WWF

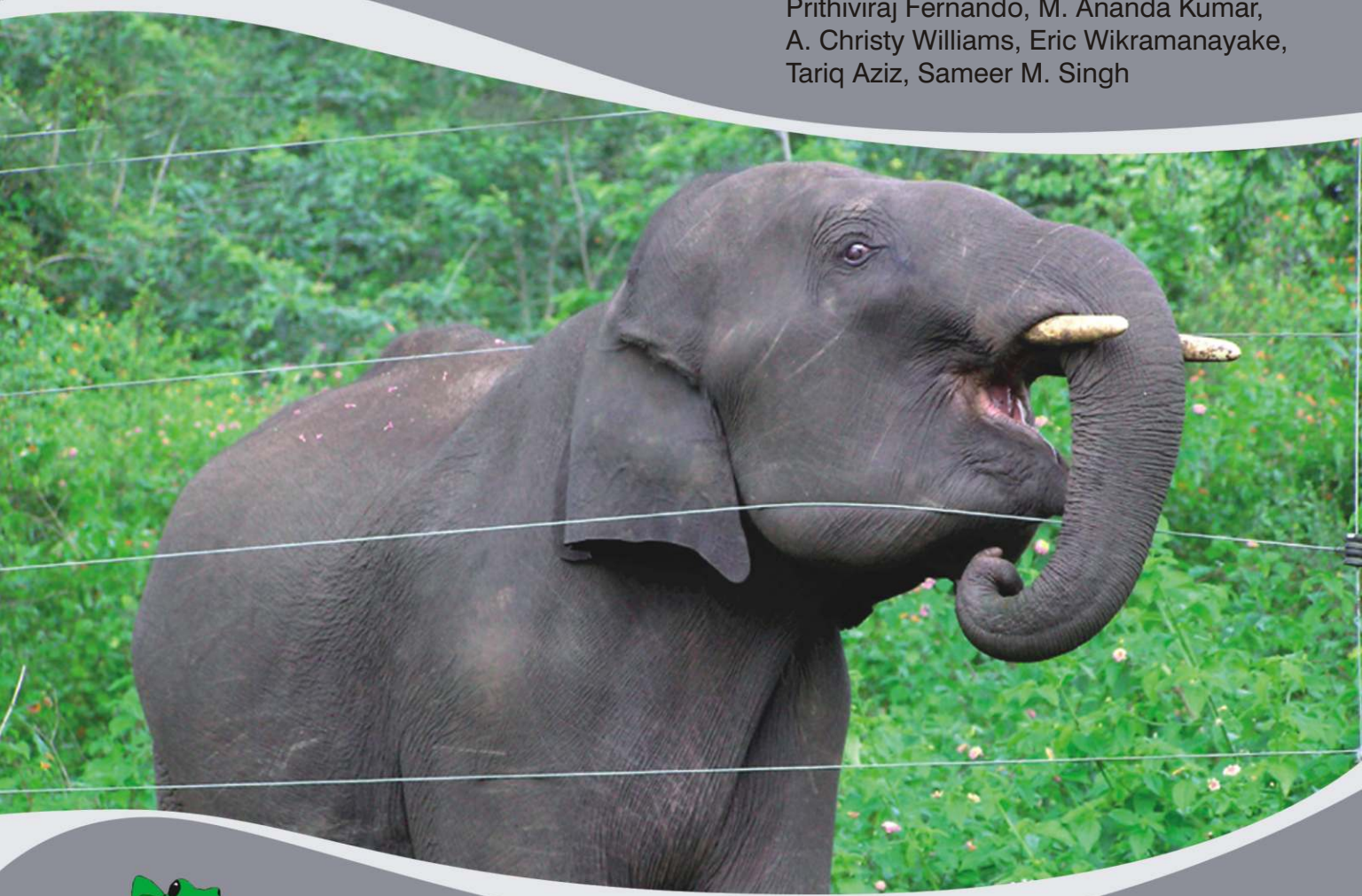
AREAS
ASIAN RHINO & ELEPHANT ACTION STRATEGY

WORLD BANK-WWF ALLIANCE FOR
FOREST CONSERVATION & SUSTAINABLE USE

Review of Human-Elephant Conflict Mitigation Measures Practiced in South Asia

(AREAS Technical Support Document Submitted to World Bank)

Prithiviraj Fernando, M. Ananda Kumar,
A. Christy Williams, Eric Wikramanayake,
Tariq Aziz, Sameer M. Singh



Centre for Conservation and Research

nature conservation foundation
science for conservation

WORLD BANK-WWF ALLIANCE FOR
FOREST CONSERVATION & SUSTAINABLE USE

Review of Human-Elephant Conflict Mitigation Measures Practiced in South Asia

(AREAS Technical Support Document Submitted to World Bank)

Prithiviraj Fernando, M. Ananda Kumar,
A. Christy Williams, Eric Wikramanayake,
Tariq Aziz, Sameer M. Singh

Published in 2008 by WWF - World Wide Fund for Nature.

Photographs by authors as credited.

CONTENTS

Preamble 1-2

LIST OF TECHNIQUES

Traditional Crop Protection 3-7

- Crop guarding
- Noise and Throwing Things
- Fire

Supplements to traditional crop protection

- Alarms
- Repellants

Organized Crop Protection 8-11

Guard teams,
Vehicle patrols,
Koonkies

Elephant Barriers 12-18

Physical
- Wire fences
- Log and stone fences
- Ditches
- Biological fences

Psychological
- Electric fences
- Cleared boundaries and simple demarcation of fields

Buffer Crops & Unpalatable Crops 19-20

Supplementary Feeding 21-22

Translocation 23-27

Chemical immobilization and transport
Elephant drives

Problem Animal Removal 28-33

Capture and domestication
Capture and semi-wild management
Elimination

Compensation & Insurance 34-35

Land-Use Planning 36-38

Providing benefits from conservation to Local communities

Recommendations 39

References Cited 40-43

Literature Cited 44-45

FORMAT FOR EACH TECHNIQUE

Technique
Applicable scale
Objective
Description of technique

Positive effects
People
Elephants

Negative effects
People
Elephants

Future needs

In-country applications
Sri Lanka

PREAMBLE

Few wild species evoke as much attention and varied emotions from humans as elephants. Their imposing size, high level of intelligence and complex social behavior attracts attention and endearment while their propensity to raid crops and sometimes aggressive behavior also instills fear and animosity. The Asian elephant (Elephas maximus) is a symbol of pride, status, and cultural heritage throughout its geographical range. Historically the elephant has been revered and worshipped as a God, used as a warrior, ambassador, beast of burden, and has held a central place in Asian civilizations. Today it is one of the leading 'flagship species' for biodiversity conservation in Asia. However, friction between humans and elephants termed Human-Elephant Conflict (HEC) occurring mainly over space and manifesting in seasonal raids in villages that lie in the elephants' range often result in retaliatory killings. This has come to seriously threaten their survival in the wild. If left unchecked it will result in the demise of an icon of Asia's heritage.

The consequences of human-elephant conflict are not only of key conservation concern but also are major socio-economic and political issues. Therefore, resolution of human-elephant conflict is a major concern and a high priority for conservation of elephants in range countries. Influx of humans and conversion of natural habitat to human dominated land-use causes fragmentation and loss of elephant habitat. With increased contact, elephants progressively raid crop fields and break down houses to get at stored crops. Chance encounters between elephants and people, as well as efforts of people to guard against elephant depredation results in injury and death of humans. Harmful methods employed by people in the process result in death and injury of elephants thereby escalating human-elephant conflict.

Farming in areas with elephants has been the norm in many parts of Asia for thousands of years. Cultivated crops represent varieties of plants that have been artificially selected and bred to increase their nutritional value, palatability, productivity, and to decrease plant secondary compounds. As such, crops are much more attractive to herbivores than wild fodder. Wherever crops are cultivated in areas with elephants, crop raiding is an overriding factor, and farmers from time immemorial have devised ways and means of guarding their crops from raiders. Today, the main issue with prevention of crop raiding by elephants is not whether or not it can be achieved, but rather how it can be actualized at a favorable cost-benefit ratio. In most cases, the problem is that the economic value of crops cultivated is very low. Although the total loss due to elephants can be considerable, the damage per-unit of cultivation is generally very low. Therefore, while many methods can be utilized to effectively safe guard crops from elephants the cost per-unit of safeguarding can be comparatively high, preventing their employment on a wide scale.

A multitude of traditional methods have been developed through the ages to reduce and prevent crop raiding by elephants in conflict prone areas. The escalation of human-elephant conflict in the past few decades and technological advances have resulted in development of additional methods to address the problem. In general, traditional methods are easy to use, have low costs and are more effective at low levels of conflict. With increasing conflict, more technical and sophisticated methods need to be used which carry higher costs. The various techniques employed in human-elephant conflict mitigation range from chasing elephants by shouting, drum-beating, noise-making, use of fire crackers, lights and torches, to engaging koonkies (trained elephants) and specially trained and equipped teams of people, construction of elephant barriers such as rubble walls, ditches and canals, biological and electric fences, deployment of alarms, development of communication systems, capture, translocation and culling of problem animals, use of highly sophisticated technology such as satellite telemetry, and compensation and insurance schemes.

No one method is a 'stand alone' universal solution for conflict resolution/mitigation. Each technique has its advantages and

disadvantages. Methods maybe used in differing permutations to increase their effectiveness. Farming practices, traditions and expectations of people, environmental conditions, habitat characteristics, resource availability and even elephant behavior may vary widely across the range of Asian elephants. Thus local information is vital to determine what methods will be appropriate for a given situation. Being intelligent and highly adaptable animals elephants also learn to circumvent and overcome many of the methods used for mitigation, and methods that were initially successful may lose their effectiveness over time. Therefore, continuous monitoring and adaptive management based on results is critical for successful human-elephant conflict mitigation. Most activities conducted to safe guard crops and to mitigate the human-elephant conflict have been developed almost entirely from the point of view of human needs. The impact of such activities on elephants has been rarely studied. Some activities such as elephant translocation and range restriction with barriers, though usually conducted with the idea of safeguarding elephants, may be extremely detrimental to their survival when used inappropriately. Therefore, it is essential to not only monitor the success of activities in mitigating the conflict but also to study their direct and indirect impacts on the elephants concerned.

TECHNIQUE:
TRADITIONAL CROP PROTECTION BY FARMERS

Applicable Scale:
Small-Medium (m^2 to a few km^2)

Objective:
Preventing Entry And/or Chasing Elephants Away From Crop Fields.

Description of Technique

Crop Guarding

Guarding of crops is conducted by farmers with different levels of organization ranging from guarding isolated fields by individual farmers to guarding the peripheries of contiguous fields by farmer or village societies. Farmers individually or collectively scare away elephants relying on the fear elephants, especially herds of females and young have of people. The mere presence of people in huts located within the fields may discourage elephants from raiding crops. Elevating huts on trees provides a vantage from which to observe the fields and also offers a degree of safety as well. The on-site presence of farmers also allows them to respond immediately to raiding elephants, thus minimizing damage.

Noise and Throwing Things:

Activities such as noise-making, shouting and throwing objects are more reactive and confrontational. Such activities may also indicate to elephants that their presence is detected, and that they have to contend with aggressive humans.

Fire:

Lighting fires has been a universal method of guarding crops against elephants and other wild animals since ancient times.

Presence of humans, noise making, fires etc. keep elephants away from crop fields or their vicinity by presenting cues that are clearly associated with humans. Such activities tend to lose their effectiveness in protecting crops as elephants become habituated with increased exposure to them, and the realization that such methods are not backed by any real physical threat or harm. Males appear to habituate to traditional methods of crop protection more readily than females in herds.

Supplements to traditional crop protection

Alarm:

Methods such as locating alarms on the periphery of crop fields work by demarcating and emphasizing human areas and alerting farmers, who then respond with additional activities to prevent raiding. Alarms by themselves can become ineffective as elephants learn and habituate to the lack of serious threat or physical harm. However, when situated on the periphery of fields or a further outer boundary, alarms can help farmers detect elephants before they enter fields. Peripheral alarm systems allow farmers to relax from keeping constant vigil thus relieving psychological stress and sleep deprivation in situations where depredations are infrequent.

Repellants:

Methods such as using 'chilli ropes' where chilli paste is mixed with grease and applied on ropes strung along the perimeter has potential to repel elephants. However, some elephants in Sri Lanka have taken to consuming chilli plants in recent times resulting in growing inefficacy of this method. The use of 'chilli bombs', where dried chillies are combined with combustible material and burnt, producing a noxious irritating smoke has been tried in Africa. Although theoretically possible the practical utility of such a method is doubtful other than as a means of advertising human presence as smoke disperses quickly with its direction being determined by the prevailing winds. This method cannot be applied across a large area with predictable results.

Locating bee boxes along the perimeter of fields has been suggested as a preventive method. However, as elephants usually raid crops at night when bees are inactive, and its difficulty of being deployed over a large area, the efficacy of the method is doubtful.

Play-back alarm calls:

Playing back alarm calls from elephants has also been tried on a small scale in Africa with no clear success, as different elephants responded differently to play back sounds. Such a method is unlikely to be of much utility as it requires expensive and sophisticated equipment that cannot be put to use over a large area. In turn, if deployed on a wide scale it could also disrupt the social behavior of elephants with disruptive repercussions on their social and reproductive behavior.

