study of man-elephant conflict in Nagarhole national park and surrounding areas of Kodagu district in Karnataka, India. *Envirosearch*, Pune. Pp.126.
- Kumar, H. (2012). Human-wildlife conflict in a degraded habitat of lower chambal valley. *Asian Journal of Research in Social Sciences and Humanities*, 2(4), 193–205.
- Kumar, M. A. (2009). Effect of habitat fragmentation on Asian elephant *Elephas maximus* ecology and behavior patterns in a conflict-prone plantation landscape of the Anamalai hills, Western Ghats. India. Technical Report. Rufford Maurice Laing Foundation, UK, 29.
- Kumar, S., & Rahmani, A. R. (2000). Livestock depredation by wolves in the great indian bustard sanctuary, Nannaj (Maharashtra), India. *Journal Bombay Natural History Society*, 97(3), 340–348.

- Kurup, G. U. (1981). Report on the census surveys of rural and urban populations of non-human primates of south India. Man and Biosphere Programme: Project, (124).
- Lamb, D. (1991). Forest regeneration research for reserve management: some questions deserving answers. Tropical Rainforest Research in Australia: Present Status and Future Directions for the Institute for Tropical Rainforest Studies (eds. Goudberg, N., M. Bonell, & D. Benzaken), Institute for Tropical Rainforest Studies, Townsville, Australia, 177–181.
- Lamboj, A., 2004. The Cichlid Fishes of Western Africa. Birgit Schmettkamp Verlag, Bornheim, Germany. 255p.
- Leimgruber, P., Gagnon, J. B., Wemmer, C., Kelly, D. S., Songer, M. A., & Selig, E. R. (2003). Fragmentation of Asia's remaining wildlands: implications for Asian elephant conservation. *Animal Conservation*, 6(04), 347–359.
- Lenin, J., & Sukumar, R. (2008). Action plan for the mitigation of elephant–human conflict in India. *Transformation*, 10, 35.
- Li, J., Yin, H., Wang, D., Jiagong, Z., & Lu, Z. (2013). Human-snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau. *Biological Conservation*, 166, 118–123.
- Linnell, J. D. C., M. E. Smith, J. Odden, P. Kaczensky, and J. E. Swenson. 1996. Strategies for the Reduction of Carnivore-Livestock Conflicts: A Review. *Nina Oppdragsmelding* 443 (1): 188.
- Linnell, J. D. C., Andersen, R., Andersone, Z., Balciauskas, L., Blanco, J. C., & Boitani, L. (2002). The fear of wolves: a review of wolf attacks on people. *NINA Oppdragsmelding* 731: 65,731.
- Lorenz, J. R., Coppinger, L., & others. (1986). Raising and training a livestock-guarding dog. Oregon State University Extension Service: Extension Circular.1238, 1–8.
- Love, A., Babu, S., & Babu, C. R. (2009). Management of Lantana, an invasive weed, in forest ecosystems of India. *Current Science*, 97(10), 1421–1429.
- Lowe, S., M. Browne, S. Boudjelas & M. De Poorter (2000). 100 of the World's Worst Invasive Species A selection from the Global Invasive Species Database. Published by The Invasive Species Specialist Group (ISSG) a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), 12p.
- Luna, R. K. (1996). *Prosopis juliflora* (Swartz) DC. Plantation trees. International Book Distributors, Delhi.
- Lydekker, R. (1907). Guide to the Great Game Animals (Ungulata) in the Department of Zoology, British Museum (Natural History).
- Mackin, R. (1970). Dynamics of damage caused by wild boar to different agricultural crops. *Acta Theriologica*. 15(27), 447-458.
- Madhusudan, M. D. (2003). Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, south India. *Environmental Management*, 31(4), 0466–0475.

- Madhusudan, M. D., & Mishra, C. (2003). Why big, fierce animals are threatened: conserving large mammals in densely populated landscapes. In *Battles over nature: science and the politics of conservation*: 31–55. Saberwal, V. & Rangarajan, M. (Eds). New Delhi: Permanent Black.
- Mahadev, S., & Chauhan, N.P.S. (2000). Study the changes in landuse pattern vis-à-vis human wild animal conflicts in Gir conservation unit (GCU) and suggest strategies for reducing the conflicts. Term paper submitted for XXI PG Diploma Course in Wildlife Management, WII, Dehradun.
- Manakadan, R., & Rahmani, A. R. (1998). Crop damage by blackbuck Antelope cervicapra at Rollapadu Wildlife Sanctuary, Andhra Pradesh. *Journal of Bombay Natural History Society*, 95, 408–417.
- Mandal, F.B. (2011). The management of species in India. *International Journal of Biodiversity and Conservation*, 3(9): 467-473.
- McCarthy, T. M., Chapron, G., & Network, S. L. (2003). Snow leopard survival strategy. International Snow Leopard Trust.
- McDougal, C. (1987). The man-eating tiger in geographical and historical perspective. *Tigers of the World*. Noyes Publications, Park Ridge, New Jersey.
- Meena, V., Jhala, Y.V., Chellam, R., & Pathak, B. (2011). Implications of diet composition of Asiatic lions for their conservation. *Journal of Zoology*, 284, 60-67.
- Meena, R.L., & Kumar, S. (2012). Management plan for Gir Protected Areas, Vol 1. Gujarat Forest Department, Gujarat, India.
- Mehta, D. (2014). Study on the Ecology of Nilgai (*Boselaphus tragocamelus*) in Saurashtra. Ph. D. dissertation. Saurashtra University, Rajkot, India.
- Miller, Daniel J., and George B. Schaller. 1997. “Conservation Threats to the Chang Tang Wildlife Reserve, Tibet.” *Ambio*. 26(3), 185-186.
- Miquelle, D., Nikolaev, I., Goodrich, J., Litvinov, B., Smirnov, E., & Suvorov, E. (2005). Searching for the coexistence recipe: a case study of conflicts between people and tigers in the Russian Far East. *Conservation Biology Series-Cambridge-*, 9, 305.
- Mishra, C., Allen, P., McCarthy, T. O. M., Madhusudan, M. D., Bayarjargal, A., & Prins, H. H. (2003). The role of incentive programs in conserving the snow leopard. *Conservation Biology*, 17(6), 1512–1520.
- Mishra, C., Madhusudan, M. D., & Datta, A. (2006). Mammals of the high altitudes of western Arunachal Pradesh, eastern Himalaya: an assessment of threats and conservation needs. *Oryx*, 40(01), 29–35.
- MoEF. (2010). Gajah: Securing the Future for Elephants in India. Government of India, New Delhi, India. Ministry of Environment and Forest.
- Mondal, K., Bhattacharjee, S., Gupta, S., Sankar, K., & Qureshi, Q. (2013). Home range and resource selection of “problem” leopards trans-located to forested habitat. *Current Science*, 105(3), 338–345.

- Mukherjee, S.K., Mathur, V.B., Hussain, S.A., Ishwar, N.M., et al. (2001) 'Non-Human primates of India.' ENVIS Bulletin, Wildlife and Protected Areas: Vol. 1, No. 1. Wildlife Institute of India, Dehradun.
- Mungall, E. C., Patel, B. H., Prasad, N., & Dougherty, S. E. (1981). Conservation and management of the Indian blackbuck antelope (*Antelope cervicapra*). Final report. Joint US–India Blackbuck Project.
- Muniappan, R., Viraktamath, C. A., & others. (1993). Invasive weeds in the Western Ghats. *Current Science*, 64, 555–555.
- Murphy, S. T., Subedi, N., Jnawali, S. R., Lamichhane, B. R., Upadhyay, G. P., Kock, R., & Amin, R. (2013). Invasive mikania in Chitwan National Park, Nepal: the threat to the greater one-horned rhinoceros *Rhinoceros unicornis* and factors driving the invasion. *Oryx*, 47(03), 361–368.
- Muthana, K. D., & Arora, G. D. (1983). *Prosopis juliflora* (Swartz) DC A fast growing tree to bloom the desert. Central Arid Zone Research Institute, Jodhpur, 342(003).
- Nath, R. (1981). Note on the effect of Parthenium extract on seed germination and seedling growth in crops. *Indian Journal of Agricultural Sciences*.
- Naughton, L., Rose, R., & Treves, A. (1999). The social dimensions of human–elephant conflict in Africa: a literature review and case studies from Uganda and Cameroon. African Elephant Specialist, Human–Elephant Task Conflict Task Force of IUCN, Glands, Switzerland.
- Nepal, S. K., & Weber, K. E. (1995). Prospects for coexistence: wildlife and local people. *Ambio*, 238–245.
- Nyhus, P. J., Tilson, R., & Sumianto. (2000). Crop-raiding elephants and conservation implications at Way Kambas National Park, Sumatra, Indonesia. *Oryx*, 34(4), 262–274.
- Odden, Morten, Vidya Athreya, Sandeep Rattan, and John DC Linnell. 2014. Adaptable Neighbours: Movement Patterns of GPS-Collared Leopards in Human Dominated Landscapes in India. *PloS One* 9 (11)
- Ogada, M.O., Woodroffe, R., Ouge, N.O., and Frank, L.G. (2003). Limiting depredation by African carnivores: the role of livestock husbandry. *Conservation Biology*. 17, 1521–1530.
- Ogra, M., & Badola, R. (2008). Compensating human–wildlife conflict in protected area communities: ground-level perspectives from Uttarakhand, India. *Human Ecology*, 36(5), 717–729.
- Olsen, J. W. (1985). Prehistoric dogs in mainland East Asia. Origins of the Domestic Dog: The Fossil Record. University of Arizona Press, Tucson, Arizona. USA, 47–70.
- Osborne, B. C., Mallon, D. R., & Fraser, S. J. R. (1983). Ladakh, threatened stronghold of rare Himalayan mammals. *Oryx*, 17(04), 182–189.
- Osborn, F. V., & Parker, G. E. (2002). Living with Elephants II: A Manual for Implementing an Integrated Programme to Reduce Crop Loss to Elephants and to Improve Livelihood

- Security of Small-Scale Farmers. Mid Zambezi Elephant Project, Harare, Zimbabwe. 21p. Mid Zambezi Elephant Project.
- Palit, S. (1981). Mikania-a growing menace in plantation forestry in West Bengal. *Indian Forester*, 107(2), 96–101.
- Pandey, H. N., & Dubey, S. K. (1989). Growth and population dynamics of an exotic weed *Parthenium hysterophorus* Linn. *Proceedings: Plant Sciences*, 99(1), 51-58.
- Parsons, W. T., & Cuthbertson, E. G. (2001). Noxious weeds of Australia. Csiro Publishing.
- Pasiecznik, N. (1999). Prosopis-pest or providence, weed or wonder tree?
- Pasiecznik, N. M., & Felker, P. (2001). The 'Prosopis Juliflora'-'Prosopis Pallida' Complex: A Monograph. HDRA Coventry.
- Patel, S. (2011). A weed with multiple utility: *Lantana camara*. *Reviews in Environmental Science and Bio/Technology*, 10(4), 341-351.
- Pathak, B., Pati, B.P., Kumar, R., Kumar, A., Raval, P.P., Patel, V.S., & Rana, V.J. (2002). Biodiversity conservation plan for Gir (a supplementary management plan, 2002-03 to 2006-07). Wildlife Circle, Junagadh. Gujarat Forest Department, India, 407 pp.
- Periera, N. and Verlecar, X. N., *Curr. Sci.*, 2005, 89, 1309–1310.
- Pethiyagoda, R. (1994). Treats to indigenous freshwater fishes of Sri Lanka and remarks on their conservation. *Hydrobiologia*, 285: 189 - 201.
- Prasad, N. (1981). Home range, dispersal, and movement of blackbuck (*Antilope cervicapra*) population in relation to seasonal change in Mudmal and environs. Ph. D. dissertation, Dept. of Biosciences, Saurashtra University, Rajkot, India.
- Prater, S. H., & Barruel, P. (1971). The book of Indian animals (Vol. 2). *Bombay Natural History Society Bombay*, India.
- Priston, N. E., & McLennan, M. R. (2013). Managing Humans, Managing Macaques: Human–Macaque Conflict in Asia and Africa. In *The Macaque Connection* (pp. 225–250). Springer.
- Poudel, A., Baral, H. S., Ellison, C., Subedi, K., Thomas, S., & Murphy, S. (2004). *Mikania micrantha* weed invasion in Nepal. In A summary report of the first national workshop for stakeholders, (25).
- Rahmani, A. R. (1991). Present distribution of the blackbuck *Antilope cervicapra linn* in India, with special ephasis on the lesser known populations. *Journal of the Bombay Natural History Society*, 88(1), 35–46.
- Rai, R. K., Scarborough, H., Subedi, N., & Lamichhane, B. (2012). Invasive plants–Do they devastate or diversify rural livelihoods? Rural farmers' perception of three invasive plants in Nepal. *Journal for Nature Conservation*, 20(3), 170–176.
- Rajpurohit, K. S., & Krausman, P. R. (2000). Human-sloth-bear conflicts in Madhya Pradesh, India. *Wildlife Society Bulletin*, 393–399.
- Ramaswami, G., Prasad, S., Westcott, D., Subuddhi, S. P., Sukumar, R. (2014). Addressing the management of a long-established invasive shrub: the case of *Lantana camara* in Indian forests. *Indian Forester*, 140(2), 129–136.

- Ramaswami, G., & Sukumar, R. (2013). Performance of established native seedlings in relation to invasive *Lantana camara*, rainfall and species' habitat preferences in a seasonally dry tropical forest. *Plant Ecology*, 214(3), 397–408.
- Ranjitsinh, M. K. (1989). Indian blackbuck. Retrieved from <http://agris.fao.org/agris-search/search.do?recordID=US201300675259>
- Rathore, B. C. (2008). Ecology of brown bear (*Ursus arctos*) with special reference to assessment of human-brown bear conflicts in Kugti wildlife sanctuary, Himachal Pradesh and mitigation strategies. Saurashtra University, Gujrat, India.
- Raza, R. H., Chauhan, D. S., Pasha, M. K. S., & Sinha, S. (2012). Illuminating the blind spot: a study on illegal trade in Leopard parts in India (2001–2010). TRAFFIC/WWF India, New Delhi, India.
- Reddy, C. S. (2008). Catalogue of invasive flora of India. *Life Science Journal*, 5(2), 84–89.
- Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea and W.B. Scott, 1991. World fishes important to North Americans. Exclusive of species from the continental waters of the United States and Canada. *Am. Fish. Soc. Spec. Publ.* (21):243 p.
- Rodgers, R. C. W., & Panwar, H. S. (1986). Status report on snow leopard in India.
- Ruggiero, R. G. (1990). The effects of poaching disturbance on elephant behavior. *Pachyderm*, 13, 42–44.
- Saberwal, V., Gibbs, J.P., Chellam, R., & Johnsingh, A.J.T. (1994). Lion-human conflict in the Gir forest, India. *Conservation Biology*, 8(2), 501-507
- Sangay, T., & Vernes, K. (2008). Human–wildlife conflict in the Kingdom of Bhutan: patterns of livestock predation by large mammalian carnivores. *Biological Conservation*, 141(5), 1272–1282.
- Sankar, K., & Goyal, S. P. (2004). Ungulates of India. *ENVIS Bulletin: Wildlife and Protected Areas*, Vol 07, No. 1. Wildlife Institute of India, Dehradun, India. Pp. 448.
- Sankaran, K. V., Sreenivasan, M. A., Sankaran, K. V., Murphy, S. T., & Evans, H. C. (2001). Status of Mikania infestation in the Western Ghats. *Weeds in Moist Tropical Zones, Banes and Benefits*. Kerala, Peechi, India: Kerala Forest Research Institute. P, 67–76.
- Santiapillai, C., & Jackson, P. (1990). The Asian elephant: an action plan for its conservation. IUCN.
- Sanwal, C. S., & Lone, R. A. (2012). An Assessment of The-asiatic Black Bear-human Conflicts in Kupwara District, Jammu & Kashmir, India. *Indian Forester*, 138(10), 881–886.
- Sathyakumar, S., Kaul, R., Ashraf, N., Mookerjee, A., & Menon, V. (2012). National Bear Conservation and Welfare Action Plan 2012. MOEF, WII, WTI.
- Seegers, L., 2008. The catfishes of Africa: A handbook for identification and maintenance. Aqualog Verlag A.C.S. GmbH, Germany. 604 p.
- Sekhar, N. U. (1998). Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental Conservation*, 25(02), 160–171.

