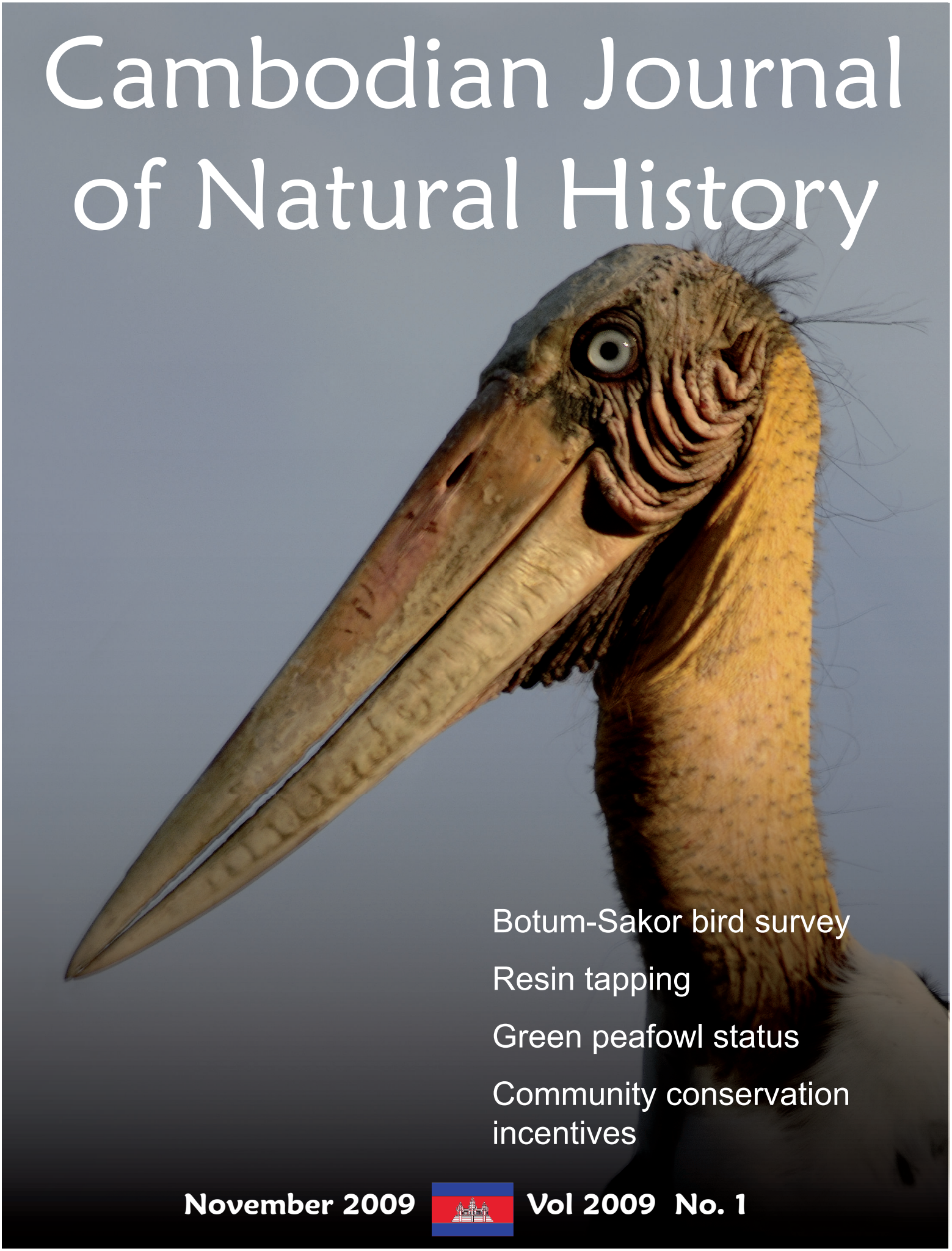
Cambodian Journal of Natural History



Botum-Sakor bird survey

Resin tapping

Green peafowl status

Community conservation incentives

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Cover photo: (© J Holden) The lesser adjutant *Leptoptilos javanicus* typically inhabits mangroves and small wetlands within dry forest (see Royan, this volume). It has a large distribution range throughout South and Southeast Asia, but has become scarce in many areas due to hunting, destruction of wetlands and the loss of big trees suitable for nesting. Cambodia now holds one of the largest populations, with an estimated 1,870 pairs. This is a globally threatened species, listed as Vulnerable by BirdLife International and IUCN.

Guest Editorial - Lessons learnt in establishing a Masters Programme in Biodiversity Conservation at the Royal University of Phnom Penh

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Cambodia is one of the richest countries in the region in terms of its biodiversity (MoE, 2004). More than 30 years of civil war, however, meant that baseline surveys of Cambodia's biodiversity did not begin in earnest until 1997 and, therefore, most plants and wild animal species are not well understood or documented (Daltry, 2008). Increasingly, Cambodia's natural resources are being destroyed by both internal and external forces, which is resulting in plants and wild animals becoming rare and threatened with extinction (MoE, 2004).

Cambodia suffers from a lack of skilled human resources to manage and conserve biodiversity in a more sustainable manner. More qualified Cambodian managers, planners and researchers are considered indispensable. In response to this need, the Royal University of Phnom Penh (RUPP), in conjunction with Fauna & Flora International (FFI), decided to establish a Masters of Science programme in Biodiversity Conservation in 2005. The MSc course covers a wide range of subjects including *Integrated Natural Resources Management, Research Analysis, Environmental Impact Assessment and Environmental Law, Project Cycle Management, Protected Areas Management, Data Presentation and Scientific Report Writing, Species Conservation, Research Methods and Applied Statistics, Geographical Information Systems*, and *Ecological Field Techniques*.

Since 2005, 120 students have enrolled in this programme, including staff from the government agencies, NGOs and private sector. The students have found this programme to be very useful, and have especially benefited from the diverse experience and perspectives of the international professors who deliver many of the lectures. By applying very strict grading and examination rules and regulations, the students have learned to work hard and become more proficient in self-study and practical research. Consequently, this programme has produced high quality students who have quickly found good jobs with higher salaries or gained promotion within their institutions. Some of our students have won scholarships to pursue their further studies abroad.

Even though our programme has had many indications of success, however, it has faced some challenges. The first is that some of our students have low proficiency in English and therefore struggle with lectures and reading materials in this language. The second challenge is that the majority of modules are taught by international lecturers who are not permanently based in Cambodia, which gives students fewer opportunities to benefit from their ongoing instruction and one-to-one mentoring. The shortage of qualified people in Cambodia can also make it difficult to find external supervisors to assist the students with their thesis projects. Finally, most students have other work to attend to and therefore have limited time to study. Consequently, some students fail their examinations and assignments, and it can take them longer than the intended two years to gain their degrees.

To overcome some of these challenges, Dr Neil Furey was appointed as Head of Academic Development in 2009 to work permanently with the programme. This has helped the programme to run more smoothly because Dr Furey can give additional mentoring and tuition to students while

they conduct their course assignments and thesis research. Another important strategy is to gradually transfer teaching duties to Cambodian nationals as more suitably qualified people become available. The immediate benefits of doing this will be to further increase the frequency of personal tutorials for students, to enable more lectures to be delivered in Khmer language, and to make the programme more sustainable.

We hope this course will continue forever and that the Centre for Biodiversity Conservation will become a research centre of excellence. We are now establishing an applied research programme to assist graduate students to pursue doctoral studies on biodiversity conservation themes in Cambodia. Alongside this, scholarships are being made available to assist good students from disadvantaged backgrounds to enrol on the Masters programme.

In my opinion, the Masters course is having a positive impact within the RUPP itself because graduate students can demonstrate the capacity to conduct research independently, offer lectures, and supervise graduate and undergraduate students in both the Department of Environmental Science and Department of Biology. This "multiplier effect" will enable even more Cambodians to understand and care for our natural heritage.

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Editor's note:- Rath Sethik and some of the recent graduates from this programme can be seen in Fig. 1 below, and the abstracts from several recent Masters theses can be found on pages 58 to 62. In addition, graduate Oum Sony is the lead author of a full paper on pages 40-57, which was based on his MSc research thesis.

Fig. 1 Rath Sethik (far right) and Callum McCulloch with MSc graduates in 2009 (© J. Holden, FFI-RUPP).

Progress in breaking the link between narcotics crime and rainforest loss in Cambodia

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One of the least publicised causes of rainforest destruction in recent years has been the production of amphetamine-type stimulants, including methylenedioxymethamphetamine (MDMA), commonly known as ecstasy. An important precursor of MDMA is safrole oil, refined from sassafras oil from the lower trunk and roots of various trees, including the Lauraceae genera *Ocotea* and *Cinnamomum*.

In the densely forested Cardamom Mountains, Southwest Cambodia, Fauna & Flora International (FFI) staff observed a dramatic escalation in sassafras oil production around 2004, soon after stricter controls had been placed on this industry in neighbouring Vietnam. Sassafras is illegally refined in Cambodia from the uncommon 'mreah prew phnom' tree, tentatively identified by local biologists as the Data Deficient *Cinnamomum parthenoxylon*. The trees are felled and their roots cut into pieces and boiled in huge cauldrons over wood fires for five-to-eight days. The distillation process consumes an enormous quantity of other trees for fuel, and the factory waste is typically discarded into streams, causing severe pollution. It takes an estimated 100 kg of oil-rich material to produce 1 kg of safrole.

The oil is carried out of the jungle in 35-litre containers by local labourers, earning a monthly wage of around $ 25, before being smuggled to Vietnam, China or Thailand, where it fetches upwards of US$ 1,725 per litre, according to research by the FFI team in Cambodia. In 2005, the United Nations Office on Drugs and Crime sent a mission to Cambodia to investigate the source of a large quantity of oil found in Vietnam. They reported that international efforts to track and control the production of ecstasy were complicated by the fact that safrole has other, legitimate uses, including the production of degreasants, tooth paste and paints. The felling and processing of mreah prew phnom trees, however, is unequivocally illegal in Cambodia.

Besides mreah prew phnom trees, the Cardamom Mountins support an exceptionally rich biodiversity, with many endemic animals and plants and well over 60 globally threatened species. Nearly 30,000 people live in and around the mountains, including indigenous forest-based minorities. Considerable efforts have been made to close the illegal distilleries that threaten these forests and hence these communities. In Phnom Samkos Wildlife Sanctuary, for example, FFI supports 49 locally-recruited Ministry of Environment rangers who has successfully raided dozens of distilleries over the past four years, and destroyed or confiscated many tens of tonnes of safrole oil and the equipment to produce it. The distilleries are usually guarded by men armed with AK47 assault rifles and some are booby-trapped with antipersonnel mines.

Local people frequently come forward to report these and other threats to the forests they depend upon. Villagers in O'Som Commune, in the Central Cardamom Mountains, for example, earn most of their annual income from harvesting wild cardamoms (*Amomum krevanh*), and consider virgin mreah prew phnom forests to provide the optimal conditions for cardamoms to grow. In 2006, the villagers alerted FFI to the presence of 16 Vietnamese-owned sassafras distilleries in and around their 11,000-hectare 'cardamom forest', where cutting

trees is forbidden. FFI responded by organising a successful joint operation in collaboration with Conservation International, Ministry of Environment, Forestry Administration, Military Police and Royal Cambodian Armed Forces to close the distilleries and arrest the owners.

On 20 June 2008, 33 tonnes of sassafras oil were burned in Cambodia at a public ceremony organized by the Cambodian Ministry of Interior, the National Authority for Combating Drugs in Cambodia and the Australian Federal Police (AFP). Although this was only part of the oil seized and destroyed in recent years, the AFP Border and International unit calculated that it could have produced 245 million ecstasy tablets, with a street value of over US$ 7 billion. Even in their raw form, the 33 tonnes would have fetched over $ 69 million in Thailand.

The enforcement operations appear to have been highly effective to date. While there were an estimated 75 active distilleries in the western Cardamom Mountains in 2006, aerial searches in late 2007 and 2008 found none. Given the exceptionally high value of safrole, however, this highly destructive industry could re-appear at any time, and Cambodia's rangers are few in number and often underpaid.

Consequently, even though the sassafras industry is just one of many crimes that rangers must address, we hope that organisations concerned with halting the narcotics trade will consider contributing financial or technical support to continue their vital role to protect Cambodia's forests.

Fig. 1 (left) A ranger destroys a giant sassafras cauldron in the Cardamom Mountains (© David Bradfield); (right) Thorn Kim Hong and David Bradfield attend a ceremonial burning of sassafras oil.

The status and distribution of green peafowl *Pavo muticus* in Cambodia

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Abstract

The global conservation status of green peafowl *Pavo muticus* (កុកនៃបាត Kang gnaok) has recently been 'upgraded' to Endangered by BirdLife International (2009). This paper reviews our current knowledge of its status and distribution in Cambodia. The species is still relatively widespread, but much reduced, and now locally common only in remote forests of the North and Northeast, the least disturbed riverine habitat of the upper Mekong River system, and to a lesser extent, the lower river valleys of the Cardamom Mountains. Southern Mondolkiri probably shelters the single largest population remaining in the world. Because the species is conspicuous and valuable, it is actively hunted and collected. This threat is the main factor behind the species decline, as it lives near permanent water, where most human activities take place. In consequence, its surviving populations are increasingly fragmented and declining throughout the country. A monitoring programme initiated in Seima Biodiversity Conservation Area, coupled with regular patrolling, has nevertheless proven that the species can recover quickly with adequate conservation measures.

Keywords

Green peafowl, *Pavo muticus*, Cambodia, conservation, distribution

Introduction

The green peafowl *Pavo muticus* is a bird that has always fascinated man by its beauty and extraordinary thousand-eyed fanning tail. Unfortunately, its large size, combined with its attractive dress, are the very reason for its predicament (Tan *et al.*, 2000). The species has a large ancestral range spreading from Northeast India, east to Vietnam, north to Southern China and south to Java. It was once common and widespread in various forest habitats and grasslands, mostly in lowlands, but has undergone a dramatic decline in the 20th century. The green peafowl is now extinct in several countries and subsists in very fragmented and small populations in the others. The only sizeable remaining populations are found in Cambodia, Myanmar, and west-central Vietnam (BirdLife International, 2009). In Cambodia, it is a resident of dry dipterocarp and semi-evergreen forests with permanent water sources, in lowlands below 300 m. This majestic bird was formerly abundant, as testified by its depiction in the bas-reliefs of Angkor by ancient Khmers (see Fig. 1). Today, Cambodia is often cited as supporting the most significant populations left in the world (e.g. Brickle *et al.*, 2008). This paper aims to provide a comprehensive review of the species' status and known distribution in the Kingdom.

Historical status in Cambodia

French naturalists Delacour & Jabouille (1925) described the green peafowl as the "*commonest game bird in Indochina*", and it is therefore inferred that the species was widespread and common in Cambodia during the first half of the 20th Century. In the 1960s, William Thomas had already noticed a decline, declaring "*it is now rare near habitation, since it is conspicuous, easily shot, and its train is valu-*

Fig. 1 Green peafowl depicted in the Bayon temple bas-reliefs (© Gregory Duplant).

able" (Thomas & Poole, 2003). In their annotated list of birds of Cambodia up to 1970, the same authors listed the bird's historical presence in six provinces (Kampot, Koh Kong, Kompong Thom, Kratie, Siem Reap and Stung Treng) without further details. After a thirty-year vacuum of information due to civil war and insecurity, documented records resumed in the late 1990s as the country progressively became peaceful and remote forests became accessible for biological surveys.

Present distribution and abundance

The current distribution of green peafowl, as presented in this paper, is based on all recent records the author could find. These included published and unpublished records from surveys, birding trips, ornithologists and incidental observers.

The review of records is organized by geographical zones of Cambodia, arbitrarily divided in six areas as follow: the Northwest, the North, the Northeast, the Southeast and the Tonle Sap, and the Southwest. The regions, and the provinces they comprise, are shown on Fig. 2. It should be noted that for the six provinces around the Tonle Sap lake, the 'upland' areas and 'lowland' (floodplain) areas fall into different zones.

The number of birds recorded, as well as the numbers of records, have been used to provide a rough idea of local abundance of the green peafowl in different regions and protected areas. Given that systematic monitoring of green peafowl has taken place in only one area, this method is currently the most sensible one to assess the relative abundance of the species, although many factors may affect its accuracy (seasonality, observers, habitat, etc.).

The distribution of records is represented in Fig. 3.

Northwest

The green peafowl has been extirpated from most of its former range in this region. There are historical records from Angkor (Engelbach, 1953) where it has now become extinct (Goes, 2000a). There is no recent record from Siem Reap Province and the only indication of occurrence in Oddar Meanchey comes from one dead market bird found in O'Smach border post in 2001 (G. O'Keeffe, *in litt.*). There are no confirmed records from Bantey Meanchey, although local reports were received from Ang Tropeang Thmor Sarus Crane Conservation area in May 2002 (Goes & Davidson, 2002a). This indicates that the species may still survive in very small fragmented populations in remote corners of the northwestern provinces.

North

In Kompong Thom, the green peafowl was historically present (Delacour, 1928), but there are no modern day records. Remnant populations may persist in the remote parts of the province, namely the Prey Long area in the Northeast corner, where no survey has been conducted.

In Preah Vihear Province, it is fairly widespread, at least in the northern part, albeit at low densities due mainly to the dry nature of the landscape. A wide-ranging three-month survey from December 2000 to February 2001 in the dry dipte-

rocarp forest dominated landscape in the north and northeastern districts had eleven encounters with the species, with a maximum of five birds in one day. Short visits to the upper Stung Sen River, in Kulen Promtep Wildlife Sanctuary, found a single individual in October 2001, two in November 2002, and one, six, five and one bird(s) in January, March, May and August 2003 respectively, all at different sites (Goes & Davidson, 2001a; 2001b; 2002b; 2003; Goes *et al.* 2004).

Northeast

Various wildlife surveys in the northeastern provinces have found a stronghold in Mondolkiri, where the green peafowl is still widespread and locally common. It was recorded in dry dipterocarp and lowland semi-evergreen forest in Seima Biodiversity Conservation Area and Snoul Wildlife Sanctuary (Walston *et al*., 2001), Phnom Prich Wildlife Sanctuary (Timmins & Ou, 2001) and Phnom Kus (Pech, 2002). Follow-up work and two dedicated call counts in the core area of Seima Biodiversity Conservation Area had 138 - 182 sightings and heard 36 - 48 calling males between February and April 2002 (Evans & Clements, 2004; Goes & Davidson, 2002a). In the buffer zone, Bird *et al.* (2006) recorded at least 140 green peafowl during a 39-day survey in January-February 2006, while a simultaneous survey in adjacent area of Phnom Prich Wildlife Sanctuary detected 55 birds (Claassen & Ou, 2006).

In contrast, surveys in Ratanakiri and Stung Treng produced few records: unspecified numbers and locations in May 1996 (Desai & Lic 1996) and one bird in Lumphat Wildlife Sanctuary in July 2005 (Davidson, 2005). Extensive land surveys in Ratanakiri and Stung Treng in June 1998 (Timmins & Men, 1998), camera-trapping in Virachey National Park (WWF, 2000), as well as a survey in Vunsay in March 2008 (Claassen & Rawson, 2008) did not record this species.

A series of river-associated records indicate the importance of the upper Mekong River system for the green peafowl. Along the Sekong River (Stung Treng), there were a total of five birds at three localities in January - March 2003 (Goes & Davidson, 2003), numerous sightings of up to 25 birds between August and November 2004 (Kry, 2004) and three groups of four to eight birds along the river and smaller tributaries between October and December 2006 (Buckingham & Prach, 2006). In contrast, boat surveys along the Sesan River (Ratanakiri) did not record any birds between May and June 1998 (Timmins & Men, 1998) or from March to May 2003 (Claassen, 2004). Along the Srepok River, an aerial survey in September 2001 detected four birds (Barzen, 2004), and many calling birds were heard in Mondolkiri Protected Forest in January 2008 (Howie Nielsen, *in litt*., 2008).

In the upper Mekong, a survey of the Ramsar site (Stung Treng) found a small population in March and April 2006 (Timmins, 2007) while subsequent field work in the central section of the Mekong between Stung Treng and Kratie during the dry season 2006 - 2007 assessed that it was "*still numerous and at relatively high densities*" (Timmins, 2008).

Southeast and Tonle Sap

There are no specific records from the central plains or the southeastern provinces. This region is dominated by floodplains and rain-fed paddies, hence with little or no suitable habitat for the green peafowl. It is unlikely that the Tonle Sap grasslands ever supported the species.

Southwest

In the Southwest, the green peafowl is scarce with few and widely scattered records, mostly in semi-evergreen forest in river valleys. During a six-month survey of three southern national parks in 1998, it was heard once and captive chicks were seen in Bokor National Park (Kampot) and heard once in Kirirom National Park (Kompong Speu), but found to have been extirpated in Ream National Park (Goes *et al.* 1998). The one bird heard in the foothills of Bokor National Park in March 2006 indicates it persists in the park, but in very low numbers (Farrow, 2006).

