

RESEARCH

Preliminary study on the basic ecology and conservation of Banteng (*Bos javanicus*) in a land concession of eastern Cambodia

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Abstract

Banteng (*Bos javanicus*) is a globally Endangered bovid with its largest remaining natural population surviving in Cambodia. Economic Land Concessions (ELC) in Cambodia is considered a key driver for forest and biodiversity loss in this megafauna-rich country. An innovative conservation project has been running in an ELC in the Eastern Plains Landscape since 2017, with the objective to demonstrate an example of a win-win partnership of agroindustry developers and conservation organizations in these imperiled forests. The presence of a breeding banteng population has been confirmed during a biodiversity survey, with multiple camera trap photographs of herds with calves. Banteng observed in the study were mainly nocturnally active, with some crepuscular activities, and can be detected in roughly equal frequency in both deciduous dipterocarp and semi-evergreen forests. Mean banteng group size was 1.9 (range 1–8; median 1) based on our limited data due to camera loss caused by theft and van-

dalism. Our study presents basic ecology data of the mainland banteng in an unprotected landscape, providing preliminary insights into their behavioural adaptability to disturbed habitats. The site is facing imminent threats currently widespread throughout Cambodia, such as illegal logging, poaching, and mining. To tackle these problems and instigate conservation awareness among the local human population, a forest patrol team consists of community rangers led by a Khmer young conservationist has been established, and their daily patrol is proving to be a useful deterrent to forest crimes. Some awareness raising activities were also organised targeting the ELC workers and local communities.

Introduction

All Asian wild cattle are threatened due to rampant hunting and habitat loss (IUCN-SSC Asian Wild Cattle Specialist Group 2010). Banteng (*Bos javanicus*) is an Asian wild cattle once widely distributed across mainland southeast Asia and the Sundaland islands of Borneo and Java, but populations have experienced dramatic declines throughout its natural range, and the species is currently categorized as Endangered by the IUCN Red List, with an estimated global population of 4,000–8,000 heads (Gardener et al. 2016). Cambodia is home to the largest banteng population within its native range, which is concentrated in the Eastern Plains Landscape east of the Mekong, reputedly supporting > 50% of the world's remaining animals (Gray et al. 2012, 2016). Cambodia has one of the fastest rates of forest loss in the world, even within protected areas (Hansen et al. 2013). The government scheme of Economic Land Concession (ELC) provides long-term land leases for domestic and foreign investors to develop industrial-scale agriculture, many of which carved out from or abutting protected areas and currently accounts for over 12% of total land area of the country. ELC is therefore considered one of the major drivers for forest and biodiversity loss in Cambodia (Gray et al 2012, Beauchamp et al. 2018).

In 2017, Kadoorie Farm and Botanic Garden (KFBG), a Hong Kong-based conservation NGO, was invited by the Chinese Government of Agriculture to launch a conservation project at Green Island Agricultural Development (Cambodia) Limited (hereinafter Green Island), a Chinese-owned ELC granted for agricultural development, with the hope to develop a demonstration site where agroindustry and biodiversity conservation can coexist. The plan has been endorsed by and gained full support from the central government bodies responsible for agriculture in both countries. KFBG's role in the collaboration is to implement biodiversity conservation projects and provide recommendations on sustainable agriculture practices.

As Green Island and its surrounding forests have never been surveyed, a series of biodiversity surveys, including camera-trapping, were conducted over the past three years. Our survey yielded some exciting results such as records of the Critically Endangered yellow-breasted bunting (*Emberiza aureola*) and elongated tortoise (*Indotestudo elongate*), the globally Endangered banteng (*Bos javanicus*), black-shanked douc (*Pygathrix nigripes*) and green peafowl (*Pavo muticus*), and two bunting species of particular ornithological interests: little bunting (*Emberiza pusilla*) - first record for Cambodia, and black-headed bunting (*E. melanocephala*) - first field record for Cambodia (Chan & Li 2017). Full results of our biodiversity survey will be published elsewhere in due course. Our field results demonstrate that this ELC supports significant conservation value on par with the country's national parks (KFBG, unpublished data). Green Island, however, is suffering from the same forest crimes currently widespread throughout Cambodia, with rampant logging and poaching happening round the clock. Our camera-trapping survey recorded the banteng on many occasions, allowing us to report some preliminary observations on the basic ecology of banteng at this highly disturbed site. Some of our ongoing conservation activities to tackle the rampant logging/hunting issues are also presented.