- Selvan, K. M., Veeraswami, G. G., Lyngdoh, S., Habib, B., & Hussain, S. A. (2013). Prey selection and food habits of three sympatric large carnivores in a tropical lowland forest of the Eastern Himalayan Biodiversity Hotspot. *Mammalian Biology-Zeitschrift Für Säugetierkunde*, 78(4), 296–303.
- Sengupta, A., & Radhakrishna, S. (2013). Of concern yet? Distribution and conservation status of the bonnet macaque (*Macaca radiata*) in Goa, India. *Primate Conservation*, (27), 109-114.
- Shah, N. (1993). Ecology of wild ass (*Equus hemionus khur*) in Little Rann of Kutch. Research Project Report, Wildlife Institute of India, Dehra Dun, India.
- Shah, N. (2002a). Status and action plan for the kiang (*Equus kiang*). Equids: Zebras, Asses and Horses. Status Survey and Conservation Action Plan (PD Moehlman, Ed.). International Union for Conservation of Nature and Natural Resources/Species Survival Commission, Equid Specialist Group, Gland, Switzerland, 72–81.
- Shah, N. (2002b). Status and action plan for the kiang (*Equus kiang*). Equids: Zebras, Asses and Horses: Status Survey and Conservation Action Plan, 72–81.
- Shah, N., and Q. Qureshi. 2007. “Social Organization and Determinants of Spatial Distribution of Khur (*Equus Hemionus Khur*).” *Erforschung Der Biologischen Ressourcen Der Mongolei (Halle/Saale)* 10: 189–200.
- Shahi, S. P. (1982). Status of the grey wolf (*Canis lupus pallipes* Sykes) in India—a preliminary survey. *Journal of the Bombay Natural History Society*.
- Sharma, D. K., Maldonado, J. E., Jhala, Y. V., & Fleischer, R. C. (2004). Ancient wolf lineages in India. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 271(Suppl 3), S1–S4.
- Sharma, G. P., Raghubanshi, A. S., & Singh, J. S. (2005). Lantana invasion: an overview. *Weed Biology and Management*, 5(4), 157–165.
- Sharma, O. P., Makkar, H. P. S., & Dawra, R. K. (1988). A review of the noxious plant *Lantana camara*. *Toxicon*, 26(11), 975-987.
- Sharma, V. K., Verma, P., & others. (2012). Parthenium dermatitis in India: Past, present and future. *Indian Journal of Dermatology, Venereology, and Leprology*, 78(5), 560.
- Siex, K. S., & Struhsaker, T. T. (1999). Colobus monkeys and coconuts: a study of perceived human–wildlife conflicts. *Journal of Applied Ecology*, 36(6), 1009–1020.
- Silva, P.C., Basson, P.W. & Moe, R.L. (1996). Catalogue of the benthic marine algae of the Indian Ocean. University of California Publications in Botany 79: 1-1259.
- Singh, A.K. and Lakra, W.S. 2011. Ecological impacts of exotic fish species in India, *Aquaculture Asia*, 16(2): 23-25.
- Singh H S. (2005). Status of Leopard (*Panthera pardus fusca*) in India. *Indian Forester*, 131(10), 1353–1362.
- Singh, H.S., & Gibson, L.A. (2011). A conservation success story in the otherwise dire megafauna extinction crisis: the Asiatic lion (*Panthera leo persica*) of Gir forest. *Biological Conservation*, 144, 1753-1757.

- Singh, H.S., & Kamboj, R.D. (1995). Predation pattern of the Asiatic lion on domestic livestock. *Indian Forester*, 122(10), 869-876.
- Singh, M, Malik, I, Dittus, W, Sinha, A, Belsare, A, Walker, SR, Molur, S, Wright, B, Lenin, J, Chaudhuri, S (2007) Action plan for the control of commensal non-human primates in public places. Zoo Outreach Organisation, Coimbatore
- Singh, M., Erinjery, J. J., Kavana, T. S., Roy, K., & Singh, M. (2011). Drastic population decline and conservation prospects of roadside dark-bellied bonnet macaques (*Macaca radiata radiata*) of southern India. *Primates*, 52(2), 149–154.
- Singh, V., & Thakur, M. L. (2012). Rhesus macaque and associated problems in Himachal Pradesh-India. *Taprobanica: The Journal of Asian Biodiversity*, 4(2), 112–116.
- Sinha, S.P., Pathak, B.J., & Rawal, P.P. (2004). Man-animal conflicts in and around protected areas - a case study of Gir National Park/Wildlife Sanctuary, Junagadh, Gujarat, India. *Tigerpaper*, 31(3), 27-32.
- Skelton, P.H., 1993. A complete guide to the freshwater fishes of southern Africa. Southern Book Publishers. 388 p.
- Smith, J. L. D., McDougal, C. W., & Miquelle, D. (1998). Chemical communication in free ranging tigers (*Panthera tigris*). *Animal Behaviour*, 37, 1–10.
- Smith, J. L. D., McDougal, C. W., & Sunquist, M. E. (1987). Female land tenure system in tigers. *Tigers of the World: The Biology, Biopolitics, Management and Conservation of an Endangered Species*, 97–108.
- Soloman, D.A. (2013) Menace and Management: Power in the Human-Monkey Social Worlds of Delhi and Shimla. PhD Thesis. University of California, Santa Cruz.
- Southwick, C.H., and M.F. Siddiqi (1994) “Population Status of Nonhuman Primates in Asia, with Emphasis on Rhesus Macaques in India.” *American Journal of Primatology* 34: 51–59.
- Spearing, A. (2002). The Snow Leopard in Zaskar, Jammu & Kashmir, NW India. Joseph L. Fox and Rodney M. Jackson, 173.
- Srivastav, A. (1997). Livestock predation by Gir lions and eco-development. *Tigerpaper*, 24(2), 1-5.
- Subedi, N., Scarborough, H., Rai, R. K., & Lamichhane, B. (2012). Invasive plants—Do they devastate or diversify rural livelihoods? Rural farmers’ perception of three invasive plants in Nepal.
- Sukumar, R. (2006). A brief review of the status, distribution and biology of wild Asian elephants *Elephas maximus*. *International Zoo Yearbook*, 40(1), 1–8.
- Sunquist, M. E. (1981). The social organization of tigers (*Panthera tigris*) in Royal Chitawan National Park, Nepal. Smithsonian Institution Press Washington, DC, USA.
- Suryawanshi, K. R., Bhatia, S., Bhatnagar, Y. V., Redpath, S., & Mishra, C. (2014). Multiscale Factors Affecting Human Attitudes toward Snow Leopards and Wolves. *Conservation Biology*. 28(6), 1657-1666.

- Suryawanshi, K. R., Bhatnagar, Y. V., Redpath, S., & Mishra, C. (2013). People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. *Journal of Applied Ecology*, 50(3), 550–560.
- Talukdar, B.K., Emslie, R., Bist, S.S., Choudhury, A., Ellis, S., Bonal, B.S., Malakar, M.C., Talukdar, B.N. & Barua, M. 2008. *Rhinoceros unicornis*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 August 2015.
- Teugels, G.G., 1986. A systematic revision of the African species of the genus *Clarias* (Pisces; Clariidae). *Ann. Mus. R. Afr. Centr., Sci. Zool.*, 247:199 p.
- Thakur, M., Ahmad, M., Thakur, R. K., & others. (1992). Lantana weed (*Lantana camara* var. *aculeata* Linn.) and its possible management through natural insect pests in India. *Indian Forester*, 118(7), 466–488.
- Thapa, S. (2010). Effectiveness of crop protection methods against wildlife damage: A case study of two villages at Bardia National Park, Nepal. *Crop Protection*, 29(11), 1297–1304.
- Thekaekara, T., Vasanth, N., & Thornton, T. F. (2013). Diversity as a livelihood strategy near Mudumalai, Tamil Nadu: an inquiry. In *Livelihood Strategies in Southern India* (pp. 49–69). Springer India.
- The Hindu 2014. Action against farming of banned fish species, Palakkad edition, February 14, 2014.
- Towers, G. H. N., & Mitchell, J. C. (1983). The current status of the weed *Parthenium hysterophorus* L. as a cause of allergic contact dermatitis. *Contact Dermatitis*, 9(6), 465–469.
- Troup, R. S. (1921). *The Silviculture of Indian Trees*, Vol. 3. The Silviculture of Indian Trees, Vol. 3, 785–1172.
- Tudor, G. D., Ford, A. L., Armstrong, T. R., & Bromage, E. K. (1982). Taints in meat from sheep grazing *Parthenium hysterophorus*. *Animal Production Science*, 22(115), 43–46.
- Vijayan, S., & Pati, B. P. (2002). Impact of changing cropping patterns on man-animal conflicts around Gir Protected Area with specific reference to Talala Sub-District, Gujarat, India. *Population and Environment*, 23(6), 541–559.
- Wada, K. (1983). Ecological adaptation in rhesus monkeys at the Kumaon Himalaya. *Journal of the Bombay Natural History Society. Bombay*, 80(3), 469–498.
- Waite, T. A., Chhangani, A. K., Campbell, L. G., Rajpurohit, L. S., & Mohnot, S. M. (2007). Sanctuary in the city: urban monkeys buffered against catastrophic die-off during ENSO-related drought. *EcoHealth*, 4(3), 278–286.
- Walton, M. T., & Feild, C. A. (1989). Use of donkeys to guard sheep and goats in Texas. *Proceedings Eastern Wildlife Damage Control Conference*. 4:87-94
- Wang, S. W., & Macdonald, D. W. (2006). Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. *Biological Conservation*, 129(4), 558–565.

- Waterhouse, D. F. (1997). The major invertebrate pests and weeds of agriculture and plantation forestry in the southern and western Pacific. Australian Centre for International Agricultural Research Canberra.
- Zhang, L. Y., Ye, W. H., Cao, H. L., & Feng, H. L. (2004). *Mikania micrantha* HBK in China—an overview. *Weed Research*, 44(1), 42–49.

Annexures

Annexure 1. List of experts and participants under various themes of discussion

Experts	Participants	Experts	Participants
<i>CARNIVORE</i>		<i>HERBIVORE</i>	
Dr. Vinay Sinha	Prerna Sharma	Sh. Vinod Rishi	Sudip Banerjee
Sh. A.K. Singh	Kaushik Banerjee	Dr. A.J.T. Johnsingh	Rahul De
Dr. Vidya Athreya	Srinivas Y	Dr. B.K. Mishra	Bidyut Bikash
Dr. NVK Ashraf	Stotro Chakra	Dr. Bivash Pandav	Ashok Kumar
Dr. Samrat Mondal	Devanshi	Dr. S.P. Goyal	Neha Awasthi
Sh. Subharanjan Sen	Nikit	Dr. K. Sankar	Aisho Sharma
Dr. Bilal Habib	Pallavi	Sh. Jagdish kishwan	Keshab
Dr. Y.V. Jhala	Pragya		Varsha
	Ashutosh Singh		Dibyadeep Chatterjee
	Athar Noor		Dr. Dhawal Mehta
	Dipanjana Naha		Harshavardhan
	Indranil Mondal		
	Punit Pandey		
	Madhura Davate		
	Anindita		
	Dr. Parabita Basu		
	Manjari Roy		
<i>INVASIVE</i>		<i>MACAQUE</i>	
Dr. G. S. Goraya	Dr. David Anderson	Dr. Parag Nigam	Ridhima Solanki
Sh. Rajiv Bhartari	Dr. S.A.Hussain	Bitapi C. Sinha	Sonu Yadav
Dr. Abhijit Das	Dr. Dubey	Dr.R.B.S. Rawat	Pranay
Dr. B.S. Adhikari	Sh. Rajiv Bhartari	Sh. R. N. Mehrotra	Naithik
Dr. S.A. Hussain	Suresh Rana	Sh. Satpal Dhiman	Nikunj
Dr. J. A. Johnson	Sweta Singh	Dr. P.C. Tyagi	Saugato
Sh. R. Suresh Kumar	Priyamvada Bagria	R. Suresh Kumar	Ravi Sharma
Sh. A. K. Bhardwaj	Rupa Bharadwaj	Dr. Anupam Srivastav	Sougata Sadhu Khan
Dr. G.V. Gopi	Ravi Sharma	Dr. K. Ramesh	
Ninad Mungi	Dimpi Patel		
	Tamali Mondal		
	Sanjay Xaxa		
	Aftab Usmani		
	Ramesh C.		
<i>LAW AND POLICY</i>			
		Sh. Aseem Shrivastav	Swati Saini
		Sh. Ajay Srivastav	Akanksha Saxena
		Sh. S.K. Mukherjee	Animesh Talukdar
		Sh. Dipankar Ghose	Naveen M
		Sh. Samir Sinha	Deepak Anand
		Sh.A.K. Wahal	Ahana Dutt
		Sh. S. S. Bist	Monica Kaushik
			Tabassum
			Ahana Dutt

No. 15-37/2012-NTCA
Government of India
Ministry of Environment and Forests
National Tiger Conservation Authority

Annexe No. 5, Bikaner House,
Shahjahan Road, New Delhi-110011.
Telefax: 2338 9883
E-mail: jdntca@gmail.com

Dated the 30th January, 2013

To,

1. The PCCF/HOFF(s),
Tiger Range States.
2. The Chief Wildlife Warden(s)
Tiger Range States.

Sir,

As you are aware, advisories have been issued by the Project Tiger / National Tiger Conservation Authority, time and again, for dealing with emergency arising due to straying of tigers in human dominated landscapes. Based on inputs from field officers, experts vis-à-vis the said advisories, a Standard Operating Procedure has been developed after fine tuning to meet the present challenges.

In this context, I am directed to forward herewith a copy of the said Standard Operating Procedure (SOP) for dealing with emergency arising due to straying of tigers in human dominated landscapes, duly approved by the competent authority, for implementation.

The SOP may please be translated in vernacular and widely circulated amongst the field staff for guidance.

Yours faithfully,

Encl: As above

(S.P. Yadav)
Deputy Inspector General (NTCA)

Copy for information to:

1. PS to MEF.
2. PPS to Secretary (E&F).
3. PPS to DGF & SS, MoEF.
4. PPS to ADG (WL).

Copy for information to:

1. Additional Director, WCCB, New Delhi.
2. IGF, Guwahati.
3. AIGs, Nagpur and Bangalore.

**STANDARD OPERATING PROCEDURE TO DEAL WITH
EMERGENCY ARISING DUE TO STRAYING OF TIGERS
IN HUMAN DOMINATED LANDSCAPES**



MINISTRY OF ENVIRONMENT AND FORESTS

GOVERNMENT OF INDIA

NATIONAL TIGER CONSERVATION AUTHORITY

STANDARD OPERATING PROCEDURE TO DEAL WITH EMERGENCY ARISING DUE TO STRAYING OF TIGERS IN HUMAN DOMINATED LANDSCAPES

1. **Title:** Standard Operating Procedure to deal with emergency arising due to straying of tigers in human dominated landscapes
2. **Subject:** Dealing with emergency arising due to straying of tigers in human dominated landscapes
3. **Reference:** Advisories of National Tiger Conservation Authority /Project Tiger on the subject
4. **Purpose:** To ensure that straying tigers are handled in the most appropriate manner to avoid casualty / injury to human beings, tiger, cattle and property.
5. **Short summary:** This Standard Operating Procedure (SOP) provides the basic, minimum steps which are required to be taken at the field level (tiger reserve or elsewhere) for dealing with incidents of tiger straying in human dominated landscapes.
6. **Scope:** The SOP applies to all forest field formations including tiger reserves besides other areas where such incidents occur.
7. **Responsibilities:** The Field Director would be responsible in the case of a tiger reserve / fringe areas. For a protected area (National Park / Wildlife Sanctuary), the concerned protected area manager would be responsible. In the case of other areas (revenue land/conservation reserve/community reserve/village/township) the Wildlife Warden, as per the Wildlife (Protection) Act, 1972, or Divisional Forest Officer/ Deputy Conservator of Forests (under whose jurisdiction the area falls), would be responsible. The overall responsibility at the State level would rest with the Chief Wildlife Warden of the concerned State.

8. Suggested field actions to deal with strayed wild carnivores (tiger / leopard)

(a) At the outset, constitute a Committee immediately for technical guidance and monitoring on day to day basis, as under:-

- i. A nominee of the Chief Wildlife Warden
- ii. A nominee of the National Tiger Conservation Authority
- iii. A veterinarian
- iv. Local NGO representative
- v. A representative of the local Panchayat
- vi. Field Director/ Protected Area Manager/ DFO I/C - Chairman

(b) Since it may not be always possible for experts from the Wildlife Institute of India to provide assistance, it is advised that some outside experts may be involved in the ongoing monitoring.

(c) Establish identity of the tiger by comparing camera trap photographs with National Repository of Camera Trap Photographs of Tigers (NRCTPT) / Reserve level photo database and find out the source area of the animal.

(d) Collect recent cattle / livestock depredation or human injury / fatal encounter data, if any, in the area. If it is an area historically prone to such incidences, detailed research work has to be carried out in order to assess the reasons for the frequent tiger emergencies in the area.

(e) In case of confirmed livestock depredation / human injury / fatal encounters or frequent straying of tiger near human settlements, set traps (automatic closure) with appropriate luring while avoiding disturbance, to trap the animal.