In the Cardamom Mountains, one female was seen in dry dipterocarp forest within the lowlands

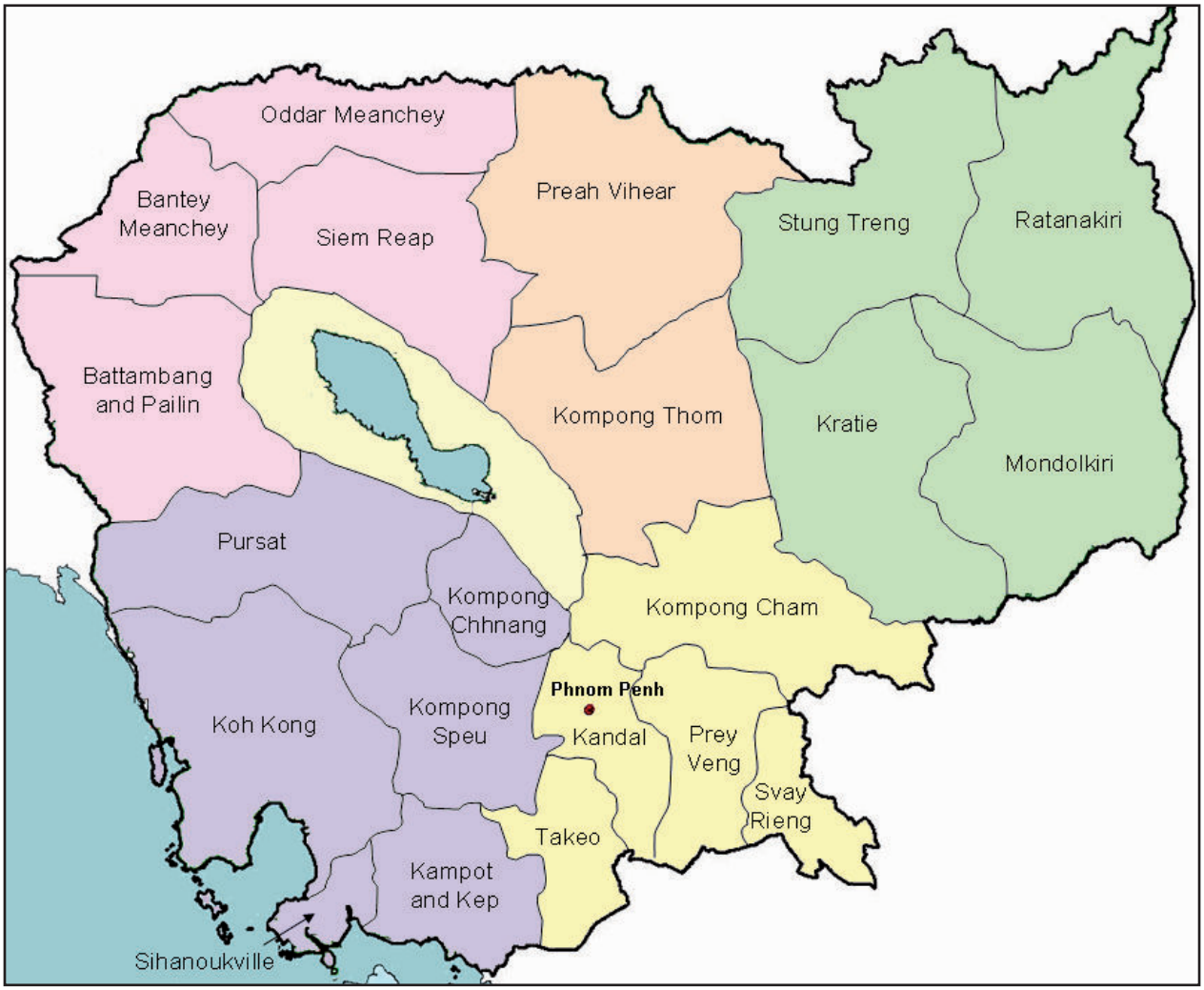

Fig. 2 Geographical regions of Cambodia.

of Phnom Samkos Wildlife Sanctuary in February 2000 (Eames *et al.*, 2002) and six birds were seen along the Sre Ambel River (Koh Kong) in August 2000 (Goes & Davidson, 2001a). In Phnom Aural Wildlife Sanctuary, one female was seen in the foothills of Phnom Aural in February or March 2001 (Swan & Long, 2002), two records were made along the Stung Thom in January 2004 (J. Daltry, *in litt*.) and single individuals were heard in two sites in Roleak Kang Cheung Commune in February - March 2004 (Holloway & Browne, 2004). During a survey in the southern Cardamoms in January and February 2003, this species was heard, seen and camera-trapped (singles to small groups) in at least five localities in Koh Kong Province (Daltry & Traeholt 2003). Finally, a recent survey in Botum-Sakor National Park heard green peafowl on five occasions between July and December 2008 (Royan, 2009).

Population

BirdLife International (2009) recently 'upgraded' – if one considers that a higher threat level is a promotion! – the global threat level of this species from the Vulnerable to Endangered category owing to intense pressure on the species (hunting) and its habitat (fragmentation) across its range. This followed the recommendation of Brickle *et al.* (2008)

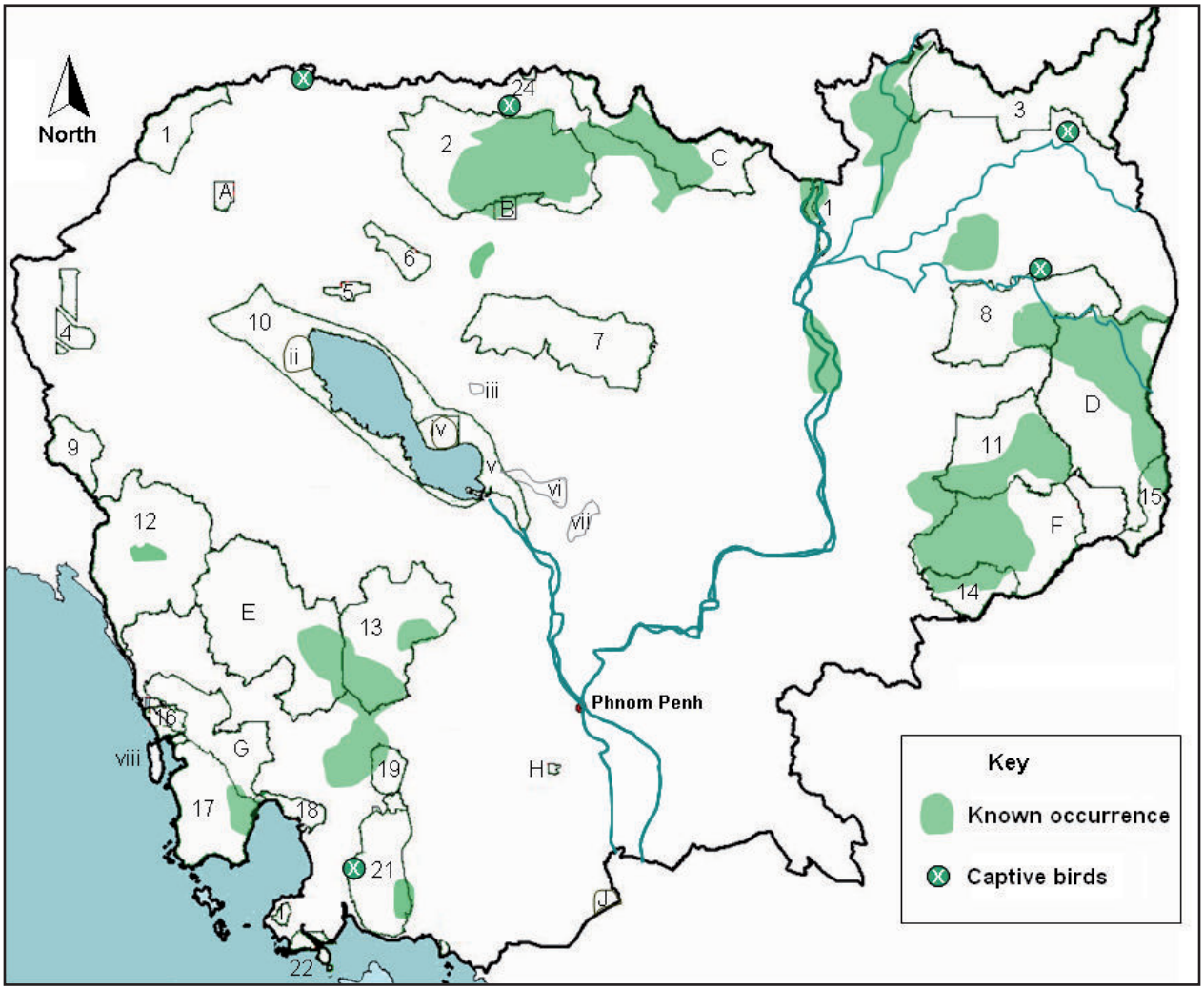

Fig. 3 Distribution of green peafowl in Cambodia.

Ministry of Environment:

1. Bantay Chmary Protected Landscape
2. Kulen Promtep Wildlife Sanctuary
3. Virachey National Park
4. Roneam Dounsam Wildlife Sanctuary
5. Angkor Protected Landscape
6. Kulen National Park
7. Beng Per Wildlife Sanctuary
8. Lomphat Wildlife Sanctuary
9. Samlaut Multiple Use Area
10. Tonle Sap Multiple Use Area
11. Phnom Prich Wildlife Sanctuary
12. Phnom Samkos Wildlife Sanctuary
13. Phnom Aural Wildlife Sanctuary
14. Snoul Wildlife Sanctuary
15. Phnom Nam Lyr Wildlife Sanctuary
16. Peam Krasop Wildlife Sanctuary
17. Botom Sokor National Park
18. Dong Peng Multiple Use Area
19. Kirirom National Park
20. Kep National Park
21. Bokor National Park
22. Ream National Park
23. Prasat Preah Vihear Protected Landscape

Forestry Administration:

A. Ang Tropeang Thmor Sarus Crane Conservation Area
B. Koh Ker Protected Forest
C. Preah Vihear Protected Forest
D. Mondulkiri Protected Forest
E. Central Cardamoms Protected Forest
F. Seima Biodiversity Conservation Area
G. Southern Cardamoms Protected Forest
H. Phnom Tmao Zoo
I. Kbal Chay Protected Forest
J. Beong Prek Lapouv Sarus Crane Conservation Area

Other protected sites:

i. Mekong Ramsar Site
ii. Prek Toal TSBR Core Area
iii. Stoeng/Chikreng Integrated Biodiversity and Farming Area
iv. Boeung Chhmar TSBR Core Area / Ramsar Site
v. Stung Sen TSBR Core Area
vi. Veal Srangai & Kouk Preah – Beung Trea
vii. Baray Integrated Biodiversity and Farming Area
viii. Koh Kapik Ramsar Site

upon reviewing the status and conservation of Galliformes in Indochina. Somewhat paradoxically, improved knowledge, mainly from Cambodia, has led to an upward revision of the global population estimate to 10,000 - 20,000 birds (formerly 5,000 - 10,000 birds). Given the rate of decline and the fact that no single known population outside Cambodia exceeds a few hundred birds, however, the global population may soon dwindle below 10,000 birds.

In Cambodia, the species' presence in a large area of contiguous forest in the Northeast, and smaller populations elsewhere, indicates that the country supports one of the most significant populations left in the world (Brickle *et al.* 2008). Although Timmins (2008) speculated that "*tens of thousands of birds*" may survive in the Kingdom, a conservative estimate of the national population based on known distribution and records is 2,000 to 3,000 birds. The 3,000 km^2 Seima Biodiversity Consevation Area alone definitely shelters more than 1,000 birds, the largest known population across its range. Encouragingly, the monitoring programme of the Wildlife Conservation Society, in collaboration with the Forestry Administration, has shown that this population has increased since conservation activities started in 2003 (WCS, 2006). Densities in other parts of Cambodia are definitely lower. The populations in Preah Vihear Province and the southern Cardamom Mountains are nevertheless globally significant and probably number in the low to mid hundreds each.

The drier landscape in the Northeast naturally limits the suitable habitat to areas with permanent pools or streams, while high elevations in the Southwest largely restricts the peafowls to lower river valleys. This makes these two populations much more vulnerable to human persecution and fragmentation, the more so in the Southwest where patrolling and conservation are negligible in view of the vast extent of the protected landscape. The population of the upper Mekong River (Kratie) is certainly less significant in absolute numbers (perhaps 50 - 100 birds), but its concentration in a small and well-defined area provides a unique opportunity for immediate, straightforward and cost-effective conservation action. This site has been designated as a 'provincial special protected area' and, if effectively protected, its green peafowl population may rapidly increase (Timmins, 2008).

Conservation

Human persecution and loss of habitat are the two main and synergistic factors behind the species' widespread and continuous decline. Firstly, green peafowl are the victims of specific and opportunistic harvesting of eggs, and hunting of adults driven by the high market value of live birds and of train feathers. In a 14-month survey of zoos and captive wildlife in Cambodia, 31 green peafowl were censused, and this was amongst the top three threatened species in terms of number of birds held (Goes, 2000b). This testifies to the bird's prized value as a pet and ornamental species. The green peafowl's requirement for permanent access to water makes it particularly vulnerable to persecution from recurrent contact with people collecting forest resources and establishing new settlements. Therefore hunting disproportionately impacts on the green peafowl compared with other forest-interior galliformes in Indochina, and constitutes the single most important factor behind its precipitous decline (Brickle *et al.* 2008). Widespread habitat loss for agriculture (slash and burn of riverine forest, conversion of wet grasslands) and from disturbance (fishing) forms another significant threat, and converges with human persecution to further increase the vulnerability of the species.

The establishment of Indian blue peafowl *Pavo cristatus* farms to supply the market demand in train feathers represents a potential threat through hybridisation of escapees with wild populations. Such a farm has recently been reported from Pailin (Brickle *et al.* 2008). In any case, the blue peafowl should not be allowed anywhere near any known or suspected wild population.

Given this generally unfavourable picture, the national population of green peafowl is certainly declining and increasingly fragmented. The case

of a healthy and increasing population, such as that of Seima Boidiversity Conservation Area, is an exception to the rule. Nevertheless, this exception is invaluable not only in the significance of its protected population, but in showing the competent authorities within the Royal Government of Cambodia that effective conservation measures are able to reverse the trend of decline.

From a conservation awareness point of view, the existence of a sizeable captive population can be seized as an opportunity to experiment with some reintroduction programmes. The Angkor Thom forest (9 km^2), lined with moats, constitutes an ideal habitat to initiate and efficiently manage such a programme. No doubt reintroducing this highly charismatic species in the forest surrounding its centuries-old carving in stone would carry a lot of symbolic meaning as well provide a high profile case for conservation education and awareness activities for generations of Cambodian and foreign visitors. As dusk settles, the Angkorian ruins may again resound with the loud, penetrating call of the green peafowl. Then one could say with pride that man has brought a stone image back to life.

Acknowledgements

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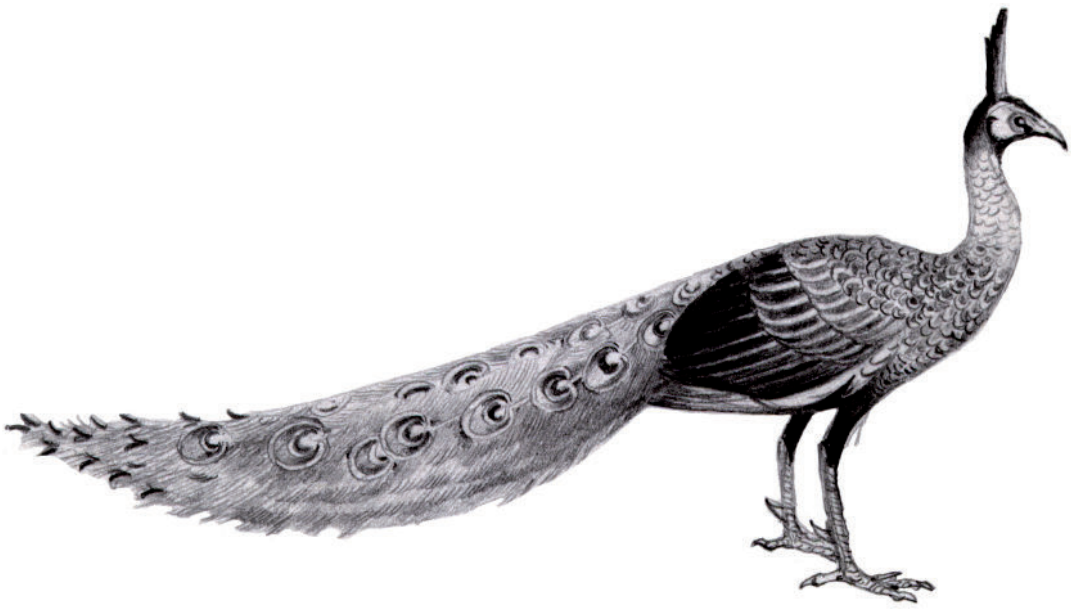

Fig. 4 Green peafowl (© Srey Bandol).

Liquid resin tapping by local people in Phnom Samkos Wildlife Sanctuary

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សេចក្តីសង្ខេប: ជ័រទឹក គឺជាសារធាតុស្អិតចេញមកពីប្រភេទដើមឈើទាល ដែលដុះនៅក្នុងប្រទេសកម្ពុជាយើង។ ជ័រទឹកត្រូវបានគេប្រើប្រាស់ជាចំបងក្នុងការលាបឈើ បិទទូក និងលាបគ្រឿងសង្ហារឹមជាដើម។ ការស្រាវជ្រាវដោយផ្អែកលើសម្ភាសន៍ និងការចុះទៅពិនិត្យនៅទីវាល ទៅលើការដងជ័រទឹកពីដើមឈើទាលពីរប្រភេទ គឺឈើទាលបង្គួយ និងឈើទាលគ ត្រូវបានធ្វើឡើងនៅក្នុងសហគមន៍ពីរក្នុងដែនជម្រកសត្វព្រៃភ្នំសំកុស។ ក្នុងចំណោមប្រជាជនចំនួន ១00គ្រួសារ មាន១៤គ្រួសារត្រូវបានរកឃើញថា ជាអ្នកប្រកបរបរដងជ័រទឹក។ ក្នុងចំណោមនោះ អ្នកដែលមានដើមឈើជ័រតិចជាងគេចំនួន២៣ដើម អាចរកប្រាក់ចំណូលបាន៣៩ដុល្លា និងអ្នកដែលមានដើមឈើច្រើនជាងគេចំនួន៥00ដើម អាចរកប្រាក់បាន ៨៤0ដុល្លា ក្នុងមួយខែពីការលក់ជ័រទឹក។ ការសិក្សានេះបានធ្វើការប្រៀបធៀបផលប្រយោជន៍ និងផលប៉ះពាល់ចំពោះព្រៃឈើពីការដងជ័រ និងបានធ្វើការពិភាក្សាទៅលើបច្ចេកទេស នៃការចោះយកជ័របែបបូរាណនេះផងដែរ។ គេបានរកឃើញថា ការដងជ័រទឹកបានទទួលប្រាក់ចំណូលខ្ពស់ និងមាននិរន្តរភាព។ ទិន្នផលនេះអាចកាត់បន្ថយភាពពឹងអាស្រ័យ ទៅលើការកាប់បំផ្លាញព្រៃឈើ ដែលមិនមាននិរន្តរភាព និងមានឥទ្ធិពលដោយប្រយោល យ៉ាងខ្លាំងទៅលើទឹកចិត្តរបស់ប្រជាសហគមន៍ ក្នុងការចូលរួមអភិរក្ស និងស្តារព្រៃឈើឡើងវិញ។ លទ្ធផលនេះហើយ គឺជាបំណងប្រាថ្នារបស់ក្រុមការងារនៃក្រសួងបរិស្ថាន និងអង្គការអភិរក្សសត្វព្រៃ និងរុក្ខជាតិអន្តរជាតិ ដែលបានរួមគ្នាគ្រប់គ្រងដែនជម្រកសត្វព្រៃភ្នំសំកុសនេះអស់រយៈពេលជាច្រើនឆ្នាំមកហើយ។

ពាក្យគន្លឹះ: អនុផលព្រៃឈើ តំបន់ការពារធម្មជាតិ ប្រភេទឈើទាល ដែនជម្រសត្វព្រៃភ្នំសំកុស។

Abstract

Liquid resin is a sticky substance exuded from dipterocarp tree species native to Cambodia. The resin is mainly used to soak wood to make water-resistant floors, boats and furniture. Interviews and field-based surveys of liquid resin collection from two species of dipertocarp trees (*Dipterocarpus costatus* and *Dipterocarpus* sp.) were carried out in two villages in Phnom Samkos Wildlife Sanctuary. Fourteen of the 100 families interviewed were identified as resin tappers, who each 'own' between 23 and 500 trees and earn from US$ 39 to US$ 840 per month from selling resin. A comparison of the benefits of collection to local livelihoods and the impacts to the forest was made, and the traditional tapping techniques discussed. It was found that the income generated from resin collection is significant and also sustainable. The profit has a strong indirect influence on the motivation of local people to be involved in forest restoration and conservation, and reduces their dependency on unsustainable logging: an outcome desirable to the Ministry of Environment and Fauna & Flora International who jointly manage the Phnom Samkos Wildlife Sanctuary.

Keywords

NTFP, protected area management, dipterocarp trees, Phnom Samkos Wildlife Sanctuary.

Introduction

Liquid resin is a sticky substance exuded from the trees *Dipterocarpus costatus, D. alatus, D. dyeri, D. jourdainii*, *D. intricatus* and other species. Resin is a fluid or potentially soluble substance from a tree that usually functions to coat wounds or repel predators (Ankarfijard & Kegl, 1998). The liquid resin discussed in this paper is often called *chor teuk* in Khmer language, and is traditionally used for lighting fires and waterproofing baskets and boats. Today, resin is mainly used in the manufacture of paint, vanish and lacquers, as a fixative in perfumes (Ankarfijard & Kegl, 1998), and to soak wood used to make floors, boat and furniture (Hang, 1995). The resin is collected using various methods and sold locally, creating an income for communities in or on the edge of forest areas.

