HUMAN-WILDLIFE CONFLICT IN AND AROUND SEIMA BIODIVERSITY CONSERVATION AREA, MONDULKIRI AND KRATIE PROVINCES, CAMBODIA

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WCS WILDLIFE CONSERVATION SOCIETY
CAMBODIA PROGRAM

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Kara Scally, Tom D. Evans and Nut Meng Hor

Wildlife Conservation Society Cambodia Program
Cambodia Rural Development Team
Forestry Administration

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Glossary of Khmer terms

chamkar	farmland, excluding rice paddy
krom	'group' – in official terms a sub-village, one part of a 'phum', with its own krom chief
phum	'village' – in official terms, an administrative village with one overall village chief, in general usage any collection of houses

Abbreviations

CRDT	Cambodia Rural Development Team
FA	Forestry Administration
HH	Household
HWC	Human-Wildlife Conflict
NTFP	Non-timber Forest Product
SBCA	Seima Biodiversity Conservation Area
WCS	Wildlife Conservation Society

Krom (subvillage) names used in tables

AK	Andoung Kraloeng
PK	Pu Clair
PCK	Pu Chu Kraom
PCL	Pu Chu Leu
TR	Trapeang Ronheav

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Cover Photographs

Tom Evans/WCS, Amy Veder, CRDT

EXECUTIVE SUMMARY

Human-wildlife conflict (HWC) is an important issue globally and is widely reported as a problem in the Seima Biodiversity Conservation Area (SBCA). The aims of the present study were (1) to investigate qualitative perceptions of HWC across the SBCA and surrounding areas; (2) to build on previous quantitative work in Andoung Kraloeng village; (3) to test some simple methods for reducing crop-raiding in Andoung Kraloeng; and (4) to identify management options for HWC in the SBCA.

SBCA is a large upland forested protected area with many small villages situated inside the forest. Most of the these villages are of the Phnong ethnic group and depend heavily on farming and collection of forest products. There are larger Khmer-dominated villages at the edges of the study area.

Landscape-wide perceptions were studied using a very simple questionnaire administered in 102 settlements and more detailed focus-group discussions in 15. Localised and small-scale problems with Asian Elephants were noted in eleven settlements, including crop and hut damage, damage to resin-tapping equipment and occasional frightening close encounters. Loss of livestock to large carnivores (presumably Tigers, Leopards and Dholes) also seems to be a relatively small and localised problem, with only eleven settlements reporting losses of one or more cattle/buffalo in the past year. By contrast, losses of chickens and ducks to civets, birds of prey etc. are frequent and occur everywhere, although few husbandry measures are taken to minimise losses.

Crop-raiding was reported in almost all areas, although it seems to be less severe in the Khsim and O Am-Chneng areas, possibly due to reduced wildlife populations. Wild Pig was reported as the worst pest overall in 69% of settlements and macaques in 20%, with rats, parakeets and others also reported. The second most important pest in each village was usually drawn from the same short list. Wild Pigs are the worst pest of rice, cassava and yam and second worst for corn and banana. Various traditional protection methods are used including overnight guarding, snaring, bamboo clappers and fencing, although fences are rare because of the labour requirement.

Focus groups suggested that 10-20% of families experience serious losses (roughly 25% or more of crop destroyed) but these estimates were not supported by more detailed fieldwork – actual average damage levels appear much lower, which is a common finding in studies of this kind. The first coping strategy after a serious crop loss is reported to be to increase resin-tapping, then to seek wage labor or harvest other NTFPs, then to borrow from within the community. Getting credit from a trader is the last resort.

The quantitative work aimed to record levels of crop damage and test protective methods in five small settlements totaling 78 households. Systematic damage monitoring was conducted, with regular family visits followed by a field visit if recent damage was reported. Area and approximate intensity of damage were measured and other variables recorded. In total 78 fields were entered in the protection trial (93% of those in the five settlements) and 48 (59%) completed it according to the protocols. Of these 25 tested rags soaked in waste engine oil and 23 tested fences of fluttering videocassette tape, according to a split-field design, with traditional protection measures used in addition.

In post-harvest interviews, farmers estimated average crop losses to wildlife of 18%. However, although damage was common (59% of fields) the measured area damaged was very low (average only 80m^2 per damaged field, about 0.5% of the area). In total 86% of fields experienced no damage or less than 1% damage, with just eight fields experiencing 1-5% damage, 1 experiencing 5-10% and two about 11%. Given available data on rice yields this gives a total loss of c.160 kg unhusked rice yield across the whole village, worth about $52 at local prices, or less than $1 per field. These low levels may be partly due to the protection trial but they are consistent with data from the 2004-5 season (when the trial was much less extensive) and villages considered that the overall levels of loss were only slightly reduced compared to that year.

The protection trial itself was inconclusive. Protected field sections experienced no less damage than unprotected sections, but (when taking protected and unprotected halves together) fields with cassette fences had much lower levels of damage than those with oily rags. This unexpected result suggests that the cassette fences may have some deterrent effect well outside the fence line, making the planned statistical tests inappropriate. Farmers considered that both methods had some effect, cassette more than oil, and expressed interest in using them again.

Recommendations

For elephants, the problems are not yet serious (except very locally) but could become so in time. Further research and monitoring are appropriate. Long-term approaches should include careful land-use planning in high-risk areas and possibly the use of novel deterrents or compensation schemes.

For large carnivores the problems are also still small (although potentially serious for the very small number of farmers affected). Further research and monitoring are needed so that if the problem escalates, prompt action can be taken, Compensation schemes are very hard for livestock but moving pastured animals out of high risk areas or night-time coralling can potentially work.

Crop-raiding by pigs and monkeys is a widespread annoyance and affects attitudes to the SBCA but the actual damage levels do not appear to be a serious livelihood issue as yet. Further work is needed to find low-cost, sustainable methods to reduce damage and improve tolerance. Several options are reviewed. The donation of cassette-tape fences to at-risk families is easy to manage and may be affordable (cost of materials estimated at $5000-7500 annually across the whole SBCA). A compensation scheme would be cheaper ($1000 per year in payouts if the Andoung Kraloeng case study is a good guide) but would require much more administration. It would have an added benefit of involving communities in measuring the scale of damage, which might alter perceptions about its severity. It is recommended to further pilot these two methods before making a final decision, and to keep looking for other low cost alternatives. In the longer term subsidised fencing of at-risk fields may be appropriate.

សេចក្ដីសង្ខេប

ទំនាស់រវាងមនុស្សនិងសត្វព្រៃ (HWC) គឺជាចំណោតបញ្ហាដ៏សំខាន់មួយ នៅទូទាំងពិភពលោក ហើយត្រូវបានគេរាយការណ៍ថាជាបញ្ហាដែលកំពុងកើតឡើងនៅក្នុងតំបន់អភិរក្សជីវៈចំរុះ "សីមា" ។ ការសិក្សាមួយត្រូវបានរៀបចំឡើង ក្នុងគោលបំណងដើម្បី (១) ស្វែងយល់ពីទស្សនៈរបស់ប្រជាជន ដែលរស់នៅ ក្នុង និងជុំវិញតំបន់អភិរក្សជីវៈចំរុ "សីមា" ពាក់ព័ន្ធនឹងទំនាស់រវាងមនុស្សនិងសត្វព្រៃ (២) ប្រើប្រាស់ជាមូលដ្ឋានទូវរាល់បទពិសោធន៏ការងារដែលបានអនុវត្តកន្លងមកនៅភូមិអណ្ដូងក្រឡឹង (៣) សាកល្បងវិធីសាស្ត្រសាមញ្ញមួយចំនួនដើម្បីកាត់បន្ថយការខូចខាតផលដំណាំដោយសារសត្វព្រៃបំផ្លាញនៅភូមិអណ្ដូងក្រឡឹង (៤) កំណត់ជំរើសសមស្របសំរាប់ការគ្រប់គ្រងទំនាស់រវាងមនុស្សនិងសត្វព្រៃ ។

តំបន់អភិរក្សជីវៈចំរុះ " សីមា " គឺជាតំបន់ការពារដ៏ធំមួយ ដែលគ្របដណ្តប់ទៅដោយព្រៃឈើ ភ្នំ និងមានភូមិតូចៗជាច្រើនតាំងនៅរាយប៉ាយពាសពេញព្រៃក្នុងតំបន់អភិរក្សនេះ ។ ភាគច្រើន ប្រជាជនរស់នៅក្នុងភូមិទាំងនេះគឺជាក្រុមជនជាតិដើមភាគតិច " ព្នង " ដែលរស់នៅពឹងអាស្រ័យទៅលើការធ្វើកសិកម្ម និង ការប្រើប្រាស់ផល-អនុផលព្រៃឈើ ។ ប៉ុន្តែភូមិមួយចំនួននៅតាមព្រំប្រទល់នៃតំបន់សិក្សា លើសលុបទៅដោយជនជាតិខ្មែរ ។

មានក្រុមចំនួន ១០២ ត្រូវបានគេជ្រើសរើសដើម្បីធ្វើការសិក្សា ដោយប្រើបញ្ជីសំនួរយ៉ាងសាមញ្ញបំផុត ហើយការប្រជុំពិភាក្សាជាក្រុមត្រូវបានគេធ្វើឡើងនៅក្នុងភូមិចំនួន១៥ ដើម្បីប្រមូលពតិមានលំអិត ។ ជាលទ្ធផលបានបង្ហាញថា បញ្ហាដែលបង្កដោយដំរីត្រូវបានគេរាយកាណ៏ថាកើតមានក្នុងកំរិតទាប និងដោយកន្លែង នៅក្នុងភូមិចំនួន ១១ ដែលភាគច្រើនបង្កការខូចខាតលើផលដំណាំ ខ្ទម និង សម្ភារៈ សំរាប់ប្រមូលជ័រទឹករបស់អ្នកភូមិ ។ ជួនកាលបង្អើលអ្នកភូមិដែលធ្វើដំណើរមកជួបប្រទះពួកវាដោយចៃដន្យ ។ ការបាត់បង់សត្វស្រុក ដោយសារពពួកមំសាសីចាប់ជាចំណី (ដូចជា ខ្លាធំ ខ្លារខិន និង ឆ្កែព្រៃ) ក៏មានកំរិតតិចតួចនៅឡើយ ហើយកើតឡើងដោយកន្លែងផងដែរ ។ ដោយហេតុថាមានភូមិចំនួន១១ បានរាយការណ៏ថា កន្លងមកក្នុងភូមិពួកគេមានបាត់ គោក្របីមួយឬច្រើនជាងមួយក្បាល ។ ប៉ុន្តែការបាត់បង់មាន់ទាដោយសារសំពោច និង មំសាបក្សី កើតមានជាញឹកញាប់ និងគ្រប់ទីកន្លែង ទោះបីជាអ្នកភូមិបានប្រើប្រាស់វិធីសាស្ត្រចិញ្ចឹមមួយចំនួន ដើម្បីបង្ការការបាត់បង់ក៏ដោយ ។

ការខូចខាតដំណាំដោយសារសត្វព្រៃបំផ្លាញកើតមានស្ទើរគ្រប់ទីកន្លែងទាំងអស់ លើកលែងតែនៅភូមិ ឃ្សឹម អូរអាម និង ឆ្នែង មិនសូវមានបញ្ហានេះកើតឡើង។ ជ្រូកព្រៃត្រូវបានគេ រាយការណ៏ថាជាសត្វបំផ្លាញខ្លាំងជាគេគឺប្រមាណ៦៩ ភាគរយនៃភូមិសិក្សា ឯសត្វស្វាជាសត្វបំផ្លាញជាងគេគឺ ២០ ភាគរយនៃភូមិសិក្សា។ សត្វកណ្ដុរ សេក និងសត្វជាច្រើនទៀតក៏ត្រូវបានគេរាយការណ៏ថា បានបំផ្លាញដំណាំអ្នកភូមិផងដែរ។ បើគិតតាមភូមិនិមួយៗសត្វបំផ្លាញដែលជាប់ចំណាត់ថ្នាក់លេខមួយគឺជ្រូកព្រៃ ចំណាត់ថ្នាក់លេខពីរគឺស្វា។ ជ្រូកព្រៃច្រើនបំផ្លាញដំណាំស្រូវ ដំឡូងមី និងដំឡូងជ្វា ចំណែកឯស្វាចូលចិត្ត បំផ្លាញពោត និង ចេក។ វិធីសាស្ត្រការពារ

តាមបែបបុរាណ ដែលអ្នកភូមិនិយមប្រើកន្លងមក ដូចជា ការយាមពេលយប់ ការដាក់អន្ទាក់ ការព្យួរត្រដោកឬស្សី ការធ្វើរបង ប៉ុន្តែគេកម្រប្រើវិធីចុងក្រោយនេះណាស់ ដោយសារការធ្វើរបងទាមទារកំលាំងពលកម្ម និងពេលវេលាច្រើន។

តាមរយៈក្រុមពិភាក្សាបានលើកឡើងថា ១០-២០ភាគរយនៃគ្រួសារដែលបានសិក្សាធ្លាប់រងគ្រោះដោយសារសត្វព្រៃបំផ្លាញដំណាំពួកគេយ៉ាងធ្ងន់ធ្ងរ (កំរិតការបំផ្លាញប្រហែល ២៥ ភាគរយ ឬច្រើនជាងនេះ) ប៉ុន្តែការប៉ាន់ស្មាននេះ មិនស៊ីគ្នានឹងលទ្ធផលនៃការចុះទៅពិនិត្យជាក់ស្តែងដល់ទីកន្លែងដែលបង្ហាញថា កំរិតនៃការបំផ្លាញមានភាគរយទាបជាង។ យុទ្ធសាស្ត្រចិញ្ចឹមជីវិតរបស់អ្នកភូមិ ក្រោយពេលសត្វព្រៃបំផ្លាញដំណាំរបស់ពួកគេ ដំបូងគឺខំប្រឹងច្បោះដំរបន្ថែម បន្ទាប់មកស្វែងរកការងារដោយលក់កំលាំងពលកម្ម ឬក៏ចូលព្រៃដើម្បីប្រមូលផល-អនុផលព្រៃឈើ បន្ទាប់មកចាប់ផ្តើមខ្ចីលុយពីញាតិមិត្តក្នុងភូមិ ហើយជំរើសចុងក្រោយគឺខ្ចីលុយពីឈ្មួញនៅផ្សារ។

ការសិក្សាផ្នែកស្ថិតិក៏ត្រូវបានគេធ្វើឡើងផងដែរ ដើម្បីកត់ត្រាពីកំរិតការខូចខាតផលដំណាំ និង សាកល្បងវិធីសាស្ត្រការពារ នៅក្នុងភូមិចំនួន ៥ ដែលមាន ៧៨ គ្រួសារ។ ប្រព័ន្ធត្រួតពិនិត្យការខូចខាត ត្រូវបានគេរៀបចំឡើងតាមរយៈការចុះសំណេះសំណាលតាមគ្រួសារជាទៀងទាត់ និងការចុះទៅពិនិត្យដល់ទីកន្លែង បើសិនមានការរាយការណ៍ថាមានការបំផ្លាញដំណាំដោយសត្វព្រៃ។ ទំហំផ្ទៃដី និង កំរិតនៃការខូចខាតត្រូវបានគេ ប៉ាន់ប្រមាណ ហើយការប្រែប្រួលផ្សេងៗទៀត ក៏ត្រូវបានគេកត់ត្រាទុកផងដែរ។ ជាសរុប ដីចំការចំនួន ៧៨ កន្លែង (៩៣ ភាគរយ) ត្រូវបានគេជ្រើសរើសសំរាប់ធ្វើការសាកល្បងអនុវត្តវិធីសាស្ត្រការពារ ហើយក្នុងនោះដីចំការ ៤៨ កន្លែង (៥៩ ភាគរយ) បានបញ្ចប់ការសាកល្បងរួចហើយ។ ក្នុងចំណោមដីចំការទាំង ៤៨ កន្លែងនេះ មាន ២៥ កន្លែង បានសាកល្បងវិធីសាស្ត្រការពារដោយប្រើក្រណាត់ជ្រលក់ប្រេងម៉ាស៊ីន ដាក់តាមព្រំប្រទល់ចំការ ហើយ ២៣ កន្លែងទៀត ប្រើវិធីសាស្ត្រព្យួរហ្វីលកាស្សែតវីដេអូ នៅតាមព្រំប្រទល់ចំការ រួមផ្សំជាមួយវិធីសាស្ត្រការពារតាមបែបបុរាណដូចដែលបានរៀបរាប់ខាងលើផងដែរ។

តាមរយៈការសំភាសន៍អ្នកភូមិនៅក្រោយរដូវប្រមូលផល ពួកគាត់បានធ្វើការប៉ាន់ស្មានថាផលដំណាំដែលខូចខាតដោយសារសត្វព្រៃ ជាមធ្យមប្រហែល ១៨ ភាគរយ។ ទោះបីការបំផ្លាញកើតមានស្ទើរគ្រប់ចំការ ប៉ុន្តែ ៥៩ ភាគរយនៃដីចំការទាំង៤៨ កន្លែង មានផ្ទៃដីដែលទទួលរងការខូចខាតតិចតួចប៉ុណ្ណោះ (ជាមធ្យមខូចខាតត្រឹមតែ ៨០ ម៉ែត្រការេ នៃផ្ទៃដីចំការទាំងមូល ប្រមាណ ០,៥ ភាគរយ)។ ជាសរុប ៨៦ ភាគរយនៃចំការសាកល្បង មិនទទួលរងការខូចខាត និងទទួលរងការខូចខាតផលដំណាំតិចជាង ១ ភាគរយ ចំការចំនួន ៨ កន្លែង ទទួលរងការខូចខាត ១-៥ ភាគរយ ចំការ ១ កន្លែង ទទួលរងការខូចខាត ៥-១០ ភាគរយ និង ចំការ ២ កន្លែង ទទួលរងការខូចខាតប្រហែល ១១ ភាគរយ។ តាមរយៈទិន្នន័យទទួលបាន ផលស្រូវសរុបទូទាំងភូមិដែលបាត់បង់ចំនួន ១៦០ គីឡូក្រាម គិតជាទឹកប្រាក់មានចំនួន ៥២ ដុល្លា (តំលៃនៅមូលដ្ឋាន) ឬ តិចជាង ១ ដុល្លាក្នុងមួយចំការ។ ការបំផ្លាញដោយសត្វព្រៃមានកំរិតតិចតួចបែបនេះ ប្រហែលមកពីការអនុវត្តវិធីសាស្ត្រការពារ

ប៉ុន្តែទិន្នន័យនេះប្រហាក់ប្រហែលនឹងទិន្នន័យកាលពីឆ្នាំ ២០០៤-២០០៥ ពេលដែលវិធីសាស្ត្រការពារមិនទាន់ត្រូវបានគេអនុវត្តអោយបានទូលំទូលាយនៅឡើយ។ ជាទូទៅ អ្នកភូមិគិតថា ផលដំណាំដែលទទួលការខូចខាតឆ្នាំនេះមានកំរិតថយចុះតិចតួច បើប្រៀបធៀបទៅនឹងឆ្នាំ ២០០៤ និង ២០០៥។

ការសាកល្បងវិធីសាស្ត្រការពារសត្វព្រៃមិនអោយបំផ្លាញដំណាំទាំងពីរខាងលើនេះមិនបានផលទេ។ តាមរយៈបទពិសោធន៏កន្លងមក ចំការដែលប្រើវិធីសាស្ត្រការពារសត្វព្រៃ នៅតែទទួលរងការខូចខាតក្នុងកំរិតប្រហាក់ប្រហែលនឹងចំការ ដែលមិនបានអនុវត្តវិធីសាស្ត្រការពារដែរ។ ប៉ុន្តែចំការដែលប្រើហ្វីលកាស្សែតវីដេអូទទួលរងការខូចខាតតិចជាងច្រើនបើប្រៀបធៀបទៅនឹងចំការដែលប្រើក្រណាត់លាបប្រេងម៉ាស៊ីន។ ប្រការនេះបង្ហាញថារបងហ្វីលកាស្សែតវីដេអូមានឥទ្ធិពលក្នុងការបង្អើលសត្វព្រៃទាំងនោះបានខ្លះ និងមានប្រសិទ្ធិភាពល្អតែនៅផ្នែកខាងក្រៅខ្សែ ជាហេតុធ្វើអោយការសាកល្បងផ្នែកស្ថិតិ មិនមានលក្ខណៈសមស្រប។ ជាទូទៅកសិករទាំងនោះយល់ថាវិធីសាស្ត្រទាំងពីរនេះមានប្រសិទ្ធិភាពខ្លះដែរ (ហ្វីលកាស្សែតវីដេអូមានប្រសិទ្ធិភាពល្អជាងប្រេងម៉ាស៊ីន) ហើយបង្ហាញការចាប់អារម្មណ៏ចង់សាកល្បងវិធីសាស្ត្រទាំងពីរនេះម្តងទៀត។

អនុសាសន៏

ចំពោះសត្វដំរី ពេលនេះមិនទាន់បង្កបញ្ហាធ្ងន់ធ្ងរនៅឡើយទេ (លើកលែងតាមកន្លែងមួយចំនួន)ប៉ុន្តែពួកវានឹងបង្កបញ្ហាធ្ងន់ធ្ងរនាពេលអនាគត។ ជាការសមស្របបំផុត ដែលតម្រូវអោយមានការសិក្សាអោយបានស៊ីជំរៅបន្ថែមទៀត និងរៀបចំប្រព័ន្ធតាមដាន និងត្រួតពិនិត្យអោយបានទៀតទាត់។ ផែនការគ្រប់គ្រងរយៈពេលវែងគួរតែគិតគូរផងដែរពីផែនការប្រើប្រាស់ដីធ្លីដោយប្រុងប្រយ័ត្ន នៅតាមតំបន់ដែលសំបូរសត្វព្រៃបំផ្លាញនិងបង្កគ្រោះថ្នាក់ ព្រមទាំងគិតគូររកវិធីសាស្ត្រប្លែកៗដើម្បីកាត់បន្ថយគ្រោះថ្នាក់និងការបំផ្លាញដំណាំដោយសារសត្វព្រៃ ឬក៏គិតគូរពីសំណងរាល់ការខូចខាតទាំងឡាយ។

ចំពោះបញ្ហាបង្កឡើងដោយមំសាសីក៏នៅកំរិតតិចតួចនៅឡើយ (ទោះបីជាមានគ្រួសារមួយចំនួនតូចទទួលរងការខាតបង់ធ្ងន់ធ្ងរក៏ដោយ)។ វាជាប្រការចាំបាច់ ដែលតម្រូវអោយមានការសិក្សាបន្ថែម និង បង្កើតអោយមានប្រព័ន្ធត្រួតពិនិត្យសមស្រប និងទៀតទាត់ ដើម្បីចាត់វិធានការដោះស្រាយអោយទាន់ពេល ករណីដែលដឹងថាបញ្ហានេះរីករាលធំឡើង។ សំណងសំរាប់ការបាត់បង់សត្វស្រុកដោយសារបញ្ហាខាងលើនេះ ពិតជាពិបាកដោះស្រាយខ្លាំងណាស់ ប៉ុន្តែអ្នកភូមិអាចអនុវត្តវិធីបង្កាដោយកុំទៅឃ្វាលគោនៅកន្លែងដែលសំបូរគ្រោះថ្នាក់ និងគួរតែបំពាក់ភ្នក់ភ្លើងនៅពេលយប់។