Information systems:

In areas where elephants are not resident but occur only during certain periods of the year, or when elephants make incursions into areas where they are not usually found, the possibility of HEC is high as people are taken unawares. In such situations advance warning of elephant movements through an informant system or mass media may help reduce HEC. It is also theoretically possible to monitor the movements of individual crop raiders and 'problem elephants' through GPS satellite radio collars and warn villagers of their presence in a particular location. This would entail identifying and collaring individual problem animals, receiving GPS locations via satellite or GSM technology, mapping the location on GIS maps, and informing the particular farmers who are at risk. However, given the very high expense of such equipment (around $ 5,000-8,000 per collar), their limited life (1-2 years), and the cost and effort involved in capturing and collaring such raiders, the benefit of such methods compared to the cost is very low and they cannot be applied to any area of significance or a significant number of animals. Therefore, such methods have limited practical application for day to day HEC management. In addition, usually farmers are only too well aware of the presence of problem elephants in their areas. The more pressing problem for them is how to protect their crops from such elephants. However, using such collars in scientific studies to identify temporal and spatial patterns of crop raiding, possible contributory factors, effectiveness of preventive methods etc. in different areas would provide valuable insights, which can then be used to develop more effective mitigation techniques for specific situations.

Positive Effects

People: Crop guarding gives farmers a sense of empowerment. When and where successful, occasional crop-raiding by elephants is not perceived as being significant.

Elephants: Because the above methods are non-lethal, they do not cause significant harm to elephants.

Negative Effects

People: When these methods fail - as they are bound to with eventual habituation - the animosity towards elephants begin to increase, as does the perception of the crop-depradation being significant. Furthermore, confrontational methods increase the risk of injury and death to farmers from elephants as the aggression levels increase on both sides.

Elephants: The failure of traditional methods with increased and repeated use, are likely to make people less tolerant of elephants and more likely to employ harmful and lethal methods.

Future Needs

Long term scientific assessment of the success and failure of traditional and supplementary methods of crop protection and changes in people's attitudes towards elephants and crop raiding with continued use of such methods; assessment of their impact on elephants, especially any differential impact on particular groups such as adult males or female groups.

IN-COUNTRY APPLICATIONS

Sri Lanka

Crop guarding:

In parts of Sri Lanka where elephant depredation is high, huts are constructed on trees, whereas in areas with low depredation rates construction is on the ground. Tree huts are usually constructed over 12 feet from the ground, and vary in construction and sophistication from a simple flimsy platform with a thatched roof, to more elaborate and sturdy constructions with mud and cow dung floor and walls of woven reeds, coconut fronds or woven sticks etc. In some established villages in the north-west of Sri Lanka, individual plots are configured as segments of a circle radiating out from the centre, so that each individual plot has a section of the perimeter. In some villages in the south where paddy is cultivated, the farmer society allocates the responsibility of guarding a segment of the perimeter of the aggregation of plots to each farmer, irrespective of whether an individual's plot is situated at the perimeter or within the plot. Such organized communal guarding of tracts tends to be very successful, especially when agricultural activity in the tract is coordinated with all farmers commencing cultivation and harvesting at the same time. However, it requires cohesion among the farmers and a central authority which can penalize those who do not comply with their guard duties. In most old village communities there is a high level of relatedness and cohesion among farmers which facilitates communal crop protection.

In contrast, in many of the vast tracts of cultivation under modern mega-irrigation development and settlement schemes, fields at the centre are well buffered from depredation by the surrounding fields, and since settlers have diverse origins there is little cohesion and agreement between farmers. In such situations it is difficult employ organized crop protection successfully as the farmers with fields in the centre are reluctant to participate in perimeter guarding. Lack of coordination in agricultural activities increases the risk of depredation. For example, the growing of different varieties of paddy by individual farmers results in harvesting of fields at different times. When a perimeter field is harvested early it is no longer guarded and affords access to elephants into the unguarded central fields.

Noise and throwing things

Noise is perhaps the most common and often used method around the country and consists of banging on tin cans, shouting, and lighting of firecrackers. The Department of Wildlife Conservation has a program of providing 'ali-wedi' or elephant firecrackers (large firecrackers approximately 25 cm in length and 2.5 cm diameter) to farmers in high HEC areas. Throwing objects ranging from rocks and sticks to firebrands at elephants are practiced commonly throughout the country. In some parts of the northwest, people have thrown lighted coconut shells packed with ash soaked in kerosene oil onto elephants, resulting in burn injuries to elephants. Adult males that habitually raid respond to such methods with increased aggression, escalating HEC.

Fire

Hanging lighted lamps along the perimeter is a more recent adaptation of fires and is practiced in the northwestern region. In some areas in the south lanterns with a reflecting cup that revolves in the wind have been fashioned and are strung on poles along the perimeter. Use of high power re-chargeable flashlights to scare elephants has become commonplace in recent times.

Alarms

Different types of alarms have been used to effect varying from bottles and tin cans strung along trip wires to ones that set off firecrackers or electric alarms fashioned from car horns. In general low cost low tech options are more liable to be widely taken up and used by farmers.

Simple alarm tin cans with stones. Traditional crop protection by farmers in north west Sri Lanka
© Prithiviraj Fernando

India

Crop guarding:

Crop guarding techniques have been a regular practice in almost all parts of the villages in the fringe areas of elephant habitats. Establishment of temporary elephant scare squads consisting of local construction of 'Tangsis/Machans' (temporary tree houses) on trees or on the ground to guard crop fields may help in effective guarding of crop fields and has been in practice in many parts of India. The Forest Department of Tamilnadu has initiated several mitigation techniques among which is the distribution of 25 high power search lights to farmers and tribals in settlements at a cost of Rs. 1.5 lakh ($ 3,250) to scare away the elephants straying into farm lands. However, their efficacy in sustainable and consistent cooperative guarding remains to be scientifically tested.

Noise and throwing things

Making noise to prevent elephant movement and chase elephants away from farm lands is the most commonly used technique in many villages adjoining elephant habitats. Methods such as shouting, drum-beating, fire crackers, firing gun shots into the air (by forest officials only), using torch light, pelting stones and lighted fuel-woods or other handy objects are used in dealing with raiding elephants. Some of these methods in Barpathar, Narayanguri, Raghobil, Mayongpara, and Barangabari villages of Manas National Park, Assam have yielded good results. Usually it involves groups of over 10 people resorting to shouting, using loud speakers, switching on radio or television sets from inside houses etc. Frequent use of fire crackers may habituate and eventually instill a lack of fear in elephants towards such methods. On several occasions elephants were observed exhibiting mock charges towards people employing such methods.

Fire

Burning rubber tubes and tires, use of fuel wood, power search lights etc. may be temporarily effective but tend to lose efficacy in the long run.

Alarms

Use of trip wire alarm systems as a method of intimating elephant incursions into farm land has not been widely practiced in India. Practice of trip-wire system with the involvement of local people has been under trial in some villages of Assam.

Information systems

Development of an effective communication system through establishment of informant network may be useful in fragmented landscapes such as the Anamalai hills where damages to grain stores and houses are the main results of human-elephant conflict. Articles in daily news papers, information network systems with the involvement of forest department personnel and plantation communities, and display of information about elephants on TV cable channels have been found to be useful in reduction of human elephant conflict (Kumar 2006) in certain areas. Use of satellite radio collars to track elephant movement and informing local people have been tried on an experimental basis (Venkataraman et al 2005, Rameshan 2007).

Recently six teams of 24 tribals have been employed as anti-depredation staff and deployed at Chinnathadagam, Narasipuram, Mangarai, Mulli-Velliangadu, Ansur and Sirumugai in the Coimbatore district of Tamilnadu to monitor movement of elephants and provide advance information for preventive measures.

TECHNIQUE:
ORGANIZED CROP PROTECTION BY TEAMS, KOONKIES AND VEHICLE PATROLS

Applicable Scale:

Medium-large (few km^2 to about a hundred km^2)
Preventing entry and/or chasing elephants away from larger tracts of cultivation.

Objective:

Preventing entry and/or chasing elephants away from larger tracts of cultivation.

Description of Technique

By Teams:

Organized crop protection by teams is expensive and requires dedicated staff, equipment and a recurrent budget. It is applicable to situations such as large plantations owned by companies. The technique is based on constructing a barrier (usually an electric fence) on the boundary between the plantation and elephant habitat which is guarded by teams of people in watch huts built along it. The main deterrent probably is the electric fence and not the intensive guarding as the fence prevents the majority of elephants especially herds, from entering plantations. However, some elephants, especially adult males may challenge such barriers. The additional protection provided by guard teams aims to reduce the likelihood of elephants challenging and breaching the barrier.

Vehicle patrols

Mobile patrol teams that respond to a breach situation can increase the effectiveness of crop protection. However, its success depends on the accessibility by vehicle to such points of occurrence, the ability to detect and inform the mobile team of such a breach in a timely manner and the response time. The use of technical equipment such as radio communication between mobile patrols and those who man watch huts, integration of automated indicators of breach points into the barrier, all terrain vehicles, powerful search lights etc. can increase the effectiveness of such protection. However, the costs involved escalate with increased sophistication.

Crop protection by koonkies

The use of tame elephants or koonkies to chase away crop-raiding elephants are best applicable and efficient where points of incursions are limited so that koonkies can be stationed at strategic locations for quick response. Where raiding incidents occur over large areas, and getting to the breach site takes a long time, using koonkies may be inefficient and inappropriate.

Positive Effects

People: The 'feel good factor' is high because there is active prevention of crop raiding and the perception that the problem is being addressed. It also provides employment to a large number of people.

Elephants: Where such guarding is successful and prevents raiding through non-injurious and non-lethal methods, the decrease in HEC may be of benefit to elephants.

Negative Effects

People: Use of koonkies may sometimes put mahouts in danger during the operations, especially when large herds are being driven. The operation may result in koonkies panicking due to aggressive reactions by wild elephants.

Firearms may cause injury or prove fatal in situations involving inexperienced users. Therefore, use of firearms should be limited to trained personnel.

Elephants: With increasing habituation of wild elephants towards these methods, teams are likely to employ more lethal and injurious means, including firearms and physical force with heavy equipment such as bulldozers and excavators to push elephants out and protect themselves.

Future Needs

Scientific assessment of the success and failure of such organized crop protection and economic assessment of the cost and benefit; GPS radio telemetry study of raiding and movement patterns of habitual fence breakers and crop raiders and their response time to organized crop protection.

IN-COUNTRY APPLICATIONS

Sri Lanka

In southern Sri Lanka organized crop guarding by teams is practiced in sugar cane plantations that have been established adjacent to protected areas harboring elephants e.g. Uda Walawe National Park and Yala National Park Block IV. Electric fences have been constructed around the peripheries of these plantations. At other places elephants have been restricted to the protected areas by electric fences along the adjacent park boundary.

Access roads and watch huts along the fences are manned at night, helping patrolling and monitoring the fence lines. Lamps are lit at points where regular breaching occurs. Patrolling is done by mobile teams on tractors usually equipped with firearms, spotlights, thunder flashes and flares. The teams usually patrol through the night. When elephants manage to break the fences and enter the plantation they are rounded up and herded back out by these teams.

The Department of Wildlife Conservation also has a number of mobile groups called 'Elephant Control Units' that respond to complaints from villagers by visiting the relevant sites to chase elephants away, usually to the nearest forest.

India

Forty two elephant scare camps have been set up in Sakelshpur, Alur, Yesalur and Arkalgud regions in the Hassan district of Karnataka that will provide koonkies for managing crop raiding.

Managing HEC in Sonitpur in Assam India

Since 1972, 65% of the lowland semi-evergreen forest along the Himalayan foot hills in Assam has been destroyed. Human population in the region has increased by 20% in the last 10 years with pristine habitats being converted to croplands. In addition to population expansion, large tracts of forests have been cleared by an active timber mafia while political machinations have led to widespread encroachments. As a consequence human-elephant conflict became more pronounced. Often humans are killed when elephants raid farms and houses. As a result elephants are killed in retaliation by irate communities.

In a quest to reduce Human Elephant Conflict (HEC) WWF studied the conflict and developed a two pronged strategy to manage it in the district of Sonitpur in North Bank Landscape in Assam to keep elephants off crop fields and to regenerate lost elephant habitats.

Local communities were trained in understanding animal behavior and were shown the big picture of the conflict as understood after research. Trained elephants were employed to assist local communities in pushing elephants back into the forests through synchronized elephant drives. 72 anti depredation squads consisting village youths and over 15 trained elephants operating at strategic locations have brought down the losses due to conflict by a huge margin. The attitude of people towards elephants and their conservation also has shown positive trends.