In the 1980s, resin collection was the main source of income for many forest communities, especially minority groups, in the provinces of Kompong Thom, Preah Vihear, Mondulkiri (McKenney *et al.,* 2004), Ratanakiri, Kampong Speu and Pursat (pers. obs.). During the 1980s and 1990s, resin trees in forest concessions contracted by the Cambodian Government were permitted to be selectively logged regardless of disagreement from villagers (McAndrew & Oeur, 2004). After the disappearance of resin trees from these areas, the local people who had been harvesting resin turned to unsustainable activities, such as logging, and the collection of hard resin, mushrooms, rattan, vines and bamboo for their livelihoods. After 2000, when all forest concessions were suspended by the government, local communities living around the forest edges began to tap the scattered resin trees that remained in their areas to supplement their income. Today, Preah Vihear, Kampong Thom, Mondulkiri, Oddar Meancheay Provinces are the main sources of resin exported from Cambodia (McKenney *et al.,* 2004)

Traditionally, people in the Phnom Samkos Wildlife Sanctuary (PSWS) in the Cardamom Mountains of Southwest Cambodia have depended heavily on collecting various kinds of Non-Timber Forest Products (NTFPs). These resources have contributed to people's livelihoods in many ways through direct consumption, income-generation and as construction materials, medicines, ornaments and fragrances (Phan, 2005). The question of whether these resources have been harvested in a sustainable manner or not remains uncertain as the population in these areas has rapidly increased (Anon, 2006), putting pressure on the limited resources and possibly degrading natural habitats. Anecdotal observations suggest that collection of some types of NTFPs (e.g. mushrooms and hard resin) has declined since 2005. While this could be an indicator that these resources have become scarce, the collection of NTFPs changes from year to year according to the market demand.

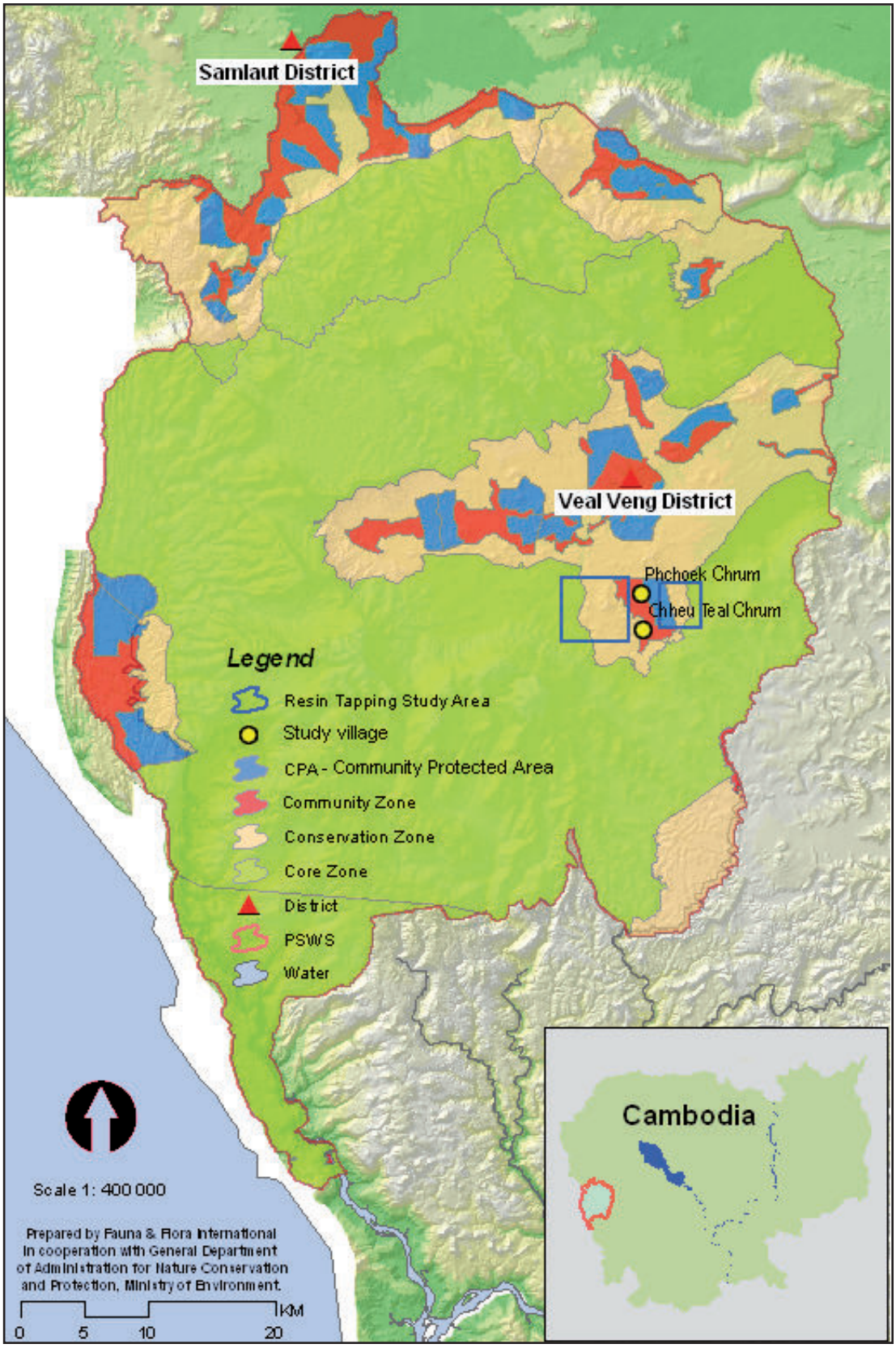
The collection of liquid resin appears to have increased in PSWS since 2008, because of increased road access, increased market demand, higher prices offered by traders and tighter restrictions by ranger patrol teams on illegal alternatives. Of all the NTFPs surveyed in recent years, liquid resin has provided the most significant income to local tappers. This collection does not necessarily harm the trees, which can continue to be used by future generations (WRM, 2001).

After the zoning of natural resource management areas in the Phnom Samkos Wildlife Sanctuary was completed in 2007 (Fig. 1), all relevant stakeholders have been involved in a programme to protect and conserve resources in a sustainable manner. The zoning restricts access of local communities to resources in the Conservation Zones and Core Zones where more resin trees occur. However, local communities have the right of temporary ownership and access to NTFPs to areas designated as Community Protected Areas (CPAs).

The purpose of this survey was to:

- Find out the number and types of species that are tapped for resin;
- Find out the importance of resin collection activities to the protection and reproduction of remaining resin trees, and the conservation and natural rehabilitation of the forest areas;

Fig. 1. Phnom Samkos Wildlife Sanctuary.



- Recommend ways for local people to get involved in resource management; and
- Identify and recommend harmless resin tapping techniques.

Methods

The survey was carried out in 2008 in two villages in PSWS, Phchoek Chrum and Cheuteal Chrum, where local people had been tapping resin from trees since 2006 (resin collection was not reported from these villages in 2005: Phan, 2005; Sar, 2005). Questionnaires on resin collection activities were prepared and used by the survey team to interview all individuals in the villages. After two days of interviews, the survey team, accompanied by resin tree owners, visited the resin tree areas and observed the tapping, collection, re-tapping and transportation techniques used. Possible impacts that these activities have had on the trees and surrounding forest were also assessed.

Three resin-tapping holes were measured on sample trees to see how they compared in size to the diameter of the tree at the level of the resin hole. Save Cambodia's Wildlife (SCW) also provided data gathered from 852 individual trees, which included the species, tree diameter, and the height (H) width (W) and depth (D) of the resin holes.

The equipment used to collect data included questionnaires, datasheets, measurement tapes, Diameter at Breast Height (DBH) tapes, a hand-held global positioning system (Garmin™ eTrex®) and a digital camera.

Results

General observations

The survey identified 14 resin tappers from the two villages of Phchoek Chrum and Cheuteal Chrum. who own resin trees The resin is tapped from two species of dipterocarp tree, *Dipterocarpus costatus* and another, unidentified species of *Dipterocarpus*. The two species were distinguished by different leaf size, bark texture and resin transparency. *Dipterocarpus* sp., locally named *cheuteal kor*, has larger leaves, smoother bark, and a more opaque resin than *D. costatus*. According to interviews and observations, the 14 tappers used an estimated total of 2,083 resin trees, which were patchily distributed in the PSWS Conservation Zone and Core Zone.

Tapping technique

A pyramid-like hole is made at the base of a tree trunk about 50 cm above ground. The size of the hole varies according to the trees diameter. With an average diameter of 80 cm, the average width, height and depth of the hole is 41 cm, 30 cm and 24 cm, respectively. These proportions seem to be similar to the tapping conducted in Thailand with a ratio of 30: 30: 20 cm (Subansenee, 1995). This makes a hole volume of 29,520 cm^3 from which resin is col-

Fig. 2 Group of *Dipterocarpus* spp used for resin (© Neang Thy)

Fig. 3 Hole carved into tree to extract resin (© Neang Thy).

lected. To make it easier to cut, and to increase resin flow, the hole is cut between buttresses on the tree, if present. Only one hole is cut in trees with a Diameter at Breast Height (DBH) <100 cm and one or two holes in trees with a DBH >100 cm. The DBH measurements of 852 tapped trees showed that 26% of the trees harvested had a DBH smaller than 60 cm, the minimum permitted diameter of these species for cutting (Seng, 2000), and the smallest tree to be tapped had a DBH of only 34 cm. The largest tapped tree measured in the tapping area had a DBH of 177 cm.

Resin production and profit

The reported rate of resin flow from individual trees depended on the tree localities and season. Individuals growing near a water source, such as a stream or in wet areas in the lowlands, reportedly produce more resin than those on hills or at higher altitudes. The tappers estimated that 30 resin trees provide around 30 litres of resin or one container per week. This suggests that an average of approximately 0.14 litres of resin can be collected from a single tree every day. This rate of resin flow is higher than the 0.11 litres per tree per day, or 30 - 40 litres per year, recorded in Northeast Cambodia (Prom & McKenney, 2003).

Table 1 shows the names of resin tappers with their respective number of trees and the approximate amount of resin produced per month, the sale price per container and the calculated monthly income gained from selling resin.

Resin is collected almost all year round except in the hottest part of dry season from March to April, when the trees are in a dormant state during the process of abscission (Guttman, 1998) and do not exude resin. Tappers sometimes tap in the dry season without realizing the trees are dormant and believe them to be dead when they do not excrete resin after burning. When there is enough moisture in the soil again, the resin starts to flow. One or two people are able to tap 50 - 100 trees per week. The

Table 1 Resin production and income in Phchoek Chrum and Cheuteal Chrum Villages.

No.	Name of resin tapper	Number of resin trees	Mean estimated resin yield per tree per day (litres)	Total resin produced per month (litres)	Number of containers sold per month	Unit cost, 2007	Unit cost, 2008	Income per month in 2007 (US$)	Income per month in 2008 (US$)
1	Rom	500	0.14	2,100	70	5	12	350	840
2	Pich La	350	0.14	1,470	49	5	12	245	588
3	Yuth	350	0.14	1,470	49	5	12	245	588
4	Ta bin	50	0.14	210	7	5	12	35	84
5	Ta Ty	50	0.14	210	7	5	12	35	84
6	Sorn Yuth	72	0.14	302	10	5	12	50	121
7	Yin Nay	130	0.14	546	18	5	12	90	218
8	Kung Cheun	120	0.14	504	17	5	12	85	202
9	Ta On	23	0.14	97	3	5	12	15	39
10	Soth	136	0.14	571	19	5	12	94	228
11	Pock	50	0.14	210	7	5	12	35	84
12	Ta Korm	132	0.14	554	18	5	12	90	222
13	Nat	51	0.14	214	7	5	12	35	86
14	Sor Veng	69	0.14	290	10	5	12	50	116
		2,083		8,749	291			1,454	3,500

Fig. 4 Starting a fire in the resin hole (© Neang Thy)

Fig. 5 Resin tapper camp with canisters (© Neang Thy)

more resin trees that are present, the more tappers can be employed.

Burning

Burning is a necessary means to stimulate flow and extract the resin (Swift, 2005). Re-tapping is carried out usually after a week, according to the interviewees. A torch is made from a bundle of small twigs soaked in liquid resin in the hole and set on fire for about three to five minutes. The fire is extinguished before the tapper moves to another resin tree.

Transportation

Thirty-litre plastic containers are used to keep resin during the collection process. Full containers are brought to the collector's base camp or to main trails for transportation. Some tappers do not stay in the forest, but collect resin during the day and return home in the late afternoon. The resin is transported by oxcart from base camp to the village for sale. Those who do not own an oxcart hire one for transportation.

Markets

The resin collected by villagers from Phchoek Chrum and Cheuteal Chrum is sold locally to two middlemen living in Pramoay (Veal Veng District capital). The price of resin fluctuates according to the season and the market demand. The final destination and the main use of the resin that was seen tapped during the present survey is unknown.

Discussion

An estimated 2,083 resin trees belong to 14 owners out of approximately 100 families in the two villages, Phchoek Chrum and Cheuteal Chrum (Table 1). The total amount of resin collected per month is 291 30-litre containers, which brought a total income to the tappers of US$ 3,500 per month in 2008. The total income seems very high, however, possibly because this survey coincided with a peak collection period. At the time of the present survey, resin tapping was the major source of income for the tappers of the villages.

If supplemented with seasonal crops (e.g., rice, corn, bean and sesame), the current income generated mainly from resin collection could support the tappers without resorting to illegal and unsustainable activities. In addition to resin collection being a potentially sustainable source of income, this activity could encourage local communities to conserve the remaining resin trees from such threats as illegal logging and forest clearing (WRM, 2001; Community Forestry International, 2006). By allowing the forest that contains resin trees to rehabilitate, these areas of the Sanctuary will become more effectively managed (Prom, 2009). With strong support from government ranger patrol teams, tappers are probably the best protectors of their resin tree areas.

Over time, the number of resin trees in Cambodia has rapidly decreased due to loggers who come, primarily, from outside the local communities. Villagers are often coerced into selling resin trees, being told that the trees will be cut whether they sell them or not. In 1997, a guard working for Colexim shot and killed a person in Ronthas Village, Sandan District, Kompong Thom, who protested against the cutting of resin trees (WRM, 2001). Traditionally, however, resin trees were rarely damaged or killed because they were of high value to the villagers and passed down from generation to generation (WRM, 2006; Prom, 2009).

The 14 resin tappers represent 14% of households in the villages, who can at least reduce their dependency on unsustainable activities. They would probably not have a majority in making decisions about the management of the natural resources in their communities, however. To influence a longer-term and sustainable consensus to protect the resin tree areas, more community members should, by any means, benefit from resin extraction. Resin products will not become the main source of income for the local economy while the density of trees remains low and trees are not shared with every family.

If the total income from resin collection in 2008 were equally divided by the number of families (100) in the two villages, then each family would earn at least US$ 35 per month. This monthly earning would have been enough to meet the needs of the local people in recent, when they subsisted on rice, bush meat, and traditional medicine, but it is no longer sufficient to meet local requirements now that the villagers have more access to markets and the cost of basic supplies are higher. The fact that a small percentage of villagers in Phchoek Chrum and Cheuteal Chrum can afford motorbikes, televisions, cell phones, better clothing and better medical treatments develops a desire amongst the remainder of the community for such higher cost products. If the local people increase the number of resin trees from 2,083 active trees to approximately 5,000 trees, however, by allowing the existing young trees to mature and conducting some additional planting, then each family could own 50 trees and earn at least US$ 84 per month (provided the current human population density is maintained).

Importantly, unlike many other seasonal NTFPs such as hard resin, mushrooms and cardamoms, liquid resin can be collected during most months apart from the hottest period in the summer (Guttman, 1998). This can play a vital role in contributing constantly to local livelihoods throughout the year

Although resin collection is recognized by Article 22 of the Protected Areas Law (2008) and Article 40 of the Forestry Law (2002) as a traditional and harmless NTFP, resin tapping does have some impacts on forest ecosystems. The first impact is from cutting the holes, which physically changes the tree trunk and may partially disrupt the flow of water through the trunk. Two holes were observed on some trees with a DBH <100 cm, and other holes were too large in proportion to the tree DBH, e.g. one with a width, height and depth of 83: 77: 77 cm at the base of a tree 146 cm in diameter. The width and depth of holes were about half the tree diameter. A hole of 41: 30: 24 cm would be more acceptable to trees with DBH>60 cm. Furthermore, the stimulation of resin flow by burning expands the holes following each collection. This can also cause the trees to die at an early age, because more resin flows out and trunks are intolerant to such heavy wounding and burning (Walston *et al.,* 2001). Burning could also be destructive if the fire accidentally spreads out to large areas during the dry season, especially in semi-evergreen forest and at the edges of dry dipterocarp forest.

The regular presence of tappers in natural forests also inevitably results in a slight fragmentation of habitats, disturbance to wildlife and opportunistic hunting for bush meat (Subansenee, 1995). The domestic cattle used to transport resin products on oxcarts from the collection sites to villages present another kind of potential impact because they risk spreading disease to wild animals, especially the native wild cattle.

As a result of the price of resin products increasing from year to year, coupled with the lack of other

livelihood alternatives, more people are turning to resin tapping. While current tapping extends about five kilometres from villages in Phnom Samkos Wildlife Sanctuary, an increase in resin tapping would push people further into the off-limit areas, especially the Core Zone. Added to this, smaller resin trees will be potentially tapped. The 26% of trees tapped with a diameter smaller than 60 cm (the minimum permitted size for cutting) are regarded unacceptable because such tapping is more like affect their growth, make them more susceptible to disease, and make them lose function or burn down when the holes become larger.

Resin products from the villages surveyed in PSWS are currently sold to middlemen. As indicated in Table 1, the price of a 30-litre container of resin increased from US$ 5 in 2007 to US$ 12 in 2008. The tappers agree to sell to the middlemen at almost any price, however, because they need money to buy food, have only limited containers and have little choice but to sell it and go back to tap more. Another factor keeping the price low is that the transport of resin products within Cambodia requires a permit and a tax is paid to the government (according to the Forestry Law). In reality, most buyers have never applied for an official permit and do not pay tax because they consider it bureaucratic. Instead, they prefer to give bribes to inspectors at all the checkpoints (Prom & Mckenny, 2003).

The destination and use of resin from the tappers that were surveyed is unknown. It is likely that a small amount of the resin product is used for the shipbuilding industry in Cambodia and the rest is exported for multiple purposes, probably to the neighboring countries of Thailand and Vietnam. The same product from Mondulkiri is sold to Vietnam (Anon, 2007) and then re-exported to China (Subansenee, 1995), where it is used to make torches, a preservative for wood and bamboo, varnish and printing ink, to caulk boats and waterproof bamboo baskets (when mixed with powdered gum dammar), and to produce balsam oil for perfume bases (Subansenee, 1995; WRM, 2006).

Conclusion

Resin tapping in the Phnom Samkos Wildlife Sanctuary provides a traditional, relatively environmentally harmless and sustainable means of income, and is recognized by both Protected Areas Law and Forestry Law. While there are some impacts on the trees and forest from the collection, especially in prohibited zones, the contribution that resin tapping provides to forest management cannot be ignored.

Resin tapping seems to fit well with the goal of the Wildlife Sanctuary because communities indirectly preserve wildlife through protecting resin trees and their habitats, and also provides local people with a substantial income from selling the resin. It is better to risk a small impact from resin tapping than the disappearance of resin trees and their habitats by logging and forest clearing.

Recommendations

- Resin collection by local communities should be conducted on trees with a diameter larger than 60 cm, because trees of this size are mature enough to resist the cutting and burning.
- Resin holes should be as small as possible to avoid damaging resin trees, bearing in mind that the holes are enlarged by every burning. The standard dimension of holes should be 25-30% of the tree's diameter.
- Burning of the resin holes should be carried out with care, and the fire extinguished before the tapper leave, to avoid forest fires. Children must not be involved in the burning activities.
- Tapping should not take place further than four kilometres from the villages or within the Core Zones of protected areas because it disturbs wildlife and could damage the fragile forest ecosystem. While it is not ideal that tappers are allowed in the Conservation Zones, it is better to give villagers the right to tap and protect resin trees than see logging of resin trees by illegal loggers and land clearers.

- Tappers should carry out an inventory of their resin trees and mark them with a numbered tag to manage their trees efficiently. The number of resin trees of each tapper should be reported to the community and the protected area director.
- Education and awareness extension should be provided to all tappers on forest management. Information should be provided on the reasons not to hunt animals during resin collections. Tappers should know that they have the right to tap, inherit or transfer the resin trees to someone else, but they have no right to cut down or sell the trees because they are not their property. If any tree dies or is logged, or any trap set in their collection areas, the owners must report it to the community and protected area management authority. If tappers fail to report illegal activities, they should be suspended or prohibited from collecting resin and their resin trees will be transferred to other villagers who are willing to abide by these regulations.
- Rangers in the protected area must provide a quick response to any illegal activities reported by the tappers in their respective collection areas.
- Community Protected Area committees could set up trading cooperatives to buy resin and sell it directly to the markets or exporters to command a larger profit for the tappers and their communities. The contract between the community traders and the buyers should confirm the tappers will provide a sufficient quantity of resin and, in return, be guaranteed a higher price than they would obtain from middlemen.
- Taxes on resin collection should be paid to a community fund that will be used to plant more resin trees for the next generation and provide benefits to the whole community. Small scale family plantations could also be started and young resin trees protected for future tapping and habitat restoration.
- The tax payment to the government should be removed to increase the local profit.
- For resin collection to be more effectively managed, the whole community should be involved in forest protection and enabled to generate a supplementary income from selling resin.
- Further research on resin tapping should be conducted to determine the average rate of resin flow per day from a tree, the impact of resin tapping, techniques used, the sustainability of collection and the linkages between forest protection and tapping activity.