Although it is well-known that banteng show adaptability and some resilience to disturbed habitat, and larger herds are found congregating along abandoned logging roads (Journeaux et al. 2018), little is known

about the effects of logging on their ecology (Prosser et al. 2016), and little information is available for populations living in unprotected areas, particularly for the mainland banteng *B. j. birmanicus* (IUCN-SSC Asian Wild Cattle Specialist Group 2010; Gray et al. 2016). Recent studies showed that Bornean bantengs, *B. j. lowi*, regulated their diel activity, foraging behaviour and diet in response to logging and forest regeneration (Gardner et al. 2018, 2019); furthermore, they showed a reduction on body conditions in conventionally logged forests compared to reduced-impact logging forests (Prosser et al. 2016). In this study, based on a limited set of camera trap data, we provide a glimpse into the ecology and adaptability of mainland banteng in the highly disturbed and unprotected forest in a land concession.

Study site and methods

Green Island is located in Sambour district of Kratie Province, eastern Cambodia (12°47'--12°51'N, 106°13'--106°23'E, altitude range: 70–230 m). The total area of Green Island, leased for 50 years starting from 2006, is about 130 km², and the management of Green Island has agreed to allocate 80 km² (~61.5% of the ELC) as a private protected area. Natural vegetation currently covers ~70% of Green Island, which is a mosaic of deciduous dipterocarp forest (DDF), mixed deciduous forest (MDF) along watercourses and dense semi-evergreen forest (SEF) on elevated grounds (Fig. 1). It is worth noting that this vegetation mosaic is shown to be the preferred habitat of banteng in the country (Phan & Gray 2010). Green Island is within the Eastern Plains Landscape, situated close to the provincial boundary with Mondulkiri adjacent to the mega-fauna-rich Phnom Prich Wildlife Sanctuary, thus connecting this ELC to other important wild cattle populations in Mondulkiri Province. Our camera trap survey started in January 2017. A total of 65 camera traps (Loreda L710, YIANWS-LOREDA R&D CENTER, Qingdao City, China) were deployed in microhabitats thought to likely maximize the probability of detecting medium- to large-sized ground dwelling mammals, such as animal trails, water sources, and underneath fruiting trees.