ការខូចខាតដំណាំដោយសារសត្វជ្រូកព្រៃ និងស្វា បានកើតមាននៅពាសពេញតំបន់អភិរក្សជីវៈចំរុះ "សីមា" ហើយបានធ្វើអោយប្រជាជនមានទស្សនៈអវិជ្ជមានចំពោះកម្មវិធីអភិរក្ស។ ប៉ុន្តែតាមសភាពជាក់ស្តែង កំរិតនៃការខូចខាតទាំងនេះ មិនទាន់បង្កផលប៉ះពាល់ធ្ងន់ធ្ងរដល់ជីវភាពរស់នៅប្រចាំថ្ងៃរបស់ពួកគាត់នៅឡើយទេ។ ដូចនេះវា

ទាមទារអោយមានការខិតខំបន្ថែមទៀត ក្នុងការស្វែងរកវិធីសាស្ត្រការពារណាមួយ ដែលមានស្ថេរភាព និងចំណាយតិច ដើម្បីកាត់បន្ថយការខូចខាតដោយសារសត្វព្រៃ និងបង្កើនការចូលរួមគាំទ្ររបស់ប្រជាជនជាមួយកម្មវិធីអភិរក្ស។ ជំរើសជាច្រើនត្រូវគេពិចារណាឡើងវិញ ដូចជាការផ្តល់អំណោយជាហ្វីលកាស្សែតវីដេអូដល់គ្រួសារដែលដំណាំពួកគេងាយទទួលរងការបំផ្លាញ គឺជាប្រការមួយងាយស្រួលក្នុងការគ្រប់គ្រង ហើយកម្មវិធីអភិរក្សប្រហែលជាអាចលៃលកថវិកាសំរាប់ការចំណាយនេះ(ចំណាយលើសំភារៈដែលគេប៉ាន់ប្រមាណថាប្រហែល ៥០០០-៧៥០០ដុល្លា រៀងរាល់ឆ្នាំ សំរាប់ចែកចាយនៅទូទាំងតំបន់អភិរក្ស)។ ចំពោះគ្រោងការផ្តល់សំណងចំពោះការខូចខាត ប្រហែលជាចំណាយតិចជាង ត្រឹមតែ១០០០ដុល្លាក្នុងមួយឆ្នាំ បើសិនករណីសិក្សារបស់ភូមិអណ្តូងក្រឡឹងអាចយកធ្វើជាគំរូបាន ក៏ប៉ុន្តែតម្រូវអោយមានការចាត់ចែងការងារផ្នែករដ្ឋបាលច្រើន។ វានឹងផ្តល់ប្រយោជន៏បន្ថែមទៀត បើសិនសហគមន៏មូលដ្ឋានបានចូលរួមក្នុងការវាស់វែងក៏រិតនៃការខូចខាត ដែលអាចជួយអោយពួកគេមើលឃើញច្បាស់ និងផ្លាស់ប្តូរទស្សនៈថាសត្វព្រៃបានបង្កផលប៉ះពាល់ធ្ងន់ធ្ងរដល់ជីវភាពរស់នៅរបស់ពួកគេ។ យកល្អគួរតែសាកល្បងវិធីសាស្ត្រទាំងពីរខាងលើនេះអោយបានល្អិតល្អន់បន្ថែមទៀត មុននឹងធ្វើការសំរេចចិត្តជាចុងក្រោយ ហើយខិតខំរិះរកវិធីសាស្ត្រដទៃផ្សេងទៀត ដែលមានប្រសិទ្ធិភាព និងចំណាយតិច។

INTRODUCTION

This report covers research on human-wildlife conflict (HWC) in the Seima Biodiversity Conservation Area (SBCA) during September 2005-June 2006, with a focus on Wild Pig damage to rice crops. Some communities in the SBCA report HWC as a significant livelihood problem. This causes negative attitudes towards conservation and also results in preventative killing of large mammals. Thus in 2004 WCS and the Forestry Administration began a series of surveys to assess the scale and distribution of this problem, and to test methods to manage it.

The first study covered six small settlements in the Core Area (Evans *et al.* 2006). The second study, described here, continued work in these settlements and expanded the work across the wider landscape. As a result of the studies we now have a clearer understanding of the scale and pattern of the problem. This report concludes by discussing some of the options for HWC management and makes recommendations for the next steps in developing an effective strategy, including some further research.

Aims of the 2005/2006 study

The aims of the present study are as follows:

1. To further quantify of the scale of the crop-raiding problem in Andoung Kraloeng village
2. To test the effectiveness of waste-oil and video cassette tape as protection methods by expanding the study to all five settlements that participated in the 2004-05 monitoring study
3. To investigate the issue and perceptions of crop-raiding and depredation more widely across the SBCA landscape
4. To conduct a preliminary review of HWC management options for the SBCA.

Background

International context

HWC is a relatively recent issue in conservation and development literature, although it is not a new problem (Naughton-Treves 1997). Damage by wild animals to crops and loss of livestock to carnivores has always occurred, but at some locations this conflict has intensified over recent decades. Human population increases, habitat loss and degradation, and encroachment into protected areas have brought humans and wildlife into closer and closer contact. Furthermore, conservation efforts have meant that hunting and culling have been banned in many places, resulting in a concurrent recovery of some larger vertebrate populations (Sekhar 1998, Treves and Karanth 2003).

HWC is emerging as one of the most serious problems where people and wildlife co-exist (Woodroffe *et al.* 2005b, Thirgood *et al.* 2005). In one study crop raiding was reported as the number one constraint on agricultural productivity (Gillingham and Lee 2003) and it is complained about vociferously elsewhere (e.g. Gadd 2005, Hill 1997, Hill 2000, Naughton-Treves 1997, Naughton-Treves, Rose and Treves 1999, most papers in Woodroffe *et al.* 2005a). Depredation on livestock by carnivores can also cause significant losses to farmers (Butler 2000, Madhusudan 2003) with losses of up to half annual average per capita income in extreme cases, such as snow leopard and wolf depredation in India (Mishra 1997).

Frequency, distribution and severity of crop damage is not experienced uniformly across a landscape. Damage is typically caused in areas adjacent to the forest (Hill 1997 & 2000, Naughton-Treves 1998, Rao *et al* 2002, Saj *et al* 2001, Sekhar 1998) to staple crops when they ripen (just prior to harvest) by highly intelligent and adaptable species

(Naughton-Treves 1997 & 1998, Naughton-Treves *et al* 1998, Hill 1997 2000) creating a threat to food security (Hill 1997 & 2000, Murphy and Mulonga 2002, Naughton-Treves *et al* 1998, Weladji and Tchamba 2003). Severe damage by larger vertebrates can also be extremely unpredictable, even within known high-risk areas. Elephants in particular may only cause localized damage (one or two farms) every few years (Naughton-Treves 1997 & 1998). Furthermore, marginalised families may be allocated land in these more risky areas, increasing the threat to already vulnerable households (Naughton-Treves 1997, Naughton-Treves, Rose and Treves 1999). Scarcity of land elsewhere means families are often unable to relocate away from forests. Conservation measures often preclude people from killing crop-raiding animals (for meat or to reduce the risk of damage) (Naughton-Treves 1998, Sekhar 1998). Restrictions or bans are also often in place for activities such NTFP resource extraction – another traditional coping mechanism (Sekhar 1998, Weladji and Tchamba 2003).

HWC has transformed from simply competition between humans and animals to a political issue between people and parks, as well as acting as a flashpoint for broader tensions between local people and protected area management authorities (e.g. Gillingham and Lee 2003). There are several reasons for a conservation organization to examine this issue. Conservation measures that decrease locals' ability to cope while increasing the risk of crop damage or depredation are morally questionable, and create resentment toward the management authority (Naughton-Treves, Rose and Treves 1999). Under these conditions locals may not comply with park regulations such as NTFP extraction, hunting or grazing (Rao *et al* 2002, Sekhar 1998, Weladji and Tchamba 2003) and at the extreme locals may deliberately sabotage the conservation project. The continued existence of some parks is in question and local support may be politically crucial – poorly managed HWC can potentially undermine this.

Much of previous research characterizing the problem has focused on large iconic species: elephants and big cats. This is because they can cause a serious threat to livelihoods, because of the fear associated with them, and because they have been subject to retaliatory killing (Tilson and Nyhus 1998, Nyhus, Tilson and Sumianto 2000, Treves and Karanth 2003). More recently primates have been recognized as a significant crop pest (Hill 1997, Naughton-Treves 1998, Hill 2000, Gillingham and Lee 2003), along with a number of animals such as Wild Pigs (Naughton-Treves 1998, Sekhar 1998, Gillingham and Lee 2003) and other medium to small ungulates (Hill 1997, Sekhar 1998). Smaller species such as squirrels (Hill 1997), porcupines (Hill 1997, Sekhar 1998) and birds (Hill 1997, Gillingham and Lee 2003, Weladji and Tchamba 2003) have also been noted as crop raiders.

Research on HWC in Asia has largely focused on livestock depredation (see Mishra 1997, Karanth and Gopal 2005 also see Rao *et al* 2002, Sekhar 1998), where significant populations of Tigers and other carnivores (such as Leopards) exist in reserves adjacent to densely populated agricultural land posing a risk to both livestock and humans (Sekhar 1998). Elephants pose similar threats in Asia as they do in Africa and Human Elephant Conflict (HEC) been studied, particularly in India (e.g., Madhusudan 2003, Williams 2001), as well as in Sumatra (Nyhus, Tilson and Sumianto 2000), Lao PDR (M. Tyson pers.comm.) and China (Zhang and Wang 2003). There have been a few studies on crop damage in general (Karanth 2003. Rao *et al* 2002, Sekhar 1998).

Current best practice in management of human-wildlife conflict

It is now recognized that managing HWC is not simply a matter of applying the right technological solution in the right location to minimize the economic damage caused (Hoare 2001, Treves and Karanth 2003). Treves *et al.* (2006) propose a framework for the managing HWC. This framework was used as guidance in designing the studies and recommendations presented in this report. This framework is summarized below

Step 1: *Baseline Applied Research*
Collect site-specific data characterizing the problem, including;

1. Systematic data collection on timing, location, and extent of damage
2. Distribution of damage and affected households
3. Experimental or quasi-experimental testing of mitigation techniques
4. Attitudes and perceptions to the damage, wildlife and to potential interventions. Stress the importance of establishing why there is a discrepancy between reported and observed damage levels, rather than testing the accuracy of perceptions.

Step 2: *Participatory Planning for Co-Management*
The objective is to have a consensus on interventions, and to set up the management framework (including recruitment of people, division of tasks and timelines). Emphasis is placed on the on the following points:

1. *If* HWC is a priority of locals, participatory planning can be important for relationship building
2. Can generate innovative ideas
3. Must include joint objectives (that include addressing human welfare and mitigation of threats to wildlife)
4. Provide alternatives to be chosen by consensus and include more than one. Interventions include those that decrease the severity or frequency of damage events or those that increase tolerance.

Step 3: *Monitor*
Need to address the following questions:

1. Did implementation go as planned?
2. Were threats abated?
3. Were the objectives achieved?

The overall aim is to develop a site-specific plan sensitive to the political context of HWC locally, using a set of interventions acceptable to all parties involved (rather than attempting to find a silver-bullet) which are monitored (and adapted) appropriately, to co-manage the problem sustainably in the long-term.

Study site

The SBCA was created by Ministerial Declaration (*prakas*) in 2002, within the area of the now defunct Samling International logging concession. The site is managed primarily by the Forestry Administration (FA) under a collaborative program with the Wildlife Conservation Society Cambodia Program (WCS). It covers approximately 305,000 ha in the provinces of Mondulkiri and Kratie and supports a mix of deciduous and evergreen forest types in the foothills of the Annamite mountain range. It has great value both for its biodiversity, notably populations of many rare mammals and birds (Walston *et al.* 2001, WCS/FA 2006) and for the human livelihoods that it supports, especially for members of the Phnong and Stieng indigenous ethnic groups (e.g. Evans *et al.* 2003, ICC 2003, McAndrew *et al.* 2003). The site is divided into a core zone and eastern and western buffer zones (Figure 1), A high level of traditional forest product collection is allowed in each zone and each also contains many villages. The zones differ mainly in the extent of commercial activity that is permitted.
The principal livelihoods of the Phnong and Stieng communities are subsistence farming of paddy rice and/or rotational shifting cultivation (depending on available land) and collection of forest products, above all liquid resin which is sold in large volumes by most families (Evans *et al.* 2003, McAndrew *et al.* 2003). Growing cash crops (especially

cashew, cassava and soy) is becoming commoner in most villages, together with wage labour and livestock rearing in some (WCS/FA unpublished data). The logging concession operated from 1996 to 2000 and the roads it created have since allowed hundreds of ethnic Khmer and Cham families to move in along the south-western border of the SBCA over the past five years (Evans and Delattre 2005). Most of their income is from cash crops and wage labour and they have cleared large areas of forest in order to plant their crops. They are much less dependent than the Phnong and Stieng on forest product collection.

Previous studies of human-wildlife conflict in SBCA

Various recent livelihood studies in Mondulkiri suggest that crop raiding is a significant and widespread problem issue, but generally contain little detailed information. For example, AAH (2003) reported that 'crop depredation by wild animals (especially pigs and parakeets) as well as small pests constitutes the most regular cause of crop losses in the province. Every year wild mammals, birds, rats and insects decrease crop production.' No further details are given. McAndrew *et al.* (2003) stated that damage by wildlife (notably pigs) was one of the key limitations to crop productivity in Dak Dam and Sre Preah communes, but gave no further information. Evans *et al.* (2003) noted that 'In all [four surveyed] villages [in the SBCA Core Area] crop depredation by wild animals (especially pigs and parakeets) was reported to be a significant problem; a big cat also killed several cattle in Ph. Kati in 2001.' but collected no further data. Drury (2005) studied hunting behaviour in Sre Preah and Sre Khtum communes and noted that prevention of crop raiding was reported as an important factor in some interviews. Wild Pig, macaque and porcupine were noted as the main pests hunted around fields, with Green Peafowl, civets, Sambar and doves as minor pests.

Ironside (2004) highlighted the problem of crop-raiding in Andoung Kraloeng, drawing particular attention to Wild Pigs that reportedly come in large herds of 20-30 animals and can destroy a swidden in one night. He notes that 'Villagers report that pigs often destroy 60% of the harvest...'. They also eat tubers, pineapples, sugar cane and other crops. He also described reports of porcupines, monkeys, parakeets, deer and (in Trapeang Ronheav) "geese" causing damage.
As a result of these comments, a preliminary study of crop raiding and depredation was made in Andoung Kraloeng (Figure 1) in the September 2004-January 2005 rice harvest season (Evans *et al.* 2006). The village is an administrative unit made up of six geographically separate settlements (administratively called sub-villages or, in Khmer, *kroms*). Five kroms were studied in depth: Pu Poanh, Pu Chu Leu, Pu Chu Kraom, Pu Clair and Andoung Kraloeng (Figure 1). They are all in a hilly upland area at 500-600 m. The sixth, in a flatter area at 200m, reported very low levels of crop-raiding.

The four principal crops grown were hill rice, corn, cassava and yam (often intercropped with each other and dozens of minor crops). Wild Pigs were reportedly by far the most significant vertebrate pest for all four key crops. Most of the damage happens by night in the ripening or ripe crop just before harvest. The other significant pests for all these key crops were monkeys (macaques), rats and porcupines. A long list of minor pests included squirrels, parakeets, civets and domestic cattle. Reports suggested that most families regularly suffer serious losses, with figures from 50-100% of the crop often cited in group interviews. No clear opinions emerged concerning the factors that predicted risk of serious damage at a given field.

Existing crop protection methods include offerings to the spirits, sleeping in a hut at the field near harvest time, use of dogs, use of bamboo clappers to make noise, building fences and snaring. Sleeping in the fields appears to be quite effective and fences more so, but fences are rarely built due to the effort involved. Snaring kills some animals and deters others. The tradition of reciprocal sharing of produce between households helps families to cope with serious losses in a particular year; furthermore, if a domestic animal causes damage its owner must provide compensation.

This study also monitored 58 families across the five settlements during the harvest season to obtain a quantitative estimation of crop-damage. It was found that average levels of damage were much lower than reported in interviews. Inspection of reported damage found that most families experienced 0-1% loss of crop area (estimated by eye), with a few experiencing 1-10% and just a few experiencing losses estimated at 30-60% losses[1]. Some of these families also participated in a trial of two new field protection methods (waste-oil posts or video-cassette tape fences). Half of each treated field was left unprotected as a control. However, levels of damage were so low in both treated and control sides that the effectiveness of the methods could not be assessed. This low overall level of damage was one of the most important findings of the study.

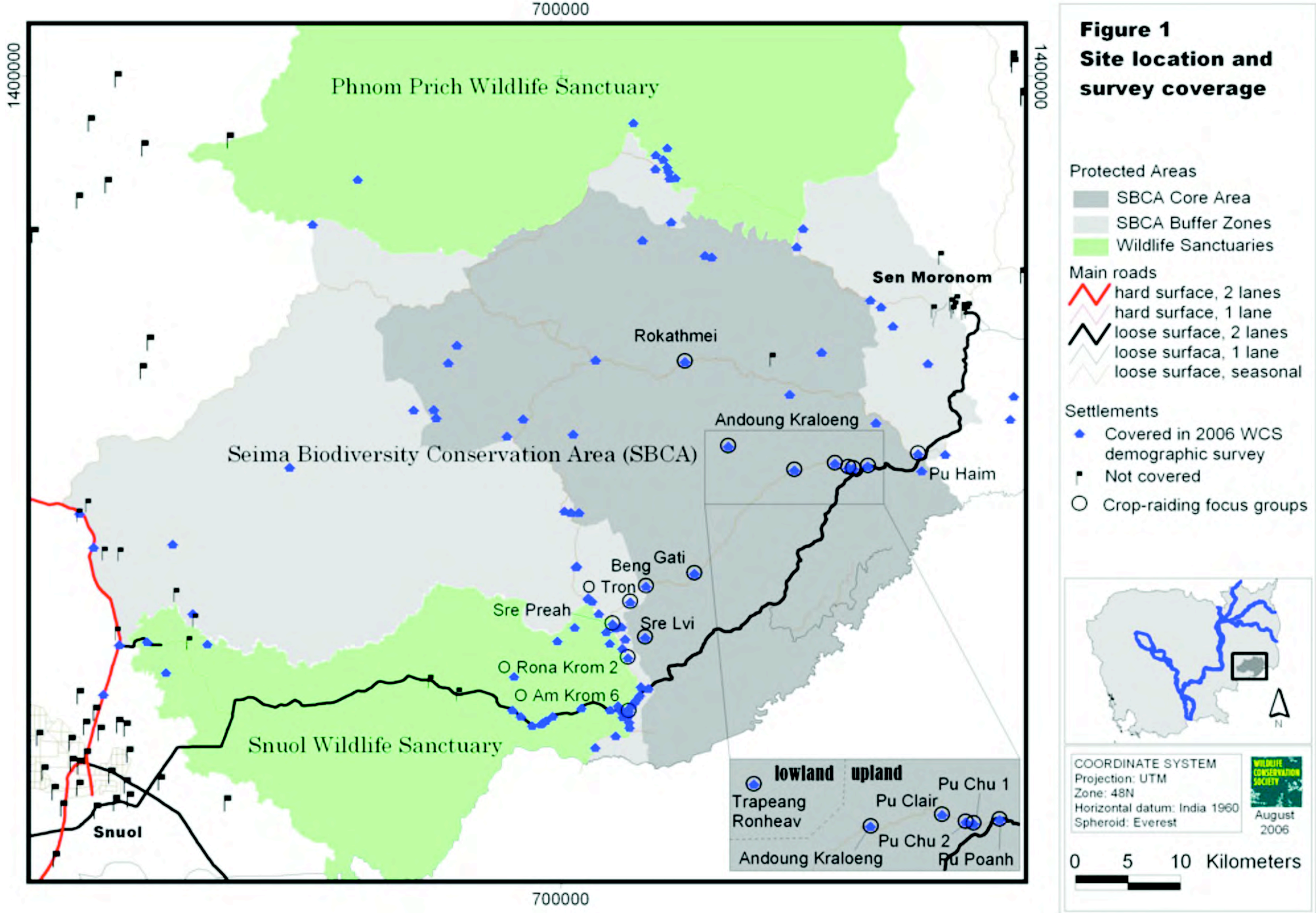
There has been no systematic recording of livestock depredation in the SBCA, but judging from discussions with many local residents and government officials there appear to have been few recent incidents in the Core Area. This must be partly due to the very low densities of large carnivores that currently exist. The same is broadly true for conflict with elephants.

The study concluded by identifying the need for further research on the following topics:

- the baseline level of crop damage in different years
- trials of novel protection methods
- further study of the effectiveness of existing protection methods
- expanding the scope to cover other parts of the conservation area.

[1] Measurements during 2005-6 suggest that these 2004-5 figures are likely to be substantial overestimates.

Figure 1
Site location and survey coverage



METHODS

This study consists of two parts:

1. A broad survey of perceptions of crop raiding across the whole landscape.
2. A detailed study of levels of crop raiding and a trial of two new protection methods in Andoung Kraloeng village.

Landscape level perception study

Three methods were used to collect data over a wide area:

1) Standard questions during a landscape-wide demographic survey.
2) Focus group discussions in selected villages
3) Site visits to any locations where the team received incidental reports of recent elephant damage to crops

An extensive demographic survey was conducted during January-June 2006 covering every known settlement in the SBCA or within 5 km of its boundaries, except for non-rural ones close to Sen Monorom town and a handful of small satellite settlements elsewhere (Figure 1). The village or krom chief was interviewed with a short questionnaire covering population size and basic livelihood information (CEDAC and WCS in prep.). The final three questions covered HWC (see Table 1).

Table 1. HWC questions from demographic survey

Question	*Supplementary information*
• *Is crop-raiding a serious problem (in this settlement)*	• Name top three crop raiding species, in order.
• *Are there problems with wild elephants (around this settlement)?*	• If so, what?
• *Are there problems with large animals killing livestock (around this settlement)?*	• In last 12 months a) how many cattle and b) how many buffalos

Nine settlements in or near the SBCA Core Area were visited during 20 November-12 December 2005 to gather information on crop damage and depredation through focus group discussions (Figure 1). The dominant ethnicity is Phnong in all except O Am Krom 6 (mainly Stieng). Data were pooled with data collected in September 2004 in the six kroms of Andoung Kraloeng during the previous study (Evans *et al.* 2006).

