

**Guidelines for Protecting Crops from Raiding by Elephants
Around Salakpra Wildlife Sanctuary, West Thailand**



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LIVING CONSERVATION



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ACKNOWLEDGEMENTS

I would like to thank the Elephant Conservation Network (ECN) and the Zoological Society of London (ZSL) for their foresight in coming up with this much needed study and for financing the study trip. First, I wish to thank Dr. Matt Walpole and Belinda Stewart-Cox for coming up with the wonderful idea of an Afro-Asian human-elephant conflict mitigation link and lessons sharing, particularly between my project in Transmara District, Kenya and ECN's Salakpra project in Thailand. My visit to Thailand was a great success due mainly to the tirelessly fine-tuned logistical support and excellent organisational skills of Belinda Stewart-Cox and Jittin Ritthirat. I would also like to recognise the contribution to the success of this work of the village monitors and farmers that we visited. My gratitude also goes to the sanctuary officers manning the different stations that accommodated us and prepared delicious meals. In the stations we visited, rangers were kind enough to share with us information concerning conflict and elephant related threats.



Left: Noah with Veera, the ECN village monitor for Ta Manao, and Jittin in a raided sugarcane field

Right: Noah with Jittin and Belinda with the ECN truck known as 'chang uerk' or white elephant. White elephants have royal status because they are sacred and revered in Thailand.



EXECUTIVE SUMMARY

Increasing human-elephant conflict continues to generate challenges for elephant conservation and management. Many conflict mitigation approaches, both traditional and modern, have evolved with varying degree of success and differ between elephant ranges. However, some of these approaches are unknown to most HEC mitigation practitioners and can only be learned about through exchange visits and the sharing of lessons.

ECN and WWF/DICE realised the need to compare the status of human-elephant conflict approaches in Africa and Asia, focusing on two sites in Kenya and Thailand, and to compare different conflict mitigation strategies between them. In seeking to promote novel *in situ* conflict mitigation strategies that can enhance the well being of elephants and people, the Darwin Initiative and ZSL funded this study strip. The purpose of this report is to document a variety of proven as well as new approaches that could be used to protect crops around the Salakpra Wildlife Sanctuary in order to minimise human-elephant conflict while at the same time monitoring their degree of success.

To find out about local human-elephant conflict strategies and to establish what other methods might be appropriate, this trip began with field visits across the project site, interviews with ECN staff, village monitors, protected area personnel and farmers, and reviews of published documents. This report has several sections including: an introduction (section 1.0) which describes the background and context of the problem being addressed. The purpose of ECN and ZSL (section 1.1), the terms of reference (section 1.2) and the exchange trip schedule (1.3) are also noted.

Section 4 contains a review of the strategies used to mitigate human-elephant conflict by local people with an evaluation of their strengths and weakness. Section 5 describes methods from Africa which the project might adopt and details the scientific protocol to use. It also presents sample forms for recording data.

The report concludes with some recommendations that may help the project realise its goal. The report also reviews traditional and novel HEC mitigation techniques (sections 1.8 and 1.9) that are being tried by local farmers in order to reduce HEC in and around the sanctuary. Each technique is considered for its suitability, applicability, and effective monitoring. These mitigation measures have the potential to succeed if they are socially, politically, financially, ethically and environmentally acceptable. A table details the current mitigation measures being elsewhere, primarily in Africa, together with their written references.

Finally the report makes specific conclusions (section 1.10) and recommendations (section 1.11) for ECN on methods of HEC mitigation derived from field experience and from the literature.



With Jittin Ritthirat (left), Charlotte Johnston (third right) and rangers at a mineral lick favoured by elephants near the Thung Salakpra guard station

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1. Introduction

Human-elephant conflict (HEC) in Thailand, as in any other elephant range, poses a serious threat to wild elephant conservation. Other threats include human encroachment, both legal and illegal, into elephant habitats and the resultant fragmentation and loss of habitat.

Thailand has two elephant populations; wild elephants (c. 2,000) and domesticated elephants (c. 3,500). With a human population of around 60 million, half of whom are farmers, the likelihood of people and elephants coming into conflict has increased. Conflict has a negative impact on people's livelihoods and for this reason, the Elephant Conservation Network (ECN) chose to undertake a human-elephant conflict mitigation project around the Salakpra Wildlife Sanctuary because it is the problem hotspot of Thailand's most important conservation area, the Western Forest Conservation Complex, the core of which is a World Heritage Site. The second phase of the project began in July 2005 with support from the Zoological Society of London and the Darwin Initiative. Its aim is to better understand the problem through surveys and monitoring, and to test some simple, cost-effective conflict mitigation measures.