- (f) Set up camera traps near kill site to confirm / establish the ID of the animal.
- (g) Ensure unobtrusive guarding of the kill to allow feeding of the carcass (if not close to a human settlement) besides safeguarding from poisoning (for revenge killing).
- (h) Create 'pressure impression pads (PIPs)' in the area to ascertain the daily movement of the animal, while plotting the same on a map (4"=1 mile scale or 1:50,000 scale).
- (i) Proactively involve District Collector / DM and SSP / SP of the area to maintain law and order in the area, besides avoiding crowding by local mobs. Acquaint them with human-tiger conflict issues and guidelines of the NTCA to deal with the situation.
- (j) In all instances of wild carnivores like tiger / leopard straying into a human dominated landscape, the district authorities need to ensure law and order by imposing section 144 of the Cr.Pc. This is essential to avoid agitation / excited local people surrounding the animal spot which hampers capture operation, leading to serious injuries on people and staff. It is also necessary that police and local administration be involved at an early stage. Effective coordination with them is critical to control mobs which as has been seen in several instances, worsen the situation and lead to avoidable fatalities/ tragedies.
- (k) Take help of the district level officials to alert the villages in the vicinity of the area having the spatial presence of the tiger.
- (l) If successive trapping efforts fail, chemical immobilization of the wild carnivore should be done by an expert team having a veterinarian, as per the protocol at **Annexure-I**.

- (m) In case, the tranquilised tiger is found to be healthy in prime or young age without any incapacitation (loss of canine, injury, broken paw etc.), as confirmed / certified by the Committee as constituted at para (1), then it may be released after radio collaring in a suitable habitat with adequate prey base, away from the territory of a resident male tiger (if any) or human settlements, under intimation to the National Tiger Conservation Authority. (Under no circumstances an injured / incapacitated tiger should be released back, and the same needs to be sent to a recognized zoo).
- (n) Under no circumstances, a tiger should be eliminated by invoking the Wildlife (Protection) Act, 1972, if it is not habituated for causing human death. The guidelines for dealing with 'man-eaters' are annexed for compliance / guidance in this regard (**Annexure-II**).
- (o) In case of a healthy tiger/encumbered tigress occupying a sugar cane field or similar habitat, attempt should be made first to attract it to nearby forest area, while avoiding disturbance. If such operations fail, the animal should be captured through immobilization for release in low density area of a nearby tiger reserve/protected area after radio collaring.
- (p) An authorized spokesperson of the Forest Department, should periodically update the media (if required) to prevent dissemination of distorted information relating to the operation / incidents. Sensalization or distorted information can lead to further damage.
- (q) In case monitoring using camera traps (Phase-IV) is ongoing in the area, the minimum tiger numbers based on individual tiger captures, should not be given undue publicity without due cross checking with the National Tiger Conservation Authority.

- (r) The Chief Wildlife Warden has to take the final decision on whether a tiger has to be released back in the wild or transferred to a zoo.
 - (s) It is important to have properly designed suitable cages and transport mechanism which cause least stress to the captured carnivore.
9. **Preventive / Proactive Measures** to be followed in tiger straying incidents / areas prone are at **Annexure-III**.
 10. Guidelines for prioritizing areas for tiger monitoring are at **Annexure-IV**.

**PROTOCOL ON
IMMOBILIZATION AND
RESTRAINT OF TIGERS**

PROTOCOL ON IMMOBILIZATION AND RESTRAINT OF TIGERS

General Consideration

Behavior: Tigers in conflict or those strayed into human habitation differ considerably in behavior as compared to those in native/ natural habitats. The animals may be stressed, shy, elusive, secretive and even unpredictable thereby posing challenge in capture. These animals may even pose safety threats for human involved in capture as well as to general public. ***Utmost care needs to be taken to ensure safety of humans when attempts for capture are made.***

Capture options: Tigers can be captured employing physical and chemical restraint methods or combination of both. The physiological and emotional status of the animal; length of the procedure; the environmental conditions; terrain/ escape cover; equipment availability; drug appropriateness and availability and most importantly the safety of the operator/team needs to be considered prior to making a choice of procedure. Both the procedures have their benefits and limitations however the present guidelines would focus primarily on the chemical restraint procedures.

Chemical Restraint

Chemical immobilization has become an important tool in wildlife management over the last few decades. Advancement and development in this field has resulted in use of newer and safer drugs for immobilization, and efficient and reliable systems of drug delivery. Chemical Immobilization involves use of drugs to restrict animal's movement by inducing a state of insensibility and preventing deliberate and coherent mobility. The technique is well suited for tigers in conflict as it allows capture of select individual, enables selection of time of capture and causes minimal stress to the animal. Chemical restraint drugs alter certain CNS functions without compromising the vital functions and produce a state of anaesthesia which immobilizes the animal to the extent that provides considerable safety both for human and animal.

Immobilization Equipment

Due to difficulty of directly approaching and handling wild animals, it is necessary to have safe and effective methods by which drugs can be administered. Projected darts have proved to be effective and safe option

for delivering drugs to wild animals. The dart is projected through an equipment and discharges the medicaments intramuscularly upon impact. The darts are available in different sizes, however are specific to the type of equipment used to propel them. Different power projection systems have been used for projecting the darts however for tigers; the system that employs compressed gas/CO₂ to propel the dart should be selected. Light weight plastic darts of 3-5 ml. capacity should be used for remote injection using air powered/CO₂ tele-injection projector. Needle length is critical factor while darting tigers. The outside diameter of the needle should be 1.5- 2.0 mm and length of 38- 40 mm.

Immobilization Drugs

Though there are varieties of drugs that have been used for capturing tigers, a combination of alpha-2 adrenergic agonists (sedatives) and dissociatives have proved to be effective for immobilizing tigers.

Alpha-2 adrenergic agonists/ Sedatives: These drugs are CNS depressants with good sedative, muscle relaxant, and analgesic properties. These drugs need to be used with caution in animals as they produce initial hypertension followed by severe hypotension, bradycardia, hyperglycemia and glucosuria, disrupts thermoregulation and may lead to regurgitation/ vomiting in carnivores. These drugs however have the advantage of being non-controlled, inexpensive and reversible. The drugs have been extensively used in felids in combination with dissociatives. A mixture of *Xylazine* and *Ketamine* in a proportion of 1.25 :1 known as Hellabrunn mixture has been effectively used in tigers and other carnivores.

Another new Alpha-2 agonists Medetomidine in combination with ketamine has proved to be effective and specific sedative in large carnivores as it induces rapid drug induction and has specific antidote for reversal.

These Alpha-2 adrenergic agonists can be negated by antidote.

Examples: Xylazine, Detomidine, Medetomidine.

Antidotes include Yohimbine hydrochloride, Atipamezole hydrochloride, Tolazoline hydrochloride.

Dissociatives

These include the psychotomimetic drugs that are cyclohexamine derivatives. The drugs act by separating the conscious mind from sensory and motor or control mechanism in the brain (dissociative) producing, rapid analgesia and a trance-like state (psychosis) which may be as a

result of over stimulation of the CNS. The animal appears unaware of human presence. They have the advantage of being rapidly absorbed following IM, IV administration, have good safety margin and cause little depression of the respiratory and circulatory system. Pronounced muscle rigidity, hyperthermia, hyper salivation, convulsion and rough recovery are common side effects. These effects can be considerably reduced by combining these drugs with a tranquilizer or sedatives. Their effect cannot be reversed and the animal has to be monitored for long till complete recovery takes place. These drugs lack specific antidote.

Examples: Phencyclidine, Ketamine hydrochloride, Tiletamine Hydrochloride

The choice of drug for immobilization may include the Hellabrunn mixture (HBM) (Xylazine –Ketamine mixture in ratio of 1.25:1) in appropriate doses. The dosage can be decided on the spot, taking into consideration the animal's health and condition, level of excitement, physiological status, sex, time of the day, and ambient temperature besides other habitat parameters. Medetomidine in combination with ketamine has proved to be effective for capturing tigers in conflict as it provides short and rapid induction thereby ensuring minimal movement of animal following darting.

Recommended drug/ dosages for immobilization of adult tiger

Sr. No.	Drug(s) for immobilization	Male	Female	Reversal drugs (antidote)
1.	Hellabrunn mixture (HBM) [Xylazine (XYL) and Ketamine (KET)] mixture in a ratio of 1.25:1	3.0 ml (375 mg XYL & 300mg KET) to 3.5 ml (437.5 mg XYL & 350 mg KET)	2.5 ml (312.5 mg XYL & 250 mg KET) to 3.0 ml (375 mg XYL & 300mg KET)	Yohimbine hydrochloride (0.125 mgkg ⁻¹ body weight)
2	Medetomidine (MED) and Ketamine (KET)	50-60 µg kg ⁻¹ body weight MED and 1-2 mgkg ⁻¹ body weight KET		25-35 mg of Atipamezole hydrochloride

Approach to the Target Animal

A four wheel field vehicle or trained captive elephants may be used to approach the animal taking due care of human safety and an overriding degree of patience. In a terrain where the vehicle cannot be used, possibility of darting the animal from a *machan* (raised platforms) may also be considered. Tigers in conflict provide limited opportunities for darting and therefore require adequate experience by personnel in effective darting as well as knowledge of anatomical peculiarities. Hindquarters should be preferred for tele-injection however depending on the opportunities; other suitable areas can also be explored.



Preferred darting site in a large carnivore

Induction Phase

The time interval between injection (darting) and the point when the animal is rendered immobile is induction period. The total time for the completion of induction may vary from 10-15 minutes. A close observation should be kept by the team for any movement of the animal however the team should ensure minimal disturbance during induction.

Handling and Care of the Immobilized Animal

The animal should be approached quietly and following steps should be followed:

- Removal of dart
- Blindfolding to protect the cornea from direct sunlight, dust and injury.
- Ensuring proper animal positioning (sternal or lateral recumbancy) to maintain patent airways and ensure normal breathing and circulation.
- Assessing the status of animal, the degree of muscle relaxation and the rate and depth of respiration. Assessment of anesthesia should be done using following methods:

- Monitor tissue perfusion: Anesthetic drugs frequently depress the contractile force of the heart and vasodilatation results in decreased tissue perfusion. Evaluation of tissue perfusion should be done by observation, auscultation, palpation and capillary refill time.
- Monitor gas exchange: Respiratory rates are highly variable during anesthesia.
- Quality of respiration should be evaluated by observing animal's chest movement.
- Monitor level of CNS depression by assessing the muscle tone-jaw tone and eye reflexes.
- Monitor vital signs such as respiration, heart rate and body temperature.
- Examine animal for any wound or injuries (including status of canines and claws).
- Estimate animal body weight and if possible take bodily measurements.

Shifting of the Animal to Stretcher

The animal should be shifted to a stretcher and placed in lateral or sternal recumbancy. Animal should then be shifted to a transport container.

Reversal of Anesthesia

Specific Alfa-2 antagonists (Yohimbine HCl , Atipamezole HCl) should be used to reverse the anesthesia.

Supplemental Information

- Preparedness:** All equipment for crating the animal, radio collars and accessories, emergency medicaments, biological sampling accessories, transport containers and any other essentials should be in place before the animal is darted.
- Data recording:** A complete immobilization record, particularly including each drug given, amount given, time of administration and physiological parameters should be maintained during the procedure. These details should be recorded in the datasheet in the format provided. It would be appropriate to ensure human safety considerations to meet any eventuality at all the time.
- Assessing depth of anaesthesia:** It should take about 15 minutes for the drug induction to happen. Prior to approaching the animal, the depth of anaesthesia should be assessed by either tapping on the tail or ears with the help of long pole and if the animal does not react, it should be approached. The depth of anaesthesia should be optimum if the jaws can be opened and the

tongue exteriorized with little or no resistance. Other indicators would include responses to stimulation of body, feet, cornea, ears and tongue. The physiological parameters should be assessed and should include assessment of temperature, respiration, pulse and color of mucous membrane including condition of pharynx, gingiva and teeth. In case of emergency (depressed respiration or cardiac arrhythmias or depression) the animal should be revived. Emergency drug including cardiac and respiratory stimulants should be kept handy at all times. The physiological parameters should be assessed and should include assessment of temperature, respiration, pulse and color of mucous membrane including condition of pharynx, gingiva and teeth.

- d. **Managing emergencies:** Emergency drugs and equipment would be available during the entire operation. Adequate supplies of emergency drugs should be ensured at all times.
- e. **Composition of team:** Capturing large felids poses a challenge and therefore requires a skilled team comprising wildlife managers, biologists, trained veterinarians and most preferably an individual specializing in animal anaesthesia.

Data Sheet for Recording and Monitoring Immobilized Animal

Area Details

Date

Location GPS Lat..... Long.....

Collar Frequency

Purpose of capture

Ambient temperature Day (cloudy, bright)

Animal Details

Species Physical condition

Emotional state before drugging Sex

Approximate age Weight (kg).....

Breeding status

Body Measurements

Nose tip to Tip of tail Nose tip to base of tail

Nose tip to base of skull (Occipital) Tail length.....

Height (Shoulder blade to heel) Hind limb length

Left fore limb or Hind limb paw dimension Length Width

Neck girth Length of Canines

Immobilization Details

Name of Immobilizing Drug(s)	Time of Injection	Drug dose given	Route	Site
1.				
2.				
3.				
4.				

Behaviour at the time of darting

(running, walking, standing, excited)

Induction time when animal goes down/ approached.....

Animal Monitoring

Time	Signs shown following immobilization	Respiration Shallow/ deep/ irregular & rate	Temperature (°F)	Pulse (rate)

Drug reversal

Name of reversal Drug(s)	Time of Injection	Drug dose & volume given	Route	Site
1.				
2.				

Time when animal shows first sign of recovery -

Details about recovery event till animal regains consciousness /shows signs of recovery

.....

Any other comments -

Supplemental drugs

Name of other supportive Drug(s)/antibiotic(s) etc. given	Trade name	Volume used	Route	Site
1				
2.				
3.				
4.				

Biological sampling

Name of sample	Preservative used	Examination required	Handed over to	Remarks

Annexure-II

GUIDELINES FOR DECLARATION OF BIG CATS AS ‘MAN-EATERS’

- Both tiger as well as leopard are known to cause habituated loss of human life (man-eaters). Such confirmed ‘man-eaters’ should be eliminated as per the statutory provisions provided in section 11 of the Wildlife (Protection) Act, 1972.
- Tiger as well as leopard are categorized under Schedule I of the Wildlife (Protection) Act, 1972, with highest statutory protection against hunting under section 9 (1) of the said Act. Hence, such species can be killed if they become dangerous to human life or are so disabled / diseased beyond recovery.
- Under section 11 (1) (a) of the Wildlife (Protection) Act, 1972, the Chief Wildlife Warden of a State alone has the authority to permit hunting of such animals becoming dangerous to human life or disabled or diseased beyond recovery. However, as per the statutory requirement, the Chief Wildlife Warden of the State has to state in writing the reasons for permitting elimination before hunting.
- There are several reasons for a big wild cat like tiger or a leopard to get habituated as a ‘man-eater’, viz. disability due to old age, incapacitation due to serious injury or loss / breakage of its canines etc. However, there may be several exceptions, and hence specific reasons have to be ascertained on a case to case basis.
- The tiger bearing forests and areas nearby prone to livestock depredation, besides having human settlements alongwith their rights and concessions in such areas, are generally prone to ‘man-eaters’. Besides, loss of habitat connectivity in close proximity to a tiger source area owing to various land uses also foster straying of tiger near human settlements, eventually ending up as a ‘man-eater’.

Suggested steps on loss of human life due to tiger / leopard

- Constitute a team for technical guidance and monitoring on day to day basis, as below:
 - A nominee of the Chief Wildlife Warden
 - A nominee of the National Tiger Conservation Authority
 - A veterinarian
 - Local NGO representative
 - A representative of the local Panchayat
 - Field Director/Protected Area Manager/DFO I/C - Chairman
- Set up camera traps near kill sites, besides creating pug impression pads to monitor the day to day spatial movement of the wild carnivore.
- Inform the district officials (Collector / DM / SP) for duly alerting the local people to refrain temporarily from the area where human death(s) has / have been reported, besides ensuring tranquility in the area from mobs / crowds of local people.
- Obtain / establish the ID of the aberrant animal causing loss of human life, through the committee constituted for the purpose, through camera trappings or direct sightings or pug impressions if camera trappings could not be done, besides collecting pieces of hair / scats of the carnivore (if available) for DNA profiling.
- A differentiation should be made between 'human kill' due to chance encounters and 'habituated man-eaters'. As most of our forests outside protected areas are right burdened, the probability of chance encounters is very high. Further, tigers often use agriculture / sugar cane field and similar cover along river courses while feeding on livestock or blue bull, which may also cause lethal encounters with human beings. Such animals should not be declared as 'man-eaters'. However, confirmed habituated tiger / leopard which 'stalk' human beings and feed on the dead body are likely to be 'man-eaters'.
- The declaration of an aberrant tiger / leopard as a man-eater requires considerable examination based on field evidences. At

times, the human beings killed due to chance of encounters may also be eaten by the animal (especially an encumbered tigress in low prey base area). However, such happenings are not sufficient for classifying a tiger / leopard as a 'man-eater', which can best be established only after confirming the habituation of the aberrant animal for deliberate stalking of human beings, while avoiding its natural prey.

