มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

รายงานวิจัยฉบับสมบูรณ์

ทุนวิจัยหมวดเงินอุดหนุน (ว.1)

ประจำปีงบประมาณ 2559

เรื่อง ผลกระทบของหย่อมป่าและพื้นที่ชายขอบป่าต่ออัตราการรอดและการถูกล่ารังของนกป่า

The effect of forest fragmentation and forest edge on nest survival and predation rates of forest birds

คณะผู้วิจัย

ชื่อ-สกุล Mr. Andrew J. Pierce หัวหน้าโครงการ

สังกัด สรบ. มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ชื่อ-สกุล นางสาว ดาภะวัลย์ คำชา ผู้ร่วมโครงการ

สังกัด ทรัพยากรธรรมชาติ คณะทรัพยากรชีวภาพและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ชื่อ-สกุล ดร. วังวร สังฆเมธาวี ผู้ร่วมโครงการ

สังกัด ภาควิชาวิทยาศาสตร์สิ่งแวดล้อม คณะวิทยาศาสตร์ หมาวิทยาลัยขอนแก่น

ชื่อ-สกุล Assoc. Prof. Dr. George A. gale ผู้ร่วมโครงการ

สังกัด ทรัพยากรธรรมชาติ คณะทรัพยากรชีวภาพและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

เดือน มีนาคม พ.ศ.2560

บทคัดย่อ

ภูมิภาคเอเชียตะวันออกเฉียงใต้ได้ชื่อว่าเป็นภูมิภาคที่มีอัตราการสูญเสียพื้นที่ป่าเร็วที่สุด โดยมีสาตุหลักมาจากความต้องการใช้ทรัพยากรธรรมชาติของมนุษย์ไม่ว่าจะเป็นการตัดไม้ทำลายป่า การบุกรุกพื้นที่ป่าเพื่อเปลี่ยนเป็นพื้นที่การเกษตร กิจกรรมของมนุษย์ต่างๆเหล่านี้ทำพื้นที่ป่าขนาดใหญ่กลายเป็นหย่อมป่าขนาดเล็ก (forest fragment) และยังก่อให้เกิดปัญหาพื้นที่ชายขอบป่า (edge effect) ตามมา พื้นที่ชายขอบป่าส่งผลกระทบต่ออัตราการรอดของรังนก (nest survival) และความสำเร็จในการทำรังของนก (nest success) ซึ่งทั้งสองอย่างนี้เป็นดัชนีชี้วัดที่สำคัญในการเปลี่ยนแปลงประชากรนก ในการวิจัยครั้งนี้เราได้ทำการศึกษาผลกระทบของพื้นที่ชายขอบป่าที่ต่ออัตราการรอดของรังนก ความสำเร็จในการทำรังของนก และศึกษาสังคมของสัตว์ล่ารัง ในพื้นที่ป่าดิบแล้งของสถานีวิจัยสิ่งแวดล้อมสะแกราช อ. วังน้ำเขียว จ. นครราชสีมา ในช่วงของฤดูกาลผสมพันธุ์ของนกป่าระหว่างเดือนกุมภาพันธ์ถึงเดือนสิงหาคม พ.ศ. 2559 เราได้ทำการสำรวจหารังนก โดยเริ่มสำรวจจากพื้นที่ชายขอบเข้าสู่พื้นที่ใจกลางผืนป่า นอกจากนี้เราได้ทำการติดตั้งกล้องบันทึกภาพแบบเคลื่อนไหว 24 ชม. และกล้องดักถ่ายภาพสัตว์แบบอัตโนมัติที่รังนกเพื่อทำการศึกษาชนิดของสัตว์ล่ารัง จากการศึกษาเราสำรวจพบรังนกทั้งสิ้น 200 รัง จากนก 22 ชนิด ซึ่งเราพบว่าความสำเร็จในการทำรังของนกป่าในพื้นที่ศึกษามีค่าต่ำมากคือ มีความสำเร็จในการทำรังเพียง 8.6% และมีอัตราการถูกล่าที่สูงถึง 87% จากข้อมูลการติดตั้งกล้องบันทึกภาพแบบเคลื่อนไหว 24 ชม. และกล้องดักถ่ายภาพสัตว์แบบอัตโนมัติที่รังนกจำนวน 116 รัง จากนก 14 ชนิด เราสามารถบันทึกเหตุการณ์การล่ารังได้ทั้งสิ้น 61 ครั้ง จากผู้ล่า 8 ชนิด โดยเราพบว่า งูเป็นสัตว์ที่เข้าล่ารังบ่อยที่สุด (43%) รองลงมาคือ ลิงกัง (30%) กลุ่มนกผู้ล่า (10%) และนกสาลิกาเขียว (10%) เมื่อเราทำการวิเคราะห์หาความชุกชุมของสัตว์ล่ารังทุกชนิดพบว่า ไม่มีความแตกต่างอย่างมีนัยสำคัญระหว่างความชุกชุมของสัตว์ล่ารังที่อยู่บริเวณชายขอบป่าและพื้นที่ใจกลางผืนป่า