Over 200 crop-raiding incidents have been recorded since February 2006 and GIS maps are being finalized. These provide the information necessary for designing conflict mitigation measures. I was contracted by ECN / ZSL to assist the project put in place some mitigation measures and design the monitoring protocol that will help in measuring the successes the sanctuary indicate that crop raiding is a serious threat to elephant conservation efforts and to people's livelihoods.

1.1 Elephant Conservation Network

Founded by Belinda Stewart-Cox and Jittin Ritthirat in 1998, the Elephant Conservation Network is a community-linked conservation initiative that aims to tackle the problems caused by elephant crop raiding around the Salakpra Wildlife Sanctuary and Tham Thanlod National Park in Kanchanaburi Province, west Thailand. It is supported by the Zoological Society of London's Conservation Programme with funds from Darwin Initiative. It works with local communities, NGO's and Thai government agencies, including the provincial administration and the Ministry of Natural Resources and Environment.

1.2 Terms of reference

The terms of reference for this work were to review the current status of HEC in and around Salakpra Sanctuary, and examine practical and novel approaches towards their resolution. Specifically, individual TORS were as follows:

- (a). Help to design and establish effective crop protection trials in the ECN target areas;
- (b). Help formulate data collection forms to monitor the efficacy of the crop trials;
- (c). Provide a trip report detailing the recommendations and data protocols provided;
- (d). Provide follow up advice by email to help the ECN team finalise implementation.

1.3 Trip schedule

Thu 8 Mar	Arrived Bangkok. Travelled with Belinda to project office in Kanchanaburi (KB)
Fri 9 Mar	Met ECN staff, project presentation / trip planning with Belinda & Jittin
Sat 10 Mar	Site visit: around south Salakpra to Khao Daeng / Chongla. Stay at Chongla guard station
Sun 11 Mar	Site visit: across sanctuary to Ta Manao / other HEC sites. Stay in core area of Salakpra
Mon 12 Mar	Site visit: west side to raided areas of Ko Buk / 900 rai & into forest. Back to project office
Tue 13 Mar	Detailed crop-protection trials planning (am) meet farmers on site, buy equipment (pm)
Wed 14 Mar	Fieldwork with Jittin / other ECN staff setting up crop-protection trial sites @ Khao Daeng
Thu 15 Mar	Fieldwork with Jittin & other ECN staff setting up crop-protection trial sites @ Ta Manao
Fri 16 Mar	Media day: presentation /crop-trials site visit for 12 journos (TV/press). Stay in Salakpra
Sat 17 Mar	Media visit to elephant core areas in Salakpra. Group lunch. Return to KB, late to Bangkok
Sun 18 Mar	Brunch meeting with Belinda to review trip & plan future. Return to Nairobi late evening.



Above: Noah and Jittin in a sugarcane field regularly raided by elephants in Khao Daeng. These fields abut the forest near a dry stream-bed that has long been used by elephants to reach the permanent stream beyond. Crop-raiding was not a problem until sugarcane was planted.

Below: Belinda with papaya trees knocked over by elephant for no clear reason. The fruits, ripe & unripe, had not been touched.



Above: the 6-km long, 100m wide strip of land inside Salakpra but owned by EGAT because it is under the hydro-dam's pylons is loaned to landless farmers but is vulnerable to raids by elephants. The farmers club together to pay one man to operate a single line electric fence around the area.

2. Description of project site

Salakpra Wildlife Sanctuary (858 Km²) is in Kanchanaburi province, west Thailand. Gazetted in 1965, it was Thailand's first wildlife sanctuary (Figure 1). It was also the first place where crop-raiding by elephants was recorded. The total population of elephants is thought to be between 120 (Srikrajang 2003) and 150 (Kongrit et al. 2007).

When the Srinakarin hydro-electric dam was built 25 years ago, people moved into area immediately around the sanctuary, settling into prime elephant habitat i.e. areas with permanent water and good soils. Elephants were squeezed into a shrinking forest peninsula with a central mountain ridge that makes the area rockier and less able to sustain a sizeable elephant population. The dam also inundated optimal riverine habitat and blocked many traditional elephant routes to the river. This altered situation has pushed elephants into closer contact with people and a new era of conflict. Human activities such as logging and livestock grazing also increased, thereby damaging elephant habitats even inside the protected area.

Conflict in the form of crop-raiding has been recorded in 15 villages (Figure 2), so the Elephant Conservation Network has 15 village monitors (VMs) who are trained to map, measure and record every conflict incident whenever and wherever it occurs.