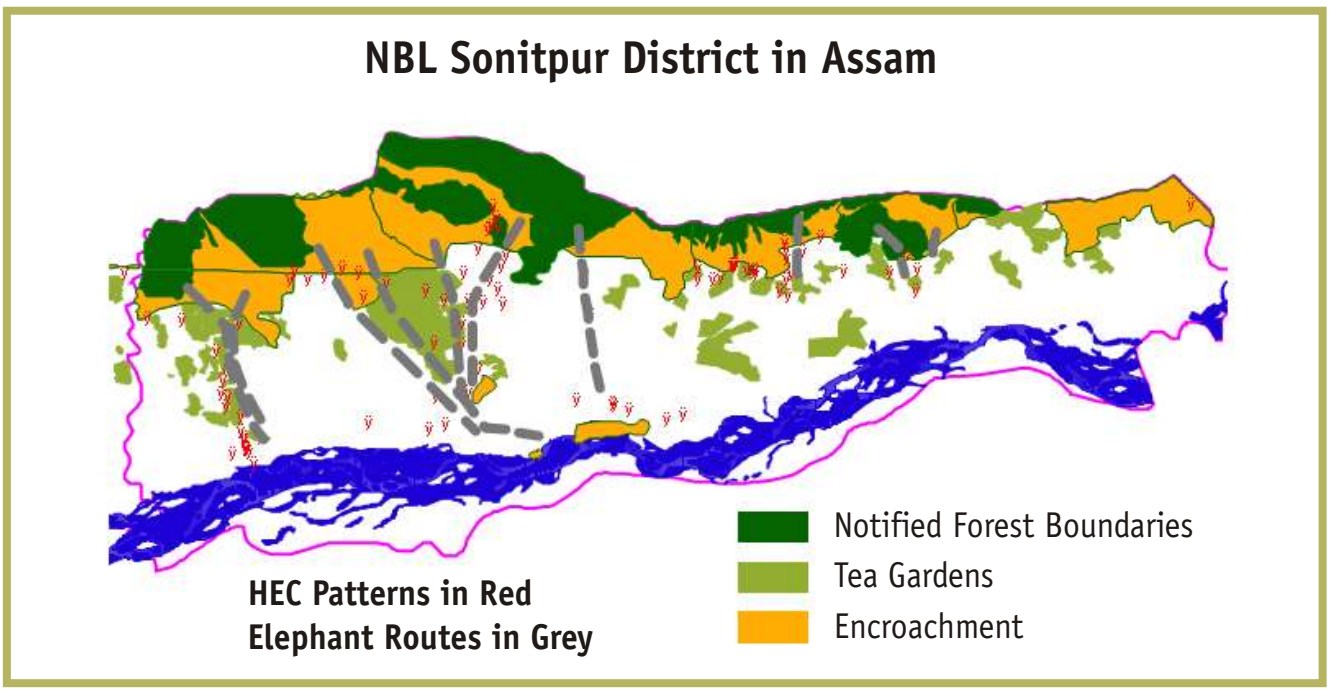
It is clearly understood from the experience in Sonitpur on HEC management that a well informed community willing to manage the conflict can reduce the losses to tolerable limits even as its root causes are being addressed over the long term.

At a policy level, the idea of replicating the Sonitpur experience on HEC management in other parts of the region will bring the

real large scale impact and generate support for elephant conservation.

- Average elephant death has gone down from 26 in 2002 to 10 in 2004. Retaliatory killings of elephants has gone down by approximately 80 percent in 2004.
- Average human death has gone down from 24 in 2002 to 10 in 2004 in Sonitpur.
- A cost benefit analysis reveals that an investment of INR 10, 00,000 (cost of implementation of the HEC mitigation strategy in Sonitpur only) has resulted in a saving of value worth more than 80 times of the investment made*.
- Twenty-two percent saving in agricultural production in Tezpur Revenue Circle in 2004 as a result of implementation of the HEC mitigation strategy.

** (Analysis done for Sonitpur West only. For details refer to the Annual HEC Report 2004-2005.)*



- Securing elephant and tiger habitats by connecting existing protected areas.

TECHNIQUE:
ELEPHANT BARRIERS

Applicable Scale:
Very small-very large (m^2 to a few thousand km^2)

Objective:
To deny access to an area to elephants.

Description of Technique

A barrier is an obstruction constructed on the boundary between areas where elephants occur and where they should not. It can be used for exclusion i.e. to prevent elephants from coming into an area (e.g. crop field or village) or inclusion ie. to contain elephants in a particular area (e.g. protected area).

Barbed wire fence broken by elephants in Walawe left bank development area, southern Sri Lanka. © Prithiviraj Fernando

In constructing effective barriers two basic conditions should be met, viz;

1. Elephants should be restricted to one side of the barrier

If a barrier is to be constructed through an area inhabited by elephants, all elephants have to be physically removed from the side they are to be excluded. Therefore, such a program should be an integral part of barrier construction (see section on translocation).

2. The barrier should prevent elephants from crossing it throughout its entire length

When confronted with a barrier elephants tend to walk along it for many kilometers in an attempt to find an opening. Thus all potential openings such as where the fence crosses streams, rivers, gullies, roads etc. should be secured .

A Barrier can be physical and/or psychological. The former presents an absolute obstruction to movement across and has to be able to withstand physical challenges by elephants, while the latter works by discouraging elephants from challenging

Physical Barriers

Wire fences:

Applicable scale: (very small to medium) m to less than one km

The cost of totally elephant proof wire fences, built with steel cables and iron girder (e.g. Addo elephant park South Africa) is prohibitive. Fences built with regular fencing material (wire and concrete or wooden posts) has little effect on elephants since they can be pushed over and thus do not represent a real physical barrier.

Log fences and stone walls

Applicable scale: (very small to medium) m to less than one km

Log and stone barriers are more effective than wire fences and can be built to withstand challenge by elephants. However, such robust construction is very expensive, hence both log fences and stone walls are not widely used and have very little practical applicability.

Ditches

Applicable scale: (very small to large) m to less than 20 km

The construction of elephant proof trenches is based on the theory that it should be too wide for an elephant to stride across and too narrow for an elephant to get into. Commonly used dimensions of trenches are 3m wide at the top, 1m wide at the bottom, and 2m deep. However, the dimensions vary from place to place. In Sri Lanka, they are usually about 2m deep, 2m wide at the top and 1.5m wide at the base. In Bannerghatta National Park - India, a 15 km trench around the park was 2.5m wide at the top, 1m at the bottom and 2m deep (Suresh 1992).

Eroded elephant ditch (newly constructed and abandoned trench), Lunugamvehera National Park Sri Lanka.
© Prithiviraj Fernando.

The main problem with trenches is erosion and caving-in of the side walls which fills up the trench, enabling elephants to cross it. The likelihood of erosion and caving-in depends on soil conditions and rainfall. The sides of trenches can be stabilized with concrete, stones and tar/asphalt, but this increases the cost significantly. Where concreted ditches/canals are constructed for some other purpose as in the case of irrigation canals, their judicious location, for example at the perimeter of an irrigation development area may help offset costs and make them serve an additional purpose of keeping out elephants.

Costs

Construction and maintenance of trenches is labor intensive. In India nearly 95% of expenditure on trenches is spent on hiring labor (Suresh 1992). The present cost of digging a trench is estimated to be around US $ 2,160/km (Tamilnadu Forest Department). In Sri Lanka, the cost of digging a trench is estimated to be around US $ 4000/km (Sri Lanka Wildlife Conservation Department).

Effectiveness

There are various reasons for ineffectiveness of trenches in preventing elephant incursions into crop lands. These include defective construction, environmental factors such as erosion, deliberate filling-in by people and elephants, and non-maintenance. The efficiency of trenches is negatively correlated with the age and number of roads and paths that cross the trench. Nath & Sukumar (1998) randomly examined 0.5 km to 8 km lengths along 150 km of trenches excavated by the Forest Department in the Coorg district of Karnataka, India. The average dimensions recorded for each stretch of trench were below the standard measurements with discontinuation of the trench at several road crossings. They estimated that environmental factors accounted for 16.8% and human errors for 20.6% of failures. Subjective evaluation on general condition of trenches in terms of uniformity in depth, steepness of side walls, soil packing on the walls, presence of plants etc., revealed that 23 trenches were in poor state of functioning. Also notable is the local peoples' evaluation of trenches as having medium to low effectiveness. Jayant et. al (2007) evaluated 11 trenches over 47.5 km built between years 1987-1988 and 1995-1996 in Karnataka, India and found failure points ranging from 0-21/km. Failures were mainly due to roads maintained by the Forest Department or foot paths made by local people. Other factors such as filling of trenches due to dumping of soil by people and breaking of sides by elephants,

erosion and collapse of trench walls due to rain or stream flows, non-completion of trenches due to the presence of boulders, logs/trees, rocky terrain, and stream beds cutting across trenches were also responsible for elephant incursions. A trench built alongside an electric fence built in 1997-1998 was rated highly effective and eliminated human-elephant conflict (Jayant et. al 2007). A Rocha India (2006) inspected a 10 km length of trench in Banneraghatta National Park in Karnataka, India, and found 882 failure points.

Biological fences

Applicable scale: Very small (m)

A number of thorny plant species such as agave, cacti and bougainvillea have been tried out as 'biological fences'. However, it is usually impractical to consistently grow such barriers to the length and depth required and without gaps to deter elephants from breaching the barrier. Additionally, because of their thick skin, the thorns prove an ineffective deterrent to elephants. In fact shrubs such as Acacia eburneum with 3-6 cm long thorns are preferred elephant food.

Unsuccessful biological fencing with Agave - Yala National Park Sri Lanka.© Prithiviraj Fernando.

Psychological barriers

Electric fences:

Applicable scale: very small to very large (m to hundreds of km)

Electrified fences are commonly employed by individuals and private companies to protect farm lands from elephants and by governments and conservation agencies to restrict elephants to particular areas. If maintained properly it can be the most successful barrier against elephant depredation. Electric fences carry a high voltage at low amperage as a pulsed current. They do not cause physical harm to elephants but gives a powerful and unpleasant electric shock upon contact. Since an electric shock is presumably very different to any stimulus an animal would encounter naturally, they tend to be very wary of it and not to adapt to it easily. However, some elephants eventually adapt with prolonged exposure. Elephants have been known to breach electric fences by using tusks which do not conduct electricity, pushing or kicking down fence posts and stepping over the fence using the thick soles of their feet to depress the wires. Some elephants also learn that an electric shock does not harm them and simply barge through the wires. Once an elephant learns to breach an electric fence, the fence becomes useless against the particular individual. Therefore, the most important aspect of a psychological barrier such as an electric fence is to discourage elephants from initially challenging it. This can be enhanced by making it more visible and obvious, keeping it fully functional, and through judicious, strategic placement.

Some fences are maintained on a duty cycle of 12 hours, from 6 PM to 6 AM, with the current switched off during daytime as elephants are less likely to challenge it during daylight and to conserve batteries. Electric fences vary widely in their construction. They commonly consist of 2 to 5 wires fixed 1m - 0.3m apart to a height of 1.5m - 2m, with posts 5m - 20m apart. Posts are made of concrete, stone, wood, bamboo, fiberglass or metal. Commonly used insulator materials are ceramic or porcelain, rubber-hose and plastic.

Costs

The cost of electric fences vary with the design (height, number of wires, distance between posts, energizing system etc.) and the material used (type and gauge of wire, type of posts, installation hardware such as wire tighteners, insulators, tension springs etc.). Fences installed in 2007 along the border between plantations and the Indira Gandhi Wildlife Sanctuary in the

Anamalai hills cost around $ 2829/km. The current cost of electric fencing with 2-3 high tension wires, standard hardware and concrete or timber posts in Sri Lanka is around $ 3,500-5,000/km. The costs of basic temporary fencing erected by farmers with locally made energizers, small gauge GI wire, sticks and improvised hardware are less than $ 100/km.

Effectiveness

The effectiveness and the longevity of electric fences depend on their construction and maintenance. Use of high quality components such as porcelain or UV stabilized insulators and other hardware, non corroding wires etc. make fences long lasting and can even last decades if constructed with quality materials coupled with good maintenance. Good maintenance requires daily inspection of fence for wire breaks, loosening, current leakage from objects or plants touching the wires, replacing damaged posts, inspection of batteries, powering energizer etc. Clearing vegetation from underneath the fence is essential to prevent current leakage from plants touching the wires especially where live wires run close to the ground. This can be done by manual clearing or use of chemicals.

Elephant at power fence in Uda Walawe National Park Sri Lanka. © Prithiviraj Fernando

Fences erected along the ecological boundary between elephant habitat and human areas (edge of permanent human settlements and cultivations), tend to be more effective because maintenance is easier due to better access and less likelihood of challenges by elephants.

Fences within forest areas tend to be less effective and not lasting due to logistical difficulties in maintenance. In addition, due to the reduced human presence in forests, elephants are more likely to spend longer time testing and challenging the fences.

A number of studies have examined the effectiveness of electric fences in India (Nath & Sukumar, 1998; Chauhan and Chowdhury, 2002; Jayant et. al 2007)) and Sri Lanka (Gunaratne and Premaratne 2006). Nath & Sukumar (1998) found private and company owned fences to be moderate to highly effective, and government owned fences less effective in Karnataka. They found 84% of privately owned fences were operational as compared to the 17% of state Forest Department fences. Jayant et. al (2007) found individually owned fences were effective in reducing crop depredation from 80% to 20% and that 14 out of 18 fences inspected required maintenance and repairs. Chauhan & Chowdhury (2002) observed that maintenance was inadequate and broken insulators resulted in failure in 74% of fences in northern West Bengal.

Cleared boundaries and simple demarcation of fields:

Applicable scale: very small to small (m to less than a km)

Methods such as clearing a strip of vegetation, stringing audio tape on a line of stakes, placing a line of lamps or lights along the perimeter of a field can also be considered psychological barriers. They indicate human presence, thus discouraging elephants fearful of humans from raiding. The disadvantages are that elephants soon learn that they do not represent a real threat, making them ineffective in the long term. However the low cost associated and their combined use with other crop guarding methods may be successful in decreasing depredation.

Simple demarcation of fields - north central Sri Lanka. © Prithiviraj Fernando

Positive Effects

People: The successful deployment of a barrier will prevent elephant intrusion into human areas thereby providing safety from elephant depredation.

Elephants: In an area where elephants suffer morbidity and mortality from actions of humans, keeping them away from such areas could provide benefit.