อัตราการรอดของรังนกในพื้นที่ศึกษาของเราค่อนข้างต่ำมากเมื่อเทียบกับอัตราการรอดของนกในพื้นที่อื่น (20%) ซึ่งสาเหตุหลักที่ส่งผลให้นกมีอัตราการรอดที่ต่ำมากนั้นยังไม่ชัดเจน แต่คาดว่าการเปลี่ยนแปลงสังคมและพฤติกรรมของสัตว์ผู้ล่าซึ่งได้รับผลกระทบจากปัญหาการเกิดหย่อมป่าและพื้นที่ชายขอบป่าน่าจะเป็นปัจจัยที่สำคัญที่ส่งต่อประชากรนกในพื้นที่

Abstract

Southeast Asia has the highest rate of forest loss of tropical region in the world. The major cause of habitat conversion is human demand for natural resources such as timber logging and the conversion of the vast areas of natural forest to agriculture and urban areas. Such activities increase natural habitat fragmentation as well as increase the edge effects. Edge effects influence on avian nest survival and nest success, which are key parameters that can be used to estimate and predict changes in populations. We investigated the effects of forest edge on nest success and defined nest predators at the forest edge and forest interior in the dry evergreen forest in the Sakaerat Environmental Research Station in northeastern Thailand. During the breeding season from February to August 2016 we searched for nests starting at the edge into the forest interior. To assess the nest predator species video cameras and camera traps were placed on the active nests of selected species. During the breeding of 2016 we found 200 active nests from 22 species. The overall natural nest success was 8.6% and the predation rate was quite high 87%. From video cameras and camera traps set at 116 nests from 14 species, we detected 61 predation events and recorded 8 nest predator species. Snakes were the main predator (43%) follow by Pig-tailed Macaque (*Macaca leonina*) (30%), raptors (10%) and Common Green Magpie (*Cissa chinensis*) (10%). The relative abundance index for all nest predator species combined was not significantly higher at the edge compared to the forest interior. Nest success from our study was quite low compare the other studies in tropical forests and our previous study which nest success was around 20 %. The mechanisms that effect on such low nest success and high predation rates are still unclear, however the changing in predator community and behaviors affect by edge effects and fragmentation may be significant factors.

กิตติกรรมประกาศ

คณะผู้วิจัยขอขอบคุณมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีที่ได้สนับสนุนงบประมาณสำหรับการดำเนินงานวิจัย ซึ่งเป็นทุนวิจัยหมวดเงินอุดหนุนที่ได้รับการจัดสรรจากรัฐ และขอขอบคุณภาควิชาการจัดการทรัพยากรธรรมชาติ คณะทรัพยากรชีวภาพและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี และสถาบันพัฒนาและฝึกอบรมโรงงานต้นแบบ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ที่ได้อำนวยความสะดวกในการใช้พื้นที่และเครื่องมือต่างๆ สำหรับการศึกษาวิจัย

คณะผู้วิจัยขอขอบคุณ ดร. ทักษิณ อาชวาคม ผู้อำนวยการสถานีวิจัยสิ่งแวดล้อมสะแกราช อ. วังน้ำเขียว จ. นครราชสีมา และเจ้าหน้าที่ประจำสถานีวิจัยฯทุกท่าน ที่ได้ให้อนุญาตและอำนวยความสะดวกแกคณะวิจัยในการปฏิบัติงานภาคสนาม

คณะผู้วิจัย

30 มีนาคม 2560

สารบัญ **หน้า**

สารบัญเรื่อง (Table of Contents)

สารบัญตาราง (List of Tables) **หน้า**

ตาราง (Table)

สารบัญภาพ (List of Illustrations)

ภาพ (Figure)

บทนำ (Introduction)

ความสำคัญและที่มา

Habitat fragmentation changes predator communities, habitat microclimates, and functional connectivity across landscapes (Bélisle 2005), understanding how birds respond to fragmentation, is essential for predicting local species extinctions, distribution patterns, and abundance across ecosystems, both in human-dominated and natural ecosystems (Gillies & St Clair 2008, 2010, Kennedy & Marra 2010). Despite the potential importance of the landscape configuration, the effects of landscape structure on potential predators and bird movement patterns remain poorly understood, especially in tropical habitats, where little is known about nest predator responses to forest fragmentation (Robinson & Sherry 2012). While the pattern of bird loss from fragments has been documented in tropical countries such as Brazil (Anciaes and Marini 2000) and elsewhere in the Amazon (Canaday 1996) (although remains poorly documented in Asia), we are still largely unaware of the mechanisms causing this pattern.

Increased nest predation may be a critical mechanism that negatively affects birds breeding in small forest fragments globally. The most famous mechanism proposed is that forest bird species suffer the consequences of changed predator community dynamics in forest fragments (Robinson & Sherry 2012). Increased rates of predation on nests are hypothesized to lead to lower juvenile recruitment, which then causes populations of some forest bird species to be unable to replace themselves (Robinson et al. 1995; Terborgh 1974). Ecology theory suggests that the elimination or loss of top predators such as tigers leads to an increase of middle-level predators (*mesopredators*) such as macaques and civets which are more likely to predate nests. However, the evidence for the mesopredator release hypothesis in tropical forests is weak to nonexistent (Robinson & Sherry 2012). Furthermore, a study in tropical Africa suggested that at least some forest birds actually reproduce more successfully in fragmented habitats than continuous (Spanhove et al. 2009). The problem is that predation rates among different species living in the same habitat can vary widely (Robinson et al. 2000; Pierce and Probrasert 2013), such that comparisons between fragmented and less fragmented forests need to be conducted on the same set of species (Robinson & Sherry 2012).

