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SOUTH ASIAN ASSOCIATION FOR REGIONAL COOPERATION

Human-Wildlife Conflict in the Mountains of SAARC Region
Compilation of Successful Management Strategies and Practices

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Mountain Ecology Division
SAARC Forestry Centre
Thimphu, Bhutan
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Foreword

Human-Wildlife Conflict (HWC) occurs when the wildlife's requirements overlap with those of human populations, creating costs to residents and wild animals. It is more serious where wildlife population density is higher and habitats are fragmented. Such conflicts are becoming more prevalent as human populations increase and diversify, development expands, resources shrink, the global climate changes, and other factors increase the human-wildlife interface.

The problem is more serious in the SAARC region as the costs are more severe because of dense rural human population with considerably low income levels. Human Wildlife Conflicts is perceived as the major cause of poverty in rural Bhutan and the situation is not very different in other parts of the SAARC region. The economic losses due to small animals are also quite significant especially in the mountains.

If sustainable solutions for wildlife and people are not adequate, local population develops negative attitudes towards forests and wildlife, exacerbating the conflict and undermining conservation efforts. Hence, it is necessary to ensure that conservation solutions are socially, ecologically, economically and politically robust and sustainable. The SAARC Forestry Centre intended to identify and publish the successes from the SAARC region achieved in the field of Human-wildlife conflict resolution.

Six success stories presented here cover a wide range of innovative HWC resolution models dealing with early warning systems, sterilization efforts, effective and cheaper electric fencing, other barriers, offsetting economic losses through damage compensation and insurance, conservation education and economic incentives.

I would like to thank the authors for their valuable contribution and also appreciate the team at the SAARC Forestry Centre for having put in considerable efforts in screening the various papers received, selecting and editing the same to meet the format of this publication.

We hope that this publication titled 'Case studies on successful resolution of Human-Wildlife Conflicts in the mountains of the SAARC Region' would be useful to a range of stakeholders in the SAARC region as well as across the world for gaining insight, replication and further development.

Sangay
DIRECTOR

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FABRICATED ELECTRIC FENCING (FEF) SYSTEM: A NEW APPROACH TO MITIGATE HUMAN-WILDLIFE CONFLICT IN BHUTAN

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Summary

Crop depredation by wild animals is one of the most important Human Wildlife Conflict (HWC) faced by the Bhutanese farmers. The conflict has direct and indirect consequences in terms of household food security, livelihoods and socio-economic condition of the rural farmers. Some of the indicators of these problems are increasing rate of abandoning agriculture land and rural-urban migration. To address this important issue, RDC-Wengkhar in collaboration with NPPC and RDC-Yusipang has developed a model of electric fence, which includes imported IEC certified energizer and locally fabricated fencing materials as well as locally innovated fence designs for different problem species of animals. It is found to be safe for both human and wild animal as well as cost effective and socially acceptable technology for the Bhutanese farmer to mitigate human wildlife conflict. Recently Bhutan Electricity Authority (BEA), Bhutan Power Cooperation (BPC), Bhutan Standard Bureau (BSB) and the Ministry of Agriculture and Forests (MoAF) have approved this technology to be used as one of the crop protection methods. Now the efforts are being made by various concern agencies/institutes (government, NGOs and private enterprises) to promote this technology in the farmers' field to mitigate Human-Wildlife Conflict. The same technology and the approach could be shared and promoted in the SAARC neighbouring countries, where they face similar situations.

Key words: Fabricated electric fence (FEF); human wildlife conflict; energizers; insulators

I. Introduction

About 69% of the total Bhutanese population live in rural areas and they earn their livelihood by engaging in agriculture and livestock related activities. Among various constraints and challenges in agriculture, the crop depredation by wild animals (such as wild pigs, monkey, barking deer, sambar deer, wild elephants, Himalayan black bear and porcupine) is single most important human wildlife conflict (HWC) issue faced by the Bhutanese farmers. Farmers have to guard their crop on an average of 3-4 months annually and crop guarding is a routine farming activity in almost all farming communities in Bhutan (Chhetri et al, 2013). Despite practicing vigorous crop guarding, farmers lose on an average of 30-70% of the crop annually to the wild animals (Agriculture Statistics 2010). In some cases crop loss can be as high as 100% in certain crop like maize and potatoes in the event that the farmers failed to or forgot to guard their field even one night or a day (Penjor et al, 2010). Earlier, many studies have shown that crop damage by wild animals was one of the main causes of fallowing of agricultural land and rural urban migration. This is because most Bhutanese youth including farmers opted for non-farming

activities as they do not fancy village life that will be spent guarding crops against the wild animals (Kuenselonline, 2010)

The Royal Government of Bhutan had been persistently trying its best to mitigate the conflict through discussion and deliberation in many forums and at various levels including the Parliament. Various mitigation strategies such as crop compensations and crop insurance scheme were tried and promoted. Other methods like snaring, culling, trapping of wild boars, using sound and light repellents including expensive commercial electric fence system have been repeatedly experimented in the farmers' fields on pilot scale. Few were proven successful in areas where they were tried but methods like snaring, culling and trapping were found not so compatible to our Gross National Happiness (GNH) Philosophy as well as to Nature Conservation rules and regulations. At the same time, besides using traditional crop guarding methods, the farmers also innovated various new methods to keep away wild animals from their farms. For example use of dummy tiger (Fig 1) to imitate as a predator for monkeys to prevent monkeys from entering into farm is quite popular and proved successful in certain villages in the eastern region (Kuensel 2011). However, farmers' recent innovation of trapping electricity directly from the home supply and taking to the agriculture field proves to be bad innovation because it causes high risk of electrocuting both humans and animals beside it being an illegal practice. This practice was started past few years back in some villages in the east and began to be employed in most regions in the country. Due to such practice, the incidences of electrocution of humans, livestock as well as wild animals are on rise every year. Some of these incidences were occasionally reported in the media but many remained unreported possibly due to lack of proper monitoring system and also fear of repercussion and other negative consequences from the concerned authorities (Wangdi, 2013).

Figure 1.Use of dummy Tiger to scare away monkey from the field

Based on the experiences from other countries and some trial results within the country, it was learnt that with the use of standard electric fencing system could effectively control most crop raiding wild animals without putting such risk for both human and animals. But the gap remained in the availability of the affordable electric fence materials and the expertise to build proper electric system under Bhutanese conditions. The overall cost of bringing external expertise and import of commercial electric fence materials was found too expensive for Royal Government of Bhutan to realize its potential to be used as crop protection method. Against this background, the concept of Fabricated Electric Fence (FEF) System was initiated in 2006 by Renewable Natural Resource-Research and Developmental Centre, (RNR-RDC) Wengkhar in collaboration with other agencies under the Ministry of Agriculture and Forests. The main objective of FEF project was to develop safe and cost effective electric fence system, where average Bhutanese farmers can afford to install in their field. After years of research, it was finally achieved mainly by using readily and locally available fencing materials wherever possible and developing local expertise

in electric fencing. It is found to be safe and effective to control almost all crop raiding animals and also cost effective compared to other crop protection methods. Some of the salient features of locally fabricated electric fence (FEF) system are discussed as follows.

II. Silent features of FEF

1. Safety aspects of Fabricated Electric Fence system

FEF has been tested more than five years in different locations across the country for different species of wild animals. It was found safe for both human and animals at the same time very effective to deter most crop raiding animals (Fig. 2). It has also gone through vigorous safety tests by authorities like Bhutan Electricity Authority (BEA), Bhutan Power Cooperation (BPC) and Bhutan Standard Bureau (BSB) (Fig. 3) before it was approved in 2013. To further reinforce the safety aspects of the FEF the following procedures and measures were adopted and were being followed:

- Mandatory to use IEC-60335-2-76 (International Electrotechnical Commission) certified energizers in FEF which is currently being imported from China.
- In any electric fence system, electric shock is used to deter animals or the people. The level of safety is mainly associated with the amount of electric energy that is released by the energizer. Higher power energizers are always more risky than lower powered ones. Therefore, in FEF system it was decided not to use energizers whose output energy is greater than 5 Joules. It will be strictly monitored by Bhutan Electricity Authority (BEA) and Bhutan Standard Bureau (BSB).
- If the energizers are to be powered by electricity, the installer of the FEF should consult the appropriate authorities BPC and BEA and get approval before installation of electric fence.
- Wherever the electric fence were installed, precautions and warning signboards has to be installed mandatorily to minimise the risk for general public from getting accidental electric shock from the FEF system. Ministry of Agriculture and Forests has to create awareness to general public on the safety aspect of electric fence.

Figure 2. Women testing electric shock from the FEF installed in their village

Figure 3. Demonstration of safety aspects of FEF to regulating autoritie

2. Cost parameters as an indicator of effectiveness of FEF

One of the important features of the FEF is its cost per kilometer length of fence. The average cost of four-strain of FEF was about Nu 30,000-35,000/km (490-570 USD) for line powered and Nu 40,000-45,000/km (655-735 USD) for the solar powered system. When compared to various fencing types (Fig 4), FEF is 125% cheaper than 6 strained barbed fence with wooden post, 163 % cheaper than 6 strain barbed fence with MS (Mild Steel) angle post, 174% cheaper than commercial solar electric fence with MS angle post and 181% cheaper than GI chain link fence with MS angle post.

One of main cost cutting factors in FEF is the use of fencing materials such as GI (Galvanized Iron) wire, nails, HDPE pipe insulators and earthing materials which are readily and cheaply available in the local markets. Once trained on how to fabricate the materials, any individual farmer in the village can fabricate the fencing materials (Fig.5). This practice would make farmers self-reliant and farmers need not have to depend upon the commercial companies for certain accessories. The other cost cutting factors is the use of wooden posts which are abundantly available in most villages. In commercial type of electric fence, none of the accessories are available in Bhutan and it has to be import from specified branded company outside Bhutan, which is why they are expensive and unaffordable to Bhutanese farmers.

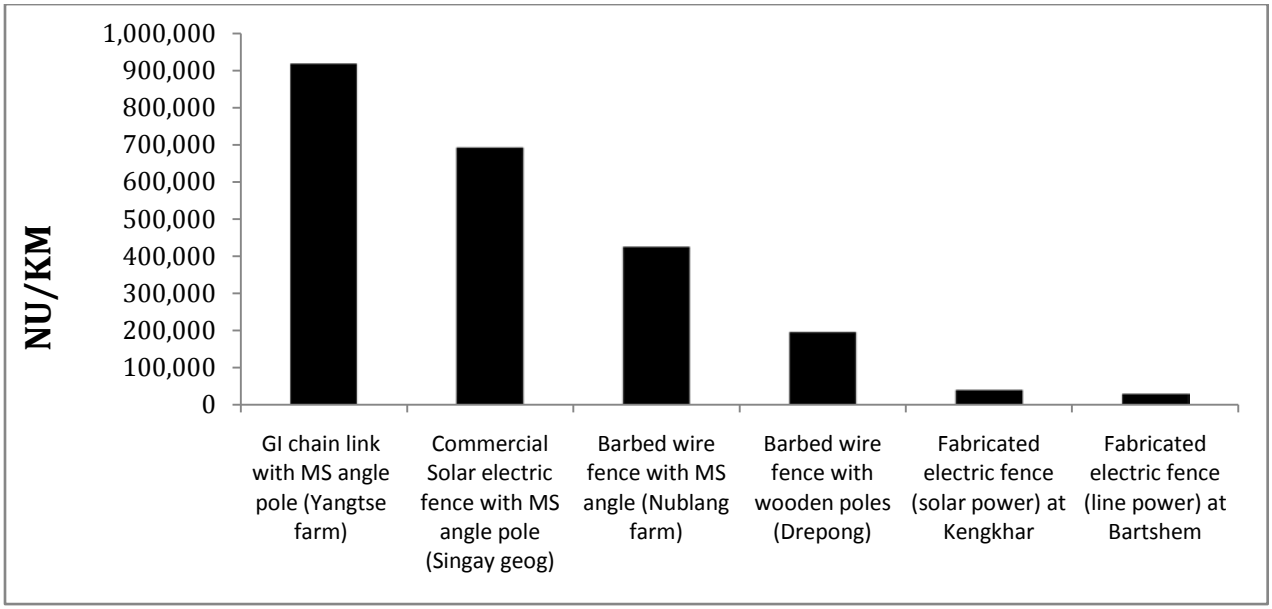

Figure 4. Cost comparison of various fencing system (Data source: Engineer section RDC-Wengkhar, WCD-MoAF)

Figure 5. Using readily available materials in FEF: Elderly women fabricating electric fence insulators using HDPE pipe and iron nails (**A**). Elderly man fixing GI wire and HDPE insulators to the wooden post (**B**); Entry/Exit gate constructed from local materials (**C**); Locally made wooden box to contain energizers, batteries and other accessories (**D**)

3. Locally innovated fence designs and its effectiveness

The effectiveness of the electric fence depends on the correct design and timely maintenance of the fence system**.** In FEF various fence designs for different problem species were being developed based on the observation of animal behaviour through camera traps and farmer's indigenous knowledge. For example, seven strain fence designs for monkey was developed after observing from camera trap on how monkey escaped from normal fence design (Fig 6 A&B). The FEF offers opportunities to the users to improve the fencing design based on animals' behaviour.

Elephants are a serious problem in the southern parts of Bhutan and are reported that they are not deterred by conventional electric fence system. However, the new design developed for elephants based on farmers' knowledge appears to be successful in keeping elephants out in some trial sites in Southern Bhutan. The design consists of one or two strains of GI wire positioned at 1.5-1.6 m from the ground supported on the wooden pole, erected at 45^0 angles from the entrance side of the field (Fig 7). The wooden post is protected by wrapping a few loops of electrified wire around the post. According to some village people, most wild elephants tend

to avoid any hanging wires because they had experienced the deadly electric shocks from live wire laid by Indian farmers/poachers near borders when they migrate to Indian side. For other animals like wild pig, Bear, Deer, Porcupines and stray cattle, four to five strains of GI wires were enough to control them effectively (Fig 8).

Figure 6. Design for Monkey: Monkey escaping from initial design (A). New design developed for Monkey (B)

Figure 7. New electric fence design for wild elephant in Singay Geog

Figure 8. electric fence design for wild boar, deer, bear and cattle

4. FEF as community managed electric fence system

Most of the available literature and success stories on the use of electric fence system to mitigate HWC are mostly from the private or the project managed electric fence systems. There is little or no information on success and failure of community managed electric fence system elsewhere. The FEF is essentially promoted as community managed electric fence system for the following reasons:

- In most villages, the settlement areas and agriculture land are clustered together and it is easier to install electric fence along the common boundaries and managed by the community.

- Less fencing materials are required to fence the common boundary than fencing individual farms, which saves money and time.
- When whole community is involved, there will be more labour force to complete the works (especially installation) on time.
- When whole community is fenced its collateral effect (moving animals from fenced area to non-fenced area) is minimized.
- This model (community managed electric fence system) basically follows public private partnership (PPP) model in which during initial installation, government or projects provides initial cost to procure essential fencing materials: energizer, battery, GI wire, HDP pipes for insulator, solar panels etc., and community contributes: labor and the wooden posts. After completion of installation of FEF, it is handed over to the community. The community manages the fence according to the by-laws and management plans agreed by majority members of the community. Apart from monitoring, the government agencies or project does not provide any financial or material support for maintenance except technical and advisory support to the community in respect to FEF.

III. Impact of fabricated electric fencing System

1. Physical impacts

From 2006 to September 2014, about 116 Km length of fabricated electric fence system was established in 13 Dzongkhags and 34 different Geogs across the country. It has benefited about 958 households and protected approximately about 1074 acres of agriculture land (Table 1) from different wild animals. Of the total length of 116 KM, about 70% of the establishments were carried out recently by Geog Extension Officers and other agriculture staffs from different Dzongkhags and central programs after they have received the training course on electric fence. About 70 agriculture staffs from various Dzongkhags and central programs and about 20 staffs from local government including school dropouts were given the hands-on training on FEF (Table 2). It is expected that this trained manpower will be the main players for up-scaling the FEF in their respective Geogs and villages.

2. Socio-economic impacts

Although no detailed and updated impacts studies had been conducted so far in those fenced areas, one study was conducted in 2012 in the Eastern Bhutan for few selected villages where FEF was established. Also in 2014, some impact assessment study was carried out in the villages where MAGIP (Market Access and Growth Intensification Program) has funded the establishment of the FEF. Those two studies concluded the following on the socio-economic impacts of FEF:

- In both studies, crop damage by wild animals was about 70-80% initially and such damages were reduced to less than 10% after the establishment of FEF. In some villages, there was report of no crops damage at all and found that farmers no longer practiced crops guarding throughout the cropping season after establishment of FEF.
- About 30-40% of the farmers in some study area re-cultivated the land that was left fallow due to wild animal damages, which resulted in increased of food sufficiency in the villages by almost 30-50% as people could spare more time for farming activities.

- Apart from the benefit of protecting their crops, other social benefits were also observed in the study (Chhetri et, 2013)
  - ❖ Women in the village got more time for caring their children, to do kitchen gardening and weaving activities since they no longer need to guard their crops. The school going children got more time for their academic studies at home as they no longer needed to assist their parents in guarding crops after school. The students' performances in their academics was said to have improved compared with non FEF sessions.
  - ❖ Household families were sleeping well at night without having to worry about their crops.
  - ❖ It was reported that there was decrease in the frequency of family disputes and community conflicts related to crop guarding and crop damages.
  - ❖ The community cohesion for community related activities became very easy after establishment of FEF

Table 1. List of the places where FEF was installed as of September 2014

Dzongkhag	Location	Fence length (KM)	No. of beneficiary	Approx. Area protected (Acre)	Purpose / Target animals to be controlled
Thimphu	Yusipang, Chang Geog	1.6	7	21	Bear & wild pig in apple orchard
	Sisina, Mewang Geog	1.0	1	13	Demo of FEF at Agriculture technology park
	Geney Geog	1.5	1	19	Wild pig & other wild animals
	Tsheluna, Mewang Geog	5.8	30	63	Wild pig & other wild animals
Haa	Katsho Geog	8.0	87	104	Wild pig & other wild animals
Punakha	Thinleygang, Tobesa Geog	0.4	1	4.5	Pilot site to control Monkey & other wild animals
Trongsa	Around Trongsa Dzong	0.3	1	0.0	Prevent monkeys entering into Dzong
	KabaDraba, Nubi Geog	6.5	21	78	Training of core groups
	Jongthang, Nubi Geog	1.5	18	20	Monkey & wild pig
Sarbang	Latshakha, Singye Geog	7.0	45	95	Elephant & wild pig
	Kamidara, Gakidling Geog	1.5	9	20	Monkey & wild pig
	Sershong Geog	0.9	14	9.0	Hare & other wild animals
Bumthang	RDC-Jakar	0.2	1	3	Demo of FEF at RDC-Jakar
Trashigang	Muktangkhar, Bartsham Geog	4.0	17	60	Wild pig & other wild animals.
	Nalung, Bartsham Geog	4.5	18	70	Wild pig & other wild animals.
	Tsebar, Bidung Geog	7.5	67	95	Wild pig & other wild animals.
	Yonphupam, Kanglung Geog	8.5	120	110	Wild pig & other wild animals.
	Tonglingpam, Radhi Geog	3.0	27	45	Monkey & wild pig
	Breng, Phongmey Geog	2.5	20	51	Wild pig & other wild animals
	Tashigang, Tseza Geog	1	60	30	Wild pig & other wild animals.

Mongar	Phosorong, Mongar Geog	0.8	1	5	Wild pig & other wild animals.
	Shajola, Kengkhar Geog	1.4	9	25	Wild pig & other wild animals.
	Atingkhar, Chaskhar Geog	1.8	30	30	Monkey & wild pig
	Gompa, Chaskhar Geog	1.0	4	10	Wild pig & other wild animals.
	Silambi Geog	1.0	5	13	Wild pig & other wild animals.
	Dedrang, Mongar Geog	0.8	1	2	Monkey & wild pig
	Negkhang, Mongar Geog	0.7	1	3	Monkey & wild pig
	Ridaza, Mongar Geog	0.8	1	3	Monkey & wild pig
	Drametse Geog	3.0	34	40	Monkey & wild pig
Lhuntse	Jalang, Minjey Geog	0.9	2	5	Wild pig & other wild animals.
	Dragong, Minjey Geog	0.9	1	2	Wild pig & other wild animals.
	Chatong, Jerry Geog	1.4	12	25	Monkey & wild pig
	Metsho, Metsho Geog	4.0	44	70	Monkey & wild pig
Tashiyangtse	Litcheen, Yangtse Geog	2.0	14	28	Wild pig & other wild animals.
S/jongkhar	Bhoney, Phuntshothang Geog	6.0	34	80	Elephant, wild pig & other animals
Pemagatshel	Wolugtang, Nanong Geog	4.0	8	50	Wild pig & other wild animals
	Guyum, Chongshing Geog	2.0	35	30	Wild pig & other wild animals
	Yegur, Khar Geog	4.0	18	45	Monkey and wild pig
	Tshelingkhor, Zobel Geog	3.0	38	40	Monkey and wild pig
	Nanong, Nanong Geog	3.6	37	45	Monkey and wild pig
Zhemgang	Kihar, Buli Geog	2.2	28	25	Monkey and wild pig
	Gomphu, Tong Geog	4.0	36	50	Monkey and wild pig
	Total	**116.5**	**958**	**1074.5**	

Table 2. No. of RNR staffs and Geog officials provided hands-on training on installation and maintenance of electric fence as of September 2014

Dzongkhag/Institutes	**No of RNR Staffs trained**	**No of Gup/ Tshokpa trained**
Pemagatshel	4 Agriculture extension	2 Tshokpas, 3 drop out students
Mongar	8 Agriculture extension	1 Tshokpa
Lhuntse	8 Agriculture extension	1 Tshokpa
Tashigang	8 Agriculture extension 18 Agriculture extension	3 Tshokpas, 1 Gup 4 farmers
Tashiyangtse	1 Agriculture extension	1 Tshokpa
Trongsa	6 Agriculture extension 3 Forestry extension	2 Tshokpas
RDC Bajo	2 Agri Staff	
RDC Bhur	2 Agri staff	
RDC Jakar	2 Agri staff	
AMC Paro	3 staff 1 RAMC Khangma staff	
NPPC Dagana	2 Plant Protection staff 1 Agriculture Extension, Tsezageog	1 Tshogpa, Tsezageog
Total	**70**	**20**

IV. Current efforts of various concerned agencies on up-scaling of FEF

1. Efforts of Ministry of Agriculture and Forests

Ministry of Agriculture and Forests (MoAF) has been putting lot of effort to scale up this technology for the benefit of farming community after the technology had been approved by Bhutan Electricity Authority and Bhutan Power Cooperation in 2013. The strategies of MoAF are as follows:

i. The guidelines along with extension manual on FEF had been developed illustrating the major features and stepwise procedures to install and maintain FEF.
ii. A task force was formed at the national level to co-ordinate various activities of electric fence.
iii. A separate unit was created under Wildlife Conservation Division under Department of Forests and Park Services to liaise issues related to FEF to relevant stakeholders. Presently MoAF is focusing on the capacity development of field staffs in handling electric fence technology as it is a new technology. Most RNR staff in the implementation level do not possess necessary skills to implement electric fencing activities in the farmers' field. Therefore, MoAF recently started the training of 'core groups' (staff from Regional Research and Development Centre and Central programs) on FEF. These trained core groups will impart trainings to the other field staff through hands on training in their respective regions (Fig 9).
iv. As part of the above mentioned material, MoAF had been developing visual media programs and being aired periodically by national television (Bhutan Broadcasting Service) for mass public awareness on electric fence.