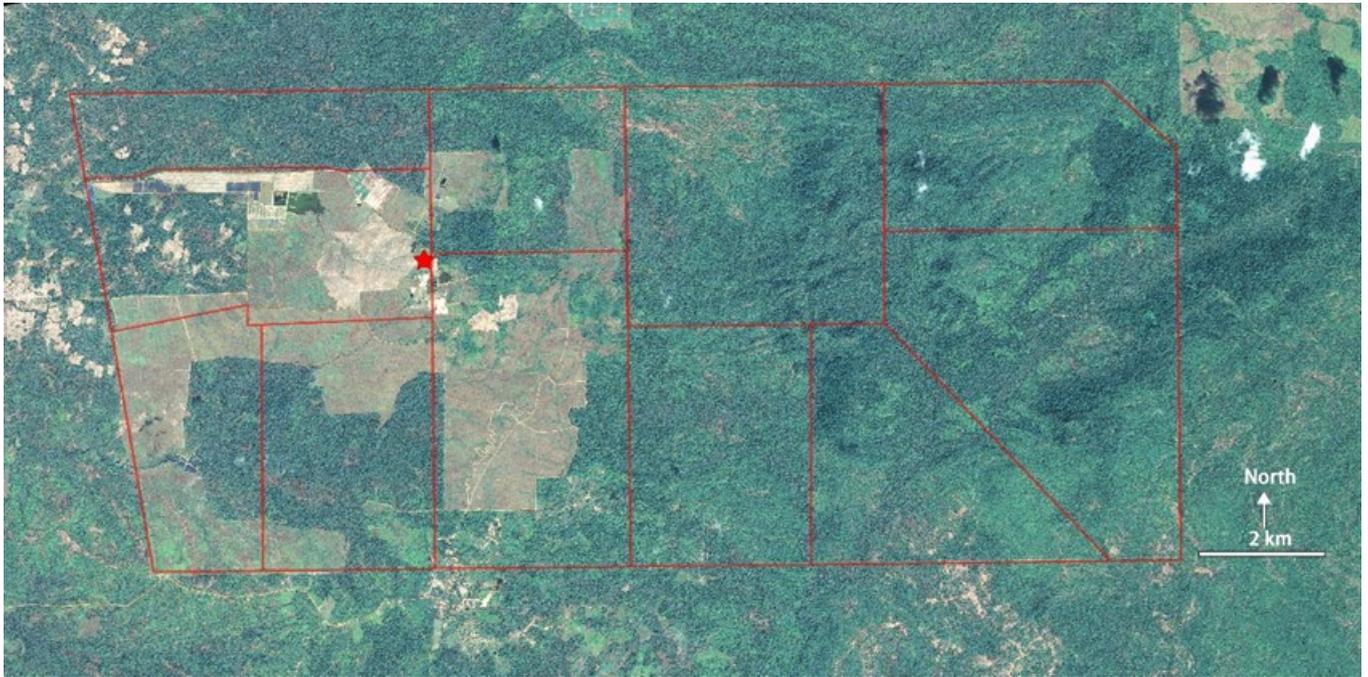


Fig. 1 The study site, Green Island in eastern Cambodia, is still largely under natural forest cover. The outer red box is boundary of the ELC; the inner red lines are borders of different 'land lots' assigned by the Cambodian Government. Red star indicates the location of the headquarters.

We defined a camera trap record as a notionally independent record if it occurred 30 minutes or more after an image of the same species at the same station. One trap-night was defined as a continuous 24-hour period of camera operation. Due to the extremely high intrusion rate of loggers and poachers, camera trap units were constantly stolen or destroyed, with only four to six camera trap units remaining operational from January 2018 until the end of December 2019, which severely limits our ability to collect representative data for two-thirds of the three year study period. To understand the basic ecology of banteng in an ELC with frequent and severe human disturbances, we compared our camera trap data with that of Phan & Gray (2010) collected from two of Cambodia's key protected areas in the Eastern Plains Landscape, and followed their data analysis approaches on group size estimation and activity pattern analysis.

Results

With our limited camera trap data, banteng were recorded by 14 camera trap units (21.5%) over 6515 trap-nights between January 2017 and December 2019, which produced 31 independent records of banteng. This forest bovid was camera trapped in the two major vegetation types of the site: seven units in DDF and seven units in SEF. Of the 31 independent banteng

records, 17 (55%) were from DDF and 14 (45%) were from SEF.

The banteng in Green Island was predominantly nocturnal with some crepuscular activities; 90% of records were between 1800–0600 and the peak was in the early morning between 0300–0700; there were no records between 0900–1700 (Fig. 2). Our data suggested banteng activities were the highest between March–May (94%), and calves were only photographed during this season ($n=5$). However, the observed trends could be an artefact of biased sampling effort since 50% of total trap-nights are in March–May due to the colossal loss of camera traps. Based on our very limited dataset, banteng herd size in Green Island was between one and eight (median = 1; mean = $1.9 \pm \text{SEM } 0.3$); the biggest herd of eight heads included two calves (Fig. 3). Mean banteng group size in Green Island was 1.9, and 61% of our camera trap records were of single individual (Fig. 4). Our preliminary results on habitat preference and diel activity pattern, and to a certain degree group size, are broadly similar with that reported by Phan & Gray (2010).