- Under no circumstances, mere an animal resorting to cattle depredation should be declared as a 'man-eater', despite the fact it may venture close to human settlements. To avoid untoward incidents in such situations, the efforts to trap the animal (chemical immobilization / use of traps) should alone be resorted to.
- Set up trap cages (automatic closure) in areas most frequented by the carnivore (with appropriate luring) for trapping.
- In case successive trapping operation fails set up an expert team for chemical immobilization of the aberrant animal as per the annexed protocol.
- The option of capturing the aberrant animal either through traps or chemical immobilization should be invariably resorted to as the first option. The wild carnivore thus captured, should be sent to a nearest recognized zoo and NOT released in the wild.
- Elimination of a tiger / leopard as a 'man-eater' should be the last option, after exhausting the option of capturing the animal live as detailed in the SOP.
- The Chief Wildlife Warden of the State after the above due diligence should record in writing the reasons for declaring the tiger / leopard as a 'man-eater'.
- After 'declaring' the man-eater, its elimination should be done by a Departmental personnel having the desired proficiency, while providing the fire arm with the appropriate bore size (not below .375 magnum). In case, such expertise is not available within the Department, an expert may be co-opted from the other State Governments or outside with due authorization.
- No award / reward should be announced for destruction of 'man-eaters'.

Annexure-III

DETAILED INSTRUCTIONS FOR THE PROCEDURE TO BE FOLLOWED IN TIGER STRAYING INCIDENTS / AREAS PRONE FOR SUCH INCIDENTS : PREVENTIVE / PROACTIVE MEASURES

- (a) Identify the crisis spots / districts in the State.
- (b) Conduct science based research and analysis to arrive at reasons for frequent straying of tigers in such areas.
- (c) Prepare a google map indicating forest patches, territory of the tigers, nearby habitation and corridors.
- (d) Form monitoring teams consisting of locals with wireless communication on 24X7 basis besides rapid response team.
- (e) Establish an early warning system.
- (f) Issue alert to all nearby villages to take utmost caution.
- (g) Monitor the cattle kill and immediately pay ex-gratia / compensation in the case of eventuality.
- (h) Use electronic surveillance to monitor the movement of the tigers during the night.
- (i) Water holes, cattle kill, transmission lines should be regularly monitored.
- (j) Put in place Rapid Response Team (RRT) for capturing the animal to avoid lethal encounter. The RRT to be equipped with the following:-
 - (i) A field van/mini-truck with built in rails for accommodating a trap cage, with space for equipments, attendants and staff.
 - (ii) A tranquilization kit with drugs for chemical immobilization.
 - (iii) Taser gun for instant immobilization of the animal.
 - (iv) 2 mobile phones for continued communication with the authorities.
 - (v) 4 wireless handsets.
 - (vi) 2 GPS sets.
 - (vii) 1 long ranging night vision for seeing objects in the dark.

- (viii) A digital camera.
- (ix) 4 trap cages (2 for tiger and 2 for leopard).
- (x) 1 mini-tractor for transporting the cage in rugged terrain.
- (xi) 2 search lights.
- (xii) 2 radio collars with receiver and antenna.
- (xiii) 2 portable tents.
- (xiv) Portable hides – which can be set up fast, to be used for persons with tranquilizers
- (xv) 2 folding chairs with table.
- (xvi) Hand held audio system.
- (xvii) Rope and net.
- (xviii) First aid kits

- (k) The rapid rescue team is required to ensure unobtrusive close monitoring of the animal with least disturbance, for tracking its movement.
- (l) In addition, at places which are not waterlogged, camera traps should be set up (fixed to a post or a tree) for establishing the identity of the animal.
- (m) The rapid rescue team also requires due capacity building and 'hands on' field training involving the Wildlife Institute of India and other relevant outside experts, if needed.

PRIORITISING AREAS FOR TIGER MONITORING

The tiger source areas and its surrounding forests have the maximum tigers, besides some protected areas and forest patches. The districts/forest divisions having spatial occupancy of tiger as indicated in the maps need ongoing monitoring on a daily basis. In this context, the following actions are indicated:

- (a) Monitoring the tiger source areas using camera traps to generate photo ID for creating a photo database (Phase-IV monitoring)
- (b) Implementing Phase-IV monitoring in areas having tiger occupancy as indicated in the map
- (c) Periodic comparison / review of camera trap tiger photos to fix ID of tigers reported in several areas near a source site
- (d) Complementing the camera trap monitoring with simple foot patrolling in the peripheral areas, while maintaining day-to-day record as per Phase-IV monitoring protocol
- (e) Monitoring livestock depredation by tiger and ready payment of compensation
- (f) Keeping track of sudden change in land use in areas having tiger presence
- (g) Avoiding blockage of traditional tiger / wildlife corridors in areas outside the tiger reserves falling in various forest divisions
- (h) Monitoring sudden change in cover values in tiger areas (change in cropping pattern etc.)
- (i) Monitoring tiger movement along river courses
- (j) Keeping track of insecticides sale outlets and their use in tiger bearing areas (to avoid poisoning of water)
- (k) Networking through local workforce for gathering information relating to wandering gangs traditionally involved in poaching of wild animals
- (l) Keeping track of local market days

- (m) Fostering creation / maintenance of wildlife monitoring register at the Gram Sabha level in areas outside tiger reserves, with incentives for informing tiger presence
- (n) Creation / maintenance of 'wildlife / tiger offence register' at the Gram Sabha level with reward system for assisting in crime detection
- (o) Deploying special monitoring teams around highways, open wells, railway tracks, electrical transmission lines, village ponds, natural water holes, irrigation canals
- (p) Insulating high tension electrical transmission poles in tiger bearing areas, besides covering open wells and irrigation canals
- (q) Keeping track of encumbered tigresses in tiger bearing areas for monitoring the dispersing young ones
- (r) Periodic checking of samples from water points/perennial water sources for lethal contamination
- (s) Alerting local people in right burdened, tiger bearing areas to prevent lethal encounters
- (t) Periodic disease monitoring of village cattle in the tiger bearing areas to avoid disease transmission to natural prey base for tiger
- (u) Monitoring natural salt licks to prevent poisoning / poaching in tiger bearing areas
- (v) Keeping track of local ironsmiths engaged in preparation of 'gin traps', snares etc.
- (w) Creation of wildlife crime dossier and exchange of such information with field units in tiger bearing areas under intimation to the NTCA
- (x) Fortnightly monitoring of tiger mortality and progress of tiger offence cases ongoing in the courts of law by the Chief Wildlife Warden
- (y) Monthly monitoring of tiger mortality and progress of tiger offence cases ongoing in the courts of law by the PCCF/HOFF
- (z) Use sniffer dogs for detection of body parts, escape routes and other leads

(The SOP has been prepared by the NTCA with inputs from Shri P.K.Sen, Dr Ullas Karanth, Ms Prerna Singh Bindra, Dr P.K.Malik, Dr Parag Nigam and field officers)

No. 15-37/2012-NTCA
Government of India
Ministry of Environment & Forests
National Tiger Conservation Authority

Annexe No.-V, Bikaner House,
Shahjahan Road, New Delhi-110011.
Telefax: 2338 9883
E-mail: jdntca@gmail.com

Dated: 18th March, 2013

To

1. The PCCF/HOFF (s),
Tiger Range States.
2. The Chief Wildlife Warden (s),
Tiger Range States.

Sub: Standard Operating Procedure (SOP) for disposing Tiger/ leopard carcass/ body parts – reg.

Sir,

Advisories have been issued by Project Tiger/National Tiger Conservation Authority from time to time, on different issues relating to tiger mortality, post mortem, reporting etc. Based on the same and with inputs from field officers / experts, a Standard Operating Procedure (SOP) for disposing tiger/ leopard carcass/ body parts has been developed to meet the present challenges.

A copy of the said Standard Operating Procedure (SOP) for disposing tiger/ leopard carcass/ body parts, duly approved by the competent authority, is forwarded herewith for information and necessary action.

The SOP may please be translated in vernacular and widely circulated amongst the field staff for guidance.

Yours faithfully,
SD/-

Encl: As above.

(S.P. Yadav)
Deputy Inspector General (NTCA)

Copy to:

1. PS to MEF.
2. PPS to Secretary (E&F).
3. PPS to DGF & SS, MoEF.
4. PPS to ADG (WL)
5. Additional Director, Wildlife Crime Control Bureau, New Delhi.
6. Inspector General of Forests, Regional Office, Guwahati.
7. Assistant Inspector General (NTCA), Nagpur and Bangalore.

**STANDARD OPERATING PROCEDURE FOR DISPOSING
TIGER/ LEOPARD CARCASS/BODY PARTS**



MINISTRY OF ENVIRONMENT AND FORESTS

GOVERNMENT OF INDIA

NATIONAL TIGER CONSERVATION AUTHORITY

STANDARD OPERATING PROCEDURE FOR DISPOSING THE TIGER/ LEOPARD CARCASS/BODY PARTS

1. **Title :** Standard Operating Procedure for disposing the tiger/ leopard carcass/ body parts.
2. **Subject:** Tiger death/seizure of body parts
3. **Reference:** Advisories of the Ministry of Environment & Forests/ Project Tiger/ NTCA on the subject (Advisory No: 1-60/89-WL I dated 04-11-1994 from the Addl. IGF (wildlife) Ministry of Environment and Forests)
4. **Purpose:** To ensure that the carcass/ body parts of tiger/ leopard are disposed of in a transparent manner to prevent any pilferage for illegal market.
5. **Short summary:** This Standard Operating Procedure (SOP) provides the basic, minimum steps which are required to be taken at the field level (tiger reserve or elsewhere) for disposing of tiger/leopard carcass/ body parts where carcass is available or the body parts have been seized.
6. **Scope :** The SOP applies to all forest field formations including tiger reserves besides other areas where the incident has occurred.
7. **Responsibilities:** The Field Director would be responsible in the case of a tiger reserve. For a protected area (National Park / Wildlife Sanctuary), the concerned protected area manager would be responsible. In the case of other areas (revenue land/conservation reserve/community reserve/village/township) the Wildlife Warden, as per the Wildlife (Protection) Act, 1972, or Divisional Forest Officer/ Deputy Conservator of Forests (under whose jurisdiction the area falls), would be responsible. The overall responsibility at the State level would rest with the Chief Wildlife Warden of the concerned State.
8. **Detailed instructions for the procedure to be followed for disposing of the tiger/ leopard carcass/ body part(s) where body part(s) / carcass is available**

(i) At Scene of crime (SoC) / incident: when carcass or parts available:

- Follow the SOP issued by the NTCA on dealing with the tiger mortality/ seizure of body parts.
- Dispose of the carcass by incineration in the presence of the Field Director or an officer not below the rank of the Conservator of Forests besides the Post Mortem (PM) Team having representation from the civil society institution
- While incinerating the carcass, the sequence must be photographed and video recorded.
- Before leaving the site, ensure that the whole carcass including bones are fully burnt.
- After ensuring the complete incineration of the carcass, prepare a 'Panchnama (Memo) on disposal of the carcass, duly signed by the PM Team and officer incharge, and send a final report (Annexure-I) to the CWLW under intimation to the NTCA with supporting photographs/ documents.

(ii) In case of seizure of body parts (Skin – dry or fresh/ bones/meat or other body parts):

- Follow the SOP issued by the NTCA on dealing with the tiger mortality/ seizure of body parts.
- In case of seizures of body parts, the same may be required as evidence for prosecution in the courts of law and hence in such situations do not dispose the same till the orders of the concerned court for such disposal are obtained.
- Once orders have been obtained by the competent authority, dispose of the body part (s) by incineration in the presence of the Field Director or an officer not below the rank of the Conservator of Forests besides the Team (same as prescribed for the Post Mortem) having representation from a civil society institution
- While incinerating the body parts, the sequence must be photographed and video recorded.
- Before leaving the site, ensure that the whole/ all body parts are fully burnt.
- After ensuring the complete incineration of the body part (s), prepare a 'Panchnama' (Memo) on disposal of the body part (s), duly signed by the said Team and officer incharge, and send a final report (Annexure-I) to the CWLW under intimation to the NTCA with supporting photographs/ documents.

(iii) In cases of seized stock of wildlife trophies obtained during seizure/ confiscation:

- All seized stock of wildlife trophies, where no case is pending in a Court of law, should be destroyed through incineration in the presence of the Field Director or an officer not below the rank of the Conservator of Forests besides a team (same as prescribed for the post mortem) having representation from a civil society institution.
- While incinerating the body parts, the sequence must be photographed and video recorded.
- Before leaving the site, ensure that the whole/ all body parts are fully burnt.
- After ensuring the complete incineration of the body part (s), prepare a 'Panchnama' (Memo) on disposal of the body part (s), duly signed by the said Team and officer incharge, and send a final report (Annexure-I) to the CWLW under intimation to the NTCA with supporting photographs/ documents.
- The provisions of the Wildlife (Protection) Act, 1972 must be followed before destroying such stock.

FINAL REPORT

To be submitted for disposal of each case of tiger/ leopard carcass/ body part (s)/ trophy

1	Name of Office	
2	Locational details of the mortality: description, GPS, Compartment /Block/Range /Sub-Division/ Forest Division/ Tiger Reserve or place/ time	
3	Date of Mortality/ carcass report	
4	In case of seizure of body parts details indicating the status of carcass or seized material	
5	Details of the person (staff/ Others) who reported the incident first: name/address/ contact details/ telephone numbers/e-mail	
6	For carcass: Date, time and Place of Post Mortem (PM)	
7	Details of PM Team (names/designation/ address/ contact)	
8	Details of the missing body parts, if any	
9	Cause of death as ascertained after the PM	
11	Colour photographs of the carcass/ body part (s)- (close ups, indicating injury, if any); details of comparison with camera trap photo data base	
12	Cause of death: Natural/ Poaching	
13	In case of poaching/ seizure of body parts: i. further action taken/ proposed: ii. attach colour photographs of the seized body part/s iii. attach certification regarding species identity (for bone pieces/ meat/ other body parts which are not physically	

	identifiable) iv. action taken with respect to offenders/ suspects (if arrested) v. status of Case/ complaint: number, date of filing the complaint, Sections of law, name of Court where filed	
14	Panchnama/memo of disposal of carcass/ body part (s)	Enclosed/ not-enclosed
15	Remarks if any	
16	Signature of the Officer In-charge with name, designation, date and stamp	

(SOP prepared with inputs from Field Officers of Tiger Reserves)