Figure 9. Capacity development in FEF: Training for RNR Staffs (**A**); and young people in the village (B)

2. Dzongkhag and the local government efforts

Dzongkhag and the local government are playing vital role in up-scaling the electric fence technology in dzongkhags. In most Dzongkhags, they have identified and prioritized the human-wildlife conflict hotspot areas and some already reflected electric fence activities in the annual work plans. Recently some Gewogs and Chewogs also are proposing to use their Gewog Development Grand (GDG) budget for installing electric fence in the villages.

3. Efforts from Area Wide Development Projects and NGOs

Currently, some area wide development projects such as MAGIP (Market Access and Growth Intensification Program) and GCCA (Global Climate Change Alliance) provide some financial support to promote the technology in their project sites in the eastern region. In certain areas in western, central and southern regions, SNV provides some support to up scale the electric fence technology. The private companies like Mountain Hazelnut Ventures (MHV) also have already initiated and investing resources especially in capacity development to promote the same electric fencing system to their client farmers to protect their hazelnut plants from animal damages.

V. Conclusion

In last two decades, human-wildlife conflict mainly the agriculture crop damage by the wild animals have become important issues in Bhutan because of the expansion of wild animals especially the wild pigs after the wild dogs, its natural predator were deliberately poisoned in 1980s to protect the livestock. Since then, the Ministry of Agriculture and Forests faced big challenge to protect the livelihood of 69% of the Bhutanese population who depend on agriculture. The quick solutions like extirpation of problem species by shooting, culling and trapping etc., done elsewhere in the world was never the good solution to the Philosophy of Gross National Happiness (GNH). For now, fabricated electric fencing system provides the best alternatives for the Bhutanese farmers, where wild animals were not killed but prevented from entering agricultural fields. The same technology and the approaches could be shared and promoted in the SAARC neighbouring countries where they face similar situations.

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FOSTERING HUMAN–ELEPHANT COEXISTENCE IN THE VALPARAI LANDSCAPE, ANAMALAI TIGER RESERVE, TAMIL NADU

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Summary

Human-elephant conflict, leading to loss of lives of people and elephants and damage to property and crops, poses a major challenge for conserving elephants outside Protected Areas across Asia. The Anamalai hills (Tamil: Elephant Hills) is home to the second largest wild Asian elephant Elephas maximus population in India. The Valparai plateau, with 220 km^2 of tea and coffee plantations interspersed with patches of forests and Eucalyptus plantations, is a fragmented landscape home to several endangered and endemic species of Western Ghats including elephants. Extant rainforest fragments and riparian patches within tea and coffee plantations provide refuges for elephant use and movements across the plateau into surrounding protected areas. Our study since 2002 reveals that over the years about 100 elephants use plantations with consistent inter-annual movement patterns across the landscape. The Nadu Ar–Sholayar riverine system flowing through the middle of the plateau is critical for elephants, highlighting the need for developing native vegetation along the river with the involvement of local companies to facilitate free passage for elephants and minimize human-elephant interactions. There are also six major plantation companies, smaller estates, and 70,000 people who depend on plantations for their livelihood, indicating imperative for coexistence measures. Encounters with elephants that lead to human deaths and damages by elephants to buildings and food stores cause economic losses and trauma among local people and reduce their tolerance levels. Although elephants used the landscape year-round and there were seasonal peaks of conflict incidence (October - February), elephant presence and their duration of stay was not directly related to conflict. Based on spatial clusters and seasonal peaks of conflict, we have developed targeted mitigation efforts. On the Valparai plateau, human fatalities were due to unaware of elephant presence and their movements through plantations. During the study, we have implemented Elephant Information Network (EIN) that conveys advance information on elephant presence and their movements in plantations to local people to avoid any injury or fatal encounters with elephants. The information is conveyed through: (i) local television cable channel as a 'crawl', (ii) bulk SMS sent directly to local people, (iii) installation of mobile-operated elephant alert indicators (red LED lights) in strategic locations. These measures have been received positively by people and along with anti-depredation squad of the Tamil Nadu Forest Department have helped reduce incidence of conflicts during the past two and half years, with no human death due to elephants in 2013. The study reveals that simple, adaptable, and locally appropriate conflict mitigation techniques coupled with sustained efforts from stakeholders would foster human-elephant coexistence in modified landscapes.

Key words: Asian elephant *Elephas maximus*, early warning system, human–elephant conflict, plantations

Introduction

Conservation of wild Asian elephants and management of human-elephant conflict outside Protected Areas is one of the major challenges for state Forest Departments, conservation scientists, and stakeholders. In landscapes, where people and elephants share spaces, negative interactions may intensify into conflicts leading to loss of lives and damage to property and crops (Madhusudan 2003, Kumar *et al.* 2004, Fernando *et al.* 2005, Graham *et al.* 2010, Hedges and Gunaryadi 2010). Conflicts, if not addressed through appropriate prevention and mitigation measures, may also lead to decreased tolerance towards elephants among local people. Further, as few studies on African elephants (Burke *et al.* 2008, Ahlering *et al.* 2011) have revealed, human-induced pressures may increase stress levels in elephants and affect their survival in human-modified landscapes.

The Asian elephant (*Elephas maximus*) has been recognized as National Heritage animal by Government of India. Two-thirds of its population persists in non-protected areas either close to or within human-dominated landscapes and creates conditions for greater contact with people (Sukumar 1989, WWF 2000). Over the past few decades, human-elephant conflict has escalated with increasing human population coupled with hydro-electric projects, agriculture expansion, transportation networks and reservoirs within forested elephant habitats, resulting in fragmented elephant populations in Asia (Leimgruber *et al.* 2003). Elephant populations in small parcels of habitat with reduced resource availability may damage crops and human property in adjoining areas (Desai 1991, Madhusudan 2003). On average, nearly 400 people and about 100 elephants lose their lives annually besides crop and property damage due to conflicts between people and elephants in India (Rangarajan *et al.* 2010). Thus, human-elephant conflict resolution not only has scientific and conservation importance but a management and social need to retain traditional values of tolerance in people towards elephants in human-elephant relationships (Singh and Kumar 2014).

There have been various mitigation measures such as electric fences, elephant proof trenches, and early warning systems to resolve human-elephant conflict across Africa and Asia (Fernando *et al.* 2008, Graham *et al.* 2010). Nevertheless, very few of them have focused on impact of conflict mitigation measures in terms of cost-benefit ratio, functionality, feasibility of techniques, and benefits to people (Hedges and Gunryadi 2010, King *et al.* 2010, Graham *et al.* 2011, Chen *et al.* 2013). On the other hand, there is a lack of information on the efficacy of conflict mitigation techniques in terms of reduction in incidence of conflicts, sustainability, ease of adoption by local communities, and increased tolerance of people towards elephants.

The Anamalais (in Tamil: Elephant hills) in southern Western Ghats of India is an important conservation area for Asian elephants in India. These hills comprises of Tiger Reserves, Wildlife Sanctuaries, National parks, and Reserved Forests which span over 5700 km², holding the second largest wild Asian elephant population in India (Sukumar 1989, Baskaran *et al.* 2013). Over the last century, the Valparai plateau within the Anamalai hills has witnessed forest conversion that has left only remnant pockets of rainforest in a landscape dominated by commercial plantations. As this landscape is surrounded by protected areas, elephant use of these areas for foraging and wide-ranging seasonal movements (Kumar *et al.* 2010) will inevitably continue and bring the animals into contact and possible conflict with people.

In this article, we briefly explain the movement of elephants based on a four-year study carried out between 2002–2007 to understand critical areas used by elephants in the landscape, herd movements, spatial and temporal patterns of conflict incidence. Based on this research, we developed and implemented elephant early-warning systems as a pro-active conflict avoidance and mitigation measure. We describe the implementation of these systems and their effect on conflict incidence over a 3-year period between 2011 and 2014 in the Valparai plantation landscape.

Study area

The Valparai plateau, a 220 km² plantation landscape, is a critical landscape for Asian elephants in the Anamalai hills in southern Western Ghats. The plateau is a landscape matrix of tea and coffee plantations interspersed with rainforest fragments and *Eucalyptus* plantations. The Valparai plateau is in the midst of Tiger Reserves, Wildlife Sanctuaries, and Reserved Forests which form an important landscape for movement of elephants. At least 45 rainforest fragments within monoculture plantations act as refuge for elephants to move across the plateau (Mudappa and Raman 2007, Kumar *et al.* 2010, Mudappa *et al.* 2014, Figure 1). The plantations on the Valparai plateau belong to six major companies, a few smaller estates, and individual owners. As per 2011 census, the Valparai plateau has a human population of around 70,000 people and a majority of them have been working in tea and coffee plantations (Census of India, Ministry of Home Affairs 2011). As elephants use the landscape along with people whose livelihood depends on plantations, interactions and encounters may lead to human-elephant conflicts (Kumar *et al.* 2004). Resolving conflicts requires efforts to promote coexistence between people and elephants through pro-active, innovative measures with the active involvement of local stakeholders including the Tamil Nadu State Forest Department, plantation management, estate workers, conservation groups, and other citizens.

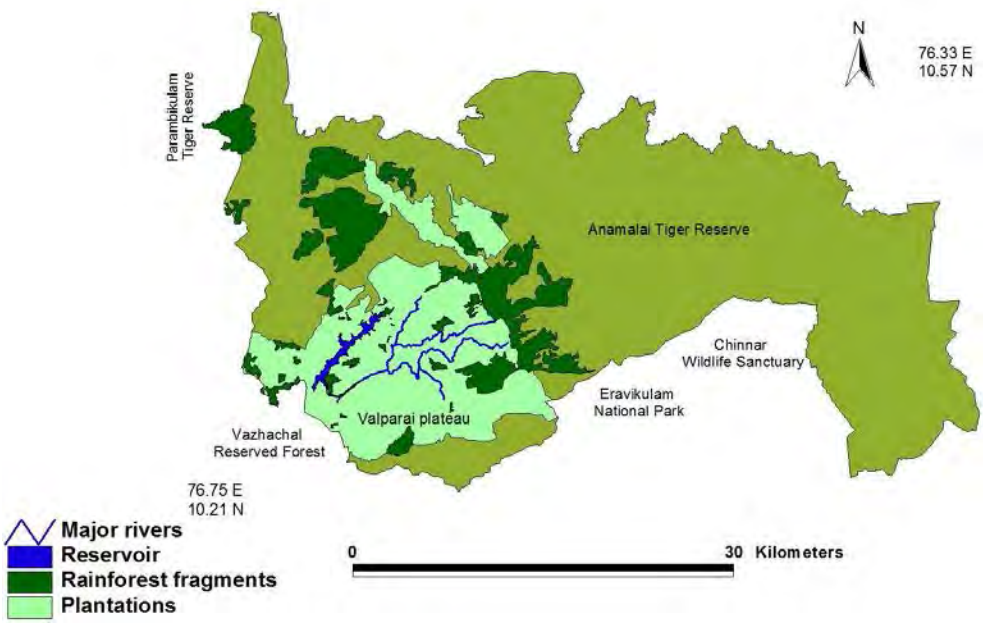

Figure 1. Map of Valparai plateau (light green) with rainforest fragments (dark green) and surrounding protected areas (green)

Tracking elephants and incidence of conflicts

Direct surveys, indirect signs such as feeding, dung, fresh tracks along movement paths, and information from local informants were used to detect elephants and record their movements on the Valparai plateau. Each individual elephant or herd detected were followed through plantations until they entered surrounding protected areas. Elephants in regular herds were identified based on age-sex composition, physical markings such as lumps, tears, ear shape, ear folding, degree of ear folding, tail length, tusk length and shape, herd size, age-sex composition, position of the young in relation to mother (Moss 2001, Kumar and Singh 2010). Habitat parameters such as habitat type, distance to nearest forest fragment, distance to nearest human settlement and plantation types were noted. Elephant locations (recorded on GPS units) were plotted on the study area map to understand critical areas of use and movement patterns across plantations (Kumar *et al.* 2010). Conflict incidents were recorded by visits to damage sites, where we noted information on date, place, time of incident, habitat type, GPS location, type and cost of material loss, records of injury or death of people, if any (Kumar *et al.* 2004).

Results and Discussion

Role of natural vegetation

We found that around 80 – 100 elephants use the Valparai plantations annually with three herds (around 45 - 50 elephants) that regularly spent about 8 – 10 months in a year on the Valparai plateau. Presence of natural vegetation in the form of rainforest fragments and riverine vegetation played a crucial role as habitat refuges, providing space for resting and foraging, and facilitated elephant movements across the plateau (Kumar *et al.* 2010). Tea, an open habitat, is primarily used by elephants to move between forest fragments. Our long-term research clearly indicates that the Nadu Ar – Sholayar riverine system, which flows in the middle of plateau forms a critical area for elephants to move across surrounding Protected Areas (Figure 2). Growing natural vegetation on either side of river with a width of 10 m would facilitate easy passage for elephant and minimize interactions with humans thereby reducing human-elephant conflicts on the Valparai plateau.

Human-elephant conflicts

Widespread human habitations and high human densities in the Valparai landscape witnessed regular movement of elephants and led to negative interactions in the form of episodic loss of human lives due to accidental encounters or damages to property. Property damage by elephants occurred mainly to ration shops and school noon-meal centres where food grains such as rice and lentils, salt and sugar were stored. As these food grain stores were either within estate worker's residential colonies or close to human habitations, damages also occurred to adjoining residences, causing fear and trauma among local people. Based on identification of these conflict-prone stores and buildings, specific recommendations were made to plantation companies and State Forest Department for conflict mitigation, and some of implemented measures were the following:

a. Ration shops that were attached to estate worker residences were moved to separate buildings that could then be better protected, which improved overall safety.
b. Storage of food grains in school noon-meal centres was discouraged which resulted in reduced incidences of damages to school kitchens by elephants.

c. Some companies insured buildings from damage, and as damage was offset by payments received for insurance claims, this reduced economic loss and requests for compensation from State Forest Departments
d. The State Government is pursuing a proposal for mobile ration stores and distribution to local people
e. Food grains was kept in more secure centralised stores and brought to distribution centres only on specific days, after which the store was cleaned and kept empty.
f. A few buildings, bungalows, and residential colonies were protected using small electric fences (instead of fencing off large areas of estate), which reduced costs of fencing and provided targeted protection

There is no damage to tea crop as it is non–palatable and negligible amount of damage to coffee bushes by elephants was noticed in plantations.

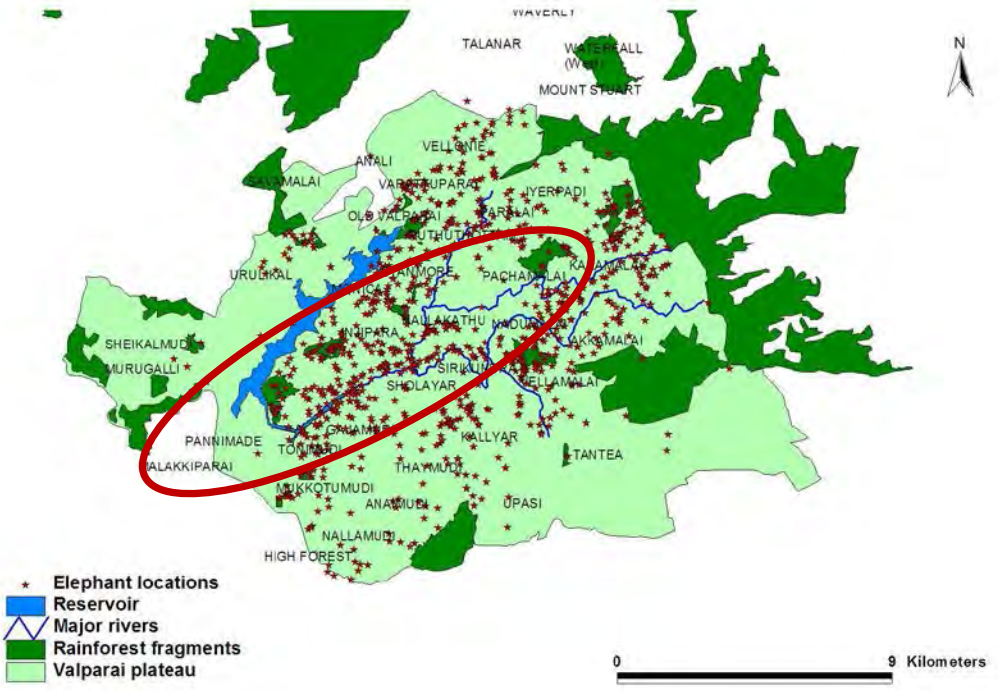

Figure 2. Distribution of elephant herd locations (red stars) on the Valparai plateau. High concentration of locations along Nadu Ar and Sholayar riverine system (red circle) in the middle of plateau forms critical habitat for elephant movements.

Human deaths due to elephants

Avoiding loss of life due to elephants is a critical aspect of human – elephant coexistence measures, as loss of life triggers anger, fear, and antagonism among local communities towards elephants. Execution of human-elephant coexistence measures with the involvement of local communities has far-reaching positive impacts in reducing pressures on elephants while fostering tolerance in local communities towards elephants.

There were 41 human deaths due to accidental encounters with elephants between January 1994 and September 2014. Most people (66%, 27 out of 41 incidents) lost their lives during a three-

month period between December and February which denotes peak conflict period within the year (Kumar and Raghunathan 2013). Investigating the circumstances of human deaths clearly reveals that most deaths (31 out of 41) occurred during unexpected encounters (people unaware of presence of elephants and encountering them when outdoors) and lack of safety at work and home. Nearly 72% of human death incidents (29 out of 41 incidents) occurred on main or estate roads. This suggested that conveying early intimation about elephants and their movement to people in plantations may help prevent unexpected encounters. In 36 out of 41 cases, lack of early warning was the primary cause for loss of life. The other fatal encounters were due to inebriation, misjudgement of elephant movement, and ignoring advance intimation. Thus, the conflict mitigation on the Valparai plateau would require:

- An '*early intimation*' to communicate about elephant presence and their movements to people as a measure to avoid direct encounters
- Provision of '*in-house'* warning systems in selected localities along elephant movement routes
- *Adequate coordinated efforts* by stakeholders in the management of human-elephant conflict on the Valparai plateau

Implementation of early warning measures

During the past several years, the Nature Conservation Foundation in cooperation and support from the Tamil Nadu State Forest Department and plantation companies have been implementing early warning systems to develop an effective *Elephant Information Network* (EIN) in the Valparai region in the following three ways:

1. **Use of Television network**: Location and tracking of elephants is carried out by a team comprising of indigenous people as a part of Conflict Response Unit (CRU), besides Forest Department field staff and local people. This information on elephant location is displayed as a 'crawl' on local cable TV channels after 5 PM on a daily basis to reach out to people as an early elephant intimation system. Currently, the cable channel covers nearly 5,000 families on the Valparai plateau.

2. **SMS service**: Bulk SMS service was initiated to send out text messages about elephant presence and their movements within plantations to people who are willing to receive information on their mobile phones. On a daily basis, these messages are sent in English and Tamil to people residing within a 2 km radius of the location of the elephant herd (Figure 3). The 2 km radius was chosen based on our long-term research because of the high likelihood (> 80%) that elephants would move within that distance over a 24-hour period.

Figure 3. Advance intimation about elephant presence over bulk SMS to people through short message service

Our recent analysis of people's response calls to the SMS initiative reveals that this measure has been extremely helpful and serves as a timely alert to the presence of elephants, allowing people to take adequate precautions to avoid direct encounters with elephants and safeguard property. It has also enabled multi-way communication between the conservation group, Rapid Response Teams of the Forest Department, and people by creating a “My Message” attitude among local communities.

3. **Installation of elephant alert indicators**: Mobile operated LED-light alert indicators were installed in 24 locations to signal the presence of elephants and their movements within a 1km radius of each light (Figure 4). These indicators are equipped with a SIM card and fitted with red flashing LED bulbs on a 10 m long pole and are located in strategic places that are visible from up to 1km away. Each light can be operated from any of three registered mobile phones. At least two persons from every “light locality” are registered with each light and are responsible for activating these lights when information regarding elephants is passed onto them. During the last two years, on an average, after the initial month of installation and training, the local community itself operated the lights 98% of the time. Additional areas were covered with voice-based elephant alert indicators by the Forest Department to widen the network of early warning to local people.

Other measures such as Rapid Response Teams from the Tamil Nadu Forest Department have been critical in reaching out to elephant locations and safeguarding people and property.

Figure 4. Mobile operated alert indicators for commuters in a residential colony in a tea estate indicating elephant presence in a kilometre radius from the light in the Valparai region. Photo: Kalyan Varma

Effectiveness of early warning systems

Reduction in incidence of property damage across years

Presence of elephant herds have been noticed throughout the year on the Valparai plateau. The number of days spent by multiple elephant herds or a single herd split into multiple sub-herds/solitary individuals (elephant herd-days) gradually increased from between Year 1 (2011 – 12, 658 elephant herd–days), Year 2 (2012 – 13, 1756 elephant herd–days), and Year 3 (2013–14, 1926 herd–days). Number of days spent by different elephant herds appeared to be higher during relatively dry period of November – April in Year 1 (n = 404 herd-days, 61.4%), Year 2 (n = 1139 herd-days, 65%), and Year 3 (n = 1279 herd-days, 66%). However, no statistical difference was noticed in time spent by elephant herds between dry and wet seasons across years (χ^2= 5.44, df = 2, p >0.05). Overall, number of conflict incidents decreased by 41% in Year 2 (n = 88) and 35% in Year 3 (n = 97) as compared to the Year 1 (n = 150). Damages to property by elephants were low across many months in Year 2 and Year 3 as compared to Year 1 but peaking between November and January (Figure 5). However, duration of elephant herds' was not significantly related to occurrence of conflicts on the Valparai plateau (r = 0.21, df = 34 , p >0.05).

