



ASIAN ELEPHANT CONSERVATION AND
HUMAN-ELEPHANT CONFLICT MITIGATION IN
KAENG KRACHAN NATIONAL PARK, THAILAND

INTERIM REPORT
TO THE
INTERNATIONAL ELEPHANT FOUNDATION
FROM THE
WILDLIFE CONSERVATION SOCIETY (WCS)

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Report prepared by: Petch Manopawitr, WCS-Thailand Program
pmanopawitr@wcs.org

Puntipa Pattanakaew, WCS-Thailand Program
ppattanakaew@wcs.org

Simon Hedges, WCS Asian Elephant Coordinator
shedges@wcs.org

Anak Pattanavibool, PhD, Director, WCS-Thailand Program
anakp@wcs.org

Principle Investigator: Anak Pattanavibool, PhD, Director
WCS-Thailand Program
P.O. Box 170, Laksi, Bangkok 10210 THAILAND
T : +66 2 503 4478(9), F : +66 2 503 4096

Additional Contacts :

Colin Poole
Director
Asia Program
Wildlife Conservation Society
2300 Southern Boulevard
Bronx, NY 10460
T: 718-220-5885
F: 718-364-4275
E: cpoole@wcs.org

Sylvia Alexander
Development Officer
Foundation Relations
Wildlife Conservation Society
2300 Southern Boulevard
Bronx, NY 10460
T: 718-741-1643
F: 718-364-7963
E: salexander@wcs.org

The Wildlife Conservation Society (WCS) has made significant progress conserving and mitigating threats to elephants in Thailand's Kaeng Krachan National Park (KKNP). We are pleased to submit the following interim report.

1. Summary of Progress

- WCS-Thailand has completed pilot recce-survey transect elephant surveys in Kaeng Krachan National Park (KKNP). Interpreting results from recent elephant surveys utilizing the fecal DNA-based, capture-recapture method at other sites, WCS has concluded that this methodology is indeed best for KKNP.
- Based on results of a dry-season survey, we produced a map of the spatial distribution of elephants, and threats facing them and their habitat.
- WCS conducted a Fecal DNA Sample Collection Training course for 26 KKNP staff, March 7-9, 2007; and fecal DNA-based, capture-recapture surveys in all elephant hotspots were carried out from March to June 2007, with a total of 646 samples collected.
- Management recommendations were submitted to Park authorities in January 2007 to strengthen our protection scheme.
- We facilitated law enforcement training for 32 patrol staff; and a law enforcement monitoring system has been underway since January 2007.
- Crop-raiding incidents in KKNP from November 2004 through February 2007 totaled 723, or an average of 27 incidents per month.
- Most incidents (105 incidents or 88 percent) occurred within 400 meters of the forest edge; the furthest recorded incident was 1.27 kilometers from the forest edge.
- We have set up experimental human-elephant conflict (HEC) reduction plots using crop damage assessment data from September 2006. All experimental plots are located in recent HEC hotspots, within 500 meters of the forest edge, which our data shows to be the most vulnerable zone.

2. Background

KKNP is Thailand's largest national park, covering 2,900 square kilometers at the southern end of the Tenasserim Range on the border with Myanmar, and is part of a larger protected forest complex in Thailand covering 4,373 square kilometers (see Figure 1). We have reason to believe that KKNP contains a large and internationally significant population of Asian elephants (*Elephas maximus*), but no population estimate is available for the Park, and little is known either about the distribution of elephants within the Park's boundaries, or threats to the elephants and their habitat. WCS's Kaeng Krachan Elephant Project aims to address these issues by training Park staff in modern survey methods, and conducting surveys to: (1) assess the size and distribution of the elephant population in KKNP, using methods proven to be effective for forest elephant surveys

elsewhere in Southeast Asia; and (2) identify threats to the elephant population and habitat. The project also aims to reduce HEC, particularly crop raiding, a major problem in and around KKNP. HEC mitigation will benefit both local farmers and the Park's elephants. The lessons learned from our work in KKNP will also assist farmers to reduce HEC elsewhere in Thailand and at other HEC hotspots in Asia.

3. Project Goals

- Determine the distribution and size of the elephant population in KKNP.
- Reduce threats to KKNP's elephants and their habitat, and facilitate more effective protection of this important elephant population.
- Mitigate HEC in and around KKNP, and promote use of effective HEC mitigation methods at other conflict hotspots in Thailand.
- Train KKNP staff and other interested organizations and individuals in modern elephant survey techniques, and HEC assessment and mitigation methods.

4. Specific Objectives

- Assess the size of the KKNP elephant population using fecal DNA-based, capture-recapture surveys.
- Map elephant distribution, and the spatial distribution of threats to elephants and their habitat in KKNP, and make appropriate management recommendations.
- Continue implementing HEC reduction strategies at selected KKNP demonstration sites.
- Continue quantifying HEC in and around KKNP to assess the effectiveness of our conflict reduction strategies.
- Improve protection of elephants and elephant habitat in KKNP.
- Train rangers and Thai biologists: (a) to design and conduct elephant surveys using modern peer-reviewed, sampling-based survey methods; and (b) implement an HEC reduction strategy using methods that have proven effective elsewhere.