Another related key mechanism which might explain the loss of species in fragmented landscapes is dispersal limitation. For example, for forest birds living in forest fragments that in combination with low nesting success, young (juvenile) birds which do fledge might not be able to reach sites isolated by fragmentation or successfully disperse away from fragmented sites. In other words, it may be difficult for forest birds to pass through a non-forest matrix to reach a fragment, such that over time with low recruitment and low reproduction (such as due to high nest predation rates described above), fragments slowly loose individuals and species over time.

Due to extensive work conducted in Khao Yai National Park on birds (reviewed by Round et al. 2011 and Lynam et al. 2006), top predators & mesopredators (Lynam et al. 2006; Jenks et al. 2011) and nest predators

(Pierce and Pobprasert 2013), fragmented forest sites with similar as possible habitats (and similar birds & nest predators) to Khao Yai are most appropriate for this proposed study. Khao Yai is large (>2,000 km^2) and still retains significant numbers of large predators (clouded leopard and dhole, Jenks et al. 2011) and therefore this previously collected data will serve as a baseline comparison to nest predation data from small forest fragments obtained during our proposed study.

วัตถุประสงค์และขอบเขตของการวิจัย

1. To determine the nesting patterns of birds in smaller forests
2. To compare nesting of birds in forest fragments with those of Khao Yai National Park (KYNP)
3. To determine the main predators of selected forest fragments
4. To compare predation rates of fragments with the studies at KYNP
5. To determine the effects of forest edge on nest survival and nest predation rates

We will conduct the study in the Sakaerat Environmental Research Station (SERS), Nakhorn Ratchasima, where locates within the richly structured landscape matrix of the Dong Phayayen - Khao Yai Forest Complex in northeastern Thailand. SERS is largely isolated by agriculture, a large reservoir and a major 5-lane road. The total area of the research station is approximately 80 km2 (Trisurat, 2006) while the adjacent reserve is of similar size, however the estimated area of contiguous evergreen forest is probably 160 km^2. Finally, we will compare the results from SERS to the previous study in Khoa Yai Nation Park.

ประโยชน์ที่คาดว่าจะได้รับ

Habitat fragmentation is having a large negative impact on biodiversity globally (reviewed extensively Robinson & Sherry 2012) particularly in tropical countries such as Brazil (Anciaes and Marini 2000) and elsewhere in the Amazon (Canaday 1996)—but we know very little about how fragmentation is impacting Thailand's biodiversity. Better understanding of these impacts will improve our ability to partly mitigate these impacts. Furthermore, training of young Thai researchers, staff and students will lead to the establishment of a core of ornithological field workers who will be able to conduct future studies of birds elsewhere, in a wide range of forest types leading to a better understanding of the ecology of Thailand's birds and other wildlife. The results from this study will provide knowledge and data for SERS' extensive education program for Thai students of the present and future. We will also attempt to engage young staff of the Department of National Parks, Wildlife and Plant Conservation in training. Finally, publishing scientific data from our proposed study will also add to our knowledge of tropical ecology and conservation of birds and other Southeast Asian biodiversity.

ทฤษฎีและ/หรือแนวความคิดที่นำมาใช้ในการวิจัย (Literature Review)

Southeast Asia has the highest rate of forest loss of tropical region in the world. The increasing of natural habitat destruction such as habitat conversion to other land use has been a severe threat on biodiversity. The major cause of habitat conversion is human demand for natural resources such as timber logging and the conversion of the vast areas of natural forest to agriculture and urban areas. Such activities decrease the available habitats for wildlife also increase natural habitat fragmentation as well as increase the edge effects.

Habitat fragmentation is described as a process in which "a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original" (Wilcove et al. 1986). Fragmentation has four main effects: 1) reduces the amount of habitat available, 2) increases the number of small habitat patches, 3) reduces the average size of habitat patches and 4) increases the isolation of patches (Fahrig 2003, Van den Berg et al. 2001).

For birds, nest survival (probability of a nest surviving a given day) and nest success (percentage of nests that survive to produce at least one fledgling) are some of the parameters that can be used to predict the population changes. Fragmentation appears to reduce nest survival and nest success for tropical birds (Newmark and Stanley 2011, Korfanta et al. 2012) and the major cause of the nest failure is nest predation (Lahti 2001, Newmark and Stanley 2011). Habitat fragmentation changes the composition of predators in the habitat (Bélisle 2005). One theory suggests smaller habitat fragments tend to lose the largest predators (tigers, leopards), which would normally otherwise control the population of smaller, mid-trophic level predators or mesopredators (e.g., civets, macaques). Thus the loss of large predators leads to a large increase in smaller predators which is referred to as the mesopredator-release hypothesis (Robinson and Sherry 2012). This mesopredator increase is thought to increase the predation on bird eggs and nestlings which eventually results in the reduction of bird populations or local extinctions in forest fragments. However, the mesopredator–release hypothesis while having some support from the temperate zone is largely unproven in the tropics.

Distance from the patch edges is one factor that might affect nest predation rate (Newmark and Stanley 2011). Nest predation rate is increased along the edge as a result of the increases of nest predator abundance and activity along the edge compared to the patch interior (Lahti 2001, Newmark and Stanley 2011), although this pattern may depend on the structure of the predator community and surrounding landscape.