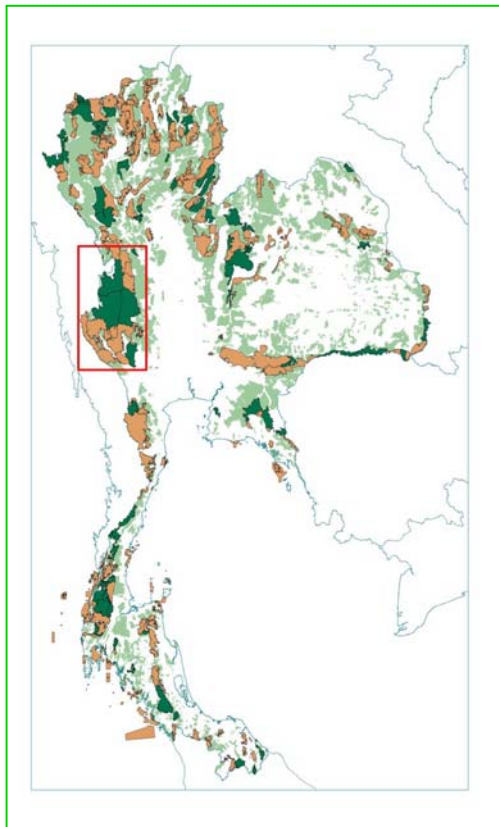
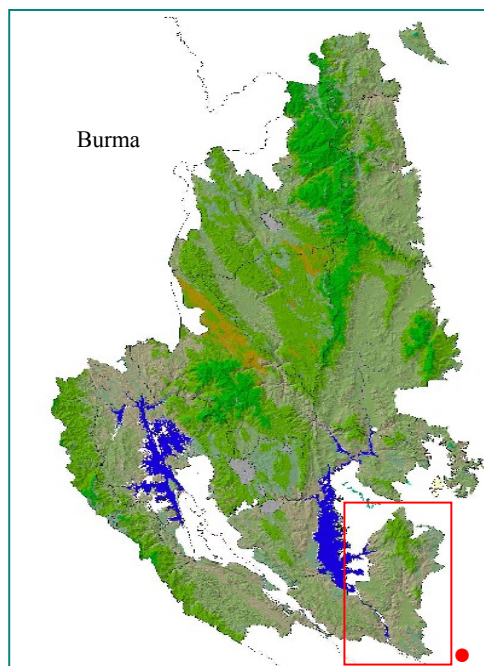


Figure 1: Map of Thailand showing the surviving forest cover in 1990 and the protected areas (grey reserved forest, brown national parks, green wildlife sanctuaries) with the Western Forest Conservation Complex boxed in red.

Figure 2: Map of the Western Forest Complex showing the Khao Laem and Srinakarin Reservoirs with the project area boxed in red. The provincial capital, also called Kanchanaburi (red dot) is roughly 25kms from the tip of Salakpra.



2.1 Farming activities and crop raiding in the project site

Sugarcane is grown in a large commercial scale around the southern part of Salakpra. Other crops include mangos, teak and cassava. On the western side of the sanctuary, farmers plant a mix of crops for sale and for subsistence. These crops included: mangos, banana, maize and papaya which are popular with elephants and cassava, rubber, chilli and cotton which are not.

3. Crop protection measures already used by farmers

Crop raiding in and around the sanctuary is not a new phenomenon - it was first recorded in 1982 - but it has increased significantly in the last 8-10 years as more and more people exploit the forest in way or another and as farmers started to plant commercial crops favoured by elephants along the sanctuary boundary. Some farmers tried to protect their crops with bamboo fences or home-made alarm systems but as crop raiding became more frequent and more intense, they devised other, more effective methods for deterring elephants. These include:

3.1 Simple electric fences

One or two strands of wire, either connected via a transformer to a mains electricity cable (converting 220 amps to 8,000 volts) or to a car battery (110 amps to 8,000 volts). The wires held about 1m high with plastic bags tied at irregular intervals to flutter in the breeze. Farmers believe this method works well but no one has ever monitored its effectiveness using quantifiable data.

3.2 Non-electrified fences

Smooth wire or plastic string is tied 1-2 meter above the ground and hung with plastic bags at irregular intervals to flutter in the breeze and reflect moonlight. Some villagers maintain that this deters elephants because it looks like an electric fence but again, no one has monitored its effectiveness using quantifiable data.

3.3 Watchtowers and guarding

3.3.1 Watchtowers

Watchtowers built in tall trees near the sanctuary boundary are used by guards at night to detect elephants from a distance. Farmers know how difficult it is to get elephants out of a sugarcane plantation once they get in, so several of them have installed a trip-wire system that warns of approaching elephants.

3.3.2 Guarding

Farmers around Salakpra say their crops are at risk if left unguarded at night. Guards are hired by farmers to keep vigil at night, but they are in short supply. Guarding is sometimes augmented with prayers and sweet talking exhortations to the elephants to persuade them not to destroy the crops. Guards should be stationed on the frontline where elephants usually emerge from the forest.