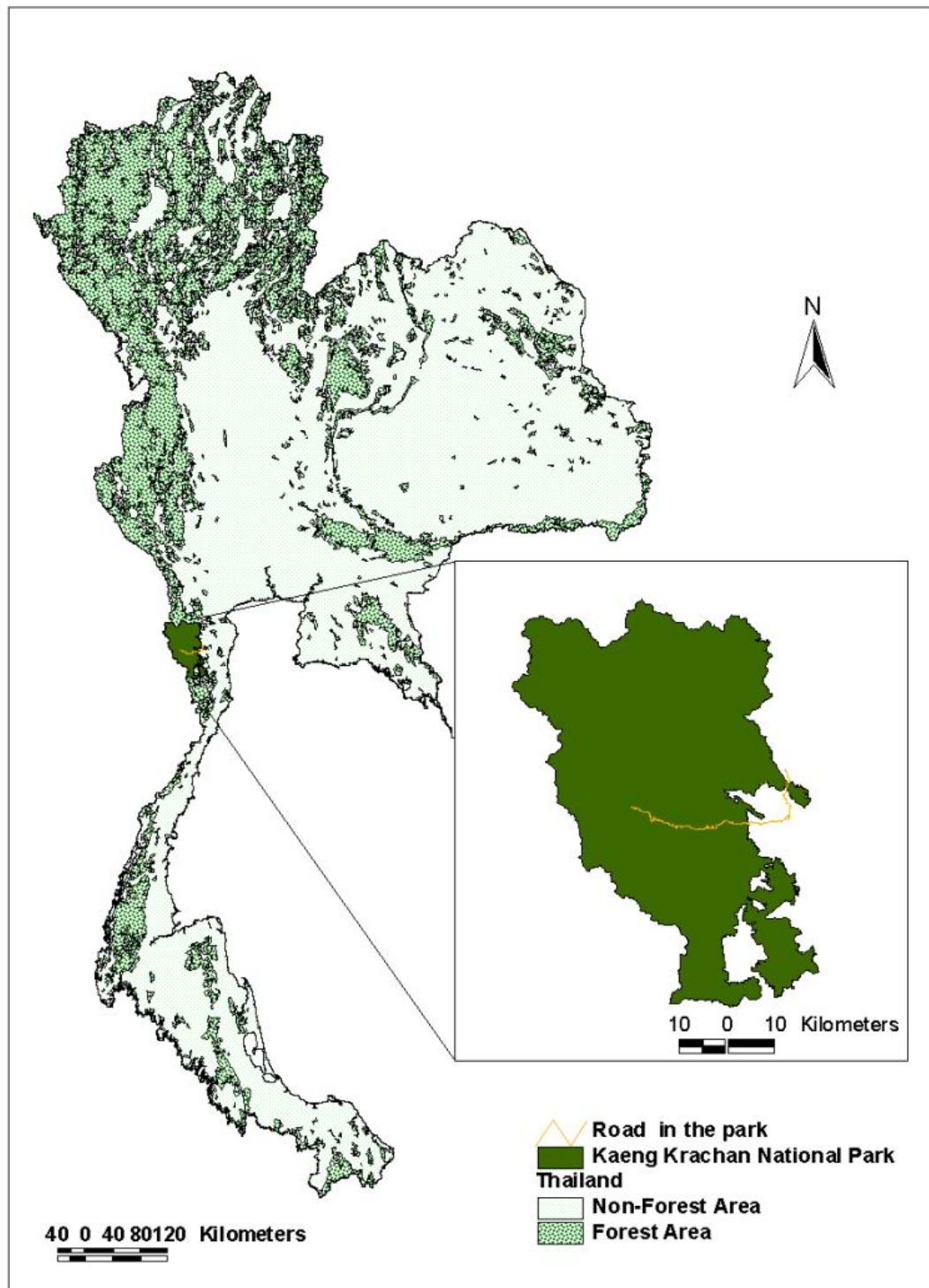


Figure 1: Location of Kaeng Krachan National Park within Thailand.

5. Performance Report

Objective 1: To assess the size of the KKNP elephant population using fecal DNA-based, capture–recapture surveys.

Our comprehensive elephant distribution survey, which used the recce-survey transect (RST) method, has helped identify 25 elephant hotspots in KKNP (Figure 2a). WCS and KKNP conducted a Fecal DNA Sample Collection Training course for 26 park staff, March 7-9, 2007, at Pa La-U sub-station. Simon Hedges, WCS Asian Elephant Coordinator, and Worawidth Wajjwalku, Associate Professor of Veterinary Medicine at Kasetsart University, contributed their expertise to the training, after which the three fecal DNA-based, capture-recapture surveys conducted in all identified elephant hotspots were carried out from March to June 2007 (see photographs in Appendix A). With four survey teams working simultaneously, each round took about two weeks to complete, with two-week intervals between rounds. A total of 646 fecal DNA samples were collected from several sites during three surveys (Figure 2b). The findings will be analyzed in the Veterinary Medicine Laboratory at Kasetsart University under the supervision of U.S. molecular biologists with significant experience in these techniques.

Figure 2a: Location of elephant hotspots in KKNP.