One focus group was held at each settlement and used Rapid Rural Appraisal methods to collect the qualitative information outlined below.

1. A matrix ranking the key crops and the key pests for each of them.
2. A crop and wildlife damage calendar for the most important crop species.
3. Current protection methods in use and coping strategies when serious crop damage occurs.
4. Livestock depredation (animals lost and animals responsible).
5. How many families usually suffered damage, and the severity of this.
6. Recent trends in crop damage.

Incidental reports of elephant damage were collected by other members of the conservation project during wildlife surveys and law enforcement patrols. These were followed up as quickly as possible by the crop-raiding study team. The owner of the crop was interviewed and the exact site of damage was visited where possible. Results for crop and pest species are presented based on their overall ranking across all villages visited. No settlement listed all crops or pests. As a result, there were many 'zero' ranks - where there was no rank allocated as the crop or pest is not important in a given settlement. These zero ranks pose a problem when attempting to calculate averages or medians as they distort the results.

In order to account for this, results were truncated and zero ranks replaced with a dummy rank one lower than the truncation point. The truncation point was the number of crops/pests ranked in the village with the least number of crops/pests (excluding Trapeang Ronheav which had far fewer than any other). For example, if Village A only listed 9 crops, then ranks given to all other crops at all other villages that were zero or >9 were replaced with a ranking of 10. The overall ranking of a given crop or pest was then based on the average rank, calculated across all villages.

Crop raiding and protection methods study

Protection and damage monitoring

Kroms Pu Chu Leu, Pu Chu Kraom, Pu Clair, Pu Poanh and Andoung Kraloeng were studied. The unit of study was the individual field. Farmers were free to continue with their existing protection strategies. In addition, two novel protection methods were tested, as in 2004.

1. Waste Engine Oil – a rag soaked in waste engine oil is placed on a 1m bamboo stake. Stakes are placed at a distance of 2 or 3 m around the boundary of the chamkar. The smell of the oil is the repellent, so rags should be regularly re-soaked to retain their smell and efficacy.
2. Video-cassette – A three strand fence is made using video cassette tape. ≥1m stakes are placed around the boundary of the chamkar at 3 m apart. Video-cassette is strung at approximately ankle-, knee- and thigh-height. The cassette should be tied at each stake when strung so if the cassette tape breaks others sections of the fence maintain their integrity. The glint of the cassette in sunlight and the whirring sound made in the breeze are its repelling characteristics.

A third method was also tested on a very small scale (five chamkar). This method was suggested at the pre-trial settlement meeting in Pu Poanh. This method had been used previously by the individual who suggested it. The white inner bark from the Samraong tree (species uncertain) is used in thin strips (approximately 2-3 cm in width) and strung as a fence (as for video cassette tape, above).

Before the study, meetings were held at all five settlements to identify participants and describe in detail how to implement each protection method. At this time it was explained that the protection method would be allocated randomly to each family and only half of each chamkar could be protected, the other half acting as the control. Farmers with more than one field were able to test different methods on different fields. People were free to participate or not in the study. At this stage all families expressed interest in participating.

Approximately two weeks later another set of settlement meetings was held. Protection methods were explained again and allocated. The protected half was also chosen at random; west or east. This was in order to prevent farmers selectively protecting the more vulnerable side of their chamkar. The division was west/east, as a north/south division could vary in rice quality as a result of the direction of the sun thereby confounding the results (as poorer quality rice could be less attractive to crop raiding animals). The farmers were instructed to open up a narrow path around their chamkar and down the middle (between division between the protected and control side) to improve accessibility, to make stakes (for the oil or fencing) and then to collect the protection materials, which were free of charge.

Visits were made to each protected chamkar to collect basic information as follows: field age; slope (flat, slight, moderate, steep); number of people usually working on the chamkar (men, women, and older children); subjective assessment of rice quality (all made by KS to ensure consistency; good, ok, poor); and owner's assessment of soil quality (good, ok, poor).

During this time we found that some households were not interested in participating in the trial or were reluctant to protect their fields as required. Reasons for not participating included undertaking waged labour instead (they were therefore unable to be present at their chamkar), or a perception that damage was not a problem for them, making the protection measures unnecessary. These families were therefore excluded from the trial, but we continued to monitor them for damage reports and we also completed a post-harvest interview with them.

Damage monitoring

Three field assistants were recruited from Pu Poanh, Pu Chu Kraom and Andoung Kraloeng to assist in the collection of damage notifications. Their task was to visit local chamkars every day and collect information on the presence or absence of damage from the chamkar owner. If the owner was not present they followed up with them in the village where possible. At times they were able to identify the presence of damage when the owner was absent and noted this. The assessment team (KS and NMH) was notified as soon as possible when an incident of damage occurred. In addition to this, the assessment team made semi-regular visits every few days to all fields asking all individuals encountered, about known cases of damage.

When a damage notification was received a field visit was made and information on the incident collected on a standard Damage Report form consisting of two parts.

a) Interview: The chamkar owner was interviewed to determine the date of damage, the time of day (day or night), the type and estimated number of animals, the presence or absence of humans at the time of the incident and an estimate of the amount lost. This was expressed in one of two traditional measuring units (seu or sa), which is a small or large multi-purpose basket respectively, used when harvesting rice. These are handmade by each family and differ slightly in size. We also noted any additional details that were raised during the interview.

b) Inspection: A sketch of the field and the area damaged was made, and any landscape features (forest, grass, scrub, streams) were noted as well as any visible traditional protection methods used. The damaged area was mapped in metres by pacing and an area in m^2 calculated later. Damage was categorized into four levels based on how much crop had been eaten/lost within the measured area:

- very slight 0-10%
- slight 10 - 32%
- moderate 33% - 66%
- severe > 66%

The level of damage, estimate of the area damaged (% of the field) and amount lost (% yield) were made subjectively, to compare with later calculations. We also tried to identify the entry point of the animal. This was important to determine if animals had entered through a protected or unprotected area. Precise field area measurements were calculated by using a GPS to record boundary co-ordinates for all damaged fields.

For data analysis, the area damaged was calculated by multiplying each damage area measured by the mid-point of its categorization (very slight, slight, moderate, severe) to give the equivalent area if damage intensity had been 100% - hereafter called the 'adjusted area'.

Field boundary coordinates were collected for all chamkar that suffered damage, allowing percentage damage to be calculated. It was hoped to estimate other field sizes from satellite imagery but suitable cloud-free images could not be obtained.

Post-harvest household questionnaire and village meetings.

Post-harvest household questionnaire

After each chamkar was harvested, the household was interviewed. Questions were structured or semi-structured, broken into two parts.

a) General information

- Yield (expressed in sa including an estimate of capacity in kg if known) - Often informants were only able to provide an approximate range in answer to this question.
- Variation in yield from the previous year
- An approximate comparison of large vertebrate damage for the 2005-06 and 2004-05 harvest
- Frequency of sleeping at the chamkar (an indication of guarding)

b) Protection Strategies

- A subjective evaluation of the effectiveness of the new protection strategy
- Any problems encountered
- Whether the farmer planned to use it in the future, and their willingness to pay
- Alternative protection methods (ranked) if the new methods are not used
- Any new protection ideas

Rankings were not obtained from all individuals. In these few cases, the first method mentioned was ranked 1st and so.

Post-harvest village meeting

Once all chamkar were harvested, village meetings were held to discuss the trial and to discuss various scenarios for management in future. Questions were semi-structured and focused on gaining an understanding of how effective the new techniques were overall, compared to each other, and compared to traditional techniques. We also asked for information about how this year's damage compared to previous years.

We then discussed different options for future action. We asked people what action they would take if WCS/FA provided minimal support in future. The scenario presented was that not enough money would be available to totally fund protection, but that there would enough to either provide a partial contribution to protection for each household, or, to retain all the money and use it for a compensation fund.

They were then asked what they would do if funding were increased to provide enough for full protection for each household.

Finally each group was asked how they would prefer a compensation fund to be managed if it were to be set up. They were asked to focus on decision-making on the use and dissemination of funds; by the community or by WCS/FA.

Post harvest meetings were held separately at Pu Poanh, Pu Clair and Andoung Kraloeng. A joint meeting was held for Pu Chu Kraom and Pu Chu Leu. All meetings were from January 31st– 2nd February 2006.

RESULTS

Landscape level perception study

Crop importance

Focus groups listed 22 crop species (Annex 1). Rice was the most important in all cases, although work in O Rona in late 2006 suggests that cashew is overtaking rice there (WCS/FA unpublished data). Corn, cassava and bananas consistently ranked as the next three most important crops in most of the villages. Yam and Cashew receive high rankings (5th and 6th overall) despite the fact that they are only grown in about half of the settlements studied. Pumpkin and pineapple are also clearly important crops across the landscape, receiving overall rankings of 7th and 8th.

Preferred crops vary with location. Yams were important in Pu Haim and most of Andoung Kraloeng. Soy and Sesame (both cash crops) ranked as important in O Am, O Rona and Sre Preah, which are all located in flat lowland areas near good roads. Cashew, another cash crop, is more widespread and ranks quite highly both in remote upland and accessible lowland areas.

Reported frequency and severity of damage

In the demographic survey respondents rated crop raiding as 'serious' in 37/102 settlements (36%) 'not serious' in 66 and 'unknown' in one (Figure 2). Inside the Core Area 16/28 settlements (57 %) reported serious problems. In the heavily populated Khsim and O Am-Chneng areas almost no settlements reported serious problems. These results probably give a good picture of the broad pattern but should be cautiously interpreted at the level of individual settlements as statements made in focus group meetings and the rating given during the demographic survey do not always match the frequency of damage estimated during the focus groups was typically up to 50% of families each year. Gati reported slightly higher levels (roughly 2/3 of families), and Beng village reported that all six families there have experienced damage.

Generally, focus groups reported that 10-20% of families experience 'serious' damage. Beng reported all the damage they suffered this season was serious, whereas in Gati only one family among more than 30 suffered serious damage. O Tron reported that 6 of the 10 families in their settlement had suffered serious damage.

Of the few groups that were able to specify what constitutes serious damage one (Sre Lvi) stated that losses of approximately 10 sa[2] was considered serious. Another (O Am) stated that crop losses of 30-50% were considered serious, whilst Beng stated losses of more that 25% was serious. As discussed later, these estimates should be treated with great caution.

In Sre Lvi we visited a field where damage was reportedly serious. Two areas of damage were estimated, one of approximately 200m^2, another of 209m^2. Based on the same criteria used in the damage study completed in Andoung Kraloeng the damage within the damaged area affected approximately 80% of the crop. If the field size was assumed as 1 hectare, then this equates to loss of 4% of the field area, and so presumably around 4% of yield. The field owner estimated he had lost approximately 30 sa out of a total potential yield of 100 sa, which is likely to be a large overestimate.

[2] A large traditional basket of varying capacity.

Six of the eight focus groups where trends were discussed said that damage levels are increasing. Three indicated this was due to increasing wildlife populations (O Rona, Sre Lvi, O Am), whereas Rokathmei stated that animals were now aware of the locations of chamkar, resulting in increased damage. Beng village said this year's damage is greater, but in the past two or three years there have been no Wild Pigs as they died. Gati indicated that the trend is for increasing levels of damage, but that this year is not significantly worse, whereas O Tron reported there has been no change in levels of damage over the years. Only Sre Preah said that damage levels are decreasing. They attributed this to land clearing and also because there are more dogs (that scare the Wild Pigs).

Pests reported

Several categories of animal used by interviewees are thought to contain more than one species (e.g. 'monkey' probably refers to two or more species of macaque *Macaca*, 'parakeets' probably refers to several *Psittacula* species and 'civets' could refer to several members of the Viverridae). No attempt was made to determine precisely which member(s) of the group were pests in each individual settlement due to time constraints (see Annex 2 for a list of the taxa likely to be involved). For convenience the folk taxonomic groups used by interviewees are referred to as 'species' hereafter. By this definition twenty vertebrate pest species were listed in the nine focus group discussions in late 2005.

No additional species were reported as key pests in the wider demographic survey.

Whether or not the problems were serious, respondents in the demographic survey were asked which pests were most important (Table 2). Wild Pigs were reportedly the worst vertebrate pest in most villages across the landscape (68 of 102, 66%). Monkeys were most important in 20 settlements and a handful of other species ranked most important in one or more of 12 villages. Monkeys and Wild Pigs were the two most often reported second rank pests, with parakeets also significant and a wide range of others including three notable threatened species, each at one village: Green Peafowl, elephant and Eld's Deer.

Responses did not match individual focus group results in every case, but the geographical pattern is probably quite reliable (Figure 3). Wild Pigs were reported as the top pest in almost every settlement in or bordering the Core Area, plus many in the eastern buffer, but few in the western buffer. Monkeys were reported most important in a cluster of settlements in eastern Snuol Wildlife Sanctuary but only a few settlements elsewhere. All five settlements reporting rats as the top pest were in the Khsim area. This presumably represents a mixture of habitat quality and past hunting pressure reducing the densities of the larger crop-raiding species.

Table 2. Main crop-raiding species at a landscape scale

Most important pest	**Number of villages reporting at this rank**	**Second most important pest**	**Number of villages reporting at this rank**
Wild Pig	68	Monkey	38
Monkey	20	Wild Pig	19
Rat	5	Parakeet	18
Parakeet	3	None	8
None	2	Rat	6
Other[1]	4	Others[2]	8
Total reports	102		97

[1]Small birds, porcupines, squirrels

[2]Small birds, porcupines, Eld's Deer, elephants, Green Peafowl, hares, Sambar, squirrels.

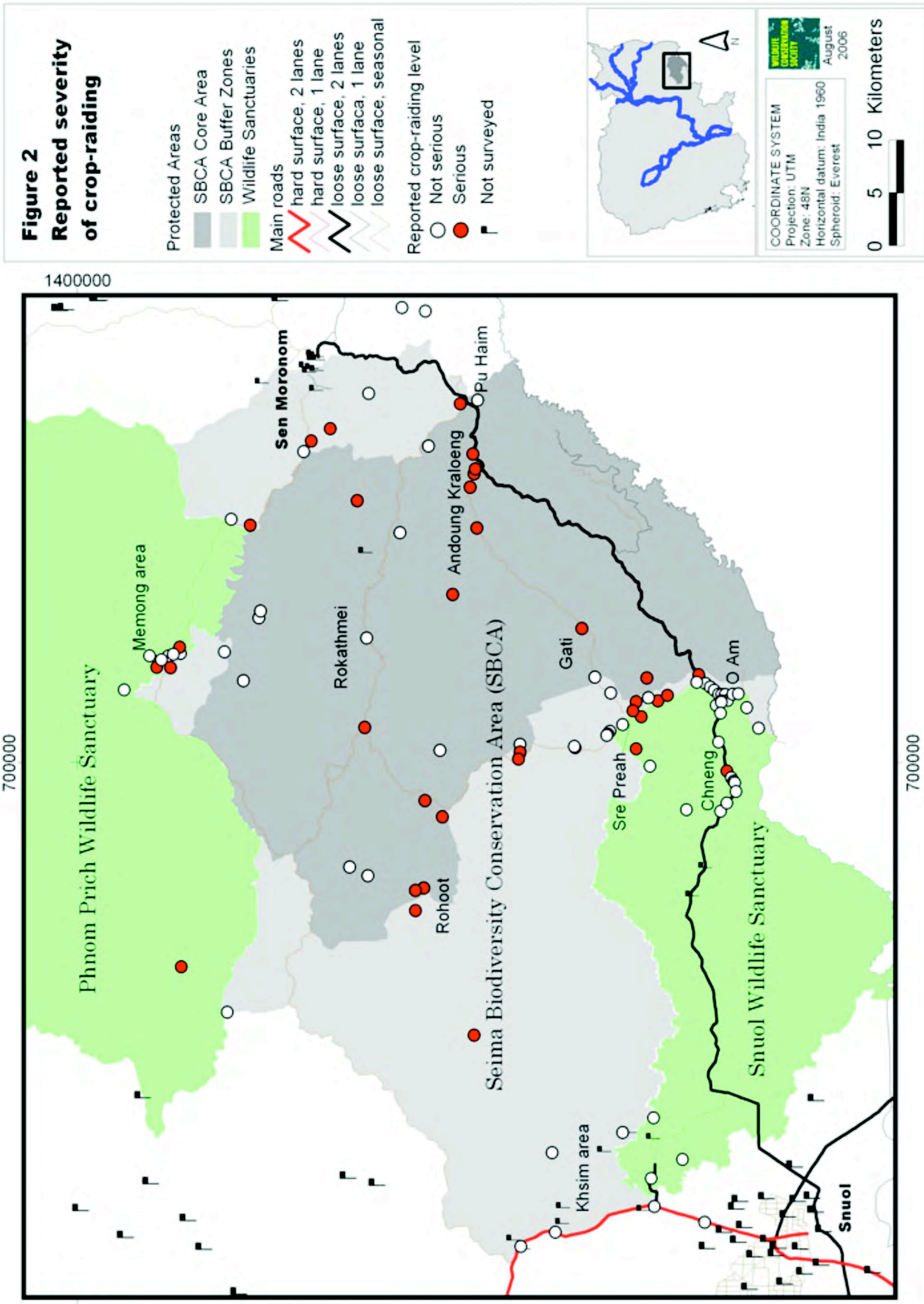


Figure 2
Reported severity of crop-raiding
Protected Areas
SBCA Core Area
SBCA Buffer Zones
Wildlife Sanctuaries
Main roads
hard surface, 2 lanes
hard surface, 1 lane
loose surface, 2 lanes
loose surfaca, 1 lane
loose surface, seasonal
Reported crop-raiding level
Not serious
Serious
Not surveyed
COORDINATE SYSTEM
Projection: UTM
Zone: 48N
Horizontal datum: India 1960
Spheroid: Everest
August 2006
0 5 10 Kilometers
1400000
700000
1400000
700000
Phnom Prich Wildlife Sanctuary
Seima Biodiversity Conservation Area (SBCA)
Snuol Wildlife Sanctuary
Memong area
Rokathmei
Rohoot
Sen Moronom
Andoung Kraloeng
Pu Haim
Gati
O Am
Sre Preah
Chneng
Khsim area
Snuol

