



The Effectiveness of Bengal Florican (*Houbaropsis bengalensis*) Conservation in Cambodia

SAN Sovannary^{1*}, THI Sothearen¹, EANG Savet¹, SON Virak², CHHIN Sophea²

¹ Forestry Administration of Ministry of Agriculture Forestry and Fisheries (MAFF), Preah Norodom Blvd., Phnom Penh, Cambodia

² Ministry of Environment (MoE), Techo Heritage Building, Lot 503, Bassac River, Sangkat Tonle Bassac, Khan Chamkarmon, Phnom Penh, Cambodia

ARTICLE INFO

Editorial responsibility: CHEY Chan Oeurn
Received: 21 April 2022
Revised: 20 May 2022
Accepted: 20 August 2022
Published online: 31 December 2022
© 2022 Published by Research Office, (RUPP). All rights reserved.

Keywords:

Bengal florican (*H. bengalensis*)
Ecotourism
Community development
Protected landscapes
Tonle Sap Lake

សង្ខេប

សត្វខ្យីប (*Houbaropsis bengalensis*) ត្រូវបានចុះបញ្ជីក្រហមនៃអង្គការ IUCN ជាប្រភេទសត្វដែលងាយស្រួលបាត់បង់ និងជិតផុតពីការបាត់បង់នៅក្នុងពិភពលោក។ សត្វនេះរស់នៅលើវាលស្មៅដែលមានដីល្អ ក្នុងប្រទេសឥណ្ឌា នេប៉ាល់ និងប្រទេសកម្ពុជា។ តំបន់អភិរក្សសត្វខ្យីបមានទំហំ ៣១.១៥៩ ហិកតា (៣១២ គីឡូម៉ែត្រការ៉េ) នៅក្នុងខេត្តកំពង់ធំ និងសៀមរាប។ សហគមន៍មូលដ្ឋានចាំបាច់ត្រូវចូលរួមក្នុងការគ្រប់គ្រងតំបន់វាលស្មៅ និងយល់ដឹងអំពីមូលហេតុនៃការថយចុះនៃចំនួនសត្វខ្យីប។ សកម្មភាពអភិរក្សនៅក្នុងតំបន់អភិរក្សសត្វខ្យីបរួមមាន៖ ការដើរល្បាតនៅទីវាលដើម្បីការពារការបរបាញ់និងការទស្សនាជញ្ជីង, បង្កើនការអប់រំផ្សព្វផ្សាយពីបរិស្ថាន, និងការផ្តល់ការគាំទ្រអភិវឌ្ឍន៍កសិកម្មលើដីនៅក្រៅតំបន់អភិរក្សសត្វខ្យីប។ គោលបំណងនៃការសិក្សានេះគឺដើម្បីប៉ាន់ស្មានពីនិន្នាការនៃចំនួនសត្វខ្យីបក្នុងអំឡុងពេល ១០ ឆ្នាំចុងក្រោយ (ឆ្នាំ២០១០ ដល់ ២០១៩), ដើម្បីកំណត់កត្តាគំរាមកំហែងដល់ការអភិរក្សសត្វខ្យីប និងដើម្បីស្វែងយល់អំពីកម្រិតយល់ដឹងរបស់ប្រជាជនលើការអភិរក្សសត្វខ្យីបនៅប៉ែកខាងជើងបឹងទន្លេសាប គឺតំបន់អភិរក្សសត្វខ្យីបនៅស្រុកស្មោង-ដីក្រែងនិងស្រុកបាយ-ចុងដូង។ វិធីសាស្ត្រក្នុងការសិក្សាស្រាវជ្រាវនេះគឺការជ្រើសរើសជនគន្លឹះ ៩៧ គ្រួសារសម្រាប់ធ្វើសម្ភាស និងការប្រើបន្ទាត់ត្រង់ស៊ុកចំនួន ៧១ ដើម្បីប្រមូលទិន្នន័យសត្វខ្យីប។

ការសិក្សាបានរកឃើញថា នៅតំបន់អភិរក្សសត្វខ្យីបស្មោង-ដីក្រែងក្នុងរយៈពេលបីឆ្នាំចុងក្រោយនេះ ចំនួនសត្វខ្យីបនៅមានស្ថេរភាពជាធម្មតា។ រីឯវត្តមានសត្វខ្យីបនៅបាយ-ចុងដូងនៅតែបន្តថយចុះ។ កត្តាគំរាមកំហែងដល់ការអភិរក្សសត្វខ្យីបនៅតំបន់នោះរួមមាន៖ ការបរបាញ់ ៣០,៧%, ការប្រើថ្នាំបំបាត់ ១៦,៤%, ការបាត់បង់ទីជម្រក ១៥,៦%, ការធ្វើស្រែប្រាំង ១៣,១% និងការយល់ដឹងទាប ៥,៧%។ ការអង្កេតការវិនិច្ឆ័យសកម្មភាពឃ្នាលគោក្របី៖ នៅស្មោង-ដីក្រែងមាន ៤៨,១% ក្នុង២៥បន្ទាត់ត្រង់ស៊ុក, នៅបាយ ការអង្កេតចំនួន ៣០ បន្ទាត់ត្រង់ស៊ុកមាន ២៨,៩%, និងនៅក្នុងតំបន់អភិរក្សចុងដូង លើការអង្កេតចំនួន ១៦ បន្ទាត់ត្រង់ស៊ុកមាន ៣២%។ ជាងនេះទៅទៀត ប្រជាជននៅតំបន់នោះមានការយល់ដឹងអំពីគោលបំណង (ទាក់ទាញភ្ញៀវទេសចរ, រក្សាលំនឹងប្រព័ន្ធ អេកូឡូស៊ី, ចំណូលចូលសហគមន៍, ការពារធនធានធម្មជាតិ, និងបង្កើតមុខរបរដល់ប្រជាជន) នៃការអភិរក្សសត្វខ្យីបមាន ៨០,៤% និងប្រជាជនដែលមានការយល់ដឹងពីការគ្រប់គ្រងនៅក្នុងតំបន់អភិរក្សមាន ៧៨,៤% (ការដើរល្បាត និរន្តរភាពស្រូវកម្មវិធីការពារសំបុកសត្វ និងសេវាអេកូទេសចរណ៍)។ សរុបសេចក្តីមក តំបន់អភិរក្សសត្វខ្យីបនៅស្មោង-ដីក្រែងមានសារៈសំខាន់យ៉ាងខ្លាំងដល់ការស្វែងរកចំណី និងអត្រាសំរាប់សត្វខ្យីបមានកម្រិតខ្ពស់។ តំបន់ទាំងនោះក៏បានចូលរួមលើកស្ទួយកម្រិតជីវភាពប្រជាជនតាមរយៈការផ្តល់សេវាទេសចរណ៍ (នាំភ្ញៀវមើលសត្វ)។ ដើម្បីធ្វើឱ្យការអភិរក្សសត្វខ្យីបនៅតំបន់អភិរក្សបាយ-ចុងដូងបានប្រសើរឡើង ការអប់រំផ្សព្វផ្សាយ ការល្បាត និងការអនុវត្តច្បាប់យ៉ាងតឹងរឹងត្រូវបានបង្កើន។

* Corresponding author: Forestry Administration of Ministry of Agriculture Forestry and Fisheries (MAFF), Phnom Penh, Cambodia.
E-mail addresses: sovannarysan2018@gmail.com (S. Sovannary).

ABSTRACT

Bengal florican (*Houbaropsis bengalensis*) is a critically endangered bustard (type of bird) inhabiting alluvial grasslands in India, Nepal and Cambodia. Bengal Florican conservation areas (BFCAs) cover 31,159 ha (312 km²) in Kampong Thom and Siem Reap provinces. Local communities need to get involved in the management of grasslands and understand the reasons for the decline of Bengal florican. Conservation activities within BFCAs include field patrols to prevent hunting and land encroachment, environmental education and raising awareness, and provision of agricultural development support for lands outside the BFCAs. This study aims to estimate the population trends of Bengal florican (*H. bengalensis*) in the last ten years (2010-2019), to determine threats to Bengal florican in BFCAs, and to understand the perceptions of the locals regarding Bengal florican conservation in the northern Tonle Sap Protected Landscape, Cambodia. In the BFCAs of Stoung-Chikraeng and Baray-Chong Doung districts, data was collected in terms of seventy-one factors for use in a line transect method, and key informant interviews were conducted with ninety-seven respondents. This study found the population of Bengal florican in Stoung-Chikraeng has been stabilizing in the last three years (2017-2019). In Baray-Chong Doung the population of Bengal florican is still declining in the BFCAs. The threat factors to the population of Bengal florican in the conservation areas have been found to be: hunting 30.7%, chemicals 16.4%, habitat loss 15.6%, rice planting in the dry season 13.1%, power transmission lines 10.7%, and low education (public awareness) 5.7%. The observation of human disturbance using a line transect method found 25 line transects with strong cattle foraging (48.1%) in Stoung-Chikraeng, 30 line transects with cattle foraging (28.9%) in Baray and 16 line transects with cattle foraging (32.0%) in Chong Doung BFCAs. 80.4% of the respondents understand the purpose of the Bengal florican conservation (to promote ecotourism activities, ecological balance, community income, to protect the natural resources, create jobs for local people) and 78.4% of community members understand the management conservation of Bengal florican in BFCAs (Wild patrolled, Sustainable Rice Platform, Nest protection program, Ecotourism service). We concluded that Stoung-Chikraeng is an important area for Bengal florican conservation due to the food supply and a high survival rate of Bengal florican. The area was also found to be amenable to linking conservation participation to improved livelihoods of the local community through ecotourism (bird watching). To improve the conservation of Bengal florican in Baray-Chong Doung, we propose increasing education and public awareness.

1. Introduction

Bengal florican (*Houbaropsis bengalensis*) has been listed as a critically endangered bustard inhabiting alluvial grasslands in India, Nepal and Cambodia (BirdLife International, 2018). This species has been recorded in the Indian subcontinent and parts of Southeast Asia, including Cambodia. However, *H. bengalensis* is now extinct in Bangladesh, and Vietnam (BirdLife International, 2010; DNPWC, 2016). Bengal florican is one of three bustard species that is endangered, declining at an alarming rate throughout its former range, as its grassland habitat has been converted to farmland, or degraded by overgrazing of livestock (Baral et al., 2002). The global population of Bengal florican is estimated at approximately 250-999 mature individuals (BirdLife International, 2018).

In Cambodia, Bengal florican has been

recorded outside of the Tonle Sap Region including Ang Trapeang Thmor in Banteay Meanchey Province (northwestern Cambodia) and Boeung Prek Lapouv Protected Landscape in Takeo province (Mekong delta area next to the Vietnam border) (Gray et al., 2009). BFCAs covering 31,159 ha (312 km²) in Kampong Thom, and Siem Reap provinces, established by a Prakas issued by the Ministries of Agriculture, Fisheries and Forestry (MAFF), to protect the grassland as it is a critically necessary habitat for this species (WCS, 2010). In Cambodia, Bengal florican has been treated as a highest preservation priority, this is due to the fact that the large amount of grassland and population breeding around the Tonle Sap Great Lake are seriously threatened by the conversion of grassland to agricultural land (Mahood and Son, 2010; Ibbett, 2015). Bengal florican is an omnivorous species,

which feeds on fruits, shoots, flowers, insects, frogs, and small reptiles (Thakuri, 2018). In the breeding season, males become conspicuous by their bold plumage and demonstrations of gallant lekking displays (Ibbett, 2015).

BFCAs are areas managed in accordance with an integrated plan for the conservation of the natural environment and for the sustainable use of natural resources (Chhetry, 2008). Successful community-based conservation models implemented at Stoung-Chikraeng BFCAs could possibly be modified and applied in India and Nepal, to reduce the chance of extinction of bustards there (Mahood et al., 2019). Conservation activities within BFCAs include field patrols to prevent hunting and to document any land encroachment, lobbying for support from government decision-makers, environmental education and awareness-raising, trials of co-management arrangements for traditional resource use, and provision of agricultural development support for land outside the BFCAs (Gray et al., 2009).