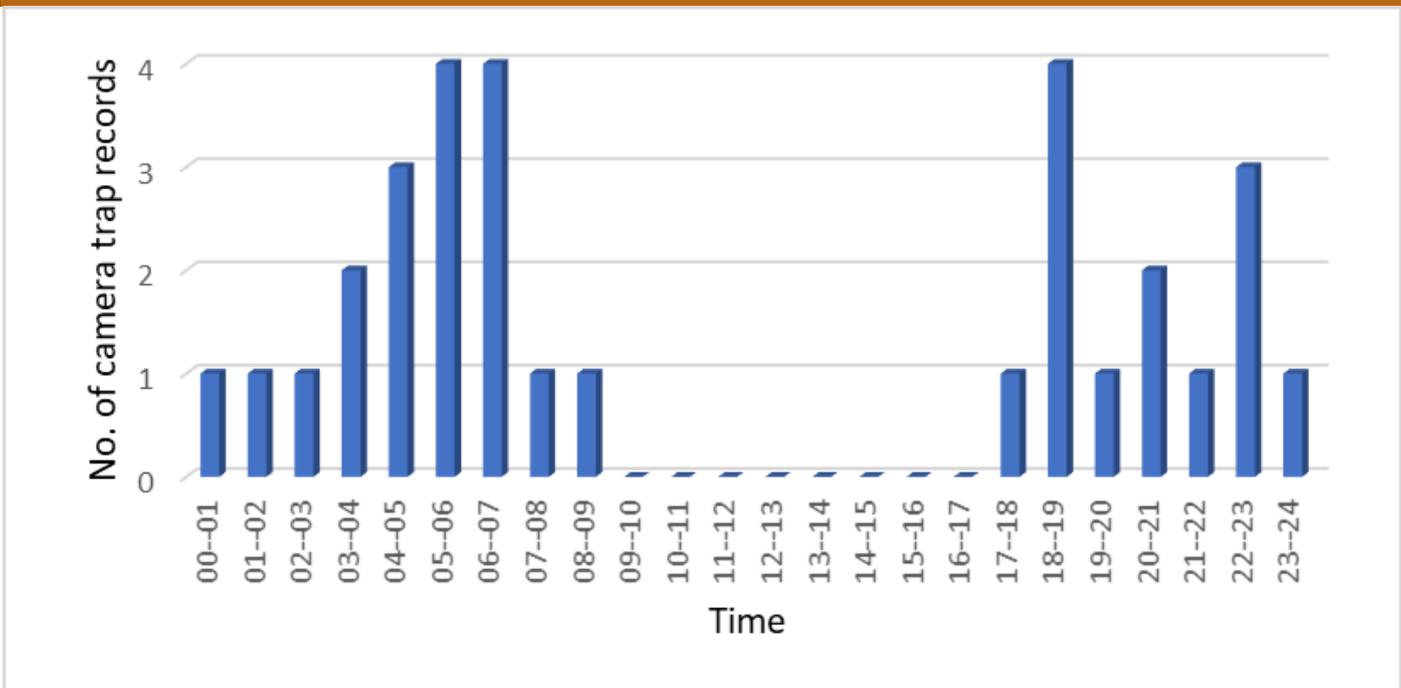


Fig. 2 Diel activity pattern of banteng, based on total number of camera trap records between April 2017 to May 2019, from Green Island, eastern Cambodia.

Threats

With around 300 agroindustry workers and their families living inside Green Island and six communes of >1400 households adjoining the western and southern boundary of the ELC, the forest and its biodiversity are facing imminent threats such as illegal logging, poaching, and mining, as happening elsewhere in Cambodia including protected areas. Chainsaw sound were a continuous background noise during patrol and fieldwork; gunshots were occasionally heard; snares, electrocuted hunting wires and mist nets were regularly found; banteng with snare injuries were photographed (Fig. 5). A mining company, with their own permits issued by respective government departments, started gold prospecting in a corner of the forest. While some of these threats, such as gold prospecting, might take government interventions such as policy reform to resolve, we are actively tackling the problems of logging and hunting.

Conservation interventions

Protection

As hunting and habitat loss are the greatest threats to Asian wild cattle (IUCN-SSC Asian Wild Cattle Specialist Group 2010), KFBG have been funding Green Island to establish a forest patrol team since June 2019 to tackle the rampant logging/hunting issues. A

small team of seven community rangers, all former loggers/hunters from the surrounding villages, were recruited and is being led by a Khmer conservation officer. We delivered training on biodiversity and conservation to the team members, equipped them with essential field tools including motorbikes and, to instill a sense of pride in their banteng conservation work, the team was named “Banteng Forest Patrol Team” with a team logo designed and printed on their uniform (Fig. 6). The team carried out daily patrol throughout the ELC, some at night with armed police and on a few occasions with enforcement officers of the Cambodian Ministry of Agriculture, Forestry and Fisheries. Their daily patrol is proving to be a useful deterrent to forest crimes – since patrol began last June the team detected and expelled 327 illegal loggers/poachers; destroyed/confiscated 13 hunting rifles, 529 snares/traps, 50 fishing nets, 30 mist nets and 1150 meters of electrocuted hunting wire. In addition one small Indian civet (*Viverricula indica*), one long-tailed macaque (*Macaca fascicularis*), four Asian woollyneck (*Ciconia episcopus*), three red junglefowls (*Gallus gallus*) and one Burmese python (*Python bivittatus*) were rescued from traps, and were either released if unharmed, or sent to the Phnom Tamao Wildlife Rescue Centre in Takeo Province.