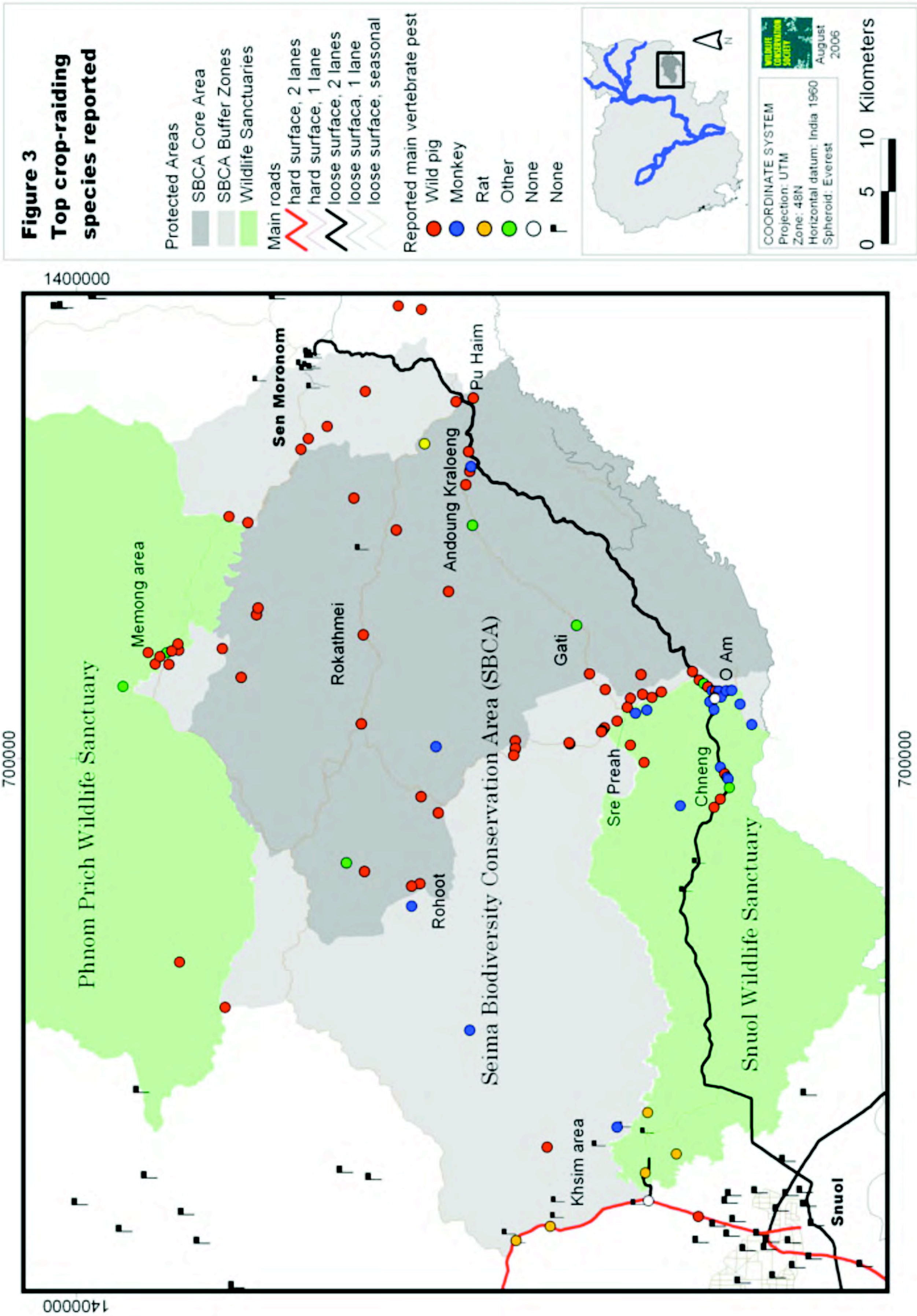


Figure 3
Top crop-raiding species reported

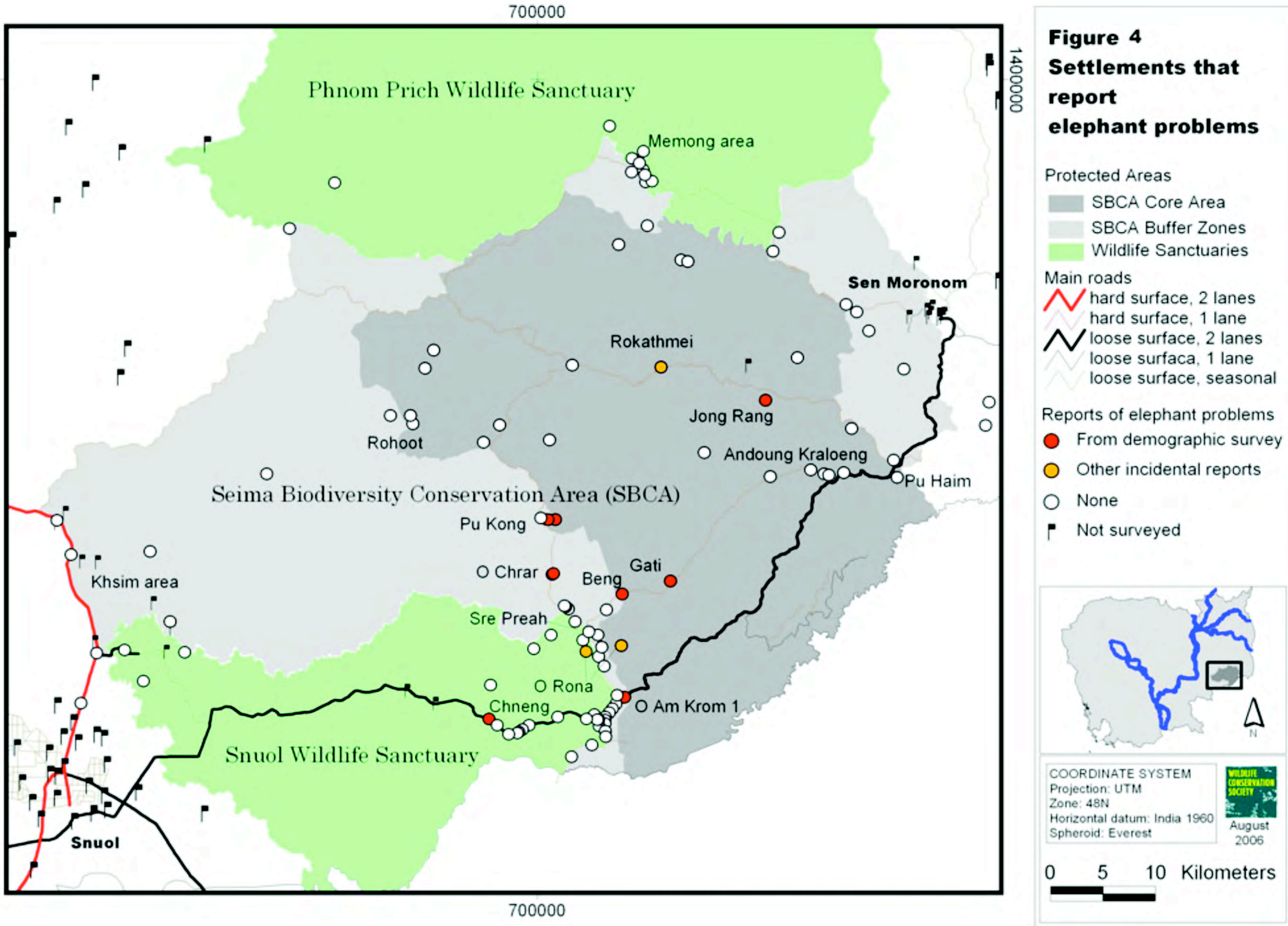

700000
1400000
Phnom Prich Wildlife Sanctuary
Memong area
Sen Moronom
Rokathmei
Jong Rang
Rohoot
Andoung Kraloeng
Pu Haim
Seima Biodiversity Conservation Area (SBCA)
Pu Kong
Khsim area
Chrar
Beng
Gati
Sre Preah
Rona
Chneng
Am Krom 1
Snuol Wildlife Sanctuary
Snuol
Figure 4
Settlements that report elephant problems
Protected Areas
SBCA Core Area
SBCA Buffer Zones
Wildlife Sanctuaries
Main roads
hard surface, 2 lanes
hard surface, 1 lane
loose surface, 2 lanes
loose surfaca, 1 lane
loose surface, seasonal
Reports of elephant problems
From demographic survey
Other incidental reports
None
Not surveyed
N
COORDINATE SYSTEM
Projection: UTM
Zone: 48N
Horizontal datum: India 1960
Spheroid: Everest
August 2006
0 5 10 Kilometers

Table 3 summarises the top pests associated with the six most important crops in villages where focus groups were conducted (see Annex 3 for more details). Wild Pigs are the most important pest for rice, the key crop. They also rank one or two for all other crops except cashew. Macaques and porcupines receive several high rankings. Rats and squirrels are moderately significant pests for most of the top six species, whereas parakeets are less so, but are still important as they rank in the top 6 for the key staples; rice, corn and cassava.

The top six crops suffer damage from a wide range of pest species, ranging from 8 in total for yam to 16 pests for rice (average of 12 pests per crop species). Crops of lesser importance suffer damage from fewer pests (average 4.9 range: 0 for eggplant – 13 for soy).

Some pest species with low overall significance are important pests to at least one of the key crops. Civets are infrequently mentioned as pests but receive high rankings when they are. They are most important pest for bananas and second most important pest for cashew. Loris is also infrequently mentioned overall, but it ranked as the sixth most important pest for cashews. Green Peafowl is the sixth most important reported pest species for rice across the 13 villages, despite being reported as a pest in only six settlements (Beng, Gati, Rokathmei, Pu Clair, Pu Poanh, Trapeang Ronheav). Gati also ranked it first as a pest for soy, and Pu Clair ranked it 8th for corn. Domestic livestock (cattle and pigs) are moderately significant pests for cassava and yams.

Table 3. The top six reported pests for the top six crops

Overall Pest Ranking[1]	***Animal***	***Crop*** *Rice n = 14*	*Corn n = 13*	*Cassava n = 14*	*Banana N = 12*	*Yam n = 6*	*Cashew n = 6*
1	Wild Pig	1	2	1	2	1	5
2	Macaque	2	1		3		3
3	Porcupine		3	2	5	2	
4	Rat	3	5	3	6	3	
5	Parakeet	4	6	6			
7	Squirrel	5	4	4	4	4	1
14	Civet				1		2
11	Domestic Pig			5		5 =	
12	Domestic Livestock					5 =	4
10	Green Peafowl	6					
19 =	Slow Loris						6

[1] Overall ranking is averaged across all crop species in seven villages (those with complete records of overall pest ranking)

Elephant damage

Eight settlements reported recent elephant problems during the demographic survey (Figure 4). Incidental reports worth following up were received from two of these and one additional settlement. There were subsequent reports of low level elephant problems in two other settlements and further questioning is likely to reveal further low or minor problems. The majority of problems were in two clusters – the O Am-Pu Kong area near the south-west of the Core Area and the upper reaches of the O Rang River near Rokathmei[3]. Elephant distributions in the Core Area are poorly understood but what is known from surveys in 2006 matches well with reported problem locations (Figure 4).

The three recent incidents investigated in detail were: Rokathmei (which occurred in approximately July 2005), O Por (November 2004) and Beng (March 2004). Significant damage to the individual chamkar fields in Rokathmei and O Por reportedly resulted in most of the upland rice crop being destroyed. The incident in Beng involved all the banana fruit being eaten in one chamkar as well as the hut being destroyed. The farmer suspected this was caused by the domestic elephant from Gati. In all three cases no one was present in the chamkar. Krom 1 of O Am village also reported recurrent damage to banana trees and field huts. There have been reports of elephant damage in Phum Andoung Kraloeng, but these have all been caused by the domestic village elephant.

Unattended resin jerry cans (and occasionally motorbikes) left in the forest have been destroyed in various places. Regular encounters with elephants also make people afraid to go to certain areas of forest (e.g. around Sre Lvi and Pu Kong). We are not aware of any recent injuries caused by elephants, although in the past six years at least two people in the Andoung Kraloeng area have reportedly been killed by elephants that they were attempting to shoot.

Residents in Gati, Beng, Rokathmei and O Por all reported that they have been aware of the resident elephant populations for several years. The chamkar owners in Rokathmei and O Por both indicated this was the first time elephant damage has occurred. This may reflect changes in distribution of either the human or elephant population.

[3] The report from Chneng actually took place in the Core Area when the respondent was resin-tapping near O Pam.

Seasonality of damage

The seasonality of damage from major pests varies between crops. Annex 4 provides an example of a typical crop calendar prepared during focus group meetings.

<u>Rice</u>

Rice is planted just before the rainy season, during May. Most damage begins in September (when flowering starts) and intensifies during October – December when the rice is ripened and being harvested. Some animals cause damage from planting onwards, notably rats, but also squirrels and domestic livestock.

<u>Corn</u>

Corn has a short growing and harvesting season. It is planted around April and harvested in about July. The harvest lasts roughly a month. It seems squirrels and domestic livestock can cause damage during both the growing and harvest phase, but most animals only cause damage during the short harvest period.

<u>Cassava and yam</u>

Cassava and yam are planted in April/May. After 4 – 6 months harvesting can occur and then occurs continuously throughout the year. Crop damage to a given plant starts at the same time the tubers can be harvested and also continues throughout the year. No particular peaks were reported during this year's study, however a peak from September/October until December/January was reported during group interviews in Andoung Kraloeng in 2004. They indicated that pig damage intensified during this period because there is an abundance of food generally (rice in particular). During other parts of the year pigs remain in the forest as they are not attracted to the fields and therefore do not cause much damage during these other times.

Banana

Bananas are planted in April or May and take a year before they begin fruiting. Harvest begins then and continues throughout the year. Crop-damage also occurs continuously, as soon as fruiting begins.

Cashew

Cashew is usually planted in April (late March to mid-May). Fruiting occurs after two or more years and harvest is from January until April or May. All crop-damage coincides with the harvest period.

Overall

Overall, there is year-round pressure from crop damage. Throughout the year bananas and cassava are at risk. In the latter part of the year corn and then rice are damaged. During the start of the year cashew (if grown) is damaged. There is a general peak in damage during October-December when rice, cassava and soy are all more vulnerable.

Protection methods

Protection methods reported in focus groups were very similar to those already known from Andoung Kraloeng. Sleeping at the chamkar is the most important protection method (Table 4). Five out of eight settlements ranked it as 1. Only one settlement did not include sleeping (the reason for this is unclear) while another (Sre Lvi) ranked it ninth.

Snaring is also very important, with an overall ranking of 2. There were several zero rankings, but these probably reflect fear of reporting snaring, given the overall high ranking it receives in other settlements. Fences are rarely used, except in Beng where they are the primary protection method because the chamkar are located near the village so also need to be protected from domestic cattle.

A few minor novel protection methods were also mentioned. Soap or shampoo was mentioned as a protection method in Pu Haim and Rokathmei, but is only effective for a few days. One individual in Pu Haim had previously used waste oil, and indicated it was effective for approximately two weeks. In Sre Lvi, one individual had used his own urine (in the same manner as waste oil), which he reported is effective for a few days.

Table 4. Preferences among crop protection methods

Overall Rank	Method	Ave. Rank	Village					
			Beng	Gati	O Am	O Tron	Sre Lvi	Sre Preah
1	Sleep in field	1.8	2	1	1	1	5	1
2	Snare	3.2	3	2	5	5	1	3
3	Ompo	3.3	4	3	2	2	4	5
4	Fence	3.5	1	5	3	5	5	2
5 =	Log fence	4.3	5	5	5	4	2	5
5 =	Bonfire	4.3	5	4	5	3	5	4
6	Scarecrow	4.5	5	5	4	5	3	5
7 =	Bamboo Fence	5	5	5	5	5	5	5
7 =	Make noise	5	5	5	5	5	5	5
7 =	Windchimes	5	5	5	5	5	5	5

Coping strategies

In all villages the most important coping strategy to deal with significant crop losses was increasing the frequency of resin tapping (Table 5). Increased waged labour was also important as a coping mechanism, even in relatively remote settlements such as Rokathmei and Gati. Collecting other NTFPs is another key strategy. Collecting rattan or lianas was ranked third overall and collecting forest food (tubers) was fourth.

In many settlements, borrowing from community members is the next option. This system is a feature of most Phnong villages. No interest is charged between community members, although there is a reciprocal obligation in future harvests. Borrowing will usually occur between relatives, but is not confined to them. Borrowing from the community is preferable to selling livestock as livestock is a form of capital saving that is only liquidated when absolutely necessary. Borrowing from the shop is the least preferred option of all because of the expense it incurs, with villages reporting interest of 100% being charged (paying twice as much back when they are able to pay).

Table 5. Overall ranking of coping strategies

Overall Rank	*Method*	*Ave. Rank*	*Village*								
			Beng	*Gati*	*O Am*	*O Rona*	*O Tron*	*Pu Haim 1*	*Rokathmei*	*Sre Lvi*	*Sre Preah*
1	Resin tapping	1.1	1	1	2	1	1	1	1	1	1
2	Wage labour	2.7	6	3	1	2	4	2	2	2	2
3	Collect rattan	3.9	2	2	4	3	6	6	6	3	3
4	Forest food	4.3	3	4	5	6	3	3	5	4	6
5	Borrow from community	5	5	6	3	4	5	5	6	6	5
6	Sell livestock	5.1	6	6	6	6	2	6	4	6	4
7	Borrow (either)	5.7	6	6	6	6	6	6	3	6	6
8	Borrow from shop	5.9	6	6	6	5	6	6	6	6	6
9	Fishing	6	6	6	6	6	6	6	6	6	6

Depredation

Small carnivores

All focus groups reported that chickens and (where kept) ducks suffered depredation. Ducks were kept at O Am, O Tron, Sre Lvi and Sre Preah. Civets, eagles and mongooses are the most commonly mentioned predators, and eat both adult and chicks. Snakes take chicks and eggs. Wild cats and rats were also mentioned as a problem in Sre Preah. Wild cats take adults and chicks of chickens and duck, and rats take chicks and eggs.

No information was obtained on the severity of this problem, or any patterns that may occur seasonally. Observations suggest there are few steps taken to protect any domestic animals. Only pigs have been observed penned. Poultry are almost never confined.

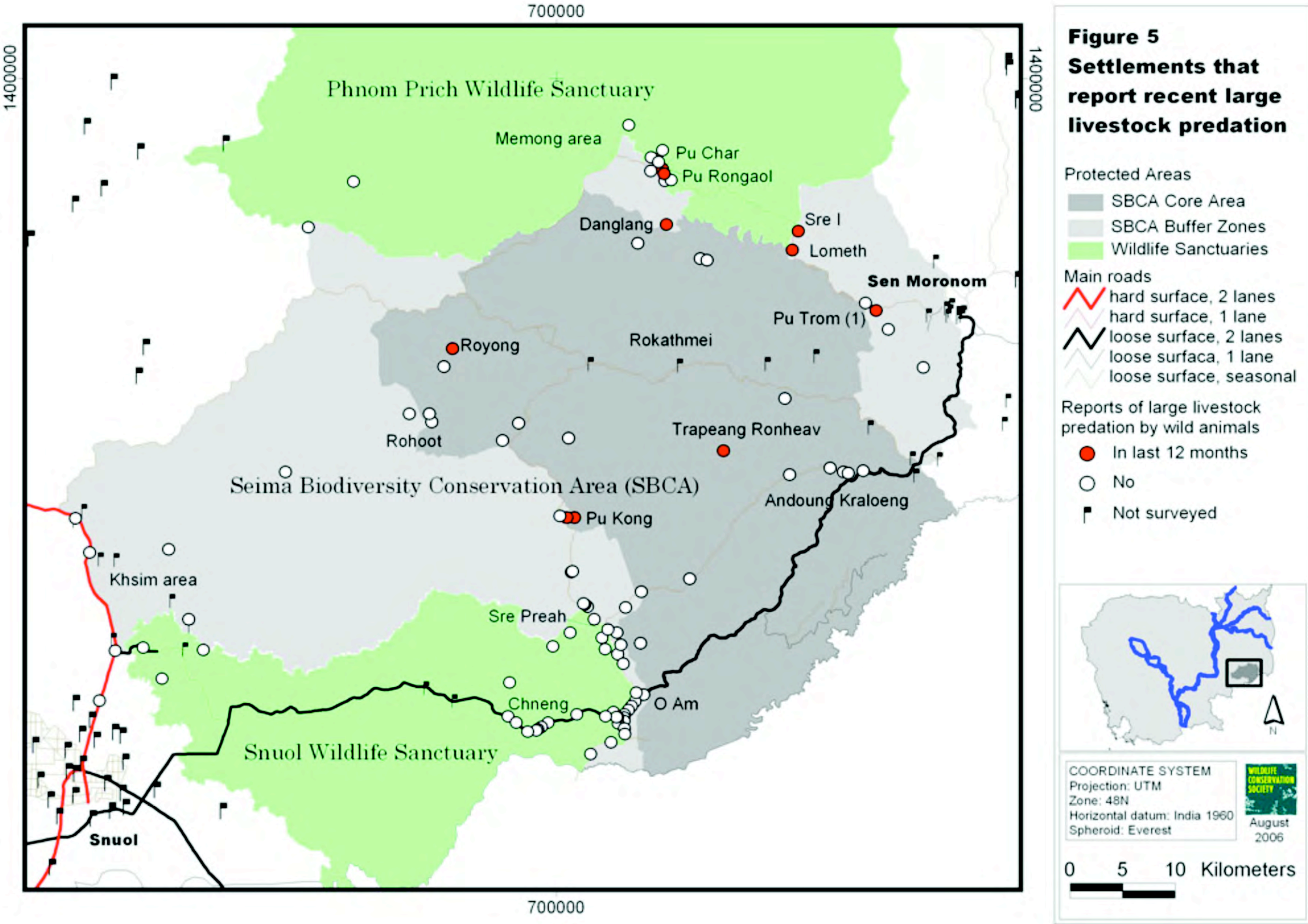


Figure 5 Settlements that report recent large livestock predation

Large carnivores

In the demographic survey, ten settlements reported large carnivores taking large livestock in the past twelve months, and the distribution was different from that of elephant damage or general crop-raiding (Figure 5). Three were in the middle third of the Core Area (two parts of Pu Kong, where several cows and buffalos were reported to be taken in late 2005, reportedly by a large cat[4]) and Trapeang Ronheav (where one was taken in 2005, again reportedly by a large cat). One record was in the northwest of the Core Area (in Royong) where wild canids were considered the culprit.

Unexpectedly, the rest of the records were almost all in the north of the eastern buffer zone, around Memong, an area generally considered to have relatively low mammal populations (Clements 2002). At least 11 cows and one buffalo are reported taken in the past twelve months across six settlements. The predator species was reported on only two occasions – in both cases, wild canids were blamed.

Livestock husbandry techniques are poor across most surveyed villages. Cattle and buffalo are left to roam unattended in the forest throughout the dry season when they are not needed for labour. They often travel 5-10 km from their home village at this time.

[4] This may be an overestimate due to multiplication of second hand reports. For example, a report of three large buffalos killed in 2005 was investigated and eventually traced to the loss of a single juvenile.

Crop raiding and protection methods study

This section has been organized thematically, presenting results from the protection trial, post-harvest interview and village meetings together.

Village and household information

Village sizes, land-holdings and participation in the trial

There are 78 households in the studied settlements (5-30 per settlement, Table 6). Of these 69 have at least one chamkar cultivating rice (simply referred to as a chamkar). The others either own shops, farm paddy fields at Trapeang Ronheav or cultivate cashew and soy. Families that shared chamkar were counted as a single household for this study's purposes. This occurred in only a few cases.

Sixty three households with chamkar (91%) participated in the crop protection trial but only 48 (68%) completed it on at least one of their fields (Table 6). A household was classified as a 'dropped out' if they failed to protect their fields according to the protocols. Completion was worst in Andoung Kraloeng where 72% of households dropped out.

Table 6.Number of households owning chamkar and participating in trial

	All HH			*Entered (%)*[1]			*Not Entered*		
Krom	**Total**	*With Chamkar (paddy)*	*Without Chamkar*	**Total**	*Finish*	*Drop Out*	**Total**	*With Chamkar (paddy)*	*Without Chamkar*
AK	**14**	14	-	**14** *(100)*	4 *(28)*	10	**-**	-	-
PC	**5**	4	1	**4** *(100)*	4 *(100)*	-	**1**	-	1
PCK	**30**	26 (1)	3	**25** *(93)*	21 *(77)*	4	**5**	1 (1)	3
PCL	**20**	16 (1)	3	**13** *(76)*	13 *(76)*	-	**7**	3 (1)	3
PP	**9**	9	-	**7** *(78)*	6 *(66)*	1	**2**	2	-
TOTAL	**78**	69 (2)	7	**63** *(91)*	48 *(68)*	15	**15**	6 (2)	7

[1] Of those households that own a chamkar

There is considerable variation in the number of women-headed households between kroms, from none to 44%. Overall, women head 19% of households: the same ratio that entered the protection trial (Table 7).

Table 7. Household gender, chamkar ownership and participation

	All			*Entered*			*Not Entered* *With chamkar*		
Krom	**Total**	*Women %*	*Man %*	**Total**	*Women %*	*Man %*	**Total**	*Women %*	*Man %*
AK	**14**	14	86	**14**	14	86	**-**	-	-
PC	**5**	-	100	**4**	-	100	**1**	-	100
PCK	**30**	7	93	**25**	4	96	**5/2**	40/20	60/20
PCL	**20**	35	65	**13**	39	61	**7/4**	29/14	71/43
PP	**9**	44	56	**7**	57	43	**2/2**		100/100
TOTAL	**78**	19	81	**63**	19	91	**15/8**	27/13	73/40

The majority of households only own one chamkar (81%) with a few owning 2-3 (Table 8). The average is 1.2 chamkar per chamkar-owning family or 1.05 chamkar across all households. Of the 12 households with more than one chamkar, two were female-headed (16%), roughly comparable with the percentage of female headed households overall (19%).

Table 8. Number of chamkar owned by household and entry in the trial

Krom	HH	Entered				Not entered	
		Total	1 (%)	2 (%)	3 (%)	Total	1 (paddy)
AK	F	**2**	2	-	-	**-**	-
	M	**12**	9	3	-	**-**	-
Total		**14**	11 (79)	3 (21)	-	**-**	-
PC	M	**4**	2	2	-	**-**	-
Total		**4**	2 (50)	2 (50)	-	**-**	-
PCK	F	**1**	1	-	-	**1**	1
	M	**24**	23	1	-	**(1)**	(1)
Total		**25**	24 (96)	1 (4)	-	**1 (1)**	1 (1)
PCL	F	**5**	4	1	-	**(1)**	(1)
	M	**8**	7	1	-	**3**	3
Total		**13**	11 (85)	2 (15)	-	**3 (1)**	3 (1)
PP	F	**4**	3	-	1	**2**	2
	M	**3**	-	3	-	**-**	-
Total		**7**	3 (43)	3 (43)	1 (14)	**2**	2
Total		**63**	51 (81)	11 (18)	1 (1)	**6 (2)**	6 (2)

Post-harvest interviews

Post harvest interviews were completed with 57/63 households that entered the trial (90%), 42/50 households that completed the trial (84%) and 4/8 non-participants (Table 9).