Community Management Committees were formed to ensure local communities benefit from livelihood activities. Several innovative Payment for Ecosystem Services (PES) mechanisms have been piloted in villages surrounding BFCAs, these include ecotourism and sustainable rice platforms, which are a form of wildlife-friendly rice cultivation programs that have been successfully implemented elsewhere in Cambodia (Clements et al., 2010). Other PESs include nest protection payments, and an ecotourism scheme, whereby villages receive payments for successful sightings of Bengal florican (Mahood and Hong, 2013). In Asia, Bengal florican (*H. bengalensis*) occurs in only a few countries in India, Nepal, and Cambodia, however, it is extinct from Bangladesh and Vietnam (BirdLife International, 2010, 2018; DNPWC 2016). Many threats to these individuals have been described (Gray et al., 2007, 2009; Mahood et al., 2018; Packman et al., 2014).

Bengal florican conservation in Stoung-Chikraeng has been very successful and the population of Bengal florican was stabilized where community-based conservation implemented by the Ministry of Environment is supported by the Wildlife

Conservation Society (WCS, 2019). The effective conservation of Bengal florican depends on an understanding of the species habitat requirements and disturbance tolerance levels (Gray et al., 2007). To assess qualitatively the potential impact of power lines on the Bengal florican, we reviewed published and unpublished data on rates of collision between bustards and power lines and examined the location of breeding and non-breeding areas and migration routes about planned transmission routes (Mahood et al., 2018). The importance of the local community to participate and pay attention to Bengal florican in terms of activities of wildlife conservation and protect critically endangered species, is that it can provide benefits through ecosystem services. The implementation of successful conservation projects often includes environmental education and involvement of local communities. This paper aims to identify the effectiveness of and challenges to Bengal florican (*H. bengalensis*) conservation commitments in the northern Tonle Sap Protected Landscape, Cambodia. The study specifically focuses upon: (1) estimating the population trend of Bengal florican (*H. bengalensis*) in the last ten years (2010-2019) in the northern Tonle Sap protected Landscape; (2) determining threats to Bengal florican in the northern Tonle Sap Protected Landscape, Cambodia; and (3) understanding local perceptions and interventions toward Bengal florican conservation in the northern Tonle Sap Protected Landscape, Cambodia.

2. Literature review

The taxonomical name of Bengal florican is *H. bengalensis* in the Kingdom Animalia, Phylum Chordata, Class Aves, Order Gruiformes, Family Otidae, Genus *Houbaropsis*, Species: *bengalensis*, Sub-species: *bengalensis* (Fig.1)(DNPWC, 2016). Bengal florican (*H. bengalensis*) was listed as Critically Endangered on the IUCN Red List with the global population estimated to range from 250-999 mature individuals. Physically, adult Bengal floricans reach 66-68 cm in length and 55 cm tall (BirdLife International, 2018). In the last decade, most bustards have become globally endangered according to the IUCN Red list. The Great Indian bustard (*Ardeotis nigriceps*) and Bengal florican (*H. bengalensis*) are critically endangered species, and two other endangered species are Ludwig's



Fig. 1. Male (A) and Female (B) Bengal florican (*H. bengalensis*).

bustard (*Neotis ludwigii*) and Lesser florican (*Sypheotides indicus*). Four bustards are vulnerable, such as the Great bustard (*Otis tarda*), African houbara (*Chlamydotis undulata*), Asian houbara (*Chlamydotis macqueenii*).

Seven species of bustard are near threatened, including the little bustard (*Tetrax tetrax*), Kori bustard (*Ardeotis kori*), Arabian bustard (*Ardeotis arabs*), Denham's bustard (*Neotis denhami*), Nubian bustard (*Neotis nuba*), Blue Bustard (*Eupodotis caerulescens*), Little brown bustard (*Eupodotis humilis*). As well, there are ten species ranked as lesser concerns, including the Australian bustard (*Ardeotis australis*), Red-crested korhaan (*Lophotis ruficrista*), White-bellied bustard (*Eupodotis senegalensis*), Heuglin's bustard (*Neotis heuglinii*), Buff-crested bustard (*Lophotis gindiana*), Black-bellied bustard (*Lissotis melanogaster*), Ruppell's korhaan (*Eupodotis rueppellii*), Karoo Bustard (*Eupodotis vigorsii*), Northern black bustard (*Afrotis afraoides*), and Hartlaub's bustard (*Lissotis hartlaubii*).

2.1 Ecology and behavior

Bengal florican (*H. bengalensis*) is omnivorous and feeds on insects such as grasshoppers, beetles, ants occasionally lizards, small snakes, grasses, flowers, shoots, berries, and seeds, depending on seasonal availability (Thakuri, 2018, Ali and Ripley, 1987; del Hoyo et al., 1996; Sterling et al., 2006). Bengal florican is a ground-dwelling, defenseless grassland bustard that

lives in lowland grasslands (Ali and Ripley, 1987). The breeding season lasts from March to August and females lay 1-2 eggs on the ground under tall grass. The eggs are glossy olive-green color with purple-brown flecks, and are incubated for 25 to 28 days (Baral et al., 2002; Poole and Tan, 2003). It appears to favour relatively open, short grasslands (Baral et al., 2002). The males provide no care for the chicks (Narayan, 1992).

2.2 Geographical range

Bengal florican (*H. bengalensis*) is distributed in two isolated populations: in South Asia in the Terai area of Nepal and India; and, *H. b. blandini* is found in Southeast Asia in Cambodia (Fig. 2) (DNPWC, 2016).

Approximately 66% of the world population of Bengal florican remains, with 80% found in Kampong Thom province, Cambodia which is situated to the northeast of the Tonle Sap lake (Packman et al., 2014). In Nepal, it is found in the protected areas and adjacent sites of Shuklaphanta Wildlife Reserve, Bardia National Park, Chitwan National Park and Koshi Tappu Wildlife Reserve. The population in those areas is estimated to be under 100 individuals (Baral and Inskipp, 2005; BCN and DNPWC, 2011; Inskipp et al., 2016). In Cambodia, the population of Bengal florican was estimated to include 104 (89-117) adult males (Mahood et al., 2019) The distribution of this species, on the basis of recorded sightings, includes two areas outside the Tonle Sap lake region: Ang Trapeang Thmor, Banteay Meanchey province in

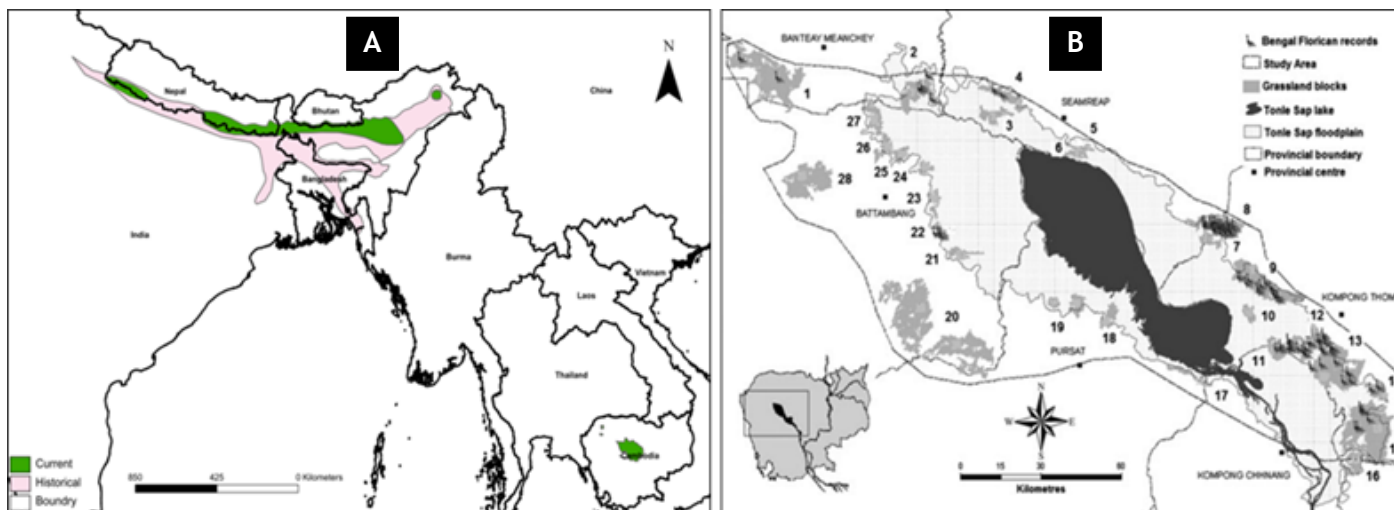


Fig. 2. (A): Global Distribution Range of Bengal florican (*H. bengalensis*) and (B), distribution of Bengal florican (*H. bengalensis*) in Cambodia. Source: (DNPWC, 2016; Gray et al., 2007).

northwest Cambodia, and Boeung Prek Lapouv, Takeo province in the Mekong delta. The species is also found in Bengal florican conservation areas in Siem Reap and Kampong Thom provinces (Gray et al., 2009; Mahood et al., 2019).

Habitat requirement. Bengal florican is a grassland dwelling bird species that prefers a dry habitat with relatively open short grass and scattered bushes (Thakuri, 2018). During the breeding season, short grassland appears to be favored for foraging and displaying, but the males seek shelter in tall grass and females spend substantial time in the tall grass for breeding (Thakuri, 2018). In Cambodia, local seasonal movements are related to flooding in the area of the Tonle Sap protected landscape. In the dry season, Bengal florican breeds in grassland in the inundation zone of the lake and then moves to the nearby open forest areas during the rainy season (Son virak, 2016). The primary habitat requirement for breeding is grassland where sufficient grass cover is available (Gadhvi, 2003).

2.3 Threats

Human population growth has increased pressure on the protected zones and surrounding areas due to land encroachment, conversion of grasslands and forests into agricultural lands, unsustainable natural resource extraction, and overgrazing by livestock. Each factor has resulted in habitat loss and natural environment degradation (Bajracharya et al., 2014). Habitat loss due to livestock grazing occurs because some

people that live around the area use cows or buffaloes in agriculture. Population declines also result from wildlife hunting for sales or for food consumption (Gadhvi, 2003).

2.4 Grassland habitat loss and degradation

The key threat to Bengal florican is grassland loss and modification of its habitat throughout its range (Bird Life International, 2018). The key causal factors effecting extensive loss and modification of grasslands are drainage, conversion to agricultural use and plantations, extensive cutting, burning and ploughing practices, invasive species, scrub expansion, overgrazing, heavy flooding, dam construction, and illegal development (Thakuri, 2018).

2.5 Overgrazing and disturbance

Disturbances by people and resulting from cattle grazing during the breeding season are serious threats (Baral et al., 2013). The local people enter the breeding habitat in the early morning and late afternoon to collect cattle dung and grass, and the timing corresponds with peak activity periods of Bengal Florican breeding behaviors (Thakuri, 2018). Tourism activities such as bird watching disturb the Bengal florican and could further reduce breeding success (Thakuri, 2018).

2.6 Power line collision

Collision is a common threat for all bustards which fly at the height of high tension lines and other power supply lines (Thakuri, 2018). The

proposed power transmission lines may also affect the Bengal florican (Mahood et al., 2018). Cambodia's Bengal Florican will need to traverse the power lines at least two times each year on their annual migration. Additionally, at BFCAs in Stoung-Chikraeng, power lines are located close to an important Bengal florican habitat and that is predicted to significantly increase adult male mortality (Mahood et al. 2018). The location of the power line could therefore end breeding at Stoung-Chikraeng BFCAs and increase mortality in adjacent areas. Given the potential for colonization of newly created grassland by human activities, there is an urgent need to identify and rehabilitate abandoned or unproductive agricultural land near Stoung-Chikraeng BFCAs to draw the bustards away from the areas close to the power line (Mahood et al., 2018).