In Thailand, from previous studies of nesting success in Khao Yai National Park percent nest success was approximately 20% (Pierce et al. unpubl).The main cause of nest failure was nest predation and the 3 major nest predators were responsible for over 75% of nest predation events included macaques (~44%), snakes (22%), Green Magpie (9%) and others (25%) (Pierce and Pobprasert 2013). On the other hand, from the studied in Sakaerat Environmental Research Station where was still a large fragmented patch (>70 km2) found that the percent nest success was less than 5% but similar to Khao Yai National Park the major cause of nest failure was nest predation and more than 53% of nest predation event was macaques follow by snakes (18%), Green Magpie (18%) and others (11%) (Pierce et al. unpubl.).

However, Thailand have been experienced the effects of forest fragmentation and forest edges on biodiversity commonly causes by agricultural expansion and urbanization but the study of its impacts in Thailand remains poorly compare to other tropical region in the world.

วิธีดำเนินการวิจัย (Materials and Method)

Study area

This study is being conducted in Sakaerat Environmental Research Station (SERS) a relatively small forest reserve (80 Km^2) for Thailand, which has a relatively extensive protected area system compared to its neighbors. SERS was established in 1967 after being disturbed from urban development and expansion of agriculture area for several years. In 1982 the station ran the reforestation program using native plants to recover the areas from the extensive grassland disturbance and during 1982-1983, the remaining farmer families living within the station boundaries were successfully resettled to the newly established agricultural village of Wang Nam Khieo. The vegetation types in SERS include of dry-evergreen forest and dry-dipterocarp forest which cover around 70% of the area, the rest of the area include of small patches of bamboo, plantation and grassland (Figure 1). The type of edge of the site is "hard" in the sense that the forest ends abruptly and sharply, which is the 5-lane highway (Route 304) (Figure 2).

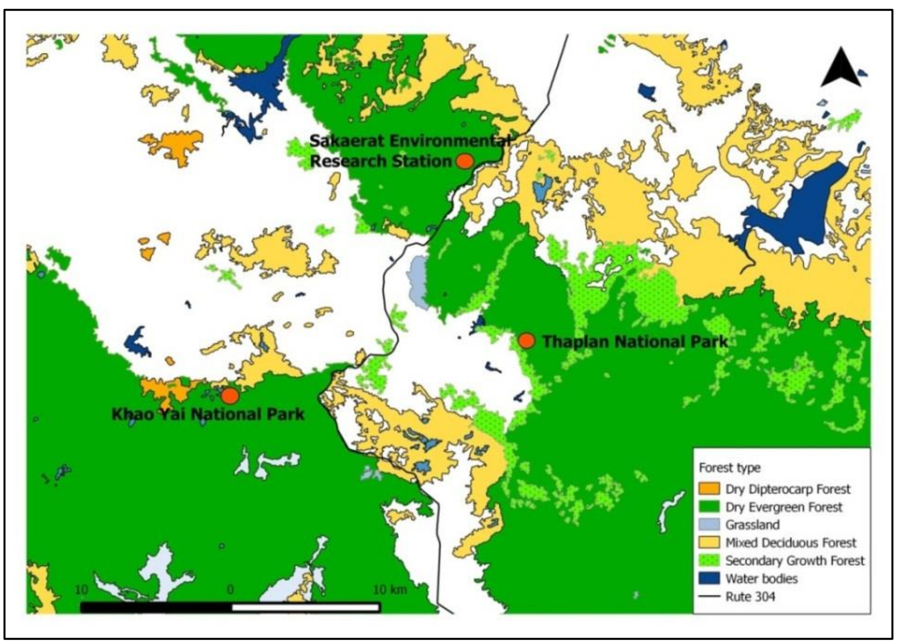

Figure 1. Map showing the locations of the study areas located along the edges of Sakaerat Environmental Research Station.

Figure 2. Map showing the 5-lane highway edge of the study site at Sakaerat Environmental Research Station

Establishment of study plot

Plots, up to 30 ha in size (600 x 500 m) with markers every 50 m will be established (as similar as possible to the Mo Singto Plot in Khao Yai) in all study areas. We will be looking for isolated evergreen forest 500-850 m elevation to minimize the differences between the fragments and the larger Khao Yai forest. We will also setup two 1km-long line transects to looking for the potential effects of forest edge depending on the distance from the edge.

Bird surveys

We will conduct initial bird surveys using point distance sampling to estimate species richness and abundance. Eight Points will be stratified on the transect based on distance from forest edge (0, 120, 240, 360, 480, 600, 720, 840 m) to standardize the potential effects of edge depending on the distance from the edge. Each point will be visited at 2 times per month. Points will be surveyed in the early morning starting around 0600 hours and will finish by 0900 hours as this time of the day has the highest bird activity. The detections will be recorded as directly seen and/or heard. Each point will be surveyed for 10 minutes (Gale et al 2009). Basic vegetation measures of vegetation stem density, basal area, and canopy cover will also be assessed at survey points.

Nest finding and monitoring

During the breeding season we will search for the nest. Once found they will be monitored for success/failure every 2 days. Where possible, nestlings of these will also be banded and radio collared to assess juvenile survival and dispersal. Twenty one nest boxes (17x26 cm) were placed at each study site along 1,000 m transect from the forest edge into the forest interior at every 50 m, 25 m away from each reference point switch between left and right for each point at 1.5 meter height on the tree with 15-20 cm DBH. The entrance of each nest box faces south. When those nest boxes are occupied they will be monitored the same system as natural nest in order to measure nest survival/ nest success and to assess the nest predation.