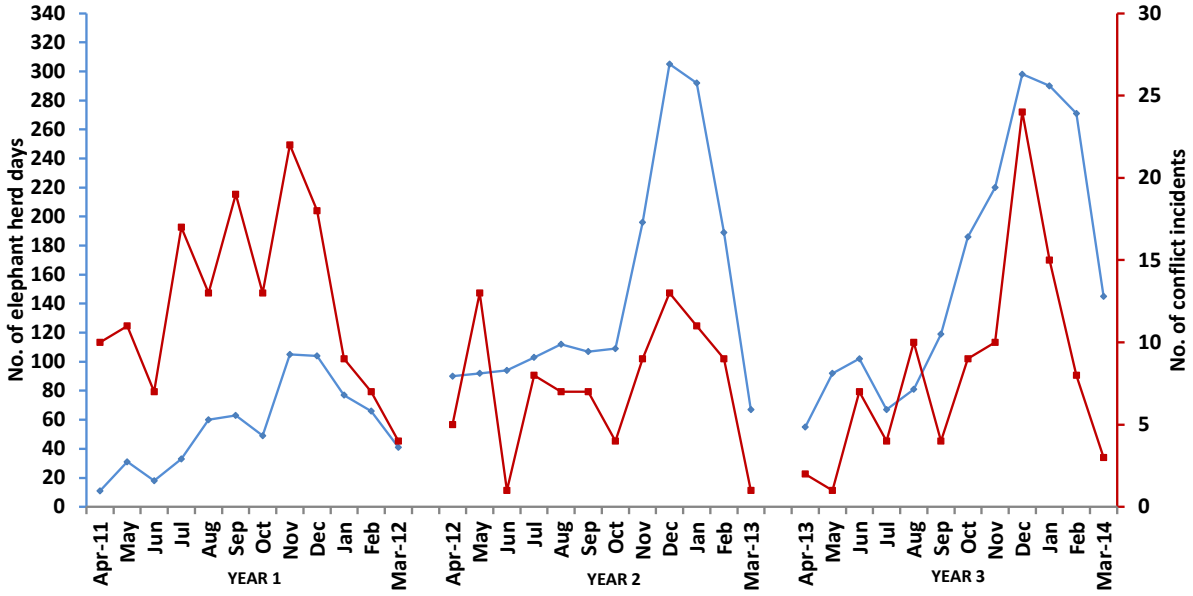

Figure 5. Monthly distribution of incidents of property damage by elephants and elephant herd-days over a three year period on the Valparai plateau

On the Valparai plateau, two ecological factors seem to determine elephant densities. One, during transition period from wet to dry, availability of fresh grass in swampy areas of tea and coffee plantations attracts elephants to spend more time in relatively open areas. Secondly, availability of water in rivers and streams passing through swampy regions of plantations and rainforest fragments on the plateau would influence elephant distribution. When elephants use these habitats for water or forage, human disturbance such as chasing of elephants may affect forage and water intake, behaviours such as feeding, resting, play etc., and may also lead to

break-up elephant herds into small sub-herds, thereby aggravating incidence of conflicts (Kumar and Singh 2010).

The decrease in number of incidents in the Year 2 and Year 3 from Year 1 is largely attributed to the efforts taken by the Forest Department field staff to safeguard property, timely intimation of communication about elephant presence, and cooperation of plantation companies and local people. However, steps should be taken to shift ration shops and noon-meal centres at least 100m away from habitations, change in food storage patterns coupled with adequate protective measures around food grain stores, and allowing elephants to move across plantations with no disturbance would further reduce incidences of property damage by elephants.

Reduction in human fatal encounter incidents

Intensive tracking of elephants and advance intimation through early warning systems to people for the past three years have been positively received by people. Collective efforts by the Forest Department and conservation organizations with the help of technological interventions resulted in gradual decrease in human fatalities from 2011 to 2013 with no incident of human death or injury due to elephants noticed in 2013 (Figure 6). However, there were two fatal incidents in February 2014. Circumstantial evidence indicates that one death occurred due to ignorance of early warning information and the second incident was due to fatal injury sustained while running away in panic and not due to direct attack by elephants. These incidents highlight the necessity to carry out sensitization programmes and communicate precautionary measures through interactive meetings with estate people.

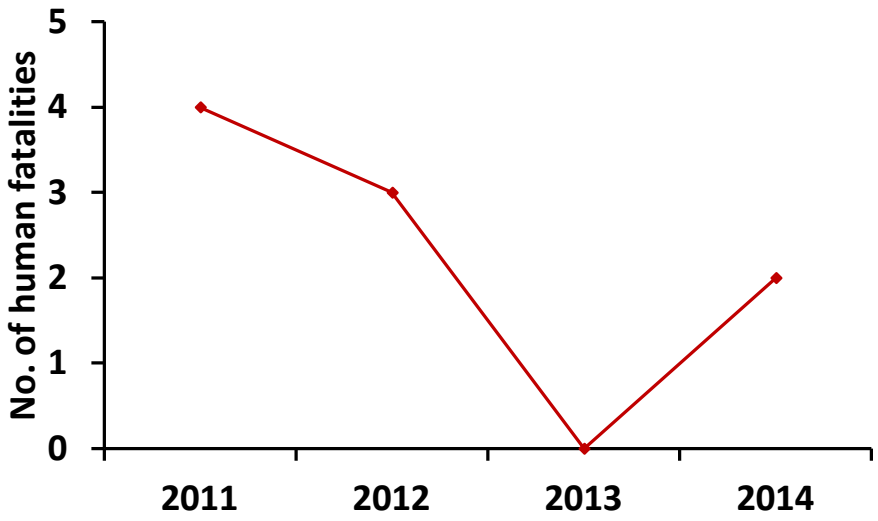

Figure 6. Distribution of human deaths due to elephants across years. Reduction in number of fatal encounters as result of early warning systems on the Valparai plateau

These human-elephant coexistence measures, particularly bulk SMS service, need to be strengthened by institutionalizing these measures for long-term sustainable implementation through the Forest Department. This will enable sustainable and effective avoidance of fatal incidents, reduce property damage by elephants and promote long-term coexistence. Unlike in many other places where incidences of human-elephant conflict are on rise, there has been a down-trend in occurrence of property damage and loss of human life due to elephants on the

Valparai plateau. Such collective efforts by stakeholders, Forest Department, and conservation and scientific organizations would further enhance human-elephant coexistence in the Valparai region. As a long–term measure, there is a need to protect existing rainforest fragments along elephant movement areas by declaring them as satellite elephant reserves and developing natural vegetation along Nadu Ar and Sholayar river with the involvement of plantation companies, which would minimize human-elephant interactions on the Valparai plateau. This study highlights the importance of long-term research and monitoring of elephants and developing science-based mitigation techniques that are locally adaptable and suitable that can be implemented with the involvement of stakeholders in order to achieve effective management of human-elephant conflict and promote coexistence (Kumar and Raghunathan 2013).

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M. Ananda Kumar is a Scientist at the Nature Conservation Foundation. He has been involved in wildlife research and conservation of mammals for over 20 years. His PhD in Psychology involves studying Asian elephant use, movements, and their behaviour and conflicts with people in a human-dominated landscape in the Anamalai hills in southern India. This work led to on-ground implementation of innovative measures to minimize conflicts between people and elephants. These measures have been recognized and are being promoted by the Tamil Nadu State Forest Department. This work was honoured by the prestigious Carl Zeiss Wildlife Conservation Award in 2012. His work features in the academia in the form of 20 peer-reviewed scientific papers and several technical reports. Ananda Kumar is currently involved in understanding human-elephant interactions across forest-farm landscapes in India.

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MANAGING CONFLICTS OVER LIVESTOCK DEPREDATION BY LARGE CARNIVORES

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Summary

Managing wildlife-caused damage to human interests has become an important aspect of contemporary conservation management. Conflicts between pastoralism and carnivore conservation over livestock depredation pose a serious challenge to endangered carnivores worldwide, and have become an important livelihood concern locally. Here, we first review the primary causes of these conflicts, their socio-ecological correlates, and commonly employed mitigation measures. We then describe a community-based program to manage conflicts over livestock depredation by snow leopards Panthera uncia and wolves Canis lupus. A threats-based conceptual model of conflict management is presented. Conflicts over livestock depredation are characterized by complex, multi-scale interactions between carnivore and livestock behavioral ecology, animal husbandry, human psyche, culture, world-views, and socio-economic and education levels of affected peoples. A diversity of commonly employed conflict-mitigation measures is available. They aim at (i) reducing livestock depredation through better livestock herding, use of physical, chemical or psychological barriers, removal of carnivores, and use of livestock guard animals, (ii) offsetting economic losses through damage compensation and insurance programmes, and (iii) increasing peoples' tolerance of carnivores through indirect approaches such as conservation education and economic incentives. For effective management, conflicts need to be understood along two important dimensions, viz., the reality of damage caused to humans, and the psyche and perceptions of humans who suffer wildlife caused damage. The efficacy of commonly used mitigation measures is variable. A combination of measures that reduce the level of livestock depredation, share or offset economic losses, and improve the social carrying capacity for carnivores will be more effective in managing conflicts than standalone measures

Key words: Snow leopard *Panthera uncia*, wolf *Canis lupus*, Himalayas, Central Asia

Background

Effectively managing conflicts over wildlife-caused damage to human welfare is a global conservation challenge (Woodroffe, Thirgood & Rabinowitz 2005a). The most widespread forms of conflict arise from damage to crops and property by wild herbivores, killing of livestock by large carnivores, and, sometimes, injury or even loss of human life caused by large-bodied wildlife (Madhusudan & Mishra 2003). The costs of these conflicts are generally disproportionate on local communities who live alongside wildlife and share natural resources with them. Conflict management is particularly difficult in developing and underdeveloped economies because on the one hand, the human communities involved often represent the poorest sections of the society, while on the other, the carnivore species involved are often

highly threatened (Mishra et al. 2003a). In an increasingly human-dominated natural landscape, managing such conflicts has become as important to wildlife management as protection itself is.

Across the world, large carnivores conservation comes into conflict with livestock production due to livestock depredation (Merrigi & Lovari 1996; Mazzolli, Graipel & Dunstone 2002; Treves, Jurewicz & Naughton-Treves 2002; Ogada et al. 2003; Inskip & Zimmermann 2009). Lethal control has historically been a common approach to manage this problem, and has resulted in eradication and large-scale range collapses of carnivores (Woodroffe, Thirgood & Rabinowitz 2005a). Conflicts over livestock depredation are believed to have led to two carnivore extinctions; the marsupial wolf *Thylacinus cynocephalus* Harris 1808 in Australia and the Falkland Island wolf *Dusicyon australis* Kerr 1792 in the last 150 years (Woodroffe et al. 2005a). Even today, the choice and implementation of mitigation measures often continue to be driven by tradition or socio-political expediencies rather than by science, resulting in inadequate and even damaging conflict resolution programs.

Persecution in response to livestock depredation threatens the survival of the snow leopard *Panthera uncia* Schreber 1775 across the mountains of south and central Asia. The species is listed as Endangered in the IUCN's Red List and in Appendix I of the Convention on International Trade in Endangered Species. Pastoralism is the predominant land use in the snow leopard's arid, high altitude habitat, which brings the conservation of the species into conflict with livelihood generation of the indigenous peoples (Mishra et al. 2003a). The extent of livestock predation by the snow leopard and other sympatric carnivores such as the wolf *Canis lupus* Linnaeus 1758 is reported to be high (a loss of 1.9 to 5 livestock heads per family annually), equivalent to 2.9 to 12 percent of the livestock holding (Oli, Taylor & Rogers 1994; Mishra 1997; Jackson & Wangchuk 2001; Namgail, Bhatnagar & Fox 2007). This translates to significant financial losses for local communities, and, in retaliation, the species is persecuted throughout its range (Mishra et al. 2003a). The retribution killing also makes the snow leopard particularly vulnerable to the demands of the illegal trade in carnivore fur and bones (Mishra 2003; Mishra & Fitzherbert 2004).

In this chapter, we review the main dimensions and causes of human-carnivore conflicts over livestock depredation worldwide, and the commonly employed mitigation measures. These are summarized into a general threat-based model for managing conflicts with endangered carnivores. We then describe a pilot effort in India's mountains to understand and manage the the problem of livestock predation by the snow leopard, and highlight the main lessons learnt.

Understanding livestock depredation conflicts: the causes

Conflicts have two important dimensions – the reality of damage caused by wildlife to humans, and the perceptions and psyche of humans who suffer wildlife-caused damage (Suryawanshi et al 2013). An understanding of the nature of conflicts along both these dimensions is important if they are to be managed effectively, since they together influence human responses to these losses.

Why do carnivores kill livestock? Large-bodied carnivores have a protein-rich diet and often specialize on ungulate predation, which makes them prey on livestock whenever an opportunity is present (Treves & Karanth 2003). Domestic animals are particularly vulnerable since a decreased risk of predation in a human-mediated environment has led to a degeneration of their anti-predatory abilities. This includes a reduced capacity to detect predators and escape from

them, and a breakdown of their camouflage coloration (Zohary, Tchernov & Horwitz 1998; Madhusudan & Mishra 2003). Although easier to hunt, predation on livestock is generally risky for a carnivore, given the occurrence of retribution killing or meat retrieval from livestock carcasses by livestock owners (Madhusudan & Mishra 2003). It nevertheless remains an attractive option, particularly considering the low success rate of predators in capturing wild ungulates (e.g., an estimated 5 % of all hunting attempts by tigers on wild prey was reported to result in successful kills; Schaller 1967), and the greater relative density of livestock (Madhusudan & Mishra 2003). It appears that as livestock populations increase or wild prey populations decline, so does the extent of predator attacks on livestock (Frank, Woodroffe & Ogada 2005; Bagchi & Mishra 2006; Kolowski & Holekamp 2006). Predator attacks on livestock can be locally high, even in areas of high wild prey abundance (Stahl et al. 2001b). It appears that sometimes high wild prey abundance could sustain higher carnivore populations, leading to an incidental increase in livestock depredation. All these factors make livestock inherently vulnerable to predation by large carnivores, rendering some amount of carnivore-caused livestock mortality inevitable as long livestock and large carnivores occur together (Madhusudan & Mishra 2003).

Inadequate anti-predatory livestock management is another important cause of livestock depredation (Woodroffe et al. 2007; Stein et al. 2010). Species such as the snow leopard and wolf are often reported to enter poorly constructed livestock corrals, resulting in surplus livestock mortality (Jackson & Wangchuk 2001; Rigg et al. 2011). Allowing livestock to graze unattended or lax guarding while herding also makes them vulnerable to wild carnivores (Mishra 1997; Thirgood, Woodroffe & Rabinowitz 2005; Dar et al. 2009). In many parts of the world where large carnivores were eradicated, systems have evolved where livestock is allowed to range free and unattended. The subsequent recovery of large carnivore populations has resulted in intense conflicts, as unguarded livestock become easy prey (Breitenmoser et al. 2005; Kaartinen et al. 2009). Predation on livestock perhaps also increases when an individual carnivore gets injured and becomes incapable of hunting wild prey.

Understanding conflicts over livestock depredation: human responses

Several factors influence the way in which affected people respond to livestock depredation. Depending on religious beliefs and cultural taboos, people's tolerance for large carnivores can sometimes be high, such as amongst the Buddhist pastoral communities of the Himalaya, but they ultimately fail to protect the carnivores in the face of intense conflicts (Mishra 1997; Liu et al. 2011). Livestock losses attributed to wild carnivores tend to get exaggerated in people's perceptions, often mistakenly (Mishra 1997, Rigg et al. 2011; Suryawanshi et al 2013). These perceptions can result in strong emotional and political consequences, ultimately resulting in persecution of carnivores (Kellert et al. 1996).

At a global, macroeconomic level, the intensity of conflict with carnivores over livestock depredation and peoples' responses do not seem to be correlated with the wealth of affected peoples. For some, particularly in the developing world, livestock depredation can have serious impacts on livelihood, and may even contribute to keeping people below national poverty lines (Mishra 1997; Madhusudan 2003; Mishra et al. 2003a). Although nations with developed economies should, in theory, have a greater capacity to absorb economic losses and thereby have greater tolerance towards wild carnivores, conflicts there seem equally intense, and there is continued legal and illegal killing of carnivores (Bangs et al. 2005; Woodroffe et al. 2005b;

Rosen & Bath 2009; Agrawal et al. 2010). Range collapses of large carnivores have taken place world-wide, and have been even more stark in Europe and North America compared to Africa and Asia (Rangarajan 2001; Woodroffe et al. 2005b). This is possibly a reflection of the overriding influences of other factors such as culture, politics, empowerment, technology and world-views in the way people respond to wild carnivore damage (Kellert et al. 1996; Kaltenborn, Bjerke & Strumse 1998). The extent of retaliatory killing of carnivores against livestock depredation is also increasing in many areas, encouraged in some cases by the illegal international markets for carnivore furs, bones and body parts (Mishra 2003; Mishra & Fitzherbert 2004; Wingard & Zahler 2006; Dar et al. 2009; Liu et al. 2011).

On the other hand, at the micro-economic and community levels, there is evidence linking the affected peoples' attitudes and responses towards wild carnivores with their economic condition and levels of education. In both developed (Kaltenborn & Bjerke 2002; Skogen & Krange 2003) and developing economies (Bagchi & Mishra 2006; Rigg et al. 2011), the responses of affected people even within the same community tend to be more negative when their livelihoods are more dependent on livestock, in contrast to people who have access to alternate sources of income (Suryawanshi et al. 2013). Furthermore, past experiences with predators may be an important factor in the way an individual responds to such conflicts. There is also some indication that the negative attitudes towards carnivores become less intense with increasing education levels within a community (Naughton-Treves, Grossberg & Treves 2003; Skogen & Krange 2003).

There is recent evidence suggesting that the importance of factors affecting human attitudes toward carnivores can change depending upon the scale of human organization (Suryawanshi et al. 2014). Although it is generally understood that people affected by livestock depredation are less acceptable of carnivores, the extent of livestock predation has rarely been identified as an important determinant of attitudes toward large carnivores. Suryawanshi et al. (2014) have shown that humans perceive the risk to livestock based on the extent of damage faced by the entire community and thus the extent of livestock lost to carnivores is an important determinant of attitudes to carnivores at the scale of the larger community (Suryawanshi et al. 2014). Such scale-specific information can help managers apply conservation measures at appropriate scales.

Peoples' attitudes towards individual carnivore species are also influenced by the physical and behavioral characteristics of the carnivores, their potential physical threat to humans, and their cultural and historical associations (Kellert et al. 1996; Kleiven, Bjerke & Kaltenborn 2004; Gusset et al. 2009; Suryawanshi et al. 2014). Species such as the wolf, African wild dog and dhole *Cuon alpinus* Pallas 1811 have suffered greater persecution because of stronger negative attitudes towards them. The wolf was despised by Euro-American settlers, although it was viewed as a source of positive inspiration by native Americans (Kellert et al. 1996). A strong cultural bias against the wolf is reflected in strong negative attitudes and relatively high persecution of the species compared to other sympatric carnivores such as the mountain lion *Puma concolor* Linnaeus 1771 in North America and the snow leopard in Asia (Mishra 1997; Kleiven et al. 2004). Although the causal relationships are not clear, greater visibility, greater perceived threat, and conspicuous behaviors such as howling and group living, may contribute to greater negative attitudes towards the wolf (Kellert et al. 1996).

Managing conflicts with endangered carnivores over livestock depredation

As seen in the previous section, as long as carnivores and livestock occur together, their behavioral ecologies predict that some livestock losses are inevitable. Therefore, conflicts over livestock depredation can at best be managed and reduced, but eliminating livestock depredation is not a reasonable conservation goal (Madhusudan & Mishra 2003). Effective conflict management needs to be sensitive to various ecological, cultural and socio-economic dimensions. Several measures are currently employed to reduce such conflicts. We have summarized the broad principles of conflict management and the relatively effective mitigation measures into a threat-based model (Fig. 1) following Salafsky and Margoluis (1999).

Reducing livestock losses

Direct measures to reduce livestock losses include better anti-predatory livestock management through corral improvement (Jackson & Wangchuk 2001), fences and other barriers (Shivik, Treves & Challan 2003), human-accompanied herding of livestock, and the use of livestock guard animals such as dogs (Breitenmoser et al. 2005; Woodroffe et al. 2007; Rigg 2011). Many deterrents and repellents that modify carnivore behavior, for instance, frightening devices (e.g. sirens, projectiles etc.) and aversive measures such as use of chemicals, have also been tried out, though mostly with limited success (Breitenmoser et al. 2005; Inskip & Zimmermann 2009). Indirect measures to reduce livestock losses include restoration of wild prey populations to reduce carnivore dependence on livestock, and reducing the interface between livestock and carnivores through human translocations (Woodroffe et al. 2005). The effectiveness of restoration of wild prey in reducing livestock depredation, however, is questionable, as mentioned earlier, especially if it leads to an increase in carnivore abundance.

Capture, translocation and release of individual carnivores from one site to another is a frequently employed measure to address depredation conflicts. Although effective in placating the affected people over the short term, these translocations generally have a temporary effect, as carnivores tend to return to the site of capture, or cause new conflicts around the site of release (Linnell et al. 1997; Athreya 2006). Athreya et al. (2011) found a four fold increase in attacks on humans by leopards around the sites of release after relocation.