2.7 Conservation activities

It is important to continue annual monitoring of the population in the BFCAs in Cambodia, and replicate the monitoring protocols in key sites in India and Nepal. It is also important to conduct research on reproductive productivity and habitat utilization in both breeding and non-breeding BFCAs (Bird Life International, 2018). The grasslands of the Tonle Sap floodplain are critically important for biodiversity and local livelihoods. Intensive traditional human use is compatible with efforts to maintain the habitat (WCS, 2009). Management decisions within the BFCAs are made through Community Management Committees (CMCs). The four main activities which take place inside the BFCAs are law enforcement, education, monitoring, and research (MAFF, 2013). Local people also report illegal activities, such as land grabbing, to the area patrol team. Activities for education and raising awareness on the benefits of the BFCAs and the laws and regulations concerning Bengal floricans and BFCA's are conducted in villages. Locals are informed of the benefits of BFCAs, which include grazing land, fishing during the rainy season period of flooding, and cricket harvesting (MAFF, 2013). Annual monitoring of the Bengal florican population and monthly monitoring of key bird species is conducted by the Wildlife Conservation Society with the Community Management Committees (MAFF, 2013).

2.8 Community-related to conservation

Community management has been successful in conservation in terms of increasing awareness and environmental education, as well as strengthening the local communities' capacity for participation in conservation area management committees (Bajracharya et al. 2005). Local support and participation are often important for effective wildlife conservation (Vannelli et al., 2019). Achieving change in community perceptions of wildlife is essential when implementing ecotourism schemes to enable more effective conservation, as well as when generating local awareness and concern for wildlife in relation to keystone species, which are frequently the focus of human-environment conflicts (Vannelli et al., 2019). The protection of Bengal florican is linked to payments into a community fund that has been used to build toilets at the village school, to repair the pagoda, and to purchase medicines (Mahood et al., 2019). Management of Stoung-Chikraeng BFCAs is carried out by a Community Management Committee. Its activities include patrolling to combat grassland encroachment, a nest protection programme that pays community members for successful fledging of Bengal florican nests, and an ecotourism scheme (Mahood et al., 2019).

3. Materials and methods

This study was conducted in three districts located in two provinces in Cambodia: Kampong Thom province (Stoung and Baray district), and Siem Reap province (Chi Kraeng district) in the northern Tonle Sap protected landscape in Bengal florican conservation areas (BFCAs) (Fig. 3). In Tonle Sap region, dominant vegetation types in the years 1996 and 1997 were wet-season rice agriculture (taking up 33% of the land area, excluding permanent water in the Tonle Sap) forest and scrublands (33% of the land), grassland (21%), and small permanent wetlands (15%) (JICA, 2000). Soils are primarily gleysols and acrisols with small areas of plinthosols, fluvisols and luvisols (MRC, 2006). The grassland area in the northern Tonle Sap is the preferred habitat of Bengal florican (Gray et al., 2007).

The data was collected from May to August of 2020. Two different approaches were developed to collect information, involving a combination of

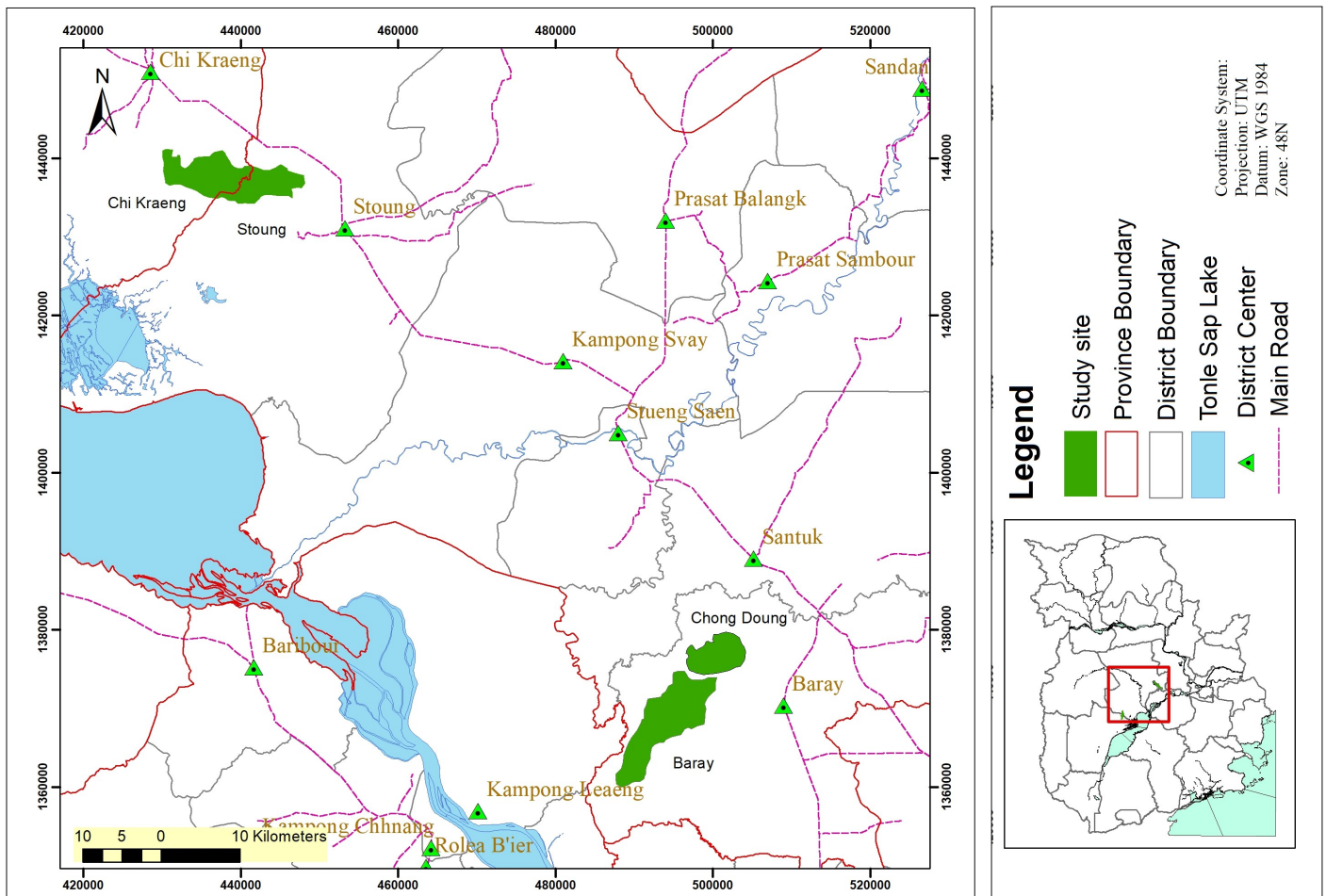


Fig. 3. Map showing locations of the study areas (BFCAs), in Kampong Thom and Siem Reap Province, Cambodia.

quantitative and qualitative methods. Quantitative tools were based on household surveys, while qualitative tools were based on focused group discussion and key informant interviews. Each data collection session (household survey, focused group discussions, and key informant interviews) during the fieldwork were collected by several well-trained questioners. To collect the data, the survey questions consisted of different types of questions. For example, some questions were closed yes-no queries, some were multiple choice, and some were open-ended queries. Data line-transects were collected in three different sites in Baray, Chong DOUNG and Stoung-Chikraeng, in relation to the relevant Bengal florican conservation areas.

3.1 Population trend

The population data of Bengal florican were collected by WCS census every year. Generally, for the purpose of accessible observation, the Bengal florican census was conducted in the dry season (March to May) as it is the breeding season, which

makes it easier to find their presence. The Bengal florican observation entails using blocks of 1 km² on a grid with a random start point and two kilometres spacing between each surveyed square. The total number of blocks in Stoung-Chikraeng was 18, in Baray it was 44, and in Chong-DOUNG it was 8. The observations were carried out every morning (from 6:00 to 8:30) and evening (from 16:00 to 18:30).

3.2 Household survey

In Chi kraeng district, Siem Reap province, the sample was selected from two villages of Lveaeng Ruessei commune which were identified to participate in the community information survey. The interviews were conducted with 7 households in Rumchey Chroh village and 9 households in Ballang village. A sample size of 16 households (Table 1) was selected for interviews from a total number of 508 households in two targeted villages of the one commune. In Stoung district Kampong Thom province, the sample size was selected from three villages in Prolay commune. Interviews were collected from 9 households in Prey Khla, 7

households in Kampong Veang and 9 households in Chhuk village. Thus, a sample of 25 households was selected for interviews from a total number of 760 households in three targeted villages of Prolay commune. In the Baray district, Baray and Chong Doung communes were selected for the interviews. In Baray commune, the interviews were collected from 6 households in Por II village, 6 households in Banak village, and 21 households in Chaktolok village. In Chong Doung commune, interviews were conducted in Samraong village with 11 households and in Ku village with 12 households. A sample size of 56 families was selected for interviews from a total population of 1722 households in the five targeted villages of two targeted communes. The Yamane formula (1967) was used to identify an appropriate total of respondents across the villages, and a Yamane formula (1973) was used to identify the appropriate total number of households selected to interview in each village, as follows:

$$n = \frac{N}{1+Ne^2} \quad (\text{Yamane, 1973})$$

Where,

n : Number of households selected to interview (total sample size)

N : Total of households in the targeted area (population size)

E : Probability of 10%

Given that there was a total of 2990 households in the 10 villages, and $e = 10\%$, or $e = 0.1$

$$n = \frac{2990}{1 + 2990(0.1)^2} = \frac{2990}{30.9} = 96.76$$

≈97 Households to select for interview

The sample size of households selected from each village in Kampong Thom and Siem Reap province for interviews was:

$$ni = \frac{n \times Ni}{N} \quad (\text{Yamane, 1973})$$

Where,

ni : Number of households selected to interview from each village

Ni : Total number of households in each village

N : Total number of households in targeted villages

N : Number of households selected to interview (total sample size)

Sample selection Chi Kraeng district Lveaeng Ruessei commune Siem Reap province:

Rumchey Chroh Village with a total of 230 households

$$ni = \frac{97 * 230}{2990} = \frac{22,080}{2990} = 7.46$$

≈7 Households to select for interview

Ballangk Village with a total of 278 households

$$ni = \frac{97 * 278}{2990} = \frac{26,966}{2990} = 9.01$$

≈9 Households to select for interview

Sample selection Stoung district Pralay commune Kampong Thom province:

Prey Khla Village with a total of 275 households

$$ni = \frac{97 * 275}{2990} = \frac{26,675}{2990} = 8.92$$

≈9 Households to select for interview

Kampong Veang Village with a total of 214 households

$$ni = \frac{97 * 214}{2990} = \frac{20,758}{2990} = 6.94$$

≈7 Households to select for interview

Chhuk Village with a total of 271 households

$$ni = \frac{97 * 271}{2990} = \frac{26,287}{2990} = 8.79$$

≈9 Households to select for interview

Sample selection Baray district Baray commune Kampong Thom province:

Por II Village with a total of 176 households

$$ni = \frac{97 * 176}{2990} = \frac{17,072}{2990} = 5.70$$

≈6 Households to select for interview

Banak Village with a total of 170 households

$$ni = \frac{97 * 170}{2990} = \frac{16,490}{2990} = 5.51$$

≈6 Households to select for interview

Chaktolok Village with a total of 653 households

$$ni = \frac{97 * 653}{2990} = \frac{63,341}{2990} = 21.18$$

≈21 Households to select for interview

Sample selection Baray district Chong-Doung commune Kampong Thom province:

Samraong Village with a total of 336 households

$$ni = \frac{97 * 336}{2990} = \frac{32,592}{2990} = 10.90$$

≈11 Households to select for interview

Ku Village actually with a total of 382 households

$$ni = \frac{97 * 382}{2990} = \frac{37,054}{2990} = 12.39$$

≈12 Households to select for interview

3.3 Focus Group Discussion (FGD)

The FGD strategy selected villages in Siem Reap and Kampong Thom province. On 15th August 2020, a group discussion was held in Baray-Chong Doung Community, Baray District, with the participation of 14 community members. On 18th August 2020, a group discussion was held in Brolay Community, Stoung District, with the participation of 12 community members. On 20th August 2020, a group discussion was held in Lveaeng Ruessei Community, Stoung District, with the participation of 14 community members (Table 2). The FGD selected respondents that were elderly who had lived in the village for many years, and also considered gender by encouraging women to participate in the discussion sessions. The FGDs were conducted with the aim of obtaining qualitative information, and a note-taker observed the discussion in order to record responses, non-verbal expressions, and communication. In this way, it was possible to add to the information collected through semi-structured questionnaires.