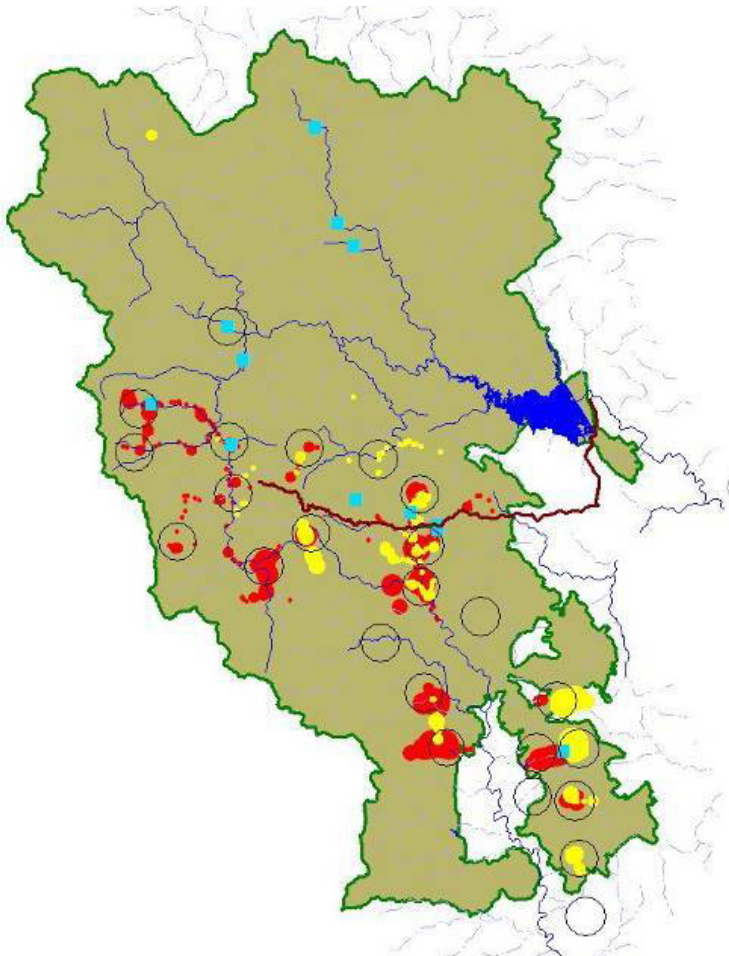
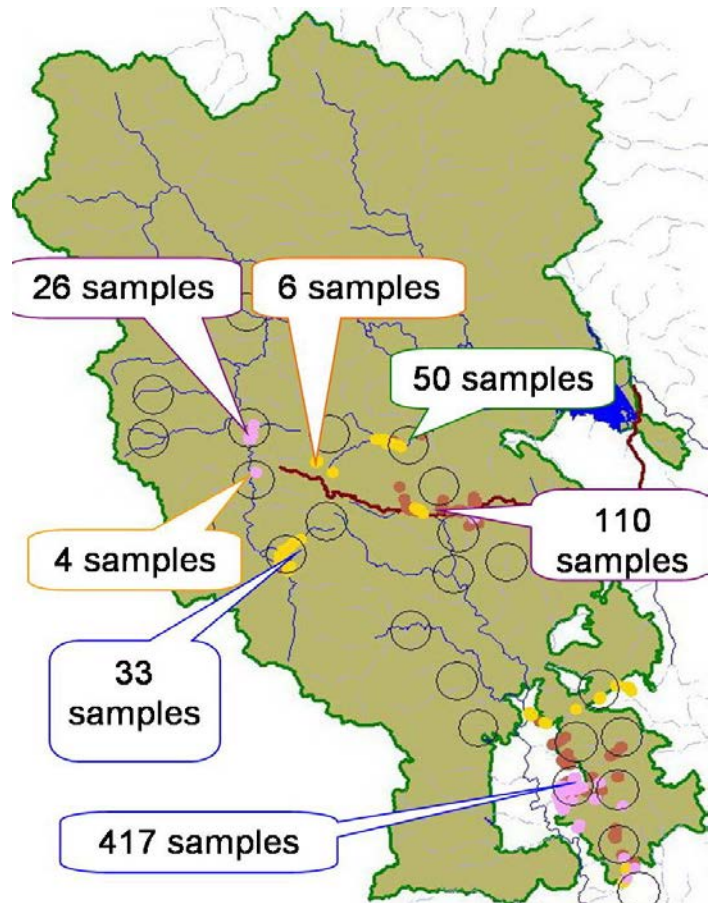


Figure 2b: Results of fecal DNA collection (646 total samples).



Objective 2: To map the distribution of elephants, and the spatial distribution of threats to them and their habitat in KKNP; and to make appropriate management recommendations.

Systematic RSTs provided the first-ever comprehensive survey of the Park, which revealed that elephants were confined to a relatively small area (about 33 percent of KKNP), and were completely absent from the northern areas (Figure 3a), not due to habitat destruction because northern habitat is intact with water year-round, but probably the result of direct poaching. This proved to be a significant finding because KKNP was previously thought to be well protected. Our surveys revealed threats to wildlife and habitat along every trail surveyed, and were concentrated in the central area near human settlement, and in the northeast (Figure 3b). It appears that poaching is rampant throughout KKNP, despite public impressions to the contrary. To help understand the scale and nature of the problem, our teams recorded the locations of illegal camps, hunting signs, logging, encroachment, and non-timber forest product collection (see photographs on page four of Appendix A). To strengthen the protection scheme, WCS provided Park authorities with management recommendations, which were well received by the KKNP superintendent and are now guiding and stimulating law enforcement efforts.

Figure 3a: Distribution of elephants in KKNP.