Predator monitoring

Cameras will be placed on the active nests in order to monitor nest predators during the breeding season using the same system as the previous Khao Yai study (Pierce & Pobprasert 2013). Results of our analysis will then be compared with predators and predation rates from Sakaerat and Khao Yai. To assess the relative abundances/occupancy mammalian meso–predators, 16 camera traps will be placed on transects adjacent to a random subset of the bird survey points.

Data Analysis

Nest success. We will determine nest success for all nests and compare with the data obtained at Khao Yai. We will use the Mayfield method to analyse daily survival rates of nests. Regression will be used to find the relationship distance from edge and nest success/predation rates.

ผลการวิจัยและข้อวิจารณ์ (Results and Discussion)

Results

Bird species richness and abundance

A total of 141 surveys were conducted from February to August 2016 We recorded 1,430 detections and found 48 species (Appendix 1). Black –crested Bulbuls (*Pycnonotus melanicterus*), Dark-necked Tailorbird (*Orthotomus atrogularis*), Puff-throated Babblers (*Pellorneum ruficeps*), White-rumped Shama (*Copsychus malabaricus*) and Striped Tit Babbler (*Macronous gularis*), were the species with the highest frequency of. Some species were observed for relatively short periods such as migratory species; e.g., a group of warblers, cuckoos and Siberian Blue Robin (*Luscinia cyane*). Most species could be found in every distance from edge into interior, but during the surveys there some bird species were found only in particular distances from the edge including Woodpeckers and Orange-breasted Trogon (*Harpactes oreskios*) and Thick-billed Green Pigeon (*Treron curvirosta*) which were found only in the interior. On the other hand, there were some species found only near the edge such as Prinias (*Prinia sp*.), Asian Koel (*Eudynamys scolopacea*) and Olive-backed Sunbird (*Nectarinia jugularis*). Total bird species richness and abundance were not correlated with the distance from the edge ((r^2=0.38, P=0.09 and r^2=0.29, P=0.17) (Figure 3a, 3b).

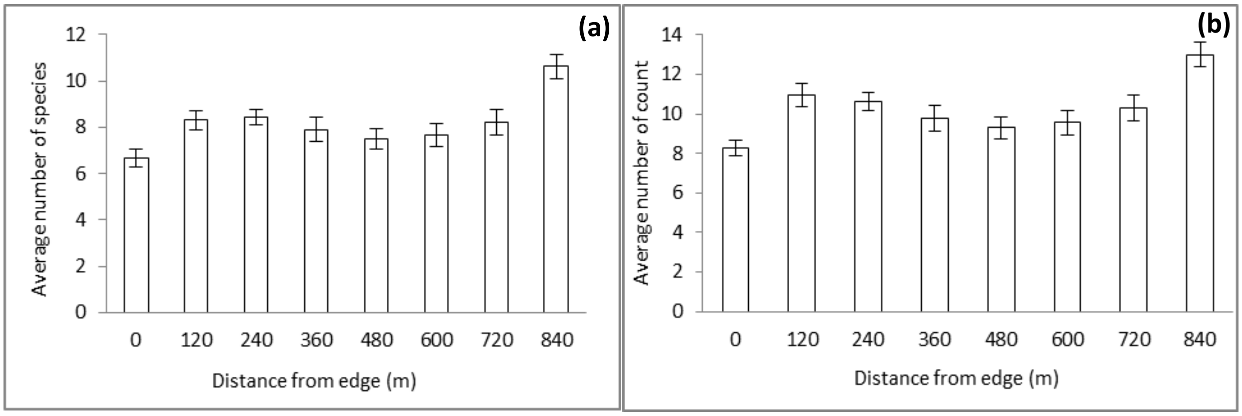

Figure 3. Relationship between number of species, detections and distance from edge into forest interior.

Nest success

A total of 1,300 nest searching hours during the breeding season February to August we found 200 active natural nests (at least lay 1 egg) from 22 species (Table 1). The most frequently found nest were those of Puff-throated Bulbul, Scaly-crowned Babbler, Puff-throated babbler, White-rumped Shama and Black-naped Monarch. In general there was no obvious difference in the number of nest found from the edge into forest interior except at 800-1,000 m which number of nest found was higher than other. From those 200 active natural nests there were 39 successful nests from 12 species. Black-naped Monarch and Scaly-crowned Babbler were the species with the highest number of successful nest (9 nests). The total exposure days of natural nest was 1,985 days we separated exposure days into 3 stages which were overall, incubation and nestling to calculate nest success for each stage. From the 200 active natural nests the overall nest success was 8.6%, 27.4% for incubation stage and 32.9% for nestling stage. The total nest success of nest box was 9.1%, 27.9% for incubation and 56.0% for nestling stage. We selected 6 species of bird with the highest number of nest monitored and exposure days to calculate separately which were Puff-throated Bulbul (n=36), Scaly-crowned Babbler (n=29), Puff-throated Babbler (n=27), White-rumped Shama (n=23), Black-naped Monarch (n=22) and Abbott's Babbler (n=15) the nest success were 6.0%, 21.0%, 11.7%,1.7%, 26.9% and 3.1% respectively (Table 2).