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About the Author

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Avifaunal inventory with annotated accounts for Botum-Sakor National Park, Southwest Cambodia

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Abstract

Avifaunal records from systematic surveys between July and December 2008 and opportunistic sightings between April 2005 and June 2009 in Botum-Sakor National Park, Southwest Cambodia, are reported. A total of 203 species were identified including seven globally threatened or near-threatened species, 14 biome-restricted species, and three subspecies endemic to the Cardamom Mountains Ecoregion. The first published report of little bronze cuckoo *Chrysococcyx minutillus* in Cambodia is also documented. The conservation importance of Botum-Sakor has been severely reduced due to continuing habitat degradation, but potentially contains globally important populations of green peafowl *Pavo muticus*, regionally important populations of white-winged duck *Cairina scutulata,* and milky stork *Mycetirea cinerea,* and supports breeding grey-headed fish eagles *Ichthyophaga ichthyaetus*. The avian diversity of Botum-Sakor is comparable to that of other protected areas within Cambodia and meets two criteria for the designation of an Important Bird Area (IBA).

Keywords

Birds, avian, biodiversity, Indochina, Cardamom Mountains.

Introduction

The knowledge of bird distribution in Cambodia is somewhat lower than that of most other countries. There are approximately 535 bird species thought to occur in Cambodia (Tan & Poole, 2003), but this species list is expected to reach 600 as survey efforts are increased and unexplored areas investigated. There are only a small number of recent studies that have aimed to document the species of Southwest Cambodia and as yet there has been no reporting on the avifauna of Botum-Sakor National Park. Daltry & Kuy (2003) conducted opportunistic surveys within the southern Cardamoms, identifying 137 species including several globally threatened species and several subspecies endemic to the Cardamom Mountains Ecoregion (which includes Botum-Sakor). The combination of several studies within this part of Cardamom Mountains provides a species list of approximately 200 species (Daltry & Kuy, 2003). Similarly, Steinheimer *et al.* (2000) combined survey work with previous reports to identify 213 species occurring in the Phnom Samkos Wildlife Sanctuary and T'Mar Bang District of the Central Cardamom Mountains.

Botum-Sakor is located near the southwest border of Cambodia, spanning the three districts of Koh Kong, Kiri Sakor and Botum-Sakor in Koh Kong Province and is one of Cambodia's six staffed National Parks. It covers an area of 183,408 hectares (1,834.08 km^2). The majority of Botum-Sakor's area comprises gently sloping lowland forest consisting of lowland evergreen and semi-evergreen broadleaved forest, *Melaleuca* woodland, grassland, mangrove forest and patches of *Oncasperma* palm. The human population of Botum-Sakor is unknown (Daltry & Traeholt, 2003) yet disturbance is known

to be high with an estimated 229 km² (~30 km²/ year) of evergreen forest lost between 1997 and 2002 through illegal logging (Traeholt *et al.*, 2005). Regular ranger patrols have now been put in place since the findings of this study; however, evidence of continued logging and hunting is regularly encountered.

This paper reports on the bird species recorded in Botum-Sakor National Park in surveys conducted by the author between July and December 2008 and additional species recorded opportunistically during Frontier-Cambodia fieldwork within Botum-Sakor National Park between April 2005 and June 2009. The aims of these surveys were to establish a comprehensive avifaunal inventory for the national park and provide insight into the distribution of species within the region, with particular emphasis on species of conservation importance.

Methods

Two study sites were used for surveys (see Fig. 1). The first study site (site A) was situated in the north of the park (11°14.732'N, 103°21.092'E) at an altitude of approximately 100 m above sea level (asl) in an area of evergreen broadleaved forest and grassland habitat. This study site was in close proximity to highway 48, which was used as a line transect for surveys. Disturbance was noted in the area with evidences of selective logging and poaching activities found.

The second study site (site B) was situated approximately 15 km along the Preaek Kon Tourt River (Preaek Phkum on some maps) (11°09.750'N, 103°22.751'E) at an altitude of approximately 5 m asl, 3 km south of the route 48 highway. The surrounding habitats were more diverse than that at site A and consisted largely of semi-evergreen broadleaved river-edge forest, grassland and small patches of *Oncasperma* palms with *Melaleuca* and mangrove habitat in brackish waters, which stretched for about 8 km from the sea. Disturbance levels at study site B appeared to be somewhat higher than that at site A with much evidence of logging activity: snares and other evidence of poaching were regularly encountered. All habitats present at the two sites were surveyed.

Systematic studies were conducted between 10 July and 13 December 2008. Site A was surveyed between 10 July and 3 September while site B was surveyed between 10 October and 13 December. Visual identifications were based upon the field guides by Robson (2007) and Tan & Poole (2003), while audio identifications were based upon reference CDs (e.g. Scharringa, 2005). Ministry of Environment rangers assisted with species identifications. All data were analysed by the author before being included in this paper.

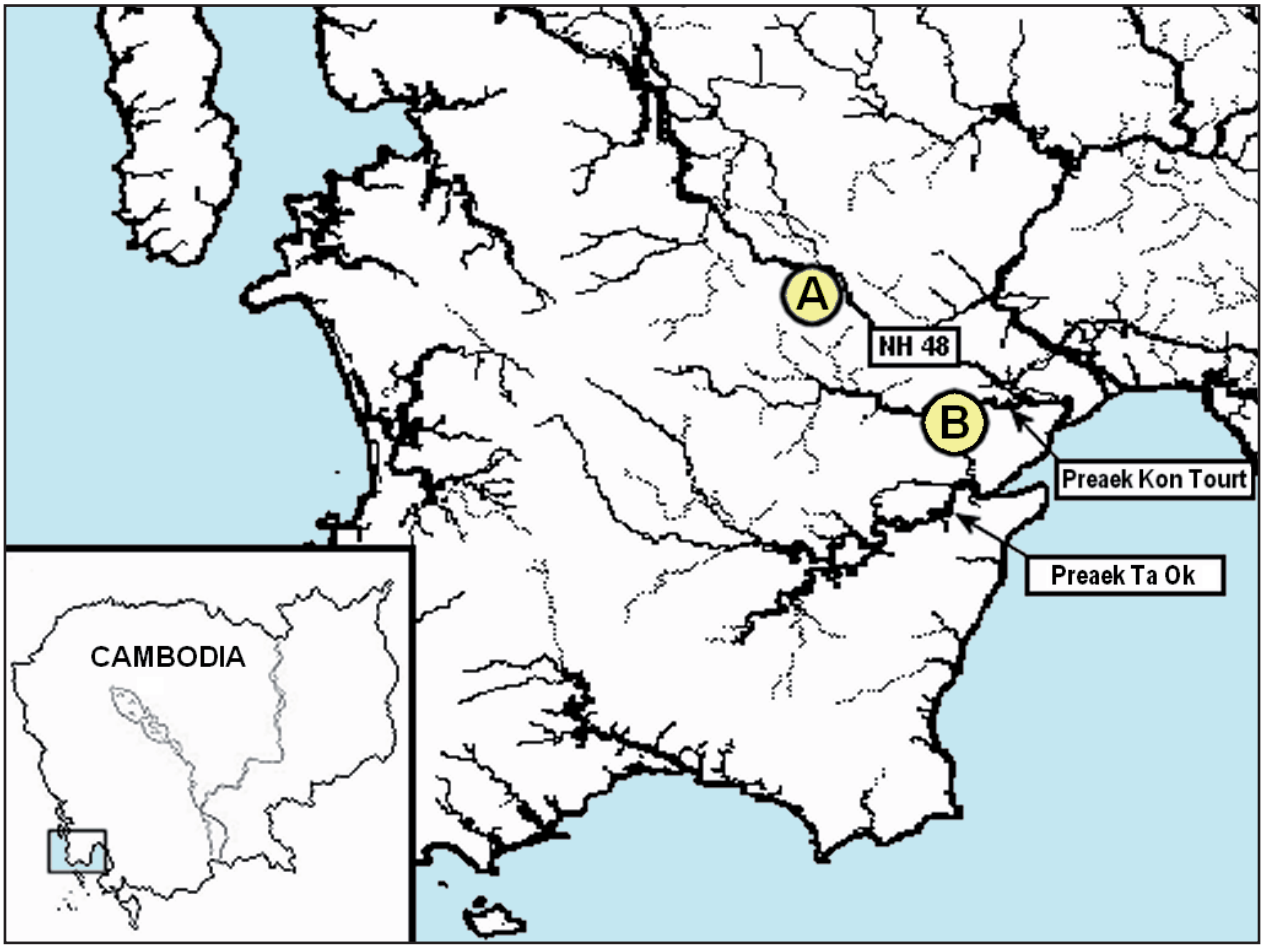
In addition to reporting on species that were recorded during systematic surveys, additional species recorded opportunistically between April 2005 and June 2009 were included. These records come from the author and past Frontier and counterpart staff and were also scrutinised by the author before being reported. Records were judged on the reliability of the source of identification, likelihood of a species occurring within the area and the distinctiveness of the species in question. Only records of species for which there could be little confusion over identification were accepted.

Results

A total of 203 species have been identified in Botum-Sakor. Twelve species are as yet unconfirmed records. Of the species identified, 181 were recorded during systematic surveys at sites A and B whilst the remaining 22 were recorded opportunistically.

Seven of the species registered are of conservation concern i.e. globally threatened or globally near threatened. The white-winged duck *Cairina scutulata* and green peafowl *Pavo muticus* are listed as Endangered, the lesser adjutant *Leptoptilos javanicus* and milky stork *Mycteria cinerea* are listed as Vulnerable to extinction and darter *Anhinga melanogaster*, great hornbill *Buceros bicornis* and grey-

Fig. 1. Map of Botum-Sakor National Park and study sites.



headed fish eagle *Ichthyophaga ichthyaetus* are listed as Near Threatened (BirdLife International, 2009).

Fourteen biome-restricted species were identified (Seng *et al.*, 2003). Seven species are restricted to Indochinese moist tropical forest and seven species are restricted to Indo-Malayan tropical dry zone (see appendix).

Three subspecies endemic to the Cardamom Mountains Ecoregion were identified during the study: the ochraceous bulbul *Alophoixus ochraceus cambodianus*, striped tit babbler *Macronous gularis saraburiensis*, and white-bellied yuhina *Yuhina zantholeuca canescens*.

In addition, 33 species that are listed in CITES appendices were recorded (see appendix).

Species Accounts

Species of Global Conservation Concern

White-winged Duck *Cairina scutulata*

A single individual was observed by the author on 9 March 2009 on Preaek Kompong Phlu. The individual was distinguished from other similar species (particularly female comb ducks *Sarkidiornis melanotos*) and feral ducks by the distinctive white wing coverts which were clearly seen, the black-speckled white hood, dark underparts and body size. This sighting is only the second modern record of the species in Southwest Cambodia (see Engelbach, 1952 and Daltry & Kuy, 2003) and one of only several reliable reports from within Cambodia. A single individual was observed on the river

bank whilst conducting boat surveys at 10h00 on a freshwater section of the river with dense largely semi-evergreen forest on either side. The bird was observed approximately 2.5 km from a freshwater swamp (Lac Chak) which is more characteristic of *C. scutulata* habitat. The area also contains many large grasslands that were largely dry at the time of observation, but during the wet season become submerged, forming large wetlands. The species appears to be present in low numbers due to lack of sightings and unfamiliarity of local people with the species. Botum-Sakor contains large areas of slow moving forested freshwater riverine habitat suitable for sustaining a white-winged duck population, but intensive selective logging has severely reduced the available breeding habitat.

Green Peafowl *Pavo muticus*

There was one record of this globally threatened species: fresh footprints identified by local guides at site A in an area of grassland in close proximity to a large river in August 2008. Five audio recordings were made at site B, all of which were in close proximity to the Preaek Kon Tourt River, with the first audio record made on 28 October 2008. All other audio records were in early November. Four recordings of calling males were made in close proximity to each other at site B, 15 km along the Preaek Kon Tourt. The first three records were possibly of the same individual in an area of dense semi-evergreen forest with the fourth record close to the Kon Tourt Village near agricultural land.

Historically, this species was widespread throughout Asia, but through hunting and habitat fragmentation, this species now only occurs in reduced fragmented populations (BirdLife International, 2001). Conversations with park rangers and local hunters suggested that this species is not targeted by hunters due to a particular respect that local people have for its beauty and, possibly more significantly, due to the low trade value of this species compared to other hunting targets, such as Asian slow loris *Nycticebus coucang* or Sunda pangolin *Manis javanica*. It is quite possible that Botum-Sakor contains a healthy population of this globally threatened species and may be of global significance. There have been reliable reports of a large roost near the village of Chamkar Leu on the east coast, while the Preaek Ta Ok and Preaek Kompong Phlu in particular contain good quality green peafowl habitat. Species-specific studies during the calling season could potentially provide an estimate of their density in Botum-Sakor.

Lesser Adjutant *Leptoptilos javanicus*

There were 13 records of this globally threatened species during surveys at site A and B. Most sightings were of individuals. Eleven of these were at the most western parts of the Preaek Kon Tourt, particularly around open grasslands and meadows, while there were only two records at the eastern end of the river near brackish waters. This species is present in Botum-Sakor throughout the year, but its breeding status is unclear. The presence of mature adults during the breeding season in Botum-Sakor suggests that the species breeds within the area, but no nests have been observed and locals appear unfamiliar with stork nests.

Milky Stork *Mycteria cinerea*

Three individuals were observed on mudflats at the Preaek Ta Ok Kompong Som estuary on 12 May 2009. Of the three stork species recorded, *M. cinerea* appears to be present at the lowest density. The species may be a dry season visitor to coastal mud flats, but the lack of sightings limits analysis of seasonal behaviours. Milky storks have also been recorded at Ream National Park, Kampong Smach and Preaek Taek Sap in Southwest Cambodia (Birdlife International, 2009), but the breeding status of this species in the Southwest remains unclear.

Great Hornbill *Buceros bicornis*

There were eight records of this near threatened species at site A, all of which were in areas of tall canopy evergreen forest, with seven of the eight records in July. At site B, this species was regularly encountered within close proximity to the Preaek Kon Tourt River, usually found perched in the tallest trees. Groups of up to five individuals were

observed at this location. This species is present in Botum-Sakor throughout the year, but observations during the breeding season consisted of individuals only, suggesting that immature individuals remain in Botum-Sakor whilst breeding birds move to areas with taller forest and better nesting habitat.

Darter *Anhinga melanogaster*

One individual was observed in an area of brackish water close to mangrove habitat on Preaek Kon Tourt in October 2008 with two further sightings of individuals on Preaek Ta Ok and Preaek Kompong Phlu in March and July 2009 respectively. The low number of records suggests that this species exists at low densities within Botum-Sakor and is not breeding.

This is the second modern record of this species in the southwest of Cambodia since Seng (2008) recorded the species in the Sre Ambel area, and may indicate an increase in distribution following the protection of Tonle Sap colonies that were close to extinction approximately six years ago (Goes, 2005).

Grey-headed Fish-Eagle *Ichthyophaga ichthyaetus*

Two observations of individuals in flight were recorded of this species at site B. Both observations were made approximately 15 km along the Preaek Kon Tourt above an area of high quality evergreen forest approximately 100 m asl near the route 48 highway. A breeding pair and nest were found next to a freshwater swamp near the village of Kompong Phlu in May 2009.

This species was distinguished from the lesser fish-eagle *I. humilis* by its white tail with terminal black band. Lesser fish-eagles have not been recorded in Botum-Sakor. This sighting is significant due to a lack of confirmed records from Southwest Cambodia, and because Robson (2007) does not state the occurrence of the species in coastal wetlands.

Species of Regional Conservation and Distribution Interest

Wreathed Hornbill *Aceros undulatus*

This species was recorded at site B only, with the number of observations increasing with the onset of the dry season. Sightings of this species at Site A during the dry season, outside the period of this study, suggest a degree of regional migration (as with the great hornbill). Noticeably more common than the great hornbill, groups of three or four individuals were regularly observed, and on one occasion, a group of 12 was observed. As with the great hornbill, this species does not appear to be breeding in Botum-Sakor, possibly due to lack of nesting habitat caused by a history of intensive selective logging.

Little Bronze Cuckoo *Chrysococcyx minutillus*

A single individual was recorded by the author at site B on 27 October 2008 in semi-evergreen river edge forest next to Preaek Kon Tourt. This is the first published record for the species in Cambodia, with two further records from Thmar Bang and Prey Nup mangroves (F. Goes, in prep.). As the host species, golden-bellied gerygone *Gerygone sulphurea*, has also been recorded, it is plausible that little bronze cuckoo is breeding in Botum-Sakor.

Green Imperial Pigeon *Ducula aenea*

Threatened in both Laos and Thailand (Tan & Poole, 2003), this species was found to be extremely common at both study sites and is potentially the commonest pigeon species in the area. Records were largely of individuals or pairs, but a group of approximately 30 individuals was observed at study site A.

Black Kite *Milvus migrans*

There were three records of individuals at site A, all of which were seen from the route 48 highway near forest edge and meadow habitat. There was a single record of an individual from the Preaek Kon Tourt River at site B in October 2008. This is the third record for Southwest Cambodia (F. Goes, pers. comm.).

White-bellied Sea Eagle *Haliaeetus leucogaster*

Recorded only at site B, this species was observed on five occasions. One observation was over freshwater, 15 km upstream the Preaek Kon Tourt River whilst four observations of four separate individuals were recorded during a boat survey on brackish waters close to the river mouth. There appeared to be at least one breeding pair close to the river mouth.

This species has also been recorded on Preaek Trapeaung Rung in the northwest of Botum-Sakor, suggesting the species is found throughout coastal areas of the national park.

Woolly-necked Stork *Ciconia episcopus*

There were three records of this species at site A and eight at site B during the systematic surveys. As with the lesser adjutant, all observations were close to grassland. This species appeared to be more widespread within Botum-Sakor than the lesser adjutant, because birds were seen at both study sites and their distribution appeared to be more continuous along the Preaek Kon Tourt River.

The breeding status of this species is unclear, with no nests or nesting behaviour observed.

Black-and-red Broadbill *Cymbirhynchus macrorhynchos*

A single observation was made at the western end of the Preaek Kon Tourt River during surveys at Site B in November 2008. This species was regularly observed during the breeding season, however, with 10 active nests counted on the Preaek Kon Tourt alone between April and June 2009, indicating that the species is largely a breeding visitor to Botum-Sakor.

Golden-crested Myna *Ampeliceps coronatus*

One group of approximately six individuals was recorded over the Preaek Kon Tourt River at site B in semi-evergreen river edge forest.

Hill Myna *Gracula religiosa*

This species was observed to be common at both study sites and was recorded daily. Most observations were of pairs, but groups of six or seven individuals were occasionally observed at both sites.

Discussion

Avifaunal diversity in Botum-Sakor National Park was estimated at approximately 200 species. Botum-Sakor has a substantial bird community and this level of diversity is comparable to other protected areas such as Kirirom and Ream National Parks (Goes *et al.*, 1998), Phnom Samkos Wildlife Sanctuary (Steinheimer *et al.*, 2000) and the southern Cardamoms (Daltry & Kuy, 2003; Pilgrim & Pierce, 2003). There is a large diversity of habitats within Botum-Sakor with various forest, freshwater and coastal habitats present. This variation in ecosystems suggests that Botum-Sakor may be an important area for many bird communities.

Seven of the species identified are of particular conservation interest due to their global status, and the presence of a potentially non-hunted population of green peafowl is particularly interesting. There also appears to be a substantial population of lesser adjutants and great hornbills, although it remains unclear whether these species are breeding within Botum-Sakor. Surveys in habitats not covered in this study, such as the relatively undisturbed small mountain range in the northwest of the park, may result in the recording of additional species.

Areas that contain several species of conservation importance should be afforded high levels of protection to preserve bird communities. High levels of disturbance were noted at both study sights, and disturbance levels are potentially higher on the western and southern sides of the park. Evidence of illegal logging and poaching was encountered during the study, while the planned development of a power station and possible tourist resorts in the Southwest, adjacent to Kaoh Sdach Island, will undoubtedly threaten important bird habitats.

At present, Botum-Sakor meets two criteria for the designation as an Important Bird Area (IBA). Criterion A1 is met because there are substan-

tial populations of species of global conservation concern and criterion A3 is met because Botum-Sakor also possesses significant numbers of a bird species whose distribution is confined to one biome (Seng *et al.*, 2003). Therefore, it is recommended that Botum-Sakor should be designated as an IBA. Until population densities of key species can be estimated, this designation should be at the national level. Initial studies and conversations with locals suggest that diversity within Botum-Sakor is highest around the Preaek Ta Ok, north through the Preaek Kon Tourt and NH 48 highway, and west towards the small mountain range. Any IBA designation should encompass these areas.

Further studies within Botum-Sakor are planned by Frontier with the aim of obtaining more detailed information on the distribution of key species within the park. Areas of the park which are important for key species, such as white-winged duck and green peafowl, should be identified and future conservation measures aimed at preserving these habitats. A number of species of global conservation interest that occur in the southwest of Cambodia, such as black-necked stork (Daltry & Kuy, 2003), greater adjutant stork, painted stork, brown hornbill (Goes *et al.*, 1998), masked finfoot, white-shouldered ibis (Engelbach, 1948) and silver oriole (Daltry & Kuy, 2003; Pilgrim & Pierce, 2006) were not recorded in this study. It is a key objective of future surveys to further investigate the presence or absence of these species so that their distribution and habitat requirements can be further analysed and their status assessed.

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About the Author

ALEXANDER ROYAN has been working for Frontier-Cambodia in Botum-Sakor National Park since July 2008. His main interest is the conservation of avifaunal diversity in tropical regions, having worked in Bolivia prior to his arrival in Cambodia. Now that a comprehensive species list for Botum-Sakor has been obtained, he is developing species-specific studies directed at those of particular conservation importance.

Appendix

Table 1 Birds recorded in Botum-Sakor National Park. *See next page for key*.