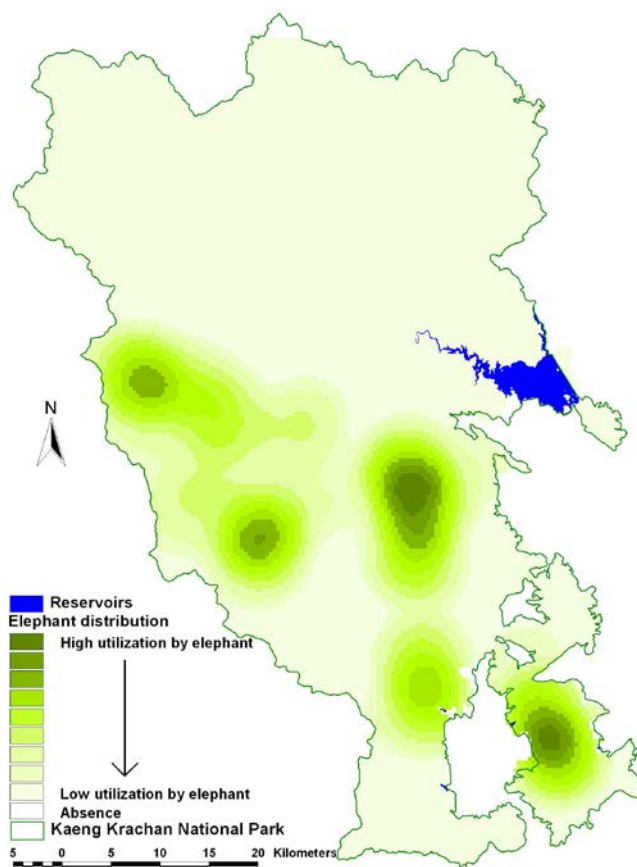
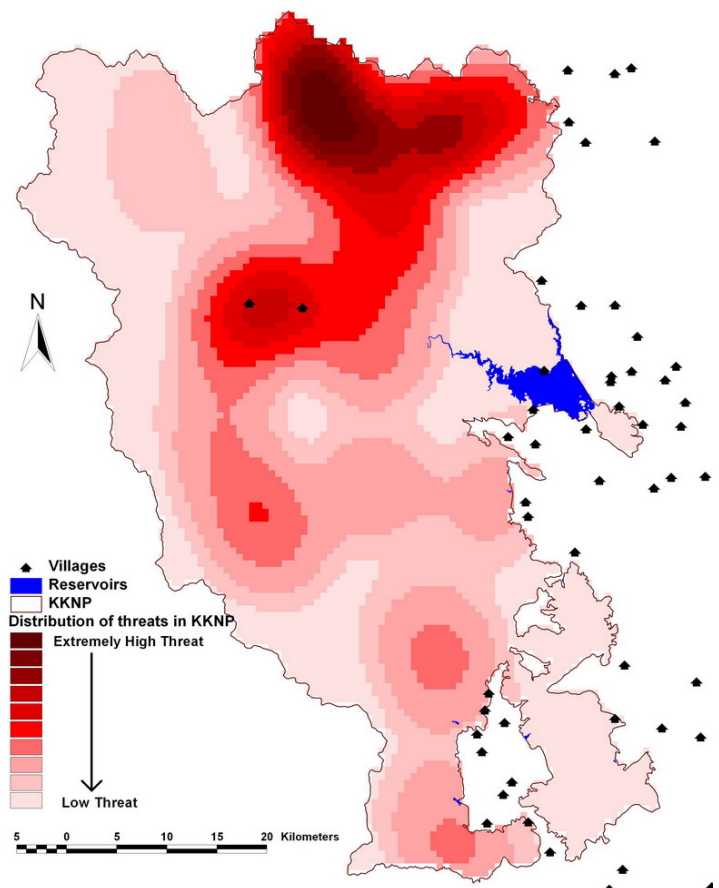


Figure 3b: Distribution of high-risk areas based on threat assessment collected during RST surveys.



Objective 3: To continue implementation of an HEC reduction strategy at selected demonstration sites throughout KKNP.

We set up experimental HEC reduction plots based on the findings of a September 2006 crop damage assessment, all of which are in recent HEC hotspots within 500 meters of the forest edge, the most vulnerable zone. We selected four mitigation methods to test: chili deterrents, vinegar deterrents, electric wire fences, and normal wire fences. Details of each method are described below. All four mitigation sites are equipped with a detection system made of siren and trip-wires placed every 200 meters along the fence. We built huts at each demonstration site to serve as guard stations (see photographs on page eight of Appendix B).

Detection Systems:

String and siren trip-wires, tested in Sri Lanka and Sumatra, are now being evaluated in KKNP. They help alert farmers who have fallen asleep, enabling them to detect elephants before they enter and damage crop fields.

Deterrent Systems:

- **Chili deterrent:** We set up experiments with chili-based irritants: *pepper grease* (old engine grease and dry chili powder, mixed together and applied to string fences surrounding crop fields) and *pepper dung* (cattle dung mixed with ground hot chilies, dried in the sun, and then burned to create a noxious smoke). Both methods have proven effective in Africa but have not been tried in Thailand until now. Our ongoing work in Sumatra suggests that chili-based methods may not be especially effective under Asian conditions; and our initial test with tame camp elephants was not promising either. Nevertheless, we felt it would be useful to test this method with wild elephants using locally acquired chili. The results will be available in the second year of these activities.
- **Vinegar deterrent:** We built string fences around crop fields and suspended water bottles filled with vinegar to create a noxious smell, a popular local method. It has proven quite effective because vinegar is extremely painful to scratches on elephant skin. However, it is normally used in combination with other methods and has never before been formally tested. These tests are also ongoing, and results will be available in the second year of these activities.
- **Electric wire:** Electric fences are used locally to keep cattle inside designated areas. We employ an electric controller to generate a high voltage pulse (about 12 kv AC), which is also very short (about 0-120 msec), called a shock wave. This short shock wave causes pain when touched, but is not dangerous to large mammals such as elephants, or to humans. Although electric wire is widely used, formal tests have never before been conducted. Tests are ongoing, and results will be available in the second year of these activities.