Lethal control

Although the complete extirpation of carnivore species is amongst the surest ways of eliminating conflicts over livestock depredation, it is not an option if conflict management is to be a conservation goal rather than purely an animal husbandry one. Carnivore eradications, in addition to defeating conservation goals, also have cascading, often unpredictable effects such as meso-predator release, giving rise to new forms of conflict (Treves & Naughton-Treves 2005). While selective lethal control and regular harvest of predators continues to be employed (Bangs et al. 2005; Sæther et al. 2010) and advocated (Ikeda 2004) as a means to address the problem of livestock depredation, there is little scientific support for its long-term efficacy (Inskip & Zimmermann 2009). Like carnivore translocations, the effects of selective removal of carnivores in reducing livestock depredation are generally temporary, and the problem tends to re-emerge as the vacant carnivore territories are soon taken over by migrants (Stahl et al. 2001a; Treves & Naughton-Treves 2005). Localized lethal removal of carnivores from any site therefore tends to have spatially disproportionate effects, as new animals move in and the site effectively serves as a sink, affecting carnivore populations over much larger spatial scales (Woodroffe et al. 2005a). Although carnivore behavioral ecology predisposes certain age and sex classes such as transient,

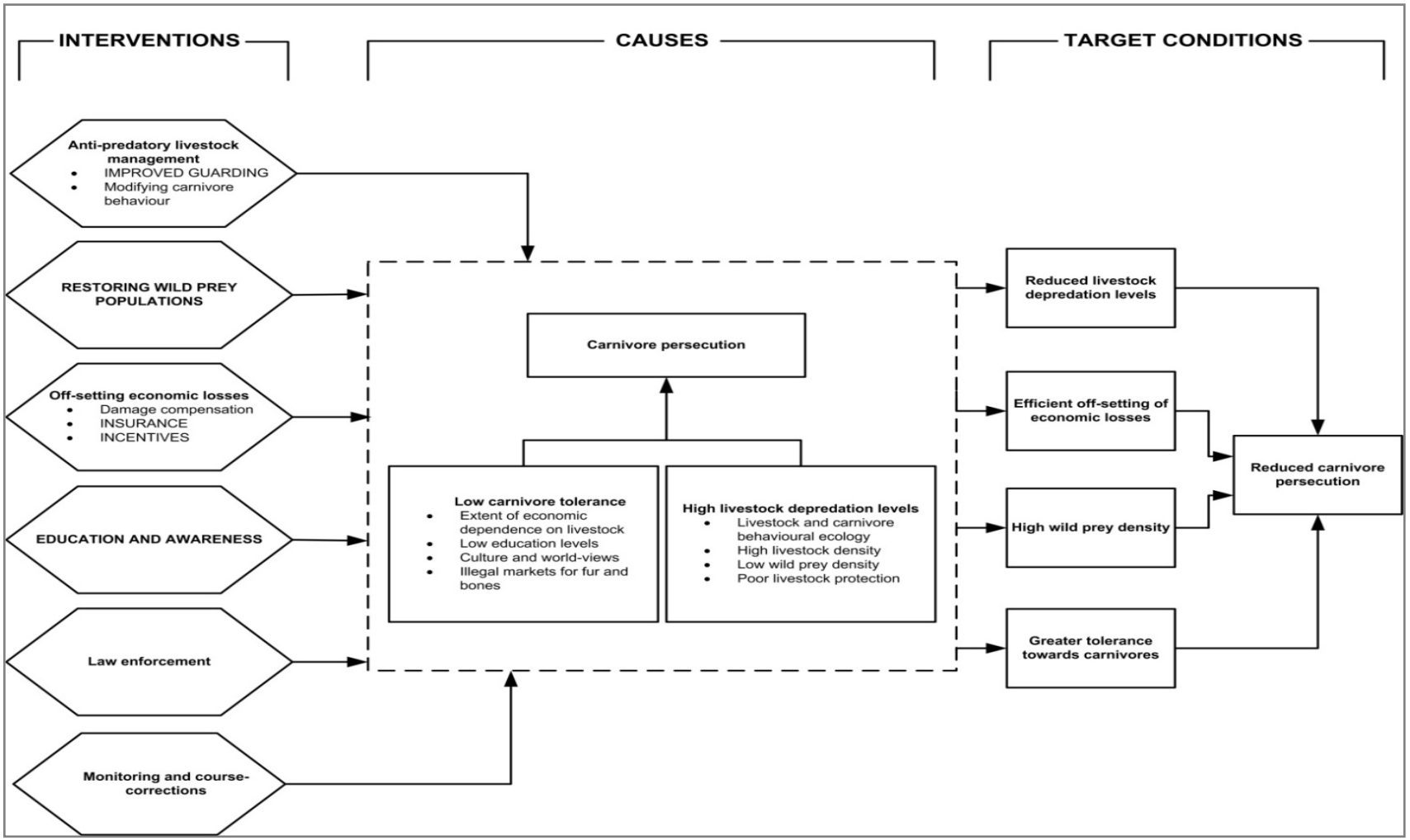
sub-adult males (Saberwal et al. 1994; Madhusudan & Mishra 2003) towards taking greater risks and disproportionately preying on livestock near human settlements, the so called selective removal of 'problem carnivores' mostly tends to be non-selective, with reviews showing that a third to over four-fifths of the carnivores removed under such programs were not involved in conflict incidents (Treves & Naughton-Treves 2005). There is empirical evidence showing rapid extinction of populations of species such as the lynx *Lynx lynx* due to proportional harvest for controlling livestock damage (Sæther et al. 2010). Lethal control should therefore remain the last option for addressing livestock depredation conflicts between humans and endangered carnivores.

Damage compensation and indirect efforts

Damage compensation forms an important component of contemporary conflict management, and is often achieved through compensation programs (Nyhus et al. 2003; Schwerdtner & Gruber 2007). These programs focus on off-setting wildlife-caused direct economic losses, and generally do not address either the opportunity costs of conservation for affected peoples, or the psychological costs of living with large and potentially dangerous wildlife. Despite this limitation, by attempting to shift the economic burden of conservation from local communities to the society at large, compensation programs, in principle, represent a socially just means of conservation and conflict management. However, unless managed carefully, many compensation programs have resulted in aggravating conflicts rather than mitigating them (Nyhus et al. 2003). State-run compensation programs often fail to address conflicts due to several factors such as low compensation rates, false claims or corruption, bureaucratic apathy, and the time and effort required in securing compensation (Mishra 1997; Nyhus et al. 2003; Madhusudan 2003; Maclenan et al. 2009; Agrawal et al. 2010). Successful programs also need to adapt as costs of compensation increase with the recovery of the carnivore species (Treves et al. 2009). Furthermore, a certain amount of livestock loss to wild carnivores has perhaps been traditionally acceptable amongst many local communities. Poorly managed, state-run compensation programs pose the danger of creating a perception that large carnivores are the state's property and therefore conflict management is entirely the state's responsibility (Madhusudan 2003). Thus, although a potentially valuable conflict mitigation measure, compensation programs by themselves are often unable to change peoples' attitudes towards carnivores (Naughton-Treves et al. 2003; Gusset et al. 2009), and yet, discontinuing them causes retaliation and hostility (Bangs et al. 1998).

Efforts have also been made at livestock insurance programs (see next section) and facilitating conservation-linked economic benefits to affected communities. In the Skoyo village of Pakistan's Baltistan region, a pilot community-managed livestock insurance program against snow leopard depredation was supported by a wildlife tourism enterprise (Hussain 2000). In the Ladakh region of India, assistance to communities for corral-improvement cut down livestock losses to snow leopards significantly (Jackson & Wangchuk 2001). An incentive program called Himalayan Homestays in the same region promotes snow leopard conservation by facilitating income generation for communities through wildlife tourism (Jackson & Wangchuk 2004). In Mongolia, an incentive program called Snow Leopard Enterprises involves local handicrafts development and sales to provide additional income to herders (400 families) across the country's snow leopard range in exchange for moratorium on killing snow leopards and their prey (Mishra et al. 2003a).

Fig. 1 A conceptual model of conflict management showing the main causes of human-wildlife conflicts over livestock depredation by endangered carnivores, the desired target conditions, and the relatively effective conflict-management interventions currently employed. Lethal control or selective removal of wild carnivores often undermines conservation efforts and does not address the conflict at hand. The interventions in capital letters represent the ones employed in the human-snow leopard *Panthera uncia* conflict management program described in the second half of the paper



Inskip and Zimmerman (2009) list several other conflict mitigation measures that have been tried out, and indicate that many of them have largely been ineffective. Clearly, managing conflicts over livestock depredation by large carnivores is complex and multi-faceted. Different factors such as education, culture and folklore, perceptions, experience with carnivores, etc., shape human attitudes towards carnivores. Human attitudes, in turn, interact with the actual livestock damage by the carnivore, which is affected by livestock herding and guarding practices, livestock density, wild-prey densities etc. This complex interaction determines human tolerance of carnivores in conflict. Thus, there is no single measure that is adequate in itself; effective conflict management generally will involve a combination of measures that aim at reducing the risk of livestock depredation, sharing the costs when depredation does take place, and increasing the social carrying capacity for carnivores through awareness programs on the one hand and access to alternate sources of income on the other (Fig 1).

Program Activities

Research: understanding and managing human-snow leopard conflicts

The cold and arid Spiti Valley (33°35′−33°0′N, 77°37′−78°35′E) in the Indian Trans-Himalaya is an important region for the conservation of high altitude wildlife, including the snow leopard and the wolf. Both these species are involved in livestock depredation across their range. A state-run compensation program was operational in the region for many years, but was largely ineffective in mitigating the conflict due to low compensation rates, and the time, effort, and ironically, money, required to secure the meager compensation amounts that were estimated to offset only 3% of the perceived economic losses to local communities (Mishra 1997). A perceived escalation of livestock depredation levels in the Spiti Valley about 15 years ago (soon after the establishment of two protected areas in the region), had led to a local perception of an increase in the carnivore populations in the region.

During surveys conducted in 1996, local people reported losing *c.* 12 % of their livestock holding annually to wild carnivores. The estimated loss per family was equivalent to half of the average annual per capita income (Mishra 1997). The carnivores were persecuted – wolf litters were regularly destroyed, a snow leopard had been recently killed in one of the surveyed villages, and, whenever possible, meat was retrieved from livestock as well as wild ungulate kills. The causes of this conflict were not clear, but it appeared unlikely that there had been any increase in the carnivore populations, given their continued persecution by the people. On the other hand, an increase of c. 38 % in the livestock population over the previous decade seemed to be an important cause of the perceived escalation in livestock depredation cases (Mishra 1997).

The results of a research program in the region established that the existing livestock densities in over four-fifths of Spiti's rangelands were so high that livestock production itself was getting compromised (Mishra, Prins & van Wieren 2001), and this overstocking was leading to competitive depletion of bharal *Pseudois nayaur* and ibex *Capra sibirica* populations (Bagchi, Mishra & Bhatnagar 2004; Mishra et al. 2004). Even in the best representative sites for wild ungulates in Spiti, the density of wild ungulates was about half (4-8 animals km^{-2}) compared to the density of livestock, and, in many rangelands, up to an order of magnitude lower (Mishra 1997; Mishra et al. 2004; Bagchi & Mishra 2006). Pastoralism and associated activities had caused wild herbivore declines, and, over historical time, possibly even precipitated local extinctions of potential prey species such as marmots *Marmota himalayana* Hodgson 1841 and some ungulates (Mishra et al. 2002).

The high relative abundance of livestock vis-à-vis wild ungulates thus seemed to be the main cause of the relatively high level livestock depredation in Spiti Valley. A study on the diet of the snow leopard showed that livestock formed an important group of prey, contributing 40 to 58 % of the snow leopard's diet (Bagchi & Mishra 2006).

Studies on animal husbandry practices, socio-economic conditions and land use showed that inadequate herding was also contributing to high levels of livestock depredation in Spiti Valley. Livestock is owned by individual families, while most of the grazing land is communally owned (Mishra, van Wieren & Prins 2003b). Although the rangelands are overstocked, the per family livestock holdings are not very large (e.g., an average of 13 livestock heads; Mishra 1997), being limited by peoples' ability to supplement-feed livestock during winter (Mishra et al. 2003b). Livestock owners therefore made conscious trade-offs that resulted in an increased, but apparently acceptable, risk of livestock losses to carnivores (Mishra et al. 2003b). Communal herding of livestock, where the entire village livestock is herded by a few chosen herders, was leading to less diligent herding, increasing the risk of depredation, but decreasing the labor investment in herding for each family substantially (to one man-day a month in the larger villages; Mishra et al. 2003b). Similarly, in the interest of more efficient use of pastures at higher altitudes and decreased investment in herding, people let the adult horses, yaks and accompanying calves range free and unguarded, increasing the risk of predation (Mishra et al. 2003b). Most of the collective decisions pertaining to herding, natural resource use and regulation, and co-operative work are made by traditional and democratic village councils, which continue to be fairly strong bodies at the village level.

Over the last 25 years, the importance of livestock as a source of cash-income has gone down to varying extents in different parts of Spiti Valley (Mishra 2000). This has followed the adoption of cash-crops, increasing tourism and employment in government-aided development projects. In villages where people have adopted cash-crops, the estimated per capita cash-income from agriculture itself is equivalent to the average per capita income of the state (Mishra 2000). In such villages with reduced livelihood dependence on livestock, people are more tolerant of wild carnivores, while they continue to have strong negative attitudes in villages where the relative dependence on livestock for cash-income remains high (Bagchi & Mishra 2006). Livestock are still needed for a variety of goods and services (milk, meat, plough, etc.) and the agricultural production is considerably dependent on the manure generated by them (Mishra et al. 2003b).

Our studies on human ecology and attitudes suggested that (i) the traditional administrative bodies were still intact to enable community-based conflict management programs, (ii) there was scope for improvement in herding practices to reduce livestock depredation levels, (iii) overall reduction in livestock was not possible owing to relatively small livestock holdings at the level of individual families, (iv) people had the economic capacity to participate in insurance programs, and (v) greater access to alternate sources of income increased people's tolerance for carnivores.

Conflict management in Spiti Valley

Based on this knowledge, a multi-pronged conflict management model was initiated, first in a single village called Kibber in Spiti Valley that aimed to (i) reduce depredation levels by increasing wild prey density and improving livestock herding practices, (ii) offset economic

losses through a community-based livestock insurance program, and (iii) increase the social carrying capacity for wild carnivores through and education and outreach.

Increasing wild prey density

Ecological research showed that the populations of wild ungulate prey were reduced due to forage depletion by livestock. Traditionally, many village councils in Spiti have leased some of their pastures to visiting migratory graziers in summer (Mishra et al. 2003a). Following this model, in 1998, a pilot prey recovery program was initiated through an agreement with the village council of Kibber, one of the larger villages in the area. A rangeland area of 500 ha was set aside for wild prey recovery, where livestock grazing and all other forms of extractive use were curtailed. As an incentive and compensation for lost grazing, the area was leased from the village council (at c. US$ 425 per year), using the traditional grazing leases to migratory graziers as guidelines for negotiating the lease amount (Mishra et al. 2003a). The amount, used for village development work, was provided to the village council annually.

Livestock insurance program

In 2002, a community-based livestock insurance program was started in Kibber. The regulations and guidelines were drafted collectively with most of the livestock-owning families in the village. A committee comprising of four community members was set up, which rotates on an annual basis, and is responsible for collecting premiums, managing accounts, and maintaining an insurance register. It also verifies the cause of livestock death. The decision on composition of the insurance committee, the premium amounts (decided based on peoples' ability and willingness), compensation amounts (aimed at off-setting, on average, 100 % of the value; Table 1), and most other regulations are made and revised collectively. There are clauses that safeguard the interests of wildlife by forbidding wildlife persecution including the collection of carcass/meat from livestock kills. The program is restricted to large-bodied livestock species, and does not include sheep and goat due to their high number and relatively low value. Only adult animals are covered under the program, though for yaks, young and sub-adults are also included due to their high value.

The villagers accepted that negligent herding was an important cause of livestock losses to wild carnivores and considered various options to improve herding and make the herders more responsible. Small monetary rewards were instituted (US$ 25 to 40) for herders for good anti-predatory herding over their six-month terms. For free-ranging yaks in the distant pastures, local knowledge suggested that most of the depredation losses take place when individuals get separated from the main herd. To address this problem, during the period following the yak birth season, two villagers, supported by the insurance fund, are sent every week to herd the straggling yaks together.

Of a total of 68 families in Kibber who owned the types of livestock covered under the insurance program, 50 joined the program initially. However, within the first two months, 9 families withdrew their membership, either because they sold their livestock, or because they became unsure about the future of the insurance program. By 2006, 45 families (66 %) from Kibber were participating in the program. Excluding the data from families that withdrew their membership, a total of 172 livestock heads from Kibber was insured in the first year, and this increased to 190 by 2006.

On average, the participating families from Kibber contributed US$ 16 as annual premium in the first year, increasing to US$ 20 by 2006. Of the total money in the insurance fund collected over five years, c. 60 % was contributed through conservation funds, while the remaining 40 % came in the form of premium contributions. In 2004, the Kibber insurance program was expanded to include livestock from three relatively smaller neighbouring villages of Kee (35 families), Gete (6), and Tashigang (6). This increased the number of participating families to 70 and insured livestock to 260 by 2006. Between 2002 and 2006, 38 large-bodied livestock insured under the Kibber program were lost to wild predators, and two died of disease (Table 1). A total amount of c. US$ 3225 was paid as compensation from the insurance fund for these losses. The instances of disease-caused mortality of insured animals were treated as special cases and half of the compensation amount was provided to the owners based on collective agreement.

In 2005, two members of the insurance program made false claims regarding the loss of insured livestock to wild carnivores. Given the high community involvement in paying premium as well as managing the program, these false claims were easily detected, and the two were warned that such attempts would not be tolerated in the future.

A separate conflict management program along similar lines was started in the neighboring village of Chichim (58 families) in 2004. A total of 38 families joined the Chichim insurance program in 2004, and insured 64 large-bodied livestock. By 2006, almost all the families (56) were participating in the program, with a total of 161 large-bodied livestock insured. A smaller (400 ha) grazing set-aside was also created in the rangelands of Chichim in exchange for a lease of US$ 500 per year. The total economic value of livestock insured under the Kibber and Chichim programs in 2006 was US$ 60613.

By 2006, over a period of 5 years from initiation, the Kibber insurance program (together with the villages of Tashigang, Gete, and Kee) became financially self-sustaining, and is no more subsidized by conservation funds. In the same year, a similar insurance program, adapted to local needs and conditions, was started in Ladakh to cover the villages of Rumtse Gya, Sangmath Gya, Rongthya Gya and Sasoma. The program has since been expanded to the snow leopard habitat of South Gobi, Mongolia. Our colleagues and partners have also recently initiated pilot livestock insurance programs in snow leopard habitats of China and Pakistan.

Corral improvement

Majority of attacks on livestock in Spiti were reported in the open pastures, as the animals are usually penned inside houses or in secure corrals. In some villages of Spiti and several in Ladakh, however, poorly constructed corrals have been an important cause of catastrophic livestock losses to snow leopards. We therefore expanded our program to include collaborative predator-proofing of corrals with the local communities, which has been undertaken in one village of Spiti and several in Ladakh.

Education and outreach

Conflict over livestock depredation, alongside a general lack of awareness of conservation issues amongst people, is believed to be amongst the most important threats to wildlife conservation in the Himalayan region (McCarthy & Chapron 2003; Trivedi, Bhatnagar & Mishra 2006). To promote conservation awareness and increase the tolerance, or the social carrying capacity for wild carnivores, a multi-pronged conservation education program was initiated in Spiti Valley in 2006, and subsequently in Ladakh (Trivedi et al. 2006). This has included the development of

books and educational aids, training of youth and teachers in conservation education, nature clubs and indoor and outdoor nature conservation and interpretation activities and annual outdoor camps for children from schools across Spiti Valley and Ladakh.

Evaluation and evidence

Within 4-years, there was a three-fold increase in the density of bharal within this grazing set-aside (Mishra et al. 2003a). In 2004, under a new agreement with the village council, this was expanded to an area of c. 1500 ha in exchange for an annual payment of c. US$ 1200 for village development. Removal of livestock-imposed forage limitation from part of the area has led to a significant increase in the population of bharal from c. 100 animals in 1996 to >400 animals in the last 7-8 years (Fig. 2) over a landscape of c. 4000 ha, which now supports one of the highest densities of bharal (c. 10 animals km^{-2}) reported anywhere (Oli 1994; e.g., Schaller 1998).

Fig. 2 Population trends of livestock and bharal *Pseudois nayaur* between 1996 to 2007 in the site of the conflict management program in Spiti Valley, Indian Trans-Himalaya. A community-based conflict resolution program is being implemented in the region. A population recovery effort for bharal was initiated in 1998 by freeing key areas from livestock grazing, while a livestock insurance program was initiated in 2002, and conservation education and awareness efforts in 2006. Trends in livestock populations come from annual door-to-door censuses, while those of bharal come from periodic field surveys (see Mishra et al. 2004 for methods).

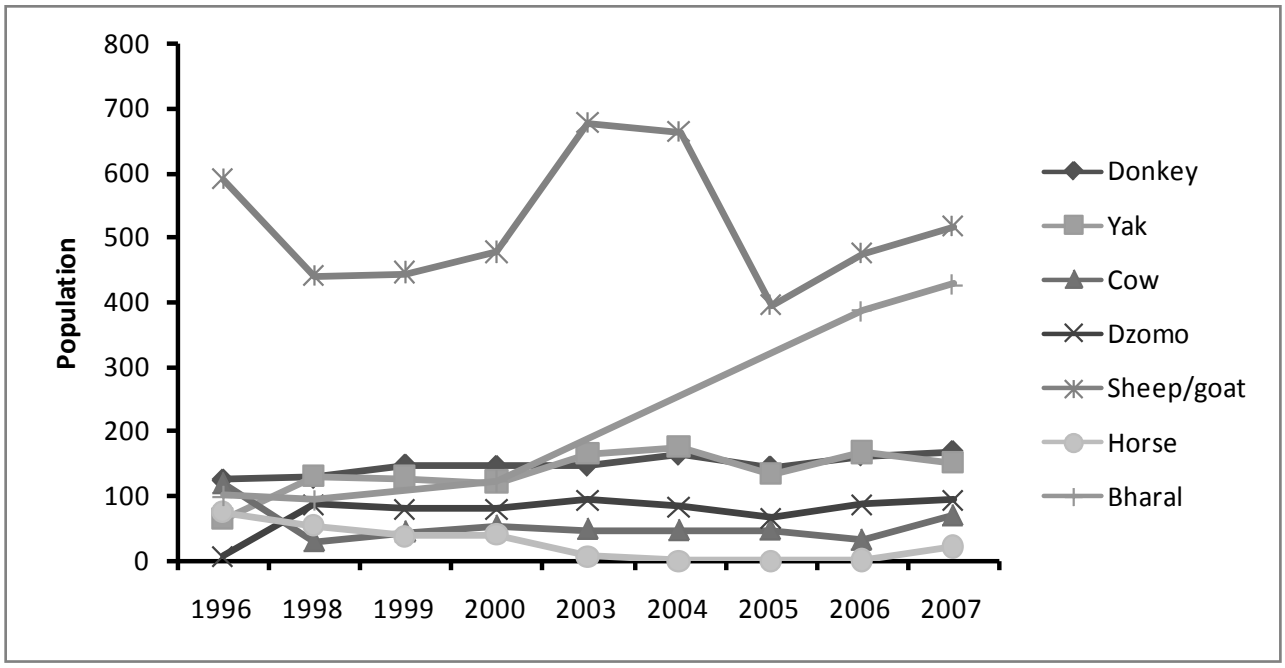


Table 1. Details of the pilot livestock insurance program in Kibber region of Spiti Valley, Indian Trans-Himalaya, initiated as part of a community-based program to manage conflicts over livestock depredation by snow leopards *Panthera uncia* and wolves *Canis lupus*. The table also indicates the number of animals insured and killed between 2002 and 2006. The Ivlev's electivity index (see text) indicates the risk of predation for each livestock type.