3.4 Planting unpalatable crops

Some farmers have planted unpalatable crops such as tobacco, teak, rubber, cotton, tapioca, chilli, and eggplant as a buffer between the forest area and the fields planted with palatable crops. However, other farmers have switched completely and now plant only unpalatable crops.

3.5 Torches and reflecting CDs

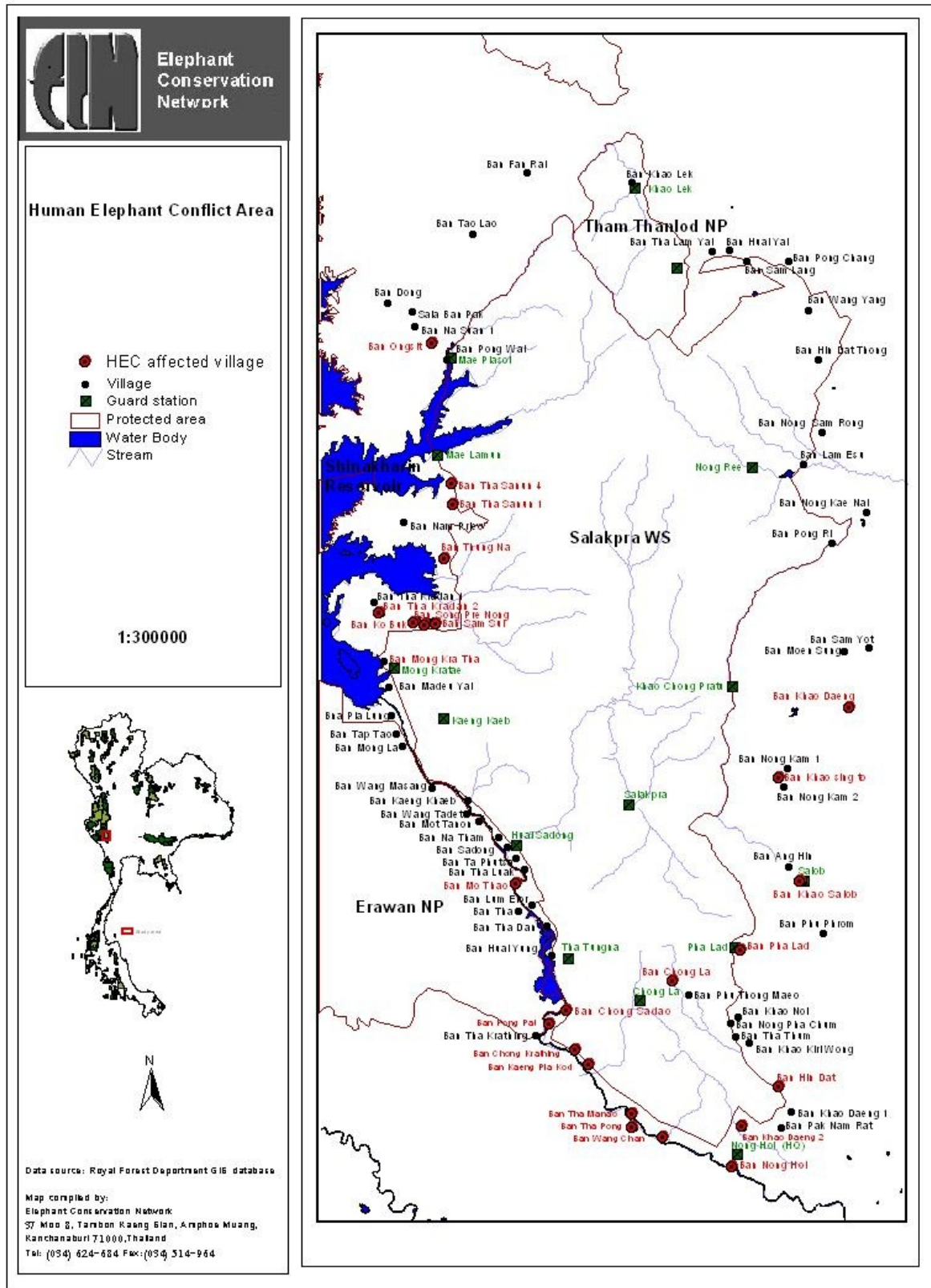
A torch powered by a car battery is tied to a pole facing the direction where elephants emerge from the forest. The CD reflects the light beam and flickers as it swivels around in the breeze. This is thought to make elephants that a person is there with a torch.