Additionally, a team protocol for elephant guards was adopted, as follows: The team arrives at the guarding stations around 5:00 p.m., checks all equipment, and assures that the warning system is working properly before dusk. The team then separates into smaller groups of one or two persons, and patrols the fence every two to three hours. If sirens sound, team members in separate guard stations communicate by two-way radio to coordinate a response. The team uses multiple techniques, including shining spotlights and setting off fire crackers. We assess the effectiveness of passive (i.e., fences) and active deterrents alike by recording elephant behavior and comparing

the frequency and impact of raids before and after adoption of the crop guarding methods. The preliminary results indicate that a vigilant system is key to deterring elephants from raiding crops. Detailed results of our HEC reduction program will be submitted with our final report.

Objective 4: To continue quantifying HEC in and around KKNP to assess the effectiveness of our reduction strategies.

WCS-Thailand Program staff, KKNP rangers, and local villagers have teamed up to conduct systematic crop damage assessments since November 2004. The data collected between October 1, 2006, and February 4, 2007, show that crop raiding incidents in KKNP occur mostly in identified hotspots. A total of 119 incidents were recorded, and 69 farmers from 12 villages in four sub-districts, two districts, and two provinces were affected. Since November 2004, this has brought the total number of crop-raiding incidents in KKNP to 723, or 27 incidents per month (Figure 4). Incidents in the latest period occurred from the northern end of the enclave at Ban Khao Laem, to Ban Haui Yang in the south. Most incidents (88 percent) occurred within 400 meters of the forest edge. The furthest recorded incident was 1.27 kilometers from the forest edge (Figure 5).

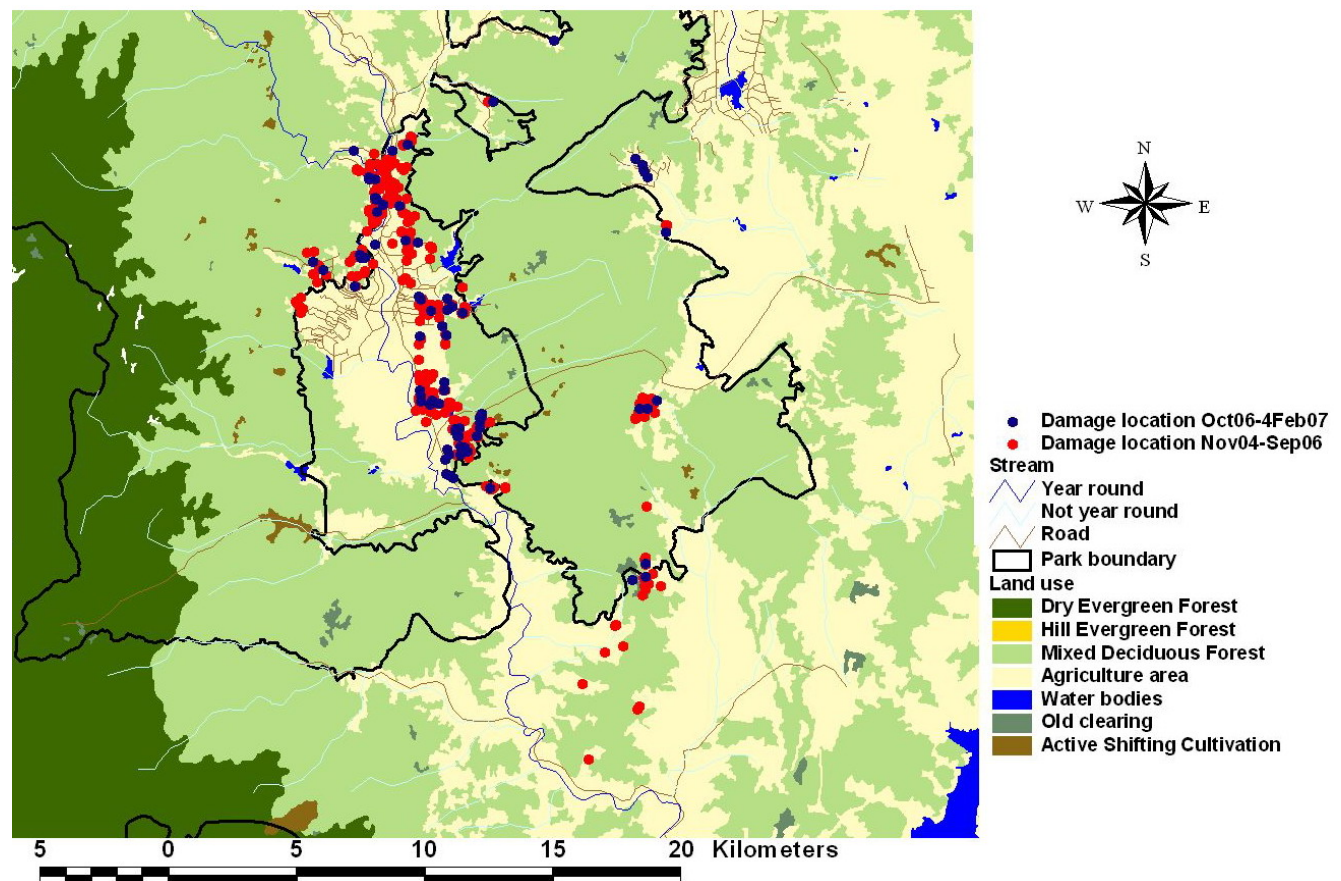


Figure 4: Distribution of crop-raiding incidents around KKNP between October 2006 and February 2007.