To estimate the relationship between nest success and distance from the edge, we combined all nests at every 200 m interval to estimate nest success at each distance interval. There was no correlation between nest success and distance from the edge (r^2=0.469, P=0.133). However, the percentage nest success seemed to be lower at further away from the edge (Figure 4).

Table 1. The number of exposure days separated by species and nesting stage.

No.	Species	No. of Nest	Exposure days			Nest type
			Egg	Nestling	Overall	
1	Abbott's Babbler	15	90	25.5	115.5	Open-cup
2	Asian Fairy Bluebird	3	17	10	27	Shallow open- cup
3	Black-crested Bulbul	7	40	7	47	Open-cup
4	Black-headed Bulbul	1	4	0	4	Open-cup
5	Black-naped Monarch	22	167.5	106	273.5	Open-cup
6	Common Green Magpie	8	42.5	13	55.5	Shallow open- cup
7	Emerald Dove	1	3	0	3	Platform
8	Great Eared Nightjar	1	20.5	10	30.5	Bare Ground
9	Greater Racket-tailed Drongo	1	5	0	5	Cradle
10	Green-billed Malkoha	1	7	0	7	Shallow open-cup
11	Hainan Blue Flycatcher	1	5	1	6	Cup-shaped
12	Laced Woodpecker	1	9	0	9	Cavity
13	Lesser Necklaced Laughingthrush	1	9	0	9	Shallow open-cup
14	Puff-throated Babbler	27	190	97.5	287.5	Dome, ground
15	Puff-throated Bulbul	36	240.5	89.5	330	Open-cup
16	Red Junglefowl	1	4	0	4	Shallow hollow
17	Scaly-crowned Babbler	29	237	117.5	354.5	Open-cup
18	Striped Tit Babbler	1	7	10	17	Looes ball-shaped
19	Stripe-throated Bulbul	10	81	40	121	Open-cup
20	Tickell's Blue Flycatcher	5	52.5	23	75.5	Cup-shaped
21	White-crested Laughingthrush	5	45	28	73	Shallow open- cup
22	White-rumped Shama	23	75.5	55	130.5	Open cavity
Total		**200**	**1352**	**633**	**1985**	

Table 2. Nests success of 6 species with the highest number of nests monitored.

Species	No. of active nests	Exposure Days	% Nest Success
Overall	200	1985	8.6
Abbott's Babbler	15	115.5	6.0
Black-naped Monarch	22	273.5	21.0
Puff-throated Babbler	27	287.5	11.7
Puff-throated Bulbul	36	330	1.7
Scaly-crowned Babbler	29	354.5	26.9
White-rumped Shama	23	130.5	3.1

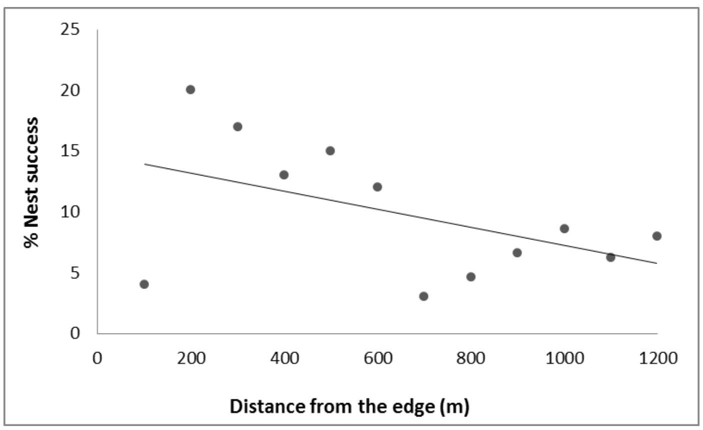

Figure 4. The distribution of nest success relative to distance from the edge

Nest predator monitoring

From video cameras and camera traps set up at 116 nests of 14 bird species during the breeding season we recorded 61 predation events by 8 nest predator species including of Green Cat Snake (*Boiga cyanea*), Bridal Snake (*Dryocalamus sp*.), Common Green Magpie (*Cissa chinensis*), Shikra (*Accipiter badius*), Crested Goshawk (*Accipiter trivirgratus*), Pig-tailed Macaque (*Macaca leonina*), Grey-bellied Squirrels (*Callosciurus caniceps*.), Northern Treeshrew (*Tupaia belangeri*). There were 2 predation attempts by Crested Goshawk but did not succeed and 1 event of Common Palm Civet scavenged on dead nestling. Snakes were the most important predator with 26 events (43 %) from at least 2 different species (*Boiga cyanea and Dryocalamus sp.*) follow by Pig-tailed Macaque (*Macaca leonina*) 18 events (30%), group of raptors 6 events (10%) and Common Green Magpie (*Cissa chinensis*) 6 events (10%).

The total predation rate was very high approximately 87%. We combined number of predations at every 50 meter to estimate the relationship between number of predation and distance from the edge. We found that number of predations was correlated with the distance from the edge (r^2=0.662, *P*<0.001) (Figure 5).