Table 9. Summary of post-harvest interview information

Krom	Type of Chamkar[1] completed/dropped out							No. households interviewed		Total no. households	
	None	Oil	Cass	Fence	Bark	Un-known[2]	Non-part.	Part. completed/dropped out	Non-part	Part.	Non-part.
AK	2	1/5	4/1	1	-	2	-	5/13	-	14	-
PCK	1	6/2	11	-	-	-	1	17/20	1	25	2
PCL	2	7	4	-	-	-	2	11/13	2	13	4
PC	-	2	3	1	-	-	-	4	-	5	-
PP	-	2	3	-	2/1	-	1	5/7	1	7	2
Total	5	18/7	25/1	2	2/1	2	4	42/57	4	63	8

[1]Total of chamkar is greater than total number of households as some households have more than one chamkar

[2]Chamkar we were unaware of until we completed the post-harvest interview. These are most likely to be small areas of cultivated land next to their houses. They are not included in any other analysis as chamkar (i.e., these households are treated as owning one chamkar).

Chamkar information

A total of 76 chamkar entered the trial (Figure 6), with 48 completing in accordance with the protocols (25 using cassette and 23 using oil; Table 10). Only six chamkar did not enter the trial.

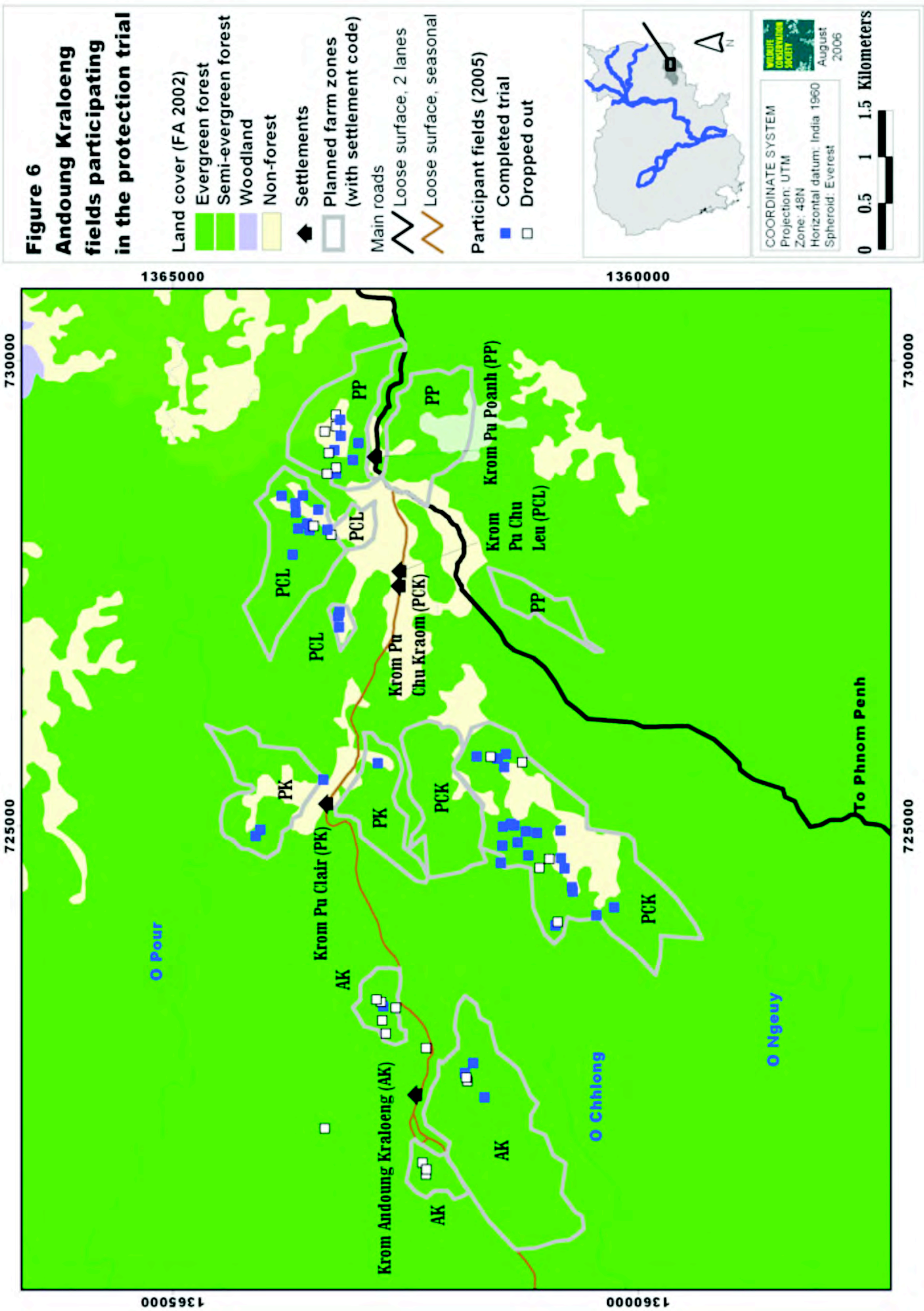


Figure 6 Andoung Kraloeng fields participating in the protection trial

Table 10. Participation in and completion of trial

Krom	ENTERED						NOT ENTERED
	Completed		*Dropped Out*				
	Cassette	*Oil*	*Bark*	*Fence*	*No Protection*	*Poorly Protected*	
AK	3	1	-	2	3	8	-
PC	2	2	-	-	2	-	-
PCK	12	9	-	-	1	4	1
PCL	5	8	-	-	2	-	3
PP	3	3	3	-	-	3	2
TOTAL	25	23	3	2	8	15	6

General information

General chamkar information was collected for 98% of chamkar that entered the trial (91% of all fields in the village). The average age of a chamkar was 2.8 years. 62% of chamkar were between 1 and 3 years old, 25% were between 4 and 7 years and 12% were of mixed age (a chamkar consisting of parts that were cleared in different years). Nearly all owners rated their chamkar soil quality as good (77%) or OK (11%), with one mixed-age field rated as 'good and ok'. Only 7% of chamkar were rated as bad. A rating of bad does not necessarily correspond with the age of chamkar. Two rated bad were 2 years old, one was 4 years and two were 7 years old. Clearly few people cultivate land they consider has poor soil, suggesting that availability of land, and labour to prepare new plots, are not limiting. The rating of rice quality closely matched the rating of soil quality: 64% rated as good, 26% as OK and 7% were rated as poor quality.

Most chamkar are worked on by 2 – 3 individuals (73%), 54% of chamkar are worked on by two people and 19% by three. Only 6% of chamkar are worked by a single individual. 22% are worked on by 4 – 7 people.

52% of chamkar were either flat or slightly sloping. 25% had a moderate slope and 16% were a mixture. Only 6% of chamkar were classified as steep. Although most chamkar were cultivated on gentle slopes overall, there was some variation in the slope categories between villages, most notably in Pu Poanh, where all chamkar rated as steep were located. Few gently sloping areas are available near this village.

Field size

The average measured field size was 0.85 ha, ranging considerably from 0.47 – 1.2 ha between settlements (Table 11). Comparisons with data collected in 2003-4 suggests some changes in average field size in each settlement, but since the 2005-6 data were for damaged fields, not a strictly comparable random sample, not too much should be read into this.

Table 11. Average chamkar size and estimated area of rice cultivation

Krom	Total No. Fields[1]	No. Fields Measured	Total Area Measured (ha)	Average Field Size (ha)	Estimated Area of Cultivation (ha)	2003 Field Area (ha)[2]	Change (ha)
AK	17	9	7.78	0.86	14.62	0.74	+0.12
PC	6	5	2.37	0.47	2.82	0.54	-0.07
PCK	27 (1)	16	19.17	1.20	32.4	0.87	+0.33
PCL	18 (1)	13	7.96	0.61	10.98	0.84	-0.23
PP	14	7	5.05	0.72	10.08	0.76	-0.04
Total	82 (2)	50	42.33	0.85	70.9	0.75	+0.1

[1]Includes participant and non-participant families with chamkar, two families own paddy fields in Trapeang Roheav which have been excluded from calculations, as this is a different kind of rice and cultivation. These are shown in parentheses.
[2] WCS/FA unpublished data.

Yield

The overall average yield reported in post-harvest interviews was 16.6 sa of unhusked rice per field (range: 2 -60; n= 63 of 69 families with chamkar). The average varied greatly between settlements (from 7.8 – 27.2) (Table X).

Table 12. Average reported unhusked rice yields per chamkar

Krom	Number of families	Average reported yield (sa) per chamkar	Range (sa)	Estimated average yield (kg)[1] per chamkar	Range (kg)[1]
AK	13	12.1	4 – 25	494.7	164 – 1025
PC	4	7.8	5 – 10	356.5	230 – 460
PCK	20	27.2	12 -60	1179.4	519.6 – 2598
PCL	13	13.2	5 – 27	504.8	191 – 1031.4
PP	7	8.4	2 – 17	396.9	94 – 799
Average Overall		16.6	2 – 60	702.4	94 – 2598

[1]Calculated using the corresponding average sa weight (kg) from CRDT data.
[2]Estimated for participant and non-participant chamkar

These figures can be combined with field area data to estimate yields per hectare (Table 13). These estimates are based on a multiplying together a number of rather approximate parameters that may covary in unknown ways and so should be seen as indicative rather than exact.

Table 13. Estimated yields of unhusked rice per hectare

Krom	Estimated average yield (kg)[1] per chamkar	Number of chamkar[2]	Estimated total yield (tonne)	Estimated total field area (ha)[2]	Estimated average yield (tonne/ha)
AK	494.7	17	8.41	14.62	0.58
PC	356.5	6	2.14	2.82	0.76
PCK	1179.4	27	31.84	32.40	0.98
PCL	504.8	18	9.09	10.98	0.83
PP	396.9	14	5.56	10.08	0.55
Average Overall	702.4	82	57.0	70.9	0.80

1 From Table 12
2 From Table 11

CRDT measured yield more precisely on a subset of eleven fields by weighing the yield on the day of harvest and measuring field area with a GPS (Table 14).

Table 14. Average rice yield on selected intensively studied fields

Village	**Number of fields studied**	**Average yield (t/ha)**	**Range (t/ha)**
AK	2	1.5	1.4 – 1.5
PC	2	1.0	0.9 – 1.1
PCK	3	1.3	0.7 – 1.7
PCL	2	1.0	0.5 – 1.6
PP	2	1.6	1.4 – 1.7
Total	11	1.3	0.5 – 1.7

These figures are much higher than those in Table 13. It is likely that the samples were not representative of the average for the whole village (e.g. some model farmers were chosen) and so we use the figures from Table 13 in further analysis. But this difference is a useful reminder to use the broad estimates from the post-harvest interviews with caution.

The figures in Table 13 can be used to estimate average rice sufficiency (Table 15). This is based on an estimated rice requirement of about 200 kg per person per year. This requirement varies depending on many factors and so these estimates are only indicative.

Table 15 Estimated average rice sufficiency after 2005-6 harvest season

Krom	**Number of heads in chamkar families (N)**	**Estimated monthly rice consumption (Nx16.5 kg) tonnes**	**Estimated available edible rice (=67% of total yield) tonnes**	**Months of deficit (=12-months of sufficiency)**	**Cost of deficit ($ per person per year)**
AK	77	1.27	5.63	7.6	37.4
PC	26	0.43	1.43	8.7	42.9
PCK	122	2.01	21.33	1.4	6.9
PCL	51	0.84	6.09	4.8	23.6
PP	37	0.61	3.73	5.9	29.2
Total	313	5.16	38.19	4.6	22.80

An average rice sufficiency of 4-5 months is consistent with two previous interview-based studies in this village (Evans *et al.* 2003, Ironside 2004). However, it may be an underestimate, given that this was a relatively good harvest year with ideal weather conditions. The figures suggest that in all the settlements except Pu Chu Kraom, families need to find an average income of $20-40 per head (approximately $100-200 per household) from other sources to cover basic rice needs each year.

Existing protection methods

In post harvest interviews people reported their intention to use a variety of traditional protection methods (Table 16). Preferences varied between villages (Annex 5).

Table 16. Traditional protection methods

Rank	Sleep	Ompo	Knife snare	Scarecrow	Fence	Fallen log fence	Clear around	Bark[1]
Frequency	48	31	19 *(4)*	19	9	8	7	5
Frequency by rank								
1st	24		8 *(2)*	2	6	4	4	3
2nd	14	13	2 *(2)*	2	2	4	1	2
3rd	10	13	4	7			1	
4th		5	5	8	1		1	

[1]Bamboo fences and bonfires were also reported occasionally.

Sleeping in the chamkar by night is the most important protection strategy. Reported frequency of sleeping at the chamkar varied considerably, from some settlements where the majority of chamkar were frequently slept at (such as Pu Chu Kraom), to other settlements where sleeping at the chamkar is far less common (Andoung Kraloeng) (Table 17).

Table 17. Reported frequency of sleeping at the chamkar (percentage)

Krom	*Always*	*Usually*	*Sometimes*	*Never*	*No Answer*
PCK	57	10	24	10	-
PCL	46	-	26	26	-
AK	25	-	13	63	-
PP	11	22	11	44	11
PC	-	-	33	66	-
Overall	36	6	21	36	2

The second commonest protection method reported was the ompo[5]. This is an activity that is linked to sleeping at the field, as the farmer must be present to employ it. Use of dogs is presumably also associated with use of ompo. Snaring was mentioned third most frequently, but was perhaps under-reported. Scarecrows are frequently mentioned and used relatively extensively, but fences are not extensively used. The protective effect of having other chamkar adjacent was mentioned on at least two occasions during the interviews.

Damage and protection monitoring

Detailed quantification of damage was made during the protection monitoring. More general damage information was collected in post-harvest interviews and meetings.

Frequency of damage

Damage was reported in 42 chamkar (59% - considering both completed and drop-outs, range 33% - 80% between settlements) (Table 18). This covers the entire monitoring period including the period immediately prior to protection being used.

[5] These are bamboo noise-makers placed around the field. A ‘hammer’, rigged to a pulley, hits the bamboo to make a clattering sound when pulled

Table 18. Frequency of damage to chamkar

Krom	*ENTERED* No. Chamkar	Yes (%)	No (%)	*COMPLETED* No. Chamkar	Yes (%)	No (%)
AK	17	53	47	4	50	50
PCK	26	50	50	21	42	58
PCL	15	80	20	13	77	23
PC	6	33	67	4	50	50
PP	12	50	50	6	33	66
Total	76	55	45	48	52	48

Female headed households had a noticeably higher chance of reporting damage than male-headed households (Table 19).

Table 19. Frequency of damage to chamkar according to household type

Household	*ENTERED* No. Chamkar	Yes (%)	No (%)	*COMPLETED* No. Chamkar	Yes (%)	No (%)
Men	60	50	50	37	46	54
Women	16	75	25	11	73	27

There were 75 damage reports, an average of 1.79 reports per chamkar (Table 20). Damage reports were attributed mainly to Wild Pigs (63%) and monkeys (29%) with the remainder due to squirrels, porcupine, domestic elephant, domestic cattle and domestic pigs. Both pigs and monkeys sometimes visit the same field repeatedly. About 50% of fields attacked by pigs were only attacked once and the rest 2-3 times. Only single monkey reports were received from individual fields but these sometimes covered multiple incidents so the frequency of repeat attacks may be similar.

Table 20. Number of damage incidents

Damage	*No. Incidents* 1	2	3	4	Total Chamkar	Total Incidents
All	22	11	6	3	42	75
Pig	16	11	3	-	30	47
Monkey	18	2	-	-	20	22
Other	6	-	-	-	6	6

Of the 75 reports, 73 (97%) involved rice, six involved cassava (four of those covering rice as well) and one also involved pineapple[6]. Because the majority of damage was to rice, the remainder of this discussion will focus on damage to rice only, unless stated otherwise.

Species responsible

In interviews Wild Pigs were ranked first as pests and monkeys second in both 2004-5 and 2005-6 (Annexes 6 and 7). This is consistent with observed damaged, since Wild Pigs were responsible for 51% of the total area damaged and monkeys 26%. The remainder is almost completely accounted for by two incidents, one involving domestic cow (13% of the total damage area) the second due to a domestic elephant (10%). Thus 23% of the damage reported was caused by domestic stock.

In total 36 post-harvest interviewees (54%) reported some Wild Pig damage. Other smaller pests such as rats, squirrel and Red Junglefowl listed more frequently than pigs and monkeys as pests,

[6] Five of the six reports about other crops were a result of wild pig damage, and the sixth due to porcupine.

but at lower ranks. This gives a good picture of the pest profile overall. Notably, damage reports were never made for these species, with the exception of one report for minor squirrel damage.

Severity of damage

The total area damaged was very small in relation to total field area (Table 21). About 0.7% of rice crop area was affected by damage. If partially damaged areas are converted to the estimated equivalent area of complete damage, about 0.35% of total crop area was lost.

Table 21 Areas damaged in relation to total rice area

	Area affected (intensity of damage varies)	**Adjusted area (i.e. equivalent at 100% intensity)**
Total damage	5228 m^2	3019 m^2
Damage (% total field area of village)	0.70%	0.35%
Average damage/field	67m^2	40 m^2
Average damage/damaged field	124m^2	80 m^2

For most damaged fields damage is very low, with 82% of chamkar experiencing either no damage or damage of <1% (Table 22). Just a handful of fields experience more severe damage (5-11%). The four fields that experienced the highest damage levels account for 39% of the total adjusted damage area (1169m^2 of 3019m^2).

Table 22. Number (and percent) of chamkar in each damage class

Chamkar Participation		*Damage Class*[1,2]					
		0	*<1%*	*1 – 5%*	*5 – 10%*	*> 10%*	*n*
Completed	Damage in Trial	29 (60)	14 (29)	1 (2)	1 (2)	2 (4)	48
	Damage Overall	24 (50)	16 (33)	4 (8)	0	3 (6)	48
Drop-outs	Damage Overall	10 (38)	12 (42)	3 (11)	1 (4)	0	28
Total		34 (45)	28 (37)	7 (9)	1 (1)	3 (4)	76

[1] Note that the damage classes may not equal the total number of chamkar presented in Table X as field area information was not available for three damaged fields preventing calculation of damage class for these fields.

[2] This is based on the adjusted damage area as a percentage of the total field area

Estimates of damage (in traditional units of sa and seu) were also collected during post harvest interviews and subsequently compared to reported total potential yield in sa (=reported yield+reported loss to wildlife). Overall, estimated average losses were 18% of potential yield. This is more than 50 times higher than would be estimated based on the area of damage. About 50% of losses were attributed to Wild Pigs (or 9% of yield), 18% to monkeys and the remainder to a range of smaller animals such as rats, red jungle fowl, doves and squirrel. These percentages match closely the proportions of measured damage attributable to each species.

Predicting damage

Focus group discussions suggested that there are few reliable ways to identify vulnerable fields before damage occurs, although fields that are more isolated are usually at greater risk of damage and a field that is surrounded by others usually doesn't need to worry about damage. Fields are monitored as the rice season progresses and if there are signs of wildlife visits, then people will start protection. People in Pu Clair mentioned that damage to corn early in the season can help predict 'pig levels' for other crops.

Vaue of rice lost

The total estimated value of the rice lost to crop-raiding is relatively small (Table 23).

Table 23. Value of rice lost due to wild animal damage in surveyed settlements[7]

	Area Damage Overall m²	Average damage per chamkar* m²	Est. Loss Overall kg	Est. loss per chamkar *kg	Est. Cost for all chamkar^ (USD)	Cost per field^ (USD)
Serious only	780.6	390.3	41.8	20.9	12.54	6.40
Moderate & Serious	1029	342.9	55.2	18.4	16.54	5.51
Total	3018.7	39.7	161.8	2.1	52.4	0.64

* Per monitored field in relevant category
^ Average across all fields

The rice lost is estimated to be worth $52.4 for all damage within the village, with $12.5 resulting from serious damage (i.e. >10% of field damaged) and $16.5 for moderate and serious losses together (>5% damage). This indicates a reimbursement value of approximately $5.5 per field for moderate to seriously damaged fields and an average of <$1 per field across all fields. The damaged patches of rice are here assumed to be of average quality. If animals feed in especially rich parts of a field then the total losses would be somewhat greater.

Protection trial

Likelihood of damage

Of the 76 chamkar that were initially entered into the trial, 48 (63%) completed the trial testing waste oil and cassette. During the trial period there were 23 damage incidents affecting 17 chamkar that completed the trial (35%; Table 24). All were caused by wild animals. For both protection methods, the frequency of damage was similar on both protected and control sides, so there is no suggestion that either method was effective in reducing the likelihood of experiencing damage at this spatial scale. Indeed, the opposite may even be true, because for oil the number of damage incidents was higher on protected sides than on control sides (13:9), and for cassette the number of affected sites was higher for protected than unprotected areas (3:1). However, the sample sizes are too small to test this statistically.

Table 24. Summary of damage to protected chamkar: No of fields (No. Incidents)

	Protected	*Control*	*Both*	*Total*
Oil	6 (10)	6 (6)	3 (3)	13 (19)
Cassette	3 (3)	1 (3)	-	4 (4)
Total	9 (13)	7 (7)	3 (3)	17 (23)

The most notable result is that fields with one part protected by oil were more than three times more likely to experience damage than fields with one part protected by cassette. At first glance

[7] Costs were calculated assuming a conversion factor of 0.67 kg husked rice per kilo of unhusked rice and a replacement cost of 1200 riel per kilo of rice (WCS/FA unpublished data) converted to USD at 1USD = 4000 riel.

this appears to be a highly statistically significant difference ($\chi^2_1 = 8.58$, $p<0.001$, two-tailed test). However, accepting this conclusion would imply that the protective methods have an influence far outside the field boundary and not just within it. If that was true, then the fields in the sample could not be considered independent from their neighbours and the test is not valid. Nonetheless it is an interesting result and suggests the need for further study.

Severity of damage

A similar pattern is seen when the severity of damage to damaged fields is considered (Table 25). Area data are not available for undamaged fields so analysis covers only damaged fields.

Table 25 Average intensity of damage (percent of area)

	Total field damage	*Protected Side*	*Control Side*	*Average benefit of protection (control-protected)*
Oil	1.89	2.10	1.40	-0.69
Cassette	0.23	0.48	0.05	-0.43

In both oil and cassette-protected fields that were damaged, average damage was slightly more serious on the protected side than on the control side (i.e. average benefit of protection was negative). However, overall average damage on damaged fields was more than eight times less on fields with some cassette protection than on fields with some oil protection; this was true both overall and separately for protected and control sides. This difference is in addition to the increased likelihood of experiencing damage in the first place. Given that the independence of fields cannot be assumed (see above) no statistical tests can be performed on this result.