Livestock type	Body mass in kg	Monthly premium amount in US$	Compensation amount in US$ if livestock is killed by wild carnivores	Total number of insured animals killed by wild carnivores between 2002-2006	Mean number of animals insured each year between 2002-2006	Ivlev's electivity index
Yak young male	72	0.25	75.0	5	5	0.64
Yak young female	72	0.25	62.5	7	6	0.71
Donkey adult female	83	0.25	37.5	5	27	0.08
Donkey adult male	97	0.25	62.5	5	31	-0.13
Yak sub-adult male	115	0.63	125.0	6	18	0.36
Yak sub-adult female	115	0.50	87.5	4	20	0.13
Cow adult female	191	0.38	125.0	1	18	-0.31
Dzomo adult female	214	0.38	125.0	1	25	-0.45
Yak adult female	228	0.50	175.0	3	35	-0.29
Yak adult male	368	0.75	325.0	1	40	-0.62

While the role of increased wild prey abundance is debatable, better anti-predatory herding presumably helped in reducing livestock losses to wild carnivores from an estimated 12 % of the livestock population in 1996 (Mishra 1997), to an average (±SD) of 4.4±0.84 % between 2002 and 2006 (calculated annually as a proportion of insured livestock lost to carnivores to the total number of insured animals). Of the total of 38 insured livestock lost to wild predators between 2002 to 2006, yaks accounted for 68% of the mortality and 79% of the compensation amount paid, donkeys for 26% and 14%, and cattle and dzomo (female hybrids of yaks and cows) for 3% and 4% each, respectively (Table 1). Most of the livestock lost were relatively small-bodied (Table 1), with the risk of predation, represented by the Ivlev's electivity index (Jacobs 1974), showing a strong negative correlation with mean body mass of livestock (Spearman's correlation coefficient -0.86, p=0.001).

A reduction in carnivore-caused livestock mortality as a result of the conflict management program could potentially lead to an escalation of the livestock population and thereby have a negative feedback on the extent of livestock losses to wild carnivores. However, given that livestock holdings in the study area were limited by people's ability to supplement-feed livestock during winter (Mishra et al. 2003b) and not by carnivore predation, an increase in the livestock population as a result of decline in carnivore-caused livestock mortality was not expected. This was confirmed by examining the trends in the population of large-bodied livestock (the species covered under the insurance program) of Kibber village, obtained through annual livestock censuses over a 13 year period (Fig. 2).

This conservation and conflict management program has addressed the threat of retaliatory persecution of the carnivores. No carnivore persecution has taken place since the program was initiated, and the villagers, on a few occasions, have also turned away outsiders intending to hunt bharal and ibex (Mishra et al. 2003a).

As seen earlier, damage compensation programs, although an important measure to offset losses, are beset with problems unless managed carefully. The experience with snow leopard conflict management suggests that community-based insurance programs, though less experimented with, are potentially more effective in terms of their financial sustainability, participatory nature and transparency, and internal checks on false claims and corruption. However, their effectiveness is contingent upon strong community coherence, sustained dialogue and strong partnership between the community and conservationists or managers, and people's economic ability to participate in them. Compensation and insurance programs, therefore, need to be viewed along a continuum, with greater compensation/conservation subsidy made available at lower end of the economic spectrum.

Conclusions

Conflict management has become a critical aspect of wildlife conservation. Conflicts over livestock depredation are characterized by complex interactions between carnivore and livestock behavioral ecology, animal husbandry practices, human perceptions, psyche, culture, world-views, socio-economy and education. The causes of livestock depredation by wild carnivores and the responses of livestock owners to predators also vary over space and time (Skogen & Krange 2003; Schwartz, Swenson & Miller 2003; Bagchi & Mishra 2006), as does their willingness and ability to participate in specific conflict resolution measures. Effective conflict management therefore is contingent on a sound understanding and monitoring of wildlife ecology, human socio-economy and attitudes. It generally requires a combination of measures that aim to reduce

depredation levels, off-set economic losses, and increase the social carrying capacity for carnivores.

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KULBHUSHANSINGH SURYAWANSHI

I aim to work towards wildlife conservation through robust applied scientific research informing management and policy. My work, so far, has focused on the understanding and conservation of the alpine and high-altitude regions of the Himalaya and other Central Asian mountains. My Doctoral thesis focuses on identifying the causes of livestock predation by snow leopards and finding ways to minimize it through management of wild herbivore and livestock populations. I also examined the perceptions and attitudes of local herders to find ways of minimizing the persecution of the snow leopard. I used population ecology to develop an understanding of the interactions between large carnivores, their wild ungulate prey and livestock. My interests are diverse. Currently, together with collaborators, I am working a range of project aimed at understanding the implication of climate change on the rangelands of Central Asia, understanding livestock predation by snow leopards inside livestock pens and finding ways of minimizing it.

PROSPECTS OF MANAGING HUMAN-RHESUS MONKEY CONFLICT IN HIMACHAL PRADESH, INDIA

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Summary

Human-Rhesus Monkey conflict in Himachal Pradesh involving attacks on humans and heavy crop damages has been recorded highest in comparison to other species. Monkeys are increasingly coming in close proximity to human habitations due to their longstanding relationship of commensalism. Expanding human populations, provisioning in temples & along roadsides, open access to junk food in urban areas, opportunities of access to crops, lack of natural predation have allowed the Monkey population to increase over and above the carrying capacity particularly in urban environs. Programme activities like statewide surveys to estimate populations have allowed understanding the problem. Some management strategies like translocations, establishing a primate park, using scaring methods to reduce conflicts were tested and were found to be of limited success. Sterilization is the flagship ongoing programme to control population, which has been estimated to prevent births close to one lakh (1,00,000) till end of March, 2014 assuming one infant per female per year. This method is also acceptable in social and religious context but it may take several years to achieve the goal of sterilizing the 80% population as the capture rates of individuals in a troop are gradually declining with currently practiced drop door cage method. Capturing methods need to be improvised to enhance capture rates to make the programme more effective. Removals through extensive trapping and export for biomedical trade is considered as one of the effective solution to control the size of the population and reduce damage but this method is not possible due to the ban imposed by Government of India in 1978. Plans are also in pipeline to look into more details of the behavioural management of human-Rhesus monkey conflict to reduce negative interactions, assess the associated zoonotic risks and undertake the scientific evaluation of the ongoing sterilization programme through external collaboration.

Key words: Human-Rhesus monkey conflict, sterilization programme, commensalism, translocation, primate park, export

Situation

Rhesus Monkey, *Macaca mulatta* is the most widely distributed nonhuman primate native to Afghanistan, Bangladesh, Bhutan, central and southern China, northern and central India, Lao PDR, Myanmar, Nepal, Pakistan, Thailand and Vietnam. The species is listed as Least Concern

in the IUCN Red List of Threatened Species in view of its wide distribution, presumed large population, and its tolerance of a broad range of habitats [Timmins et al., 2008]. This species is also protected under the Indian Wildlife (Protection) Act, 1972 and listed in Schedule II Part 1.

Almost all nonhuman primates have been identified as crop-raiders. Crop raiding is integral to the ecology of primates inhabiting an area of human-animal interface [Naughton-Treves, 1998]. Agricultural and horticultural practices may make foods accessible to primates specifically at those times when natural foods are limited. When natural foods are limited, high quality easily digestible human foods provide an alternative source of nutrition for primates and crop raiding may intensify [Horrocks & Baulu, 1994].

In Himachal Pradesh, Rhesus Monkey and eight other species like wild boar have been declared by the Government as crop damaging animals since the year 1984 when complete moratorium was imposed on hunting [Government of HP Letter, 1984; 2010]. All these species are protected under Indian Wildlife (Protection) Act, 1972 and can only be hunted as per this Act after obtaining a valid permit from authorized officer if any of these species have become dangerous to human life or to property (including standing crops on any land) or the animal is disabled or diseased beyond recovery.

Damages to agricultural crops by monkeys and other species account for a loss of about INR 184.28 Crores (US$ 30,133,281 approx.) per annum [HP Agriculture Department Report, 2014]**.** Similarly a loss of about INR 150.10 Crores (US $ 24,544,202) to horticultural crops have been assessed for the period of 2006-07 to 2013-14 [HP Horticulture Department Report, 2014]. Although the methods used to assess the losses are not validated, the figures are clearly indicative of high losses.

The number of attacks on humans by Monkeys has been recorded highest in comparison to other species during the period of study from April, 2004 to March, 2014 (see Figure 1). The official records concerning monkey attacks on humans were analyzed to assess the extent of negative interactions (see Figure 2). The records included data concerning the number of cases reported, extent of human injury, relief offered to the victims. A total of 2050 cases of Monkey attacks over a period of last 10 years from 2004-05 to 2013-14 have been reported to the Wildlife Wing. The extent of human injury caused is classified into four categories as simple injury, grievous injury, permanent incapacitation and deaths. No deaths and permanent incapacitations due to monkey attacks were reported. The amount paid to the Monkey-attack victims as relief from the government accounts for nearly INR 96,13,574 (US$156,077) [Records CWLW Office, 2003-2014].

Figure 1. Comparison of the number of conflict cases reported for different species during 2004-05 to 2013-14

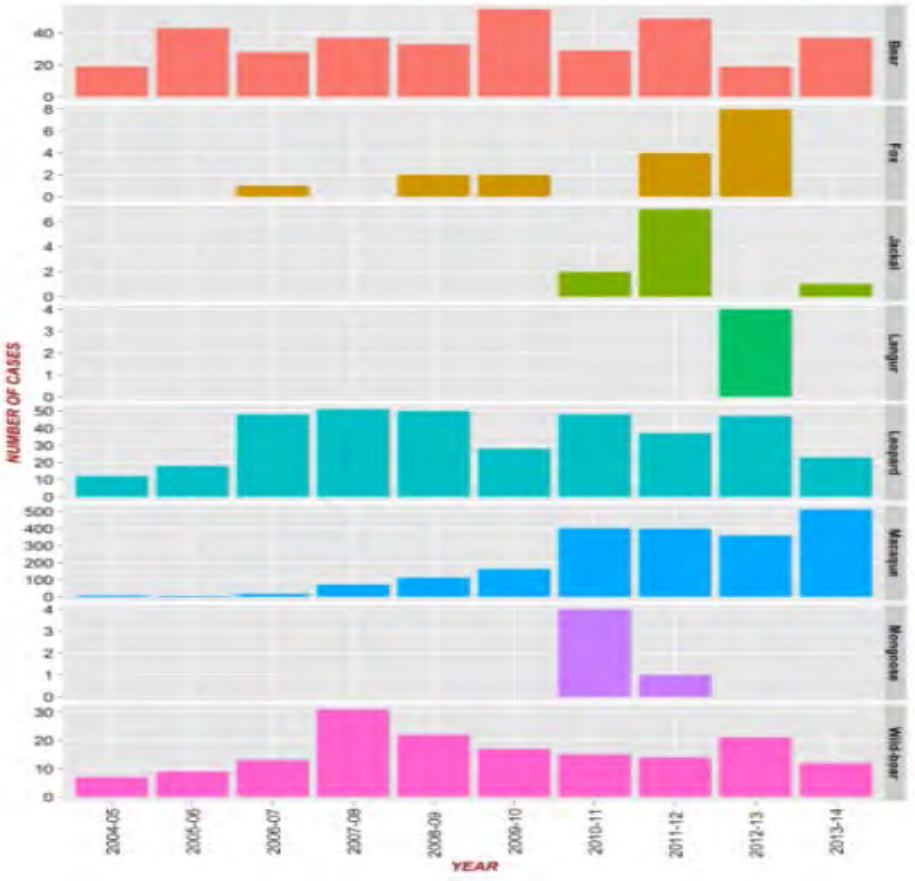
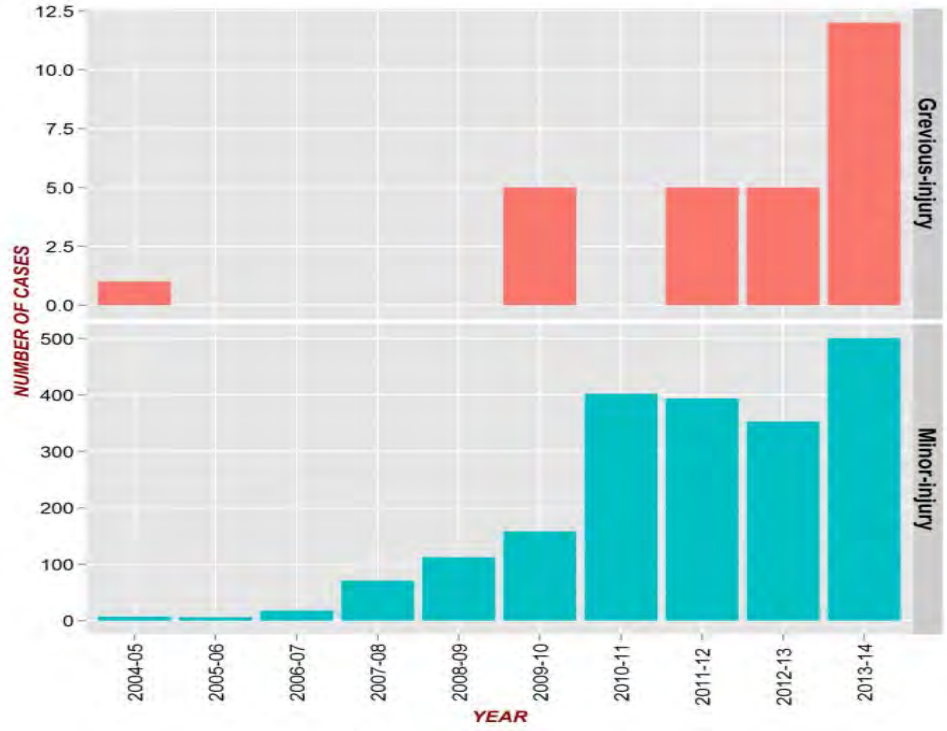


Figure 2: Number of conflict cases reported across the study period

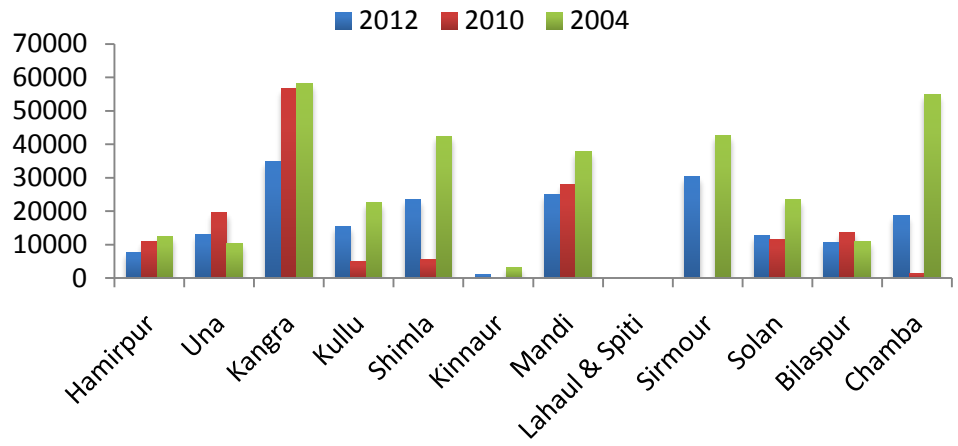


In late 1950's more than 100,000 monkeys were exported to United States(US) annually from India for bio-medical research and vaccine production. India's export quota reduced subsequently in 1960`s to about 20,000 owing to strong protests from within and outside the country for inhumane use of Rhesus Monkeys in neutron radiation experiments at the US Armed Forces Radiobiology Research Institute(AFRRI) at Bethesda, Maryland in violation of the agreement entered between India and US in 1955 [Newsletter, IPPL, 1978]**.** Also the species declined in numbers. Population surveys in 1959-60 in Northern India indicated that population had declined substantially throughout the decade of 1950s. In 1965 when this survey procedure was duplicated, it was found that population decline continued to occur due to trapping and demand for export, though the number of juveniles in a group had increased due to reduced demand for export [Southwick & Siddiqi, 1968]. The export from India was banned in April, 1978. Over a period of 20 years, 1959-1960 to 1979-80, the Rhesus monkeys were no longer abundant and widespread in northern India and in certain regions the decline was over 90% [Southwick et al., 1983]. Their population declined from an estimated two million animals in 1960 to approximately 1,80,000 in 1980. Reassessment of Rhesus populations in 1985 showed a remarkable recovery of 129% from their low points in 1978-1979. The estimated population of Rhesus in India in 1985 was in the vicinity of 4, 10,000 - 4,60,000 individuals. Though there were numerous favourable factors but the population increase was mainly attributed to ban imposed on export in 1978 [Southwick & Siddiqi, 1988].

Rhesus population estimation in Himachal Pradesh was initiated in the year 2003 and the first state wide survey was undertaken during December, 2003.This survey was repeated in June, 2004 and December, 2004. During the survey, a method of total head count by direct observation was used and their populations were assessed in four habitat type categories viz. Forests, Rural, Urban and Temples. As per June, 2004 survey, the population had been estimated 3,19,168 individuals in Himachal Pradesh. After these surveys, attempts were made to re-assess the populations during 2010 and 2012 in selected areas. The survey done during 2010 was confined to only 19 Forest Divisions and survey done during 2012 was focused only in hot-spot areas. Though not comparable as latter being partial surveys only confined to certain Divisions and hotspots but collectively these population estimates were helpful in understanding the population concentration of Monkeys in different districts (see Figure 3). The populations in districts Kangra, Chamba, Mandi**,** Sirmour and Shimla have been found more conspicuous as compared to other districts. The Kinnaur district has the lowest population and Lahaul & Spiti district does not have any population. Statewide survey conducted during June, 2004 was duplicated in June, 2013. Populations were recorded in five habitat type categories viz. Forests, Rural, Urban, Temples and Roadside. The monkey population has been estimated at 2,26,086 [Records, CWLW Office, 2003-2014]. Over a period of ten years, 2004-2013, this population estimate show a decline of 93082 monkeys as compared to June, 2004 survey, however the number of troops increased marginally. During survey period, rains were of important concern and no count could be carried out in Kinnaur district. This also raises questions about observability during survey and if the decline is real? It is highly likely that individuals might have been missed during the count due to adverse weather conditions. But interestingly the populations recorded in "Urban", "Roadsides", "Temple" and "Rural" habitat types have increased by about 62% whereas the populations recorded in "Forest" habitat type have decreased almost by 41%. There are two possible explanations for this; a) there was more inconsistency in count in "Forest" habitat type owing to reduced observability due to adverse weather conditions, b) the monkey populations from "Forest" habitat type have moved to a great extent to "Urban", "Roadsides",

"Temple" and "Rural" habitat types which points to a major shift from non-commensalism or semi-commensalism to commensalism relationship due to increased provisioning and easy access to junk food.

Figure 3. Year wise Monkey population in different districts



Monkeys are worshipped, protected and provisioned by villagers in Northern India, which enabled their rapid growth [Lee & Priston]. Not even a single record of natural predation of Monkeys has been found in Himachal Pradesh [Records, CWLW Office, 2003-2014] excepting anecdotes of Leopard predation. Monkeys are alternatively arboreal and terrestrial animals [Timmins et al., 2008] and can easily evade Leopard predation. Aspects such as easily available food, low predation pressure and religious sentiments are contributing factors for the increase in monkey population.

Economic loss to the farming communities due to crop raiding and increased negative interactions involving attacks on humans is leading to increased intolerance towards monkeys. Over a period of one and half month alone between 1st November, 2010 to 15th October,2010, a total of 590 applications asking for permission to hunt Monkeys were received by the Himachal Pradesh Forest Department from affected farming communities. Of these, 259 permits were issued for hunting and 15 monkeys were shot by six permit holders. Hunting of these Monkeys led to protests from animal welfare groups through representations to Government and media reports. Public Interest Litigation (PIL) was filed in the Himachal Pradesh High Court by People For Animals (PFA) Kasauli, an animal welfare group seeking a directive to ban the issue of hunting permits. In January, 2011, the Himachal Pradesh High Court ordered interim ban on issuing permits by the authorized officers for shooting of crop damaging wild animals including monkeys. The directive specifically highlighted the need to resort to other alternatives to deal with Monkeys menace [Records, CWLW Office, 2003-2014.

Programme Activities

In the backdrop of the situation which reflects magnitude of this conflict involving increased negative interactions, the Wildlife Wing of Himachal Pradesh Forest Department (HPFD) has embarked upon a multifaceted program to mitigate this conflict. All the analysis presented under

programme activities has been based on data accessed from official record files in the office of Chief Wildlife Warden, Himachal Pradesh, Shimla.

Earlier attempts initiated a decade back in the year 2003 were mainly focused on understanding the problem. A first **state wide survey** was conducted through involving frontline staff of HPFD in December, 2003 and this survey effort was again duplicated in June, 2004 and December, 2004 (see above for details) to answer the questions: where the Monkeys are? how many they are?

Shimla town has always been known for Monkeys nuisance and attempts were made to **translocate** (translocation is the human-mediated movement of living organisms from one area, with release in another) the monkey populations to far off forest habitats. From August, 2004 to January, 2005 a total of 3406 Monkeys (Shimla town and around =1786, Kufri = 85, Rampur town=143, Kalka-Shimla highway=1412) were translocated through massive trapping effort. The menace was only resolved temporarily in pockets from where Monkeys were translocated. Also the translocated monkeys eventually found access to agricultural lands in vicinity of released sites, thus creating problems in those areas. The niches vacated in Shimla town were soon occupied by neighboring monkey populations. In June 2013 survey, population of 1464 individuals was estimated which was higher than the population of 1448 Monkeys found in June, 2004 survey in spite of removals for translocation. Ultimately this strategy which only led to temporary relief at considerable costs of trapping and moving was stopped.