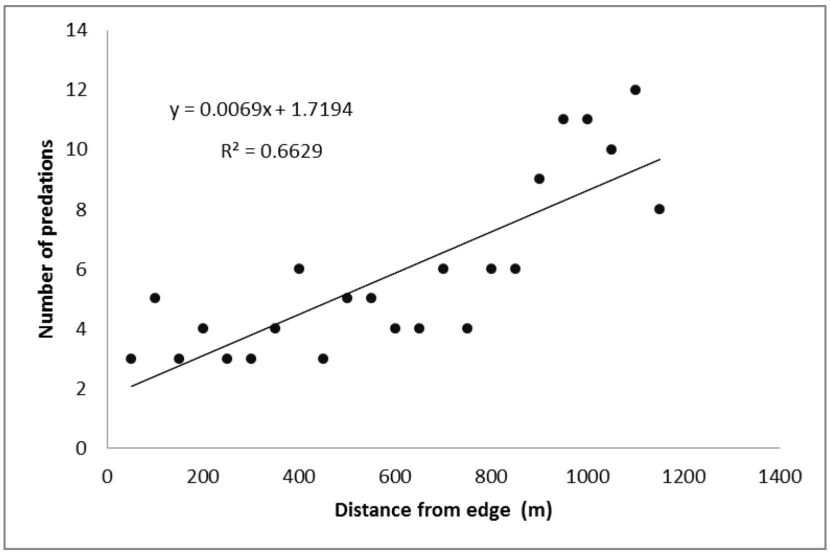

Figure 5. The distribution of number of predation relative to distance from the edge

Predator counts

From 16 camera traps we recorded 6 potential nest predator species which were Common Palm Civet (*Paradoxurus hermaphrodites*), Indochinese Ground Squirrel (*Menetes berdmorei*), Northern Treeshrew (*Tupaia belangeri*), Pig-tailed Macaque (*Macaca leonina*), Rodents and Squirrels (*Callosciurus sp.*). The most common species detected by camera traps was Rats. The average RAI across species was not significant difference between edge and interior (*P*=0.212) (Table 3). When we considered the RAI between edge and interior separately by species the results showed that every species except Rats had higher RAI at the edge than the interior, however there was only Squirrels that had significant difference of RAI between edge and interior (*P*=0.047) (Table 3).

Table 3. The relative abundance index of nest predator between edge and interior.

Predator sp.	Sciencentific name	Edge		Interior		P- Value
		RAI	SE	RAI	SE	
Common Palm Civet	*Paradoxurus hermaphroditus*	3.8	1.1	7.6	2.6	0.196
Indochinese Ground Squirrel	*Menetes berdmorei*	1.3	0.5	4.6	3.0	0.299
Northern Treeshrew	*Tupaia belangeri*	0.1	0.1	0.2	0.1	0.451
Pig-tailed Macaque	*Macaca leonina*	6.9	3.2	14.4	4.4	0.189
Rats	-	14.2	5.7	8.5	4.0	0.426
Squirrels	*Callosciurus sp.*	2.6	0.9	7.4	2.0	0.047*
Ave. across sp.		**4.8**	**2.1**	**7.1**	**1.9**	**0.212**

Discussion

Species richness and abundance

From the results we found that the total bird species richness and abundance were not significant difference at any distances from the edge, but slightly higher when further away from the edge, The area within 100 m from edge has high proportion of thorny shrubs cover which may not support the forest interior species may be relevant to explain the low detection of bird species near the edges. Moreover, the traffic noise was higher closer to the road edge effect, thus noise disturbance from the busy traffic which reduces the detection ability. Also, anthropogenic noise could distract birds, making them more vulnerable to predation (Arevalo and Newhard 2011, Summers et al. 2011). However, when analysing how distance from the edge affected on bird community the variations in the community such as diet type, feeding behavior and nesting behavior should be concerned and required the use of appropriate analysis to assess the effects of edge on bird community.

Nest success and nest predation

From results we found that the nest success was very low when compared with the previous study in Khao Yai National Park, KYNP and general nest success for tropical bird (8.6% vs. 16% vs. 23%) (Robinson et al. 2000, Pierce and Pobprasert 2013, Pierce et al. unpubl,). The predation rate was a bit higher compared to the study at KYNP (87% vs. 80%) (Pierce and Pobprasert 2013, Pierce et al. unpubl.). The nest predator composition was similar but the main nest predator was difference from the others studies (KYNP), which found that that Pig-tailed Macaques was the main nest predator and followed by the other nest predator species; snakes, avian nest predators and small mammals (Pierce and Pobprasert 2013, Pierce et al. unpubl.). From our study we found that snakes were the main nest predator followed by Pig-tail Macaque and the other nest predators. Although, the composition of the nest predator has changed, but the nest success was still low and predation rate was high, it seems that the predation by Pig-tailed Macaque has been compensated by snakes (Ellis-Felege et al. 2012).

There were no correlations between nest success and distance from the edge which may be the results of small sample size and unappropriated analysis. However, the number of predations was higher at further away from the edge this may be the results of higher number of nest found at the interior, more over the major nest predators such as Pig-tailed Macaque was forest-dependent species (Albert et al. 2013) which may increase number the predation at the interior.

Nest predator monitoring and count

The nest predator species recorded by video camera and camera trap at the nest was lower (8 species) compare to the data from KYNP (12 species) (Pierce and Pobprasert 2013, Pierce et al. unpubl.,) From the breeding season we recorded 2 different species of nest predator snake (*Boiga cyanea* and *Dryocalamus spp*.) which *Dryocalamus spp*. never recorded from the previous studies and all of them are highly arboreal. Although, the composition of the nest predator has changed, but the nest success was still low and predation rate was high, it seems that the predation by Pig-tailed Macaque has been compensated by snakes (Ellis-Felege et al. 2012).