Table 1. Households (HHs) sample size selected for an interview.

Province	District	Commune	Households	Sample
Siem Rep	Chi Kraeng	Lveaeng Ruessei	230	7
			278	9
Kampong Thom	Stoung	Prolay	275	9
			214	7
	Baray		271	9
			175	6
			176	6
		Chong-Doung	653	21
			336	11
			382	12
Total			2,990	97

Table 2. Number of respondents that participated in the focus group discussions in the communities.

Province	District	Commune	#Respondent in FGD
Siem Rep	Chi Kraeng	Lveaeng Ruessei	14
Kampong Thom	Stoung	Prolay	12
		Baray	14
			Chong Doung
Total			40

3.4 Key Informant Interviews

Key Informant Interviews (KII) with individuals were collected on eco-tourism activities in the communities of Baray, Chong-Dong, Prolay, and Lveaeng Ruessei. Interviews related to Sustainable Rice Platform activities were

conducted only in Prolay communities. The KII used semi-structured questions. KIIs were conducted to get a deeper understanding of the activities pertaining to ecotourism in each community protected areas.

3.5 Observation

We observed human disturbance activities in three different sites using a line transect method. The line transects were selected using random points in ArcGIS Version 10.5.

The length of the line was 1.5 km. We used Avanza Map Version 3.12 (a smartphone application) that was developed for offline navigation to ensure movements adhering to the transect lines. GPSMAP 64s was also used to measure the length of each transect line and to observe the human activities, which included the presence of people, motor bikes, tractors, cattle, settlements, cars, habitat loss, power lines, and company lands.

The data collection was conducted for three weeks in July 2020. A total of 71 transect lines transect were included in the sites. The data collection was carried out at different times for each site. The number of transect lines differed by location: 25 transect lines in Stoung-Chikreang (Fig. 4), 30 transect lines in Baray (Fig. 5), and 16 transect lines in Chong-Doung (Fig. 6). In the mornings the survey was conducted from 8:00 am to 11:30 am, and in the afternoons, it was conducted from 1:00 pm to 4:30 pm.

3.6 Data Analysis

This research data was analysed by using the Statistical Package for Social Science (SPSS) Version 25.0 and using descriptive statistics for quantitative analysis. Data were converted to annual figures. The analysis of the qualitative data obtained from focus group discussions was used to capture the original ideas and viewpoints of the

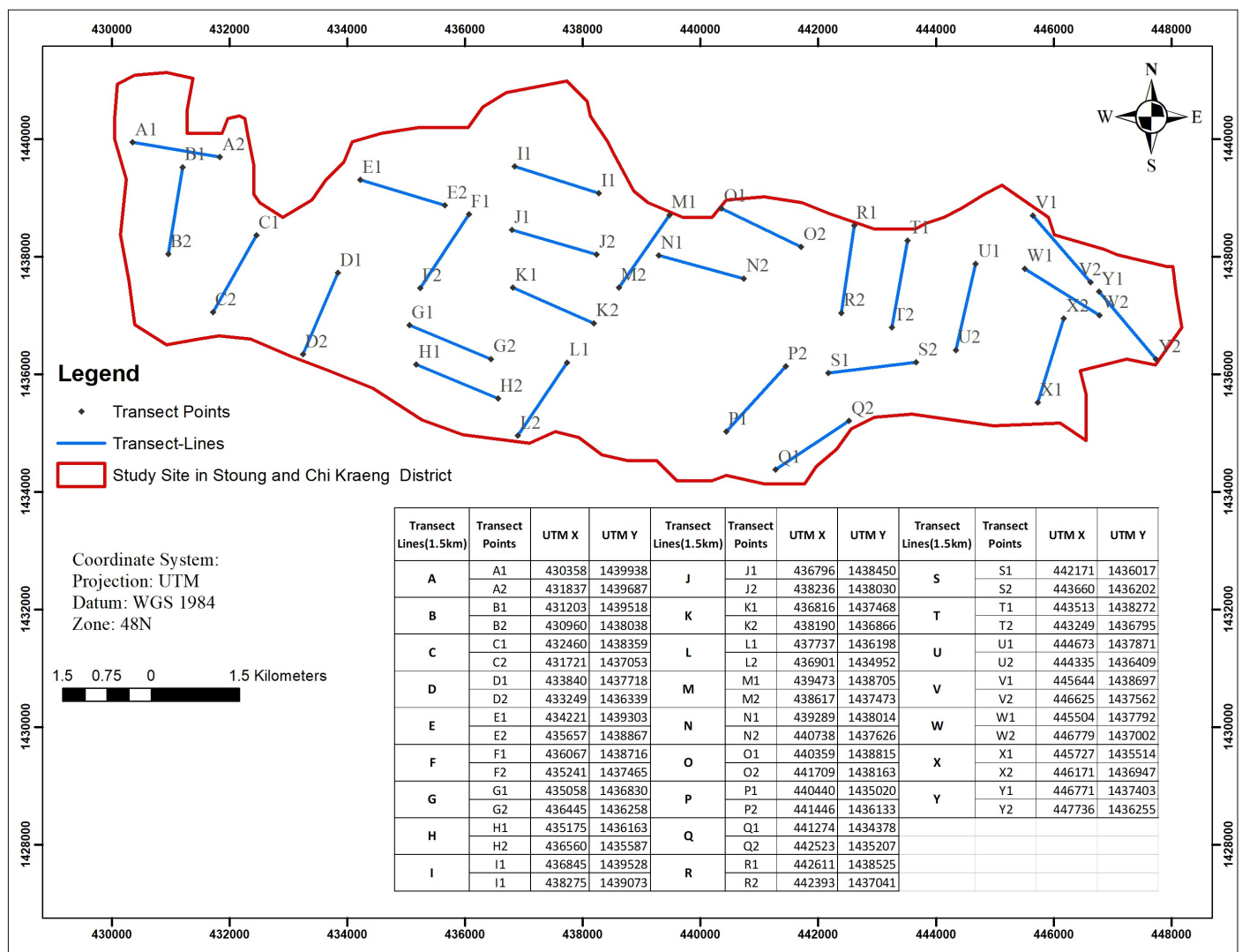


Fig. 4. Map transects lines of the study site of the Bengal florican conservation area in Stoung-Chi Kraeng.

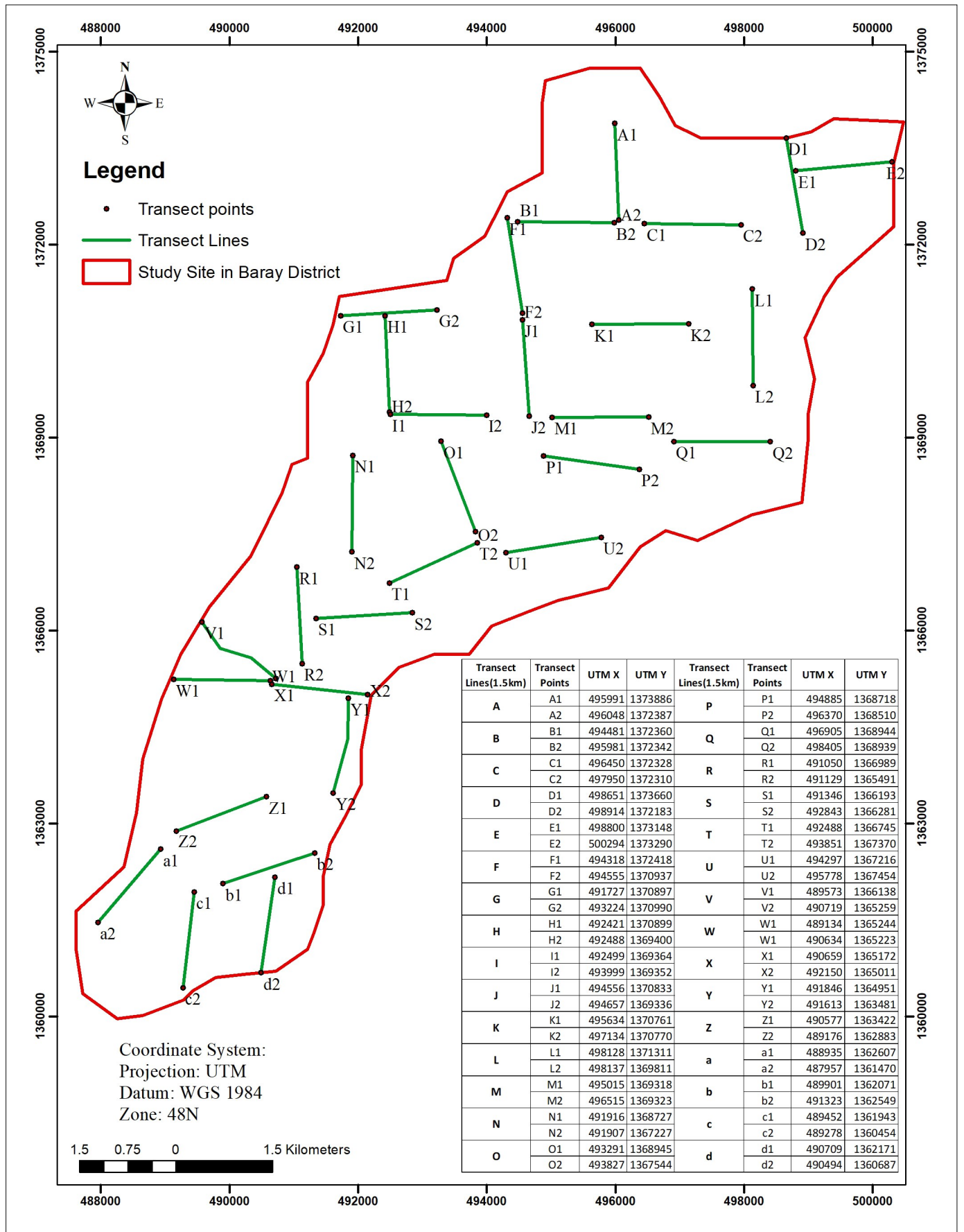


Fig. 5. Map transect lines of the study site of the Bengal Florican conservation Area in Baray.

different respondents as much as possible. For data from transect lines, we used Microsoft excel for data entry. We used SPSS to analyse multiple responses to determine the percentage of human activities in each site.

4. Results and discussions

Bengal florican conservation and community participation in ecotourism services in the Tonle Sap protected landscape.