3.6 Catapults and firecrackers

Villagers make two types fire-cracker or mini-grenade; a round one the size of a small golf-ball and a cylindrical one (right) that is slightly larger. Each has a short fuse. A fire-bomb is put in the catapult, lit and fired towards the elephant/s. Within seconds they emit a very loud bang.



Figure 3: Map showing villages affected by crop-raiding



Photographs of local crop-protection measures



CDs hung in front of a torch that is powered by a car battery and turned on at night. As the CD turns in the breeze, it flashes.



A watch-tower built into a toddy palm tree among sugarcane fields, it is big enough for two guards to rest while listening out for elephants.



This line of plastic string hung with plastic bags which are illuminated by moonlight is said to stop elephants that regularly walk by from damaging the plant nursery.



Where a road separates Salakpra and human settlement, a single wire about 1.5m from the ground runs along the forest edge and is electrified at night by a car battery.



ECN field staff Tu (left) and Veera (right) demonstrate how people use catapults to shoot home-made fire-bombs (inset) at elephants to chase them from villages & crops.



A scarecrow with tins, bamboo clanger and bells hanging on rope set up along the forest side of a field to alert villagers to the arrival of elephants.

4. Proposed crop protection trials

Designs for crop protection trials suggested to ECN are detailed in Appendix 1. These are simple, community-based methods. Every trial or demonstration plot must have a watch tower and guarding system as farmers are not willing to leave fields unguarded at night. It is also important to have a control plot for every method being tested in order to compare the impact of the test site with an unprotected field nearby. Control plots should be located over 200m away from the trial plot and details of raiding recorded daily along with those of the demonstration plots (see Appendices 2 & 3). Below, I describe the various designs that could be tried around the sanctuary.

4.1 Chilli-tobacco-oil concoction

Mix a concoction in the proportion of 500g chilli and 1000g tobacco to 5 litres of used engine oil and apply it regularly to sisal or cotton rope that encloses a regularly raided farm. In Transmara District of Kenya, this mix has been used successfully (Sitati & Walpole 2006) although we do not know which substance actually deters elephants; the chilli, tobacco or oil. These fences should be 20-50m away from the crop and the area either side of them should be clear of vegetation. I recommend the following experimental designs for testing around Salakpra:

Experiment 1: (a) Chilli-tobacco-oil concoction without hanging plastic bags

(b) Chilli-tobacco-oil concoction with hanging plastic bags

Experiment 2: (a) Chilli-oil mixture without hanging plastic bags

(b) Chilli-oil mixture with hanging plastic bags

Experiment 3: (a) Tobacco-oil mixture without hanging plastic bags

(b) Tobacco-oil mixture with hanging plastic bags

Experiment 4: (a) Engine oil without hanging plastic bags

(b) Engine oil with hanging plastic bags

These designs can be replicated in many places, each with a control plot to monitor their impact.

4.2 Low voltage electric fence

Electric fencing may have two types of experimental design controlled by (i) the source of power (i.e. mains / battery); and (ii) the number of wire strands (i.e. single / double). The fences should be 20-50m away from the crop and the vegetation should be cleared on either side. The following experiments can be tried and monitored:

(i) **Mains power** (converted via transformer to 8,000 volts)

Experiment 1: (a) One wire strand without hanging plastic bags

(b) One wire strand with hanging plastic bags

Experiment 2: (a) Two wire strands without hanging plastic bags

(b) Two wire strand with hanging plastic bags

(ii) **Vehicle battery** (converted via transformer to 8,000 volts)

The above two experiments can be replicated using a car battery instead of mains electricity.

4.3 Other crop protection strategies to test

As discussed with ECN, other crop protection strategies could also be tested to determine their efficacy. These might include:

a) Barriers

- Horizontal fences: between a grid of posts too wide for an elephant to step over; or in chair form with tall vertical posts and a horizontal grid in front (currently being tested in Laikipia)
- Growing unpalatable crops ignored by elephants as demonstrated by Thailand's Wana Kaset (Agriculture Park) project and Parker and Osborn (2006)
- Using railway tracks to create mechanical fencing as in Addo Elephant Park, South Africa.
- Using live fences e.g. Mauritius thorn or other prickly plant species (partially successful)
- Digging moats and ditches
- Stone walls e.g. Shimba Hills National Park and Laikipia (Thouless & Sakwa, 1994).

b) Deterrents

- Bees : place bee hives in key positions around a field (Karidozo & Osborn 2005)
- Sound devices and bangers. Elephants are sensitive to loud noise, especially when taken by surprise. Variable low frequency sounds triggered by a simple mechanical device, with compressed air as the source of energy (ref. Winnie Kiiru near Amboseli). Manual models may also be investigated including home-made fireworks and grenade-like bomblets.
- Light devices. Elephants dislike bright lights pointed towards them at night. Strobe lights cause disorientation. Specially designed spot-lights could be tested.
- Chemical deterrents. Because elephants have an acute sense of smell, people have tried to use hated smells to deter them but it is difficult to design a cost-effective method of delivery. Throwing devices (e.g. plastic balls or smell-bombs that discharge on impact) with ammonia, chilli, tear-gas or other noxious substance inside. Another idea is 'smell mines' placed along trails regularly used by elephants to access fields.