The pattern of damage by the two main species was compared (Table 26) but no clear pattern can be discerned, except to note that monkey damage was even more strongly concentrated in protected sections of fields than pig damage.

Table 26 Intensity of damage by Wild Pigs and monkeys (percent of area)

	Protected Side	*Control Side*	*Total field damage*
Wild Pig			
Oil	0.63	1.40	1.06
Cassette	0.00	0.05	0.02
Monkey			
Oil	1.45	0.00	0.83
Cassette	0.48	0.00	0.21

Damage was concentrated in two of the five settlements of Andoung Kraloeng, Pu Chu Leu and Pu Poanh (Figure 7).

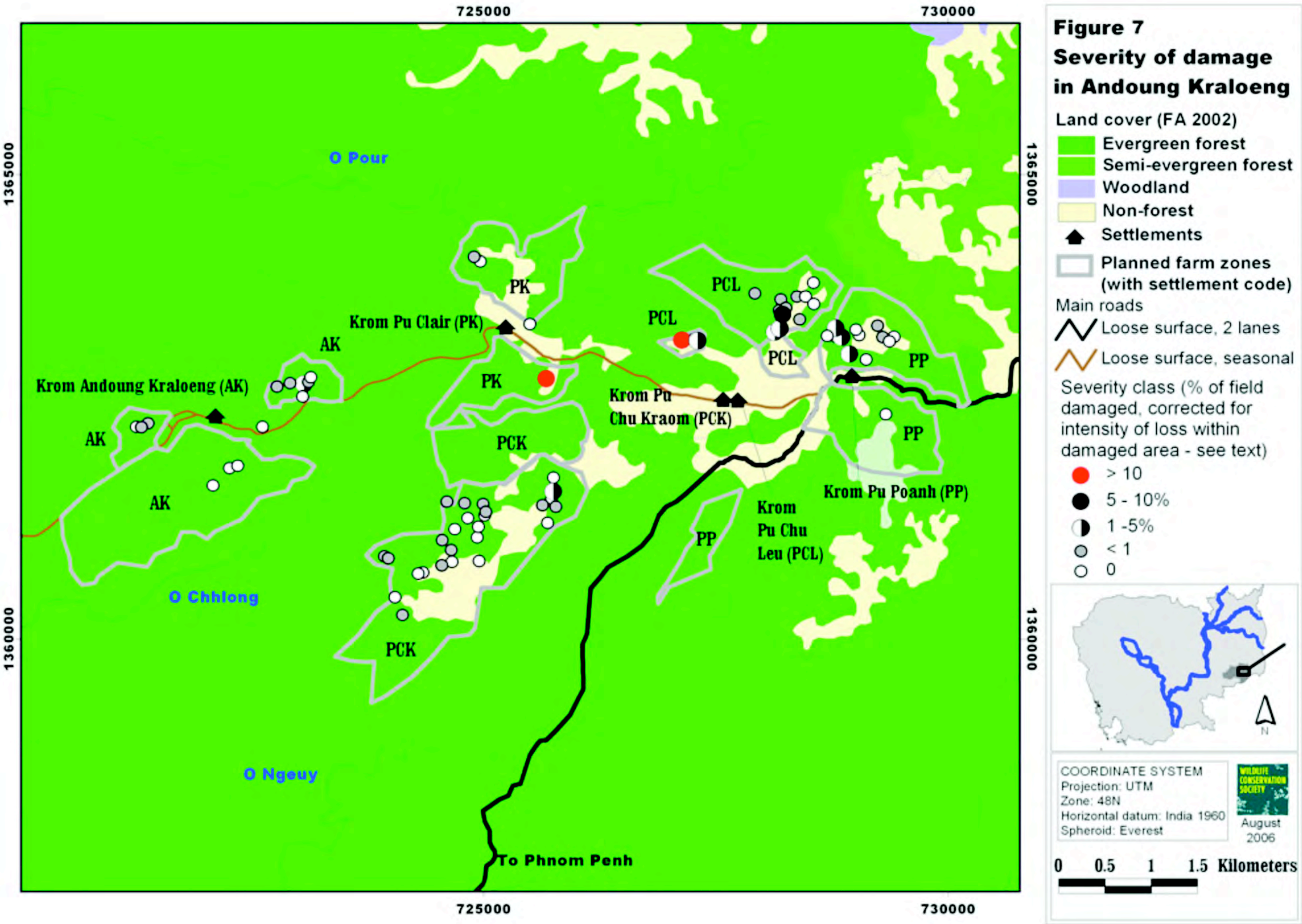


Figure 7
Severity of damage in Andoung Kraloeng

Perceptions of effectiveness

During post-harvest meetings, all settlements indicated that the levels of damage this season were a little or moderately less than normal. This reduction in damage was attributed by people to the new protection measures. The Pu Chu Kraom Krom leader also indicated that starting protection earlier than last year contributed to the reduction in damage.

Of those interviewees who trialed and completed the new methods (40 interviewees), the overwhelming majority (95%) believed there was some benefit from them, including 44% who found them very useful and 28% who found them moderately useful. Perceptions of effectiveness appear to be particularly associated with ability to protect against Wild Pigs. Those who rated a method as very effective indicated it was helpful for protecting against Wild Pigs, whereas those who felt the method was less effective frequently commented on the failure to protect against Wild Pigs and animals in general. Comments regarding effectiveness were infrequently made with reference to monkeys.

In group discussions there was no overall consensus about whether one method was better, but in post-harvest interviews those who trialed cassette rated it more favourably than those who tried oil (Table 27).

Table 27. Perception Of Effectiveness and Method Used Reported by Interviewees Who Completed (Completed and Drop Outs)

	Perception of Effectiveness %				
Method	*Very*	*Moderate*	*A Little*	*Not*	*N*
Cassette	59 (60)	18 (20)	18 (16)	5 (4)	22 (25)
Oil	33 (28)	28 (36)	33 (24)	6 (12)	18 (25)
TOTAL	48 (44)	23 (28)	25 (20)	5 (8)	40 (50)

The group in Pu Poanh believed that cassette was better than oil, and they often framed their answers to questions regarding the new protection methods with reference to cassette. They believed that cassette was best, followed by oil and then bark. They indicated that oil looses its effectiveness because it stops smelling and bark also looses its effectiveness. The group in Andong Kraloeng also believed that cassette was better than oil for the same reason with oil losing its smell, particularly after rain.

Discussions with Pu Chu Kraom and Pu Chu Leu concluded that both methods were equally effective. Pu Clair concluded the same, but suggested that oil was better for protecting against Wild Pigs, whereas cassette was better for protecting against monkeys.

A point made during discussions with Krom Andoung Kraloeng about the new methods compared to traditional techniques is that they are effective even when no one is present. The most effective traditional protection methods (sleeping and ompo) both require someone to be present. This was considered an advantage, as it allows people to spend time on other activities. Pu Clair made similar comments.

Practical issues, future use and management

Problems experienced

There were several vague comments that both oil and cassette were a little difficult to use. A few specific problems were reported. One family using cassette indicated they found it hard to locate the fencing material and another commented that the method continued to fall down in the middle section (which divided the protected from the control side). They said this was because the spirits were unhappy the method was used in the middle of the chamkar. The interviewee using bark commented it was difficult to locate the bark, a problem identified earlier during pre-trial meetings with Pu Poanh.

Future use

Of interviewees who trialed oil or cassette, 88% said that they planned to use the method again in future, irrespective of whether they dropped out (Table 28). This intention was stronger for cassette users (91%) than oil users (83%).

Table 28. Intention of participants to use a given method again

	Use Again (%)			
Method	*Yes*	*No/Not sure*	*No Answer*	*n*
Cassette	20 (91)	2 (9)	-	22
Oil	15 (83)	3 (16)	-	18
Bark	2 (100)	-	-	2
Other[1]	13 (71)	1 (6)	2 (13)	16
TOTAL	50 (86)	6 (10)	2 (4)	58

[1]Drop outs and non-participants

Overall 55% of all interviewees and 60% of those who trialed oil or cassette indicated they would be willing to pay for the method in future. But most interviewees qualified this statement that it would be contingent on them having the money to do so. Those who trialed cassette were very slightly more willing to pay for the method than those who used oil (64% and 61% respectively). People is Pu Chu Kraom and Pu Clair were most willing to pay for protection in future and those in Pu Chu Leu the least willing (Table 29).

Table 29. Agreement to pay for protection if plan to use in future

Krom	Yes (%)	No/Not Sure (%)	NA/No Answer (%)	n
AK	46	54	-	13
PCK	70	30	-	20
PCL	31	61	8	13
PC	100	-		4
PP	50[2]	25	25	8
TOTAL	55	38	5	58

[1] Two using bark and one non-participate who gave no answer
[2] 66% if bark users are omitted

The result for Pu Chu Leu may be explained by the fact there are a number of female households who are much less able to pay. As previously mentioned, Andoung Kraloeng generally doesn't suffer from high damage levels. If they perceive they have little use for the protection, then it would not be surprising they would be less willing to pay for it. Pu Chu Kraom also suffered low levels of damage, but maintained a high completion rate and clearly perceives a benefit from the new protection methods. Their higher willingness to pay may relate to their generally wealthier status.

New alternatives

Other than samraong bark, no major innovations were suggested by villagers this year. One individual believed that oil alone was not effective, but combining oil and cassette would be effective. Another believed that a two-strand cassette fence would be sufficient (rather than three). A third suggested stringing the cassette higher to catch the wind and make more noise. Something similar to this was observed in one chamkar while making a damage report, where a scarecrow was strung with cassette to catch the wind. Mosquito nets were observed hung as scarecrows in some chamkar,.

Future management

For the scenario where funds were not enough to provide new protection materials to every family, all kroms agreed that it would be best used as a post-harvest compensation fund instead. In the scenario where money was enough to provide materials to everybody, opinions differed. Pu Clair and Andoung Kraloeng both indicated they would still prefer to keep it as a compensation fund. Pu Chu Kraom, Pu Chu Leu and Pu Poanh all preferred to give protection to everyone. Andoung Kraloeng indicated that this fund could also be used during the season if there was a family that was in need of extra assistance, using the fund to purchase cassette. If funds were to be used as a compensation fund, all groups preferred that the community should manage the decision-making process. One settlement expressed a desire for funds to be physically administered at the Krom level. Otherwise, they wished WCS/FA to manage it. They were not in favour of funds being managed at the Phum level, expressing a feeling that funds would not be disseminated in a fair manner citing a previous incident where they felt this occurred.

Transparency was a concern expressed at all meetings. They indicated that all funds and the use of the funds would need to be public knowledge, with public meetings being held and all families present, to show the amount of money given and disseminated. One Krom also mentioned that if WCS/FA was to target assistance (providing assistance to only a few families) the nature of this assistance would need to be public knowledge to prevent jealousy.

Use of surplus funds was discussed in one krom, and they suggested keeping it for the follow year. They also suggested it could be used as a bank by the community, or provide funding to help them monitor illegal activity (e.g. to pay for petrol for patrolling by the community

A desire was also expressed for WCS/FA to take a close supervisory role in initial stages, if funding was provided for the community to manage.

DISCUSSION

Crop damage profile and conservation impacts

The discussion below focuses mainly on damage by Wild Pigs, macaques, porcupines and other common species, since this issue is now quite well understood and is already important in many places. The study has given a first impression of conflict with elephants and large carnivores, but further work is needed before detailed solutions can be identified. One of the main findings was that conflict with elephants and large carnivores is still at a low level and occurs in just a few villages and so it is not yet urgent to resolve it. However, as these species become commoner and less wary of humans, these conflicts will rise and may become a much more important issue that problems with common species.

Patterns of damage

There is a consistent crop and pest profile across the landscape. A small number of important staple crops are grown everywhere. Many species cause damage, but almost everywhere the list is topped by Wild Pig and monkeys, followed by more typical agricultural pests such as rats and birds (parakeets and doves). Rats are probably under-reported in this study as the focus was on larger animals.

This is consistent with findings in both Africa and Asia where damage in small holder farm settings typically occurs to highly nutritious staple crops, which are extremely attractive to a wide range of animals, even when forest food is available (Naughton-Treves *et al* 1998). Furthermore, crop-raiding species are typically adaptable, intelligent and tolerant of human presence (Naughton-Treves 1998, Newmark *et al* 1994) and are resistant to traditional deterrents such as guarding (Hill 1997 & 2000, Naughton-Treves 1998). Damage to rice and corn is particularly important, since losses to staple crops with a single ripening and harvest period that also corresponds with the peak in crop damage can threaten food security (Naughton-Treves *et al* 1998, Hill 2000, Weladji and Tchamba 2003).

In the SBCA crop damage occurs year round, but peaks during the corn and rice harvest. During this time cassava is also most vulnerable to damage, because this is the peak of tuber maturity and possibly also because of Wild Pigs attracted to fields by ripening rice. Damage occurs year round to other staple crops such as banana and yam but seems to occur at a relatively low level and is more tolerable.

Cash crops are locally important too, especially in settlements located close to population centres (Keo Seima and Sen Monorom). Cashew is grown most widely, with soy and sesame also mentioned. Cassava as a cash crop has increased in importance during 2006. Pest species ranked as most important for cashew are squirrels and civets, but these are unable to cause acute extensive damage. Wild Pigs are also listed but they are unlikely to cause severe damage except to the lowest branches of the trees. Soy is more vulnerable to damage by a wide variety of animal species by virtue of its growth habit (a small plant) and because it is a highly nutritious legume (and is therefore attractive). As populations of wildlife increase and as more people adopt cash crops, damage to these crops by wildlife may become a more important problem to locals. Threats to economic livelihood can be as intolerable as threats to food security.

Severity of damage

Some crop damage was reported to occur in every settlement in the landscape, but community leaders rated it as ‘serious’ in only a third of them. Interview results and the intensive monitoring program agree that in and around the southern part of the Core Area 50% or more of households in each settlement typically experience some level of damage, with considerable variation between settlements and probably also between years. This variability extends to the individual field level, at least in the five intensively-studied settlements, with the vast majority of fields experiencing little or no damage, and small numbers experiencing more serious damage. A strongly skewed distribution of damage is a common finding in such studies and indicates that average damage levels alone are insufficient to characterise the problem. The pattern of damage has implications for a family's ability to cope, as well as shaping their perception of the severity of the damage (Naughton-Treves 1997 & 1998, Naughton-Treves and Treves 2005).

Assessment of the detailed damage measurements in Andoung Kraloeng has to take account of the fact that many fields were using experimental new protection methods. This was perceived by villagers to have lowered average damage levels somewhat, but many damage incidents clearly occurred even in protected fields. Furthermore, general damage levels appeared to be broadly similar before and after the trials began, and in protected compared to unprotected fields, and they also seem comparable to levels recorded in the 2004-5 harvest (Evans *et al.* 2006). Thus the aggregate results seem likely to be somewhat lower than would be expected in a village where no novel protection was being attempted, but still broadly representative.

Calculated levels of damage to rice were only around 0.35% of total field area across the five settlements combined. Assuming damaged areas were of average quality, we estimate the total direct economic loss due to this damage was less than $60 across the five settlements, an average of less than $1 per family, which is low compared to other potential crop losses (e.g. weather, disease, insects) and other livelihood threats (e.g. fluctuations in commodity prices, loss of resources). This does not take account of the indirect costs to the village, in particular the labour costs of preventing additional damage through guarding and the fear of being affected by one of the occasional severe damage events. There were also additional unmeasured costs due to losses of other crops, especially corn and cassava.

Losses calculated for SBCA are considerably less than recorded in studies elsewhere. Naughton-Treves (1997) reported average crop losses of 4 – 7% in Uganda while Sekhar (1998) recorded average crops losses of 7 – 10% in India. Average crops losses by elephants of 11% (Madhusudan 2003) and 15% (Madhusudan and Karanth 2000) have been reported in India. These studies may be biased towards high conflict areas.

Damage was concentrated in two of the five settlements of Andoung Kraloeng (Pu Chu Leu and Pu Poanh). Both have a relatively high number of female-headed households, but also have their fields located close together (Figure 7). It is therefore difficult to identify if female households are in fact more vulnerable, or if there is a 'problem' Wild Pig herd close to these fields. Local opinions favour the latter explanation. It was observed that a cluster of fields damaged in Pu Chu Leu, including one of the seriously damaged fields, were all located next to a fallow field where the Wild Pigs were said to be coming from. Another severely damaged field in Pu Chu Leu was also located next to fallow fields. One of the field owners in this place said that previously, when the fallow chamkar were active, Wild Pig damage was not so much of a problem.

Farmers' estimates of losses due to larger wildlife species from incident reports and post harvest interviews were 50 times greater than those estimated by the survey team on the basis of measurements. The frequency of severe damage reported in focus groups only makes sense if the threshold for 'severe' is set at about 1% (much lower than suggested during interviews, and not severe by most standards). Thus farmers' reports on severity of crop damage in the SBCA cannot be relied upon without independent assessment. Nonetheless, perceptions rather than absolute numbers are the most important factor in shaping how people understand and react to damage (Naughton-Treves 1997), so the fact that people perceive severe losses in itself makes this a significant management problem for the SBCA.

Overestimation by farmers of damage is a common finding in the literature worldwide. One reason given for such overestimates is that those being interviewed hope to receive compensation and consequently inflate losses (Sekhar 1998, Naughton-Treves, Rose and Treves 1999, Gillingham and Lee 2003, Johannesen 2005). This may not be relevant to SBCA as no benefits or compensation for damage have ever been offered there[8]. The fact that damage estimates by eye made by KS and NMH mostly turned out to be at least 100% too high when measured objectively suggests that it is a naturally very difficult to make accurate estimates. It is possible that the sense of frustration and despair when people experience damage makes the losses *feel* more painful, especially when the farmer is already expecting a rice deficit. Farmers may also subconsciously factor in the costs they have incurred in protecting their crops and so preventing potential damage.

Perceptions regarding the significance of a pest depend also on the pattern of the damage. We found that people rarely complained strongly about smaller species such as parakeets, rats or even porcupines despite the fact they were rated as significant pests in the pilot study, during the focus group survey, and in post-harvest interviews. Incidents of acute and highly visible damage, and species causing them, are perceived as more serious than chronic, diffuse damage by more cryptic species even when measurements show the latter has greater economic cost (Naughton-Treves 1997, Naughton-Treves, Rose and Treves 1999, Naughton-Treves and Treves 2005). Smaller animals are often recorded as causing damage at levels that are similar to or exceed those of larger vertebrate animals (which are reported as much more significant pest species). This includes small monkeys (Naughton-Treves 1998, Gillingham and Lee 1999), cane rats and other rodents (Naughton-Treves, Rose and Treves 1999) and birds (Sekhar 1998, Weladji and Tchamba 2003). The reverse is found for elephants, which are rated as causing more damage relative to other large species than is actually the case (Naughton-Treves 1997).

Naughton-Treves (1997) suggests proprietorship also shapes attitudes towards crop-raiding species, particularly regarding damage by livestock where she found even significant damage by livestock was rarely reported during her study. Weladji and Tchamba (2003) found that locals assumed the economic responsibility for damage by agricultural pests such as rats and birds, but damage by larger species whose welfare has been explicitly assumed by park authorities through regulatory activities was the responsibility of the management or more broadly the government. Elephants have been referred to as 'government's cattle' (Naughton-Treves 1997), a sentiment noted elsewhere (Naughton-Treves, Rose and Treves 1999, Gillingham and Lee 1999).

Conservation impacts

The most significant conservation impact of crop-raiding is probably indirect. Reduced local tolerance for the existence of the protected area could potentially

[8] Although on one occasion during our monitoring trial, obvious domestic cattle/buffalo damage was reported as damage from wild pig.

lead to reduced government support and undermine the area's protected status, or at the very least could make it difficult to negotiate with villagers on other subjects.

There may also be direct impacts due to retaliatory killings. Several of the crop-raiding species are of conservation concern. The macaque species are relatively abundant locally but all three are red-listed[9] due to their declining global populations. Sambar and Wild Pig, whilst not threatened with extinction, are key prey species for large carnivores. Pig and macaques cause problems very widely, and three villages listed Sambar as a problem. It is impossible to judge the level of retaliatory killing of these species with current data, but it is potentially significant. There are more than 1000 farming families in and close to the Core Area - if each catches one Wild Pig or Sambar per year at the field edge (a speculative estimate) this would represent a substantial drain on the prey base for large carnivores given current prey densities.

There are also potential threats from HWC to local populations of Asian Elephant, Green Peafowl and Eld's Deer. At present these do not appear to be serious but could increase. Overall, there seems to be a low level of reported elephant damage. Some focus groups reported that they felt elephants were venturing closer to their settlements and fields, leading to crop-damage where it had not occurred before. Potentially risky encounters with elephants while out in the forest are also a worry for many villagers, and this problem will increase if people are prevented from taking their dogs with them (Keo Rityphorn, pers. comm. 2006). Green Peafowl was listed as a moderately important crop-pest in Beng, Gati, Rokathmei, Trapeang Ronheav, Pu Clair and Pu Poanh, all in the Core Area. They can reportedly cause extensive and unpredictable damage, at least occasionally.

Loris species are also of some conservation concern[10]. Lorises were listed as moderate-to-significant pest by Sre Lvi and Sre Preah for bananas and cashew. Damage to bananas may be tolerable, but significant damage to cashews may not. This, combined with the high relative trade value of lorises, may potentially increase the threat of these animals being hunted.

While Gaur have never been reported as a crop pest, there is some potential in future for conflict with the animals. One person was injured by a Gaur in Andoung Kraloeng in 2005 and there has been one road accident involving a Gaur. Recently, Gaur have been seen regularly at night on the provincial main road through the Core Area.

Mitigation: crop protection and coping with losses

Traditional protection methods

Traditional protection methods used by villages in SBCA are similar to those reported in Africa and other parts of Asia. In most studies scaring/chasing/making noise is considered the only or most effective method of protection against crop-raiding animals (Hill 1997 & 2000, Karanth 2003, Naughton-Treves 1997, Sekhar 1998, Weladji and Tchamba 2003). 'Sleeping' is the most important method used by people in SBCA. By staying at the chamkar they are more likely to detect the pig(s) and so be able to scare them away. Chasing is also considered the only reliable method against monkeys. This means human presence is required in a chamkar 24 hours a day at peak seasons for effective protection, representing a considerable labour cost. Therefore guarding will not always be employed, increasing the risk of damage. Hill's (2000) study on baboon crop-raiding in Uganda found that although men were considered

[9] Pig-tailed and Stump-tailed are Vulnerable, Long-tailed is Near-threatened (www.redlist.org)

[10] Data Deficient (www.redlist.org)

the best guarders (baboons are afraid of them), women and children actually did most of the guarding due to other commitments men must fulfill. Howard (1995 in Hill 2000) estimated that most of the cost of the resources spent on field protection (ranging from $96 to $519) in Nyabyeya Parish, Uganda was associated with the cost of guarding.