Local **traditional methods** of protecting crops from Monkeys were also studied. These mainly included use of guard dogs, fire-crackers, catapults, use of drums and guarding/chasing which had only limited success. The dexterity, deceptive skills and intelligence of some primates make containment and control very costly, inefficient and ultimately ineffective [Maples et al., 1976; Strum, 1986, 1987, 1994].

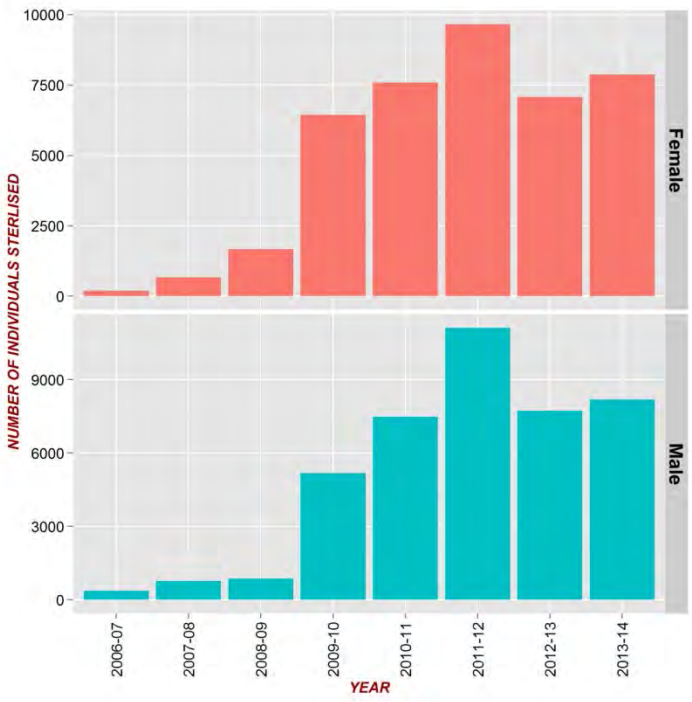
Awareness programme was initiated during 2004-2005. Leaflets and hoardings were used to educate people about risks associated with roadside provisioning. A warning to avoid feeding of monkeys along roadsides was included in the entry ticket at all toll barriers in Himachal Pradesh to sensitize visitors regarding Monkeys menace.

In the year 2004, Municipal Corporation Act was amended and a clause was introduced in Section 302, sub-section (1) **banning feeding of Monkeys**, Langurs and other stray animals in any public place excluding temple. This ban is enforceable only in Municipal Corporation limits. None of the other laws provide for feeding prohibition. Penal provision under section 289 of the Indian Penal Code regarding prohibiting feeding of Monkeys in public places has also been under consideration of the Government of Himachal Pradesh.

In the year 2007, Wildlife Wing initiated the **sterilization programme**. First sterilization centre was opened at Tultikandi, Shimla where the Wildlife Veterinarians got first hand experience of the sterilization procedures and standardized the technique. Both males and females in reproductive age class are targeted for sterilization. Sub-adults are also sterilized. Males are sterilized using vasectomy by employing technique of electrothermo cautery assisted coagulation and females are sterilized using laparoscopically assisted thermocauteric coagulation and cutting of oviducts [Rattan, *pers. comm.,* 2014]. Trapping is done mainly in hot spots in urban, roadsides, temples and rural habitat types. Monkeys are trapped by drop door cage method. The

current number of Monkeys Sterilization Centres (MSCs) in the entire state is seven which have been established between 2007 and 2013 in various districts on the basis of Monkeys population abundance as was found in surveys (for details see above) conducted from time to time. Till 31-03-2014, 82895 Monkeys (males: 41679; females; 41176) have been sterilized (Figure 4). All monkeys are released back at the same site after sterilization from where they have been trapped. This entire process takes about minimum five to six days.

Figure 4: Annual number of sterilizations in Himachal Pradesh till March, 2014



The idea of setting up of a **Primate Park** was also piloted in the year 2008 at Taradevi, near Shimla to test its effectiveness before introducing it more widely. In all 128 monkeys were introduced after sterilization near Taradevi temple in a forested habitat at different occasions. The area already has a resident population of 53. The Monkeys were initially released in temporary enclosures and were provisioned inside these enclosures. The resident Monkeys were provisioned outside the enclosures. This arrangement allowed interaction between the resident and released Monkeys. The Monkeys from enclosures were eventually allowed to exit the enclosures at different time intervals allowing them to mix up, forage and feed together with resident monkeys. Provisioning was continued and it took about six months to form a mixed troop comprising released and resident Monkeys. Integration of juveniles and sub-adults of released population was easier with resident population to form a mixed troop. Many individuals mainly adults dispersed after their exit from the temporary enclosures and found access to agricultural fields in the nearby villages which led to protests by the local people against the park. Provisioning was gradually reduced and completely stopped after about one and a half year in order to exit this idea of Primate park for the time being.

Scaring experiments by using air guns and rubber bullets to deter monkeys for preventing crop raiding have been carried out in ten selective high human-monkey conflict Panchayats falling

under ten different Forest Divisions namely Mandi, Bilaspur, Dehra, Sri Renukaji, Hamirpur, Una, Theog, Solan, Joginder-Nagar and Shimla across the state. This experiment was carried out by the field staff of Himachal Pradesh Forest Department in their respective jurisdiction in association with Panchayats. To document the impact of scaring experiments, daily observations were recorded in a predesigned format. The findings clearly indicate that these scaring measures only have temporary impact and such efforts only help to a limited extent in avoidance of crop raiding by Monkeys.

Suggestions have also been taken through a **Stakeholders consultation** workshop held during the year 2011. In all 108 participants representing more than 40 different organizations including civil society, farming communities, Non Governmental Orgainisations, Himachal Pradesh Kishan Sabha, Forest Officers representing states of Uttarakhand, Punjab, Chandigarh, Animal Welfare Board of India, Animal Welfare Organizations, Wildlife Institute of India, Departments like Agriculture, Horticulture, Animal Husbandry, Revenue, Tourism and authorities of Municipal Corporation etc. attended and contributed in this workshop. Seventeen suggestions had emerged including **1)** Establish Primate Parks; **2)** Legal ban on feeding of monkeys; **3)** Translocations; **4)** Speed up pace of monkey sterilisation; **5)** Vaccine sterilization be experimented; **6)** Survey for identification of conflict hotspots and using traditional methods in protecting agricultural crops; **7)** Access funding from Central Environment Ministry, Animal Welfare Board of India, Industrial houses, Confederation of Industries for managing Primate Parks, Sterilization Centres, field research and studies; **8)** Concerned state departments like Revenue, Agriculture and Horticulture to launch a special drive to assess the extent of damage and also extent of land being rendered fallow; **9)** Scientific culling of monkeys and other wild animals as per provision in the Act; **10)** Limited export of all age groups of monkeys for well-defined purposes; **11)** Adequate compensation to farmers for the crop damages; **12)** Surveys for estimating populations of monkeys and other wild animals; **13)** Monkey feeding stations at specific hot spots; **14)** Identify the areas where traditional methods (e.g. use dogs to chase monkeys) are used to save crops and adopt these methods; **15)** Employing local people in villages under MNREGA for guarding crops; **16)** Use of Air guns for scaring the monkeys have temporary impact and is not effective to deter monkeys; **17)** Increase availability of wild fruits in forests.

To give immediate relief to the victims in case of attacks by wild animals including Monkeys, **compensation scheme** has been recently revised. Two important changes have been made to improvise the ongoing scheme and expedite payments. These are; a) increase in relief amount and simplification of procedures b) included under essential services to expedite the payment of relief amount. Relief is only given for attacks on humans under four different categories and in case of death of live stock. The crop damage is not covered under current compensation scheme.

In countries like Mauritius where long-tailed macaque is estimated to cause more than US $1.5 million damage to agricultural crops [Bertram & Ginsberg., 1994], extensive **trapping and export** for biomedical trade is considered as one of the effective solution to control the size of the population and reduce damage. State Government also holds this perspective that export can provide more effective and quick solution to the problem in severely affected areas. It has strongly recommended to the Ministry of Environment to seriously consider the state's proposal for revoking the ban on export of Rhesus monkeys. Additionally central government has also

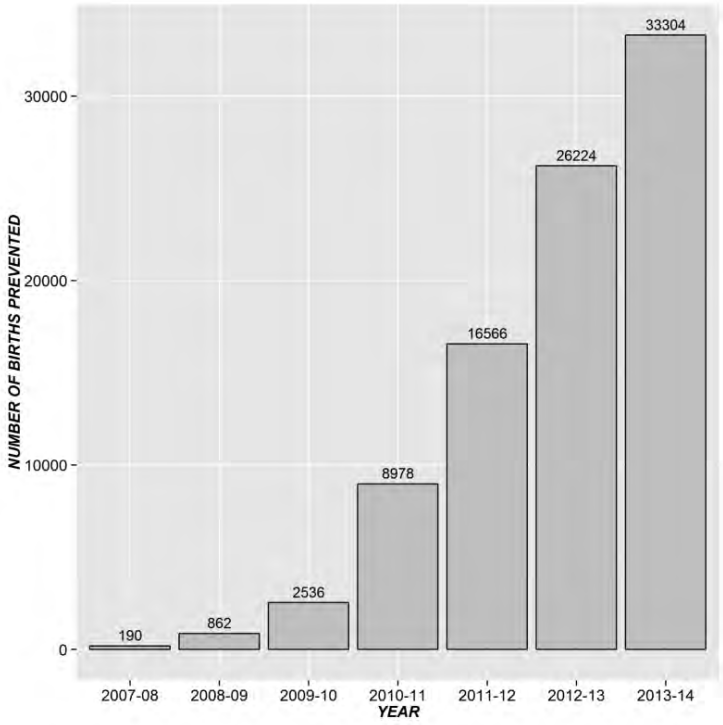
been requested to invoke the proviso made in section 62 of the Indian Wildlife (Protection) Act, 1972 to declare Rhesus (currently listed in Schedule –II, part I) as **Vermin** in select areas with high conflict rates for a defined time period, this shall legally imply that the species is listed in Schedule-V and all prohibitions on lethal control shall cease. People can physically remove the Vermin species without any legal binding and fear of prosecution. But this shall require systematic population monitoring to ensure that species do not go locally extinct in such areas within the prescribed time for which it is declared as Vermin. Outcomes of such rigorous monitoring can be used to revert the decision as and when it is warranted.

A **comprehensive habitat enrichment plantation model plan** which envisages to artificially raise multilayered stands consisting of variety of native wild fruit species preferred by monkeys has also been prepared and submitted to Ministry of Environment for seeking funding. This is a 10 years long-term plan having a budget outlay of INR 200 crore (US$32,666,400) covering an area of 10,000 hectares aiming to provide ample natural food resources to Monkeys and other wild animals in the forest habitats. This plan assumes that natural food provisioning shall lessen their tendency to raid agricultural and horticultural crops in search of food. Though currently there is financial constraint to implement this plan but it would be worthwhile to pilot this plan in few locations and test if this has any impact on reduction of conflict before it is implemented widely.

Impact

Human-Rhesus monkey conflict is a multifaceted problem. Different population control and conflict management strategies have been tried and tested roughly for last 10 years. Majority of these strategies like trapping & translocations, legal ban on feeding in Municipal Corporation limits, education and awareness, primate park, use of air guns for scaring and use of other local traditional methods for chasing/scaring in order to protect crops have very little impact in containing the problem. Never the less it helped in understanding the magnitude of the problem much better. The State has an extensive sterilization programme currently ongoing. The total number of females sterilized per year till 31 March, 2014 reveal that births estimated close to one lakh have been prevented assuming one infant per female per year as the species has long life span of 25-30 years (Figure 5). The reduction of births due to sterilization of males have not been taken into account as the species has promiscuous mating system and conclusive studies have not been taken in the state on this aspect. This method of population management is also acceptable in social and religious context but it may take many years to achieve the goal to sterilize the 80% population in reproductive age class except populations in forest habitats. The seven fully equipped MSCs have a capacity to sterilize more than 7000 monkeys annually but this has been severely reduced due to low capture rates. Captures in a troop with current drop door cage method are roughly 20-40% only mainly due to cognitive ability of the species which allows them to recognize the trappers, vehicles and cages involved in the capturing effort. The species has learnt to evade the trapping.

Figure 5: Estimated number of births prevented during the study period through sterilization



Evaluation

Majority of strategies as discussed under programme activities have limited success with considerable costs in terms of money and time. Euthanasia or lethal control of excessive populations is not possible mainly because of; a) legal protection to the species under the Wildlife (Protection) Act, 1972, b) the prevailing directive from the Himachal Pradesh High Court imposing ban on hunting and also it may not be acceptable on social and religious grounds. The implementation of mitigation strategies has been initiated in recent years and is ongoing. The scientific evaluation of success of these conflict management strategies including flagship sterilization programme is necessary and planned to be carried out through external collaborators. Anecdotal observations and rapid assessments indicate that low capture rates, sterilization and release have possibilities to break the social structure leading to splintering of troops. Subdominant males and females might become dominant which in term might affect the behaviour of the whole troop such as home-range size, foraging and interactions with neighbouring troops. Thus scientific assessment of the programme can tell its effectiveness in controlling population. There is also a need to improvise the current capturing techniques and also explore other methods to enhance the capture rate. The proposed collaborative project with University of California, Davis (US) is planned to address these aspects and answer questions relating to the efficacy of the programme [McCown, 2014]. Additionally, this project shall look into the details of the behavioural management of human-Rhesus conflict to reduce negative interactions and also investigate associated zoonotic risks.

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Dr. LALIT MOHAN

Dr. Lalit Mohan is Indian Forest Service Officer of 1983 batch. He is MSc and PhD in Zoology from AMU Aligarh, India. He worked in different positions for more than 31 years in the Himachal Pradesh Forest Department in India which includes about 15 years experience of working for conservation and management of Wildlife. Till recently, Dr Lalit worked as Principal Chief Conservator of Forests (Wildlife)-cum-Chief Wildlife Warden and after his successful tenure, now has been posted as Managing Director of Himachal Pradesh State Forest Development Corporation Limited. His work on conservation of endangered pheasants like Western Tragopan and Cheer pheasant has been appreciated by Central Zoo Authority, Government of India and World Pheasant Association (WPA), UK. He is member of WPA UK, Austria and Germany. He took initiative for conservation of many endangered species like Vultures, Snow Leopard, Brown Bear in the State of Himachal Pradesh. Man-animal conflict is a major issue in the state and he has taken various steps to control the menace especially in case of Rhesus Monkey.

EVOLVING EFFECTIVE COMPENSATION MECHANISMS FOR MAN-ANIMAL CONFLICT DAMAGE IN UTTARAKHAND, INDIA.

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Summary
Man-animal conflicts have assumed alarming proportions of late and any incidence particularly involving human death becomes a serious law and order problem. The Govt. agencies across the world have been evolving strategies to deal with this problem. While there are a number of preventive strategies, providing ex-gratia relief for the loss of life or compensating for property loss has been an important strategy post such event. Compensation mechanisms have had their shortcomings and the Governments have been trying to make amendments to it to improve its efficacy. Serious efforts in this direction were taken in the Himalayan state of Uttarakhand in north India and in December 2012 the Government came up with a novel corpus fund based compensation scheme which has been a path breaker in many ways. It has decentralised the decision making and also enhanced the rates of compensation. It also ensures that there is enough fund with the forest department to disburse the money quickly and there is no delay in such payment anymore which earlier used to be a major source of discontent amongst the affected people.

Key words: Man-animal conflicts, compensation, human-death, loss of property

Background

In many parts of the world, people and animals are increasingly coming into conflict over living space and food. This is mainly due to expanding human populations and the continued loss of natural habitats (Anon. 2006).

The impacts are often huge. People lose their crops, livestock, property, and sometimes their lives. The animals, many of which are already threatened or endangered, are often killed in retaliation or to 'prevent' future conflicts (Anon. 2006). Human-animal conflict is a problem witnessed in most areas of the world. However it is in the developing countries with large human populations that the impacts are felt most owing to higher number of poor people living in close proximity to wild animals and having a frequent interface with them owing to their direct dependence on natural resources (Anon. 2006, Palita and Purohit 2008).

India with a booming human population, strict wildlife protection legislations and religious tolerance towards animals is plagued with extreme magnitude of man-animal conflicts. While a number of solutions are being tried to deal with the problems they at best have been able to contain the problem to some degree, but could never come anywhere close to eradicating it. The solutions include killing or capturing the problem animal, building barriers or paying compensation or ex-gratia relief.

Uttarakhand: A biodiversity rich Himalayan state

Uttarakhand is an Indian Himalayan state which was carved out in the year 2000 from a larger state of Uttar Pradesh. Uttarakhand has an area of 53,483 sq. km (1.6% of India's total geographical area). From the hilly districts of Uttarakhand, two major Indian rivers originate, the Ganga and Yamuna.

It is a forest dominated state which has nearly 70% of its geographical area legally under forest. However as per the satellite imagery based interpretation 45.82% of the area of the state is under forest cover (Anon. 2014) as many areas designated as forests are alpine grasslands or permanently snow-bound areas. The main forest types of the State are Tropical Moist Deciduous, Tropical Dry Deciduous, Subtropical Pine, Himalayan Moist Temperate, Himalayan Dry Temperate, and Subalpine Forests and Alpine scrub (Anon., 2014).

Uttarakhand has six national parks, Corbett, Gangotri, Govind, Nanda Devi, Rajaji, and Valley of Flowers. They constitute an area of 5001.4 sq. km. The State also has seven wildlife sanctuaries: Askot, Binsar, Govind, Kedarnath, Mussoorie, Sonanadi and Nandhour and together they cover an area of 2683.7 sq. km. The state also has three conservation reserves: Asan, Jhilmil, and the newly declared Powalgarh covering an area of 100.5 sq. km. Together the protected areas cover an area of 14.56% of the state's geographical area. Nanda Devi Biosphere Reserve, though not classified as a protected area, is a large conservation unit in Upper Himalayas, covering an area of 5900 sq. km.

According to the 2011 Census, the total human population of Uttarakhand is 10.09 million (0.8% of the country's population). The urban population is 30.2%, while 69.8% is rural. The average population density is 189 persons per sq. km. Tribes constitute 2.9% of the State's population.

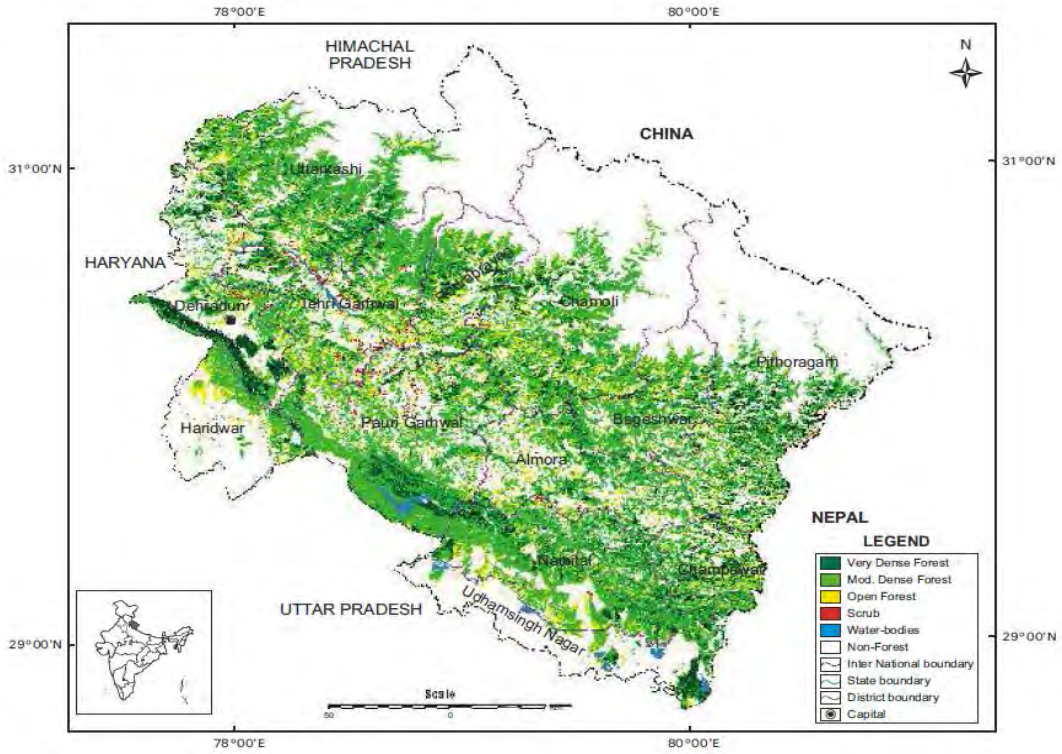

Figure 1. Forest cover map of Uttarakhand (courtesy Anon. 2014)

Extent of damage to human life and property

Uttarakhand has had a history of man-animal conflict like many other forested areas of the world. While in olden times, there was no proper documentation of the loss of human life and property or it is perhaps inaccessible today, it is through popular writings that we get an idea of scale of this problem. Some of the finest writings on the subject are very popular even today, the best being from Jim Corbett, the legendary hunter turned conservationist. Jim Corbett wrote many popular books based on his pursuit of man-eating tigers and leopards in what is today's Uttarakhand. Even though most of his books were primarily centred around hunting down man-eaters, the perfect description of flora and fauna as also the cultural and social practices make them an unavoidable read for anybody interested in the natural history of the region.

Just from the sheer number of man-eaters killed by Jim Corbett and also the number of people killed by these beasts, one can conclude that the number of people killed were in no way less than what it is today. For example the man-eating leopard of Rudraprayag operating in a small area, alone killed 125 people in ten years as per the records, which must be under-estimation in the days of poor communication in the early part of last century. Compared to that, the annual average number of deaths in the entire state of Uttarakhand due to leopard is about 17 deaths based on the statistics from forest department since the creation of the state. However the conflict appears to have increased in magnitude since the tolerance of the people has gone down tremendously while in olden times it was considered to be a way of life. There is a much greater furore from the people in any conflict taking place particularly in case of human deaths with a huge media coverage.