Negative Effects

People: Where a barrier prevents access to some fields or villages but not others in proximity, diversion of elephant depredation is likely to occur as elephants may choose the 'unprotected' fields or villages to those that are protected. Such a situation would result in local increase of depredation. Where barriers are constructed along the boundary of a National Park and elephants outside the park are not removed, prevention of their movement into the park seasonally or periodically will force them to obtain all their requirements from outside year round, hence increasing raids leading to escalation of HEC.

Elephants: The main purpose of a barrier is to prevent access to an area. Depending on the specific nature of the access prevented barriers may have varying consequences. Where elephants are denied access to a resource such as crop fields, the impact on them is likely to be low. Where they lose access to an essential resource such as a critical water source or a significant extent of foraging area, the effects can be catastrophic and lead to decline and loss of elephant populations. In situations where a barrier is constructed across elephant home ranges, inaccessibility and loss of resources can greatly jeopardize their survival. Therefore when deploying barriers it is important to consider the ranging and resource-use patterns of elephants in the area and to monitor them after its construction. If a barrier is constructed across an elephant habitat elephants on the 'wrong side' will be doomed. Similarly, driving elephants, especially herds away from their home ranges and cordoning them in other areas with barriers such as electric fences are likely to result in their decline and death, and can threaten the survival of resident elephants through increased competition for resources. Thus, injudicious and unplanned use of barriers can be extremely detrimental to elephant conservation and likely to result in loss of large numbers of elephants.

Elephants and calves may fall into trenches and get stuck or drown. Trenches with concrete side walls are particularly dangerous because elephants are unable to climb out if they fall in. It is thus important to construct points in the trenches where elephants can climb out to the side they are to be restricted to in case of falls.

Illegal electric fences connected to high tension power lines or house hold electricity can result in elephant death from electrocution.

Other: Construction of barriers may encourage setting up of permanent cultivation and settlements on the 'human' side. Consequently, where such barriers are constructed within conservation areas or state lands, it encourages encroachment and loss of natural habitat on one side and edge effects can intrude into the elephant areas.

Future Needs

Systematic evaluation of different barriers as to their costs, effectiveness and impacts on elephants and people; the use of different materials for construction of electric fences; assessment of costs and benefits of different forms of management and maintenance such as centralized or community based.

IN-COUNTRY APPLICATIONS

Sri Lanka

Wire fences:

Barbed wire fences and chain link mesh fences have been used infrequently but have had little or no success in preventing elephant movement across them.

Ditches:

Ditches have not been widely used in Sri Lanka, but subsequent to a major elephant drive undertaken to remove the elephants in the Handapangala area to the Yala National Park in the late nineties, a ditch was constructed along the north-western boundary of the Yala National Park and the northern boundary of the Lunugamvehera National Park, in combination with an electric fence. However, within a couple of years, it eroded, filled in, and became non-functional. It was re-excavated in 2006 and is effective now. Construction of another ditch along the electric fence along the western boundary of Lunugamvehera National Park began in 2007 but even before completion, parts of it eroded and caved in. It was then abandoned.

Biological fences:

Live fences have been tried out in a number of locations in Sri Lanka but none have been successful. One such is a row of agave planted along the electric fence at Uda Walawe and Yala national parks, which has been ineffective. Similarly a cactus fence tried out along the Weerawila farm perimeter failed completely.

Electric fences:

Several hundred kilometers of electric fences have been erected in Sri Lanka, mainly along National Park boundaries. An additional 600 km of fencing is planned by the Department of Wildlife Conservation in the near future. However, many of these fences have elephants on both sides which makes them ineffective. Some fences were erected after driving elephants into the parks.

An example is a fence in Yala National Park where in 2005 around 150 elephants were driven into the protected area which prevented them from accessing their dry season foraging grounds. In 2006, 250 - 300 more elephants were driven into the Lunugamvehera National Park from the adjacent Mattala area and confined by electric fences. These elephants have completely lost their home ranges.

An additional 100 elephants were driven into Lunugamvehera National Park from the Pellawatte area in 2007 and confined by electric fences. Subsequent to such range restriction increased mortality and morbidity especially of juveniles was observed both in Yala and Lunugamvehera. The confined elephant herds did not attempt to breach the fences, but appeared to maintain abnormally small ranges which were heavily over used. Because both Yala and Lunugamvehera already had resident elephants which had established home ranges and possibly at carrying capacity, it is likely that the addition of elephants could result in competition for resources and eventual habitat degradation, thereby jeopardizing the survival of all elephants including the resident herds.

Temporary fences using metal posts have been extensively used in conducting elephant drives to block out areas and drive elephants in a particular section. For example, in the Walawe Left Bank drive conducted in 2006, around 100 kms of such fencing was used.

Cleared boundaries and simple demarcation of fields have been used widely in Sri Lanka in an ad-hoc manner around crop fields in many areas, but not consistently or as part of a comprehensive crop protection plan.

India

Wire fences:

In a few areas around the Nugu Wildlife Sanctuary - Karnataka, farmers have been known to use barbed wire as preventive barriers for elephants. This serves more as a psychological barrier than a functionally effective strategy to prevent elephant incursions.

Log fences and stone walls

Stone (rubble) walls consist of rough rocks or stones piled up without cementing to form a physical barrier. Such walls used in the surrounding areas of Banerghatta National Park in Karnataka have not been successful in preventing elephant incursions into crop lands.

Trenches:

Commonly used in India, trenches have been successful in preventing elephant movements into small areas which need to be protected but have been less effective in larger areas such as Rajiv Gandhi National Park and Bannerghatta National Park. As a measure of reducing human-elephant conflict, the Forest Department of Karnataka has ordered closure of 5 kms of trenches in the Anechowkur to Alalur (Mysore district) to facilitate free movement of elephants. This indicates the non-suitability of trenches to mitigate conflicts in some areas.

Electric fences:

Electric fences are widely used to protect crops and settlements from elephant depredation. In North West Bengal electric fences were mainly used for protecting human habitations: about 60% of fences were around human settlements, followed by crop lands (18%) and plantations (14%). Around 75% of fences contained 2-3 strands of wire. (Chauhan and Chowdhury, 2002). In areas surrounding Wynad Sanctuary in Kerala, Coorg district of Karnataka and in several places in Tamilnadu, protection of farm lands and plantations was the primary focus of fences. Fences were maintained cooperatively by local people and the state Forest Department (Nath & Sukumar, 1998; Jayant et. al 2007). Barua (1995) discusses the use of older power fences erected in the 1980's, when 180km were erected around agriculture lands and tea gardens in North Bengal.

There has been considerable amount of success with electric fences in privately owned cultivated lands as compared to government owned electric fences (Nath & Sukumar 1998) in India. Electric fences have proven to be successful in limiting elephant incursions into farm lands. They have been highly successful in some parts of Coorg in the state of Karnataka. On the Valparai plateau in the Anamalai hills many coffee estates have been protected by solar power fences. These fences are often on the regular movement routes of elephants. Recently, the state Forest Department of Tamilnadu has initiated erecting fences along the border between plantations and surrounding protected areas excluding inter-state highways between Tamilnadu and Kerala in the Anamalai hills. Such steps may not be useful due to two main reasons. Firstly, it blocks elephant movements between protected areas they have been using across plantations on the Valparai plateau. Secondly, it will direct entry of elephants to the openings at the inter-state highways which may increase the human-elephant conflict situation on the plateau. In such areas the concept of 'fence-in property' rather than 'fence-out elephants' is a better adaptive strategy to reduce property damage by elephants.

Well implemented electric fencing in strategic locations along with community support involving people in the design, execution and maintenance is essential to positively influence people's attitudes and may go a long way in successful human-elephant conflict resolution. Such steps are in progress in areas surrounding Waynad Wildlife Sanctuary in the state of Kerala.

TECHNIQUE:
BUFFER CROPS AND UNPALATABLE CROPS

Applicable Scale:
Very large (hundreds of km^2)

Objective:
Decreasing the attractiveness of areas to elephants by substituting crops consumed by elephants with those that they do not.

Description of Technique

Sesame cultivation in Mattala - south Sri Lanka.©Prithiviraj Fernando

Elephants eat many or most of the food crops usually grown adjacent to elephant areas, the exceptions being crops such as tea, coffee, tobacco, medicinal crops, spices, sesame, chilli and citrus. However, individuals may try out new plants and adapt to them, especially as they become more abundant, and subsequently even crops formerly not consumed may be regularly raided. For example, elephants have begun to feed on the non native Teak (Tectona grandis) and to a lesser extent chillies in Sri Lanka. Teak is not native to Sri Lanka but was introduced decades ago as a valuable timber species. Until about 10-15 years ago there were no reliable records of elephants feeding on teak, but they now strip the bark of teak trees and have taken to toppling them. In Uda Walawe National Park, around 10 km^2 of a dense teak plantation was completely demolished by elephants. Forest plantations such as rubber, timber, and fuel-wood consisting of tree species that elephants do not consume could serve a similar purpose. However, in many such plantations, although the primary crop is not consumed by elephants undergrowth such as grass may attract elephants.

Theoretically it should be possible to reduce HEC and eliminate elephants from areas by planting crops not eaten by elephants. The critical factor however is the scale and homogeneity of the area transformed into unpalatable crops. If many hundreds of km^2 are completely planted with unpalatable crops it is likely to reduce the conflict because of the absence of elephants due to lack of food. However, areas of the scale of tens of km^2 or less will not have a major impact because elephants may travel through such areas and in the case of tree crops, may use them for cover during day time. The same applies to cultivating buffers of unpalatable crops around crop areas. Unless the buffer is at least a few km broad and is completely homogenous, it is unlikely to have a significant impact.

Positive Effects

People: The economic loss to farmers from crop raiding by elephants may be decreased by cultivating crops that are not consumed by elephants. However, some loss may yet be incurred from damage caused by trampling when elephants walk through such areas.

Elephants: Elephant death and injury due to HEC may be decreased.

Negative Effects

People: Alternative crops may not have as good a market and losses due to trampling by elephants that move across such plantations may be substantial, there by negating the value of switching to alternate crops.

Elephants: Land converted to crops unpalatable for elephants are lands that elephants cannot use. Growing unpalatable crops over large areas will result in loss of habitat and ranging areas, threatening the survival of elephants that used to range in such areas.

Future Needs

Identification of crops unpalatable for elephants; monitoring of behaviour and movements of elephants in areas planted with unpalatable crops.

IN-COUNTRY APPLICATIONS

Sri Lanka

Unpalatable crops are not used intentionally as a HEC mitigation measure to any great extent in Sri Lanka. However, some farmers in high HEC prone areas cultivate sesame and tobacco, and refrain from growing crops especially attractive to elephants such as manioc, sweet potato, corn and melon.

India

Growing crops unpalatable to elephants as a buffer to farm lands is mainly directed to provide alternate revenues to farmers in the high human-elephant conflict zones. Crops such as coffee, lemon etc. which are not mainly subjected to elephant depredation have posed serious economic losses to farmers due to trampling by elephants. Use of these crops as buffers is restricted by the type of soil, rainfall, topography, availability of water, and market prices. Change of crop pattern from traditional livelihood farming to alternate crops by farmers does not seem to be practical and is unacceptable to cultivators in many areas. However, pilot studies on effects of alternate crops such as capsicum, beetle nut, lemon, with introduction of Citrus spp and Patchouli plants as elephant deterrents along with other economically viable crops are in experimental stages in Chirang-Ripu Elephant Reserve in Manas National Park, Assam.

Practices such as change of crops and introduction of alternate crops have been tried out in some places in the states of Maharashtra and Assam. Most agriculture lands close to elephant habitats are owned by small farmers and they traditionally grow particular subsistence crops such as paddy, jowar, finger millet etc. Switching to alternate crops may require adopting agriculture practices different to the traditional practices and people are usually reluctant to do so.

TECHNIQUE:
SUPPLEMENTARY FEEDING

Applicable Scale:
Few individuals

Objective:
Provide food for elephants so that they will not raid crops

Description of Technique

Elephants at garbage dump - Hambantota south Sri Lanka. © Prithiviraj Fernando

Provision of highly nutritious food, on par with cultivated crops should prevent the need for crop raiding by elephants. Therefore, if such food is deposited daily in an area where crop raiding is a problem it should attract the raiding elephants and keep them there, thereby preventing raiding and reducing HEC. However, the scale of provisioning required is very high. A single wild elephant would consume around 150-300 kg of food daily, the amounts being higher for adult males than females. Providing such amounts of food for any significant number of elephants indefinitely, on a daily basis, is logistically and economically impossible. In some areas, elephants are thought to enter human habitations and break into human dwellings in search of salt. If such behavior actually occurs, provision of salt licks within elephant habitat may decrease conflict.

Positive Effects

People: High 'feel good factor' for those who are involved in conservation, and may reduce raiding locally, over the short term.

Elephants: Provides additional nutrition and over the short term may decrease problems to elephants from HEC.

Negative Effects

People: Elephants may develop a 'taste' for the provided food, and where crops are used it is possible that such elephants may become more inclined to raid, especially if the practice is discontinued or if the supplementary food is insufficient to fulfill their needs. Increased contact and familiarity with people may lead to greater predilection for raiding and aggressive behavior towards people by particular males.

Elephants: If it results in increased contact and familiarity with humans and/or raiding, retaliation by farmers to may cause more harm to elephants.

Future Needs

Economic assessment of the costs and benefits of such supplementary feeding; scientific assessment of the impact on the behavior of elephants provided to such resources and the resultant impact on HEC.