Awareness raising campaign

During a rapid participatory rural appraisal conducted at the onset of our project, logging is considered by a large proportion of the local communities as a major income source, and hunting is also widely practiced by both villagers and the workers. To instigate conservation awareness among the local human population, some awareness raising activities have been organ-

ised, targeting the 300 local workers employed by Green Island and their families. These include a mural painting activity at the workers' quarters depicting key biodiversity features of the site, as well as conservation talk to all workers and their families. We are planning to expand our educational work to the surrounding communes soon with the help of our local rangers.



Fig.3 A herd of banteng with calves camera-trapped in Green Island, eastern Cambodia. Photographed on 8 April 2017.

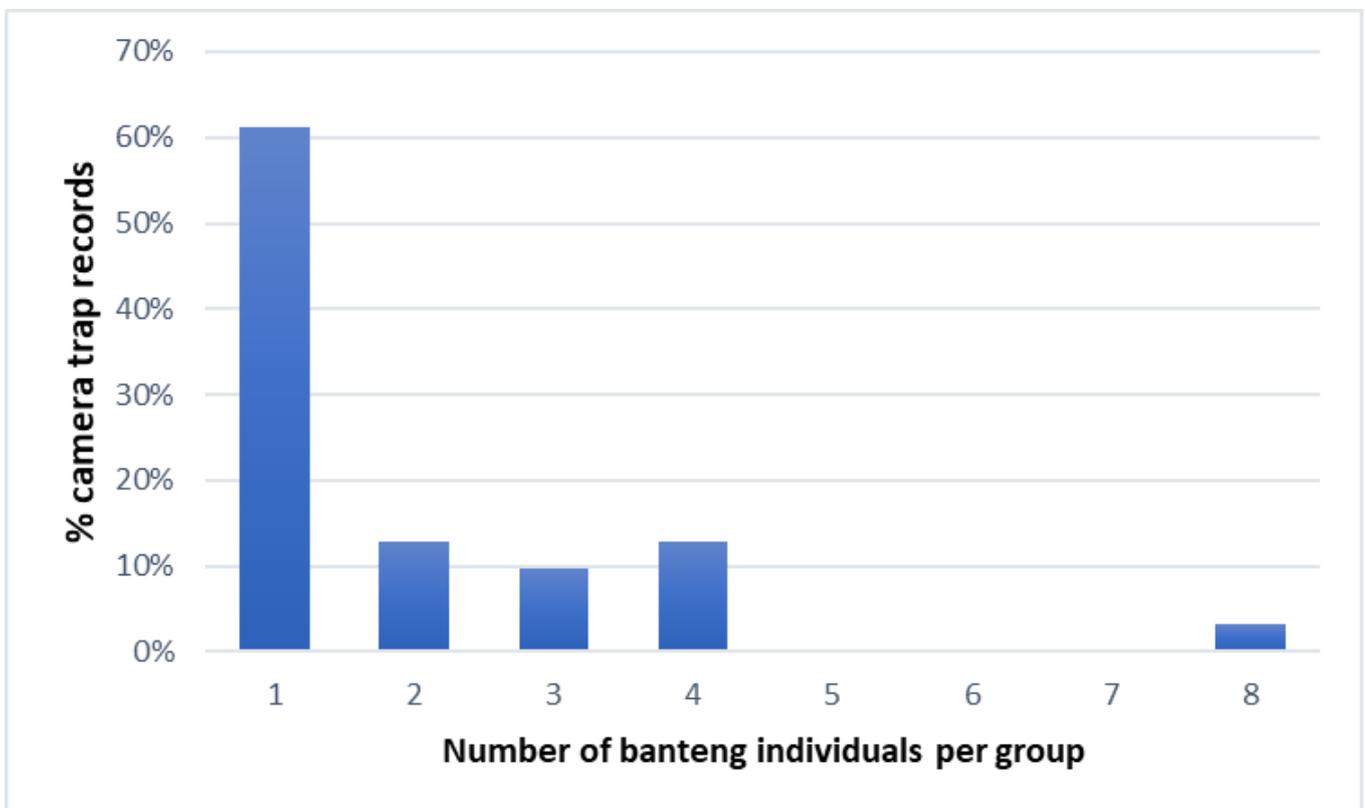


Fig. 5 Number of banteng individuals per camera trap records from Green Island, eastern Cambodia.



Fig. 5 A male banteng with a snare injury (red circle) photographed in Green Island, eastern Cambodia. Photographed on 8 April 2017.