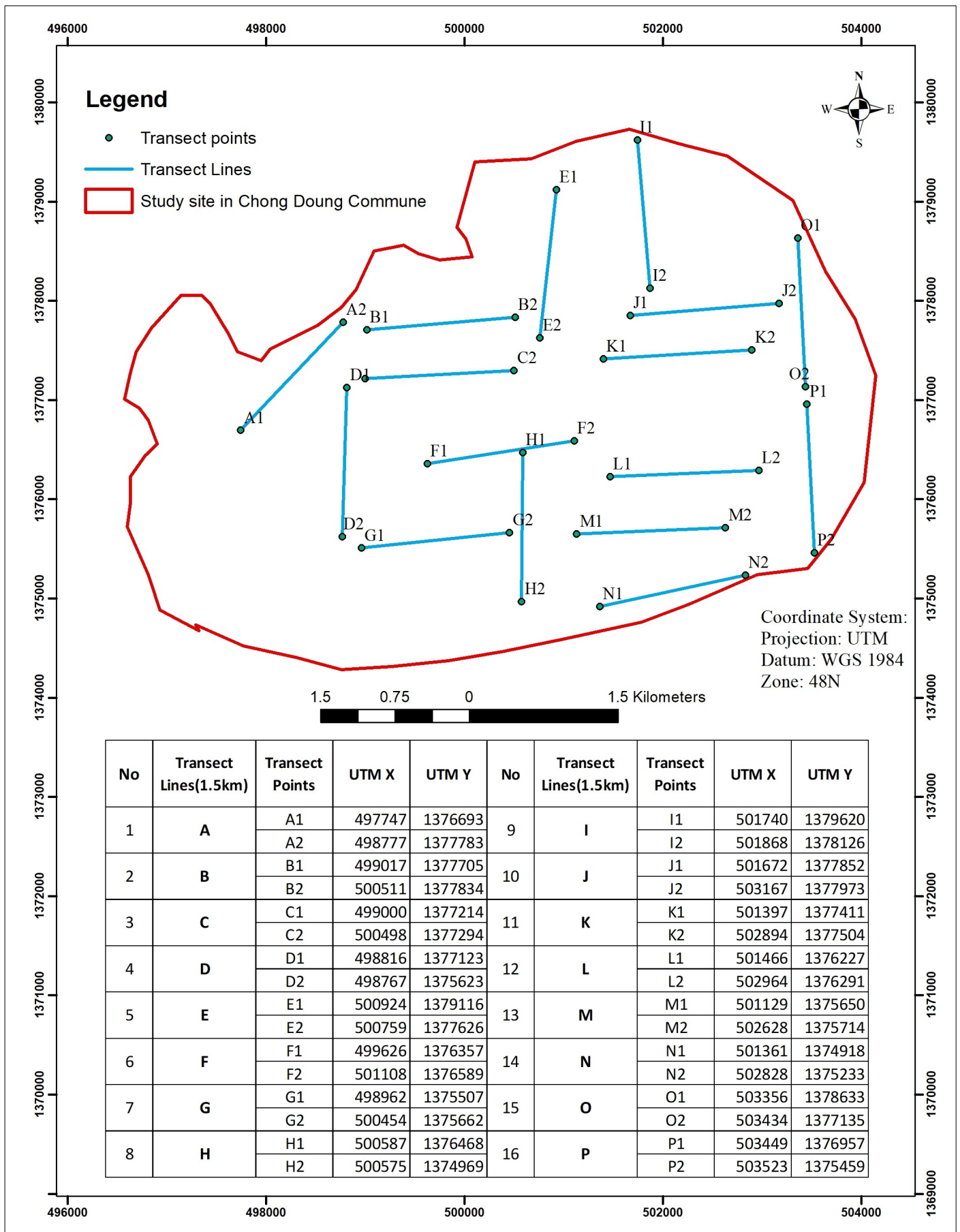


Fig. 6. Map transect lines of the study site of the Bengal Florican conservation Area in Chong-Doung.

Overall, the population of Bengal florican in Bengal florican population in Stoung-Chikraeng BFCAs for Baray-Chong Doung and Stoung-Chikreang decreased by 29 displaying males from 2011 to 2010. However, in 2013, there was an increase in 2019 there was an increase at both sites. The the presence of Bengal florican of 29 displaying

males when compared to 2012. Following that, in 2015, the Population of Bengal florican decreased 21 display males when compared with 2014 (Fig. 7). However, the population of Bengal florican in Stoung-Chikraeng stabilized in during the period from 2017 to 2019. Regarding the population of Bengal florican in Baray-Chong Doung BFCAs, from 2010 to 2012 the number population of Bengal florican decreased by 19 displaying males, but from 2012 to 2013 the population of Bengal florican increased by 8 displaying males. In 2015, no displaying males were found in Baray-Chong Doung BFCAs, but since 2016, the Bengal florican have reappeared (Fig. 7).

Fig. 8 shows the percentage of community members that are involved in conservation activities in the northern Tonle Sap protected areas. Overall, the community members mostly involved with conservation activities were linked to Community Protected Areas (CPA), and less community members were involved with the surveying of powerlines.

According to the 97 families interviewed, activities for Bengal florican conservation in Baray-Chong Doung and Stoung-Chikraeng were: working with community protected areas (CPAs) at a rate of 33.1%; 18.0% of families were involved with outreach education; 16.9% participated with patrols and law enforcement; 7.9% worked in the ecotourism sector, 6.4% participated in nest protection and Sustainable Rice Platforms (SRP); and, 3.4% worked surveying power lines.

The local community members that participated in patrolling and law enforcement (Fig. 9) varied for the three communities. In Chikreang district the community members that were involved with patrolling and law enforcement was 13.4%, while those not involved was 3.1%.

In Stoung district 16.5% of the community members were involved in these activities, while 9.5% were not involved. In Baray district 16.5% were involved and 41.2% were not involved.

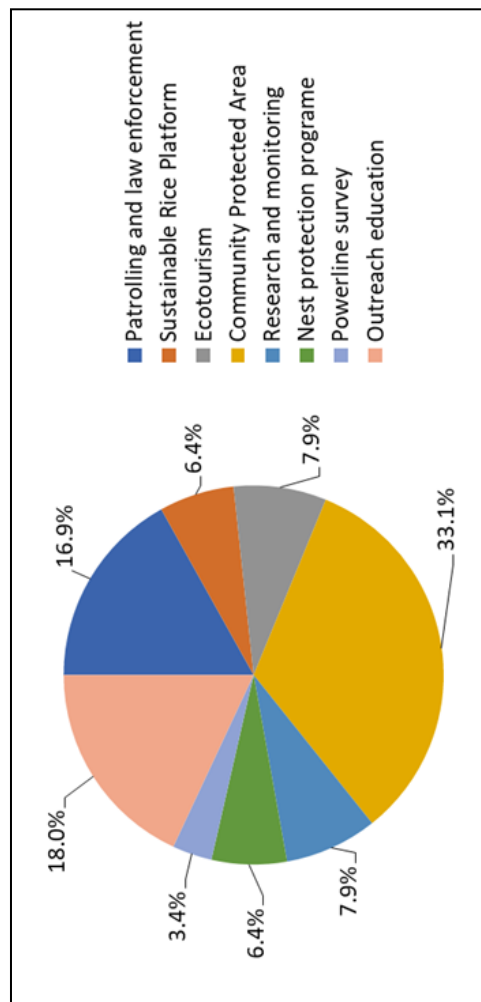
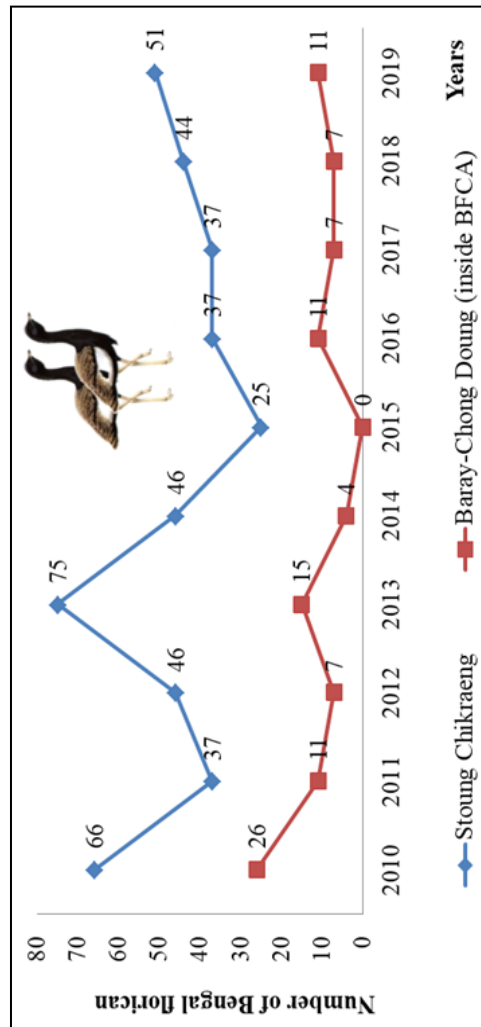


Fig. 7. The population trends of Bengal florican from 2010-2020 in Stoung Chikraeng and Baray-Chong Doung. Sources: Data from WCS 2010-2019.

Fig. 8. Types of activities in the Bengal florican conservation areas in the Tonle Sap protected landscape.

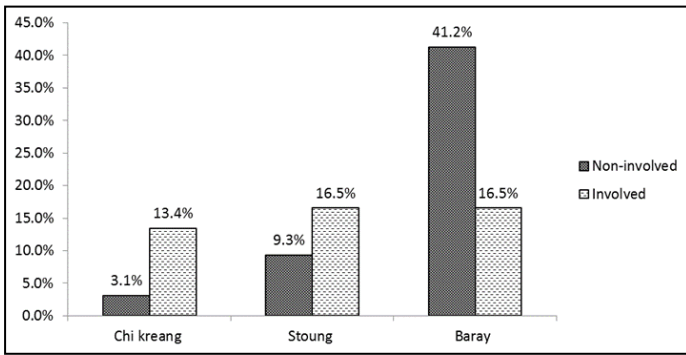


Fig. 9. Percentage of community participating in patrolling and law enforcement activities in BFCAs.

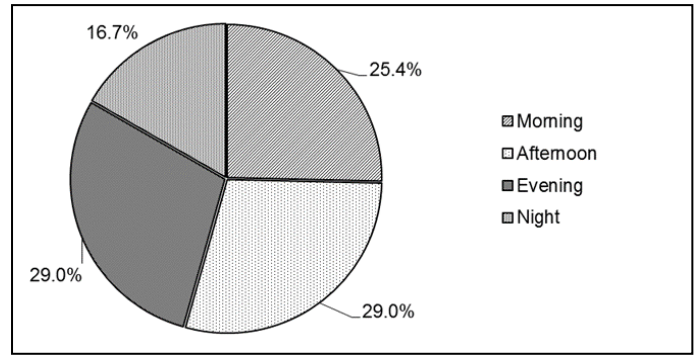


Fig. 10. Time of day of community members participate in patrolling and law enforcement in BFCAs.

The amount of community members that went to patrolling in BFCAs in the morning was 29.0%, in the afternoon 29.0%, and at night 16.7% (Fig.10). Generally, the community members went on patrols or participated in law enforcement one time per week. Community members provided scores by evaluating patrols and law enforcement in each BFCA. 17.4% from Lveng Russey community felt that the activities of patrols and law enforcement in conservation areas were good, 2.2% felt that the activities were very good, and 8.7% felt that the activities were average. In the Brolay community, 28.3% of community members said that the activities of patrols and law enforcement in conservation areas were good, 6.5% felt the activities were very good, and 2.2% said they were average.

shown in Fig. 12. In the Stoung district, 13.4% of Brolay community members were involved, and 12.4% were not involved. In Chikraeng district, 7.2% were involved, and 9.3% were not involved. In Baray district, 1% were involved and 56.7% were not involved (Fig. 12).

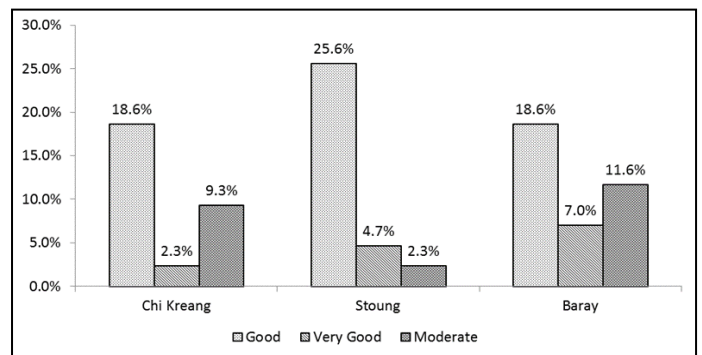


Fig. 11. Community members provided scoring on the effectiveness of patrolling and law enforcement management in BFCAs

In Chi kreang district, 18.6% of the respondents rated the activities of patrols and law enforcement in conservation areas as good, 2.3% rated the activities as very good, and 9.3% of the respondents rated those activities as average. In Stoung district, 25.6% of respondents rated on patrols and law enforcement as good, 4.7% rated the activities as very good and 2.3% rated them as average. In Baray district, 18.6% of the respondent rated the activities of patrols and law enforcement in conservation areas as good, 7.0% rated the activities as very good, and 11.6% of the respondents rated those activities as average (Fig.11).