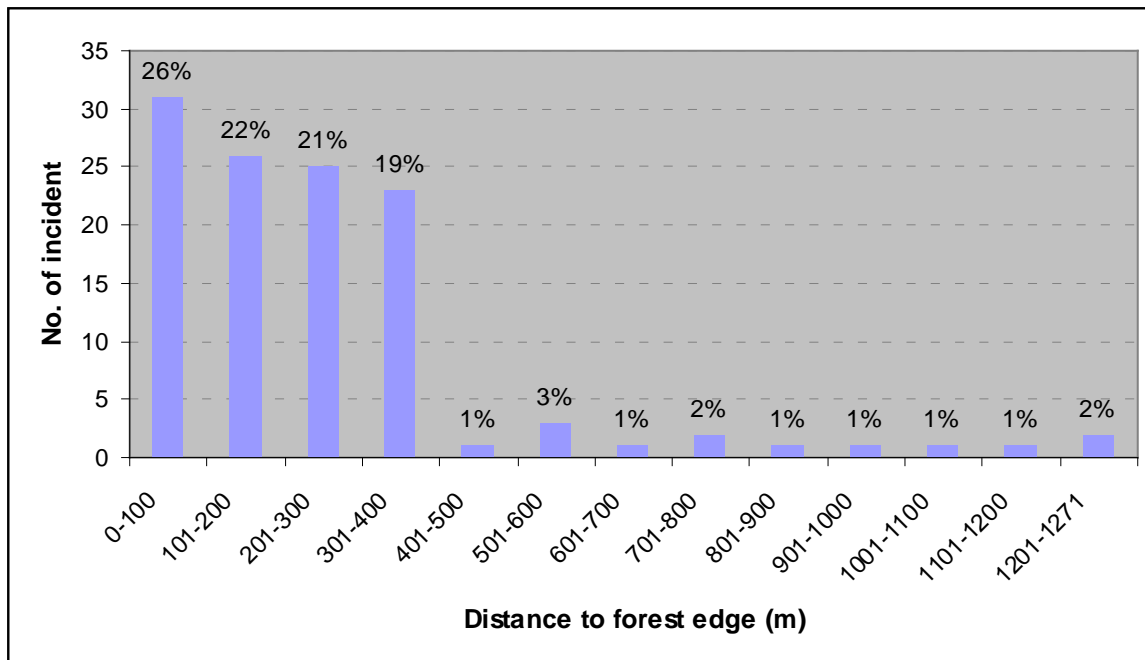


Figure 5: The distance of crop raiding incidents from the nearest forest edge, October 2006 to February 2007.

For about 41 percent of HEC incidents in this period, we recorded information on elephant group size showing that elephants typically raid in small groups (one animal: 37 percent of the time, three animals: 24 percent). Elephants normally enter crop fields from dusk (1800h) to dawn (0600h), but the data shows that the most likely time for elephants to enter fields is between 2100-2359h (53.2 percent: 25 incidents). However, up to 60 percent of the time (72 incidents), we have no information about the actual time of the raids.

From October 2006 to February 2007, crop-raiding incidents involved 13 species (Table 1), but elephants most frequently raided only five: banana, coconut, papaya, pineapple, and jackfruit. Most raided crops were ready to harvest, except pineapple and coconut. Pineapples were better guarded during the harvesting season, and elephants raided coconuts for their shoots, not for fruit.

Based on market value data obtained from the Department of Agriculture Extension (2006), WCS estimates total direct economic losses due to crop damage by elephants, for the period November 20, 2004, to September 30, 2006 (679 days), to be about US\$211,325 (7,607,712 Baht), which is about US\$113,599 (4,089,565 Baht) a year. The total number of farmers who experienced HEC problems in and around KKNP was 218, so the average economic loss per person per year was US\$521 (18,759 Baht). Given that the annual per capita income of local farmers is about US\$864, economic loss caused by HEC should have had a significant impact. However, economic loss data from each farmer, ranging from US\$4 to US\$7,555, revealed that the loss for a large number of affected farmers (44 percent) was less than US\$100 per year (Figure 6). Furthermore, for about 75 percent of affected farmers, their average annual economic loss was about US\$500; and only 25 percent of these, about 55 farmers, faced very serious economic loss. A paper on these findings will be presented at the 21st Annual Meeting of the Society for Conservation Biology 2007, in

South Africa, and is entitled “*Economic analysis of crop depredation by elephants at Thailand’s Kaeng Krachan National Park suggests that land use change, not crop guarding, is the solution.*”

Crop species	Growth Stage			Damage Type			Damage Intensity			Frequency of crop-raiding incidents	Cost of damage (US\$)
	Mature	Intermediate	Seedling	Eaten	Eaten/Trampled	Trampled	Low	Medium	High		
Banana	23	21			44				44	44	3,098.92
Coconut	5	14			18	1	7	2	10	19	1,523.07
Pineapple	3	10	1	2	12		9		5	14	1,263.38
Papaya	5	4		1	7	1	1		8	9	632.52
Jackfruit	5	2			6	1	6		1	7	660.13
Guava	1				1		1			1	29.36
Palmyra											
Palm		1			1				1	1	12.75
Rubber tree		1	2			3	1		2	3	15.74
Ground wax	1					1			1	1	52.67
Chili		1				1			1	1	19.01
Durian			1			1			1	1	310.84
Santol		1				1	1			1	60.69
Betel nut		1				1			1	1	12.75
Total	43	56	4	3	90	10	26	2	75	103	\$7,691.84

Table 1: Crop species damaged by elephants from October 1, 2006, to February 4, 2007.