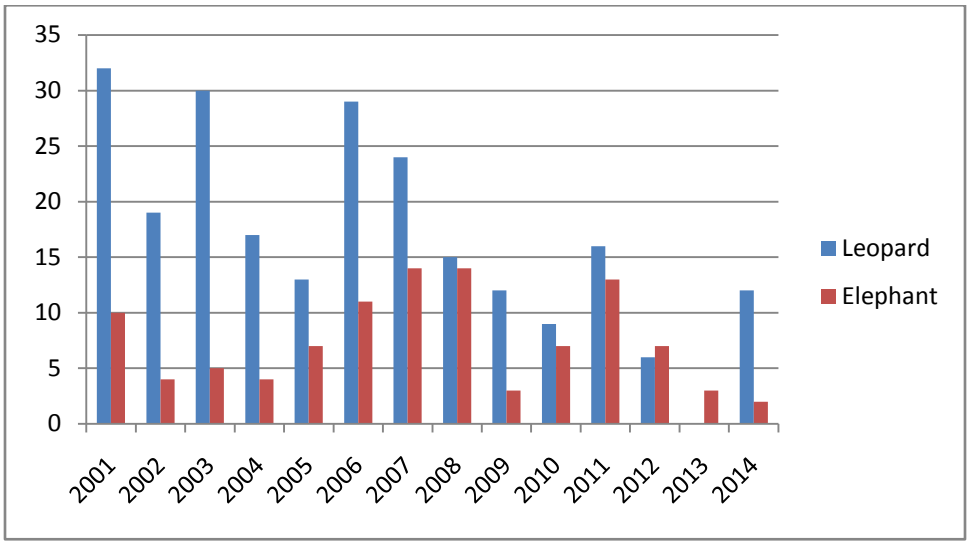

Figure 2. No of humans killed by wild animals in Uttarakhand owing to two major wild animal species responsible for conflicts from year 2001 to 2014

Looking at the statistics of human deaths (figure 2), it is evident that the main wildlife species responsible for loss of human lives in Uttarakhand are leopards and elephants. While elephants (*Elephas maximus*) are found in the foothills in the tropical forest rich southern part of the state, leopards (*Panthera pardus*) are found in the entire state excepting very high altitude areas (above 3500m). However it is in the mid-hills (see figure 1) that the there are maximum deaths due to leopards which is the area with poor wild prey owing to poor and degraded forest cover. The

case of humans injured (figure 3) owing to wild animal though is a little different. Here, the primary species responsible are leopards closely followed by Bear (mainly Himalayan black bear, *Selenarctos thibetanus* in mid to upper hills). Another interesting observation is the overall decline in the cases of human deaths or injury which is perhaps owing to quicker response from the forest department to deal with conflict owing to better communication, equipment and expertise. In addition better housing with lesser use of open air toilets may also be a reason for this decline.

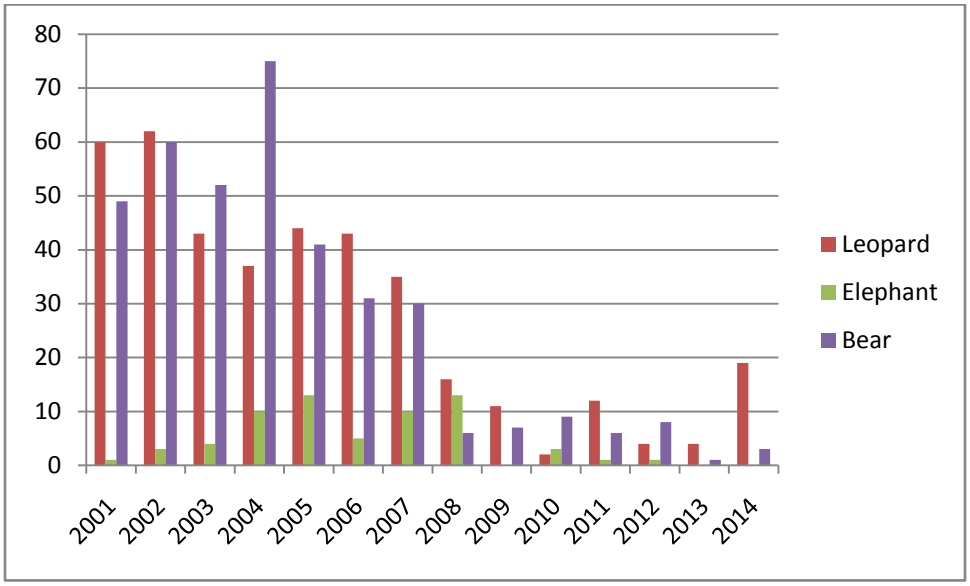

Figure 3. Number of humans injured by wild animals in Uttarakhand owing to three major wild animal species responsible for conflicts from year 2001 to 2014

While the cases of human death and injury take place intermittently, what bothers the people on a regular basis is the loss to property, mainly crops. The main wildlife species responsible for this include elephants and nilgai (*Boselaphus tragocamelus*) in the foothills, while wild pigs (*Sus scrofa*) do the damage across the state. Of late rhesus monkeys (*Macaca mulatta*) too are causing a lot of damage to crops and also occasionally bite humans. The problem is so large and spread out that it is difficult to present in quantified terms.

Methods to deal with the problems

Like any management problem the issue of man-animal conflict has long term and short term solutions, both of which are important in their own way.

There are some very long term solutions such as proper land use planning which will ensure that both humans and animals have the space they need. Protecting key areas for wildlife, creating buffer zones and investing in alternative land uses are some of the steps to make this happen. In order to be truly effective, prevention of human-wildlife conflict has to involve the full scope of society: international organizations, governments, NGOs, communities, consumers and individuals. All this may not be possible until the local community plays the key role as they are the ones who face the conflict directly. Interestingly they are also the people who can benefit the most from this if they are empowered to manage their relationship with wild animals, which can become allies in bringing income and promoting a better quality of life for all (Anon. 2006).

However the field forest and wildlife managers, often have to look for immediate and short term measures to deal with this conflict. After all, it is they who have to face the anger and acrimony of the local people most, which often becomes too explosive.

Variety of short term solutions has been put to action to deal with the problem of man-animal interface conflict. Some of them are preventive to reduce the chances of conflict taking place while many of them try to deal with it after the incident has happened.

The most important of the preventive methods is creating barriers and a number of them have been tried depending on the species, terrain and climate. They range from vegetative barriers, to trenches, walls and electric fences and have varying efficacy and costs. Alternating cropping and keeping vigil are also preventive methods in vogue.

The main problem faced by the manager is when an incidence of conflict actually takes place. It assumes serious proportions if it pertains to loss of human life or serious injury. At times the situation can become so serious that it becomes a law and order problem. The measures taken by the managers at such times are of immediate nature and usually include a two pronged strategy. First and foremost is to deal with the causal animal which is often killed, captured of scared away from the immediate vicinity of the problem site. There is an administrative system in place for this which is governed by the wildlife (protection) act 1972 which empowers the chief wildlife warden of the state or the authorised officer as the case may be, to declare an animal as problem animal and give orders for its killing or capturing.

The second part of the strategy is to try to compensate for the loss. While compensation is acceptable for loss of property, it is not meaningful in case of loss of human life since it cannot be compensated monetarily. In such cases ex-gratia relief is provided to the kin of the victim. In the rest of this paper, for the sake of convenience, the word 'compensation' is used for both compensation for loss of property and ex-gratia relief in case of loss of human life unless otherwise stated.

While it is not possible to trace the history of initiation of compensation schemes, they are definitely not very old. There is a school of thought which strongly feels that compensating for wildlife damage is not good for conservation. While compensating farmers and pastoralists for loss of their crops and livestock can reduce hunting pressure, it can also lead to a decrease in efforts to prevent damage and exacerbate conflicts with wildlife (Bulte and Rondeua, 2005). In a country like India where there has been a lot of tolerance towards wild animals owing to social and religious reasons, it according to many has led to alienation of people from wildlife. Traditionally Indians took the loss due to wild animals as a way of life but now most of them feel that the wild animals belongs to the Government and it is Government's duty to compensate them for the losses caused by such animals. The extreme anger displayed by people in such situations probably partly stems out of this. Never-the-less since compensation is being practiced for a substantially long time it will be impossible to withdraw it and the effort should be to make it efficient and a genuine solution to the problem. Moreover it actually helps in providing financial help to poor people in the hour of need.

Evolution of Compensation strategy in Uttarakhand

Strategy before December 2012

When Uttarakhand became a new state in November 2000, it inherited the compensation strategy from its parent state Uttar Pradesh. The prevailing administrative order in this regard was issued on 06 December 1996. It had provisions for compensation for loss of livestock, crops and houses as well as ex-gratia relief for human loss of life or injury. It had certain conditions laid out for payment of compensation which at times were not very easy to follow. These included informing the nearest forest officer not below the rank of a forester/assistant wildlife warden within 24 hours of the incident and a preliminary enquiry by him/her. The final enquiry of the case was to be done by a wildlife warden/assistant conservator of forests, an officer of superior rank. After the enquiry, if the case is found to be correct the conservator of forests of the region (circle) was to forward the case to the chief wildlife warden of the state who would be the final authority to take a decision on the matter. The order also identified the budget head from which the disbursement of the sanctioned compensation would be made. The ex-gratia relief in case of human death in this order was Rs 50,000/-. The major lacuna with this order was that the procedure involved multiple steps which were very difficult for villagers to go through. It was beset with red-tape and though it was expected that it would help curb false fabricated cases, it also adversely affected the genuine ones. In fact the procedure was so long that in most cases people failed to take them to the logical end. Even if somebody managed to get the procedure complete, very often the concerned forest divisions would not have budgetary provision in the requisite accounts head delaying the payment for months. Many divisions had pendency of huge amounts of money, often carried over for months and sometimes years.

After the creation of the state of Uttarakhand, this order was revised on 28th July 2005. This order only increased the amount of compensation, but the rest of the administrative procedure remained as cumbersome as the previous one. For example the ex-gratia relief in case of human death was doubled to Rs 1,00,000/- in reference to the 1996 order. Thus the administrative orders for compensation in Uttarakhand failed to make a genuine positive impact in the overall effort to deal with the problem of man-animal conflict. There was however a higher disbursement of compensation post 2005 as is evident from the charts below (figure 4, 5, and 6) which display the compensation disbursed in select representative forest/wildlife divisions in Uttarakhand. This is partly due to the fact that number of cases increased slightly post 2005 but primarily owing to increase in compensation rates.

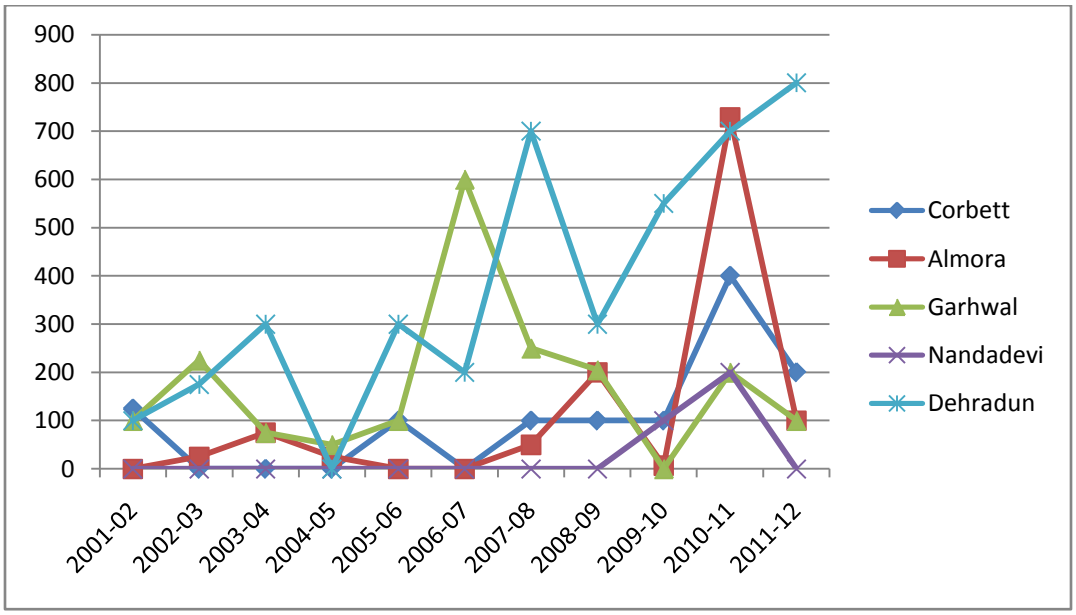

Figure 4. Ex-gratia relief paid for human deaths due wild animals in select representative forest/wildlife divisions in Uttarakhand in thousand Indian Rupees from 2001-02 to 2011-2012.

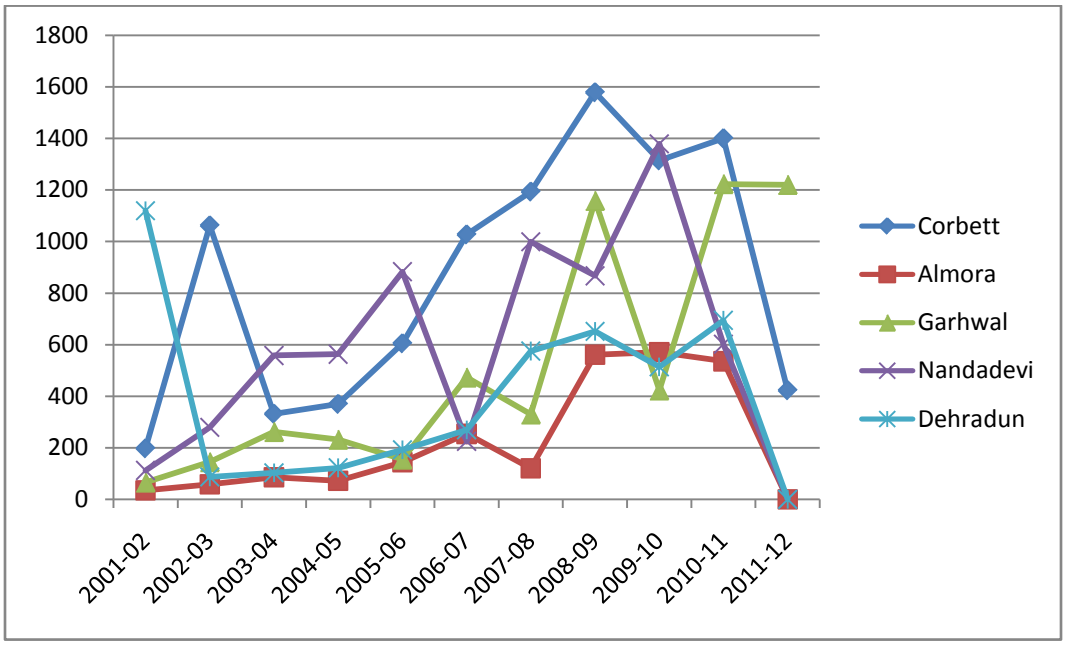

Figure 5. Compensation paid for loss of livestock in select representative forest/wildlife divisions in Uttarakhand in thousand Indian Rupees from 2001-02 to 2011-2012.

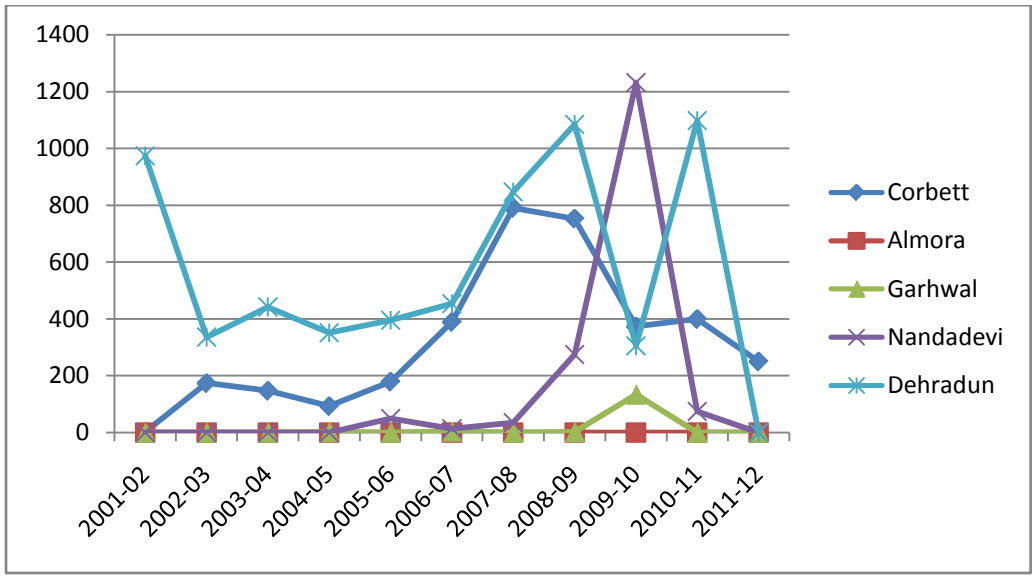

Figure 6. Compensation paid for crop damage in select representative forest/wildlife divisions in Uttarakhand in thousand Indian rupees form 2001-02 to 2011-2012.

The new rules in December 2012

10th December 2012 was a major watershed in the history of man-wildlife conflict in the state of Uttarakhand. On this day 'man-animal conflict relief fund disbursement rules' were issued by the state Government. Instead of the prevailing administrative order, these rules created a corpus for a steady supply of funds for financing the compensation relating to loss of human life and property. The corpus was created from funds from various sources viz. state Government, financial support from central Government, grant from compensatory afforestation fund management and planning authority, Uttarakhand (CAMPA), grant from Uttarakhand forest development corporation, grants from private and public sector or other agencies. The fund has a working committee headed by the principal chief conservator of forests (PCCF) and additional PCCF planning and financial management (APCCF, PFM) as the member secretary. The fund is maintained as an interest bearing account in a nationalised bank operated by APCCF, PFM. The account has titles for each forest/wildlife division to which APCCF, PFM would transfer money as per the requirement of the respective division ensuring that a minimum sum of Rs 20,00,000/- will be maintained at all times in each division. The rules mandate that once there is a disbursement from a division, and written information is sent to APCCF, PFM it is mandatory to replenish the amount in the title account within 48 hours. Thus the now rules ensure that money is always available for disbursement for compensation and budgetary constraints are not faced anymore.

There is also a major decentralisation in the decision making for the validity of the claims in the conflict cases in the new rules. While earlier orders empowered only the chief wildlife warden of the state to sanction the claims, the new rules have made the divisional forest officer (DFO) as the final sanctioning authority, thus bringing in a reduction of three tiers in the decision making. Also since the decentralisation is to DFO level, intense monitoring and speedy disposal of the cases is a reality now. However owing to this decentralisation, there is no nodal office which maintains the overall records on compensation as the final decision is taken at the division level. Thus it is difficult to get the state-wide picture of the incidences of man-animal conflicts.

The compensation rates have also been enhanced considerably in the new rules. As a sample, the ex-gratia relief for death of human adults has been raised to Rs 3,00,000/- from Rs 1,00,000/- in the 2005 order. Thus the rates of compensation have now become much meaningful. The overall comparison of compensation rates from the three Govt. orders across various categories is given in table 1 (Annexure 1).

Another major improvement is the very quick disbursement of interim relief to the victim of the man-animal conflict. Now within 48 hours of the first information of the incidence involving a human being, a relief of 30% of the total expected compensation amount/ex-gratia relief based on the nature of the incidence (injury/death), will be disbursed by the DFO based on a joint confirmation of the incidence by the local village headman/elected public representative and the local forest guard. This has facilitated paying for the immediate medical attention required by the injured victim or in case of death providing an immediate financial assistance to the kin of the deceased in the need of hour. In case of loss of livestock, the procedure is largely similar, but the interim relief is only 20% of the expected amount of compensation.

The remaining amount is disbursed after the final enquiry report is submitted by the assistant conservator of forests (ACF) or wildlife warden (WLW) as the case may be to the DFO. In case the case turns out to a false one, the interim relief will be recovered from the person concerned. This clause will certainly reduce the chances of misuse of the rules.

Conclusions

The new rules have drastically improved the efficiency of the compensation mechanism. No longer there are complaints about delay in payment of compensation and people are largely satisfied with the new enhanced rates. Although the precise information on volume of compensation post 2012 order is not available the field managers report a higher degree of satisfaction amongst the rural affected people of the state. Onus now lies with the DFOs to ensure that this new mechanism is not misused. Also there should be a nodal office to maintain the records of all man-animal conflict cases so that the overall state-level picture may be available which may help in evolving the policy and procedures further.

On the whole this new scheme has improved the compensation mechanism in Uttarakhand substantially and can be a model for other states in the country to follow.

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Annexure 1

Table 1

Rates of compensation payable in Uttarakhand since 1996 in Indian rupees

Conflict event\Year of order	**1996**	**2005**	**2012**
Human death or injury			
Minor injury	-	-	15000
Serious injury	5000	15000	50000
Partially disabled	10000	25000	100000
Fully disabled	50000	100000	200000
Death of adult	50000	100000	300000
Death of minor	25000	50000	300000
Death of livestock			
Cow	1200	-	15000
horse mule	1200	-	40000
Bull 3yr +	2300	-	
Buffalo 3yr +	2500	-	15000
Goat	-	-	3000
Damage to Crops @ per acre			
Sugarcane	2500	-	25000
Paddy/Wheat/Pulses	2000	-	15000
Other crops	1000	-	8000
House property			
Non-masonry house completely damaged	3000	-	25000
Non-masonry house partially damaged	600	-	20000
Thatch house/hut	400	-	5000
Masonry house partially damaged	-	-	15000
Masonry house completely damages	_-	_-	50000

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SHIFTING PERSPECTIVES IN HUMAN WILDLIFE CONFLICT: UNHEARD VOICES FROM THE SIKKIM AND DARJEELING HIMALAYA

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Summary

The case study highlights the nature of human wildlife conflict (HWC) in remote mountainous areas of Sikkim and Darjeeling, making a case that while being different to conflicts caused by larger mammals in the plains, conflict brought about by a host of small animals also has grievous impact on communities' lives and livelihoods. These communities live in difficult circumstances far removed from social amenities and HWC adds a heavy burden on their food and livelihood security. Being located in a globally significant biodiversity hotspot, the Eastern Himalaya, where conservation efforts take centre stage, their plight has remained understated and unheard. Under the circumstances, the case study narrates HWC management measures undertaken by forest fringe communities, building upon existing knowledge and strengthening their ongoing practices as possible measures of managing HWC. It also presents the coming together of two non- governmental organisations, WWF- India and DLR Prerna to address the issue of HWC in the landscape bringing about larger learning and facilitation on best practices. The limited conceptual and policy focus and resultant neglect of this critical issue of mountain HWC makes voicing the issue an important management measure. The paper also highlights the need to bring about more interdisciplinary discourse, convergence and investment to address this growing phenomenon which impacts lives of people.