In SBCA people reported that they cannot rely on their dogs to detect pigs as they sleep also, so the individual must be awake. There is a trade-off between remaining vigilant during the night and being productive during the day. This balancing act between the costs and benefits of increased vigilance may explain the variation in sleeping rates between settlements in Phum Andoung Kraloeng, considering the importance placed on it as a protection strategy. In general chamkar belonging to Pu Chu Kraom, Pu Chu Leu and Pu Poanh are located closer to the settlement area, which may increase the frequency of sleeping. However other factors influence frequency of sleeping rates at the chamkar. It has been reported that levels of damage in Andoung Kraloeng are generally lower that those at other settlements in this phum. Because protection is employed adaptively, this lower level of sleeping may reflect a lower need to protect rather than a failure to protect. Pu Poanh and Pu Chu Leu both have a higher number of female households, meaning they may be less able to sleep at the chamkar due to other family commitments within the village.

Scarecrows are frequently mentioned and used relatively extensively. Despite this most people report that they are not particularly effective (e.g. they may work for a few days against monkeys). Their ease of construction is probably the main reason for their prevalence. A similar conclusion could be drawn for the use of ompo. Methods such as scarecrows and noise makers are also used elsewhere, but similar conclusions are made about their effectiveness. Fencing (either typical fences or 'live' fencing using shrubs) and the planting of buffers can be effective protection methods (Sekhar 1998) but they are often impractical in SBCA where cultivation is on small shifting swidden plots. Only two chamkar were fenced in Phum Andoung Kraloeng, and these were owned by well-off households. This is a good reflection of the high labour costs associated with these kinds of protection methods.

Snaring is also considered an important method of protection. Farmers and field staff of the conservation project report that only a few snares are usually set around each chamkar and they do not catch a large number of animals (usually 0-2 animals per farmer per year). Therefore the reason for their high ranking is unclear. It is possible that farmers are under-reporting the number of animals caught as well as the number of snares used. Farmers report that animals are scared of snares, so this repelling characteristic may also be important.

Snaring and other forms of hunting of crop-raiding animals, although infrequently mentioned in the literature, are traditional ways mitigate damage. Hill (1997) mentioned bow and arrows are used to deter baboons. Hunting has been alluded to elsewhere (Infield and Namara 2001) and increases in crop raiding have been reported following hunting bans (Hill 2000). At least two studies suggest that hunting can be an effective way to reduce damage levels. In her detailed studies of factors that predicted damage levels from crop-raiding in Kibale, Uganda, Naughton-Treves (1998) found only hunting explained differences in damage levels between villages. Similarly, Geisser (2004) examined the effectiveness of three management techniques (hunting, supplemental feeding and electric fences) on reducing crop-damage by Wild Pigs in Canton Thurgau, Switzerland. He found that only hunting effort and hunting success reduced the frequency of damage to agricultural crops. Both studies failed to find reductions as a result of other protection methods such as guarding (Naughton-Treves 1997) and use of electric fences or supplemental feeding (Geisser 2004). Furthermore, inability to hunt crop-raiding animals due to park regulation has been noted as a source of discontentment by locals towards management authorities (Hill 2004, Naughton-Treves 1997, Hill 2002 in 2004).

Novel protection methods

The results of the protection trial are ambiguous. The experiment gave no evidence that the protected half of a field was less likely to be damaged than the control side, or that the damage would be less serious. The sample sizes were relatively low, especially given the skewed distribution of minor vs severe damage events, and so random variation could have obscured a benefit if it was only small. A much larger and more complex trial would probably be needed to provide a definitive result, and there would need to be much stricter supervision of participating farmers. Such investment is not justified given the current scale of the problem. There is a suggestion that cassette provides some protection at a broader spatial scale, extending outside the boundary of the protected crop, but the study design was not suitable for analysing this.

In villages that experienced high levels of damage (Pu Poanh and Pu Chu Leu), people clearly preferred cassette over tape. Where damage was less serious, people seemed to think that both methods were effective. The overall conclusion during all village meetings was that the novel methods were better than traditional methods or nothing at all. There were insufficient data to test the effectiveness of bark; households in Pu Poanh believed it to be useful, but less so than cassette and oil.
Overall there is sufficient belief in the cassette method amongst villagers, based on their own observations, and enough hints that it is genuinely effective, based on formal observations, to make it useful as part of a program to improve attitudes to crop-raiding. However, it should be noted that the cost greatly exceeds the likely value of the damage avoided. Also, any effectiveness the method has is likely to decline as the pests become habituated, so further innovations need to be tried.

Most people reported the novel methods to be easy to use, but the high drop-out rate suggests otherwise and we noted some specific problems during the trial. The waste oil method was relatively easy to set up, but many people failed to regularly re-oil the rags, making it difficult to judge effectiveness. However, at least one incident of damage occurred shortly after the oil stakes were put in place – so clearly some pigs are not deterred by the method. Cassette was more labour intensive to put in, but required little maintenance afterwards. However, during late-November and December (coinciding with the start of the harvest) strong winds typical of that time of year resulted in cassette strands breaking and coming loose. In most cases however there was still at least one strand of fence unbroken on the section. We never observed attempts to mend the fences, possibly because people were busy with the harvest. It is conceivable that even broken strands of cassette still have some deterrent effect.

It is recommended that in future any trials of methods are tested on entire fields or field groups. Considerable difficulty was experienced during this study getting people to protect only half a field, in putting in protection down the middle, and in preventing people from protecting the control side with the protection method – particularly after damage was experienced. This caused some drop-outs and also irritated participants since they did not fully accept the rationale for dividing the fields and resented leaving half of a field vulnerable to attack. This problem might be even worse if whole fields were the unit of analysis, as then some farmers' would have all their crops in the unprotected control group. It would be preferable to use a cassette treatment as the control group for any future trial, analogous to medical trials that tend to use the best known treatment as a control, rather than a no-treatment group.

Review of management options

Although average levels of HWC in SBCA are low now, it is important to begin to develop a management strategy for two main reasons:

1. the perception of the conflict in local communities is already quite high
2. levels of conflict will increase as wildlife populations grow and become less wary of people (in particular Asian Elephants and large carnivores)

Initiating an ongoing programme to manage HWC in SBCA will provide an opportunity to 'test-manage' the problem while it is still relatively easy to do so. Co-management approaches will also be easier to develop before the two sides become polarised by HWC complaints.

Regardless of the exact nature of HWC work instigated by WCS/FA the primary objective is to raise tolerance since eliminating the problem is not feasible (Naughton-Treves 1998, Treves *et al* 2006). A co-management approach is needed, with the interventions being determined by negotiation with those affected (Treves *et al* 2006). It is also important that multiple interventions are used, as no single intervention can effectively address the problem (Treves *et al* 2006). Improving tolerance can be achieved in two main ways: reducing damage or improving people's ability to cope (Treves *et al* 2006), as discussed below.

Interventions to reduce crop damage

A common response to crop raiding by NGOs and development agencies is the provision of modern protection methods. Electric fences are a good example in Africa (e.g. Knickerbocker and Waithaka 2005). Unfortunately modern protection measures are rarely practical in rural communities even if the technology is provided due to the expense of ongoing maintenance costs (Nyhus *et al* 2000, Osborn 2002, Osborn and Parker 2002). Practitioners have instead called for improvements of existing methods to be formulated at the community level to ensure sustainable solutions are found (Osborn and Parker (2002), Osborn and Parker 2003, Treves *et al* 2006). These must be low-tech for communities to be able to utilize them (Osborn 2002, Osborn and Parker 2002). Community based solutions also encourage affected communities to take ownership of the problem, dissuading expectations that authorities will provide solutions (Osborn and Parker 2003, Sekhar 1998). Three approaches are to improve detection, to deter animals from entering fields, or to influence the siting of vulnerable land-uses.

Improving detection

Alarm systems can improve detection and have been particularly important for elephants, which often come at night and are reportedly very quiet when they enter fields (Osborn and Parker 2002). Cans, bells, and other items that make a noise when hit are rigged up as a fence, which moves and 'chimes' the alarm when an animal presses against it. This system when tested not only improved detection but the security provided by the alarm system also meant farmers were more willing to stay at their fields (Osborn and Parker 2002). In SBCA an alarm system will not assist protecting against monkeys because they will quickly learn to avoid it, but it may assist in detection of Wild Pigs and, in the future, elephants.

Coordinated field patrols also improve detection when field owners take it in turns to patrol and guard against intruding animals, particularly elephants. Patrols increase detection and spread the labour cost of guarding. Their use has been reported in places where fields are grouped together adjacent to the park edge. Patrolling is easy in this geographical situation but poses more of a problem on widely spread swidden fields, on uneven terrain with difficult access. Therefore in SBCA patrolling may have a role at the main paddy field areas or in places where extensive permanent cultivation has been established at the boundary of the reserve (e.g. O Am, O Rona and Sre Preah). Community patrols often require substantial external effort to set up and run.

<u>Improving deterrence</u>

Deterrents are either active or passive (Osborn and Parker 2003). Passive deterrents are essentially fences or other barriers that prevent animals from entering fields. Fences can offer reasonably effective protection against many animals except elephants, which can break them. Monkeys will not be deterred either as they can easily scale them. Trenches can prevent elephants (Nyhus *et al* 2000, U. Karanth pers. comm. 2006) but if the structural integrity is compromised (such as slipping banks) elephants can take advantage of this.

Another passive defence is buffer crops – species that are either less palatable or less valuable than the main crop. Because most raiding animals don't usually stray far from the forest margin, they will be less likely to penetrate far enough to damage the more valuable crops. Another method is clearing vegetation between fields and the forest margin. Fallow fields, grassy areas or the forest provide a refuge for crop-raiding animals (Nyhus *et al* 2000, Hill 2000, Naughton-Treves 1998). If these areas are cleared, animals are less inclined to expose themselves in order to raid crops. Unfortunately both of these techniques are most useful where there is 'hard edge' between the forest and fields. The additional labour that would be required to clear forest to provide a buffer (either with crops or cleared land) for chamkar in SBCA is not practical. Again, these methods may be worth investigating in the medium-term future in the buffer zone of SBCA where permanent agricultural areas have been established if raiding of cash crops becomes a serious issue.

Active deterrents scare raiding animals. In more developed countries automated systems with triggers can be used, such as fladrey (flagging) devices that have been tested to deter wolves in North America (Shivik *et al* 2003). In developing countries people will shout, throw sticks, fire guns or missiles (e.g. sling shots) and chase animals. While scaring animals is the most effective way to deter animals already in the field it can be risky. Some species (e.g. Wild Pigs, baboons and elephants) can physically threaten people and farmers do not like having to expose themselves to these situations unnecessarily (Hill 1997, Naughton-Treves 1998).

The literature contains few experimental tests of improved protection methods but work by Osborn and Parker shows some promising avenues. In addition to improving detection with the alarm system described above, they also tested passive and active elephant deterrents based on chilli peppers. Capsaicin – the 'chilli' chemical – has been used as a deterrent for a number of animal species in spray form (onto plants) to deter herbivorous pests and has also been employed as 'pepper spray' to protect against physically threatening animals including bears, dogs – and humans.

Chillies made into sprays have been found to significantly improve deterrence of elephants (Osborn 2002), and have also been added to flammable bricks to make an acrid smoke that actively deters elephants (Osborn and Parker 2002). Chilli infused greased fences (Osborn and Parker 2002) are used as a passive deterrent and chilli plants themselves can also be used as a buffer crop. As a bonus, chillies are a cash crop that can be sold. As a result of the work of Osborn and Parkers, the 'Elephant Pepper' project was established, where chilli sauce produced from chillies grown in communities associated with the project are marketed, providing an income in addition to helping protect their crops.

The labour-intensive use of 'pepper spray' as an active deterrent is currently unnecessary in the SBCA, but greased fences and/or chilli spray applied to crops bordering wildlife habitats could be a useful passive deterrent there. Chilli sprayed directly onto plants offers the only feasible protection to monkeys, which are persistent and not easily scared or deterred by other methods. Furthermore, monkeys only ever damage a few metres into a crop from the safety of the forest edge.

Some studies have cautioned that the apparent success of experimental deterrence methods may be artificial as animals may quickly habituate (Osborn 2002, Osborn and Parker 2002, Shivik *et al* 2003), and this is also a reason cited when farmers discuss the ineffectiveness of traditional methods (Nyhus *et al.* 2000, Osborn and Parker 2002). Behavioural conditioning has been suggested as a way to deal with this problem (Osborn and Parker 2002, Shivik *et al.* 2003), however this requires careful planning and execution and may difficult to implement effectively in rural communities. Therefore, management of crop raiding requires constant innovation to prevent habituation (Hoare 2001, Osborn and Parker 2002, Osborn and Parker 2003). Osborn and Parker (2003) describe it as an 'arms race' – a battle of wits.

Finally, snaring is another option that should at least be considered as a way to reduce levels of damage, given the findings of Naughton-Treves (1997) and Geisser (2004). It seems likely to be the cheapest and most effective way to keep crop-damage low from the point of view of the farmer, and also adds meat to protein-poor diets. However, the direct catch could be a significant drain on wild populations (though no figures are available to allow an estimate to be made). Furthermore, senior enforcement staff consider that the widespread legal consumption and transport of Wild Pig and Sambar meat would make it impossible to control trade, which would enable much higher levels of hunting overall (K. Rityphorn pers. comm.).

<u>Land-use planning</u>

One of the most long-lasting solutions to HWC is to locate vulnerable landuses in low risk areas. The dispersed distribution of villages and current preferred livelihood activities makes this very hard in SBCA. Land-use planning has to work on the assumption that all existing villages will remain in their current locations, because there is not sufficient land-use stability or sufficient resources to consider proposing voluntary relocation schemes. Even when communities are receptive to them, such schemes require enormous investment to achieve lasting change and to ensure that the people moving experience lasting benefits; thus they are a last resort where other solutions are not practical (e.g. World Bank 2001).

Many small villages and cultivation areas are already fixed in locations vulnerable to crop-raiding. The scattered configuration of villages and fields, in a matrix of good quality forest, also increases the risk of direct encounters with dangerous wildlife. It is important that this problem is not worsened and so the creation of new, vulnerable areas of cultivation in remote wildlife-rich habitats should be avoided. The vulnerability of existing sites could theoretically be reduced by changing the kind of crops planted, but planting decisions are primarily driven by bigger economic considerations and farmers are unlikely to change their planting decisions as a result of small crop-raiding problems. The current trend towards cashew (which is less vulnerable) may reduce the problem somewhat, but vulnerable cash crops (cassava, soy) are also being adopted. The configuration of fields could also be improved (by grouping them together to reduce the length of vulnerable edge) but this may conflict with the need to plant on good soils and to keep plot size small to help rapid fallow regeneration.

Land-use planning will be most important in areas of growing conflict with elephants.

Interventions to improve tolerance of crop damage

Altering perceptions of the severity of damage

Crop-raiding appears from outside to have relatively small impacts but village perceptions are of a very large problem. It may be possible over time to encourage villagers to alter these perceptions. One part of this would be to involve community members in the analysis of crop-raiding measurements in future monitoring studies. If problems of low numeracy could be overcome, this might shift perceptions of the scale of direct losses that are occurring. However, there are a number of other factors influencing perceptions and theseneed to be fully understood before an effective approach can be designed.

Compensation

Compensation is frequently called upon as a means to address the problem of HWC (see Naughton-Treves 1998, Nyhus *et al* 2000, Rao *et al* 2002, Newmark *et al* 1994, Sifuna 2005). The rationale for compensation is that those affected by crop damage and livestock depredation bear an inequitable cost living close to protected areas and wildlife. Compensation decreases this cost, which is necessary because it is socially just and is a means to improving conservation effectiveness by improving attitudes.

Despite the popularity of the concept, there is little empirical evidence examining its effectiveness (Nyhus *et al* 2005). A review of compensation schemes for elephant damage in Africa (Human-Elephant Conflict Working Group undated) found most were ineffective, poorly administered and vulnerable to corruption. Payments were often low and made months or years after claims lodged, resulting in locals being antagonized rather than appeased by the system. Similar problems have been noted in India (Sekhar 1998, Mudhusudan 2003, U. Karanth pers. comm. 2006). Similar concerns were outlined in a survey of international experts on the issue (Nyhus *et al* 2003, Nyhus *et al* 2005). Schemes evolved at the community level that address site-specific issues appear more likely to succeed than more formalized, centrally-run systems, but the same risks exist.

There are also fundamental economic questions about compensation schemes (based on Nyhus *et al* 2005).

1. Compensation schemes can indirectly act as an agricultural subsidy, encouraging land conversion, may stimulate further immigration, and do not reduce the incentive to increase extraction of natural resources as payments are not tied to behavioural change (Rondeau and Bulte 2003, Bulte and Rondeau 2005).
2. There is a 'moral hazard' in providing compensation because the incentive to protect is removed.
3. Social problems can arise when payments are made in cash, with money being used for other purposes (such as gambling) (Nyhus *et al.* 2005).

The first two problems are more likely to be associated with large, provincial or state run programmes. However, there is promise in compensation schemes operated at the community level with a carefully planned payment and incentive structure (Nyhus *et al* 2005), such as those outlined by Mishra *et al* (2003) for Project Snow Leopard. Incentive programmes encourage behavioural changes and increase tolerance, and have achieved positive results in reducing poaching, killing or antagonism of snow leopards in India and Mongolia. By including incentives to reduce moral hazard and to encourage conservation friendly behaviour they have bridged the gap between a more traditional compensation scheme and direct payments, addressing several of the criticisms leveled at compensation schemes by proponents of direct payments.

A general description of a compensation scheme for pig and monkey damage to subsistence crops that would be appropriate for SBCA is outlined in Annex 8. If implemented, it should begin experimentally in a single village, probably Andoung Kraloeng. Annual compensation payouts would be around $100, but there would also be substantial external management costs.

Compensation for damage by elephants is potentially more costly as they do more damage, and the damage is also likely to cause more animosity towards the project so it will be more important to find a solution. Compensation is not appropriate now given the very sporadic nature of damage, but is one option for the longer term, if problems worsen. Compensation for livestock depredation would also be significantly more costly. The value of one lost cow would exceed the total estimated value of rice losses in Andoung Kraloeng in the 2005-06 season[11]. This, and the fact that carcasses quickly vanish (making claims difficult to validate), causes such schemes to be much more vulnerable to corruption and excessive bureaucracy (U. Karanth pers. comm.).

An alternative to providing compensation is initiating a self-insurance scheme. When carefully planned, with affordable premiums, self-insurance can be an attractive alternative as the community can take control of managing the issue, and have an increased incentive to enforce qualifying rules (such as minimum field protection standards). The downside is that they may resent using their own money. Some matching financial contribution by the project is thus necessary, as an act of goodwill, as a financial buffer and to cover community administrative costs. The system described in Annex 8 could be adapted to fit this approach. However, it should be noted that the zero-interest reciprocal lending practices within Phnong villages are effectively a self-insurance scheme themselves. Systems introduced from outside may run much less well and may even undermine the existing system.

Comparison of management options for crop damage

The projected direct costs of selected options to manage Wild Pig and monkey damage vary widely (Table X). We have assumed that field ownership is the same as Andoung Kraloeng (1.05 fields overall) and that average rates of damage to rainfed lowland rice fields and swidden elsewhere are similar to swidden losses in Andoung Kraloeng. Thus, the table only gives a rough indication of the relative cost of different management options. The cost of WCS/FA's contribution to a self-insurance fund would be about the same as the cost of compensation (assuming a 1:1 match). Cost for protecting with oil and cassette has been calculated based on protecting only two sides of a field (cassette $4.5[12] per chamkar or oil $7[13]). This is based on the rationale that only exposed sides (adjacent to the forest) will be protected and that two sides is a reasonable average value.

[11] One adult cow is worth approximately $100. One adult buffalo is worth $200-250.

[12] One cassette costs 2000 riel and contains 60m of tape. The average field perimeter is 374m. Therefore a three strand fence will cost approximately $9 per chamkar for four sides or $4.5 for two sides.

[13] One field is estimated to need 45L of waste oil, at a cost of 1000 riel per litre, plus rags estimated at $3 cost = approximately $14 all around a field or $7 for two protected sides.

Table 30. Estimates of Cost for Crop Damage Mitigation Management Options

Inputs	*No. Households*	*Rice Compensation*	*Buy Cassette (50%) subsidy*	*Providing Cassette*	*Providing Oil*
Management inputs		Medium-high, reducing once established?	Medium	Low	Low
Cash inputs					
Phum Andoung Kraloeng	78	81.2	184.5	369	574
SBCA excl. O Am[1]	1100	1155	2599	5198	8085
SBCA incl. O Am	1600	1680	3780	7560	11760

[1]O Am is treated separately from the other settlements as it has a different farming system and many families farm outside the SBCA boundary.

Paying compensation has the lowest direct costs. Paying for protection with oil is the most expensive option followed by provision of cassette. However, a compensation scheme would probably have higher management costs due to the many meetings required.

Table 31 summarises the strengths and weaknesses of the various management alternatives. Oil is excluded due to its high cost and questionable effectiveness. Land-use planning is excluded as it operates on a different scale to these other interventions – it is indispensable in avoiding the creation of future problems but will have little impact in existing problem areas. Note that there is no comparative information available on the most important variable of all – the extent to which a given approach will improve or worsen attitudes towards the conservation area. Different methods need to be tried on-site and their success monitored.

Legalised snaring around fields could be a zero-cost and effective approach at preventing the damage, but it could depress populations of key species, is considered unmanageable by many field staff and appears to be legally impossible, at least at present. It is probably not a viable option in Cambodia at present. Leaving snaring aside, a combination of three methods seems to have some promise:

(i) altering perceptions of severity by participatory measurement and analysis
(ii) assistance with the testing and provision of novel deterrent methods
(iii) setting up small locally administered compensation funds.

These can be introduced separately and any one alone may be sufficient but it is more likely that a combination will be most effective, for the following reasons:

1. Altering perceptions without providing any material assistance might leave communities feeling short-changed.
2. Encouraging deterrents that are only partially successful will mean that some damage continues.
3. Providing compensation without promoting damage-reduction methods may signal that all responsibility to minimise risks from wildlife lies with the conservation authorities, so encouraging risky behaviour.