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
[Chinese francolin]	*Francolinus pintadeanus*		H	A	Heard only.
Blue-breasted quail	*Coturnix chinensis*		S	A	
Barred buttonquail	*Turnix suscitator*		S	B	
Scaly-breasted partridge	*Arborophila chloropus*	IMTF	SH	A	
Red junglefowl	*Gallus gallus*		SH	AB	Notably more common at site B than site A.
Green peafowl	*Pavo muticus*	GEn/ ITDZ/ II	SH	AB	See species accounts.
White-winged duck	*Cairina scutulata*	END/ I	S		See species accounts.
Lesser whistling-duck	*Dendrocygna javanica*		S	B	
Heart-spotted woodpecker	*Hemicircus canente*		SH	AB	

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Grey-capped pygmy woodpecker	*Dendrocopos canicapillus*		SH	A	
Lesser yellownape	*Picus chlorolophus*		SH	A	
Laced woodpecker	*Picus vittatus*		SH	AB	
Rufous woodpecker	*Celeus brachyurus*		S		Sighting by author; secondary habitat near grassland.
Common flameback	*Dinopium javanense*		SH	AB	
Greater flameback	*Chrysocolaptes lucidus*		SH	A	
Great slaty woodpecker	*Mulleripicus pulverulentus*		SH	B	
Lineated barbet	*Megalaima lineata*	ITDZ	SH	AB	
Green-eared barbet	*Megalaima faiostricta*	IMTF	SH	AB	
Blue-eared barbet	*Megalaima australis*		SH	AB	
Coppersmith barbet	*Megalaima haemacephala*		H	A	
Great hornbill	*Buceros bicornis*	GNt/ I	SH	AB	See species accounts.
Wreathed hornbill	*Aceros undulatus*	II	SH	B	See species accounts.
Oriental pied hornbill	*Anthracoceros albirostris*	II	SH	AB	Recorded in a variety of habitats; common throughout.
Common hoopoe	*Upupa epops*		S		Sighting by author, 05/09.
Indian roller	*Coracias benghalensis*		S	AB	
Dollarbird	*Eurystomus orientalis*		SH	AB	
Orange-breasted trogon	*Harpactes oreskios*		SH	AB	
Common kingfisher	*Alcedo atthis*		SH	AB	Recorded on both large and small rivers and observed fishing from flooded forest paths; first record 08/08.
Blue-eared kingfisher	*Alcedo meninting*		SH	AB	Recorded on both large and small rivers.
Black-backed kingfisher	*Ceyx erithacus*		S	B	One record from Preaek Chipat and 5 records from Preaek Kon Tourt; possibly breeding; 7th record Cambodia, 2nd SW.
[Pied kingfisher]	*Ceryle rudis*		S		Frontier record from Preaek Kompong Phlu; uncertain source; 1st record Cardamom region, 2nd SW.
Stork-billed kingfisher	*Halcyon capensis*		SH	B	One record on wide strech of river next to cultivation.

Key to table.

Common name: square brackets indicate an unconfirmed sighting.

Status: GEnd: Globally Endangered; GVul: Globally Vulnerable; GNt: Globally Near-Threatened; IMTF: Biome-restricted species for Indochinese Moist Tropical Forest; ITDZ: Biome-restricted species for Indo-Malayan Tropical Dry Zone; I: CITES Appendix I species; II: CITES Appendix II species; III: CITES Appendix III species.

Evidence: H: Audio (call heard); S: Visual (seen); SH: Visual and Audio.

Habitat and distribution notes: WV: Winter Visitor; PM: Passage Migrant; 1st SW: first record of species in Southwest Cambodia; 2nd SW: first record of species in Southwest Cambodia.

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Ruddy kingfisher	*Halcyon coromanda*		S	B	One record from an individual captured by a fisherman December 2008 and two sightings in mangrove habitat 04/09 and 05/09; possibly breeding; 1st record Cardamom region.
White-throated kingfisher	*Halcyon smyrnensis*		S	B	One record on wide stretch of river next to cultivation.
Black-capped kingfisher	*Halcyon pileata*		S	B	Most common kingfisher species along Preaek Kon Tourt.
Collared kingfisher	*Todiramphus chloris*		S	B	One record from Preaek Kon Tourt.
Large hawk cuckoo	*Hierococcyx sparverioides*		S	B	One observation 11/08in river edge forest and one observation 02/09 in undisturbed evergreen forest.
Coral-billed ground cuckoo	*Carpococcyx renauldi*	IMTF	H	A	One record of calling individual in disturbed evergreen forest.
Drongo cuckoo	*Surniculus lugubris*		SH	A	
Asian koel	*Eudynamys scolopacea*		S	B	
Little bronze cuckoo	*Chrysococcyx minutillus*		S	B	See species accounts.
Green-billed malkoha	*Phaenicophaeus tristis*		SH	AB	
Greater coucal	*Centropus sinensis*		SH	AB	
Lesser coucal	*Centropus bengalensis*		S	AB	
Blue-bearded bee-eater	*Nyctyornis athertoni*		S		Observation by author on Preaek Kon Tourt 05/09.
Green bee-eater	*Merops orientalis*		H	AB	
Blue-tailed bee-eater	*Merops philippinus*		SH	B	One record from an area of cultivation bordering the Preaek Kon Tourt.
Chestnut-headed bee-eater	*Merops leschenaulti*		SH	B	
Vernal hanging parrot	*Loriculus vernalis*	II	SH	A	
Red-breasted parakeet	*Psittacula alexandri*	II	SH	AB	
Crested treeswift	*Hemiprocne coronata*		S	AB	
[Germain's swiftlet]	*Collocalia germani*		S	B	Uncertain identification.
[Silver-backed needletail]	*Hirundapus cochinchinensis*		S	AB	Uncertain identification.
Brown-backed needletail	*Hirundapus giganteus*		S	AB	
Asian palm swift	*Cypsiurus balasiensis*		S	A	
Fork-tailed swift	*Apus pacificus*		SH	AB	
House swift	*Apus affinis*		S	A	
[Collared scops owl]	*Otus bakkamoena*	II	S		Frontier record on Preaek Kompong Phlu; uncertain source.
Collared owlet	*Glaucidium brodiei*	II	H	A	
Buffy fish owl	*Ketupa ketupu*	II	S	B	Sighting by author on Preaek Kon Tourt December 2008 and a skin found in Kamlat Village in southern Cardamoms by author 09/09.
[Oriental bay owl]	*Phodilus badius*	II	S		Frontier record on Preaek Kon Tourt; uncertain source and identification.
Brown hawk owl	*Ninox scutulata*	II	H	B	
Great-eared nightjar	*Eurostopodus macrotis*		SH	AB	
Large-tailed nightjar	*Caprimulgus macrurus*		SH	AB	
[Savanna nightjar]	*Caprimulgus affinis*		SH	B	Uncertain identification.

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Rock pigeon	*Columba livia*	III	SH	AB	
Green imperial pigeon	*Ducula aenea*		SH	AB	See species accounts.
Mountain imperial pigeon	*Ducula badia*		SH	A	Recorded at an altitude of approximately 100 m asl.
Spotted dove	*Streptopelia chinensis*		SH	B	
Red-collared dove	*Streptopelia tranquebarica*		S	A	
[Barred cuckoo dove]	*Macropygia unchall*		H	AB	Heard only; 100 m asl.
Pink-necked green pigeon	*Treron vernans*		SH	AB	
Pompadour green pigeon	*Treron pompadora*		S		Sighting by author, Preaek Kon Tourt 05/09.
Thick-billed green pigeon	*Treron curvirostra*		S	AB	
Emerald dove	*Chalcophaps indica*		S	A	
White-breasted waterhen	*Amaurornis phoenicurus*		S	B	
Ruddy-breasted crake	*Porzana fusca*		S		Frontier record on Preaek Kompong Phlu.
Common snipe	*Gallinago gallinago*		SH	AB	First recorded on 28/08/08.
Whimbrel	*Numenius phaeopus*		SH	B	WV/PM; First recorded on 02/11/08.
Common redshank	*Tringa totanus*		S	B	WV/PM; First recorded on 10/09/08.
Marsh sandpiper	*Tringa stagnatilis*		S	B	Individual recorded by author on Preaek Kon Tourt 01/09; 1st record Cardamom region.
Kentish plover	*Charadrius alexandrinus*		S	B	WV/PM; first record 02/09.
[Grey-headed lapwing]	*Vanellus cinereus*		S		Frontier record on Preaek Ta Oak Estuary; 2nd SW; Uncertain identification.
Red-wattled lapwing	*Vanellus indicus*		S	B	
Common tern	*Sterna hirundo*		SH	B	
Jerdon's baza	*Aviceda jerdoni*	II	S		Observation of individual bird by author 03/09 in undisturbed evergreen forest; distinguished from *Accipiter* by crest on head.
Black baza	*Aviceda leuphotes*	II	S	B	
Oriental honey-buzzard	*Pernis ptilorhyncus*	II	SH	AB	
Black kite	*Milvus migrans*	II	S	AB	See species accounts.
Brahminy kite	*Haliastur indus*	II	S	B	Three observations; one 15 km inland and one at river mouth.
White-bellied sea eagle	*Haliaeetus leucogaster*	II	SH	B	See species accounts.
Grey-headed fish eagle	*Ichthyophaga ichthyaetus*	GNt/ II	S	B	See species accounts.
Osprey	*Pandion haliaetus*	II/	S	B	WV/PM; First recorded on 10/09/08.
Black-shouldered kite	*Elanus caeruleus*	II	S	B	
Crested-serpent eagle	*Spilornis cheela*	II	S	AB	
Shikra	*Accipiter badius*	II	S	AB	
Rufous-bellied eagle	*Hieraaetus kienerii*	II	S	A	Two observations over meadow and evergreen forest at extreme north of park.
Changeable hawk eagle	*Spizaetus cirrhatus*	II	S	AB	
Darter	*Anhinga melanogaster*	GNt	S	B	See species accounts.

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Little cormorant	*Phalacrocorax niger*		S	B	One record of individuals from both the Preaek Kon Tourt and Preaek Ta Ok.
Little egret	*Egretta garzetta*		S	B	
Intermediate egret	*Mesophoyx intermedia*	III	S	B	
Cattle egret	*Bubulcus ibis*	III	S	B	
Chinese pond heron	*Ardeola bacchus*		SH	B	WV; First recorded on 11/10/08.
Javan pond heron	*Ardeola speciosa*		SH	B	
Grey heron	*Ardea cinerea*		S	B	
[Purple heron]	*Ardea purpurea*		S		Frontier record on Preaek Ta Ok; uncertain identification.
Little heron	*Butorides striatus*		S	B	
Malayan night heron	*Gorsachius melanolophus*		SH	A	Single observation on a small stream within dense evergreen forest; 1st SW.
Yellow bittern	*Ixobrychus sinensis*		S	AB	
Lesser adjutant	*Leptoptilos javanicus*	GVul	S	B	See species accounts.
Milky stork	*Mycteria cinerea*	GVul/ I	S		See species accounts.
Woolly-necked stork	*Ciconia episcopus*		S	AB	See species accounts.
Hooded pitta	*Pitta sordida*		S	A	Specimen found on route 48 highway near evergreen forest at 100 m asl 07/08; 1st record since 2000.
Blue-winged pitta	*Pitta moluccensis*	IMTF	H	A	Recorded throughout year; regularly recorded between May and June; Nest and breeding pair recorded.
Black-and-red broadbill	*Cymbirhynchus macrorhynchos*		S	B	See species accounts.
Banded broadbill	*Eurylaimus javanicus*		S	B	
Dusky broadbill	*Corydon sumatranus*		SH	A	
Blue-winged leafbird	*Chloropsis cochinchinensis*		SH	AB	
Golden-fronted leafbird	*Chloropsis aurifrons*		S	A	
Common iora	*Aegithina tiphia*		SH	B	
Great iora	*Aegithina lafresnayei*		S	B	
Asian fairy bluebird	*Irena puella*		SH	AB	
Tiger shrike	*Lanius tigrinus*		S	AB	1st record Cardamom region.
Brown shrike	*Lanius cristatus*		S	AB	WV; First record 03/09/08.
Red-billed blue magpie	*Urocissa erythrorhyncha*		S	A	
Rufous treepie	*Dendrocitta vagabunda*		S		Frontier record on Preaek Kompong Phlu in dipterocarp forest.
Racket-tailed treepie	*Crypsirina temia*	ITDZ	SH	AB	
Large-billed crow	*Corvus macrorhynchos*		SH	B	Only one record from an area of cultivation.
Black-naped oriole	*Oriolus chinensis*		SH	B	First record 21/09/08.
Black-hooded oriole	*Oriolus xanthornus*		SH	A	
Scarlet minivet	*Pericrocotus flammeus*		SH	A	
Ashy minivet	*Pericrocotus divaricatus*		S	AB	WV/PM; First record 21/07/08.
Black drongo	*Dicrurus macrocercus*		S	B	
Ashy drongo	*Dicrurus leucophaeus*		SH	AB	
Bronzed drongo	*Dicrurus aeneus*		SH	AB	

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Spangled drongo	*Dicrurus hottentottus*		SH	AB	
Greater racket-tailed drongo	*Dicrurus paradiseus*		SH	AB	
Bar-winged flycatcher-shrike	*Hemipus picatus*		S	A	
Black-naped monarch	*Hypothymis azurea*		SH	AB	
Pied fantail	*Rhipidura javanica*		S		Frontier record on Preaek Kompong Phlu.
Asian paradise-flycatcher	*Terpsiphone paradisi*		SH	A	Rufous male morph.
Common woodshrike	*Tephrodornis pondicerianus*		SH	AB	
Asian brown flycatcher	*Muscicapa dauurica*		S	B	WV/PM; First recorded on 23/10/08.
[Brown-streaked flycatcher]	*Muscicapa williamsoni*		S	AB	Uncertain identification; sightings of individual on 21/08/09.
Mugimaki flycatcher	*Ficedula mugimaki*		SH	A	WV/PM; First recorded on 21/08/08; earliest recorded date.
Red-throated flycatcher	*Ficedula parva*		S	B	WV/PM; First recorded on 22/10/08.
Little pied flycatcher	*Ficedula westermanni*		S	A	Individual male recorded in evergreen forest 16/08/09; lower altitudinal range extension of approximately 100 m (Robson, 2007).
Siberian blue robin	*Luscinia cyane*		S	B	WV; First recorded on 20/10/08.
Oriental magpie robin	*Copsychus saularis*		SH	A	
White-rumped shama	*Copsychus malabaricus*		S	AB	
Common myna	*Acridotheres tristis*		SH	B	
White-vented myna	*Acridotheres grandis*		S		Frontier record on Preaek Kompong Phlu 01/07.
Golden-crested myna	*Ampeliceps coronatus*	IMTF	S	B	See species accounts.
Hill myna	*Gracula religiosa*	II	SH	AB	See species accounts.
Black-collared starling	*Sturnus nigricollis*	ITDZ	S	A	
Vinous-breasted starling	*Sturnus burmannicus*		S		Frontier record on Preaek Kon Tourt.
Velvet-fronted nuthatch	*Sitta frontalis*		S		Two Sighting by author in secondary habitat 04/09 and 05/09.
[Sand martin]	*Riparia riparia*		S	A	Uncertain identification; WV first recorded on 28/08/08.
Asian house martin	*Delichon dasypus*		S		Frontier record on Preaek Ta Ok; 11/06.
Barn swallow	*Hirundo rustica*		S	AB	WV/PM; First recorded on 27/08/08.
Pacific swallow	*Hirundo tahitica*		S	B	WV; First recorded on 02/11/08.
Red-rumped swallow	*Hirundo daurica*		S	B	WV/PM; single record 11/08.
Black-headed bulbul	*Pycnonotus atriceps*		S	B	
Black-crested bulbul	*Pycnonotus melanicterus*		SH	AB	
Stripe-throated bulbul	*Pycnonotus finlaysoni*	IMTF	SH	AB	
Yellow-vented bulbul	*Pycnonotus goiavier*		SH	AB	
Streak-eared bulbul	*Pycnonotus blanfordi*	ITDZ	S	A	
Sooty-headed bulbul	*Pycnonotus aurigaster*	ITDZ	SH	A	
Ochraceous bulbul	*Alophoixus ochraceus*		SH	AB	
Grey-breasted prinia	*Prinia hodgsonii*		SH	A	
Plain prinia	*Prinia inornata*		SH	A	

Common name	Scientific name	Status	Evidence	Sites	Habitat/ distribution notes
Striated grassbird	*Megalurus palustris*		S	B	Scrub habitat near agricultural land; 1st SW.
Bright-headed cisticola	*Cisticola exilis*		SH	B	
Asian stubtail	*Urosphena squameiceps*		S	A	Single record 06/08/09; 1st record Cardamom region.
Lanceolated warbler	*Locustella lanceolata*		SH	B	WV/PM; First recorded on 20/10/08.
Golden-bellied gerygone	*Gerygone sulphurea*		SH	A	Single record of two birds 06/08/09; 1st record Cardamom region.
Common tailorbird	*Orthotomus sutorius*		SH	AB	
Dark-necked tailorbird	*Orthotomus atrogularis*		SH	A	
Dusky warbler	*Phylloscopus fuscatus*		S	B	WV/PM; First recorded on 21/10/08.
Arctic warbler	*Phylloscopus borealis*		SH	AB	PM; First recorded on 15/07/08.
White-crested laughingthrush	*Garrulax leucolophus*		SH	AB	
[Abbott's babbler]	*Malacocincla abbotti*		H	A	Heard only; single record 05/08/08; 1st record Cardamom region.
Puff-throated babbler	*Pellorneum ruficeps*		SH	AB	
Striped-tit babbler	*Macronous gularis*		SH	AB	
Chestnut-capped babbler	*Timalia pileata*		S		Several sightings by author 04/09.
White-bellied yuhina	*Yuhina zantholeuca*		SH	A	
Indochinese bushlark	*Mirafra marionae*		SH	AB	
Yellow-vented flowerpecker	*Dicaeum melanoxanthum*		SH	B	Pair of birds recorded on 27/10/08; river edge secondary habitat.
Scarlet-backed flowerpecker	*Dicaeum cruentatum*		SH	AB	
Purple-throated sunbird	*Nectarinia sperata*		SH	AB	
Purple sunbird	*Nectarinia asiatica*		S	B	
Crimson sunbird	*Aethopyga siparaja*		SH	AB	
Brown-throated sunbird	*Anthreptes malacensis*		SH	AB	
Ruby-cheeked sunbird	*Anthreptes singalensis*		SH	AB	
Olive-backed sunbird	*Nectarinia jugularis*		SH	AB	
Little spiderhunter	*Arachnothera longirostra*		SH	AB	
White wagtail	*Motacilla alba*		S		Frontier record on agricultural land near small stream.
Yellow wagtail	*Motacilla flava*		S	A	WV/PM; First recorded on 09/08/08.
Grey wagtail	*Motacilla cinerea*		SH	A	WV/PM; First recorded on 22/07/08.
Forest wagtail	*Dendronanthus indicus*		S		WV/PM; observation by author 04/09.
Paddyfield pipit	*Anthus rufulus*		SH	B	
White-rumped munia	*Lonchura striata*		S	A	

A comparative study of incentive-based schemes for Siamese crocodile *Crocodylus siamensis* conservation in the Cardamom Mountains, Cambodia

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សេចក្តីសង្ខេប:

ឯកសារស្រាវជ្រាវនេះផ្តល់នូវភស្តុតាងបញ្ជាក់អំពីប្រសិទ្ធភាពនៃកម្មវិធី តាមរយៈគោលការណ៍លើកទឹកចិត្តដោយផ្ទាល់ និងដោយប្រយោលសម្រាប់ការអភិរក្សសត្វក្រពើភ្នំនៅតំបន់ជួរភ្នំក្រវាញ់នៃប្រទេសកម្ពុជា តាមរយៈការប្រើប្រាស់ករណីសិក្សាពីរ: (១)កម្មវិធីលើកទឹកចិត្តដោយផ្ទាល់នៅឃុំជំនាប់ (២)កម្មវិធីលើកទឹកចិត្តដោយប្រយោលនៅឃុំអូរសោម។ យើងបានធ្វើពិសោធសម្មតិកម្មមួយថា ពុំមានភាពខុសគ្នាទៅលើប្រសិទ្ធភាពនៃគម្រោងទាំងពីរនោះទេ ដោយធ្វើការប្រៀបធៀបនូវសូចនាករសេដ្ឋកិច្ច-សង្គម ទស្សនាទានសហគមន៍ ទស្សនាទានលើការនេសាទ និងកត្តាជីវសាស្ត្រ។ ប្រជាសហគមន៍ចំនួន ១០៨ នាក់ មកពីឃុំទាំងពីរខាងលើត្រូវបានជ្រើសរើសដោយគំរូចៃដន្យដើម្បីធ្វើសម្ភាស។ ការឆ្លើយតបរបស់ពួកគាត់ និងទិន្នន័យតាមដានសត្វក្រពើភ្នំប្រចាំឆ្នាំត្រូវបានវិភាគ និងប្រៀបធៀបយ៉ាងហ្មត់ចត់។ ការសិក្សានេះបានរកឃើញថា ពុំមានភាពខុសគ្នាទេ តាមការវិភាគស្ថិតិរវាងគោលការណ៍លើកទឹកចិត្តទាំងពីរចំពោះជោគជ័យក្នុងកិច្ចអភិរក្សសត្វក្រពើភ្នំ: គោលការណ៍ទាំងពីរមានប្រសិទ្ធភាពក្នុងការថែរក្សាការពារចំនួនសត្វក្រពើភ្នំដែលស្ថិតនៅឃុំជំនាប់ និងឃុំអូរសោមចាប់តាំងពីឆ្នាំ ២០០៤ មកម្លេះ។ ទោះជាយ៉ាងណាក៏ដោយតំបន់គោលដៅទាំងពីរនេះកំពុងទទួលរងផលប៉ះពាល់ដោយសារគម្រោងទំបន់វារីអគ្គីសនីពីរផ្សេងគ្នា: ដំណាក់កាលសាងសង់ (ឃុំអូរសោម) និងដំណាក់កាលបានអនុញ្ញាត (ឃុំជំនាប់)។ យើងខ្ញុំសូមផ្តល់អនុសាសន៍ថា គម្រោងគួរបង្កើតក្រុមឆ្លើយតបពីសត្វក្រពើភ្នំនៅទីវាល និងសិក្សាស្រាវជ្រាវពីអេកូឡូស៊ី និងសង្គមពេញលេញមួយទៀតដើម្បីមានទិន្នន័យជាមូលដ្ឋានគ្រប់គ្រាន់ក្នុងការត្រួតពិនិត្យតាមដាន និងបន្ទរបន្ថយផលប៉ះពាល់ពីគម្រោងអភិវឌ្ឍន៍នេះ។ ទន្ទឹមនឹងនេះ ការសិក្សាអំពីអាកប្បកិរិយាសហគមន៍ទៅលើការអភិរក្សសត្វក្រពើភ្នំ និងការប្រៀបធៀបគោលការណ៍លើកទឹកចិត្តដែលមានរយៈពេលវែងជាងការសិក្សានេះ ក៏អាចជាប្រធានបទដ៏មានសារៈសំខាន់មួយសម្រាប់ការសិក្សាបន្តផងដែរ។

Abstract

This paper provides supporting evidence of the effectiveness of direct and indirect incentive-based programmes for Siamese crocodile conservation in Cambodia's Cardamom Mountains. Using two cases – a largely direct incentives programme with Chumnoab Commune and an indirect incentives programme with Ou Saom Commune – we tested the null hypothesis that there is no difference in the effectiveness of the projects by comparing their economics, fisheries, community perceptions, and biological indicators. One hundred and eight households were randomly selected from the two communes and interviewed. Their responses, and annual crocodile monitoring data, were thoroughly compared and analysed. The study found no statistically significant difference between the two incentive schemes in terms of their success in conserving crocodiles: both schemes have been effective in maintaining the crocodile populations within Ou Saom and Chumnoab Communes since 2004. However, both sites currently have hydropower dams under construction (Ou Saom) or approved (Chumnoab) nearby. We recommend both projects establish field-based crocodile response teams and conduct another full social and ecological survey to monitor and mitigate the impacts of these developments. Community attitudes toward crocodiles as well as a longer period for comparison are also worth further investigation.