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- Chemo-mechano-electro-repellent devices, being developed by Stanford University, USA. Tested over 7-years on elephants at Riddle's Elephant Sanctuary in Arkansas, USA, combining knowledge of elephant behavior with olfactory influences on behaviour. They are developing a cost-effective, chemo-mechano-electro-repellent barrier using metal rails with rollers dispensing repellents when touched. The inner and outer rollers have a hole for pouring in a slurry of natural compounds that smells repugnant to elephants. Each device is about 10-foot wide and can be set up separately or in a linked line.

c) Human intervention / action

- Rotational guarding
- Trip wires, detectors and other early warning systems e.g. trip wire across an elephant path to release a sound that may scare off elephants and warn guards of their approach; or a trip wire around fields that would trigger an early warning signal in a watch tower or nearby house. Also infrasound alarm devices, whistle (high frequency).
- Land use planning and zoning may be the most effective and sustainable long term solution.

4.4 Measuring the effectiveness of crop protection trials

The success of any protection method can only be assessed if quantifiable data is properly collected using a standard data collection protocol. For comparative purposes, I have recommended using my own monitoring forms (Sitati and Walpole 2006), modifying them as necessary to suit the local situation (Appendix 1).

5. Other suggested monitoring protocols

5.1 Monitoring and recording crop raiding

Referring to Hoare (2001), the ECN data sheet used to monitor crop-raiding was redesigned (Appendix 2) to make it a simpler, easier, more effective tool for recording conflict incidents.

5.2 Monitoring elephant attacks on people

In order to compare the results of my work in Kenya and ECN's work in Thailand, it would be valuable to monitor the direct impact of elephants on local people (death and injury), especially as Salakpra is heavily (and illegally) exploited by people. Past incidents can be obtained from historical records kept at sanctuary headquarters, but it may be necessary to interview victims or their relatives to get more detailed information (Appendix 3).

5.3 Monitoring elephant mortality

The ECN team should also keep records of elephants known to have been killed or injured by people, to have died of natural causes or from some other cause (e.g. accident). Information can be recorded using the form provided in Appendix 4.

5.4 Monitoring elephant sightings and distribution in the sanctuary

I strongly recommend that ECN undertakes the plan it has already discussed with at least two keen and committed guard station chiefs (Chongla and Thung Salakpra) to record the sightings and signs of elephants around the station on a daily basis, monitoring their use of mineral licks and water sources. The suggested data sheet already discussed is attached as Appendix 5. This data will augment the information provided by seasonal surveys, and may better inform future planning and conflict monitoring.

6. Recommendations

The following recommendations are made for future action:

- a) The project has too few GPS units, so the conflict incidents are recorded later than they could or should be by the project officer. To save on field operation costs, it would be prudent to equip each village monitor with a GPS.
- b) Farmers / guards of selected pilot trial plots can be trained to assist in monitoring the effectiveness of the mitigation measures on a daily basis during crop growing seasons.
- c) Map and estimate the area available for elephants since most parts of the sanctuary have steep hills which may not be easily accessed by elephants.
- d) Document the biophysical and socio-economic differences and similarities between the Transmara District, Kenya and Salakpra Sanctuary, Kenya for possible publication.
- e) Publish a comparative analysis of data collected from the two study sites.
- f) Communicate by email to help ECN finalise implementation of its crop-protection trials.

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Appendix 1. Summary table showing the villages and crop protection methods currently used and to be tested.

Prepared by Jittin Ritthirat in preparation for planning crop-protection trials.