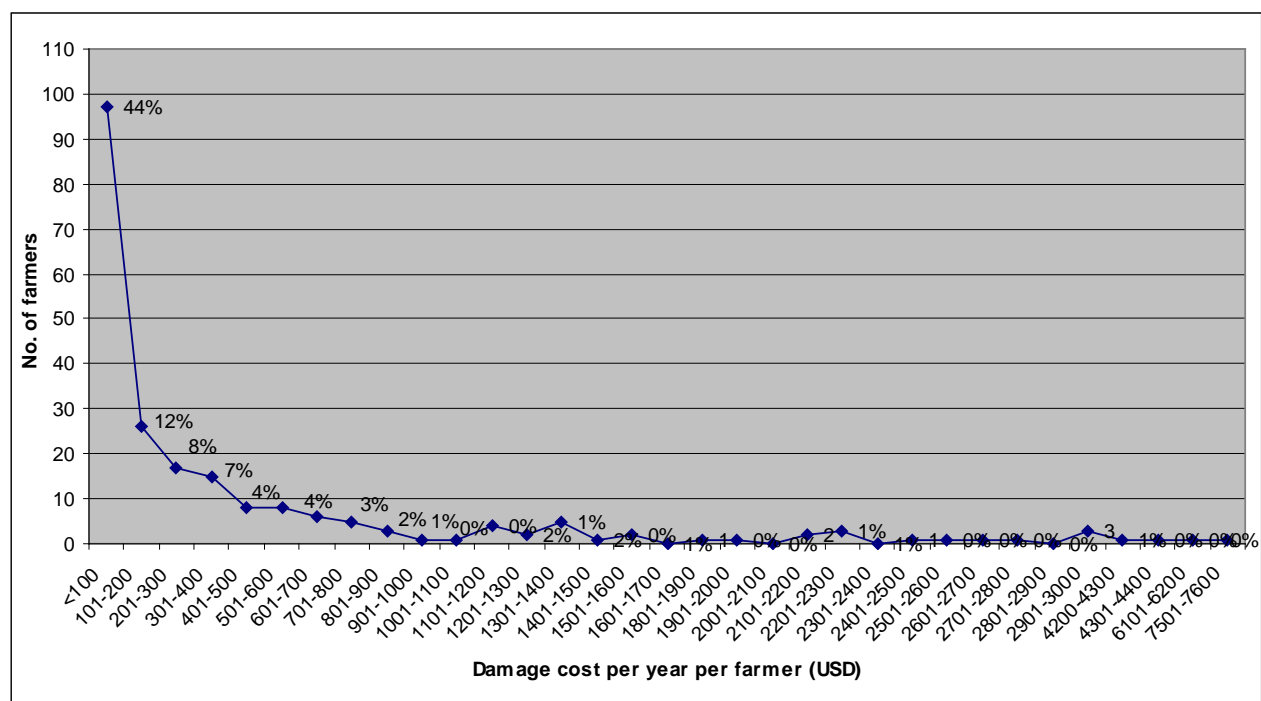


Figure 6: Distribution of economic loss by farmers (November 2004 to September 2006).

Objective 5: To improve protection for elephants and elephant habitat in KKNP (guided by threat-mapping results obtained in 2006).

In collaboration with the Royal Border Patrol Police and senior staff from Haui Kha Khaeng Wildlife Sanctuary, a World Heritage Site, we conducted law enforcement training for 32 KKNP patrol staff in early 2007. The WCS curriculum was adapted from the standard syllabus developed for CITES MIKE (Monitoring the Illegal Killing of Elephants) Law Enforcement Monitoring Program, and covered a range of topics, including the distribution of elephants in KKNP, practical field navigation techniques using map/compass/Global Positioning System (GPS) procedures for reporting patrol activities, elephant and other wildlife observations, and information on threats to elephants and their habitat. Participants received instruction through a series of lectures, practical demonstrations, and interactive discussions, and began systematic patrols following the training. Patrol teams adopted new protocols, and are now equipped with maps, compasses, GPS devices, and datasheets. These systematic patrols are focusing on high-risk areas and have been underway since February 2007.

WCS also began training qualified Park staff to be responsible for uploading and downloading patrol information on a regular basis. Each patrol team now returns to Park headquarters to report findings and download patrol route and GPS references into a central database. Monthly meetings to discuss patrol results are also scheduled. The WCS team works closely with Park authorities to strengthen the patrolling system by providing appropriate recommendations and encouraging evidence-based management. The Conservation Monitoring Center at Park headquarters has been in operation since May 2007.

Objective 6: To train rangers and Thai biologists: (a) to design and conduct elephant surveys using modern peer-reviewed, sampling-based survey methods; and (b) implement an HEC reduction strategy using methods proven effective elsewhere.

KKNP rangers have been trained in RST techniques and received on-the-job training from WCS team leaders. A training course in fecal DNA-based, capture-recapture survey techniques, led by Simon Hedges, WCS Asian Elephant Coordinator, and WCS Thailand staff was provided to 26 KKNP staff, and biology and veterinary students from Kasetsart University. The teams later received additional field training during actual surveys from March to June 2007. Crop damage assessment and HEC mitigation training are being provided in the field to Park staff, local villagers, and interested partners working on HEC in Kanchanaburi Province.