IN-COUNTRY APPLICATIONS

Sri Lanka

While the technique has not been widely used as a HEC mitigation measure, the open garbage dumps in many parts of Sri Lanka are a good approximation, and provide an indication of the likely outcome of such an exercise. The elephants that come to feed at such garbage dumps are exclusively males. They appear to spend the majority of their time at the dump, but also wander around a fairly large area coming into contact with humans and have been implicated in HEC incidents. Therefore, while it is not known if elephants that frequent the dump would raid if it were not there, some continue to cause HEC in spite of it.

In another case, the Pelwatte Sugar Company which has perennial elephant problems decided to dump the cut sugar cane tops in a location close to an electric fence that prevented elephants from going out of the Park area. This attracted a number of males to the place. However, since sugar cane harvesting is seasonal, the off seasonal congregation of males in the area created additional problems. No scientific assessment was done on the actual impact on raiding of the sugar cane plantation but the practice was discontinued.

India

Provision of supplementary food in the form of planting palatable species in the movement area of elephants is not known in India.

TECHNIQUE:
TRANSLOCATION

Applicable Scale:

Individuals to hundreds of individuals.

Objective:

Mitigating HEC and safeguarding elephants through the removal of elephants from a conflict area and their release in a 'safe' area.

Description of Technique

Chemical immobilization and transport

The term 'translocation' is sometimes used to refer specifically to capture and transport. Although capture and transport of groups of elephants has been practiced in Africa, in Asia it is limited to individual animals, usually adult males. It is most often used in the case of 'problem animals' - invariably adult males that habitually raid crops, break houses, and are aggressive or kill people. Sometimes capture and transport may be used to relocate isolated herds pocketed within small forest areas on the perception that such elephants have nowhere to go without running into humans making translocation the only option.

Problem elephant being translocated - south Sri Lanka. © Prithiviraj Fernando

Capture and transport consists of a number of activities that includes identification of a particular individual, capture, restraint, transport and release.

The proper identification of 'problem animals' is essential for the success of the exercise. However, in most cases elephant depredation occurs at night and especially in cases of human mortality, accurate identification of the individual responsible is difficult or impossible. Usually it is done on the basis of information from villagers and the whereabouts of the responsible elephant. In some cases it may be possible to track an individual from the scene of an incident, leading to a positive identification. However, in most cases the time lapse between an incident and the arrival of the capture team on site is a few days to weeks which renders the positive identification of problem animals next to impossible. In addition, many cases of human injury and death by elephants are accidents the cause of which cannot be attributed to a particular animal, with the exception of individual males or habitual raiders that are overly aggressive and liable to cause such incidents.

Capture is usually done by drug immobilization using an anesthetic dart fired from a capture gun. The response of darted animals depends on the nature of the particular animal, its awareness of the darting team, degree of disturbance etc. Some animals tend to run as soon as the dart hits them, some may remain still or walk around a little while others may respond aggressively and charge. Usually M99 is used as the anesthetic of choice. It takes around 10 minutes for the drug to take effect and in that time, the darted animal may travel a considerable distance. Depending on the situation, considering the habitat visibility, terrain, response of the animal, ability of trackers etc. a decision needs to be taken of whether to track it immediately or to wait. It is

important to find the animal as soon as possible after it goes down, as falling in sternal recumbency, or with something pressing against the trunk in water can cause death. Once the elephant is down, it is restrained with ropes. In situations where there are no trees of sufficient girth to anchor the ropes, machinery such as tractors are used as anchor points. Once the ropes are in place, the drug is reversed with the antidote and a sedative.

The next step is to load the elephant into a truck for transport. Usually an approach road is cleared to the site using a bulldozer. Then an earthern ramp is constructed, and a truck is backed into a depression on one side so the deck is level with the top of the ramp. The transport truck has a specially constructed body consisting of a metal cage made of heavy beams, and holes in the bottom through which the restraining ropes are routed and bolstered on the side. Once the truck is backed up, the ropes tied to the rear legs of the elephant are removed from their anchor and routed through the truck, then tied to a tractor. While the ropes tied to the back legs are slowly pulled by the tractor, the ropes on the front legs are slackened so that little by little the elephant backs into the truck. Once in the truck it is secured and the tailgate closed. Then it is transported to the release site, usually a National Park, and released by cutting the ropes on the legs.

Costs

Current operational costs of translocating an elephant through capture - transport is around US $ 2,000 (Department of Wildlife Conservation, Sri Lanka). It requires the services of two veterinarians, a capture team of about 15 persons, transport for personnel, specialized truck to transport the elephant, as well as capture and restraining equipment, heavy machinery as anchor points and for ground clearing. The average time for a single capture translocation is about one week.

Positive Effects

People: If the correct 'problem elephant' is identified and removed, it can have a very positive impact on HEC as usually it is a few adult males that are very aggressive and are responsible for a large proportion of HEC in an area.

Elephants: In situations where a particular elephant is creating problems and is likely to be killed or injured by people attempting to protect their crops and dwellings, its removal from the area may save its life, provided it can be moved to and contained in a 'safe' area.

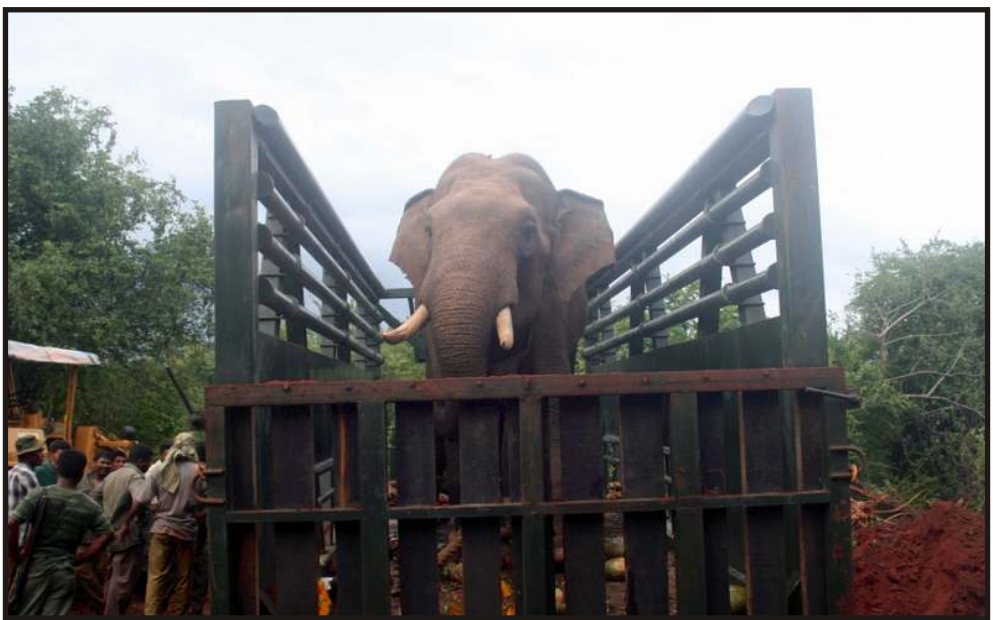
Negative Effects

People: Monitoring of translocated elephants by satellite radio telemetry in Sri Lanka suggests that translocation of problem animals also translocates the problem and often results in the escalation and spread of HEC.

Elephants: Monitoring translocated elephants suggests that adult males may not respond well to translocation and that it completely disrupts their behavior. Lack of knowledge of the area they are transported to, is likely to increase the risk of coming into conflict with people. Hence translocated elephants may come under greater risk in unfamiliar ranges than if they stayed in their home area. Elephant capture may involve severe injuries to animals in hilly terrain and sometimes may lead to death of the animal. Removal of large numbers of males from small populations is not advisable as it could lead to depletion of the local genetic pool and result in skewed sex ratios. Elephants maybe wrongly proclaimed as habitual man killers or rogues due to faulty identification of problem animals, as in most instances the identification of a troublesome elephant is done without scientific evidence. If tranquilization of elephants is done by inexperienced and untrained staff as services of experienced people are not available when required, it would carry higher risk of injury and death of elephants.

Future Needs

Monitoring of translocated elephants through radio telemetry; especially with regards to different age groups and distances moved, behaviour after translocation and interactions with elephants in the receiving area; crop raiding and interaction with people (Fernando 1997).



Elephant translocation - south Sri Lanka. ©Prithiviraj Fernando

IN-COUNTRY APPLICATIONS

Sri Lanka

Translocation through capture and transport has been used extensively in Sri Lanka to remove problem animals from areas with HEC. However, it is only very recently that such translocations have been monitored. Monitoring translocated animals through radio telemetry and incidental observations of other translocated elephants suggests that many translocated elephants return to their site of capture.

India

In 1988, one wild elephant was captured from the Terai and released in Buxa Tiger Reserve about 250 km away (Baura 1995), but the elephant returned and was found dead. In India studies have indicated that elephant capture and translocation techniques are not very beneficial for people or elephants. Nath and Sukumar (1998) suggested that elephant capture does not seem to mitigate the problem in many areas and may be useful only if a significant number of raiding elephants were removed simultaneously from a given area. Barua (1995) suggested that tranquilization or translocation of elephants is useful in dealing with problem animals. There has been a recent proposal operation to capture 20 elephants from Sakelshpur, Alur, Yesalur and Arkalgud regions and relocate them to Bhadra Wildlife Sanctuary in Karnataka. The cost of the operation was estimated to be around $ 375,000.

Elephant Drives:

Applicable scale: Groups of elephants, large areas (tens of km^2 to hundreds of km^2)

Objective: Mitigating HEC and safe guarding elephants through the removal of groups of elephants from a conflict area and their introduction to a 'safe' area.

Elephant drive at Walawede left bank - south Sri Lanka.
© Prithiviraj Fernando

Description of technique

Elephant drives are used where large numbers of animals are to be removed, and consist of a group of people walking through the forest creating a lot of disturbance and attempting to chase the elephants in a particular direction. The objective is to drive the elephants into an area, usually a National Park, and establish a barrier to prevent them from returning. Electric fences are sometimes used to contain elephants so driven into a particular area and temporary electric fences are used as an aid to the drive (see section on barriers). A major drive involves up to a few hundred people and is conducted over a period of a few months. It is usually conducted at the height of the dry season, due to logistical difficulties imposed by the wet season and to make use of the scarcity of water to move the elephants in a particular direction.

It involves people starting from one end of the drive area, lighting large firecrackers called 'thunder flashes', flares, banging on tin cans, shouting, shooting in the air etc. to drive elephants ahead of them. Water bodies in the drive area are guarded denying any access to the elephants so as to compel them to move to the next area. Once a section is 'cleared' of elephants, it can be fenced off using temporary electric fences. The cost of a drive is directly related to the extent of the drive area and the time it takes to complete the operation.

Positive Effects

People: A drive is a very visual exercise and people can easily relate to it. Consequently, drives tend to be well received by people. If the drive is successful in clearing an area of all elephants, then the people will benefit by decreased depredation. By removing the herds in an area, drives will remove the source of adult males and therefore will in the long term decrease conflict.

Elephants: One of the main objectives of a drive is to remove elephants from an area where they are under threat to an area where they would be safe. Such an outcome may be possible where there is an area with adequate unexploited resources, which can receive the driven elephants, such as an area where elephants have been hunted out.

Negative Effects

People: Although the objective of drives is to remove all elephants from an area, monitoring of drives done in Sri Lanka has shown that they almost exclusively remove herds and not adult males, especially where they are carried out on a scale of a few hundred km^2. Consequently drives that fail to remove adult males, which are the source of most conflict, will not reduce HEC in the area. The response of elephants to being driven is partly dependent on their previous exposures to conflict with people. A drive exposes them to a very high level of disturbance and consequently elephants that escape being driven but are exposed to the drive and those that backtrack are likely to respond less to disturbance, possibly with more aggression. Thus, paradoxically drives may result in increased levels of HEC. Driving operations may exert a lot of pressure on elephants and may result in habituation of elephants to these techniques and shifting of problem to new areas. Regular 'chase without capture' may make elephant herds lose fear of koonkies.

Elephants: Drives are likely to subject elephant herds to severe stress. Elephants tend to move fairly freely within their home range but are very reluctant to go beyond. They are very likely to turn back through the drive line when approaching the edges of their home ranges. In such instances, elephants invariably get shot and suffer mortality and morbidity. As a result of drives elephants may lose part or the entirety of their home range. Monitoring of two drives conducted in southern Sri Lanka where in one, herds lost the dry season range and in the other their entire range, suggests that such herds tend to lose condition and suffer high mortality.

The survival of groups that are subject to drives is likely to be very closely linked to the availability of resources in the receiving area. In Sri Lanka there are practically no cases of 'empty' habitats that have suitable resources but are devoid of elephants. Adding herds of elephants to areas which already have their carrying capacity of elephants is likely to exceed the carrying capacity of those areas. Therefore elephants translocated by drives are unlikely to survive. Additionally, exceeding the carrying capacity may have severe repercussions on the habitat of the receiving area and consequently, on the elephants that were in that area (Fernando 1997). Therefore, elephant drives are likely to be very detrimental to elephants.

Future Needs

Monitoring the morbidity, mortality and behavior of elephants subjected to drives during and post drive; their interactions with other elephants in the receiving area; assessing the effects of range restriction and range loss on the elephant demography and reproduction; monitoring the impact of artificially increased elephant densities on habitat and the habitat on elephants.