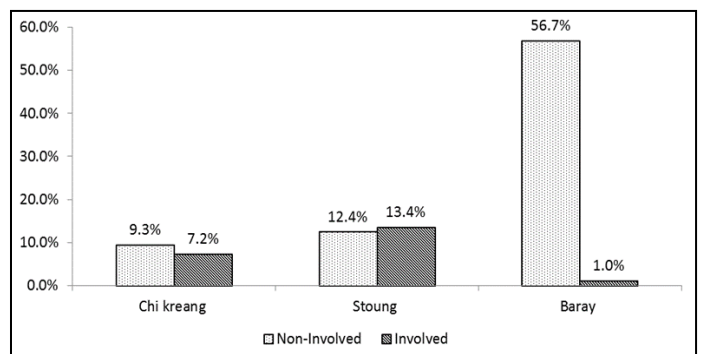


Fig. 12. Participation in ecotourism services.

Community participation in ecotourism services and Nest Protection Programme

The community members that participated in ecotourism services in the three communities is

Based on interviews with 97 community members, participation with Community Protected Areas (CPAs) can be calculated (Fig. 13). In the Baray district, 49.5% of community members were

found to be involved with CPAs, and 8.2% were not involved. In Stoung district, 24.7% of community members were involved with CPAs, and 1% were not involved. In Chikraeng district, 16.5% were involved with CPAs.

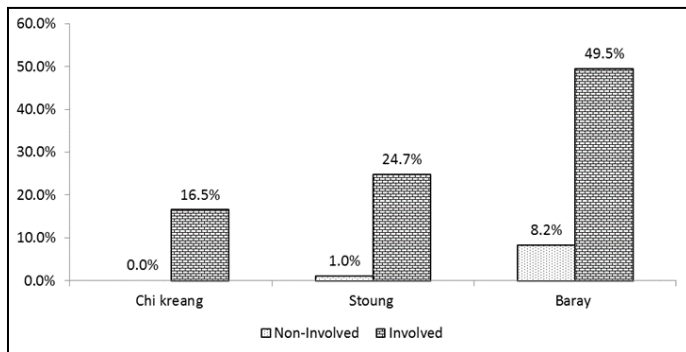


Fig. 13. Percentage of the community that participate with CPAs.

The percent of community members that participated in research activities in BFCAs was also recorded. In the Baray district, the amount of community members involved with research activities was 8.2%, while those not involved were 49.5%. In the Stoung district, 8.2% of community members were found to be involved with research, while 17.5% were not. In the Chikraeng, 5.2% were involved, and 11.3% were not (Fig. 14).

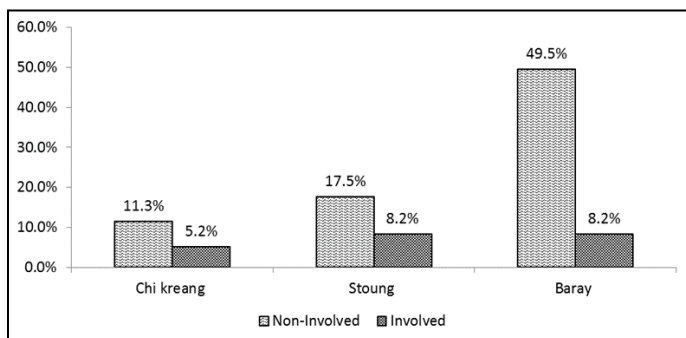


Fig. 14. Percentages of community members participating in research activities.

According to interviews with households that have members participating in research activities related to the Bengal florican, the population of the bustards was estimated to be decreasing. 52.6% of respondents estimated a decrease in the population of Bengal florican in BFCAs, 26.3% estimated that it is increasing, and 21.1% said they believed the population to be stable. The nest protection programme is a part of conservation activities (Fig. 15).

In the Stoung district, 9.3% of community members reported being involved with the nest protection programme, and 16.5% were not involved. In the Chikraeng district, 5.2% were involved with these activities, and 11.3% were not involved. In the

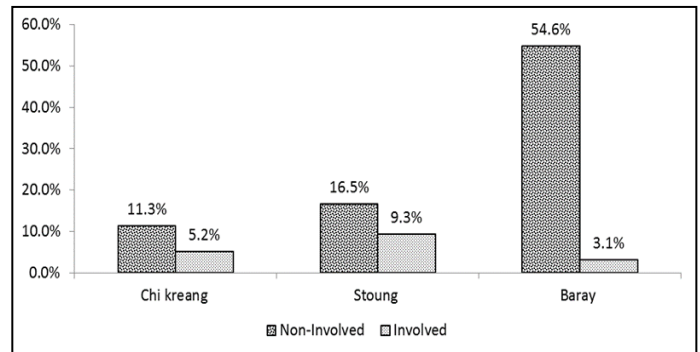


Fig. 15. Percentages of community members participating in nest protection programmes in BFCAs.

Baray district, 3.1% were involved, and 54.6% were not involved. One conservation activity for protection of Bengal florican in the northern Tonle Sap protected landscape is the power line survey. In the BFCAs the community members that participate with powerline survey were only found in the Stoung district Brolay community, because of the powerline development in that location. In the Brolay community 64% of community members were found to be involved with the power line survey, while 36% were not involved.

Regarding the power lines set up at the edge of the Tonle Sap BFCAs, 57.1% were found to have a very high impact on bird conservation, especially critically endangered Bengal florican, while only 7.1% of powerlines set up were deemed to have an impact rated as normal (Fig. 16). Community members interviewed in the three districts participated with outreach education (Fig. 17).

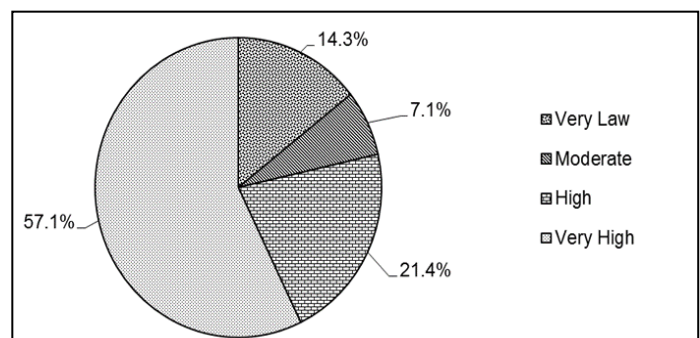


Fig. 16. Impact ranking of powerline set-ups in BFCAs by percentage.

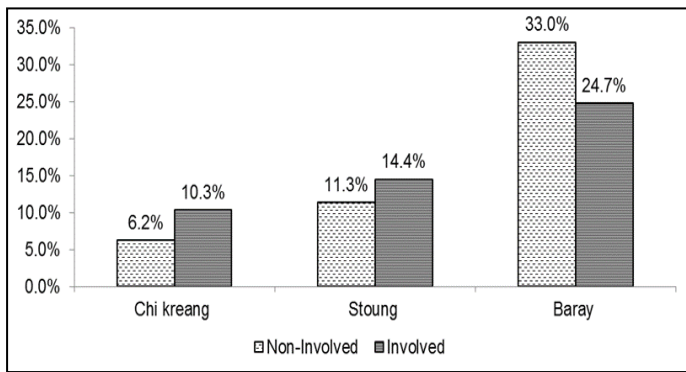


Fig. 17. Percentage of community members participating in outreach education in BFCAs.

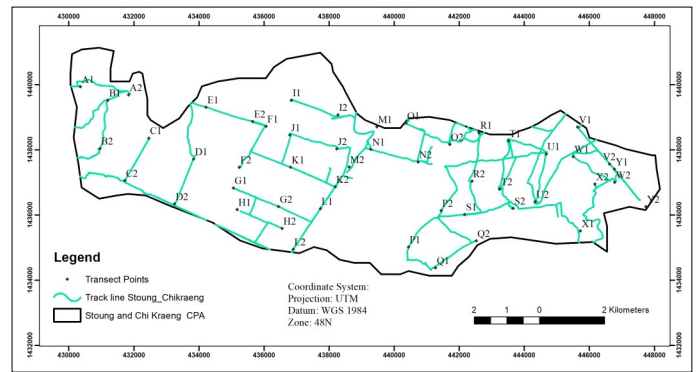


Fig. 18. Observation transects lines in Stoung-Chikraeng BFCAs.

In the Baray district, 24.7% of community members were found to be involved in these activities, and 33% were not involved. In the Stoung district, 14.4% were involved, and 11.3% were not involved. In the Chi-kraeng area, 10.3% were found to participate, while 6.2% were not involved.

The percentage of community members found to agree that the programme is important for Bengal florican conservation was 49.5%. At the same time, 50.5% of community members said outreach education was not important for conservation.

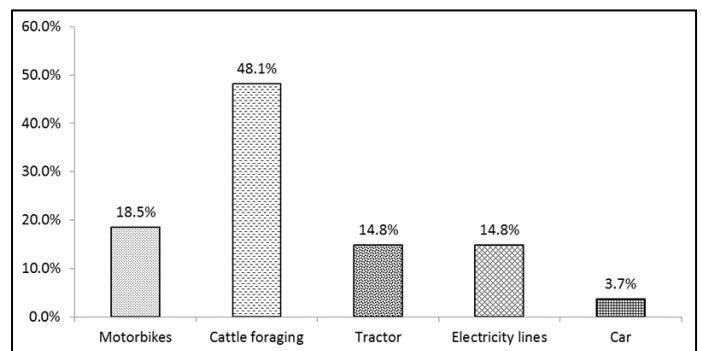


Fig. 19. Types and amount of human disturbance in Stoung-Chikraeng BFCAs.

Line transect observation

According to observation based on 25 transect line in Stoung-Chikraeng, it was found that human disturbances existed. Disturbances by percentage included: cattle foraging (48.1%), motorbikes (18.5%), tractors (14.8%), electricity lines (14.8%), and cars (3.7%) (Fig. 18 & Fig. 19). According to the 30 transect lines observations in BFCAs in Baray, Kompong Thom province, there are many types of human disturbance activities that have impacted Bengal florican Conservation (Fig. 20).

The activities causing a disturbance by percent were: 28.9% cattle foraging in grassland area, 23.7% motorbikes, 23.7% tractors, 10.5% cars, 10.5% economic land concession, and human settlement 2.6% (Fig. 21).