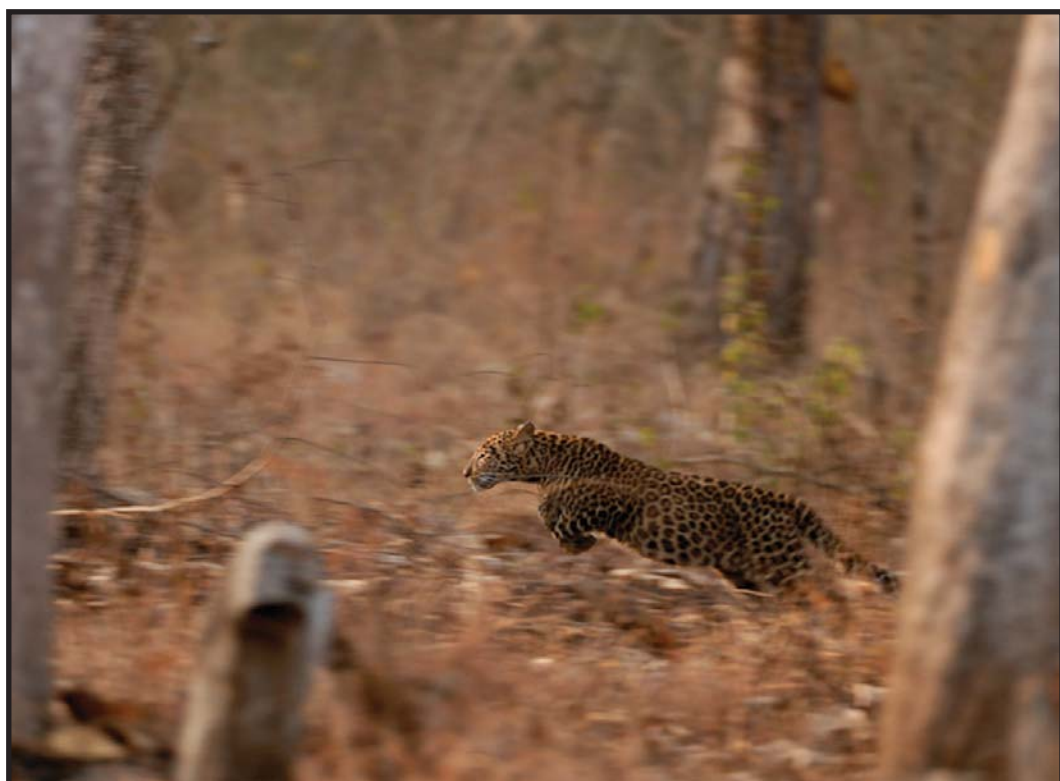
GUIDELINES FOR HUMAN-LEOPARD CONFLICT MANAGEMENT



APRIL 2011



Ministry of Environment and Forests
GOVERNMENT OF INDIA



CONTENTS

FOREWORD

INTRODUCTION

BACKGROUND

I.	AWARENESS GENERATION AND INVOLVEMENT OF PEOPLE	5
II.	TEAMWORK IN TACKLING CONFLICT	6
III.	ESTABLISHMENT OF EMERGENCY RESPONSE MECHANISM	7
III A.	MANAGEMENT OF CROWD	9
III B.	MANAGEMENT OF THE ANIMAL	11
III C.	CAPTURE AND HANDLING OF THE TRAPPED ANIMAL	12
III D.	RELEASE OR TRANSLOCATION OF CAPTURED LEOPARD	13
III E.	TRANSPORTATION OF CAPTURED ANIMAL	14
III F.	MONITORING OF TRANSLOCATED LEOPARDS	14
III G.	AVOIDABLE “RESCUE” OF LEOPARDS	15
IV.	HELPING RURAL PEOPLE BETTER PROTECT THEIR LIVESTOCK – A CONFIDENCE BUILDING MEASURE	15
IV A.	EXPEDITIOUS AND EFFECTIVE DELIVERY OF <i>EX-GRATIA</i>	16
V.	COLLECTION OF INFORMATION ON LEOPARD CONFLICT	17
VI.	DEALING WITH MAN-EATER LEOPARDS	17
VII.	PROTOCOL TO BE FOLLOWED IN CASE OF LEOPARD ATTACKS	17
	ANNEXURE-I	18
	CARE AND CAUTION IN DESIGNING TRAP CAGES	
	ANNEXURE-II	19
	IN CASE OF ATTACKS ON PEOPLE	
	ANNEXURE-III	20
	IN CASE OF ATTACKS ON LIVESTOCK OR SIGHTING OF A LEOPARD	

FOREWORD

Man-leopard conflicts have been hitting the headlines regularly in different States. I have been consulting various experts on what should be done to deal with such situations. This booklet, the first of its kind from the Ministry of Environment and Forests, is a result of the consultations with, and the suggestions from, a wide range of individuals and organizations involved in the subject, besides drawing upon reports and scientific studies available on human-leopard conflict. Knowing full well that such conflicts are locale-specific, this booklet is intended to provide a guidance framework to be adopted to deal with incidents of loss of life and livestock caused by leopards. I am sure the local communities, field forest officers, and revenue and other district administration officials will find this booklet useful in dealing with such situations.



Jairam Ramesh

Minister of State (Independent Charge)
Environment & Forests
Government of India

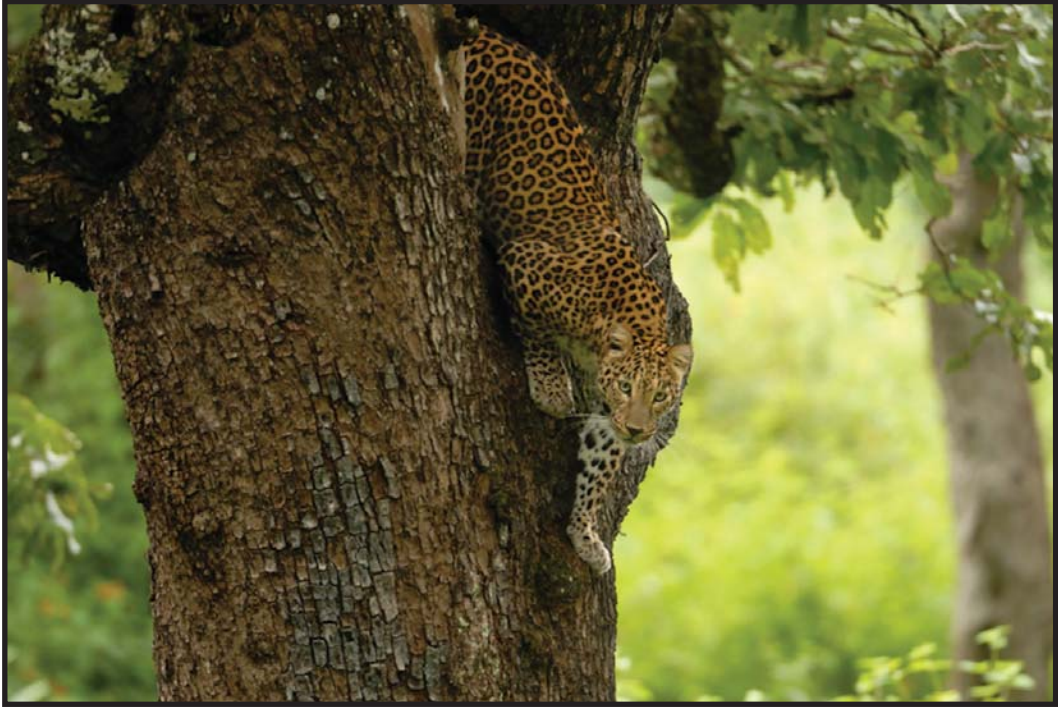
18th April, 2011



INTRODUCTION

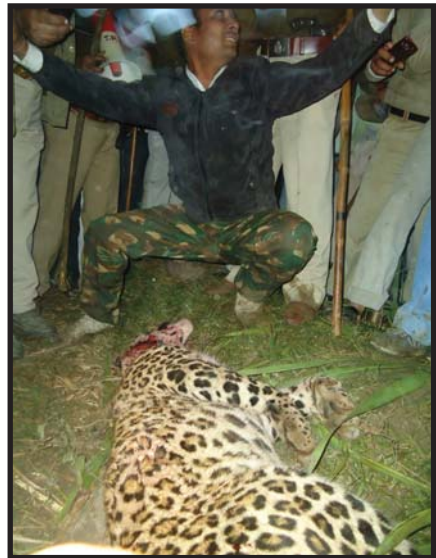
Leopards are a highly adaptable species that live in and around many human-dominated, agricultural landscapes. It is a daunting challenge to ensure the peaceful coexistence of leopards among high densities of humans of the order of 200 or more to a sq.km. Research indicates that even in such high human density areas, attacks on humans and domestic animals in most cases can be kept to very low levels. The goodwill and trust of people especially in rural areas are vital to dealing with crisis situations arising out of loss of life and livestock by leopards in rural areas. The Forest department is the first to face the heat of the public reactions and requires the goodwill and confidence of the rural community much more than any other government department.

These guidelines provide a framework not only to address the conflict after its occurrence, but also to minimize such conflicts through adoption of necessary pro-active measures.



BACKGROUND

Incidences of leopards ‘straying’ into settlements causing human casualties, and the retaliatory killing of leopards by the public have been on the rise. The efficacy of capture and translocation of leopards from conflict areas as a mitigation measure is increasingly being questioned. This has necessitated the need for having broad policy guidelines and management options to effectively deal with this gradually intensifying problem in a diversity of human-dominated landscapes across the country.



After careful consideration of the inputs received from a variety of stakeholders, the following framework guidelines are suggested for managing the human-leopard conflict situations in areas where leopards coexist among high densities of humans.

I. AWARENESS GENERATION AND INVOLVEMENT OF PEOPLE

Modern practices in wildlife conservation call for involvement of all stakeholders in the planning and implementation of conflict mitigation measures to muster greater support and cooperation from people.

The overall aim should focus on a participatory approach, ensuring support of local communities and other stakeholders for conservation and management of wildlife. Awareness programmes should target the people sharing space with leopards, in human dominated landscapes like sugarcane fields, tea gardens, fruit orchards, etc., and also the local communities living in forest dominated landscapes, especially in the hilly States of Uttarakhand, Himachal Pradesh and Jammu and Kashmir.

Sensitizing the media about the nuances of the problem of human-wildlife conflict in general and leopard depredation in particular should be an essential part of the awareness strategy. Media should contribute to diffusing the tense situation surrounding conflict with objective reporting aimed at highlighting the measures to mitigate conflict. Reporting mainly aggressive encounters with leopards can erode local people's tolerance and worsen the situation by forcing the Forest Department to unnecessarily trap the wild animal due to public pressure.

Salient Points for Awareness Campaigns

- i. Leopards often take up residence in croplands and tea-gardens.
- ii. They are not usually inclined to attack people; on the contrary, they avoid people.
- iii. Wild carnivores may attack in self-defence, and, therefore, it is advisable to avoid provoking them.
- iv. Mere sighting of a leopard in the vicinity of human habitations does not necessarily mean that the animal has strayed from a forest and needs to be captured.
- v. Arbitrary removal of leopards could lead to increased conflict. The space vacated by a captured animal will soon be occupied by another leopard.
- vi. The focus should be on long term solutions. These include better sanitation measures including proper garbage disposal in villages and towns so that feral pig and dog populations are kept under check, and do not attract wild carnivores. Providing proper toilet facilities in rural areas would go a long way in reducing incidences of accidental encounters with leopards.
- vii. Farmers should be made aware that livestock sheds should be strong, robust and leopard proof.



II. TEAMWORK IN TACKLING CONFLICT

Efforts should be made to involve all departments, wings and agencies of the government to use a well coordinated mitigation approach which is scientific, field-tested and practical, and *inter-alia*, capable of dealing with emergencies related to attacks by leopards.

In this regard, it is vital to involve the Police and Revenue Departments as they are crucial for maintaining law and order in the face of extreme public reactions. Proper training of police and local administrative staff, and constitution of a Primary Response (PR) Team, along with awareness campaigns are essential ingredients of a successful conflict mitigation strategy.

PRIMARY RESPONSE TEAM

These teams may comprise of paid or volunteer members from the local communities, who are trained to respond immediately to a conflict situation. Their primary aim should be to control the crowd and secure the area until the next level of help arrives. In the hills, where the terrain is difficult, and where houses are scattered in a forest landscape, an Emergency Response (ER) team may take time to reach the conflict site. The establishment of a Primary Response (PR) team is important to ensure crowd control before the ER team reaches the spot.



III. ESTABLISHMENT OF EMERGENCY RESPONSE MECHANISM

- ❖ Immediate response is crucial to manage all conflict situations. A trained Emergency Response (ER) team consisting of an officer not below the rank of Assistant Conservator of Forests, one qualified veterinarian, and a minimum of five trained support staff may be formed in the identified conflict area.
- ❖ Each Forest Division should have a well trained operational ER team.
- ❖ Each ER team should be equipped with chemical capture equipment, drugs, appropriate cages, etc. and should wear specially designed uniforms so that they are easily identifiable during the operation. They should also have specially designed baffle boards for protection.
- ❖ The protocol for Emergency Response should be periodically rehearsed and reviewed to incorporate corrective measures to make it more efficient.
- ❖ Establishing such well advertised ER teams that respond effectively and quickly to conflict situations will help diffuse the usual public outrage and retaliation that invariably follows such conflicts. It will also harness the goodwill of local communities. In the long term, the efficient working of the ER teams will prevent escalation and spread of conflict. It will also prevent the situation from going out of control with people taking the law in their own hands.

The Maharashtra Case Study

In response to frequent attacks on humans by leopards, the Forest Department dealt with the issue by:

- Training field staff to handle emergencies of man-leopard conflict, which led to better understanding and management of the issue.
- Micro-chipping captured leopards to understand their movements after translocation, and to monitor the efficacy of translocation.
- Initiating research on leopards living in human-dominated landscapes, to understand the dynamics of human-leopard conflict.
- Improving design of trap cages.
- Creating awareness to avoid as much as possible, unnecessarily capturing the animal.
- Encouraging interaction with media and researchers to create awareness of the complex nature of the issue.

All these experiences were outlined in a management manual that was published in 2007 by Maharashtra Forest Department.





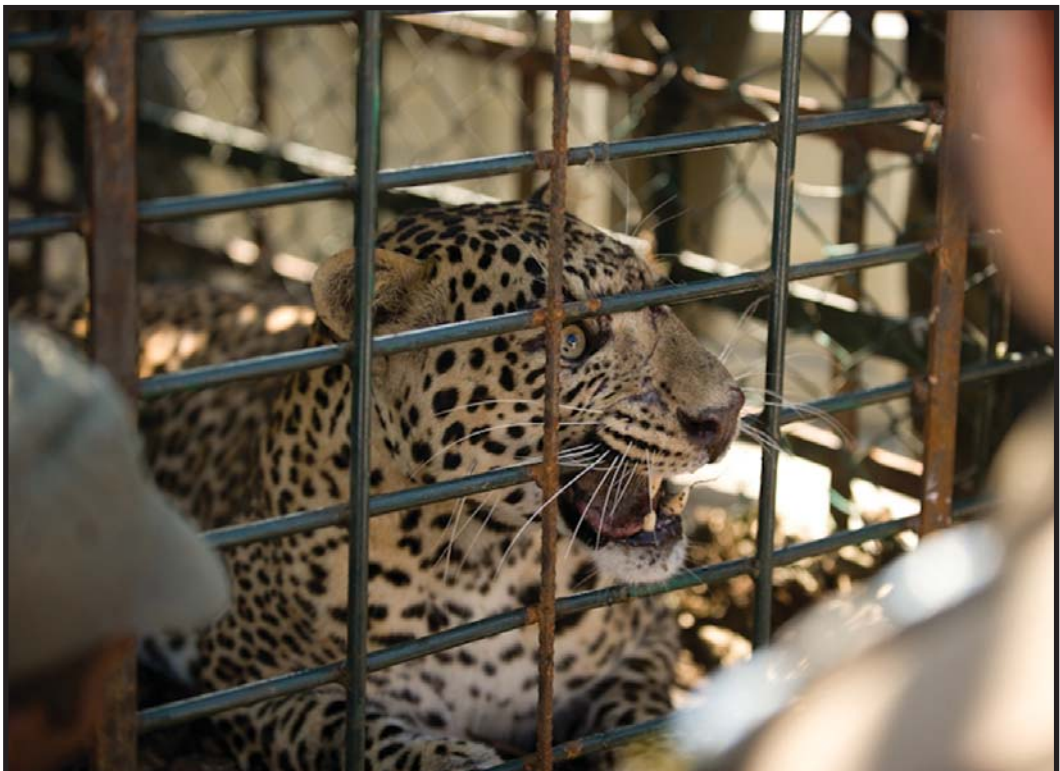
III A. MANAGEMENT OF CROWD

- ❖ Crowd management is crucial to any successful animal rescue operation. The ER team, more often than not, is obstructed and hindered in its activities by furious mobs, making it difficult to discharge its responsibilities.
- ❖ Support and cooperation of the police and civil administration should be ensured in advance to facilitate effective crowd control and to discourage formation of crowds.
- ❖ The area should be cordoned off with barricades, and the public alerted through a public address system. Regular updates should be made available to the administration and local public.
- ❖ There should be an ambulance kept ready to take care of any medical emergencies

A case study from Jammu and Kashmir

In recent years, conflict with black bear and leopards has reached serious proportions in Jammu and Kashmir. In response, the State Wildlife Protection Department proposed the following measures in 2010:

- Setting up of a Central Conflict Mitigation Command Centre with 24/7 helpline facility to receive phone calls from local people in the event of a conflict emergency.
- Feeding the details of the incident into a central database for quick future response.
- Centrally based monitoring and analysis of conflict patterns from information received in the helpline.
- Creation of community level Primary Response Teams consisting of paid or volunteer members from amongst the local communities, trained in the management of crowds in an emergency situation, till the arrival of the forest staff.





III B. MANAGEMENT OF THE ANIMAL

- ❖ The objective should be to give the animal enough space and opportunity to return to its habitat, and situation-specific rescue measures should be followed. The best method of dealing with a wild cat, in the absence of attacks on humans, is not to intervene.

Following steps are prescribed to deal with different situations.

Unconfined or Open Area:

- i. Open situations could mean a barren land, grassland, street, thicket, crop field with standing crop or woodland, with the leopard being either up on a tree or on the ground.
- ii. If the animal is in an open area surrounded by people, all attempts should be made to keep the crowd and local people from approaching near the animal, and the animal should be allowed to escape under the cover of darkness.
- iii. Drug immobilization should be avoided in situations where the animal is in the open, even if the target presents itself in an appropriate position, since a darted animal in the open can retaliate injuring people.
- iv. To trap the animal, a suitably designed light-weight trap that minimizes injury to the animal, should be used. The caution outlined in Annexure-I should be followed while designing trap cages.