Discussion

Our survey confirmed the banteng and a suite of other globally threatened wildlife still occur in Green Island, an economic land concession suffering heavy human disturbances, and breeding of banteng is confirmed by presence of calves. The ecology of mainland banteng in mainland Southeast Asia is extremely poorly known (Phat & Gray 2010), and the available information is mainly collected in protected areas (Gray et al. 2016). Our study, although limited in sampling size, presents one of the few scientifically collected natural history data in unprotected landscape. Our data suggest the basic ecology of banteng in Green Island and various key protected areas in the Eastern Plains Landscape appear similar, despite the polarised statutory land use status. The group size observed in Green Island was slightly smaller than that of Phan & Gray (2010). Single banteng was recorded in 54% of camera trap photographs in Phan & Gray (2010), while 61% of our camera trap records were of single individuals. However, it is worth noting that the accuracy of using camera trap photographs for estimating group size is questionable (Phan & Gray 2010). For example, a herd of eight banteng including two juveniles was captured by one of our camera traps (coded unit-S13) in DDF on 8 April 2017; one day later, a camera trap in SEF (unit-N14),

980 m away from unit-S13, captured a female with two juveniles. Using the natural marks of the female and the body and horn sizes of the two juveniles, we could confirm these two camera traps recorded the same female and the two juveniles, which means at least five animals of the same herd were not detected by camera trap unit-N14 inside the dense SEF. Therefore, using the number of individuals in photos/videos captured by camera traps has a high probability of underestimating banteng group size especially in dense forest. However, due to the limited camera trap data obtained, we were unable to estimate the banteng population size in Green Island. Forest users interviewed in Green Island regularly reported larger herds, with group of over 20 reported on more than one occasions; and they also reported the presence of Gaur (*Bos gaurus*) in the semi-evergreen forests of Green Island. Given that the estimated banteng density in the eastern plains landscape of Cambodia was $0.94 \pm \text{SE } 0.14$ individuals/km² in Gray et al. (2012), a population of 86 animals is therefore estimated to be living in the 91 km² of natural forest in Green Island. We plan to conduct a systematic survey on the population density and ecology of wild cattle in Green Island once the illegal logging and hunting activities are effectively controlled.



Fig. 6 Part of the 'Banteng Forest Patrol Team' employed by Green Island. Photographed on 3 October 2019.

Banteng in Green Island were mainly nocturnal but also showed crepuscular activity, spending more time on foraging and social activities from dusk until the early morning. However, we cannot ascertain if this is an ecological adaptability to reduce activity during hot sunny midday in logged open forest as reported in Bornean banteng (Gardner et al. 2018), or it is an avoidance response to heavy anthropogenic pressures (Phan & Gray, 2010).

It was reported that logging may bring short-term positive benefits for banteng by creating lush undergrowth as an ideal foraging conditions, and the extensive network of logging roads facilitates travel of Bornean banteng (Gardner et al. 2018, 2019). However, as pointed out in Gardner et al (2019), the impacts logging and ensuing poaching caused to the banteng may counteract any positive benefits. It is to be studied if similar patterns apply to the mainland banteng in Cambodia.

Logging and forest regeneration will create environmental conditions that are favourable for exotic invasive plant species in tropical Southeast Asia (Padmanaba & Sheil, 2014), and the herbivorous banteng may serve an important role in minimising the proliferation of invasive exotic plants, and benefit the regrowth of native timber species (Gardner et al. 2019), which further highlights the importance of conserving banteng in commercial forests like Green Island. However, preserving patches of dense mature forest is essential within land concessions, since banteng will use closed-canopy forest to take refuge from disturbances and to minimise exposure to high temperatures (Gardner et al. 2018)

The change in attitude and behaviours of local people are the key for safeguarding the future of tropical forest and wildlife (Ploeg et al. 2011). Members of the forest patrol team are all from the surrounding local community, therefore their change to pro-conservation attitudes and behaviours would hopefully set examples in their respective villages (Steinmetz et al. 2014). With the endorsement of the ELC company to conduct conservation work in their land, KFBG is funding all conservation activities in Green Island; including all costs of the forest patrol team, field survey and environmental outreach, which is proven to be effective and essential if the biodiversity of these forests are to be saved. It therefore appears to be beneficial for more conservation NGOs and funding agencies to look beyond protected areas and engage land concession and community forest owners in innovative partnerships to preserve the integrity of the forest landscape of Cambodia. We hope our project can demonstrate the feasibility and importance of implementing conservation work in ELCs, so that the remarkable biodiversity of these unprotected and imperiled forests can be salvaged.

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