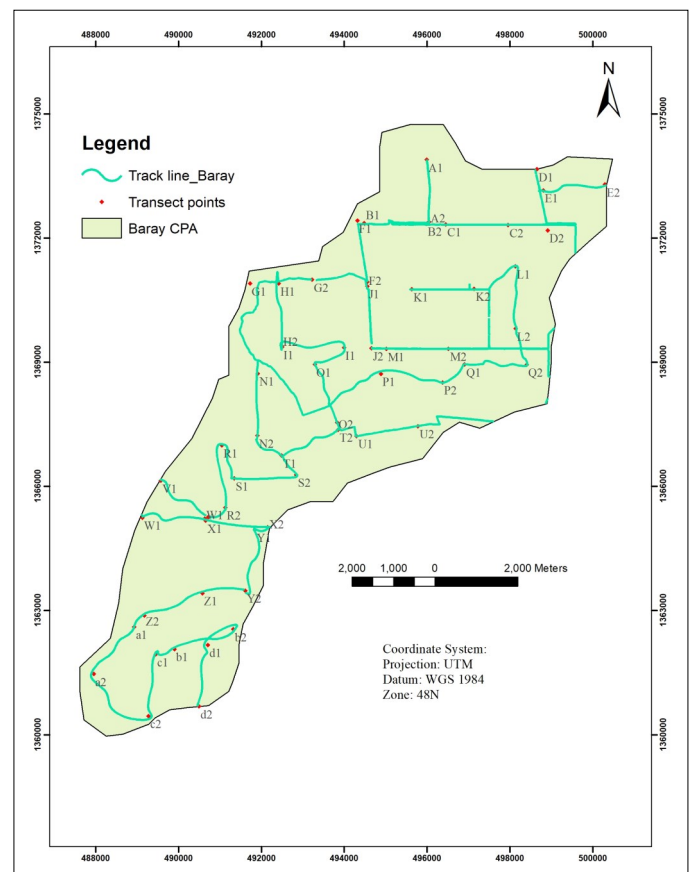


Fig. 20. Observation transects lines in Baray BFCAs.

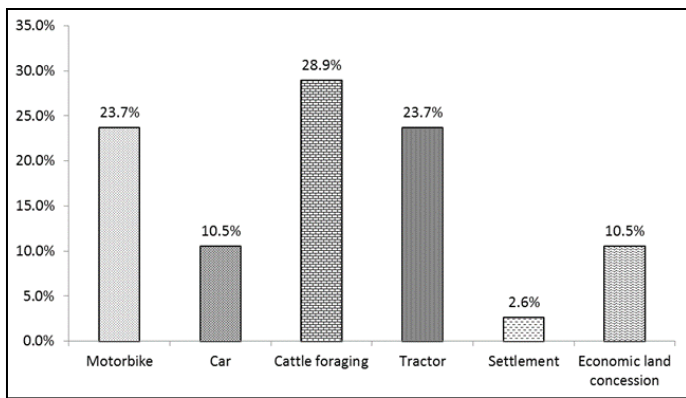


Fig. 21. Human disturbances by percentage in Baray BFCAs.

It was found that 32.0% of disturbances were caused by cattle foraging, while tractor accounted for 16.0%. Also, habitat loss from land grabbing accounted for 16.0%, settlement activities made up 12.0%, economic land concessions 12.0%, motorbikes caused 8.0%, and ‘koyon’ driven activities resulted in 4.0% of disturbances in BFCAs (Fig. 22 & Fig. 23).

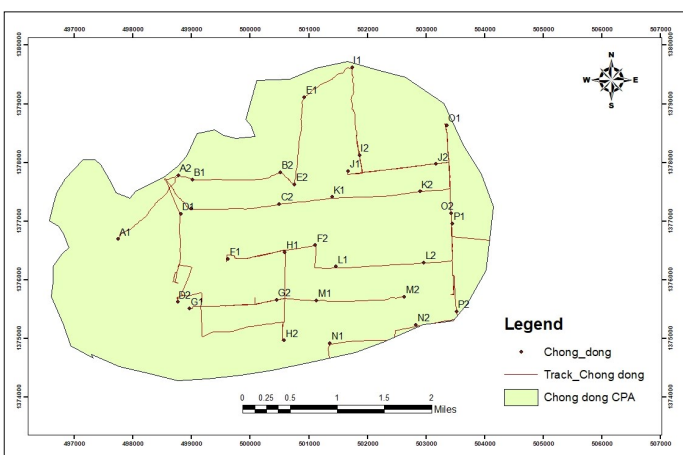


Fig. 22. Transect lines in the Chong-Dong BFCAs.

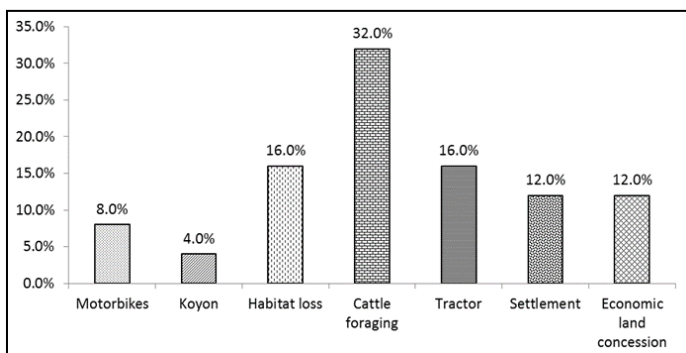


Fig. 23. Percentage of human disturbances in the Chong-Dong BFCAs.

Perception of the local communities and threat factors for Bengal florican conservation in BFCAs

Based on community interviews in the three districts, the perception of the types of threat

factors for Bengal florican conservation (Fig. 24) were found. Hunting was a threat for 30.7% (sound is used to attract the birds, which are then trapped with nets). 16.4% indicated poisoning as a threat (chemical use to destroy grass and insects in the rice field). Furthermore, 15.6% of households interviewed said land grabbing was a factor in habitat loss. The planting of rice in the dry season was a factor for 13.1%. Power lines were a threat for 10.7% (because of birds hitting the power line in flight). Low education was a factor for 5.7% and company land 7.8% based on community interviews in three districts.

Power lines were perceived to be a threat that varied with seasons in the rainy season 75%, and in the dry season 25%.

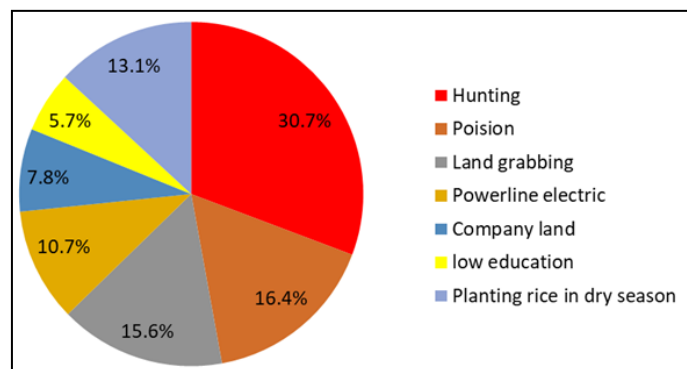


Fig. 24. Perceptions of threat factors for Bengal florican conservation areas.

The community members mostly understood the purpose of BFCAs (80.4%), although some did not (19.6%), primarily because they only participated with a community protected area (CPA) and were not involved in other activities. The local community members that were aware of Bengal florican conservation management in BFCAs differed in their opinions of that management. 78.4% of respondents viewed conservation management of Bengal florican to be good, while only 10.3% found it to be bad, and 11.3% did not have an opinion about the quality of the management. Interview findings regarding feelings about the loss of Bengal floricans in the indicate that 96.6% of the community felt sad, and only 3.1% community members felt normal.

Population trends of Bengal florican in the last ten years (2010-2019)

In Cambodia the estimated population of Bengal florican displaying males in 2018 was 104, down from 216 in 2012 (Mahood et al. 2019).

Although hunting was reduced, conversion of grasslands and low intensity agriculture to intensive dry-season rice farming rapidly emerged as a new and serious threat (Packman et al. 2014). Free-ranging dogs are a key issue for conservation in the tropics, as they function as predators, competitors, or disease transmission agents which impacts wildlife biodiversity (Punjabi, Athreya, and Linnell. 2012).

In the last ten years, the population of Bengal florican in Baray-Chong DOUNG and Stoung-Chikraeng BFCAs has been changing. In Baray-Chong DOUNG the population of Bengal has continued to decline because of habitat change (grassland changed to agricultural land for dry season rice cultivation), hunting, predators (dogs), and low level of conservation knowledge conservation of the local population (Son Virak person observe).

In Baray-Chong DOUNG BFCAs, there was no sustainable rice platform programme and little ecotourism. Also, patrolling in the BFCAs and outreach education are not strong. The population of Bengal florican in Stoung Chikraeng declined from 2013 to 2015. According to focus group discussions in Stoung-Chikraeng the powerline now set-up in the BFCAs has an impact on Bengal florican migration. For the last three years the population of Bengal florican has been stable in Stoung-Chikraeng BFCAs because of the many conservation activities progressing, including a sustainable rice platform, ecotourism, public education for conservation, and strong patrolling.

Activities for Bengal florican conservation in the northern Tonle Sap protected landscape

The effective conservation of Bengal Florican requires an understanding of the species habitat requirements and disturbance tolerance levels (Gray et al. 2007). Education and awareness-raising on the benefits of the BFCAs is ongoing (MAFF, 2013). Effective conservation of threatened species requires knowledge of distribution and an understanding of the ecological factors determining habitat suitability (Rushton, Ormerod, and Kerby 2004). The activities for Bengal florican conservation in BFCAs include: patrolling and law enforcement, sustainable rice

platform programmes, ecotourism services, Community Protected Areas, research and monitoring, and outreach education.

All the conservation activities of contribute to sustainable Bengal florican conservation. Local community participation in BFCAs can improve income and livelihoods by ensuring habitat and wildlife protection. The Sustainable Rice Platform (SRP) programme can provide technical support to community members such as information on market prices, techniques for the use of chemicals, and conservation knowledge. Ecotourism in Stoung-Chikraeng BFCAs provides communities with livelihoods and income for local development activities such as school repairs, infrastructure improvements, pagoda construction, library development, and toilets and sewage infrastructure.

In Baray-Chong DOUNG BFCAs in the Baray district of Kampong Thom province, there are less activities for conservation management than in the Stoung-Chikraeng conservation area. The conservation activities in Baray-Chong DOUNG include patrolling and law enforcement two times per month and outreach education one time per year. The income from ecotourism services in Baray-Chong DOUNG BFCAs is small because there is little tourism. In the Stoung-Chikraeng BFCAs there was found to be less human disturbance of Bengal florican conservation areas.

The conservation activities in the Stoung-Chikraeng BFCAs include strong patrolling and law enforcement which enabled strong conservation management that provided for a good habitat for the Bengal florican to find food, and resulted in a higher survival rate. Ecotourism services were successful in the area, because of the many species of birds, including critically endangered species. Outreach education conservation activities in the Stoung-Chikraeng area were found to be effective because the local people understood the importance of conservation and cooperated in the effort. Bengal florican nest protection payment schemes offered 30USD for the protection of a nest with one egg and 40USD for the protection of nests with two eggs.

Threat factors for the Bengal florican in BFCAs

In the last 20 years, extensive dry season rice cultivation has arisen and it has become the primary threat to the Bengal florican (Ibbett et al. 2019). Dry season rice development is connected with agrochemical use and rice fields take over the Bengal florican habitat needed for species reproduction, diminishing living space accessibility throughout the rearing season (Ibbett et al. 2019). Although hunting pressure has been reduced, conversion of grassland and low-intensity agricultural land for intensive dry-season rice farming has rapidly emerged as a new and very serious threat (Groves and Medellin 2013). Powerlines may also increasingly negatively impact on Bengal florican migration (Mahood et al. 2018, 2019). Although conservation actions are ongoing in BFCAs, Bengal florican is still disturbed by human activities. According to the results of group discussions in Baray-Chong DOUNG and Stoung-Chikraeng the threats to conservation in BFCAs include: chemicals used to clear grassland, hunting, habitat loss from rice cultivation, encroachment of companies, limited conservation awareness among locals, and powerline installations. According to the community committee, powerline installations can substantially impact endangered birds. In August 2020, a team powerline survey found two male Bengal florican dead under the powerline in the Brolay community, apparently because of flying into the powerlines.

The results of observations on human activities causing disturbances in Baray-Chong DOUNG and Stoung-Chikraeng BFCAs found that strong disturbances resulted from cattle foraging. The local people use grassland area in BFCAs for cattle foraging, and it can affect the nests of Bengal florican in the grassland. As a result of the strong disturbances to Bengal florican, we need stronger management and more patrolling and outreach education for local people in the area and near the BFCAs sites. Participation in conservation without financial assistance (gasoline, food), equipment (boats, GPS), was found to be insufficient as local people's livelihoods depended on farming and there was not sufficient household income to cover expenses for conservation,

according to focus group discussions in Baray-Chong DOUNG.