Keywords

Direct and indirect incentive programmes, Siamese crocodile, Cardamom Mountains, Cambodia.

Introduction

Rural and economic development have been rapidly growing around the developing world. For many decades, conservation biologists have identified the main cause of species extinction to be human-caused habitat loss (Wilcove *et al.*, 1998; Czech *et al.*, 2000; Berkes, 2004), and the increasing human population and resource-consumption are making the situation harder for wildlife (Boersma *et al.*, 2001). Balmford & Whitten (2003) asked who is responsible for paying for tropical conservation? They observed that rural populations in developing countries often bear the brunt of conservation policies.

In many cases, local communities can play an important role in protecting the ecosystems and species on which they depend or have spiritual values for. It could be argued that incentives should be paid to local communities to support their contribution (Emerton, 1999; Berkes, 2004; Sultana & Abeyasekera, 2007) and achieve conservation goals (Brown, 2002; Rao *et al.*, 2003). It is a challenge to establish such incentive-based programmes for biodiversity conservation in developing nations, however, due to rapid population growth, agricultural expansion, social hardship, and extreme poverty (Tilman *et al.*, 2001; Spiteri & Napalz, 2005). Consequently, questions of whether and how to apply incentive initiatives have been frequently debated by IUCN for more than 20 years (McNeely, 1988).

Up to now, Incentive-Based Programmes (IBPs) have been popular in the developed nations such as the USA and European countries for conservation on private land (Emerton, 1999; Clough, 2000; Ferraro & Kiss, 2002; Berkes, 2004; Spiteri & Napalz, 2005; Mayer & Tikka, 2006). IBPs could be even more popular in developing countries because they can provide a trade-off strategy for poverty alleviation (Sanderson & Redford, 2003; Kepe *et al.*, 2004; Chan *et al.*, 2007), which helps to meet the Millennium Development Goals (Rao *et al.*, 2003; Wells & McShane, 2004; Dale, 2007). Like other conservation strategies, however, IBPs can suffer from basic problems such as difficulties in overcoming variation in local attitudes, ages, gender, ethnicity, and economic class, which can result in unequal benefits and levels of participation (Mehta & Heinen, 2001; Sah & Heinen, 2001; Stem *et al.*, 2003; Spiteri & Napalz, 2005).

There are two types of incentives: indirect and direct. Both types have been discussed in terms of

their sustainable development and conservation outcomes (Ferraro & Kiss, 2002; Garnett *et al.*, 2007). The relative merits of direct and indirect incentive approaches are being hotly debated, especially concerning the management of community forests (Maikhuri *et al.*, 2001).

Indirect incentives include developing alternative markets and products, empowering stakeholders (Books *et al.*, 2006) - including women's self-help groups (Emerton, 2000; Ellis & Allison, 2004) - agricultural assistance, public schools, buildings, clinics, wells, and assistance to collect non-timber forest products (Ferraro & Kiss, 2002). Indirect schemes feature in many classic Integrated Conservation and Development Projects (ICDPs), as defined by Brandon & Wells (1992), which have been applied for many areas around the world including Madagascar (Marcus, 2001), Brazil (Brannstrom, 2001), Indonesia (Tomich *et al.*, 2002), Peru (Delgado Herrera, 2002), Sub-Saharan Africa (Ite & Adams, 2000; Scholte, 2003) and Taiwan (Tai, 2007).

Direct incentives have rarely been applied to biodiversity conservation initiatives in developing nations, and they have not been tested to see whether they work. These schemes typically relate to resource owners receiving direct financial payments for specific activities related to biodiversity protection (Hardner & Rice, 2002). In other words, monetary compensation is the trade-off between economic development and conservation (Schaible, 2000; Ferraro & Kiss, 2002; Berkes & Adhikari, 2006; Lindsey *et al.*, 2007; Reyes-García *et al.*, 2007; Tai, 2007). For example, fourteen European nations spent an approximately US$ 11 billion for a 4-year forestry contract covering 20 million hectares in Europe (OECD, 1997) and one tenth of Europe's payments - US$ 1.5 billion - were paid annually for conservation agreements during the 1990s (Clark & Downes, 1999).

Incentive-based programmes have recently been developed in the Central Cardamom Mountains as a tool for conserving the critically endangered Siamese crocodile *Crocodylus siamensis*, locally known as the mountain crocodile (*krapeu phnom*). Using an *indirect* assistance approach, Fauna & Flora International (FFI) and Forestry Administration (FA)'s Cambodian Crocodile Conservation Programme (CCCP) has been working with Ou Saom Commune (Veal Veng District, Pursat Province) since 2003 to manage its natural resources and develop sustainable agriculture, with assistance from a partner NGO, Cambodian Centre for the Study and Development of Agriculture (CEDAC). The concept of engaging Ou Saom Commune in crocodile conservation was formulated during socio-economic and ecological surveys between 2000 and 2002 (Maxwell, 2000; Daltry, 2002). In Chumnoab Commune (Thmar Bang District, Koh Kong Province), a largely *direct* incentives programme was introduced by Conservation International (CI)'s Conservation Stewardship Programme (CSP) in 2004, for the purposes of forest and crocodile protection. Both programmes strive to develop alternative livelihood strategies to reduce the need to poach wildlife or clear forests and educate and encourage the communities to be stewards of their environment.

A critical component in *both* communes has been the use of participatory land use planning to secure indigenous rights to land and natural resources while also creating agreed sanctuaries for crocodiles and other wildlife. The Ou Saom participatory land use plan was facilitated by FFI in 2003 and 2004 (Daltry *et al.*, 2004), and that of Chumnoab Commune was facilitated by CI shortly after (Milne, 2007). In the Philippines, land use planning and local governance have also become tools for conserving the critically endangered Philippine crocodile *Crocodylus mindorensis*. Local stakeholders have formed reserves and protection groups to help maintain a healthy ecosystem for future generations and to conserve the species (Miranda *et al.*, 2008).

The main difference between the two programmes in Cambodia is that the Chumnoab model makes *direct* payments to all villagers who participate in patrolling and there is a formal communal contract by which villagers agree to heed the rules. The Chumnoap villagers receive finan-

cial payments and other incentives for achieving conservation targets (including removing widllife snares) and for good behaviour, including no forest cutting, no killing of crocodiles and other wildlife, and no use of prohibited fishing gear. The Ou Saom model, on the other hand, focuses on *indirect* benefits, pays only a handful of individuals for specific tasks, and has no written communal agreement to bind the incentives to local actions.

All conservation and sustainable development initiatives should be monitored to measure their effectiveness (Ferraro & Pattanayak, 2006). Choosing the right variables is important to track success: in the case of IBPs, these should include demographic (Spiteri & Napalz, 2005), ecological, economic, attitudinal, and behavioural variables (Books *et al.*, 2006). This paper uses a variety of variables to assess the effectiveness of incentive schemes for conserving crocodiles and their habitats. We have tested the null hypothesis "*there is no significant difference between the direct incentive-based approach and indirect incentive-based approach for Siamese crocodile conservation*".

Methods

Study sites

Ou Saom Commune is in Central Cardamom Protected Forest (CCPF) on the border of the Phnom Samkos Wildlife Sanctuary, at 12°04′43″N and 103°13′44″E (UTM P48 0305036E, 1336101N), approximately 500 m above sea level. The commune is comprised of four villages: Chay Louk, Kandal, Ou Saom and Kien Chongruk (Fig. 1). It is 45 km southwest of Pramaoy (Veal Veng District Town), 165 km from Pursat. Ou Saom has 911 residents (241 families). The first three villages are alongside the two rivers of Stung Pluk (Stung Knung) and Stung Chay Louk (Stung Krav), and only Kien Chungruk is adjacent to Veal Veng Marsh, where a community-based crocodile sanctuary has been established.

Chumnoab Commune is in Thmar Bang District, Koh Kong Province, about 90 km North East of Koh Kong provincial town. This area is commonly known as 'the Areng', after the main river in this area. Chumnoab Commune is administrative-

Fig. 1. Map of the study sites.

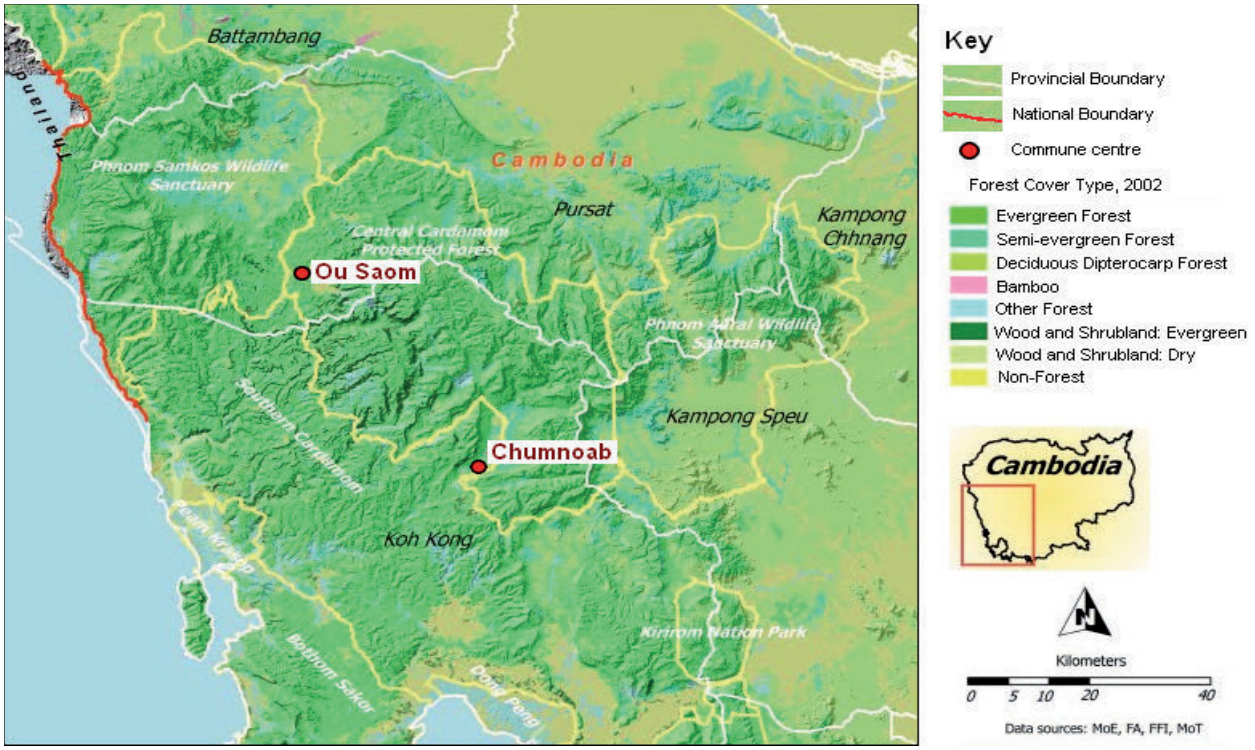


Table 1 Samples selected for interview.

Commune/ Village	HH	Sampled HH	
	N/N_i	n/n_i	F
Ou Saom	***241***	***70***	***34***
Chay Louk	77	22	11
Kandal	33	10	4
Ou Saom	61	18	8
Kien Chungruk	70	20	11
Chumnoab	***63***	***38***	***19***
Chumnoab	30	18	9
Chrak Reussie	33	20	10
Total	**304**	**108**	**53**

Key: HH = households; N/N_i = total number of households in the commune and village; n/n_i = number of households sampled; F = number of females interviewed.

ly formed of two villages, Chumnoab and Chrak Ruessei, and is at 11°35′34″N and 103°38′14″E (0345784E, 1289755N), more than 200 m above sea level. Chumnoab is also commonly considered to comprise two unofficial villages, Areng and Treak, where newcomers have settled. The commune is inhabited by 258 people (63 households).

Ou Saom and Chumnoab Communes were the only sites in Cambodia where this study could have been conducted. Both communes have established crocodile sanctuaries and have agreed conservation interventions to protect the largest known Siamese crocodile populations remaining in the wild in Asia. Veal Veng Marsh, near Ou Saom Commune, holds an estimated 40 - 50 Siamese crocodiles, and the Areng valley has an estimated 30 - 40 Siamese crocodiles.

Both communes are largely populated by the same indigenous ethnic minority who traditionally oppose the killing of crocodiles (Daltry & Momberg, 2000; Daltry & Tith, 2002; Hammond & Hor, 2002) and have therefore been able to coexist with the species since the Angkorian era. Threats to the crocodiles tend to be accidental rather than deliberate, with the main risk coming from the use of modern fishing techniques. One of the most serious risks to the small and scattered crocodile population is electro-fishing (Simpson & Nhek, 2008), which has been secretly used to catch fish in the Veal Veng Marsh and could accidentally kill even quite large crocodiles.

The similarity of Ou Saom and Chumnoab Communes in terms of their spiritual beliefs, presence of crocodiles, and remote locations in the Central Cardamom Mountains makes them excellent candidates for comparing two different incentive approaches (see below).

Sampling of households

Because Ou Saom's population is approximately three times larger than Chumoab's, a larger number of interviewees were selected here. The Yamane (1967) sampling model was used, with a ten percent sampling error (e), an acceptable level of precision. Commune samples followed the Yamane formula $n=N/[1+N(e)^2]$ and village samples were $n_i=(n \times N_i)/N$, to ensure respondents were well distributed across all of the villages. The two communes have 304 households, so according to the Yamane formula, 108 households were selected for interview, as shown in Table 1.

An equal number of male and female respondents were targeted from each village to ensure the findings were not biased by gender. The interviewees were randomly sampled by coding the full list of households and having local helpers randomly pick them out of a hat. Key informants - trusted local authories and community members - played an integral part in verifying the data. All of the interviews described in this paper were carried out during the last quarter of 2007. It should be noted that 2007 was a particularly poor year for rice production in the Cardamom Mountains.

The survey questionnaire was constructed to examine a variety of socio-economic variables, which are herein referred to livelihood trends, livelihood activities and food security (Tables 2 and 3), fish stocks and community fishing behaviours (Table 4), natural habitats (Table 5) and crocodile sightings (Table 6). A questionnaire pilot interview

was conducted in advance to remove less relevant questions or those which people were less able to answer (White *et al.*, 2005).

Other data sources

Secondary data sources were drawn from the annual Siamese crocodile monitoring surveys in the crocodile sanctuaries near Ou Saom (Veal Veng Marsh) and Chumnoab (Areng Valley), conducted by the CCCP team (with Oum Sony in 2005) using fixed transects in February every year. Along the main river through Veal Veng Marsh, the number and diameter (at their widest point) of faecal samples have been monitored along an 800 m transect since 2001. Along the Areng Valley (Chumnoab Commune), the number and size of faecal samples *and* footprints have been monitored on the sandy banks of a 11 km transect since 2002. (Footprints have not been monitored in Veal Veng Marsh because the banks of the river are grassy and do not show such prints). Methods for measuring dung and tracks are described by Daltry *et al.* (2003).

Statistical analysis

We analyzed the questionnaire data using the Chi-squared test with a confidence level α=0.05. Chi-squared tests were conducted using the statistical software package SPSS 15.0.

The size (diameter) and number of crocodile faecal samples found during annual monitoring surveys in Veal Veng Marsh from 2002 to 2007 were counted and compared. Because faecal samples were too scarce to test in Areng Valley, here we analyzed the size and number of crocodile footprints from 2002 to 2007. Three variables of tracks, "Total Hand Width", "Total Foot Width" and "Total Foot Length" were compared. Track sizes were grouped and ranked from smallest to largest (juveniles, subadults, and adult), using surveyed dates between 9 and 28 February only. Tests were conducted using SPSS SigmaStat 3.0. First, these data were analyzed using Student *t*-Test and One-Way ANOVA, but these were replaced with the non-parametric Mann-Whitney Rank Sum Test and Kruskal-Wallis One-Way ANOVA on Ranks when the data were not normally distributed.

Results

Findings from Interviews

One hundred and eight respondents were interviewed from Ou Saom and Chumnoab Communes. There was no significant difference in ethnicity between the samples: approximately 82% of both populations are Khmer Leu or Khmer Diem ("Original Khmer") or Chorng. Minh Pahng, a resident of Ou Saom Commune, told us: "*In the past, the whole population was one ethnic group based in the Ruessei Chrum area, but after the Pol Pot regime, they separated and re-settled in Chumnaob and Ou Saom*".

Table 2 Socio-economic responses

Response	Commune	
	Ou Saom (n = 70)	**Chumnoab (n = 38)**
Perception of whether livelihoods have changed as a result of the incentive programme		
Yes	83%	92%
No	17%	8%
Perception of degree of change in livelihoods		
Highly improved	9%	3%
Improved	70%	79%
The same	7%	5 %
Unimproved	14%	13%
Sources of income		
Farming	97%	84%
Fishing	79%	82%
Hunting	9%	42%
Selling non-timber Forest Products	44%	84%
Direct conservation payments	4%	74%
Patrolling	13%	74%
Selling groceries	54%	3%
Raising cattle	21%	82%
Raising chickens	86%	82%

Table 3 Food shortages (2004-2007)

Response	Commune			
	Ou Saom (*n* = 70)		Chumnoab (*n* = 38)	
Food shortage reported				
Yes	47%		47%	
No	53%		53%	
Duration of shortage				
	2004	**2007**	**2004**	**2007**
1-3 months	31%	30%	3%	34%
3-6 months	11%	13%	8%	11%
6-12 months	4%	4%	3%	3%

Table 4 Fish stocks and fishing behaviour in the crocodile sanctuary

Response	Commune	
	Ou Saom (*n* = 70)	Chumnoab (*n* = 38)
Perceived changes in fish populations between 2004 and 2007		
Increased	27%	21%
The same	23%	26%
Decreased	50%	53%
The areas where people fish		
Crocodile sanctuary	41%	100%
Streams	70%	87%
Other	16%	18%
Perception of fishing in the crocodile sanctuary		
Good	13%	37%
Bad	46%	29%
Don't know	41%	34%
Perception of potential impact on livelihoods if fishing were prohibited in the sanctuary		
No impact	39%	55%
Bad impact	36%	21%
Don't know	26%	24%

Table 5 Changes to natural habitats

Response	Commune	
	Ou Saom (*n* = 70)	Chumnoab (*n* = 38)
Perceived changes in forest cover between 2004 and 2007		
Increased	9%	16%
The same	14%	29%
Decreased	77%	55%
Frequency of observing fires in the crocodile sanctuary, 2004 to 2007		
Often	26%	45%
Rarely	7%	18%
Never	67%	37%

Socio-economic variables

More than 80% of villages in both communes reported that their livelihoods had improved as a result of the incentive programmes since 2004 (Table 2). There was not a statistically significant difference between the responses of the (largely direct) incentives group in Chumnaop and the (largely indirect) incentives group in Ou Saom.

One example of the beneficiaries is Mr Horm Paen (Ou Saom Commune) who stated during an interview that: "*After CEDAC helped us [with organic agriculture as part of the indirect incentive scheme], we can now earn a lot from peanut selling. In 2006 my family sold a season peanut crops and I bought a "Honda Wave" motorbike*" (estimated to cost > US$ 600).