Sub-District	Village	Area	Farmer's Name	Methods now used	Future methods planned by farmers	Methods suggested by ECN	Notes
Dan Mae Chalaeb	Tha Sanun 1	W	Mr. Sumon Chankham (leader)	Community managed electric fence across the ele-exit trails from forest	<i>Itchy pod (Sisiad)</i> trees planted by the ele-trail	1. Community electric fence with strong wooden or concrete posts along the forest edge with a regular system of monitoring and maintenance 2. <i>Sisiad trees</i> planted along ele-exit trail from forest	These villages lie next to the villages below. The whole length for fencing the villages is about 20 kms. covering the 2 sub-districts of Nong Ped & Tha Kradaan
	Tha Sanun 4 (the newest village to be crop-raided)	W	Mr. Kamnuan Khamsuwan (<i>Puyai Gung</i>)	Community electric fence (1 km) across ele-exit trails from forest	Increase the length of the fence to 3++ kms. to complete the ele barrier.	1. Strong electric fence with proper maintenance on the PA side 2. <i>Sisiad trees</i> planted along ele exit trail (long term)	
Nong Ped	Thung Na	W	Mr. Patpong (leader)	Community managed electric fence on forest side of road	Strong electric fence with proper maintenance	1. Strong electric fence with good maintenance on PA side 2. <i>Sisiad trees</i> planted along ele exit trail (long term) 3. Acetic acid round fields	
	Koh Buk-Samsui	W	Mr. Chamlong (leader)	Community managed electric fence <i>plus</i> fence around fields	Strong electric fence with proper maintenance on forest side	1. Strong electric fence along the forest edge with a proper system of maintenance 2. <i>Sisiad trees</i> planted along ele exit trail 3. Acetic acid round fields	

Sub-District	Village	Area	Farmer's Name	Methods now used	Future methods planned by farmers	Methods suggested by ECN	Notes
Tha Kradan	Tha Kradaan	W	Mr. Kanok (leader)	Community electric fence		1. Strong electric fence along forest edge with a proper system of maintenance 2. <i>Sisiad trees</i> planted along ele exit trail (long term)	Cultivated area lies outside the village under the pylon line (about 6km. in length)
	Mong Kratae	W	Mrs Samruai (leader) and Kanok (from Tha Kradaan)	Community managed electric fence	1. Strong electric fence with proper maintenance	1. Strong electric fence along forest edge with proper system of maintenance 2. CD + spotlight over the field 3. Unpalatable plants (farmers have already started doing this)	Cultivated area lies next to the forest edge under the pylon line (allocated to local landless farmers by EGAT). The same area at Tha Kradan
Chong Sadao	Mo Thao	Mid-West	Mr. Amporn Mr. Somyod (leader)	Modified electric fence around field	1. guarding by forest personnel	1. Chili grease + engine + tobacco around fields 2. Community electric fence across ele exit trail from forest	Dry season raid only (May-June)
	Chong Krathing	S/W	Mr. Kwed	Modified electric fence around fields		1. Early warning system	This area is on the opposite side of the River Kwai
	Tha Pong	S/W	Mr. Suchart	No			On the far side of the River Kwai but male elephants do sometimes cross over
	Pong Pad		Mrs. Rabiab	No		1. Early warning system 2. Acetic acid round field*	

Sub-District	Village	Area	Farmer's Name	Methods now used	Future methods planned by farmers	Methods suggested by ECN	Notes
Wang Dong	Kaeng Plakod	S/W	Mr. Sujin (leader)	No			
	Ta Manao	S/W	Mr. Somchok Mr. Somchai Mr. Nipon (leader)	- Electric fence round fields - Night guarding - firecrackers	1. Guarding 2. Standard electric fence	1. Early warning system 2. Standard electric fence	
	Wangjaan	S/W	Mrs. Tongbai Mr. Saaithong (leader)	Modified electric fence round fields		1. Acetic acid round fields	
	Nong Hoi	S/W	Mr. Winai Mr. Preecha Mr. Raksak Mr. Koson	Modified electric fence round fields		1. Early warning system 2. Acetic acid round fields	
	Khao Daeng	S	Mr. Surachai Mr. Tawee Mr. Sunchai Mr. Manop (leader)	1. Modified electric fence 2. Night guarding 3. Tree platform	1. Trench on a dry stream <i>Huai Pu Makha</i> (4 kms.) 2. Standard electric fence	1. Early warning system 2. Trench 3. Acetic acid around fields (Mr. Tawee & Tippawan) 4. Alternative crop (tapioca)	
	Chong La	S (inside)	Mr. Somchai Mr. Somsak	1. Guarding		1. CD + spotlight in fields	
	Phalad	S (inside)		No		1. CD + spotlight in fields	
Bo Ploi	Khao Singto	E	Mr. Wichai Mr. Wichit Mr. Tongchai (leader)	1. Guarding 2. Burn tyre 3. Ball crackers	1. Electric fence on ele exit trail (solar power) 2. Guarding 3. Red ant trees	1. Bee hives on ele exit trail 2. <i>Sisiad</i> tree planted (long term) on the exit trail	The ele exit trail from the forest is about 200-300m between two hills.
	Khao Daeng	E		No		1. alternative plants (i.e. eucalyptus already done)	Cultivated area next to the foothill
Na Suan	20. Ong Sit	W	Mr. Amnuay	No		1. Acetic acid round fields	

* Acetic acid seems to work well in the villages around Kaeng Krajan NP which we visited as part of our HEC study trip to Kuiburi. Local farmers discovered this method by themselves Pin of WCS thinks the strong acidic smell may deter elephants.