Semi-confined:

- i. If the animal is confined in a dry well or trench, a ladder let down into the well will allow the animal to escape in the night.
- ii. Here too, the public must be kept away from the site, and the rescue team should monitor the situation until the animal escapes.



Animal Confined in a Closed Area:

- i. If the animal is confined in a closed area, for example in a house, garage, under a culvert, or caught in a snare, etc., the surrounding entrance and exits should be made secure to ensure no injury to the public.
- ii. If the area is adjoining a forested area, the animal should be allowed to escape in the night, but if it is in a high human density area it should be tranquilized.

III C. CAPTURE AND HANDLING OF THE TRAPPED ANIMAL

Captured leopards should not be put on display after capture. Such unintended forced close contact with humans may alter the behaviour of captured animals with highly adverse consequences following their release. Ideally, such leopards should be kept in covered cages (Annexure-I). Only healthy fit individuals should be returned to the wild.

Following advice may be followed scrupulously while handling captured or trapped wild animals.

- i. All captured animals, irrespective of the method used to capture (chemical/trapping), should be chemically restrained for evaluation of its condition for prognosis and suitability for release.
- ii. While confined, the animal can be micro-chipped, scanned (if already micro-chipped), treated, and various morphometric parameters recorded.
- iii. If the animal is to be released back in the wild in a few days, it should be housed in a suitable transit facility with minimum exposure to humans.
- iv. If the animal is to be placed in captivity, the life time care facility to house the animal should meet the standards prescribed by the Central Zoo Authority.
- v. If an animal kept in captivity is intended to be released, thorough investigation of

its fitness, and evaluation of its response to humans should be conducted before releasing it into the wild.

- vi. If the animal has been kept for more than a month in captivity, it should not be released back into the wild.
- vii. If the animal is injured beyond recovery or permanently disabled, euthanasia is recommended as the best option. Even if the exceptional decision for euthanasia has been arrived at, the animal must be chemically restrained.
- viii. NSAIDs (Non-Steroid Anti Inflammatory Drugs) should never be used for treatment of the animal as these are contraindicated in felids. Long acting antibiotics should be used for sustained therapeutic effects even after release.

III D. RELEASE OR TRANSLOCATION OF CAPTURED LEOPARDS

The decision to capture an animal should be the last option. It is very important that human intervention is restricted to the minimum to avoid future conflict. If the captured leopard is to be released, it should be in the immediate vicinity of capture, i.e., within animal's home range.

Leopards are highly adaptable animals, and exhibit amazing homing instincts¹. A translocated leopard trying to navigate to its home territory through a dense human landscape may lead to increased incidences of conflicts rather than reducing the same. **Therefore, it is best to avoid translocation.**

No animal captured after a deliberate attack on a human should be released into the wild.



¹ In Africa, a translocated leopard traversed back a distance of 400 km to return to its home territory.



III E. TRANSPORTATION OF CAPTURED ANIMAL

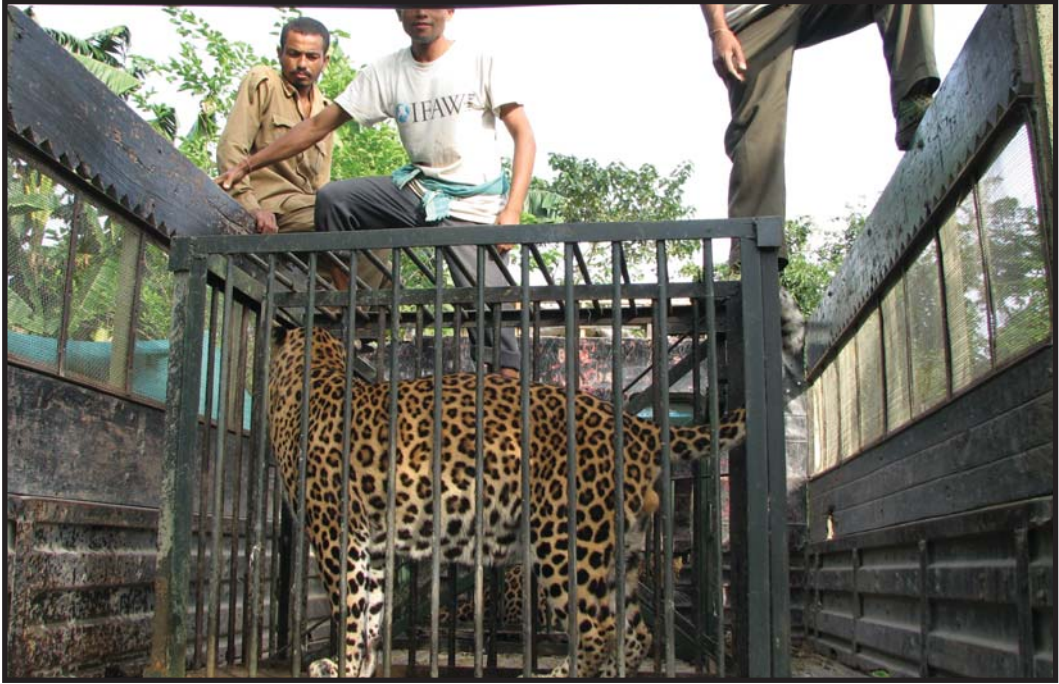
Captured animals often get injured or stressed during transportation. Stress could be detrimental to the health of the animal, which coupled with excessive exposure to humans may adversely alter its behaviour towards humans after release.

The animal once captured should be kept and transported in a stress free environment, insulated from the public. It is important that humans are not allowed to come close to the caged animal, and that the cage is also completely covered with tarpaulin or other appropriate material.

Tranquilized/captured animals must be transported in the trap itself (if suitable) or in a separate transportation cage. Care should be taken to avoid crowded places, and the animal's health condition frequently checked during transit.

III F. MONITORING OF TRANSLOCATED LEOPARDS

The success of translocation or release of leopard has to be measured and evaluated against appropriate post-release monitoring protocols. Translocation very often leads to the transfer of conflict to another unaffected site. Individual identity of all the released animals should be monitored by marking them with microchips and ear tags or colour coded collars before release. Radio collars should be put on a sub-set of released animals to monitor post-release movements and survival. Scientists and experts must be involved in such radio-tracking programmes.



III G. AVOIDABLE “RESCUE” OF LEOPARDS

A cub without its mother usually does not need “rescue” as the mother leaves the cubs when she goes hunting. Equally, cubs released without its mother have poor survival probabilities. If cubs are found alone, a watch must be kept for their mother without disturbing them. Cubs are not to be “released”, but only require “reuniting” with their mother. Reuniting should be attempted immediately in the night in the same area, from where they were picked up. A suitable camera trap placed overnight near the ‘reunion site’ would facilitate the confirmation of the reunion.

Cubs that are hand-reared in captivity have a negligible possibility of future release back to the wild. Lifetime care is the only suitable option for such cubs, since their release in the wild even after a long term rehabilitation process may only worsen the already existing conflict situation.

IV. HELPING RURAL PEOPLE BETTER PROTECT THEIR LIVESTOCK – A CONFIDENCE BUILDING MEASURE

- ❖ Subsidy should be provided for simple but sturdy and leopard-proof livestock sheds.
- ❖ Vaccination camps for livestock could also be organized in collaboration with the Animal Husbandry Department.
- ❖ Possibility of initiating state sponsored insurance schemes for livestock also needs to be explored.



IV A. EXPEDITIOUS AND EFFECTIVE DELIVERY OF *EX-GRATIA*

Immediate response to loss of life, livestock, and property caused by leopards will help calm people. This will prevent violent reactions towards the problem animal in particular and wildlife in general.

Payment of *ex-gratia* should be made fast and hassle free. The possibility of initiating self financed insurance schemes should be explored.

- i. In case of **attack on humans**, it is recommended that senior level officers immediately visit the site. A vehicle should be provided to take the victim to the nearest medical facility. **The *ex-gratia* payment should be made immediately.**
- ii. In case of **attacks on livestock**, ***ex-gratia* amount should be provided within a week.** The complaint should be made at the Gram Panchayat office, and the Forest Guard should visit the site immediately. The protocol should be verified by Forest Guard and Gram Sevak. Extra travel and phone allowance should be provided to the Forest Guard to enable him to effectively discharge this responsibility without delay. Veterinary certificate and photographic evidence should not be made compulsory requirements for disbursement of *ex-gratia* amount. The amount should be dispatched through a bank demand draft.
- iii. The use of an 'sms' based updating system to inform the victim or his relatives about the status of his/her claim, and also to receive complaints should be explored.
- iv. It is extremely important that the animal is allowed to feed off the livestock it has killed. After inspection by the forest Guard and the Gram Sevak, the carcass should be taken to a nearby secluded area, the same evening. If a leopard is deprived of its kill, it will make more kills, inflicting more losses on the farmers. Also, it is possible that after being deprived of its kills repeatedly, the animal may become desperate, increasing the intensity of conflict. This aspect also needs to be explained to the villagers.

- v. Bi-yearly meetings should be held where local MLA, panchayat heads, revenue, veterinary, health and forest department officials should discuss the problem of human-wildlife conflict, and how effectively it is being managed. Such meetings could also review the existing practice and options of mitigation with a view to making these more effective and people friendly. The above exercise should involve trained wildlife biologists and other experts.

V. COLLECTION OF INFORMATION ON LEOPARD CONFLICT

- ❖ Management of a species should be based on systematic long term data. Information on conflict incidences should be collected systematically in an appropriate format to aid decision-making.
- ❖ Long term research, focused on estimating the population and abundance of leopards in high conflict areas, should be taken up on priority.
- ❖ Identification of conflict prone areas, with data on conflict intensity, nature of conflict, and trends, must be collected for better preparation and pre-emption.

VI. DEALING WITH MAN-EATER LEOPARDS

Attacks by man-eating leopards are deliberate with an intention to kill, and usually result in death, e.g., child being lifted from the precincts of the house, and attacks on people sleeping inside the house. In such cases, every attempt must be made to identify the correct animal, and trap the animal as per the guidance outlined. Immediately after the first attack by a man-eating leopard, orders from the Chief Wildlife Wardens should be obtained to eliminate the problem animal with the help of shooters. Trap cages should be installed to capture the man-eater. This is especially crucial when such attacks occur in highly populated landscapes. **Animals trapped after deliberate attacks on humans should never be released back into the wild.** Humanely euthanizing such animals should be the preferred option.

VII. PROTOCOL TO BE FOLLOWED IN CASE OF LEOPARD ATTACKS

In case leopard attacks are reported against human beings or cattle, the protocols suggested in Annexure-II and Annexure-III respectively may be followed.

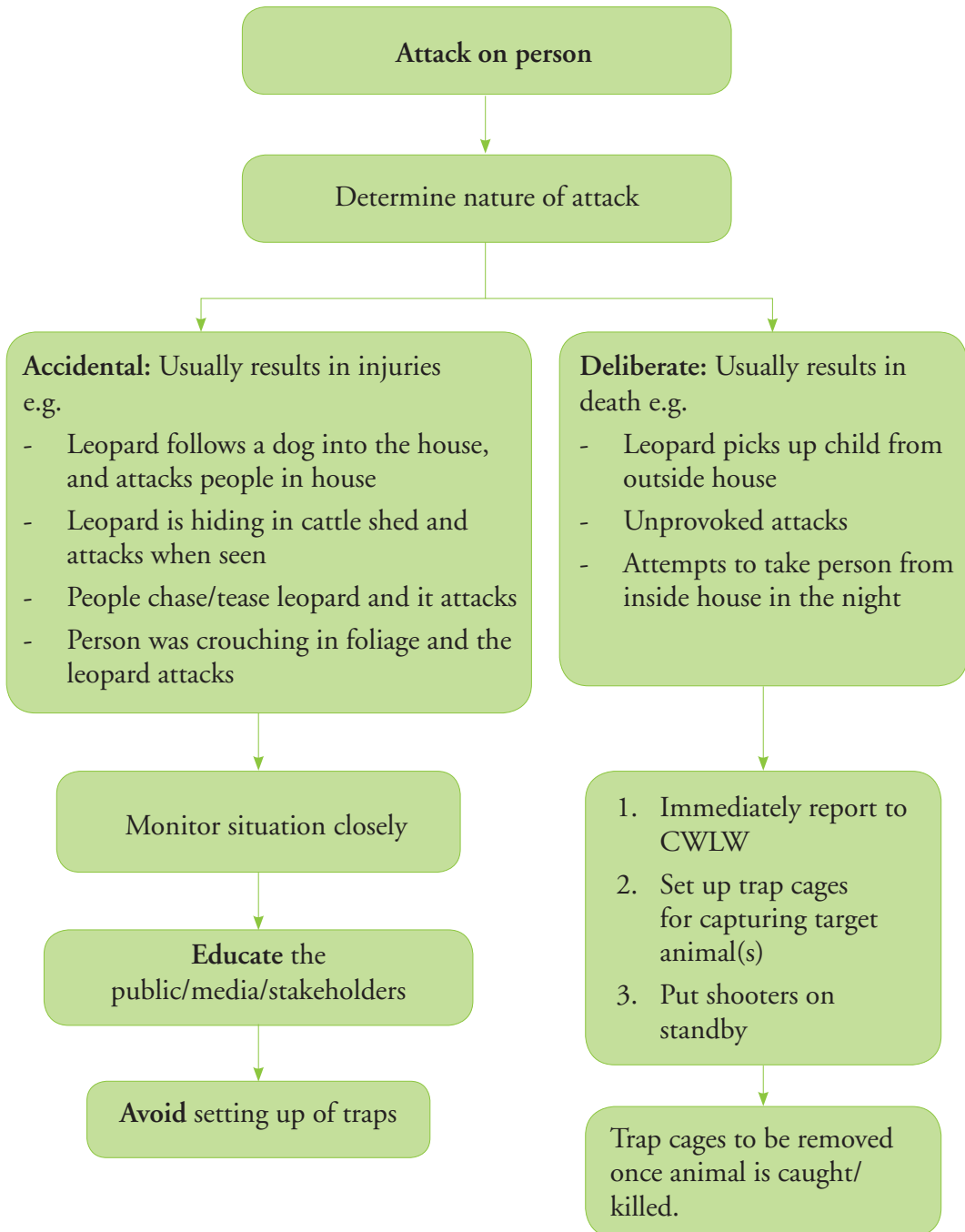
ANNEXURE-I

CARE AND CAUTION IN DESIGNING TRAP CAGES

1. Trap cages should be completely enclosed (new designs use fiberglass) with holes for ventilation.
2. Iron rods should not be used (thick chain link is preferable) anywhere in the trap cage as leopards struggle to escape by pulling at the bars which results in canines being broken.
3. Old rusty, iron cages should be discarded, and not used to house leopards.
4. There should be a gap of 1.5 inches between the cage floor and the lower edge of the trap door to prevent tails getting slammed.
5. Trap cages should be well ventilated.
6. Trap cages should be at least 6 feet in length with the trap door activation system being at the opposite end of the trap door. The height of cage should be around 4-4.5 feet and width ~ 3.5 feet. Cages made of fiber glass (currently being used in Maharashtra) are lightweight and can be carried by 4 people. Collapsible cages should also be designed and physically tested in the field to assess their effectiveness.
7. **Some Do's and Dont's for holding leopards in trap cages:**
 - (a) Trap cages should not be used for long term captivity (no more than one week). Separate temporary transit facility should be created for long term captivity.
 - (b) Only one animal can be held at a time in a trap cage.
 - (c) Water should be made available at least two times a day – either through a pipe which can be inserted in a hole at the side of the trap cage or by placing a steel bowl of water inside.
 - (d) Trap cage should not have any artificial padding (no rubber etc) as leopards have a tendency to rip off and eat it while struggling to escape. These synthetic materials could get lodged in the stomach of leopards and result in their death.