Keywords: Human wildlife conflict and management, Sikkim and Darjeeling Himalaya, Forest fringe communities

Background

Locating Human Wildlife Conflict in Sikkim and Darjeeling Himalaya

The state of Sikkim and Darjeeling district in West Bengal, India, tucked within the borders of Nepal, Bhutan, China and Bangladesh, have a common narrative as the upper and middle watershed of the mighty River Teesta. However, the socio-political history of the region is not the same. Sikkim became a constituent state of India in 1975, prior to which it was ruled by a king as an Indian Protectorate. Darjeeling has a contested history of formation with a colonial history as well as continual manifestations of regional autonomy demands of Gorkhaland, a state within India[1].

[1]The history of Darjeeling is contested from the perspective of ownership and identity with sections of the present day district coming under Sikkim, Nepal and Bhutan. The British created Darjeeling under the Bengal Residency as a sanatorium and later developed it for interests in Tea and Forests - Darjeeling District Gazetteer LLS OMalley 1907. The demand for separation from Bengal begins before Indian Independence with the demand first placed in 1911 and continues today with the recent agitation resulting in the creation of the Gorkhaland Territorial

The common narrative is seen in the inclusion of Sikkim and Darjeeling as part of the Eastern Himalaya, among Earth's biodiversity hotspots (Myers *et al*. 2000, Sunar et al 2012). "Its richness in biodiversity has many factors including its location at the juncture of two continental plates placing it in an ecotone represented by flora and fauna from both. The complex and steep topography brings about large-scale climatic variability across the north-south axis further contributing to the diversity." (ICIMOD, 2001).

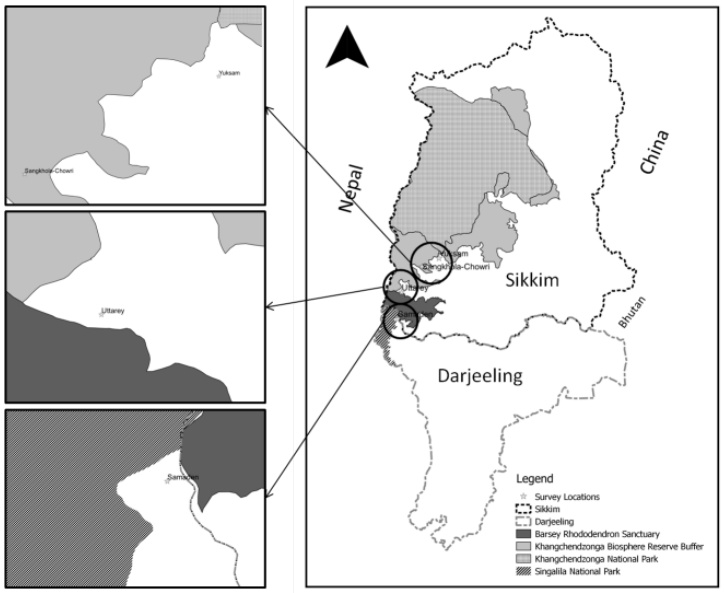

Figure 1. Locating Sikkim and Darjeeling in the case: Map by Partha S. Ghose

The celebration of the biodiversity richness from a conservation lens can be seen in the way the region has a large portion of the land under forests with a high concentration of Protected Areas.

Describing forests in Sikkim, "luxuriant forest abounding in all parts of the state, nearly 82% of the total geographical area is under the State Forest Department". The state has eight protected areas covering almost 31% of the total geographical area. (www.sikkimforest.gov.in). Likewise, the District of Darjeeling has 1303 km^2 of forest area which amounts to 41.3% of the total 3149 km^2 of the district. Darjeeling has four protected areas covering 364.2 km^2(www.wildbengal.com Directorate of Forests, WB) with Senchel Wildlife Sanctuary, one of the oldest in India, declared in 1915.

With over 15 years of conservation initiatives in the Sikkim and Darjeeling Himalaya by WWF India and DLR Prerna, the authors have observed that the conservation discourse in Sikkim and Darjeeling has a history of being shouldered by the Forest Department, with people's participation still minimal or totally non-existent. Participatory models of Joint Forest Management (JFM) do not address key issues of ownership, decision making spaces, participation and access and benefit sharing (Chakraborty, R., and Shrestha P., 2011.).

Administration, 2011, an autonomous governance institution with West Bengal and differing in physical boundaries than the Darjeeling District.

Similarly, in the context of Forest Rights Act, which changed the notion of ownership of forests and raised questions of historical injustice, the track record of implementation is poor. (Report on Implementation of the provisions of the "Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006" in the State of West Bengal. "A Citizen's Report on Status and Recommendations 2012 on Community Forest Rights under Forest Rights Act by Vasundhara and Kalpavriksh in collaboration with Oxfam for West Bengal" MoEF/MoTA Committee on Forest Rights Act, Report of visit to Sikkim State Consultation on FRA,22-24 September, 2010.)

Getting to know human wildlife conflict within mountain communities

Sikkim and Darjeeling are experiencing an escalating phenomenon of human wildlife conflict (HWC) in recent times. Consultations and interviews with communities living next to protected areas in both Sikkim and Darjeeling between 2009 and 2014 have highlighted that HWC is emerging as core issue in the last 10 to 15 years. These consultations were undertaken by World Wide Fund for Nature (WWF-India) – India in Sikkim and Senchel Wildlife Sanctuary of Darjeeling and Singalila National Park in Darjeeling by DLR Prerna, a Darjeeling based non-governmental organization, the latter being supported from Rufford Small Grants Foundation. In addition, community representatives have also been trained to collect daily data on HWC in the Singalila National Park fringes since 2011 under DLR Prerna's initiative.

In the past 10 to 15 years, HWC has gone beyond the nominal loss to people having to give up agriculture totally or change their profile of agriculture as an adaptation to the conflict. It is no longer restricted to the forest fringe communities but is spreading out to communities beyond. The issue has become a focal point of community conversations, almost equal to weather discussions in this part of the Himalaya, yet it still remains being discussed locally and has not found its way to corridors of power and policies. Reasons are multiple, chief among them being the irrefutable fact that HWC discourse is currently mega-fauna and plains centric. Mountain HWC is the result of a complex myriad of primarily small mammals raiding crops and livestock that do not stand the same graces as the prima donna mega fauna of conservation or are not listed as problem animals of HWC. The limited space for people's participation has meant that a core community issue has not gained prominence as much as it should have in policy debates. This gets compounded with the fact that the focus is on the region's investment in conservation for national and global good which is not always sensitive to micro-local needs. Forest villagers are a miniscule percentage of population and extremely marginalized, making their voices difficult to climb the ladder of voices that are heard.

Programme activities

Mapping stories of Human Wildlife Conflict in Sikkim and Darjeeling

Figure 2. Community consultation at Uttarey, Sikkim (*Pic: WWF – India*)

Community consultations in Sikkim were conducted in the fringe villages of four protected areas Pangolakha Wildlife, Fambong Lho Wildlife and Barsey Rhododendron Sanctuaries and Khangchendzonga National Park. Detailed survey on HWC patterns, main problem animals, crop loss data, measures taken by communities, compensation details were undertaken. In Darjeeling, the community consultations revolved around

the fringe and core villages of Senchel Wildlife Sanctuary and Singalila National Park. HWC was also mapped in community consultations which enabled deeper reflections on flows and patterns of HWC within a village set up. The communities were facilitated to draw a base resource map of the village, demarcate movement of animals, most vulnerable areas, immediate forest types and geography that would influence HWC. On this base map, every month an overlay of animal movement was layered which enabled the analysis of patterns and flows of HWC at the village level. Cropping patterns, seasonal mapping and forest changes, disaggregated the conflict for each village. Daily data collected in 11 forest villages fringing Singalila National Park since 2013 in Darjeeling, with partnership of community representatives, DLR Prerna and Ashoka Trust for Research and Environment and Ecology (ATREE), showed production of crops and damage to these crops in greater detail.

The geographical spread of the protected areas in the consultative process has ensured a good representative of Sikkim and Darjeeling landscape. Most of these communities have very small landholdings of 2 to 10 acres with agriculture being their primary livelihood. They grow a host of crops with potato, maize, millets, legumes, greens, squash and pumpkins being the primary crops. All the communities have livestock and some have pastoral roots as recent as a generation ago. They have a close association with the forest and depend on it for many purposes including for food, fodder, fertilizer, timber and firewood. These communities are far removed from existing social infrastructure and access to the market leading to issues of opportunity deficits and remunerative justice. Adding to the existing burden, human wildlife conflict has emerged as an extreme challenge to their lives and livelihood.

The species of animals causing damage to crops and livestock and their degree varied considerably across the different village clusters in Sikkim and Darjeeling. The main ones were wild pig (*Sus scrofa*); Himalayan crestless porcupine (*Hystrix hodgsoni);* barking deer (*Muntiacus muntjak*); Assamese macaque (*Macaca assamensis*); yellow-throated marten (*Martes flavigula*); a number of birds, the identified ones being: eagle, laughing thrush, oriental turtle dove (*Streptopelia orientalis*), bulbul; mouse; rat; squirrel; jackal (*Canis aureus*); Indian hare (*Lepus nigricollis*); Asiatic black bear (*Ursus thibetanus*); large Indian civet (*Viverra zibetha*); jungle cat (*Felis chaus*); leopard (*Panthera pardus*). The list is a diverse range of predominantly small animals and in combinations cause havoc to agricultural production.

Wild pig ranks among the topmost conflict causing animals, especially in the higher mountain villages. Most describe that wild pigs have made a foray into the villages in the last 10 to 15 years only. As more data is being generated with closer observations, the list of animals in HWC is increasing. The list of birds gets more detailed and their role in damage is significant and cannot be ignored. It must be noted that human life is only endangered with incidences of bear and human conflicts. Importantly, retaliatory actions are not heard of across the landscape.

Within the limited mountain agricultural productivity and exploitative market, HWC takes a large toll on the communities. To cite just a few examples from the consultations and data collected over a period of time, in Samanden Forest Village, Singalila National Park, Darjeeling, HWC cases was recorded for 17 different crop types.The top three animals engaged in HWC, namely wild pig, porcupine and barking deer destroyed 25.2%, 24.1% and 19.78% respectively

of the total estimated yields[2] of these crops: beans, peas, potato, squash, maize, millet, radish, soyabean and pumpkin in Samanden Forest Village during 2011 and 2012. This data shows that the size of the animal is not proportional to the damage caused, as an animal as small as the porcupine was also recorded to cause extensive damages.

Figure 3. Wild Pig inside Barsey, Sikkim captured on camera trap, (*Pic: WWF – India*)

Figure 4. Destruction of maize in Samaden FV, Darjeeling (*Pic: Sailesh C Sharma, DLR Prerna*)

The figures in Table 1 show the extent of crop loss around Barsey Rhododendron Sanctuary in Sikkim, which ranges from a low of 11.67 per cent to a high of 64.44 per cent. The list of crops includes both important cash crops like cardamom and legumes and food crops of potatoes and maize. Potato is equally an important cash crop for farmers.

Table 1. Percentage crop damaged of estimated annual yield of villages fringing Barsey Rhododendron Sanctuary, Sikkim 2012-13

Villages	Maize	Potatoes	Beans	Peas	Cardamom	Soyabean	Millet	Cabbage	Chayote
Gumpadara	34.64	30.07	39.75	38.1	42.67	64.44	25	0	0
Upper Mukrung	38.77	36.22	34.21	35.3	40	0	0	25	0
Simphok	35.29	44.55	38.06	27.6	0	32.26	0	16.67	50
Average of 3 villages	36.23	36.95	37.33	33.7	27.56	32.23	11.67	13.89	16.67

In terms of livestock depredation, poultry was the most affected in majority of the villages and yellow-throated marten followed by raptors like eagles and kites was the predominant poultry damaging species. In some cases jackals also preyed on poultry. Sangkhola-Chowri cluster in Sikkim showed that leopards were primarily predating upon Dzos, mix of yak and cow. Data from other villages indicated that livestock including cows, goats and horses were lost to leopards on a regular basis. Leopards preyed on domestic dogs too.

[2] The survey calculated the estimated yield of each crop of each village by aggregating the data from each household and against that estimated yield, crop damaged (local unit of measure was used) was recorded. The local unit of measure was standardized and the crop damaged was then converted to percentage of the estimated yield.

The emerging data shows that HWC affects both nutrition and economic security of communities who are already living in difficult circumstances. This high rate of loss in expected income is substantial in any economic context, but for marginalized communities it has devastating consequences. Primary livelihood security is at threat, and the threat continuing every year with no solution in sight has rendered communities helpless. In most instances, the village economy is now being supplemented by incomes that are derived from migration and wage labour, with solutions for HWC still remaining beyond the reach of communities.

In Sikkim, a set of rules and guidelines exist for assessment and disbursement of compensation for damage to crop and livestock in the fringe of Protected Areas. Most often, amounts were distributed without actual regards to the quantum of damage and the process fails to reach the genuine victims. Only 4% of the respondents in Pangolakha and Fambong Lho fringe areas had received compensation, while the number was 29% in case of Barsey Rhododendron Sanctuary. In the case of Darjeeling, however, there were no instances of compensation being given ever to any of the affected households nor were the villagers aware of if any such complaints would be addressed.

Community costs of human wildlife conflict raises critical questions of, should not conservation be sensitive to local communities too and address issues like HWC? The lack of redress for HWC in Sikkim and Darjeeling throws the question of where is the remunerative justice for people who are the main stewards and custodians of conservation.

Human wildlife conflict resolution

Creating spaces for HWC conversations was an important step in addressing the issue. This was a shift from the traditional intervention logic of community conservation efforts by reducing pressure or dependency on forests, to the acknowledgement that conservation efforts have a direct negative impact on people's lives. It was an acknowledgement that the issue needs to be addressed for what it is and not from a perspective that efforts will lead to a greater good for humanity and life.

Mapping exercises enabled deeper reflections on flows and patterns of HWC within a village set up. Cropping patterns, seasonal mapping and forest changes[3] disaggregated the conflict for each village. Daily data collection showed details of productivity of crops and damage to these crops.

This extended dialogue was an extremely important learning process to map the conflict, learn from existing management practices and create pathways for further action. Most communities partially fence their land, erect scarecrows, stand vigil, rattle tins, bang drums and used catapults to ward of animals. However, on the whole these practices work well for a short span of time only. Also these efforts are extremely capital intensive and resource heavy, so, limited to community actions, these interventions were proving to be losing battles against the animal raids.

[3] During 2011 to 2012 there was excessive fruiting of *Litho carpus* in the forest which made food easy and plentiful to wild pigs reducing crop raids. Since then there has been yearly excessive fruiting even though community observations put the cycle of excessive fruiting to approximately once in 10 years.

Figure 5. Bamboo fence in Darjeeling, *Photo - Roshan P Rai (DLR Prerna)*

Figure 6. Stone Wall in Sikkim, *Photo -Sailesh C. Sharma (DLR Prerna)*

Building on the existing community interventions, strengthening of the fences was undertaken as one of the major interventions. Most communities have been fencing off their most important crops with a bamboo fence. The fences are expensive and not very efficient in terms of warding off animals as well as have a very short life span. Fences in villages in Darjeeling had been strengthened with barbed wire, supplied by the forest department in the past. Community initiatives have also included long term investment of dry walls as well as trenches outside of the fences. Innovative measures which includes nets as fences with lights to ward off animal depredation in Barsey Rhododendron Sanctuary have been implemented.

Diversification of the fences to have multiple functionality lead to the notion of bio-fences or living fences which is one the main interventions that was initiated by DLR Prerna in Darjeeling. A bio-fence is a thick mesh of multiple plants grown around a village or farm boundary to ward of animals. A list of species for the bio-fence emerged from each village consultations and the species of the bio-fence to have functions of warding of animals, fodder source, soil conservation, diversification of livelihoods and biodiversity values.

Tea[4] was introduced as one of the species as it is not eaten by any of the animals coming into conflict and it also provides an additional livelihood option. Stock for other species used in bio-fence was sustainably extracted from the forest with permission and support from the forest department. Working with limited resources meant prioritizing bio-fences in most vulnerable zones of the village that emerged out of the mapping exercises. This process strengthened community decision making processes, optimum resource utilization and evolution of site specific strategies for bio-fences.

Linkage with the forest department was further strengthened and welcomed by the department. Forest Department Staff who deal with communities on a day to day basis are constantly aware of the issue of HWC but with lack of policy support are unable to take action.

In 2013-2014, five villages in Singalila National Park, Darjeeling fringe were given Indian Rupees 8000 and 1000 tea saplings each to strengthen their bio-fences. This exercise brought

[4] Tea, *Thea chinensis syn. Camellia sinensis,* was introduced to Darjeeling by the British from China and none of the animals feed on it.

about process as well as product innovation where communities figured out how best they could maximize the resource opportunity. At the end of one year, 3350 metres of bio-fence with a survival rate of 70% was built. Each village undertook the bio-fencing exercise in different ways such as providing for half wage rate for people who had to go to the forest to collect plant material, a picnic for the community on the days of planting, every household coming out with at least one adult member for strengthening the bio-fence and voluntary service. This meant that in the five villages, at least double the length and size of bio-fences were built within the resource available.

Figure 7. Bio fence at Dara Gaon, Forest Village, Darjeeling, *Photo - Roshan P Rai (DLR Prerna)*

Figure 8.*Chirrata, Photo – Sailesh C. Sharma (DLR Prerna)*

Expanding the cultivation of Chirrata (*Swertia chirrata*), a crop not affected by wild life and with a high medicinal market value, from a few families to the larger community diversified livelihood base was also another intervention. Chirrata is a relatively easy crop to grow and is grown on the sides of terraces which increased the growing space in the land. Forest department support ensures legality of the crop as not extracted from the wild. Such crops are being further explored.

In addition to the adoption of community interventions, the main intervention in Sikkim has been to look at convergence of government schemes for HWC management. Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has redefined employment guarantee and community asset building in India. Taking this opportunity, community dialogues in Uttarey and Ribdi villages bordering Barsey Rhododendron Sanctuary, in West Sikkim brought about the enlistment of fencing and bio-fencing as activities under MGNREGA. This process brought into focus HWC within the gamut of Panchayati Raj Institution, local rural self-governance, which predominantly talks about rural development and does not always engage with conservation especially in Sikkim and Darjeeling[5].

[5]Panchayati Raj is a contested institution in Darjeeling within the autonomy status of Gorkhaland Territorial Administration with resultant people's participation space limited.

At a community level, the process expanded the resource scope of asset building and development needs and priorities. At the state level, it facilitated the HWC discussion to go beyond the boundaries of the forest department and conservation organizations to initiate a much needed diversification of stakeholders for interventions. The process sets precedents that others can adopt.

Data collection, presentation and leveraging the stories that they told was key to taking them to spaces critical for policy changes. This was extremely important as the stories had never been closely heard beyond mid-management level even within the forest department. The gravity and authenticity of the stories were always questioned or relegated to a lower order priority as it did not involve the species commonly talked about in HWC or the problem animals of HWC. Smaller mammals also meant that it was concluded that the damage was way too small to be considered. Presentations of these stories backed by so called hard data, scientifically collected and collated at different forums like the Forest Department, West Bengal Fact Finding Commission on Environment (Non-Official) North Bengal Bench, 2012; Sustainable Mountain Development Summits II and III, Indian Mountain Initiative[6], 2012 and 2013 onwards has resulted in a wider solidarity, acceptance and understanding of HWC.

At a broader level, the issue of HWC also brought about a partnership of two NGOs, WWF India and DLR Prerna, which resulted in confirmation of data and community experiences, cross learning as well as adapting some of the community interventions across the landscape.

Results

Efficacy of the interventions to manage HWC

Even though the bio-fence was located in most vulnerable zones of the fringe villages only, its effect in reducing HWC has been recorded by the villagers. Communities of 5 forest villages came together and creatively strengthened 3350 metres of bio-fences putting in efforts that were beyond available resources. Its efficacy is seen in the acceptance of bio-fences by other communities like Chongri in Sikkim, and Darjeeling, the forest department and as well as continuing community investment in strengthening it.

Crops like *Chirrata* and tea is increasingly being spread within communities of Singalila National Park and Khangchendzonga Biosphere Reserve as a means of adaptation and conflict resolution of HWC as both the crops are not harmed by wild animals and offer alternate livelihood options.

Community based data collection on a regular basis in a large geographical spread in Sikkim and Darjeeling has enabled the raising of the issue in key forums. This constant dialogue and debate on the issue of HWC and its impact on communities has garnered solidarity and understanding which was not there a few years back. State level discussions in Sikkim now have HWC listed as one of the agenda and highest forest personnel talk about it officially. Not only that, the department is undertaking HWC management measures like solar fencing of Kitam Bird Sancturary Sikkim. There is growing awareness that there is need to know more about HWC in

[6]Indian Mountain Initiative (now called Integrated Mountain Initiative) is a movement of 11 mountain states and districts of Darjeeling and North Chachar Hills.

Sikkim and Darjeeling using the lens of mountains. The need for an integrated approach and convergence as a strategy is being discussed.

Enlistment of HWC in MGNREGA has diversified the stakeholder groups of the issue beyond the traditional organizations dealing with conservation. This is essential as management interventions for HWC is extremely capital intensive, making it impossible for a single organization or community to address it single handedly. Interventions are also not unilateral but multilateral and interdisciplinary requiring diverse knowledge and skill sets. This is a critical aspect of the case study as HWC management in mountain spaces of Sikkim and Darjeeling are extremely capital intensive and beyond the reach of communities, civil society or a single department. It calls for concerted efforts at an interdisciplinary level and convergence of multi-stakeholders.

The issue of HWC brought in partnership WWF-India, Sikkim and DLR Prerna, Darjeeling, two civil society organizations with no previous history of collaboration and a recognition that the issue is way bigger than a single organization to address.

Thus, the interventions of communities and civil society at a community level has definitely evolved management measures that have noticeable impacts in management of HWC, but conversations in corridors of power will ensure policy support leading to long term interventions at a landscape level and not just piecemeal interventions.

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