Perception of the local community on Bengal florican conservation

Perceptions were addressed through rapid conservation action, focusing on raising awareness of communities and law enforcement personnel (Gray et al. 2009). The success of community management conservation is tied to increasing education, development of awareness, and strengthening the local community (Bajracharya et al. 2005). This study found the local communities mostly understand the purpose and management tasks for conservation of Bengal florican, which is needed for the population of Bengal florican to stabilize or increase. In Stoung-Chikraeng BFCAs the local communities had a better understanding of conservation and were more committed to participating in the protection of Bengal florican. The local community would be very sad if Bengal florican disappeared from their area, because Bengal florican is a rare species that is important for the sustainable development of livelihoods in the area by enabling ecotours and income from conservation participation. According to focus group discussions, outreach, education, awareness, patrolling, and law enforcement are important for the conservation of endangered species, especially the Bengal florican. In order to improve the effectiveness of conservation action full participation of local authorities and communities is needed.

5. Conclusion

The study results show that the population trends of Bengal florican in Cambodia in the last ten years (2010-2019) is one of decline. However, in the Stoung-Chikraeng Bengal florican conservation the population has stabilized in the last three years, while the populations of Bengal florican in Baray and Chong DOUNG BFCAs are still declining. Some of human activities inside the areas or close to populations of Bengal florican negatively impact conservation. Local community activities that cause significant disruption to the Bengal florican include hunting and habitat encroachment. In Stoung-Chikraeng, the local community understood the purpose and management needs of Bengal florican conservation sufficiently

to provide for conservation success through strong cooperative efforts providing for the many activities involved in conservation efforts.

BFCAs are important areas for supporting the Bengal florican during non-breeding season because they are mostly covered with grassland. BFCAs are also important for improving the livelihoods of the local community by enabling benefits such as ecotourism and participation in conservation activities. Many human activities were recorded to impact negatively on in the reserves, including hunting, use of chemicals, habitat encroachment, planting rice in the dry season, powerline placement, and low education of locals.

The Bengal florican conservation area (BFCAs) in Stoung-Chikraeng is a very important area, because it provides an essential space for breeding areas and most of the local people understand the purpose of creating BFCAs and their importance for local livelihoods. This study recommends, first, to continue to conduct outreach education about the importance of Bengal florican to local people living in protected areas, especially through information dissemination using media and social media (Facebook, website, YouTube, TV, radio, and posters). Second, to implement livelihood development activities linked to better management of the grasslands, particularly Ibis rice and increased community involvement in ecotourism. Third, punish people who commit crimes in accordance with the law on forestry and the law on the environment.

Fourth, to continue to provide encouragement to the people to participate in Bengal florican nest protection. Fifth, to stop all activities that negatively impact breeding, feeding, and foraging of the Bengal florican. Sixth, to expand the community committees to all sites along with increasing the ability of these communities to both protect and manage the grasslands they use, and to engage in ecotourism where appropriate. Sixth, to continue to research and monitor through conducting monthly and annual on-site censuses in Bengal florican conservation areas. Seventh, to continue cooperation with international organizations, government, the local people, and local-level authorities.

Eighth, to support funding for construction and repair of schools, hospitals, and pagodas in conservation areas. Finally, ninth, to provide benefits for community participation conservation activities (ecotourism, patrols and law enforcement, outreach education, and research monitoring) which support improving livelihoods. In the future, studies should focus on: (a) local perceptions of the payment scheme for Ecosystem Services and conservation participation; (b) further research studies on the behavioural impact on Bengal florican of habitat change resulting from the spread of agricultural use of land; and, (c) examination of the dynamics of human disturbance needs to clearly map out the peak periods of activity.

Acknowledgments

I would like to thank to the Forestry Administration (FA), that provided opportunity to study of Master Degree of Science in Biodiversity Conservation at the Royal University of Phnom Penh. My grateful to the Centre for Biodiversity Conservation (CBC), and Fauna and Flora International (FFI) that providing technical supports and fund to conduct my research. In addition, the Wildlife Conservation Security (WCS) provided population of Bengal Florican data in BFCAs in Cambodia and BFCAs's office in Stoung for serving station to this study.

Declaration of competing interest

The authors declare that they have no competing interests.

References

- Ali, S. and S. D. Ripley. (1987) "Compact Handbook of the Birds of India and Pakistan. Oxford University Press, New Delhi." :1-737.
- Bajracharya, S. B., Prasad, R., & Basnet, G. (2014). Protected Area Management in Nepal. (NEED PUBLISHER).
- Bajracharya, Siddhartha, Prter Furley, and Adrian Newton (2005) "Effectiveness of Community Involvement in Delivering Conservation Benefits to the Annapurna Conservation Area, Nepal." *Environmental Conservation* 32(3):239-47.

- Baral, Nabin, Bijay Tamang, and Nilesh Timilsina (2002) "Status of Bengal Florican in Royal Bardia National Park, Nepal." BOMBAY Natural History Society 99(3):413-17.
- Baral, H.S. & Inskipp, C. (2005). Important Bird Areas in Nepal: Key Sites for Conservation. Bird Conservation Nepal, Kathmandu and BirdLife International, Cambridge. 2005.
- BCN and DNPWC, 2011. (2011). The State of Nepal's Birds 2010. Indicators of our changing world: The State of Nepal's Birds . Bird Conservation Nepal and Department of National Parks and Wildlife Conservation. 300pp.
- Baral, H. S., Ram, A. K., Chaudhary, B., Chaudhary, D., Timsina, A., Acharya, S., Acharya, K. P. (2013). Survey of Bengal Florican *Houbaropsis bengalensis bengalensis* (Gmelin, 1789) (Gruiformes: Otidae) in the Koshi Tappu Wildlife Reserve and adjoining areas, Nepal. Journal of Threatened Taxa, 5(7), 4076-4083. <https://doi.org/10.11609/jott.o3240.4076-83>
- BirdLife International. (2010) "Species of the Day: Bengal Florican *Houbaropsis Bengalensis*, The IUCN Red List of Threatened Species." Society 5.
- BirdLife International. (2018) "Bengal Florican *Houbaropsis Bengalensis* the IUCN Red List of Threatened Species 2018."
- Chhetry, Damodar Thapa. 2008. "Bio-diversity conservation in nepal"
- del Hoyo et al. (1996) Handbook of the Birds of the World : Hoatzin to Auks. Lynx Editions, Barcelona, Spain.
- DNPWC. 2016. Bengal Florican Conservation Action Plan 2016-2020.
- Gadhvi, I. R. (2003). Monitoring nesting sites of lesser Floricans (*Sypheotides indica*) in and around Blackbuck National Park, Gujarat. Zoos' Print Journal, 18(7), 1135-1142. <https://doi.org/10.11609/jott.zpj.18.7.1135-42>
- Gray, Nigel J. Collar, Peter J. A. Davidson, Paul M. Dolman, Tom D. Evans, Harry N. Fox, Hong Chamnan, Ro Borey, Seng Kim Hout, and Robert N. van Zalinge (2009) "Distribution, Status and Conservation of the Bengal Florican *Houbaropsis Bengalensis* in Cambodia." Bird Conservation International 19(1):1-14.
- Gray, Thomas N. E., Hong Chamnan, Ro Borey, Nigel J. Collar, and Paul M. Dolman (2007) "Habitat Preferences of a Globally Threatened Bustard Provide Support for Community-Based Conservation in Cambodia." Biological Conservation 138(3-4):341-50.
- Groves, C. and R. A. Medellin (2013) "Conservation Biology".
- Ibbett, Harriet (2015) "Understanding the Impact of Local People on Bengal Florican Populations in Central Cambodia".
- Ibbett, H., Lay, C., Phlai, P., Song, D., Hong, C., Mahood, S. P., & Milner-Gulland, E. J. (2019) Conserving a globally threatened species in a semi-natural, agrarian landscape. Oryx, 53(1), 181-191. <https://doi.org/10.1017/S0030605316001708>
- Inskipp et al. (2016). The Status of Nepal's Birds: The National Red List Series. Zoological Society of London, UK. 2016.
- JICA. (2000). Cambodia reconnaissance survey digital data project. Phnom Penh: Ministry of Public Works and Transportation.
- MAFF. 2013. "Ten-Year Species Action Plan for the Cambodian Population of Bengal Florican *Houbaropsis Bengalensis* Blanfordi."
- Mahood, Simon P. and Chamnan Hong. 2013. Finding a Place for Bengal Florican in an Agricultural Landscape. Wildlife Conservation Society Cambodia Program, Phnom Penh, Cambodia . 2013.
- Mahood, Simon P., Chamnan Hong, S. O. N. Virak, Phearun Sum, and Stephen T. Garnett. (2019) "Catastrophic Ongoing Decline in Cambodia's Bengal Florican *Houbaropsis Bengalensis* Population." Bird Conservation International.
- Mahood, Simon P., João P. Silva, Paul M. Dolman, and Robert J. Burnside (2018) "Proposed Power Transmission Lines in Cambodia Constitute a Significant New Threat to the Largest Population of the Critically Endangered Bengal Florican *Houbaropsis Bengalensis*." Oryx 52(1):147-55.
- Mahood, Simon and Virak Son (2010) "The Status of Bengal Florican in the Bengal Florican Conservation Areas"
- MRC. (2006). Soil map of the lower Mekong basin: Mekong River Commission. Vientiane, Laos.
- Narayan, Goutam (1992) "Distribution and Conservation of the Bengal Florican *Houbaropsis Bengalensis* (Gmelin) in India. Ph.D. Thesis. University of Bombay." 1992.
- Poole, Colin and Setha Tan. 2003. "A Field Guide to the Birds of Cambodia."
- Packman, C. E., D. A. Showler, N. J. Collar, Son Virak, S. P. Mahood, M. Handschuh, T. D. Evans, Hong Chamnan, and P. M. Dolman. 2014. "Rapid Decline of the Largest Remaining Population of Bengal Florican *Houbaropsis Bengalensis* and Recommendations for Its Conservation." Bird Conservation International 24(4):429-37.
- Punjabi, G. A., Athreya, V., & Linnell, J. D. C. (2012). Using natural marks to estimate free-ranging dog *canis familiaris* abundance in a MARK-RESIGHT framework in suburban Mumbai, India. Tropical Conservation Science, 5(4), 510-520. <https://doi.org/10.1177/194008291200500408>
- Rushton, S. P., Ormerod, S. J., & Kerby, G. (2004). New paradigms for modelling species distributions? Journal of Applied Ecology, 41(2), 193-200. <https://doi.org/10.1111/j.0021-8901.2004.00903.x>
- Sterling, E.J., Hurley, M.M., Minh, L.D. and Powzyk, J. (2006) Vietnam: A Natural History. Yale University Press, New Haven, Connecticut. A Natural History, 2006.
- Son virak. (2016). Master Degree of Science [Thesis about Persistence of Critically Endangered Bengal Florican *Houbaropsis bengalensis* in a modern agricultural system, Cambodia].
- Thakuri, Jyotendra Jyu (2018) "Bengal Florican *Houbaropsis Bengalensis* EDGF." Facing Extinction: The World's Rarest Birds and the Race to Save Them. (PUBLISHER)
- Vannelli, Kate, Mark P. Hampton, Tsewang Namgail, and Simon A. Black (2019) "Community Participation in Ecotourism and Its Effect on Local Perceptions of Snow Leopard (*Panthera Uncia*) Conservation." Human Dimensions of Wildlife 24(2):180-93.

WCS (2009) "Conservation of Inundated Grasslands in the Tonle Sap Floodplain." Briefing Document (November):1-4.

WCS (2010) "Conservation of Threatened Grassland Biodiversity in the Tonle Sap Basin." Briefing Document (June):1-4.

WCS (2019) Cambodia Bengal Florican Population Declines, but Conservation Can Save It. Vol. 2019. (of what?).