Reported measures of living standards varied from one year to another, from one village to another, and from household to household. There was a statistically significant difference in income sources between the two groups (X^2=51.77, *df*=8, *P* <0.0028: Table 2). Only 13% of Ou Saom respondents received money for patrolling, compared with 74% of the Chumnaob respondents (this being one of the direct incentive payments, bound in a community agreement). 42% of Chumnoab interviews admitted to earning money from hunting,

Table 6 Changes in crocodile sightings

Response	Commune	
	Ou Saom (n = 70)	Chumnoab (n = 38)
Perceived changes in crocodile population between 2004 and 2007		
Increased	67%	71%
The same	24%	29%
Decreased	9%	0%
Frequency of observing juvenile crocodiles		
Often	16%	13%
Sometimes	11%	26%
Rarely	9%	21%
Never	64%	39%

compared with only 9% of Ou Saom interviewees, which suggests the direct incentive scheme had been less effective in stopping people from hunting. An anonymous respondent said "*if patrol groups encounter a pangolin, it will be caught and sold because 1 kg of pangolin costs about US$ 50*" (whereas the payment for patrolling is only US$ 5 per day). Ou Saom was not without problems, however, with illegal electrofishing reported in Veal Veng Marsh. Farming, fishing, chicken-raising, were almost equally important for both studied groups, but the importance of commercial non-timber forest products differed strongly between Chumnoab (84%) and Ou Saom (44%) (Table 2).

There was a significant difference between Ou Saom and Chumnoab in their response to the 2004 rice shortage, the year before the Chumnoab incentive programme formally began. Chumnoab residents had more rice in 2004 than the people in Ou Saom Commune (X^2=211.11, df=2, P<0.0001, Table 3), but by 2007, there was no significant difference between the communes in terms of food availability (X^2=0.43, df=2, P<0.8062), with both communes suffering from the poor rice harvests that year. Both communes reported that 47% of households had insufficient food at least once between 2004 and 2007 (the period examined in this study).

Perceptions on fishing in crocodile sanctuaries

No significant differences were indicated between the two groups on the status of the local fish populations between 2004 and 2007 (Table 4). In both sites, half of the respondents reported the fish populations had declined, while the other half reported that fish populations were stable or had increased. Therefore, we cannot draw any conclusion about between the impact of the incentive schemes. on fish stocks.

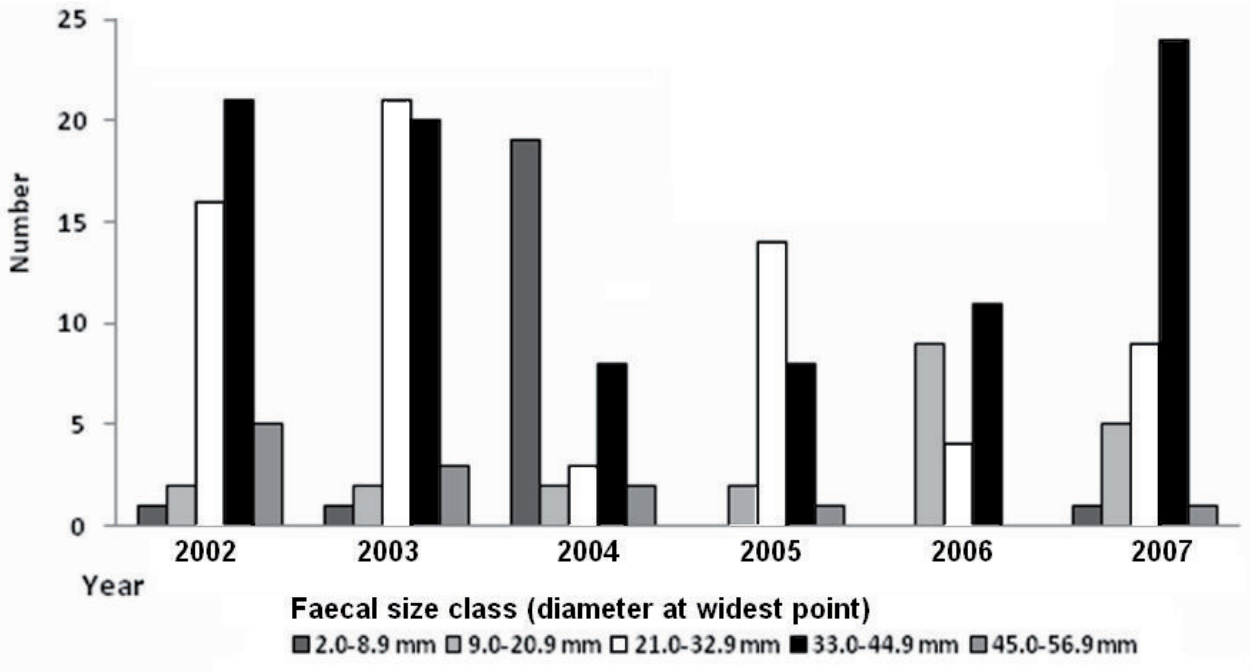
Although fishing with traditional, low-impact equipment (e.g. cast nets and fish traps) is permitted in both crocodile sanctuaries, 46% and 29% of the respondents of Ou Saom and Chumnoab respectively regarded fishing in the sanctuary to be 'bad'. A higher percentage of people from Chumnoab Commune (100%) reported that they fished in their local crocodile sanctuary, than their counterparts from Ou Saom Commune (40%), probably because their crocodile sanctuary is their nearest available place for fishing. Some villagers in both study areas continued to use prohibited fishing gear (e.g. hooks, long gill nets and electric fishing) in the crocodile sanctuaries, in spite of agreements not to do so (on the grounds that they may catch or injure crocodiles).

When asked whether local livelihoods would suffer if all forms of fishing were banned in the crocodile sanctuaries, many of the Ou Saom residents and Chumnoab responded that livelihoods would not be negatively affected, but others perceived this would be 'bad'. Fishing is a major livelihood activity that neither community can avoid (around 80% of people rely on fishing in some way: Table 2).

Perceived changes to natural habitats

Most Ou Saom and Chumnoab respondents perceived there had been a decline of forest cover in the crocodile sanctuary, but others perceived the cover had remained the same or increased (Table 5). These responses did not significantly differ between the the two communes (X^2=5.59, df=2, P<0.0616). Therefore, we cannot draw any conclu-

Figure 2 Frequency and diameter of crocodile faeces in Veal Veng Marsh (Ou Saom)



sions about the impact of the incentives schemes on forest condition.

There was very significant difference between the communities in terms of the number of people reporting fires in the sanctuary, however (X^2=9.57, *df*=2, *P*<0.0083: Table 5). In the Ou Saom crocodile sanctuary, the fires were mainly confined to the grasslands, whereas fires in the Chumnaob sanctuary were in wooded areas. Chumnoab respondents reported seeing fires more frequently than the Ou Saom residents, but this may be explained by the fact that residents from Chumnoab use their sanctuary more frequently. (On the contrary, in the experience of the authors of this paper, there have been more fires in the Ou Saom crocodile sanctuary than in the Chumnoab sanctuary in recent years). Clearing of natural vegetation for cash crops was also reported in Ou Saom, around the southern end of the Chhay Louk River. In Chumnoab, one respondent said: "*forest clearing for farming has gradually increased... many people have now received buffalos from the Conservation International [as part of the direct incentives programme], but some people indicate that forests are cleared for sale*". When 12 ha of land were cleared near the crocodile sanctuary in 2007, the community was punished with a disincentive reduction of 12 ha from the Chumnoab's proposed future agriculture zone.

Perceived changes in crocodile populations

Table 6 shows that more than two-thirds of households indicated that their local crocodile populations increased between 2004 and 2007. There was no significant difference in this response between the two communes (X^2=3.52, *df*=2, *P*<0.1722).

Chumnoab residents reported seeing juvenile crocodiles more frequently than those in Ou Saom (X^2=9.07, *df*=2, *P*<0.0283: Table 6). This significant difference may partly reflect the fact that more Chumnoab residents fish in the sanctuary and therefore have more opportunity to see juvenile crocodiles (see above), and the differences in habitat type. Siamese crocodiles continued to breed in the Ou Saom sanctuary during the study period: Mr Prum Dom, a crocodile warden and a member of Ou Saom Natural Resources Management Committee, reported "*I often saw a female crocodile with*

Figure 3 Frequency and size of crocodile hand prints in Areng Valley (Chumnoab)

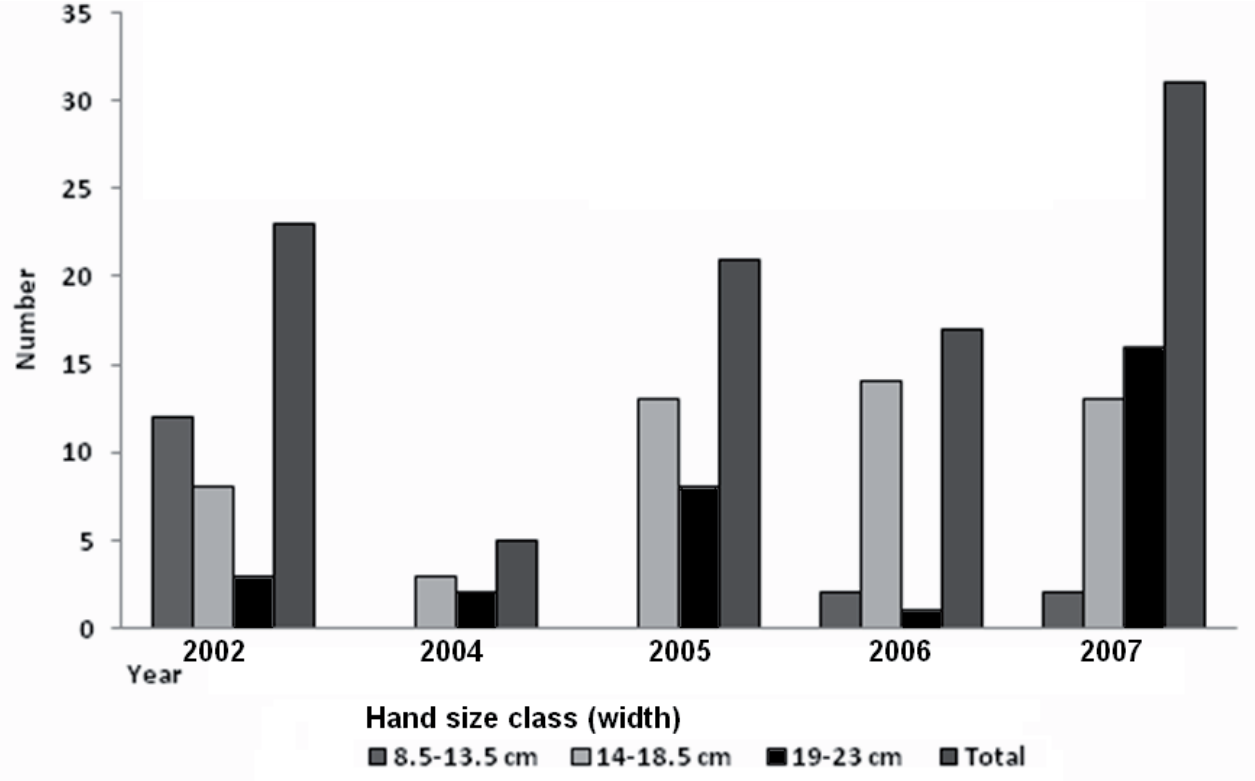
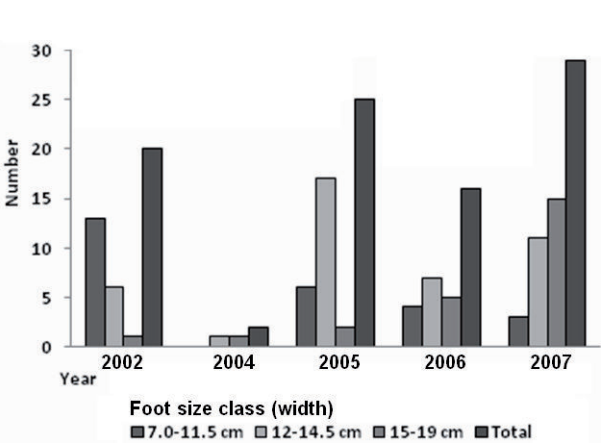
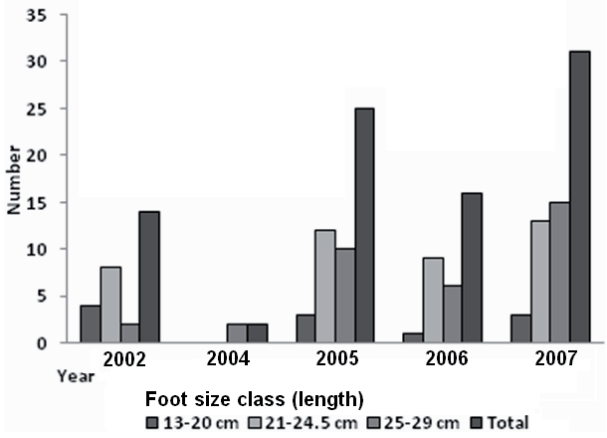


Figure 4 Frequency and size of crocodile foot prints in Areng Valley (Chumnoab)





seven babies swimming at Trapang Angploeung when I went to patrol, especially from August to October".

Annual Crocodile Monitoring Results

Ou Saom (Veal Veng Marsh)

Annual monitoring surveys were conducted in the Veal Veng Marsh by the CCCP team between 2002 and 2007. There was no significant change in the size classes of Siamese crocodile faeces recorded from 2002 to 2007 (H =3.764, df=5, P<0.584: Fig. 2) or between 2004 and 2007 (H =1.740, df=3, P<0.628: Fig. 2). Even though fewer faecal samples were found in 2005 and 2006 than other monitoring years, this variation between years was not statistically sig-

nificant (Mann-Whitney Rank Sum Test comparing 2006 and 2007: T=154.0, P<0.281).

Given that faecal diameter is correlated with crocodile body size, these findings indicate there was no statistically significant change in the abundance or body size classes of Siamese crocodiles along the transect in Veal Veng Marsh between 2002 and 2007. A visual examination of Fig. 2 suggests there has been a general increase in the population since 2004, however, with greater numbers of faeces recorded in 2007 than in any other year. The 2007 faecal data also revealed a broad array of size classes present, from juveniles (faecal diameter <9 mm) to very large adults (faecal diameter >45 mm), confirming that the Ou Saom population was reproductively active.

Chumnoab (Areng River)

The analysis of crocodile tracks found significant variation in crocodile Total Hand Width (THW) between 2002 and 2007 (One Way ANOVA F=6.739, df=4, P<0.001) and between 2004 and 2007 (Kruskal-Wallis H=12.879, df = 3, P<0.05). However, the Student t-test found no significant difference between the tracks found in 2004 (shortly before the incentive programme began) and 2007 (t=0.343, P<0.734). Significant variation in Total Foot Width was found between between 2002 and 2007 (F=5.126, df=4, P<0.001), but not Total Foot Length (Fig. 4).

These apparently conflicting results make it difficult to verify whether there has been a significant change in the abundance or body sizes of the Areng Valley crocodile population between 2002 or 2004 and 2007. A visual examination of Figs 3 and 4 suggest there has been an increase in the population since 2004, with more tracks (especially adult tracks) recorded in 2007 than in any other year. This variation might be an artifact of the amount of time spent on the surveys each year, however, because only one survey day was carried out in 2004, and eight days each in 2005, 2006, and 2007.

Although few juvenile tracks were recorded in the Areng Valley transects, it does not mean that there were no hatchlings. In fact 24 juveniles hatched in the Areng Valley in 2007, but these remained in a small oxbow lake, away from the monitoring transect.

Discussion

Milne (2007) concluded that the (largely direct) incentives programme had made positive changes in Chumnoab based on benefits received, and this has been confirmed by the present study. Importantly, our results found almost identical socio-economic conditions in Ou Saom under an indirect incentives scheme. The majority of interviewees in both communes reported that their livelihoods had improved in response to the incentives schemes.

Have the programmes achieved their conservation objectives?

Ironically, both direct and indirect incentive programmes can have negative impacts on biodiversity. One of the problems we perceived with the direct incentives programme in Chumnoab was that the donated buffalos could threaten the crocodiles and their habitat when they wander into the crocodile sanctuary. This is based on our observations of the growing buffalo population in Ou Saom Commune, which began with a donation of 60 buffalo by the Seila programme in 2001 (before the indirect incentive programme started) and numbered over 380 by 2006 (NCDD, 2006). Buffaloes are seen regularly in the Ou Saom crocodile sanctuary despite regulations prohibiting their entry, and the Cambodian Crocodile Conservation Programme has highlighted the destruction they cause (Daltry *et al.*, 2003), disrupting the water flow and ecology of the crocodiles' wetland habitats (Carvalho *et al.*, 2002).

In the two crocodile sanctuaries created by Ou Saom and Chumnoab Communes, the crocodile populations have remained stable, and possibly slightly increased, based on the annual monitoring of crocodile signs (faeces or tracks: Figs 2-4) and the questionnaire responses. Neither population has shown any indication of a decrease, and both juveniles and adults were seen at the main breeding sites, close to the monitoring transect.

Most importantly, there have been no confirmed reports of accidental deaths or captures of crocodiles in either site since 2004. Hunting has for a long time been a major threat to Cambodia's crocodiles. Between 2001 and 2004, at least 61 Siamese crocodiles were taken alive from Southwest Cambodia (Daltry & Thorbjarnarson, 2004). These include poaching incidences in both the Veal Veng Marsh and the Areng Valley within the areas that are now crocodile sanctuaries. Since the incentive based programmes began in Ou Saom and Chumnoab, hunting of crocodiles in both sites has ceased completely (according to independent evidence from the Central Cardamoms rangers and Cambodian Crocodile Conservation Programme staff), which is a significant achievement for both projects.

By contrast, during the same period at another important crocodile site, Sre Ambel River (near Chay Reap Village), in the southern Cardamom Mountains, 11 *Crocodylus siamensis* were captured for crocodile farms (Platt *et al.*, 2006). This illustrates the ongoing threat to live wild crocodiles.

There were, however, annual fluctuations in the number of tracks and dung on the monitoring transects, which make it difficult to determine precise trends in the populations. These fluctuations may be caused by a variety of natural variables that could not be eliminated, such as variation in temperature, water depth, level of disturbance and rainfall. Crocodiles move between the water and the river bank in response to temperature especially (Pheng, 2005). Therefore, even if the population size remains the same, the number of collected tracks and dung can vary from day to day and even time of the day due to changing patterns of behaviour (Traeholt, 2003). It is impossible to avoid such factors, but, by using standardized methods at the same time of year, any significant trends in population size and structure should emerge over time. Importantly, the current monitoring methods are sensitive enough to detect a sudden population crash between years, and this has not occurred.

Burning of vegetation and the use of gill nets can accidentally kill hatchlings and sub-adults, so it is worrying to note that these are still prevalent in the Ou Saom sanctuary, despite being against the community's own regulations. A hydropower development at Stung Atay (the river to the west of Ou Saom) has created additional threats to crocodiles, as Chinese field workers have reportedly caught crocodiles and tortoises for food (Van Thon, pers. comm.). When the construction stage starts in 2009, the influx of thousands of workers in this area could seriously undermine the traditional social, cultural, and spiritual beliefs in crocodile conservation. Furthermore, when more of the lands of Ou Saom are sold or become inundated by the dam reservoir by 2012 (Middleton & Sam, 2008), more people may turn to the Veal Veng Marsh (which encompasses the crocodile sanctuary) for agriculture and settlement.

How do indirect and direct programmes differ?

Some authors claim that the direct incentives are more effective than the indirect for biodiversity protection (Ferraro & Kiss, 2002), while others have pointed that indirect incentives are better than the direct for enterprise-based conservation, or that more than one approach works for a given area (Salafsky *et al.*, 1999; Salafsky & Wollenberg, 2000). In support of the latter statement, no differences have been detected between economic (direct) and non-economic (indirect) incentives on the efficacy of bird conservation in the USA (Jacobson *et al.*, 2007). The present study of two incentive-based crocodile conservation programmes in Cambodia found no statistical differences between the effectiveness of indirect and direct incentive methods. This supports the view that both approaches can have an equal impact on livelihoods and conservation.

Both incentives schemes have pros and cons. Indirect schemes may focus on creating positive alternatives to destroying their environment and encouraging behaviours that benefit conservation, but operate on a more voluntary and informal basis than the direct schemes. If an individual refuses to comply with rules to conserve biodiversity, an indirect scheme could not easily penalize them, whereas the direct incentive scheme could simply

withhold money or other direct incentives from that individual. The direct schemes therefore have a more appealing simplicity and could potentially play a more tangible role for local socio-economic development than the indirect, while still being integrated with local planning for conservation (Abbot *et al.*, 2001) and rural participation (Salafsky & Wollenberg, 2000; Schaible, 2000).

Direct incentives can be a tool for biodiversity conservation in the developing countries, but face complicated social and political challenges as well as lacking sufficient evaluation of their effectiveness (Milne & Niesten, 2009). According to Ferraro & Kiss (2002), this approach has been criticised on the grounds that "paying individual or community to do nothing might be seen as social welfare" rather than development, but it is cost-effective for short-term interventions. Some authors have argued that direct incentives may lack sustainability, requiring continuous payments, and lack empirical evidence of their long-term delivery of conservation goals (Swart, 2003; Romero & Andrade, 2004).

The two programmes in the present study also differ little in overall cost. During the study period (2004-2007), Conservation International allocated US$ 17,623 per year for Chumnoab under its conservation agreement with the commune council (CI, 2006). Every family in Chumnaob Commune obtains a monthly fee of US$ 25 every nine months for patrolling, plus additional buffalos, support to plough their fields, and extra cash for removing snares. Fauna & Flora International has spent an average of US$ 13,510 per year on the indirect incentives scheme in Ou Saom Commune, chiefly on agricultural assistance to build self-sufficiency on existing farmland (FFI & CEDAC, 2005). In addition, approximately US$ 100 per month from the Cambodian Crocodile Conservation Programme is shared among a small team of permanent local wardens in both Ou Saom and Chumnoab Communes who provide extension and monitor the crocodiles (these payments are made on an individual basis, however, and not subject to any communal agreement). While the financial costs are relatively modest, it remains to be seen whether both approaches will prove to be equally sustainable or effective in the long term.