6. Project Impact

The Kaeng Krachan Elephant Project has led to a better understanding of the status of the elephant population in KKNP, and revealed the scale of threats to KKNP's elephants and their habitat. WCS has begun to facilitate effective management and protection of the elephants and the Park, and we are collaborating with Park authorities to improve protection and establish a law enforcement monitoring system. No reports of elephants being killed in retaliation for crop raiding have been received since our HEC reduction trials began.

A long-term plan for HEC reduction is being considered, based on ongoing data collection and the effectiveness of the HEC mitigation methods being tested. We anticipate that a long-term benefit of HEC reduction activities will be an improvement in rural livelihoods around KKNP, thus fostering goodwill toward the Park. Partners to date include Kaeng Krachan National Park, Department of National Park, Wildlife and Plant Conservation, the Department of Forest Biology at Kasetsart University in Bangkok, as well as local administrative offices.

See attached photographs.

APPENDIX A: Selected WCS photographs from 2007 KKNP elephant surveys.

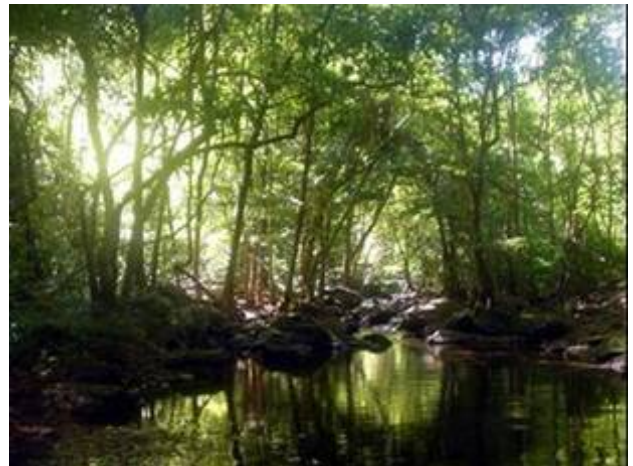
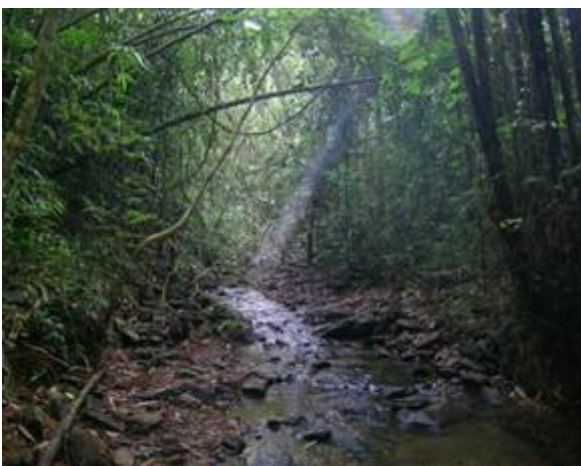
More than 30 KKNP staff participated in the 2007 surveys shown below and received on-the-job training in standard elephant survey techniques.



It proved very difficult to gain access to remote parts of KKNP due to the steep terrain and thorny thickets. In the wet season, flash floods made it prohibitively dangerous. Three of our survey teams had to be rescued by a Border Police helicopter.



WCS-Thailand elephant distribution surveys provided the first comprehensive biological surveys of KKNP, including ground checks of habitat types, shown below.



Surveys conducted in 2006 showed signs of illegal human activity throughout KKNP. The most frequently encountered threats were illegal camps, hunting signs, poaching evidence, and non-timber forest product collection. The photographs below show the remains of palm civet, wild pig, hornbill, Asiatic black bear, and a junglefowl trap.



APPENDIX B: Selected photographs of WCS-Thailand crop damage assessment activities, and human-elephant conflict (HEC) mitigation efforts in KKNP.

Crop damage assessment team shown interviewing farmers in detail about elephant crop raids.



Crop damage assessment team shown measuring the scale of damage by counting damaged trees, or the size of the affected area, using compass and hip-chain.





Examples of crop-raiding damage by elephants in the KKNP area. Crops attacked most often were banana, pineapple, jackfruit, coconut, mango, papaya, corn, and guava.





These photographs show a variety of local human-elephant conflict mitigation methods in the KKNP region.



Electric Wire



Normal Wire



Flaming Torch

Burning Tire

As shown above, farmers use passive and active methods to protect their crops. Passive methods include setting up electric fences, making small trenches, and burning tires at entry points. Active methods for scaring elephants away from crops include shining spotlights, using torches, setting off fire crackers, banging metal objects, and blowing whistles.

Building on our knowledge of HEC hotspots around KKNP, WCS-Thailand initiated the following conflict reduction strategies at demonstration sites in September 2006.

1. **Chili deterrent:** We set up experiments with chili-based irritants: *pepper grease* (old engine grease and dry chili powder mixed together and applied to string fences around crop fields), and *pepper dung* (cattle dung mixed with ground hot chilies, dried in the sun, and burned to create a noxious smoke).



2. Vinegar deterrent: We constructed string fences around crop fields and suspended vinegar in water bottles to create a noxious smell. This method is used by local people and has proven quite effective as vinegar can be extremely painful to elephants when it touches scratches on their skin.



voltage

(220W), so it caused some deterrent pain but did not harm large mammals or humans.



Detection system: String and siren trip-wires have been used as a detection method at KKNP. We are currently evaluating such detection systems because they can help alert farmers who have fallen asleep, enabling them to detect elephants before they enter and damage crop fields.



Huts (below) were built around demonstration sites to serve as guard stations.