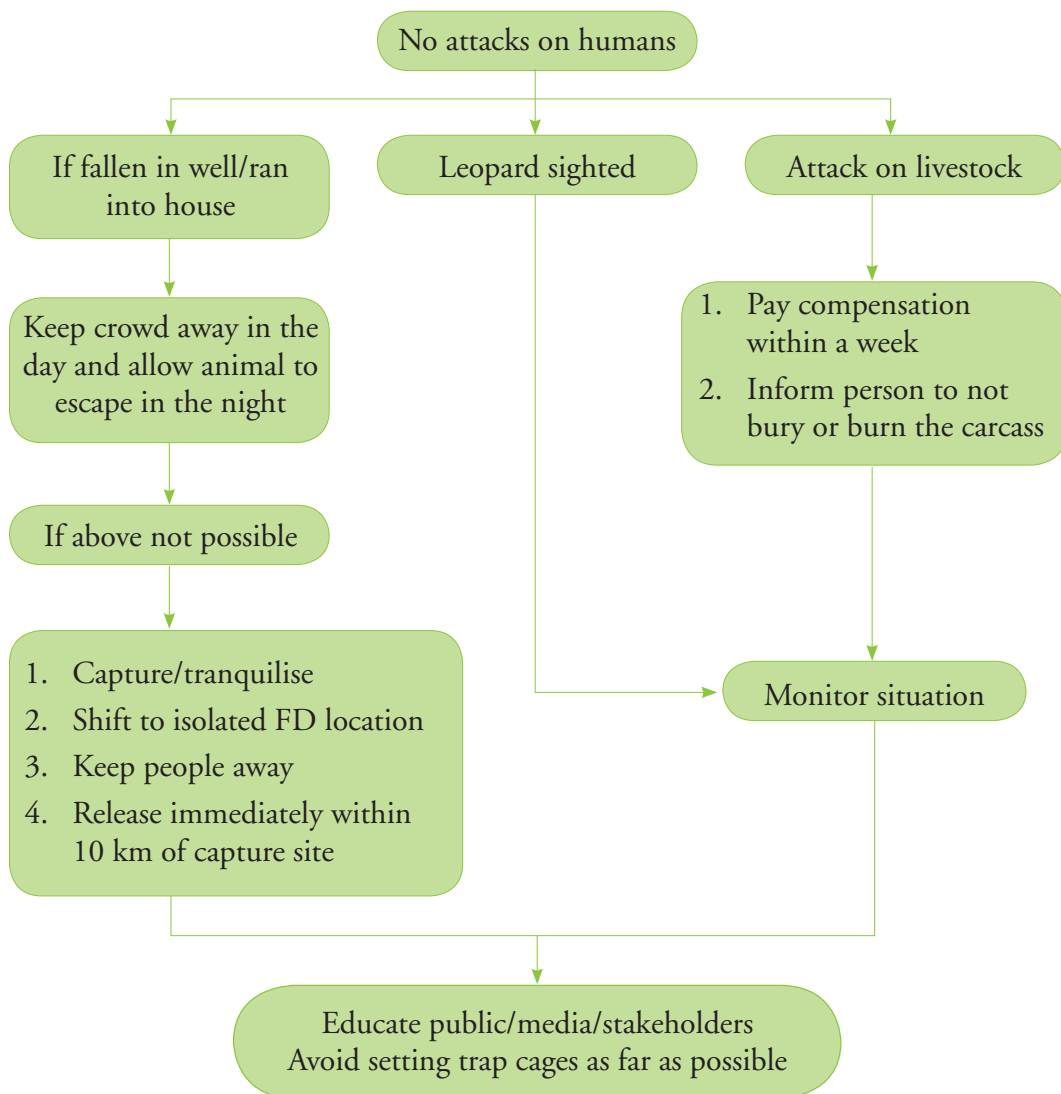
ANNEXURE-II

IN CASE OF ATTACKS ON PEOPLE



ANNEXURE-III

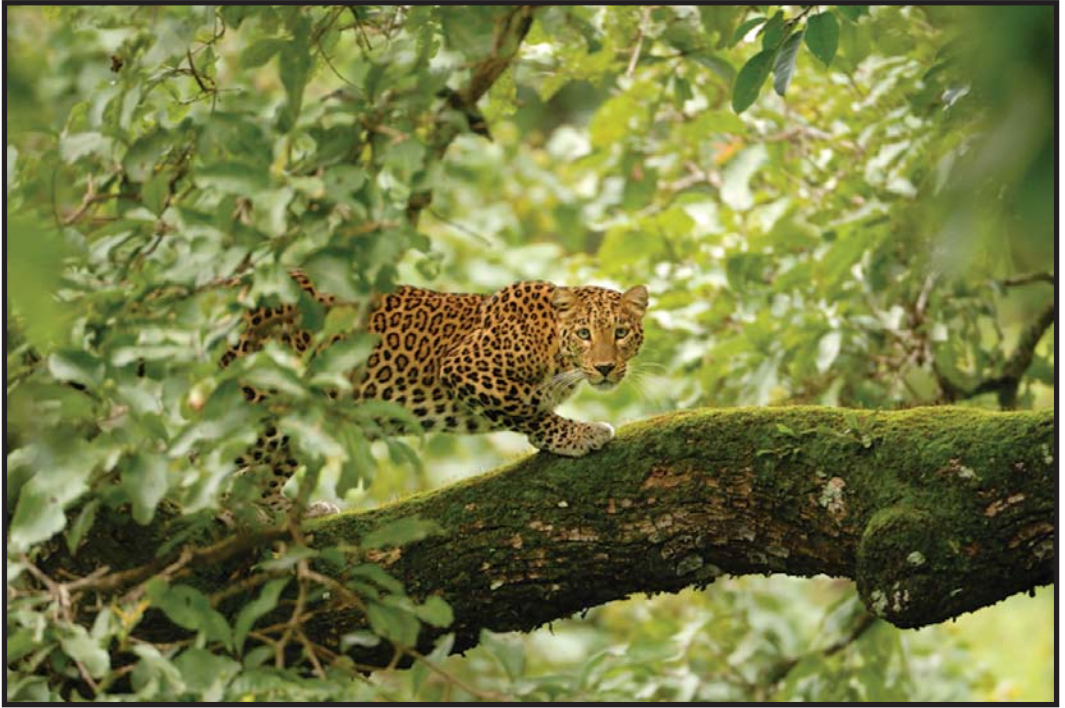
IN CASE OF ATTACKS ON LIVESTOCK OR SIGHTING OF A LEOPARD



We are extremely grateful to the following people for their contributions in preparation of these guidelines:

- A. K. Srivastava
- Amit Verma
- Aniruddha Belsare
- B. Majumdar
- G. V. Reddy
- H. S. Singh
- Jagdish Kishwan
- Janaki Lenin
- Jay Mazoomdaar
- John Linnell
- Mahesh Rangarajan
- Meghna Krishnadas
- Milind Pariwakam
- M. D. Madhusudan
- Nandini Velho
- N. V. K. Ashraf
- Paramjit Singh
- P. J. Thosre
- Prabhat Tyagi
- Prakriti Srivastava
- P. R. Sinha
- Raghu Chundawat
- Rahul Kaul
- Rashid Naqash
- S. S. Bist
- Sanjeev Pandey
- V. B. Mathur
- Vidya Athreya
- Vivek Menon
- Yashveer Bhatnagar
- Jammu and Kashmir, Department of Wildlife Protection
- Himachal Pradesh State Forest Department
- Maharashtra State Forest Department
- Wildlife Institute of India
- Wildlife Trust of India





Ministry of Environment and Forests
GOVERNMENT OF INDIA

For more information, contact:

Jagdish Kishwan
Additional Director General of Forests
Ministry of Environment and Forests
email: jkishwan@nic.in

We are extremely grateful to the following people and organizations for sharing their excellent photographs for this booklet:
Vidya Athreya, Wildlife Trust of India, Kalyan Varma, Aditya Singh, John Linnell

STANDARD OPERATING PROCEDURE TO DEAL WITH EMERGENCY ARISING DUE TO STRAYING OF BEARS IN HUMAN DOMINATED LANDSCAPES

- Title:** Standard Operating Procedure to deal with emergency arising due to bear-human interactions (conflicts) in human dominated landscapes
- Subject:** Dealing with emergency arising due to bear-human interactions in human dominated landscapes
- Purpose:** To ensure that bears are handled in the most appropriate manner to avoid casualty / injury to human beings and/or livestock, and loss to property or crops.
- Summary:** This Standard Operating Procedure (SOP) provides the basic, minimum steps which are required to be taken at the field level (Protected Area /Reserved Forest or elsewhere) for dealing with incidents of bear-human interactions in human dominated landscapes.
- Scope:** The SOP applies to all forest field formations including human dominated landscapes near forested areas where such incidents occur.
- Responsibilities:** The Protected Area Manager would be responsible in the case of a protected area (National Park / Wildlife Sanctuary). In the case of other areas (revenue land/conservation reserve/ community reserve/village/township) the Wildlife Warden, as per the Wildlife (Protection) Act, 1972, or Divisional Forest Officer/Deputy Conservator of Forests (under whose jurisdiction the area falls), would be responsible. The overall responsibility at the State level would rest with the Chief Wildlife Warden of the concerned State.

Suggested field actions to deal with strayed bear or bear-human interactions

- (a) On receiving confirmed reports of bear-human interaction (conflict) or straying of bear into human habitations in an area, constitute a Committee immediately for technical guidance and monitoring of the situation on day to day basis, as under:-
- i. A nominee of the Chief Wildlife Warden
 - ii. A veterinarian
 - iii. Local NGO representative
 - iv. A representative of the local Panchayat
 - v. Field Director/ Protected Area Manager/ DFO I/C - Chairman
- (b) Constitute a Rapid Response Team (RRT) (See Annexure-I), if not created earlier. Since it may not be always possible for experts from the Wildlife Institute of India to provide assistance, it is advised that some outside experts who have experience on bears or other large carnivores may be involved in the ongoing monitoring.
- (c) Collect recent crop/livestock depredation or human injury / fatal encounter data, if any, in the area. If it is an area that has been historically prone to such incidences, detailed research work has to be carried out in order to assess the reasons for the frequent bear emergencies in the area.
- (d) In case of confirmed crop/livestock depredation / human injury /fatal encounters or frequent straying of bears near human settlements, rush to the site along with the RRT and local police to maintain law and order in the area, besides avoiding crowding by local mobs. This is essential to avoid agitation / excited local people surrounding the animal spot which hampers safe exit to bears or capture operation, leading to serious injuries on people and staff. It is also necessary that police and local administration be involved at an early stage. Effective coordination with them is critical to control mobs which as has been seen in several instances, worsen the situation and lead to avoidable fatalities/ tragedies. If the bear has just strayed into the village and has been surrounding by people, manage the crowd in such a way so as to provide a safe exit for the bear to move into the nearest bear habitat.
- (e) If the bear had killed livestock or injury to humans or loss to crops/property, the RRT along with the local villagers should use indigenous methods such as beating of drums or empty metal containers to prevent bears returning to human habitations. This situation should be monitored until the problem is solved or reduced. Indigenous crop protection measures have to be strengthened through community participation. Burning red chillies on cow dung cakes or firewood in the periphery of villages or crop field during dusk and nights, would repel bears from those areas. However, care should be taken to avoid discomfort to humans living in the villages by selecting sites far away from habitations and taking consideration of the wind direction.

- (f) Create awareness amongst the villagers on bear behaviour and the ways to avoid a bear encounter and the ways to respond in such situations. For instance, moving in groups with sticks in hand and avoiding moving singly during dawns, dusks and nights would reduce encounters with bears.
- (g) If the bear has killed livestock inside the night shelter in a village/village fringe or raided crops in fields near villages, set up camera traps near the conflict sites to ascertain the age (adult, subadult, young) or whether single or mother with cub(s) or a pair.
- (h) Ensure unobtrusive guarding of livestock kill to allow feeding of the carcass (if not close to a human settlement) besides safeguarding from poisoning (for retaliatory killing). Reinforce roof, windows and doors of livestock night shelters, food storage rooms, shops etc. and if required replace with metal doors.
- (i) Set up hair snares around the livestock kill/crop field or on the approach path to the kill site or crop field using two or three barbed wire strands to collect hair samples of the animal for genetic analysis. Also collect bear scats at the site and the nearby bear habitats for genetic analysis.
- (j) If the bear is repeatedly straying into the village set up of bear traps (automatic closure) with appropriate luring while avoiding disturbance, to trap the animal.
- (k) In case, the captured bear is found to be healthy in prime or young age without any incapacitation (loss of canine, injury, broken paw etc.), as confirmed / certified by the Committee as constituted at para (1), then it may be released after applying an ear-tag or radio-collar (optional) in the nearest bear habitat away from human settlements. While releasing the capture bear back into the wild, 'aversive conditioning' has to be done by bursting of crackers, beating drums or firing with rubber bullets.
- (l) If in case, the captured bear is old, sick or injured, it should not be released back into the wild and instead sent to a recognized zoo or Rescue/Rehabilitation Centre.
- (m) Under no circumstances, a bear should be eliminated by invoking the Wildlife (Protection) Act, 1972, if it is not confirmed as a "problem bear" through individual identification based on genetic analysis.
- (n) An authorized spokesperson of the Forest Department, should periodically update the media (if required) to prevent dissemination of distorted information relating to the operation / incidents. Sensitization or distorted information can lead to further damage.
- (o) The Chief Wildlife Warden has to take the final decision on whether a bear has to be released back in the wild or transferred to a zoo or Rehabilitation Centre.

Instructions for the constitution and operation of a Rapid Response Team

The Rapid Response Team (RRT) comprises of a small team of well trained, well equipped field staff and one veterinarian led by a Forest Range Officer for capturing the bear to avoid lethal encounter. The rapid rescue team is required to ensure unobtrusive close monitoring of the animal with least disturbance, for tracking its movement. The RRT to be equipped with the following:-

1. A field van/mini-truck with built in rails for accommodating a trap cage, with space for equipments, attendants and staff.
2. A tranquilization kit with drugs for chemical immobilization.
3. Taser gun for instant immobilization of the animal (optional).
4. Two mobile phones for continued communication with the authorities.
5. Four wireless handsets.
6. Two GPS sets, Two binoculars.
7. One long ranging night vision for seeing objects in the dark.
8. One digital camera and Six camera traps
9. Two portable culvet traps with wheels; six bear snares
10. One mini-tractor/all terrain vehicle for transporting the trap in rugged terrain.
11. Two search lights.
12. Some Ear tags and one tag applicator and radio collars (optional) with receiver and antenna.
13. Two portable tents, camp stools.
14. Barbed wire strands (2 x 10 m) & 6 poles (2 m long)
15. Net, stretcher, ropes.
16. First aid kits, bear pepper sprays (optional), red chillies
17. The rapid rescue team also requires due capacity building and 'hands on' field training involving the Wildlife Institute of India or other expert agencies.



***Prosopis juliflora*: A Miracle Species of Hot Arid and Semi-Arid Regions of India**

**J. C. Tewari*, B. K. Mathur, P. Tewari, Yogendra Singh, Manmohan Singh,
Moola Ram and Anil Sharma**

Central Arid Zone Research Institute, Jodhpur – 342003, Rajasthan, India

*Email of corresponding author: drjctewari@gmail.com

Prosopis juliflora for which most of people still have not a value more than a weed that has become now one of most significant tree species of hot arid and semi-arid regions of India after it has been known for its multiple usefulness. Central Arid Zone Research Institute (CAZRI), Jodhpur has been pioneer in finding out of multitude products from *Prosopis juliflora* and developed methodology of various products for consumption not only by animals but also by human being, some of which important products are described in this article.

Introduction

Prosopis juliflora (Sw.) DC, an evergreen tree is native to South America, Central America and the Caribbean. It is commonly known as Vilayati Babool in India and its first introduction into India has been reported differently by different people. Rawat et al. (1992) reported that *Prosopis juliflora* was first introduced in India during 1875 in Punjab whereas Reddy (1978) stated that the first introduction of *P. juliflora* into India took place in 1877, with seeds from Jamaica that arrived in the country one year earlier. The seeds were first sown in various arid areas around Kamalapuram, in the Cuddapah District of Andhra Pradesh (old Madras Presidency) and the plant was named as “the exotic lady of South America”. Different from both these, Gupta and Blara (1972) reported that *Prosopis juliflora* was introduced in India in 1857 from Mexico. Based on these reports, it can be stated that *Prosopis*

juliflora was introduced in India somewhere during 1870s. In the present state of Rajasthan, it was first introduced in Jodhpur in 1913 where the ruler of the then state of Jodhpur named it “Royal Plant” in 1940 because of its excellent growth rate and evergreen nature in all environmental condition (except frost). Large scale aerial seeding of this tree was undertaken to establish sand dunes and sand storms in Rajasthan (Harsh et al., 1996). Further introductions of this species followed gradually into the states of Haryana, Uttar Pradesh, Madhya Pradesh, Maharashtra and Tamil Nadu (Harsh and Tewari 1998; Muthana 1985). Today, owing to its fast growth and drought hardiness with extraordinary ecological amplitude, the species has been spread throughout the length and breadth of the country, from Haryana in north to Tamilnadu in down south, and from Kutch, Gujarat in west to drier parts of Orissa in east (Tewari et al., 2000).