Appendix 3: Monitoring form for crop raiding by elephants

Village Name:
Date (Y-M-D):
Raid No.

ELEPHANT CROP DAMAGE REPORT FORM

VM Name:..... Date of CR incident:.....
Date CRI reported to ECN:..... Date CRI assessed.....

I: Place, date and general information

Village :Location (X)(Y).....
Farmer's name:.....
 Land owner (place of origin/residence).....
 If rented, landowner's place of origin/residence (village, sub-district, district, province)
.....
Crops damaged:.....Cost of crop damage estimated by farmer
First year of crop raid at the farmer's plot (year)?.....

II. Crop damage

Crop type	Crop's average growth stage: seedling 1 intermediate 2 mature 3	Date crop planted	Average quality of crop: poor 1 average 2 good 3	Total area (m2) or no. stems of crop	Area (m ²) or number of stems damaged	Eaten 1, damaged 2, both 3.	Intensity of damage to crop destroyed: low 1, medium 2, high 3	Notes

III. Damage to other property

Property	Extent of damage	Cost	Details
1. Food store			
2. House and buildings			
3. Fences			
4. Water containers (i.e jar, tank)			
5. Livestock (specify)			
6. Others (specify)			

IV. Problem Elephant

Elephant seen? Yes (bulls No..... family unit No.....)
 No

Signs seen? Yes No

What signs? Dung No. dung piles:..... bulls family unit
 Foot prints..... bulls family unit
 Other (specify)

Number of elephants (if known).....

Time of entry.....Time of exit.....

V. Protection and control methods

Protection and control methods in use at time of incident? Yes No

Methods	Tick ✓ if yes	Time starts	Time ends	Notes details/comments
1. Wildlife fence (electric fence)				
2. False fence				
3. Bells on wire to give warning				
4. Lighting near raid site/route				
5. Fire crackers				
6. Make a noise				
7. Fire a gun				
8. Guard the field				
9. Use light (i.e. torch, burn tire)				
10. Others (specify)				

Effective? Yes Reaction of elephants/animals

No Reaction of elephants/animals.....

Other comments:

.....

Appendix 4: Monitoring elephant attacks on people

Village Monitors Name: Form No.

Name	GPS x-coord	GPS y-coord	Date	Time	Sex	State	Injured/Dead

Appendix 5: Monitoring elephant deaths & injuries in/around Salakpra Wildlife Sanctuary

Village Monitors Name: Form No.

Date	GPS x-cood	GPS y-cood	Injured / dead	Carcass*	Cause of death*	Sex*	Tusks*	Comments / reason for killing

- * **Carcass:** 1: fresh 2: recent 3: old 4: very old
- * **Cause of death:** 1: natural 2: illegal
- * **Sex:** 1.male 2. Female 3: Unknown
- * **Tusks:** 1. intact 2. cut out 3. pulled out 4. naturally absent

Appendix 6: Monitoring elephant sightings / distribution within the sanctuary

Month:

Guard station:

Date	No. of elephants	Sex (1 or 2)*	Evidence: dung (1), browse (2) or elephants seen (3)	Comments (eg. direction of movement, no. calves, etc)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

*1: Mixed herd, 2: Bulls

Author's biography

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Dr. Noah Sitati completed his Bachelor of Education Degree in 1989 at Kenyatta University, Kenya, taking Botany, Zoology and Education. Thereafter he was employed by the Teachers Service Commission (TSC) at a high school teaching Biology and Geography.



After teaching for five years, he enrolled in 1995 for the Master of Philosophy degree programme in Wildlife Management at Moi University, Kenya. In 1998 he enrolled at the Durrell Institute of Conservation and Ecology (DICE), University of Kent, UK, for PhD studies in Biodiversity Management with financial support from WWF, KWS and Darwin Initiative. He finished in 2003.

With financial support from WWF, Dr Sitati then managed a two-year WWF funded human-elephant conflict research project in the Masai Mara (2001-03) testing various conflict mitigation methods and from 2003-06, he did a 3-year post-doctoral research study at DICE on mitigating human-elephant conflict in the same area. During that period, he has also supported, supervised and examined several students from Moi University pursuing elephant related studies. Dr. Sitati is a member of IUCN/SSC African elephant specialist group.



Left: Noah Sitati with Charlotte Johnston (ecotourism consultant) and some of the ECN team. Clockwise from right: Jittin, Krit, Mon, Tu, Mem, and Belinda.

Right: Noah Sitati with (left) ECN community coordinator / manager Jittin Ritthirat and (right) Veera ECN's village monitor for Ta Manao,