IN-COUNTRY APPLICATIONS

Sri Lanka

Elephant drives have been used extensively in Sri Lanka for many decades. Large scale drives have moved many hundreds of elephants into National Parks during major irrigation developments such as Mahaweli, Walawe and Kirindi oya, and with large scale plantations such as sugarcane. Drives have also been undertaken to remove elephants from HEC areas in many parts of the country. More recently, a drive costing over US $ 1 million under the Walawe Left Bank development project drove 250-300 elephants from an approximately 500 km^2 area, 30-40 km into the Lunugamvehera National Park. But it is estimated that at least an equal or greater number of elephants as driven, are still in the original area. Almost all of the elephants that were driven in consisted of females and young with very few adult males. Surveys conducted later in the drive area revealed that a majority of people still believed that the elephant problem was not solved by the drive but rather remained the same or even increased. The main reason given for the failure of the drive was its inability to remove the problem causing elephants. In addition many people claimed that repeated exposure of elephants to fire crackers, gun fire etc. during the drive had made them non responsive to such measures only making them more aggressive.

India

In India, elephant drive is one of the methods employed by the state Forest Department as a result of pressure from the public. The execution of 'Operation Jumbo' intended to drive away elephants from plantations on the Valparai plateau with the help of domesticated elephants failed to provide satisfactory results. Elephant drive operations to move 13 elephants (11 tuskers and two females) back into Orissa's Lakhari Valley sanctuary from the Srikakulam district of Andhra Pradesh yielded partial success but resulted in the death of a female. Elephant drives seem to have produced temporary relief to farmers in some parts of Assam. There have been steps taken by the state Forest Departments in Karnataka, Andhra Pradesh to shift 42 and 12 elephants respectively from plantations and agricultural areas into surrounding forests.

TECHNIQUE:
PROBLEM ANIMAL REMOVAL

Applicable Scale:
Individual animals and small groups

Objective:
Removal of identified animals from the wild

Description of Technique

Four types of activities can be considered under this heading: capturing identified problem animals and their translocation (see above), domestication, semi-wild management, and elimination.

Captured crop raider - south Sri Lanka.©Prithiviraj Fernando

Positive Effects

People: A large proportion of HEC in many areas is due to a small number of adult males who are aggressive, habitually raiding crops, breaking down houses and in the process causing human casualties. The removal of such problem animals can significantly reduce HEC in the area.

Elephants: Reduction of HEC through removal of particular individuals that are responsible for a majority of negative impacts on people prevents retaliatory actions against other elephants that do not contribute to HEC.

Negative Effects

People: Individuals or teams involved in capturing problem animals run the risk of injury and death from accidents during the operation.

Elephants: Removal of problem animals from an area effectively prevents them from playing any further role in the in-situ conservation of elephants, and is a loss of an elephant from the wild. While translocation appears to be a better option, it is also a very complicated intervention and may have varied negative repercussions both on elephants and HEC (see section on translocation).

Future Needs

Accurate and detailed information on the numbers of males in a given area; actual numbers of raiders and their behavioural patterns through time and season and particular stage of life; whether 'problem elephants' pertain to a particular period of life; characterization of problem animals with regard to age, health and physiological condition to determine if such factors play a role in making an individual a 'problem animal'. contribution of such males to elephant reproduction, their dominance and heirarchy; whether translocated males settle down in a newly translocated place or continue to break out; their interactions with other elephants in the area; whether the removal of a problem animal results in greater likelihood of another taking its place.

Capture and Domestication:

Applicable Scale: Individual animals and small groups

Objective: Removal from the wild of identified animals.

Description of Technique

Asian elephants have a long history of capture and domestication. As the main purpose of traditional capture and domestication was providing working elephants, young animals (less than 10 years of age) were generally preferred, due to ease in training and long service in captivity. Most owners also prefer females to males who go into 'musth' part of the year when they are difficult to manage. The domestication of such animals is difficult and expensive with their life times in captivity being not very long. Therefore, the practicality of capture and domestication as a HEC mitigation technique or its wide application may be limited.

Positive Effects

People: Captive elephants have been an important part of Asian history, culture and religion for thousands of years. Maintaining captive elephants is important for the continuity of such traditions. In many parts of Asia, people interact with captive elephants on a personal basis. Such contact allows developing relationships between people and elephants that is beneficial to both.

Elephants: Close contact with captive elephants plays a very important part in fostering close ties between people and elephants, and has been instrumental in maintaining a high level of tolerance and appreciation of elephants evident in parts of Asia. Where elephants are completely cut off from people and are viewed only as wild animals in the forests or in zoos, it is unlikely that such relationships and empathy will develop. Therefore, maintaining a captive population can be of important indirect assistance to the conservation of elephants.

Negative Effects

People: Training wild elephants, mainly adult males can be dangerous and poses risk to people involved.

Elephants: While maintaining a captive population can provide a very important service to elephant conservation, whether elephants should continue to be captured from the wild to maintain the captive population is debatable. Given appropriate conditions, elephants tend to breed well in captivity as exemplified by the Pinnawela elephant orphanage in Sri Lanka. Such breeding centers can very well fulfill the need for captive elephants leaving little justification for capturing elephants from the wild solely for addition to captive populations. In Sri Lanka, elephants captured and domesticated are completely taken out from the wild and as such each elephant so captured represents the loss of a wild elephant. While there may be continued interaction between wild and domestic elephants where domestic elephants are released into the forest for the night as in some parts of the mainland, the actual level of interaction and contribution of such domesticated elephants to the wild gene pool is not clear. If at all, it is more likely for captive females to be mated by wild bulls than the other way round. However, since captive born calves would continue in captivity, such an event would not directly contribute to the wild population. If females are captured from the wild, the detriment to elephant conservation will be greater than capture of males. Where domestication is used as a method of removing problem animals, it is very important to unambiguously identify the particular problem individual, the failure of which will be detrimental to elephant conservation. Capture and domestication of adult problem males is likely to carry a high risk of morbidity and mortality from rope cuts, disease etc.

Future Needs

Assessment of interactions between captive and wild populations, and the occurrence of any gene flow between them; assessment of the cost and success of bringing problem animals into captivity; assessment of numbers of private individuals, institutions etc. who would be willing to accept problem animals and bring them into captivity; assessment of methods of training and management of such animals; research into humane and efficient ways of domesticating captured problem animals.

IN-COUNTRY APPLICATIONS

Sri Lanka

Elephant capture has been discontinued in Sri Lanka since the early 1970s. In Sri Lanka captive animals do not have any contact with wild populations and no longer directly contribute to the in-situ conservation of elephants. There is a fairly strong lobby of captive elephant owners in Sri Lanka who request that more elephants be brought into captivity to maintain the captive herd. However, the preference of owners seems to be for more manageable and trainable young animals. The capture of young animals is not relevant to removal of problem animals and is not a desirable action from the point of view of elephant conservation. There is also a fairly strong animal welfare and animal rights lobby in Sri Lanka that opposes the capture of any wild elephants some of whom are concerned that initiating a program for capture of problem animals would lead to abuse and result in the capture of young animals for domestication. In the late nineties, a proposal to capture large numbers of adult males and auctioning them off was shelved after public protest. More recently the Sri Lankan cabinet approved the capturing of individual problem animals.

In 2006, a male elephant was translocated a number of times but always returned to break electric fences regularly in Uda Walawe. The 'repeat offender' was captured and given to the Pinnawela elephant orphanage. After one and half years, it is in a semi-tame condition and can be approached and fed, but is not trained as a regular tame elephant. Another problem male was captured and given to the Temple of the Tooth in Kandy. After suffering severe rope cuts and a long treatment with antibiotics, it recovered but died 2 months later.

India

Historical records confirm that capturing of bulls and cows in India was commonplace. In 1937-39, 127 elephants were captured in areas close to Buxa, Bhutan and Assam. In 1946 and 1957, 29+ elephants, 1957-58 and 1966-67, 93 elephants from Buxa and Cooch Behar divisions, and during 1971-81 117 elephants were captured from Jalpaiguri, Buxa, Cooch Behar, Kalimpong and Kurseong Divisions (Barua 1995). In 2004, a female elephant was captured to avoid crop damage at the foot hills and sent to an elephant camp in the Anamalai Hills. A recent capture of a male elephant by the Kerala Forest Department as a means of alleviating crop damage led to death of the animal during domestication (Amala 2006). Elephant captures or Khedda or Melashikar operation had been operational for a long time before 1980 in the forest divisions of Assam and North Bengal (Barua 1995). This practice is now banned in India and all captures of elephants require permission from the central government (Bist et al 2002). There has also been a recent move to remove elephants from the Coorg district of Karnataka by the state Forest Department (Anonymous 2007).

Capture and Semi-wild Management

Applicable scale: Individual.

Objective: Removal from the wild of identified animals and their management in a semi-wild condition in a restricted area.

Description of Technique

Instead of bringing problem animals into captivity, their management in a large fenced-in area as a 'bull park' can be an alternative. What is envisaged is an area enclosed by an effective elephant barrier within which such animals will have free range. However, such an approach is unlikely to be practical for a number of reasons. The animals that cause the worst problems are likely to be ones that habitually break electric fences.

Captured adult female - south India. © M. Ananda Kumar

Therefore, in order to restrict such animals to a particular area a physical barrier such as a ditch, wall or wire fence would be needed in combination with an electric fence. While it is technically possible to make such barriers elephant proof, the cost incurred usually makes it uneconomical. An adult male in Sri Lanka has a non-musth range of around 50-100 km^2 and a musth range of a few hundred km^2. Adult males on the mainland have much larger ranges with non-musth ranges of a few hundreds of km^2 and probably correspondingly larger musth ranges. Therefore, if such animals are to have anything resembling a normal range, such holding areas will have to be of a relevant scale. Smaller holding areas would necessitate supplementary feeding and more intensive management, hence entailing even higher costs. Problem animals would need to be taken care for life thus increasing the management costs for a lengthy period of time. An elephant has a life span of around 50 years and capture of a 25-30 year old male would mean a commitment to manage it for another 20-25 years. It is also possible that restricting numbers of adult males to small areas would result in increased agonistic encounters between them.

Positive Effects

People: If successful, the technique can provide a way to take problem animals out of high HEC areas.

Elephants: If successful, may provide an alternative to capturing and culling of problem animals which would provide a somewhat more 'natural' existence to the individual animals.

Negative Effects

People: Physical risk to personnel involved in capture and management.

Elephants: Risk in capture, transport and subsequent management to individual animals. Such management techniques can be limited to a few elephants at extremely high costs. In terms of elephant conservation it will be limited to keeping alive particular individuals for a period that cease to become contributing members of the gene pool. Spending limited conservation funds on such approaches could take funds away from activities that could benefit larger numbers of elephants, and have a much greater positive impact on elephant conservation and mitigation of HEC.

Future Needs

Cost benefit assessment of the approach in terms of economics and impact on elephant conservation; assessment of the ability to confine problem animals to specific areas in such a manner; study of the impact on the behavior and survival of such animals and interactions between them; assessment of the numbers of problem animals, and the proportion of such animals that would break electric fences and successfully challenge other barriers, how they do it, and development of low cost designs that would prevent their challenges.

IN-COUNTRY APPLICATIONS

Sri Lanka

In (2007), the Department of Wildlife Conservation assessed the possibility of managing problem animals using the capturing and semi wild management technique. A center is being set up in the Lunugamvehera National Park. A number of such centers in different parts of the country have been planned.

India

Capturing and semi-wild management is not practiced in India.

Elimination of Elephants:

Applicable scale: Individuals to groups

Objective: Elimination of particular animals.

Description of Technique

Official culling is not an acceptable method of management both in terms of elephant conservation and the socio-cultural climate of Asia. However killing of raiding elephants by farmers is a regular occurrence and hundreds of elephants die annually in this manner resulting in de facto culling. Animals that get killed as a result of HEC are mostly adult males. Where translocation, capture and domestication, or capture and semi-captive management of such problem animals is not an option, elimination of the problem animal by shooting is probably a better, more humane alternative than a protracted death from infected and festering gunshot wounds inflicted by farmers. Driving elephant herds and their incarceration in protected areas that are already at their carrying capacity will result in eventual decline and death from long-term food deprivation. Although not as obvious as shooting, these methods eventually amount to culling.

Positive Effects

People: In most areas the major part of HEC is due to a few adult males who habitually raid crops, break houses and are aggressive towards people. The removal of these particular individuals by whatever means would have a major impact on HEC. Therefore, elimination of such animals would bring immediate relief to the people suffering from HEC.

Elephants: Management activities such as elephant drives that endanger the lives of hundreds of females and young animals are undertaken primarily because of HEC. Relief of HEC by the removal of a few individuals would preclude the need for more damaging interventions such as elephant drives to the greater benefit of elephants.

Negative Effects

People: Risk to persons involved in such operations.

Elephants: Government sanctioned elimination of elephants as a policy may be interpreted as advocating elephant killing and may result in greater willingness to eliminate elephants and may have negative repercussions beyond the activity itself.

IN-COUNTRY APPLICATIONS

Sri Lanka

Although government sanctioned culling of elephants as a way to remove problem elephants is socio-culturally unacceptable in Sri Lanka, around 150 elephants get killed annually as a result of conflict with farmers. Most of these are adult males that raid crops. With greater awareness of the problems of translocation, capture-domestication and capture-semi wild management are being currently explored as alternatives. Clearing of elephants from large areas of habitat by driving them has been on-going for over five decades and probably has contributed heavily to the decline of elephants in Sri Lanka.

India

The process of eliminating individual problem elephants or herds has been practiced by the state Forest Departments in India. In Terai and Western Dooar regions of North Bengal 20 elephants were killed as 'rogues' or habitual 'man killers' during 1973 - 1983 and 6 more between July 1992 and February 1993 (Barua 1995).