The false impression of *Prosopis juliflora* has been till now that it has been considered as a horribly invasive useless species in most parts of the world. It is so perhaps due to unknowingness of its multiple usefulness by most of the people. The research at Central Arid Zone Research Institute (CAZRI), Jodhpur has led the concept to be turned into a useful resource of hot arid and semi-arid ecosystem. The usefulness of *Prosopis juliflora* has long been recognized since the work by Muthana and Arora (1983). It was then considered to be a valuable tree species of the desert ecosystem. Its multiple use possibilities have attracted growing interest in this species, especially in arid zone. The view of usefulness of *Prosopis juliflora* got strengthened further among the rural community when a sub-project "Value chain on value added products derived from *Prosopis juliflora*" was launched at CAZRI during 2008-09 under National Agricultural Innovation Project (NAIP). Under the project, CAZRI has successfully developed a value chain on value added products of the species by involving farmers, NGO and Industry. Various products technologies were developed for animal consumption as well as human consumption and transferred to industry for large scale production and marketing. Some of popular products are being described in this article.

Products for Animal Consumption

Cheaper concentrate feed: A very simple process technology was developed by utilizing *P. juliflora* pods mixing with

other ground feed ingredients available locally viz., tumba (*Citrullus colocynthis*) seed cake, guar (*Cyamopsis tetragonaloba*) korma, til (*Sesamum indicum*) seed cake, wheat bran, maize grain, common salt and mineral mixture. Farmers readily accepted this process technology and it is very much possible at livestock owners' doorsteps.

Multi-nutrient feed block: Guar seed meal is commonly used in multi-nutrient feed blocks. *P. juliflora* seed meal contained 2.77% minerals, 8.35% ether extracts, 44% crude protein and 44.9% total carbohydrates. These values are com-

parable with seed meal of guar. Therefore, multi-nutrient feed blocks were prepared



by replacing guar meal by *P. juliflora* seed meal. Other contents of this block are tumba (*Citrullus colocynthis*) seed cake, molasses, urea, common salt, dolomite and vitamin-mineral mixture. This reduces the cost of multi-nutrient feed block in one hand and added to its nutritive value on the other.

Densified complete *P. juliflora* block:

The pods, which have less amount of mesocarp (good source of sugar) was directly crushed/ground in the hammer mill.



Ground pods were compressed for densification in the block making machine

up to pressure 160 kg/cm² to make it as a block. The volume reduction was found more than 80 percent, which is very helpful for storage and transportation; and as well as enhancing the shelf life.

Products for Human Consumption

Prosopis coffee: *P. juliflora* coffee is major one among some of human consumption products developed from *P. juliflora*. The coffee has given brand name as ‘Juli Coffee’. The technology of *P. juliflora* coffee preparation has been standardized and passed to partner industry of the project. However, toxicity analysis for human consumption of *P. juliflora* pod flour is in progress at NIN, Hyderabad. Once a clean chit is obtained in this context, *P. juliflora* coffee will also be launched in the market. The coffee was prepared by roasting *P. juliflora* pod flour at different temperatures and mixing chicory (*Cichorium intybus*) with raw coffee powder. The prepared coffee contained 70% *P. juliflora* pod powder and 30% chicory mixture (containing 20% raw coffee powder + 10% chicory powder).



gram liquid was obtained from 350g pods. To obtain the syrup, the liquid is boiled until it reaches the necessary consistency. This thick liquid was yellowish brown in colour and can be used as a beverage. It can also be mixed with milk and fruit juices. This syrup is widely used in Latin and South America countries. The residue left after preparing the syrup was used for processing fine flour and fine fiber. The quantum of fine flour and fiber obtained from used 350g pods was 62 g and 26 g, respectively. The flour obtained by this process was quite fine, which was highly suitable for use in confectionary items. The process technology standardized for these products is given below:

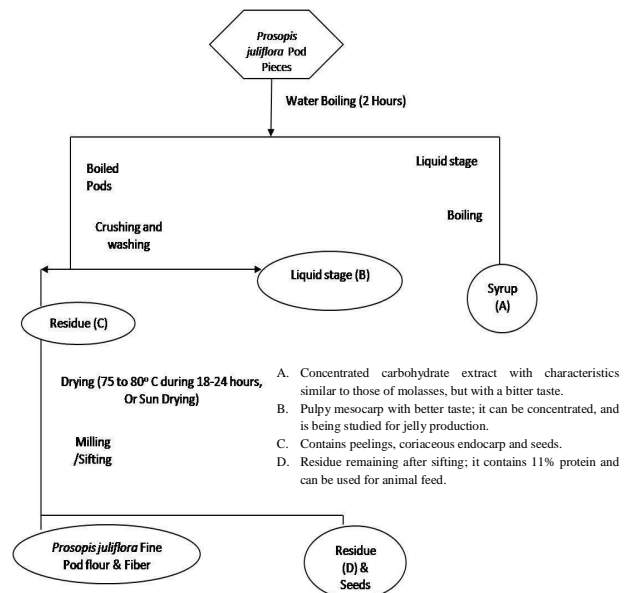


Fig. Schematic representation of process technology to prepare Juli Syrup, Fine Pod Flour and Fine Pod Fiber

All these above mentioned products are few examples of *Prosopis* pod utility. There can be numerous uses of its pods and other plant parts. The general uses of *P. juliflora* are mentioned as follows:

1. **Used as fuel:** Although the initial plantations in India were mainly established for the purpose of conservation, *Prosopis juliflora* has become the main source of fuel in rural areas and to a large extent, in urban and semi-urban areas also. Today it fulfils more than 70 percent of the firewood requirements of the rural people in the tropical arid and semi-arid regions of India (Harsh and Tewari 1998).
2. **Use of *Prosopis juliflora* wood:** Larger branches and trunks yield a high quality timber, comparable in colour, finish and physical attributes to Indian rosewood and other commercial hardwoods. Its exceptional property is its negligible shrinkage (4.17%) which is much less than for oak, maple or walnut trees (14-16%). Because of this quality furniture items made from *Prosopis* wood develop little or no cracking or warping later on (Singh, 2008). In India use of *Prosopis* wood in furniture industries is very limited because of non-availability of straight bole trees and also some extent because of a lack of knowledge. In other countries, *Prosopis* species are widely used for making furniture because of their high quality wood. The wood of *P. juliflora* is soluble to varying degrees in water, sodium hydroxide, alcohol and benzene, which

means that it can be successfully pulped for the production of writing and printing papers, textile fibres, tyre cord or cellophane. Tests have indicated that writing and printing papers could be produced from *Prosopis juliflora* logs having 30 to 50 cm in girth with 50 per cent cellulose and 30 per cent lignin (Madan and Tandon, 1991).

3. **Use of *Prosopis juliflora* biomass:** *Prosopis juliflora* is the most efficient species to convert energy into biomass. It is an excellent candidate for short rotation energy plantations considering its fast growing nature, higher biomass production potential, drought and heat tolerance and excellent coppicing ability. It produces biomass about 25 to 30 tons/ha/year at the short rotation age of 4 to 5 years (Patel, 1986). It was reported that total biomass from *Prosopis juliflora* ranked first amongst the high biomass producing native trees of arid and semi arid regions of India. (Singh, 2008). *Prosopis juliflora* trees maintain their greenery and continue to grow even during severest of the severe droughts in desert states like Rajasthan. It will be worthwhile to mention here that during 2002 drought in India, it were the *Prosopis* trees which provided livelihood security to the rural population, settled in arid and semi arid drought prone regions of the country. Wherever thickets of *Prosopis juliflora* are creating danger of encroachments to agricultural fields, they can be harvested to generate

electricity. Kutch region of Gujarat has ample scope for electricity generation as *Prosopis* thickets are naturally growing in this tract.

4. **Use of *Prosopis juliflora* Gum:** *Prosopis juliflora* exudes gum from the sap wood. On average, about 40 g of gum is produced from one plant. However, under drought conditions more gum is exuded. A single person has been estimated to be able to collect 1-2 kg of *P. juliflora* gum/day in India (Tewari, 1998). The trade in exudate gum has been increasing in India, with *P. juliflora* gum estimated to make up approximately 80% of that total gum production in Gujarat (Tewari, 1998). *P. juliflora* gum exudation increased at higher temperatures and ceased completely at the beginning of the rainy season (Tewari, 1998). The gum forms adhesive mucilage, with favourable physical and chemical properties, that can be used as an emulsifying agent. *Prosopis* gum also finds use in confectionery, mending pottery, and as an adulterant and substitute for gum arabic. (Krochmal *et al.*, 1954). It possesses fairly good adhesive strength and can be used as paper adhesive for brown paper and wall paper (Vimal and Tyagi, 1986).

5. **Medicinal value of *Prosopis*:** In India, boiling wood chips, a bark extract is used as an antiseptic on wounds, and gum is used to treat eye infections (Vimal and Tyagi, 1986). Research done at Central Arid Zone Research Institute, Jodhpur (Azam *et al.*, 2011) resulted in identification of antioxidant compound which is present in

concentrated form (6-8%) in the heart wood of *P. juliflora*. The compound was identified as (-)-mesquitol ($C_{15}H_{14}O_6$) which was compared with existing pharmacologically / therapeutically accepted antioxidant probucol and α -tocopherol and found that (-)-mesquitol is better than probucol and α -tocopherol drugs. *Prosopis* wood is reported to have medicinal value for treatment of rheumatism and against miscarriage. Some of the alkaloids of *Prosopis* species are reported to be antifungal and antibacterial. In Brazil, *P. juliflora* flour is used as an aphrodisiac, syrup as an expectorant and tea infusion against digestive disturbances and skin lesions (Rocha, 1990).

6. **Role of *Prosopis* in Carbon sequestration:** Wide spread of *Prosopis* trees may account for a significant amount of sequestered carbon, though tree species in arid and semi-arid zones are not considered at present for calculating carbon balances. But a considerable quantity of carbon can be stored in woody biomass of the species. Even a single rotation of *P. juliflora* would lead to significant amounts of total carbon sequestered. Arid zones presently contain the lowest levels of carbon in the world on a per hectare basis, and it is necessary to consider the role of arid zone forests in carbon sequestration on a regional and global level.

7. **Soil Reclamation by *Prosopis juliflora*:** *Prosopis* litter falling on the ground adds to the humus content of the salt affected soils. The organic acids

produced from the decomposed litter react with native calcium carbonate and release calcium, which exchanges with sodium on the exchange complex. Being highly tolerant to soil sodicity, the *Prosopis* roots open up otherwise impermeable sodic soil and thus facilitate entry of water in the deeper layers. The carbon dioxide released by its roots during respiration interacts with water and produces weak acids like carbonic acid. Such acid facilitate dissolution of precipitated calcium carbonate already present in sodic soils. Thus, help in reclamation of the sodic soil. It reclaims the soil to such an extent that agricultural crops can be grown without amendments (Singh, 2008).

8. *Prosopis juliflora* combating desertification: Desertification is an international problem and *P. juliflora* is solution to this. No single species should ever be seen as the sole answer but rather as a tool in the continuing fight against desertification, land degradation and resource depletion. Shelterbelts of *P. juliflora* and *P. pallida* are planted around fields in many semi-arid regions to reduce wind speed. This reduces wind-induced soil erosion, decreases desiccation by reducing transpiration and consequently increases plant and animal production. Shelterbelts can comprise one or more rows of trees, commonly three but up to ten. In India, shelterbelts of *P. juliflora* were found to have a positive effect in reducing soil erosion compared with other species and control plots. Gupta et al.

(1983) noted a 36% reduction in the magnitude of wind erosion behind *P. juliflora* shelterbelts. Shankarnarayan and Kumar (1986) noted a decrease in area wind speeds of 33-38%, 17-26% and 12-21% at distances of 2, 5 and 10 times the height of the trees, with consequent reduction in the quantities of soil removed by erosive forces. In Sudan, wind speed was reduced by an average of 14% inside *P. juliflora* plantations, and with reductions up to 36% at high wind speeds (El Fadl, 1997). Seed disposal of this species on vast areas has helped natural regeneration and produced significant results in creating green belts and windbreaks to check the rapidly spreading problem of desertification.

Conclusion

No species in the nature is useless; we need to just find out their utilities. The countless uses of *P. juliflora* have put it in the category of species of economic importance. Gone are the days when *Prosopis juliflora* was called for nothing more than a useless weed. Due to its multiple uses, it has gained public acceptance as a plant of recognized economic value. Today it is the tree species utilized for its each and every part in various ways on a commercial basis. However, we need to spread its usefulness far and wide so that it can be recognized by everyone. The inherent capacity to withstand in any environmental conditions (except frost) and huge productivity potentiality of *Prosopis* can be converted into an even greater asset besides generating tremendous local employment opportunities and numerous benefits through application of scientific and technical methods.

Reference

- Azam MM, Tewari JC, Singh Y and Roy MM. 2011. *Prosopis juliflora : A Rich Source of Antioxidant Product*. Folder published by Central Arid Zone Research Institute, Jodhpur
- El Fadl MA. 1997. Management of *Prosopis juliflora* for use in agroforestry systems in the Sudan. Tropical Forestry Reports 16. University of Helsinki, Helsinki, Finland.
- Gupta JP, Rao GGSN, Gupta GN and Ramana Rao BV. 1983. Soil drying and wind erosion as affected by different types of shelterbelts planted in the desert region of western Rajasthan, India. *Journal of Arid Environments* 6:53- 59.
- Gupta RK and Balara GS. 1972. Comparative studies on the germination, growth and seedling biomass of two promising exotics in Rajasthan desert (*Prosopis juliflora* (Swartz) DC and *Acacia tortilis* (Forsk.) Hayne ssp. *tortilis*). *Indian Forester* 98:280-285.
- Harsh LN and Tewari JC. 1998. *Prosopis* in the arid regions of India: Some important aspects of research and development. In: Tewari, J.C., Pasiecznik, N.M., Harsh, L.N. & Harris, P.J.C. (eds.) *Prosopis* species in the arid and semi- arid zones of India. Prosopis Society of India and the Henry Doubleday Research Association, Coventry, UK.
- Harsh LN, Tewari JC and Sharma NK. 1996. Performance of *Prosopis* in arid region of India. In : *Prosopis Semi-arid Fuel Wood and Forage Tree – Building Consensus for the Disfranchised*. Texas A & M University, Kingsville, Texas, USA pp. 4/21-4/34.
- Krochmal A, Paur S, and Duisber P. 1954. Useful native plants in American southwestern deserts. *Economic Botany*, 8:3-20.
- Madan RN and Tandon B. 1991. Utilisation of some of plantation, agro-forestry and social forestry species for the production of dissolving pulps. *Indian Forester* 117:29-36.
- Muthana KD and Arora GD. 1983. *Prosopis juliflora* (Swartz) D.C., a fast growing tree to bloom in the desert. Central Arid Zone Research Institute, Jodhpur, 342 003, India. 21 pp.
- Muthana KD. 1985. *Prosopis juliflora* (SW) DC, a fast- growing tree to blossom the dessert. In: Habit, M.A. & Saavedra, J.C. (eds.) The current state knowledge on *Prosopis juliflora*. FAO, Rome, Italy.
- Patel VJ (Ed.). 1986. The Role of *Prosopis* in Wasteland Development. Jivrajbhai Patel Agroforestry Center, Surendrabag, Gujarat, India.
- Rawat MS, Uniyal DP, Vakshasya RK. 1992. *Prosopis juliflora* (Swartz) DC: Fuel, fodder and food in arid and semi-arid areas: some observations and suggestions. *Ind. J. Forest.* 15, 164–168.
- Reddy CVK. 1978. *Prosopis juliflora*, the precocious child of the plant world. *Indian Forester* 104:14-18.
- Rocha RGA. 1990. *P. juliflora* as a source of food and medicine for rural inhabitants in Rio Grande do Norte.. In: The Current State of Knowledge on *Prosopis juliflora*. (Eds.) M. A. Habit and J. C. Saavedra. FAO, Rome, Italy, pp. 397-403.
- Shankarnarayan KA and Kumar S. 1986. Aerial seeding of sand dunes I. Trends in seed germination and seedling distribution. *Journal of Tropical Forestry* 2:4-20.
- Singh, Gurbachan. (2008). Managing *Prosopis* for livelihood security in salt affected and dry areas. Technical bulletin No. 10. Central Soil Salinity research Institute, Karnal, India
- Tewari JC, Harris PJC, Harsh LN, Cadoret K and Pasiecznik NM. 2000. *Managing Prosopis juliflora (vilayati Babool) – A Technical manual*. CAZRI, Jodhpur and H. D. R. A., Coventry, UK, 96 p.
- Tewari, DD 1998. *Economics and Management of Non-timber Forest Products: A Case Study of Gujarat, India*. Oxford and IBH Publishing Co. PVT. Ltd, New Delhi, Calcutta, India.
- Vimal OP and Tyagi PD. 1986. *Prosopis juliflora*: chemistry and utilization. In: *The Role of Prosopis in Wasteland Development*. (Ed.) V. J. Patel . Javrajbhai Patel Agroforestry Center, Surendrabag, Gujarat, India. pp. OVP1-OVP8.