Table 31. Strengths and Weaknesses of Mitigation Options

	1. Doing nothing	
Mitigation Technique	*Strengths*	*Weaknesses*
None	• No cost, no management inputs	• Increasing resentment towards conservation area • Disappointment in A. Kraloeng • Conservation cost borne by poor • Retaliatory killing of key species
	2. Reducing Damage	
Mitigation Technique	*Strengths*	*Weaknesses*
Chillies, Alarm system or other low-tech options	• Low-tech materials can easily be found • People can easily understand and use the techniques • Community integral to development of techniques • Possible better attitudes	• Can lose effectiveness quickly due to habituation • Effectiveness untested. • Depends on people's willingness to invest labour • Incomplete protection - some resentment continues • Significant management inputs
Cassette provided by WCS/FA	• Believed to be effective by villagers, although scientific evidence inconclusive • People understand the method • Relatively easy to administer in village • Expected better attitudes	• Depends on people's willingness to invest labour • Habituation occurs • May be ineffective vs monkeys • Environmental pollution from cassette strands • Requires WCS/FA as distributor • May be difficult to source cassette in future as is becomes obsolete • Incomplete protection - some resentment continues • Cost and management inputs
Allow limited snaring (field edges only)	• Conceptually simple • Meat benefits villagers – likely to outweigh resentment over any continued damage • Wildlife learns to avoid villages • No cost to project, small cost to families, delivery does not depend on organised system • Expected improvement in attitudes	• Law is ambiguous and may forbid snaring completely • Legal snare ownership = harder to prevent snaring in the forest? • May be difficult to monitor • Animals may not be caught by the families that suffer the serious damage (although likely to be shared) • Possible impact on key prey populations (data required) • Risk of bycatch/injury including carnivores?
	3. Improving Tolerance	
Cassette subsidy (additional points to those made above)	• Expected better attitudes • Some onus on the community = more equitable partnership	• Potentially result in negative attitudes because of the necessity to contribute financially • Cost still significant, and need to manage payments
Compensation	• Expected better attitudes • Can link to positive behaviours (e.g. minimum guard effort) • Potential to develop a linked direct payment system • Fairly low cost • Surpluses/savings spent on village development	• Potential for corruption • Significant management inputs, potential for disputes • Direct costs *may* become excessive in future • Heightened expectations risk disappointment
Self-insurance	• Expected better attitudes • Community contributions increase ownership of issue and fund • Surpluses/savings spent on village development	• Relies on widespread participation • Potential for corruption • Significant management inputs, potential for disputes • Direct costs *may* become excessive in future • Potentially result in negative attitudes because of the necessity to contribute financially • High expectations/disappointment • Potential conflict with traditional mutual self-help systems

Protecting against livestock depredation and human Injury

Methods to protect against depredation are easier to identify. Depredation tends to occur in areas where livestock are either free to graze within reserves (Karanth and Gopal 2005), or where pastures abut a conservation area (Butler 2000). Low numbers of natural prey can also contribute to depredation rates (Mishra 1997). More seriously, incidents where humans are killed typically occur in habitats suitable for the animal but where human density is high (Karanath and Gopal 2005, Nyhus and Tilson 2004a & b). Nyhus and Tilson (2004) highlighted this as a planning challenge for multi-use areas within a PA.

Controlling depredation is relatively straightforward compared to crop-raiding. Corralling livestock during the night helps to prevent carnivore attacks (Butler 2000, Jackson and Wangchuk 2001). Encouraging corralling will be one measure to mitigate this problem, although how receptive people would be to this is unclear given it is not currently practiced, there are labour costs, and there is a low risk of losses occurring. The other key approach will be to keep livestock out of high risk areas, most notably remote dry season pastures in the Core Area. It will be necessary to find acceptable alternatives or compensation when phasing out this activity.

Of even greater concern is the threat to human life. As Nyhus and Tilson (2004a & b) identified, having areas where humans and tigers overlap increases the risk of human deaths. The extensive resin tapping and fishing that occur across the SBCA landscape therefore increase the risk of a fatality. Given the conservation status of tigers, resentment towards this species can be ill-afforded, but preventing people entering the forest to tap resin is also undesirable given its livelihood importance. However, most tapping communities express a hope that they will find easier ways to make a living. Current hopes are centered on cash crop farming. To the extent that this transition occurs, the risk of injury to resin-tappers may decline naturally over time. Whilst people continue to use the forest extensively, compensating victim's families is one of the only responses that could be used, and should therefore be considered when the threat increases. The same applies for deaths as a result of conflict with elephants.

Recommendations

Development of an HWC management system

1. Land-use planning activities should aim to minimise the risks of HWC wherever possible. Planning should take into account an expected increase in numbers of wildlife species prone to conflict.

2. A specific HWC management system is needed but it should be developed slowly and cautiously, to avoid raising expectations in local communities. New approaches should be trialed only in villages with excellent community-WCS/FA relations – currently this means Andoung Kraloeng, and before long probably also O Rona.

3. During the 2006-7 harvest season, cassette fences should be provided to anyone who wants to use them in Andoung Kraloeng. Given that a disastrous harvest is expected due to disease, it may be best to make the tape free rather than seeking partial cost-recovery this year[14]. The levels of

[14] Due to delays in publishing this report, this recommendation has already been carried out. Most fields failed almost completely due to pest problems and less than 30% of families chose to use any protection. Results were not monitored since overall yields were so low and most fields were abandoned before harvest.

adoption and the levels of crop damage should be systematically monitored. Villagers should be extensively involved in the basic data analysis to help alter perceptions of the scale of damage that is occurring.

4. A small-scale compensation or self-insurance scheme should be tested in 2007-8 or 2008-9, in Andoung Kraloeng and/or O Rona, based on the design in Annex 8. The impacts and resulting attitudes should be monitored.

5. New non-lethal deterrent methods should continue to be trialed as a supplementary tool. Initial tests should be on a small scale (perhaps 3-10 interested families), ideally in areas with a history of serious attacks. Alarm fences may be the next idea to test, starting in the 2007-8 harvest season. Use of chillis in spray or fence form could also be explored.

6. If losses of large livestock become more serious a management response will be needed. This should include measures to keep livestock out of high risk areas, an assessment of improved husbandry options and, if unavoidable, consideration of a compensation scheme.

7. WCS and the FA should be prepared for the possibility that a human death will occur from HWC, so they can respond sensitively and in a timely manner.

8. No restrictions should be placed on the taking of dogs into the Core Area until the potential dangers to humans from unexpectedly meeting a dangerous animal have been considered.

9. If the planned Education, Information and Communications team is set up, they should have a clear role in the management of attitudes towards HWC.

Further research

Further research or development of monitoring systems are required in the following areas:

1. ***Conflict with elephants and large carnivores.***
    a. The simple landscape-wide survey should be repeated every 1-2 years, in conjunction with the demographic survey.
    b. Selected reported cases should be followed up to characterise the type and severity of conflicts.
    c. A more systematic and detailed monitoring system should be set up across the Core Area, based on soliciting incident reports from focal persons in key villages, covering all kinds of conflict.
    d. A preliminary study should be done to describe and map the way large livestock are pastured in the Core Area of the SBCA.

Care should be taken not to raise community expectations about compensation or other follow up from these activities.

2. ***Levels of damage in cash crops and rice paddy settings.*** These should be investigated in more detail in a few typical villages using the same or similar damage notification and reporting system as used in the Andoung Kraloeng study described here.

3. ***Conflict caused by peafowl and Eld's Deer.*** Targeted research in villages reporting problems with these two species would be useful to determine levels of damage they are causing and levels of retaliatory killing, if any.

4. ***Long-term trends in damage by Wild Pigs and monkeys.*** If incidental reports suggest a worsening situation, consider setting up a regular damage monitoring

system to help discern any trends in the levels and patterns of damage. Serious damage incidents would need to be recorded across a large number of households to provide enough records to be meaningful, but minor damage could be recorded in a sub-sample of these. Regular village visits (weekly) to obtain notifications of damage, followed up using the same damage report procedure used in the current study. This level of investment might be merited only once every 2-3 years.

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ANNEX 1 . OVERALL CROP RANKING ACROSS ALL FOCUS GROUPS

Overall Rank	Crop	No. Villages	Average	Village Beng	Gati	O Am	O Rona	O Tron	Pu Chu Kraom	Pu Chu Leu	Pu Clair	Pu Haim	Pu Poanh	Rokathmei	Sre Lvi	Sre Preah
1	Rice	13	1.0	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Corn	13	2.4	2	2	2	2	2	4	2	2	3	2	3	2	3
3	Cassava	13	2.9	3	3	4	3	3	2	3	3	2	3	2	3	4
4	Banana	13	4.8	4	4	7	6	4	5	5	5	4	5	4	4	5
5	Yam	6	6.7	9	9	9	4	9	3	4	4	5	4	9	9	9
6	Cashew	6	6.8	5	9	3	5	5	9	9	9	9	9	9	5	2
7	Pumpkin	13	7.3	6	9	9	9	6	7	6	7	7	7	6	7	9
8	Pineapple	12	7.6	8	8	9	8	8	6	8	6	9	6	9	6	8
9	Soy	4	8.2	9	6	5	9	9	9	9	9	9	9	9	9	6
10	Waxed Gourd	9	8.4	7	9	8	9	7	9	9	9	8	9	8	8	9
11	Sesame	3	8.5	9	7	6	9	9	9	9	9	9	9	9	9	7
12 =	Egg Plant	8	8.7	9	9	9	9	9	9	9	9	9	9	5	9	9
12 =	Mango	1	8.7	9	5	9	9	9	9	9	9	9	9	9	9	9
13 =	Taro	1	8.8	9	9	9	9	9	9	9	9	6	9	9	9	9
13 =	Bean	2	8.8	9	9	9	9	9	9	9	8	9	8	9	9	9
13 =	Jackfruit	2	8.8	9	9	9	7	9	9	9	9	9	9	9	9	9
13 =	Papaya	7	8.8	9	9	9	9	9	9	9	9	9	9	7	9	9
13 =	Water melon	1	8.8	9	9	9	9	9	9	7	9	9	9	9	9	9
14	Cucumber	4	8.9	9	9	9	9	9	8	9	9	9	9	9	9	9
15 =	Chilli	3	9.0	9	9	9	9	9	9	9	9	9	9	9	9	9
15 =	Sponge Gourd	3	9.0	9	9	9	9	9	9	9	9	9	9	9	9	9
15 =	Sugar Cane	1	9.0	9	9	9	9	9	9	9	9	9	9	9	9	9

Excludes Trapeang Ronheav

ANNEX 2 VERTEBRATE TAXA REPORTED AS PESTS

Locally used taxon	Likely species included
Bat	Megachiroptera
Civet	*Viverra*, *Viverricula*, others?
Dove	*Streptopelia* and others?
Elephant	*Elephas maximus*
Flying Squirrel	*Petaurista* or *Hylopetes*?
Green Peafowl	*Pavo muticus*
Macaque	*Macaca* spp (mostly *fascicularis* and *nemestrina*?)
Parakeet	*Psittacula* (four species)
Porcupine	*Hystrix brachyura* (but not *Atherurus*)
Rat	?
Red Junglefowl	*Gallus gallus*
Red Muntjac	*Muntiacus muntjak*
Sambar	*Cervus unicolor*
Loris	*Nycticebus* spp?
Sparrow	*Lonchura* and others?
Squirrel	*Callosciurus*?
Wild Pig	*Sus scrofa*

ANNEX 3 PEST RANKS FOR EACH CROP

3a Ranking Frequency of Pest Animals for All Crops

	Rank												
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Wild Pig	41	31	9	5	3	2	1	1					
Porcupine	34	22	9	6	6	3		1		1		1	
Macaque	15	25	10	9	4	7	1		1				
Civet	10	10	2	1	1			1	1			1	1
Rat	6	10	40	20	8	4	8						
Squirrel	7	7	12	22	15	9	2	1	2				
Dom. Livestock	3	3	12	8	11	11	9	5	2	2	1		
Parakeet	4	4	2	3	6	5	3	1					
Dove	2	2	2	2	1	1	3	1	1	1			
Sparrow	3				3	1	1	5			1		
Bat	2	1											
Red Muntjac	2	1						1		1			
Green Peafowl	1	1	1	1	1	1	1	1					
Dom. Pig		1	6	13	13	7	8	3	4	2	1		
Red Junglefowl		1	1		2	4	2	4	2	1			
Sambar		1	1	1	2	2	2	4	3	2	1		
Elephant		1		1	3	2	1	1	1				
Loris			2			1	1						
Flying Squirrel				2									

3b Frequency of Animal Ranking for Rice

	Rank												
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Wild Pig	11	2			1								
Parakeet	2		2	2	3	1	2						
Macaque	1	10	2			1							
Rat		1	7	4		1	1						
Green Peafowl		1	1	1	1	1	1						
Squirrel			1	4	2	2	2		1				
Dom. Livestock			1		1		1	3	2	1	1		
Porcupine				2		1				1		1	
Dove				1	1	1	3	1	1	1			
Red Junglefowl					2	4	2	3	1	1			
Sparrow					3	1	1	5			1		
Domestic Pig						1	1	1	4	2			
Elephant								1	1				
Sambar									1	2	1		
Domestic Chicken										1			
Civet												1	1

3c Frequency of Animal Ranking for Corn

	Rank										
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Macaque	7	4	1		1						
Wild Pig	6	6				1					
Rat	1	1	1	6	1	1	2				
Squirrel		1	5	1	5						
Porcupine		1	3	3	4	1					
Parakeet		1		1	2	3		1			
Dom. Livestock			1		1	2	2	2		1	
Domestic Pig				2		3	2				1
Red Junglefowl			1						1		
Dove				1							
Elephant							1				
Sambar								1	1		
Civet								1			
Green Peafowl								1			

3d Frequency of Animal Ranking for Cassava

	Rank								
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Porcupine	6	7							
Wild Pig	6	7	1						
Rat	1		11	1					
Domestic Pig			1	2	4		1		
Parakeet	1								
Dove			1						
Squirrel				6					1
Dom. Livestock				3	4	3			
Macaque				1		2			
Elephant					1				
Sambar						1	2		
Red Muntjac								1	

3e Frequency of Animal Ranking for Banana

	Rank							
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Civet	7	5		1				
Wild Pig	3	2	4	1		1	1	
Dom. Livestock	2		1		2	2	3	
Macaque	1	3	2	4	2			
Porcupine		1	3					1
Squirrel		1	1	1	5	3		1
Rat			1	3	2	1	2	
Bat	1	1						
Domestic Pig				1	1	2	2	1
Sambar			1					
Flying Squirrel				1				
Loris						1	1	
Elephant						1		

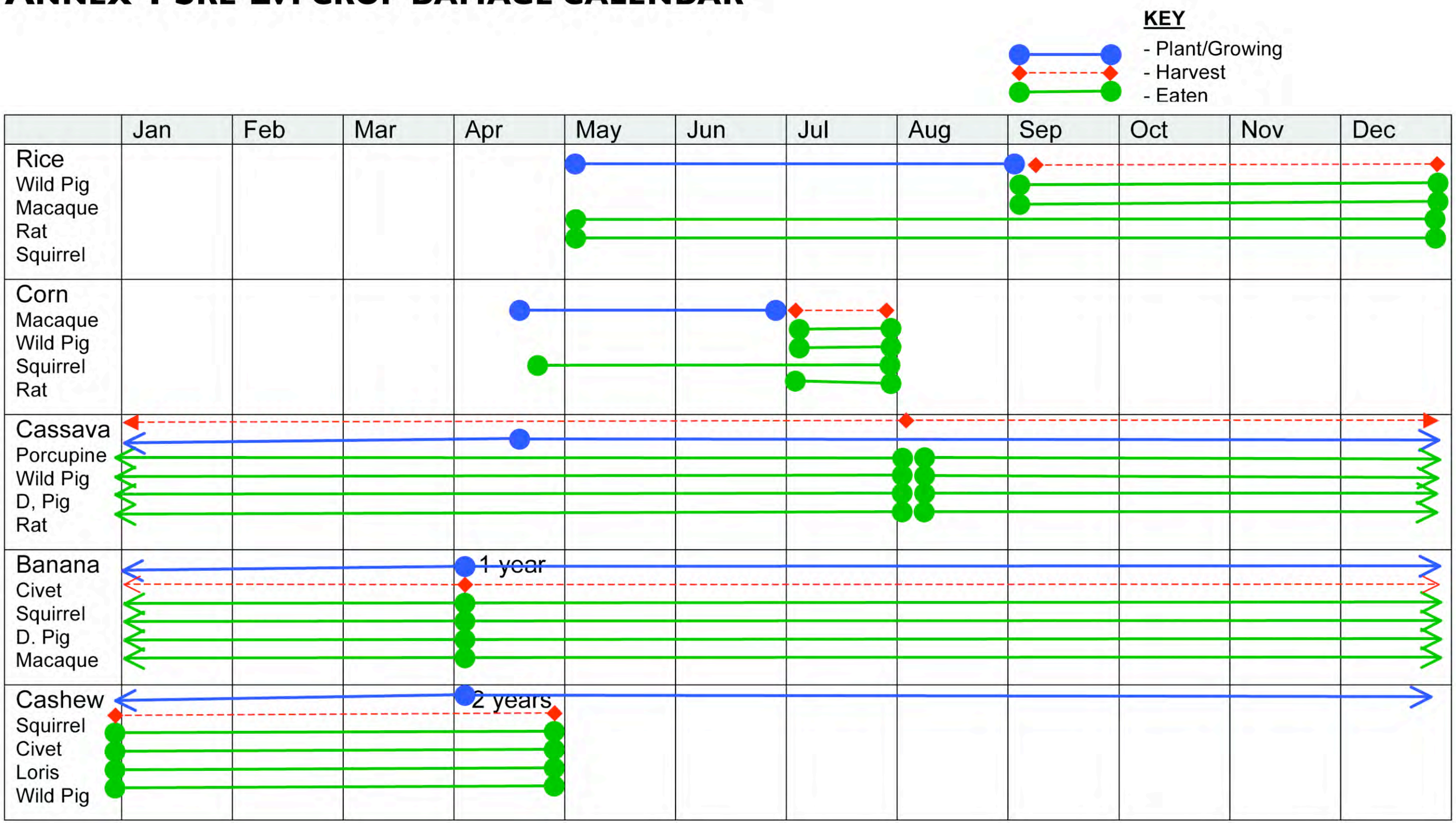
3f Frequency of Animal Ranking for Yam

	Rank							
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Wild Pig	5		1					
Rat	1	1	4					
Porcupine		5		1				
Domestic Pig			1		1		1	
Dom. Livestock				2	2	2		
Squirrel				3		1		
Elephant					1			
Macaque							1	
Sambar								1

3g Frequency of Animal Ranking for Cashew

	Rank									
Animal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Squirrel	6	1								
Civet		3	1						1	
Wild Pig		1		2	1					
Macaque			3	1						
Dom. Livestock	1			1						
Parakeet		1			1	1				
Rat		1			1		1			
Domestic Pig				1	2		1			
Loris			2							
Porcupine			1			1				
Flying Squirrel				1						
Sambar								1		
Red Muntjac										1

Annex 4 Sre Lvi crop damage calendar



ANNEX 5. TRADITIONAL PROTECTION METHODS REPORTED

		Protection Method					
Village	*Rank*	*Sleep*	*Snare*	*Ompo*	*Scarecrow*	*Fence*	*Other*
Andoung Kraloeng	*1st*	69	23	-	8	-	-
n = 13	*2nd*	15	15	39	-	-	-
	3rd	8	8	15	15	-	15
	4th	-	8	8	8	8	-
PC	*1st*	25	25	-	-	25	25
n = 4	*2nd*	50	-	25	25	-	-
	3rd	25	25	-	-	-	-
	4th	-	-	-	25	-	-
PCK	*1st*	30	10	-	-	20	40
n = 20	*2nd*	35	5	20	-	-	39
	3rd	25	5	30	10	-	-
	4th	-	10	15	20	-	-
PCL	*1st*	62	23	-	8	-	-
n = 13	*2nd*	8	8	23	-	8	23
	3rd	-	8	-	8	-	8
	4th	-	15	-	-	-	8
PP	*1st*	-	13	-	-	13 (38 Bark)	25
n = 7	*2nd*	25	-	-	13	13	38
	3rd	38	-	13	25	-	-
	4th	25	-	-	25	-	13

% of families reporting use of method

ANNEX 6. ANIMALS RESPONSIBLE FOR CROP DAMAGE 2005-06

Rank	*Rat*	*Squirrel*	*Wild Pig*	*Red Junglefowl*	*Monkey*	*dauhen*	*Dove*	*Porcupine*	*Green Peafowl*	*Bird*	*Parakeet*
1st	7	4	34	1	12	3		2	1	1	
2nd	15	12	1	10	15	1	3	5	1		
3rd	13	19	1	16	3	3	2	1		1	
4th	17	10		5		5	6	1	1		
5th	4	4		4		7	5		1		1
Total	56	49	36	36	30	19	16	9	4	2	1

ANNEX 7. ANIMALS RESPONSIBLE FOR CROP DAMAGE 2004-05

Rank	*Rat*	*Wild Pig*	*Squirrel*	*Red Junglefowl*	*Dove*	*Monkey*	*Dauhen*	*Porcupine*	*Green Peafowl*	*Bird*
1st	2	29			2	3				
2nd	10	4	9	6		6		4	1	1
3rd	17		9	7			1	2		
4th	3		7	4	5		5	1	1	
5th	4		4	3	3		2		1	
Total	36	33	29	20	10	9	8	7	3	1

ANNEX 8. OUTLINE OF A COMPENSATION SCHEME

Small community-administered compensation funds are set up. The appropriate level is probably the individual krom, a group of 10-30 households living and farming in the same area. This is the traditional level at which most community structures function in Phnong villages (e.g. Degen *et al.* 2005).

A group of representatives within the krom is selected at the start of the season to manage the fund. At this time the community sets the process for making claims, the verification process and the release of compensation. The community may choose to measure the damage or simply estimate it by eye. The community should also identify what currency is used for payments – cash or rice. Rules for qualifying for a claim (e.g. having minimum field protection standards in use) should also be set. Use of residual funds at the end of the season would need to be discussed and agreed by the community.

The size of the fund is based on the expected average damage level and the number of families in the group. It is set at the start of the season, but can be increased if unexpectedly severe damage occurs. The fund size should be publicly disclosed at the start of the season, and the disbursements and closing fund size should be disclosed at the end. In the first year the community may need to be assisted with making measurements, to help convince them that the size of the fund is sufficient for the cash value of the damage that occurs.

Regular monitoring by WCS/FA is essential to prevent corruption or nepotism. This may include participating in some field visits for serious damage and surveying community attitudes after each harvest to help identify any grievances. Tagging compensation to minimum levels of protection will help prevent exploitation of the system, as it prevents 'lazy' people claiming compensation. This can be monitored by the community themselves, because they have a vested interest in ensuring payouts are not excessive - remaining funds are available for their own compensation or for community development. Finally, the ability of WCS/FA to withdraw funding should also help to minimize abuse of the system.

The system outlined above relies heavily on community management. This was the preference expressed during post-harvest village meetings, while reducing demands on WCS/FA.

Clearly, there is no difference in cost between providing compensation or contributing to an insurance scheme, the main difference is the incentive structure. However, it is worth noting here that contributions by community members to a self-insurance fund would be best made in cash. During pre-trial meetings it became clear that contributions by families in rice can be complex. A standardized cost in riel is transparent.