TECHNIQUE:
COMPENSATION AND INSURANCE

Applicable Scale:
Small to very large (villages to country wide).

Objective:
Reduce the economic impact of elephant depredation on people by re-compensating for their losses.

Description of Technique

Compensation is intuitively an obvious way to reduce the negative impacts of economic losses and loss of life or injury due to elephant depredations. Theoretically, it should be possible to completely eliminate the impact of economic loss through adequate compensation. However, in practice compensation especially with regard to crop damage is difficult, because of the subjectivity involved in damage assessment and verification of claims. Commonly, people tend to over claim, and when such claims are not met, it leads to acrimony between authorities and people. Paying of false claims leads to widespread abuse and un-sustainable expenditure. Therefore, either way such programs are difficult to manage. Although the role monetary compensation can play in relieving disability or loss of life is debatable, it is more straightforward to assess and rates can be more easily standardized. The same issues apply for insurance. In addition, paying compensation by a government authority, especially by the same authority responsible for managing and conserving elephants reinforces the feeling that they are responsible for all harm caused by elephants and that it is solely the responsibility of the authorities to take care of the problem. Such perceptions lead to anger against the authorities when an incident of damage occurs and can lead to severe straining of relations between authorities and people. Where compensation or insurance programs are run by other institutions, such issues may be less of a problem.

Positive Effects

People: Compensation provides tangible and immediate relief to people from the economic loss imposed by damage to crops and property and helps relieve the economic burden imposed by injury or death.

Elephants: Compensation schemes may increase tolerance levels of people towards elephants.

Negative Effects

People: Non functioning and abuse of compensation schemes may lead to further acrimony between authorities and people.

Elephants: Worsening relations between elephant management and conservation authorities is likely to reflect badly on elephants as damage from elephants would be perceived as being more unacceptable, possibly leading to retaliation and greater harm to elephants. Compensation schemes may lead to reduced efforts by local people to guard their crops thus exacerbating conflicts with elephants. They may also cause an increase and expansion of agriculture into elephant habitats eventually leading to local extinction of elephants (Daniel and Erwin 2007).

IN-COUNTRY APPLICATIONS

Sri Lanka

A number of compensation schemes have been launched by the government to address the issue of damage from elephants. One such scheme through the Department of Wildlife Conservation compensates for injury and death and another through the Social Services Department for crop and property damage. However, these programs have not been very successful in gaining the approval of people due to inherent problems with compensation and bureaucratic delays and problems of assessment etc. More recently an effort is being made to involve private insurance companies in offering farmers insurance schemes against elephant damage.

India

Payment of compensation for human injuries, deaths, and property loss has been made to victims of elephant depredation through the state forest departments or the wildlife departments. The Government of India, under Project Elephant sanctions an ex-gratia payment of the equivalent of $ 2,500 to the legal heir of the family deceased in case of human death or permanent incapacitation; $ 500 for major injuries; $ 375 for crop damage; and $ 125 for damage to tiled or thatched house. However, monetary compensation paid to the victims of human-elephant conflict varies in several states.

Farmers around the Bhadra Tiger Reserve in southern India lost 14% of their annual crop to elephants, which amounted to 30% of their annual average income in this region (Madhusudan 2003 b). The compensation paid was estimated to be around $ 18,750 per year with an average of 472 cases of crop damage by elephants during 1990 and 1996 (Nath and Sukumar 1998). Jayant et. al (2007) found that the highest damage was to coffee and paddy with lesser damage to banana, areca, coconut and cardamom in the Coorg district of Karnataka. The total amount of compensation paid to people in two forest divisions was estimated to be around $ 136,925 between 1996 and 2004, with the highest amount of compensation paid to coffee (24%), followed by paddy (21%), and banana (17%).

The present system of compensating property damage seems to suffer from lack of funds, transaction costs, heavy bureaucracy, delay in disbursement of funds to victims, and false claims by people. These factors have been identified as potential threats to the success of compensation schemes (Williams and Johnsingh 1996, Nath & Sukumar 1998, Jayanth et. al 2007). Compensation schemes have proved to have less impact on resolving conflicts and failed to promote coexistence by increasing tolerance levels of people with elephants in parts of India (Madhusudan 2003). They can only address the symptoms and not the cause of conflicts (WWF 2000).

TECHNIQUE:
LANDUSE PLANNING

Applicable Scale:
Medium to very large (hundreds to thousands of km^2).

Objective:
Delineate areas of land-use so that habitat change due to human activity occurs in a planned manner in specific areas.

Description of Technique

Over a short term factors such as morbidity and mortality from poaching, HEC and management interventions determine the survival of elephant populations. Therefore, addressing such issues urgently and effectively becomes paramount, as extinction over a short term can render a long term conservation effort irrelevant. However, the final determinant of elephant survival over a long term is the quality and extent of the space they can use (Fernando 2006).

Quality: Elephants are considered an 'edge species' the optimal habitat for whom is not an undisturbed mature forest, but a landscape mosaic of secondary and regenerating forest patches and savannahs. In various types of mature tropical, evergreen or deciduous forests that are the climax vegetation over much of the Asian elephants' range, large trees dominate the vegetation and form a canopy where most of the primary production occurs. Elephants cannot reach up to the canopy in such forests and hence are denied access to the prime source of primary productivity. Depending on the amount of canopy cover the undergrowth in such forests varies from sparse to moderate. However, even in areas with some undergrowth shade tolerant species seem to prevail that tend to have higher levels of toxins. Therefore, the food available for elephants in mature forests is very limited. In contrast where the forests are cut, the influx of light creates extravagant growth of pioneer species that grow rapidly and have fewer toxins, providing a rich source of food for elephants. Grass is an extreme example where the productivity is very high during the growing period with high protein value and low secondary compounds. However it becomes fibrous and silicaceous as it matures with waning protein content. Regenerating shrubs and woody vegetation on the other hand tend to provide good fodder throughout the year. Seasonal cultivation, especially slash-and-burn or swidden agriculture creates and maintains successional areas which represent high quality elephant habitat.

Elephant densities range from around 0.1-0.2 per km^2 in undisturbed high forested habitats, to 3-5 per km^2 in regenerating scrub and savannah mixed habitats. Therefore, the type of habitat can have a strong influence on the number of elephants a given area can support. An additional factor that determines quality of elephant habitat hence densities is likely to be availability of water. However, an elephant needs to drink only a few minutes a day and can walk a few km to the source. Therefore food is likely to be a much greater limiting factor in most habitats than water. The highest quality elephant habitats would be those where both food and water are plentiful throughout the year.

Space: Elephants can survive in a wide range of natural habitats. Protected areas consist of natural habitat, and in many Asian elephant range countries they represent a significant segment of elephant space. However, due to the hands-off management of protected areas advocated in most Asian elephant range countries, such protected areas largely support low elephant densities. Due to conflict with humans the human dominated habitats that elephants can survive in are very limited. Elephant presence is not compatible with permanent human habitations and cultivations as it leads to high levels of HEC. However, elephant presence may be compatible with seasonal cultivation and forestry. Thus, the total extent of space elephants can range-in will be composed of protected areas, and some areas of seasonal cultivation and forestry.

Positive Effects

People: Proper land-use planning can help decrease HEC in a number of ways. Planned development projects that recognize certain areas as potential, prime or under development elephant habitats can incorporate mechanisms into developmental programs that reduce HEC in the area. It should include strategies for removal and subsequent management.

For example, where there is a development project that will change natural habitat into a form that is incompatible with elephants, the elephants in the area would need to be removed. HEC management methods subsequent to development, such as constructing and maintaining elephant barriers on the boundary of the developed area, can also be incorporated into the development plan. Developmental processes such as clearing of land must be conducted in an organized manner, so that the elephants have the opportunity to move away rather than be isolated in remnant non-viable patches of habitat, which increases HEC.

Land-use planning can help identify human activities that are compatible with elephant presence such as seasonal cultivation, forestry and tourism. Recognition of areas where such activities occur and elephants are present, allows development of approaches that will provide economic benefits through conservation to people who share habitat with elephants.

Elephants: Certain types of land-use activities such as irrigation development which leads to permanent cultivation and permanent settlements are not compatible with the presence of elephants. Land-use planning makes this explicit and focuses attention on the fact that such land-use changes within an elephant range will result in loss of elephants. The realization of the consequences of such developmental activities is more likely to result in management plans that address HEC, than when it is ignored. Decrease in HEC brought about by land-use planning (see above) will directly benefit elephants by reducing morbidity and mortality. Proper land-use planning allows the implementation of activities that will bring benefit to people who share habitat with elephants and as such with encouragement of activities that are compatible with elephant presence and habitat enrichment, the extent and quality of space that is available to elephants can increase.

Negative Effects

Land use planning does not have any negative implications for people or elephants.

Future needs

Demonstration of land-use planning in practice.

IN-COUNTRY APPLICATIONS

Sri Lanka

Under the 'National Policy for the Conservation and Management of Wild Elephants' which was developed in 2007, an effort has been made to integrate land-use planning with elephant conservation. Formerly, the main strategy for elephant management and conservation was the limiting of elephants to Department of Wildlife Conservation protected areas. However, an equal or larger part of elephant habitat in Sri Lanka comes under the Forest Department. Of the land under the FD with elephants, a considerable extent comes under Forest Reserves and a lesser extent is currently not declared as reserves and subject to seasonal cultivation. Under a new policy there is provision to recognize all areas with elephants as Elephant Conservation Areas (ECA). Such areas may have diverse land ownership and will include both DWC and FD reserves. Instead of attempting to exclude elephants from all areas other than DWC protected areas as in the past, elephants will be excluded only from areas of permanent human habitations and cultivations. Elephant habitat with seasonal cultivation will be part of ECAs and will be managed so that human activities that are compatible with elephant presence will be continued and will be considered Managed Elephant Ranges (MER).

India

Changes in land-use may be brought about by activities such as incentive driven voluntary relocation of people from crucial elephant habitats (Karanth 2007). However such voluntary and incentive driven resettlement of people may be limited to small homogenous communities living inside protected areas.

Recommendations

1. There is an urgent need for an umbrella strategy on the use of HEC mitigation as a conservation tool for Asian elephants. This is best led by international bodies such as IUCN AsESG in collaboration with multilateral donors (e.g. ADB, WB etc.) as they have a range wide footprint and an inclusive membership. These multilateral agencies could then help mainstream the mitigation options via their investments in the range countries. We believe that infrastructural projects (e.g. Trans-Asian highway project and various hydro-power projects) will significantly increase HEC. Costing and including HEC mitigation options at the planning stage of these large infrastructural projects will lead to economic and conservation gains.

2. Asian Elephants are large mammals with habitat requirements of 200-600 Sq. km and therefore HEC mitigation impact should be looked at the elephant population level (e.g. PAs or Landscapes) rather than at the site level (e.g. villages) even if individual projects are implemented at various geographic scales.

3. There is an urgent need to put in place well designed and cost effective monitoring schemes, across the range countries that can produce quantitative data on the impact of the various HEC mitigation programmes currently being implemented in S. Asia.

4. There is also a need for HEC mitigation techniques "cookbook" that captures information across the Asian region so that individual projects do not keep reinventing the wheel or spend significant time learning from failures at their project site rather than learning from the failures elsewhere.

References Cited

Amala. 2006. Elephants suffer as well: Elephants in Kerala unforgivable torture. The Hindu. Http://www.hinduonnet.com/thehindu/mp/2006/08/02/stories/2006080200960300.htm

Anonymous 2006. Participatory monitoring of elephants in community owned lands of south Garo Hills Meghalaya. Annual report. Samrakshan Trust.

Anonymous. 2007. Permission granted to capture two wild elephants. The Hindu. 2007. Http://www.hindu.com/2007/08/03/stories/2007080354001100.htm

A Rocha India. 2006. A Study on human-elephant conflict issues at the Banerghatta National Park, Karnataka. Technical Report. A Rocha India.

Bandara, R and Tisdell, C. 2002. Comparison of rural and urban attitudes to the conservation of Asian elephants in Sri Lanka: empirical evidence. Biological Conservation. 110: 327 342.

Bajracharya, S. B., Furley, P. A and Newton, A. C. 2006. Impacts of community based conservation on local communities in the Annapurna Conservation Area, Nepal. Biodiversity and Conservation. 15: 2765 2786.

Barua, P. (1995). Managing a problem population of elephants. Pages 151-161 in Daniel, J. C. and Datye, H. S. (eds.). A week with elephants. Bombay Natural History Society, Oxford University Press, Bombay, India.

Bist, S. S; Cheeran, J. V; Choudhury, S; Barua, P & Misra, M. K. 2002. The domesticated Asian elephant in India. In Giant on our hands: Proceedings on the International workshop on the domesticated Asian elephants. RAP publications. 129-148.

Blair, J. A. S., Boon, G. G. and Noor, N. M. 1979. Conservation or cultivation: the confrontation between the Asian elephant and land development in Peninsular Malaysia. Abstract of Land Development Digest 2: 25-58.

Chauhan, N. P. S and Chowdhury. 2002. Evaluation of electric fences for their efficacy in controlling elephant damage in northern West Bengal and suggesting improvements. The Indian Forester. 128. 179-188.

Curio, E. 1996. Conservation needs Ethology. Tree. 11: 260 263.

Daniel, R and Erwin, B. 2007. Wildlife Damage and Agriculture: A dynamic analysis of compensation schemes. American journal of Agricultural Economics. 89: 490 507.

Desai, A. A. 1991. The home range of elephants and its implications for management of the Mudumalai Wildlife Sanctuary, Tamilnadu. Journal of Bombay Natural History Society. 88: 145-156.