While both approaches have merit and have achieved similar results to date, some external development factors are hard to avoid, whether conservationists want them or not, and without bringing conservation benefits (Miller & Bobbs, 2002). Notable examples are the hydropower development in the Atay River (Ou Saom) and in Stung Chay Areng (Chumnoab), which threaten to undermine local governance and conservation agreements by bringing an influx of outsiders who are more likely to put short-term personal gains ahead of long-term or communal benefits. Moreover, the whole target direct incentive support site (Chumnoab) will be inundated when the Stung Chay Areng hydroelectrical dam is built.

Conclusion

This study found no significant differences between two incentive-based schemes in terms of their impact on local economy, fishing behaviour and relative crocodile population trends. Both appear to have been effective in maintaining wild crocodile populations at the studied sites, with a conspicuous halt in crocodile poaching. Their impact on local fishing behaviour and clearance of natural habitats is less clear, however, as a number of forbidden practices continue. Both schemes have contributed equally to building indigenous capacity in sustainable land management, based on organic farming, and strengthened local governance in the management of natural resources.

Looking to the future, (1) social and ecological surveys should be repeated to provide ongoing monitoring data for both sites, and (2) field-based crocodile response teams should be formed to mitigate threats to Siamese crocodiles when the new dams are under operation. Moreover, (3) community attitudes toward crocodiles and the impact of the incentives schemes over a longer period (e.g. ten years) should be a subject for further study. These may change as these once-isolated commu-

nities become increasingly exposed to influences from the outside world.

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Fig. 5 Wild Siamese crocodile, photographed using a camera trap (© J. Holden, CCCP)

Fig. 6 An indirect incentive: using System of Rice Intensification in Ou Saom Commune (© CEDAC).

Recent theses

This new section presents the abstracts of research theses produced by RUPP graduates awarded the degree of Masters of Science in Biodiversity Conservation. Some of the following abstracts have been slightly edited for English.

Habitat utilization of yellow-cheeked crested gibbon in Rattanakiri Province, Cambodia

Phan Channa

The yellow-cheeked crested gibbon *Nomascus gabriellae* is a globally threatened (Vulnerable) species restricted to the east of the Mekong River, Cambodia, Vietnam and possibly Lao PDR. Research on the habitat utilization of the yellow-cheeked crested gibbon was initiated in the former Pheapimex Concession south of Virachey National Park in Rattanakiri Province, Cambodia in 2007, an area likely to hold one of the most suitable sites for behavioural and ecological surveys. Activity budgets, diet, and canopy use by *Nomascus gabriellae* were studied among a sample group with three individuals. The data were collected by using a scan sampling method using both instantaneous sampling and *ad libitum* sampling. The study area covered about 1,000ha and the habitat types were evergreen forest, semi-evergreen forest and mixed deciduous forest.

The results indicated that activity budgets of *Nomascus gabriellae* differ between different individual gibbons. On average, the activity budgets of yellow-cheeked crested gibbon were spent as follows: feeding (38.26%), travelling (18.92%), resting (34.69), playing (3.43%), scanning (2.5%), vocalizing (1.64%) and grooming (0.57%). *Nomascus gabriellae* consumed 12 species of plant. Fruits were eaten most frequently, followed by leaves and flowers. The gibbons consumed more unripe fruits than ripe fruits, and they fed on more young leaves than mature leaves. Gibbons were more frequently active than inactive. Calling took place in the early morning, between 5:19-7:17am, and the gibbons preferred to call from the highest tree in their natural habitat. Calling trees recorded during this study belonged to only three tree species: *Dipterocapus costatus, Terrietia javanica*, and *Shorea thorelli*. The yellow-cheeked crested gibbons spent most of their time (82.37%) in the high canopy, 17.14% in the medium canopy level and 0.5% at a low canopy level.

This study on the ecology and behaviour of gibbons has provided baseline data for the management and conservation of *Nomascus gabriellae,* and we can compare these data to other species of Hylobatidae. These data could also be useful for planning a reintroduction and rehabilitation programme for *Nomascus gabriellae*.

Gender in Community Protected Area Management: a case study in Prey Thom Community Protected Area, Siem Reap Province, Cambodia

Heng Chinda

The Royal Government of Cambodia (RGC) and many Non-Government Organizations (NGOs) are working together to promote gender equality and especially women-empowerment in Cambodian society. Even though they try to mainstream gender and empowerment into their programmes, and this concept is widely acknowledged, gender problems are still happening and equality is still far from the reality. Many people still think that the roles, responsibilities and entitlement of men and women are fixed, unchangeable and naturally set (GAD, 2008). Cambodian women, especially those living in rural areas, still lack self-confidence and perceive themselves as inferior to men (MoWA, 2006). Although the equal rights of women and men are

formally guaranteed in the Cambodian Constitution, the promotion of gender equality and empowering women in community based natural resource management (CBNRM), particularly in community protected areas (CPAs), is still facing problems. Sometimes this is because women are balancing multiple roles; other times because society will not necessarily support women acting outside their traditional roles. In other cases, women may be provided with a certain percentage of the seats on a decision-making forum in community development, but cultural norms make it difficult for them to express their ideas and concerns (Scheyvens, 2007).

There is an extensive amount of experience and knowledge on community protected areas in Cambodia, but little is known about the roles and responsibilities of men and women, their access to and control over natural and biodiversity resources, and their involvement in making decisions in community activities. This study has tried to examine the roles of women and men in management at household and community levels, understand how women and men have access and control natural resources in the community, and describe and document the traditional knowledge and practices of women and men in relation to natural and biodiversity resources use and conservation. The study concentrated on only one community protected areas, called Prey Thom Community Protected Area, which is located in Anlong Thom Village, Khang Phnom Commune, Svay Leu District, and Siem Reap Province.

Eight Participatory Rural Appraisal (PRA) tools were used as appropriate tools for gathering information from concern stakeholders. These were: gender-specific resource mapping, seasonal calendar of economic activity, hourly activities of men and women, gender-specific community participation, decision-making matrix of men and women at household level, decision-making of men and women at community level, access to and control over resources by men and women, and focus group discussions on the traditional knowledge of men and women. In addition, key informants interviews with key stakeholders were also conducted.

The results found that the traditional gender division of labour was *not* the dominant situation in the study site. This means both men and women share responsibilities in earning income to support family livelihoods. Men have more time to spend on their recreation, but this does not mean they put all responsibilities of domestic work - such as cooking, taking care of children, and washing clothes - on women because they also shared these tasks. This is only the case in the study site, however, and it might be different among other communities in Cambodia, where different locations and different lifestyles might lead to gender divisions of labour within each household.

Women in the study site take primary responsibility for managing household finances and thus tend to have a say in household decisions. However, this does not mean that women have the right to spend the money freely on what they want: women can decide on the small daily expenses, such as amount of money spend on food, buying clothes and other household needs, but the bigger decisions in relation with the whole family are generally shared between husband and wife. This finding is consistent with the study on women in community fisheries in Cambodia, conducted by CBNRM Learning Institute in 2008, even though that was a different type of community and in a different geographical area.

Although equal rights of men and women are formally guaranteed in Cambodia constitution; there is a still an issue in the real implementation. The case of access to and control over natural resources in the study site is used to illustrate this issue. It was found that among 11 types of natural resources in the community, there were four types of resources that women were not able to access and control, and only one resource that men were not able to access and control. The accessibility of community resources was not regulated in community by-law to the specific gender: the groups perceived that access to resources by each sex depended on the

ability and skills of the individual, but sometimes this division was also related to beliefs from ancient times. Consistent with the definition of access and control given by Ministry of Women's Affairs in 2006, it can be concluded that within this particular study site, men have more opportunity to take resources directly from the forest, but women have more opportunity to make use of those resources in whatever way they prefer.

In regard to the participation of men and women at community level within the study site, women seem to participate more in the meetings and dissemination activities hosted by organizations and/or community committees. Most of the women who attended the meetings and dissemination activities did so on behalf of their husband and because these activities took place within their village. However, women at the meetings did not talk and share ideas as readily as the men. Men are better represented than women at the level of community management: out of nine community committees, only two have females (holding the position of accountant). The factors that make a woman unable to win the community election or become a community leader are culture, education level, livelihood (economic status), family and self-confidence. In addition, although decision making in the community involves discussions among committees and members, and the ideas of men and women are ostensibly given the same value, still the decision making of women is not effective due to their unbalanced representation on the community committees, as well as the fact that men took the roles of implementers.

The variety of knowledge that men and women have about forest products, plants and tree species in the study site is immense. Practicing of this knowledge is a good contribution to the conservation of natural and biodiversity resources in the community, reduction of environmental pollution, and reduction of family expenses. Therefore, the gender's roles as sustainable managers of their environment and providers for their families must be fully recognized, valued and supported because they must know their environment intimately to subsist in it, and they are experts on forest, crops, soils, water management, medicinal plants, growing techniques, and seed varieties.

Variation in vocalizations of the yellow-cheeked crested gibbons (*Nomascus gabriellae*) in Cambodia

Lim Kannitha

In Cambodia, *Nomascus gabriellae* is distributed on the east of the Mekong River in southern Mondulkiri Province, and ranges to northern Ratanakiri and Stoeng Treng Province. The species appears to be absent from Lomphat Wildlife Sanctuary, which stretches from the south of Rattanakiri Province to the very North of Mondulkiri Province and from Kingwood Industry Pte., Ltd. Concession, in Prey Khiev (Kratie, Stoeng Treng and Rattanakiri Provinces).

According to a previous study, one gibbon population in northeastern Cambodia was provisionally classified as *Nomascus siki* based on vocal analysis. That was the population in Voen Sai (14°12'N, 107°00'E) in Rattanakiri Province. Contrary to this hypothesis, a preliminary DNA and morphological analysis revealed that gibbons from this location are yellow-cheeked crested gibbons.

The present study was conducted from mid-January to mid-March in 2008. Tape recordings of gibbon calls were made in three sites in northeastern Cambodia: Phnom Prich Wildlife Sanctuary, Seima Biodiversity Conservation Area, in Mondulkiri Province and in Voen Sai in Rattanakiri Province.

This study reports on the first set of recordings of the gibbon population in Phnom Prich Wildlife Sanctuary. It also shows the variation in the song calls of the three populations, which are geographically far apart.

Behavioural ecology of impressed tortoises *Manouria impressa* (Günther, 1882) via a radiotelemetry study

Chey Koulang

This study of *Manouria impressa* took place in the Central Cardamom Protected Forest of Cambodia. It consisted of three main methodologies: community interviews, seeking and relocating tortoises, and radiotelemetry research. According to interview with 14 local people, this species faces severe threats from local consumption, wildlife trade, and traditional medicine. The population significantly decreased from 1975 to the present time. The interviewees did not know about the value of the species' presence in their areas. Some ecological information was provided from the experiences of the local people, such as clutch size, diet, habitats, microhabitats, and behaviour. The tortoise was reported to guard its nest and hiss to scare predator, which has never previously been reported.

Eleven tortoises were fitted with radio transmitters, seven of which were obtained from local people and four were found in the wild. The habitats were evergreen forest and bamboo forest at high elevation from 668-755 m with a 15°C-37°C temperature range during the study period. The *Manouria impressa* were found under logs, in leaf litter, under bamboo canes, and in holes. The microtemperatures of the hiding places were significantly lower than the ambient temperature. The relative humidity of the habitat averaged 85%, with a range from 60% minimum to 96% maximum. Canopy cover was not an important factor in choice of habitat.

The *Manouria impressa* spent most of the time hiding, and preferred to move from one hiding place to another at night. In one day, an individual could travel about 150 metres, and on average moved 16 metres (straight line distance). Breeding behaviour was described, but more study is required to find out the breeding and nesting seasons of this species. Other aspects of behavioural ecology, like feeding behaviour, were also described. This species mainly consumes wild mushrooms. The male *Manouria impressa* had significantly bigger tails than the females, but there was no significant difference between the sexes in shell length. Body mass was not correlated to home range size. The home range sizes of males and females did not show a statistically significant difference: the tortoises occupied a home range size of between 0.07 and 0.35 km^2.

Human-related factors impacting on otters at three sites in Cambodia

Nop Navy

In this thesis, I explore how human activities are impacting on otters in three sites in Cambodia: a coastal area, a lake area and along a river. Understanding what drives local people toward hunting otters can provide insights into which areas are important for the population and assist conservation efforts to protect these flagship species. Interviews with local people and key informants and focus group discussion were used to map the factors impacting on otters in the three sites and find out the solutions to promote otter conservation at those areas. The study revealed negative impacts resulting from human activities, such as hunting for the skin trade to generate more income to supplement their poor livelihoods and habitat destruction through conversion to agriculture land. The results also showed that people perceived that there had been a decline in the otter populations over the last 30 years because of human activities.

This research has great potential for selecting sites to start to conserve globally threatened otters in Cambodia as well as conserving our environment. The largest number of human activities impacting negatively on otters were found at the Tonle Sap Great Lake. According to the research data on otters from Conservation International, the number of otter skins found in the Tonle Sap area is much higher than the other two places (Stung

Treng and Tatai Krom). Furthermore, the globally threatened hairy-nosed otter also has an important population there. The number of otter hunters is also high around the lake and there are middlemen encouraging the hunters to hunt more otter skins for them. This negative trend runs parallel to the fishermen feeling hostile towards otters, and these two factors could build up a strong negative impact on the otters there. This is compounded by social problems such as the lack of alternative income sources in the villages, an undeveloped market for fish productions, and low level of law enforcement acting on illegal fishing. Most of people whose lives depend on the lake or fishing are struggling to survive on a very low income. For these villagers, conservation would therefore be a second priority after they have filled their stomachs. However, this study revealed that most of the fishermen in Tonle Sap area are willing to cooperate to serve the purpose of otter conservation if appropriate compensation is set to reduce their expenses on nets repairing and lost fish production.

In another study site, Tatai Krom, people have seen an increase in otter populations and they do not try to gain more income from otter skins because of stronger law enforcement activities in this area. People in Stung Treng also expressed their interest in otter conservation, because otters have become scarce in this are and they hope to show this species to their next generation.

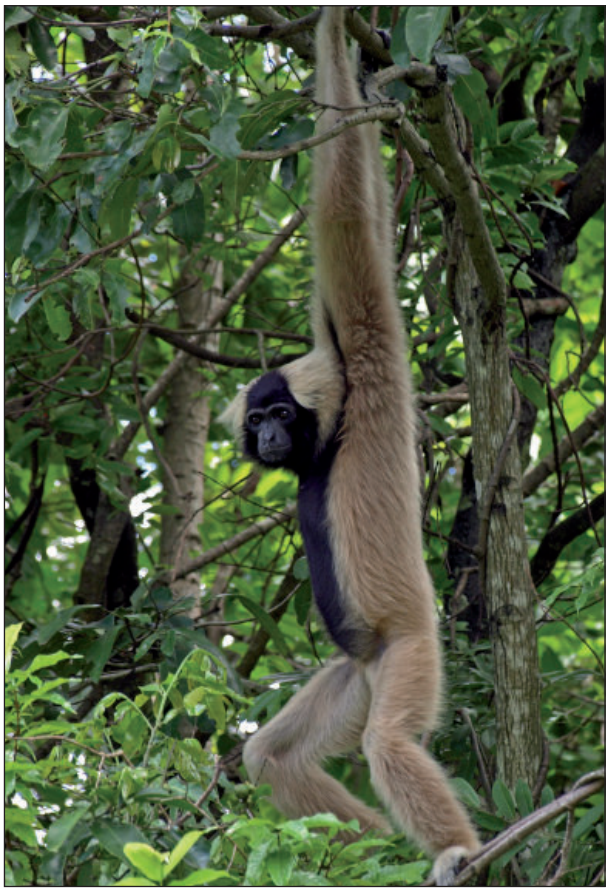
A taxonomic review of *Rhinolophus coelophyllus* Peters, 1867 and *R. shameli* Tate, 1943 (Chiroptera: Rhinolophidae) in Cambodia, Thailand, Myanmar, and Vietnam

Ith Saveng

A taxonomic review of the two cryptic species, croslet horseshoe bat *Rhinolophus coelophyllus* Peters, 1867 and Shamel's horseshoe bat *Rhinolophus shameli* Tate, 1943 (Chiroptera: Rhinolophidae) in Cambodia, Myanmar, Thailand and Vietnam, was carried out between August 2007 and June 2008. Forty-four specimens (23 of *R. coelophyllus* and 21 of *R. shameli*) from 26 localities and 28 echolocation calls (20 calls of *R. coelophyllus*, 8 calls of *R. shameli*) collected throughout Southeast Asia were analysed. The specimens from Cambodia, Myanmar, Thailand and Vietnam were defined by their skull features primarily, along with external dimensions and echolocation calls. Other informative characters proposed by previous authors were rejected in the study, including tail length, and sagittal crest, since they did not differ consistently between the taxa. Canines could still be important keys, however.

The echolocation calls of both species were confirmed, with the difference in call frequencies being of at least 10 kHz. The variation within *R. shameli* from different countries was reviewed and specimens from Cambodia and Vietnam were found to be the largest of all, while specimens from Myanmar were the smallest (sharing characteristics with *R. coelophyllus*). Intraspecific variation in *R. coelophyllus* was confirmed: they varied in external characters, internal characters and even echolocation calls. *Rhinolophus coelophyllus* in the central and southern parts of Thailand were small in size whilst the larger specimens were found in the western and northern parts. The highest call frequency was detected among small individuals. In both taxa, differences between the sexes were not evident based on taxonomic criteria. The smallest *R. shameli* from Myanmar were not well defined in both echolocation and morphology. They shared many morphological characteristics of the larger *R. coelophyllus*.

Women taking part in designing a Community Protected Area (© Matt Fox, FFI).



Pileated gibbon *Hylobates pileatus* at Phnom Tamao Wildlife Rescue Centre (© Ken Wong, RUPP).

Ith Saveng researching the taxonomy of bats (© Jeremy Holden).

Camera trap photograph of a rare hairy-nosed otter *Lutra sumatrana* (© Jeremy Holden, CCCP).

Instructions for Authors

Purpose and Scope

The *Cambodian Journal of Natural History* is a free journal that is published biannually by the Centre for Biodiversity Conservation at the Royal University of Phnom Penh. The Centre for Biodiversity Conservation is a non-profit making unit, dedicated to training Cambodian biologists and the study and conservation of Cambodia's biodiversity.

The *Cambodian Journal of Natural History* publishes original work by:

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The Journal especially welcomes material that enhances understanding of conservation needs and has the potential to improve conservation management in Cambodia.

The primary language of the Journal is English. Authors are, however, encouraged to provide a Khmer translation of their abstract.

Readership

The readership will include conservation professionals, academics, government departments, non-governmental organizations, students, and interested members of the public. In addition to printed copies, the Journal will be openly available online.

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All contributors are strongly advised to ensure that their spelling and grammar is checked by a native English speaker before the manuscript is submitted to the Journal. The Editorial Team reserves the right to reject manuscripts that need extensive editing for English spelling and grammar.

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News

Concise reports (<300 words) on news of general interest to the study and management of Cambodia's biodiversity. News reports may include, for example:

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Authors should consult examples in this volume for general style. Full papers follow a similar style to those in *Oryx – The International Journal of Conservation*. Contributions should be in English, with UK English spelling (if in doubt, Microsoft Word and similar software should be set to check spelling and grammar for "English (UK)" language). Manuscripts should be double-spaced. Submissions can be in 'doc, 'rtf' or 'wpd' format, preferably as one file attached to one covering email. The cover page should contain the title and full mailing address, email address and address of the Lead Author and all additional authors. All pages should be numbered consecutively, and the order of the sections of the manuscript should be: cover page, main text, short biography of each author, tables, figures and plates.

Title: A succinct description of the work, in no more than 20 words.

Abstract: (Full papers only). This should describe, in 100-250 words, the aims, methods, major findings and conclusions. The abstract should be informative and intelligible without reference to the text, and should not contain any references or undefined abbreviations. Authors are strongly encouraged to submit a Khmer translation of the English abstract.

Keywords: (Full papers only). Up to eight pertinent words, in alphabetical order.

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Maxwell, A.L. (2004) Fire regimes in north-eastern Cambodian monsoonal forest, with a 9300-year sediment charcoal record. *Journal of Biogeography*, **31,** 225-239.

Grismer, L.L., Neang T., Thou C. & Holden, J. (2007) A new species of *Chiromantis* Peters 1854 (Anura: Rhacophoridae) from Phnom Samkos in the Northwestern Cardamom Mountains, Cambodia. *Herpetologica*, **63,** 392-400.

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IUCN (2007) 2*007 IUCN Red List of Threatened Species.* Http://www.redlist.org [accessed 1 May 2007].

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Tables, figures and plates: These should be self-explanatory, each on a separate page and with an appropriate caption. Figures should be in black and white. Plates will only be included in an article if they form part of evidence that is integral to the subject studied (e.g., a camera-trap photograph of a rare species), if they are of good quality, and if they do not need to be printed in colour.

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Abbreviations: Full expansion should be given at first mention in the text.

Units of measurement: Use metric units for measurements of area, mass, height, etc.

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Website: www.conservationcambodia.org

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RUPP is Cambodia's oldest university, with over 9,000 students and over 400 teachers. In 2005, the Department of Biology co-founded the Centre for Biodiversity Conservation to provide training and support for national scientists. The Centre now delivers a Masters of Science curriculum in Biodiversity Conservation and has established a library, classrooms and a national herbarium and zoological reference collection for use by students and scholars of Cambodian natural science.

Websites: www.rupp.edu.kh and www.conservationcambodia.org

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