Fernando P (1997) Keeping jumbo afloat: is translocation an answer to the human-elephant conflict? Sri Lanka Nature 1:4-12.

Fernando, P., Wikramanayake E., Weerakoon, D., Jayasinghe, L. K. A., Gunawardene, M and Janaka, H. K. 2005. Perceptions and patterns of human-elephant conflict in old and new settlements in Sri Lanka: insights for mitigation and management. Biodiversity and Conservation. 14: 24652481.

Fernando P (2006) Elephant conservation in Sri Lanka: Integrating scientific information to guide policy. In: Principles of Conservation Biology, Ed.s. Groom MJ, Meffe GK & Carroll CR. Sinauer Associates, Inc. Sunderland MA USA. pp 649-652.

Fernando, K. M. C. 2006. The role of natural resource management system in reducing human-elephant conflict. Tropical Ecology and Management. Mini review.

Gunaratne, L. H. P and Premaratne, P. K. 2006. The effectiveness of electric fencing in mitigating human-elephant conflict in Sri Lanka. EEPSEA Publications. Research Report. Available on www.eepsea.org

Hoare, R. 1995. Option for the control of elephants in conflict with people. Pachyderm. 19: 54-63.

Hoare, R. 1999. Determinants of human-elephant conflict in a land use mosaic. Journal of Applied Ecology. 36: 689 700.

Hoare, R. 2001. Management implications on research and problem elephants. Pachyderm. 30: 44 48.

Hopper, G. R. 1999. Changing Food Production and Quality of Diet in India, 1947-98. Population and Development Review. 25: 443477. Http://agricoop.nic.in/stats1.htm

Jayant, K., Mehta, P., Boominathan, D and Chaudhuri,S. 2007. A study of man-elephant conflict in Nagarhole National Park and surrounding areas of Kodagu district in Karnataka, India. Final Report. Envirosearch.

Kumar, M. A., Mudappa, D., Raman, T. R. S and Madhusudan, M. D. 2004. The elephant hills: Conservation of wild Asian elephants in a landscape of fragmented rainforests and plantations in the Anamalais, India. CERC Technical Report No. 10, Nature Conservation Foundation, Mysore.

Kumar, M. A. 2006 b. Towards coexistence: First steps to modifying human-elephant relationships in a conflict-prone landscape in the Anamalai hills, India. Final Report. Submitted to WWF Nepal.

Karanth, K. K. 2007. Making resettlement work: The case of India's Bhadra Wildlife Sanctuary. Biological Conservation.139: 315 - 324.

Karanth, K. U and Karanth, K. K. 2007. Free to move: conservation and voluntary resettlements in the Western Ghats of Karnataka. In Protected Areas and human displacement: a conservation perspective. Widlife Conservation Society working paper 29. Pp. 48 59

Kushwaha, S. P. S and Hazarika, R. 2004. Assessment of habitat loss in Kameng and Sonitpur elephant reserves. Current Science. 87: 1447-1453.

Lahiri-Choudhury D. K. 1993. Problems of wild elephant translocation. Oryx. 27:53-55.

Lahkar, B.P., Das, J.P., Nath, N.K., Dey, S., Brahma, N & Sarma, P.K. 2007. A study of habitat utilization patterns of Asian elephant Elephas maximus and current status of human elephant conflict in Manas National Park within Chirang-Ripu Elephant Reserve, Assam. Technical report. Aranyak.

Leimgruber, P; Gagnon, J. B; Wemmer, C; Kelly, K. C; Songer, M. A and Selig, E. R. 2003. Fragmentation of Asia's remaining wild lands: implications for Asian elephant conservation. Animal Conservation. 6: 347-359.

Lingaraju, S and Nandish, S. 2007. Status of Asian elephants in the Karnataka. Newspaper article. Page: 8. 'Vijaya Karnataka daily'.

Madhusudan, M. D. 2003. Uneasy Neighbours: Human resource use and large mammal conservation in the tropical forests of Karnataka, India. Ph.D.thesis, Manipal Academy of Higher Education, Manipal.

Madhusudan, M. D. 2003 b. Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, south India. Environmental Management. 31: 466 475.

Mishra, C., Allen, P., McCarthy, T., Madhusudan, M. D., Bayarjargal, A and Prins, H. H. T. 2003. The role incentive programs in conserving snow leopard. Conservation Biology. 17: 1512 1520.

Nath, C. and Sukumar, R. 1998. Elephant-human conflict in Kodagu, southern India: distribution patterns, people's perceptions and mitigation methods. Unpublished report, Asian Elephant Conservation Centre, Bangalore.

Osborn, F. V. 2002. Capsicum Oleoresin as an elephant repellent: field trails in the communal lands of Zimbabwe. Journal of Wildlife Management. 66. 674-677

Osborn F. V & Parker, G. E. 2003. Towards an integrated approach for reducing the conflict between elephants and people: a review of current research. Oryx. 37: 80-84.

Parker, G. E and Osborn, F. V. 2006. Investigating the potential for chilli Capsicum spp. to reduce human-wildlife conflict in Zimbabwe. Oryx. 40: 343-346.

Parker, G. E and Anstey, S. G. 2002. Human-elephant conflict and community development in Niassa Province, Mozambique. MZEP Report to WWF SARPO. Pp 17.

Rameshan, M. 2007. GIS and remote sensing application for the mitigation and management of human-elephant conflict in and around Anayirangal region. Master's thesis. Submitted to Mahatma Gandhi University, Kottayam.

Sitati, N. W., Walpole, M. J., Smith, R. J & Leader-Williams, N. 2003. Predicting spatial aspects of human-elephant conflict. Journal of Applied Ecology. 40: 667-677.

Sitati, N. W., and Walpole, M. J. 2006. Assessing farm-based measures for mitigating human-elephant conflict in Transmara district, Kenya. Oryx. 40: 279 286.

Stuewe, M., Abdul, J. B., Mohd Nor, B., and Wemmer, C. M. 1998. Tracking the movements of translocated elephants in Malaysia using satellite telemetry. Oryx. 32. 68 74.

Sukumar, R and Gadgil, M. 1988. Male-female differences in foraging on crops by Asian elephants. Animal Behaviour. 36: 1233 1235.

Sukumar, R. 1989. The Asian elephant: ecology and management. Cambridge University Press, Cambridge.

Sukumar, R. 1990. Ecology of Asian elephant in southern India, II. Feeding habits and crop-raiding patterns. Journal of Tropical Ecology. 6: 33-53.

Sukumar, R. (1991). The management of large mammals in relation to male strategies and conflict with people. Biological Conservation. 55: 93102.

Suresh 1992. Economics of elephant proof trenches and electric fences in Bannerughatta National Park. Dissertation. Submitted to the Wildlife Institute of India. Dehradun.

Sutherland, W.J., Pullin, A.S., Dolman, P.M. and Knight, T.M. (2004). The need for evidence based conservation. Trends in Ecology and Evolution. 19: 305 308.

Taylor, R.D. (1999). A review of problem elephant policies and management options in southern Africa. Human-elephant conflict Task Force, IUCN African Elephant Specialist Group, Nairobi, Kenya

Thouless, C. R. 1994. Conflict between humans and elephants on private land in northern Kenya. Oryx 28: 119-127.
Thouless, C. R and Sakwa, J. 1995. Shocking elephants: fences and crop raiders in Laikipia district, Kenya. Biological Conservation. 72: 99-107.

Venkatraman, A. B., Saandeep, R., Baskaran, N., Roy, M., Madhivanan, A and Sukumar, R. 2005. Using satellite telemetry to mitigate elephant human conflict: An experiment in northern West Bengal, India. Current Science. 88: 1827-1831.

Webber, A. D., Hill, C. M., Reynolds, V. Assessing the failure of a community-based human-wildlife conflict mitigation project in Budongo Forest Reserve, Uganda. Oryx. 41: 177 184.

Williams, A C and Johnsingh, A J T. 1996. Status survey of elephants (Elephas maximus), their habitats and an assessment of elephant-human conflict in Garo hills, Meghalaya. Final Report. Wildlife Insitute of India, Dehradun.

Williams, A. C., Johnsingh, A. J. T. & Krausman, P. R. (2001). Elephant human conflict in Rajaji National Park, northwest India. Wildl. Soc. Bull. 29: 10971104.

Williams, A.C. and A.J.T. Johnsingh. 2004. Elephant human conflict on community lands in Garo Hills, northeast India. Journal of the Bombay Natural History Society. 101: 227-234.

Wittemyer, G; Getz, W. M; Vollrath, F & Douglas-Hamilton, I. (In Press). Seasonal dominance, seasonal movement, and spatial segregation in African elephants: a contribution to conservation behavior. Behavioral Ecology and Sociobiology. 61: 1919 1931.

WWF 2000. The Asian elephant Species Status Report: www.wwf.at/downloads/elefantzwei.pdf

Zimmermann, A. 2007. The Assam Haathi Project. Project report. Submitted to Rufford Maurice Foundation, UK.

Literature Referred

Armbruster P, Fernando P & Lande R 1999. Time frames for population viability analysis of species with long generations: an example with Asian elephants. Animal Conservation 2:69-73.

de Silva, M and Atapattu, N. 1997. Alleviation of wild elephant-human conflict and conservation of elephant in the northwestern region of Sri Lanka, Colombo mimeo.

de Silva, M., Jayaratne, B.V.R., and de Silva, P.K. 1997. A study of elephant movements in the Ruhunu National Park. Gajah.

Eisenberg, J. F.; Lockhart, M. 1972. An ecological reconnaissance of Wilpattu National Park, Ceylon. Smithsonian Contributions to Zoology No. 101.

Eisenberg, J. F.; McKay, G. M.; Jainudeen, M. R. 1971. Reproductive behaviour of the Asiatic elephant Elephas maximus L.. Behaviour 38, 193225.

Fernando P 1995. Implications of socio-ecology and genetics on the conservation and management of the Sri Lankan elephant. In: A Week With Elephants. Proceedings of the International Seminar on Asian Elephants. Eds. Daniel JC & Datye H. Bombay Natural History Society, Oxford University Press, Bombay. pp. 225-235.

Fernando P 1997. Keeping jumbo afloat: is translocation an answer to the human-elephant conflict? Sri Lanka Nature 1:4-12.

Fernando P 2000. Elephants in Sri Lanka: past, present, and future. Loris 22:38-44.

Fernando P & Lande R 2000. Molecular genetic and behavioral analyses of social organization in the Asian elephant. Behavioral Ecology and Sociobiology 48:84-91.

Fernando P, Pfrender ME, Encalada S & Lande R 2000. Mitochondrial DNA variation, phylogeography, and population structure of the Asian elephant. Heredity 84:362-372.

Fernando P, Wickramanayake E, Weerakoon D, Jayasinghe LKA, Gunawardene M & Janaka HK 2005. Perceptions and patterns in human-elephant conflict in old and new settlements in Sri Lanka: insights for mitigation and management. Biodiversity and Conservation, 14, 2465-2481.

Fernando P 2006. Elephant conservation in Sri Lanka: Integrating scientific information to guide policy. In: Principles of Conservation Biology, Ed.s. Groom MJ, Meffe GK & Carroll CR. Sinauer Associates, Inc. Sunderland MA USA. pp 649-652.

Fernando P., Wikramanayake ED., Janaka HK, Jayasinghe LKA, Gunawardena M, Kotagama SW, Weerakoon D and Pastorini J. (2008). Ranging behavior of the Asian elephant in Sri Lanka. Mammalian Biology 73:2- 13.

Hendavitharana, W., Dissanayake, S., de Silva, M., and Santiapillai, S. 1993. The survey of elephants in Sri Lanka. Gajah 12: 1-30. Hewavisenthi A.C.D. 1992. Mahaweli water-resources project. Water International 17: 33-43.

Ishwaran, N. 1981. Comparative study on elephant populations in Gal Oya Sri Lanka. Biol. Conservation 21: 303-313.

Ishwaran, N. 1983: Elephant and woody-plant relationships in Gal Oya, Sri Lanka. Biol. Conserv. 26, 255270.

Ishwaran N. 1993. Ecology of the Asian elephant in lowland dry zone habitats of the Mahaweli River basin, Sri Lanka. Journal of Tropical Ecology 9: 169-182.
Jayewardene J. 1993. Elephant management and conservation in the Mahaweli project areas. Gajah 11: 6-15.

Jayewardene, J. 1994. The Elephant in Sri Lanka. Colombo: The Wildlife Heritage Trust of Sri Lanka.

Leimgruber, P.; Gagnon, J. B.; Wemmer, C.; Kelly, D. S.; Songer, M. A.; Selig, E. R. 2003. Fragmentation of Asia's remaining wildlands: implications for Asian elephant conservation. Animal Conserv. 6, 347359.

McKay, G. M. 1973. Behavior and ecology of the Asiatic elephant in Southeastern Ceylon. Smithsonian Contributions to Zoology No. 125.

Olivier, R. 1978. Distribution and status of the Asian elephant. Oryx 14, 379-424.

Santiapillai, C.; Jackson, P. 1990. The Asian Elephant: An Action Plan for its Conservation. Gland, Switzerland: IUCN.

Survey Department 1988: National Atlas of Sri Lanka. Colombo: Survey Department.

AREAS
ASIAN RHINO & ELEPHANT
ACTION STRATEGY

www.panda.org/areas

Review of human-elephant conflict mitigation measures practiced in South Asia

WWF AREAS Technical Support Document

Photo Credit : Gert Polet/ WWF