The RAI and number of potential nest predator species seemed to be higher at the interior, where provide higher quality of food resources and habitats (Restrepo and Gomez 1998). The RAI of macaques was higher at interior but not significant difference, which similar to Albert et al. (2013) found, macaque prefers the forest interior.

สรุปและข้อเสนอแนะ (Conclusions and Recommendations)

This study aimed to investigate the effects of forest edge on avian community structures, nest survival and nest predator community in the dry evergreen forest of fragmented reserve area Sakaerat Environmental Research Station. Our results indicated that distance from the forest edge had weak influenced on avian community, nest survival and nest predator predation. The reason for such low nest success and high predation rates are unclear, however the changing in nest predator community and behaviors affect by edge effects and fragmentation may be significant factors (Robinson and Sherry 2012). Moreover, to study the dynamic of bird and nest predator community and nest survival require a long-term study to understand the effects of forest edge on wildlife.

Our work was the pioneer study of the effects of forest edge on wildlife in Thailand and in Southeast Asia. Southeast Asia is undergoing the highest rate of forest loss in the tropics and experiencing an explosion in infrastructure that could lead to increased habitat fragmentation and edge effects, but the study of its impacts in Thailand remains poorly compare to other tropical region in the world. The study provided the baseline scientific information regarding the impacts of forest edges on birds, knowledge of which should be useful for Thai government to manage forests habitat as well as researchers doing conservation planning.

เอกสารอ้างอิง (References)

Albert, A., Huynen, M., Savini, T. and Hambuckers, A. 2013. Influence of Food Resources on the Ranging Pattern of Northern Pig-tailed Macaques (Macaca leonina). Int J Primatol. 34:696–713.

Arevalo, E. and Newhard, K. 2011. Traffic noise affects forest bird species in a protected tropical forest. Rev.Biol.Trop. 59:969-980.

Ellis-Felege, S.N., Conroy, M.J., Palmer, W.E. and Carroll, J.P. 2012. Predation reduction results in compensatory shifts in losses of ground nests. J. Appl. Ecol. 49:661-669.

Gale, G.A., Round, P.D., Pierce, A.J., Nimnuan, S., Pattanavibool, A. and Brockelman, W.Y. 2009. A field test of distance sampling methods for a tropical forest bird community. Auk. 126: 439-448.

Mayfield, H.F. 1961. Nesting success calculated from exposure. Wilson Bulletin. 73: 255-261.

Pierce, A.J, Pobprsert, K. 2007. A portable system for continuous monitoring of bird nests using digital video recorders. Journal of Field Ornithology.78: 322–328.

Pierce, A.J. and Pobprasert, K. 2013. Nest predators of Southeast Asian evergreen forest birds identified through continuous video recording. Ibis. 155: 419-423

Restrepo, C. and Gomez N. 1998. Responses of understory birds to anthropogenic edges in a Neotropical montane forest. Ecol. Appl. 8:170–183

Robinson, W.D., Robinson, T.R., Robinson, S.K. and Brawn, J.D. 2000. Nesting success of understory birds in central Panama. Journal of Avian Biology. 31:151-164

Robinson, W.D. and Sherry, T.W. 2012. Mechanisms of avian population decline and species loss in tropical forest fragments. Journal of Ornithology. 153: 141–152.

Summers, P.D., Cunnington, G.M. and Fahrig, L. 2011. Are the negative effects of roads on breeding birds caused by traffic noise? Journal of Applied Ecology. 48:1527-1534.

ภาคผนวก (Appendix)

Appendix1. List of bird species

No.	Species	Scientific Name
1	Abbott's Babbler	*Malacocincla abbotti*
2	Asian Barred Owlet	*Glaucidium cuculoides*
3	Asian Fairy Bluebird	*Irena puella*
4	Banded Kingfisher	*Lacedo pulchella*
5	Bar-winged Flycatcher-shrike	*Hemipus picatus*
6	Black Baza	*Aviceda leuphotes*
7	Black-crested Bulbul	*Pycnonotus melanicterus*
8	Black-naped Monarch	*Hypothymis azurea*
9	Blue-bearded Bee-eater	*Nyctyornis athertoni*
10	Blue-eared Barbet	*Megelaima australis*
11	Blue-winged Leafbird	*Chloropsis cochinchinensis*
12	Brown Hawk Owl	*Ninox scutulata*
13	Common Green Magpie	*Cissa chinensis*
14	Common Iora	*Aegithina tiphia*
15	Common Tailorbird	*Orthotomus sutorius*
16	Crested Serpent Eagle	*Spilornis cheela*
17	Dark-necked Tailorbird	*Orthotomus atrogularis*
18	Emerald Dove	*Chalcophaps indica*
19	Great Iora	*Aegithina lafresnayei*
20	Greater Flameback	*Chrysocolaptes lucidus*
21	Greater Racket-tailed Drongo	*Dicrurus paradiseus*
22	Greater Yellownape	*Picus flavinucha*
23	Green-billed Malkoha	*Phaenicophaeus tristis*
24	Green-eared Barbet	*Megalaima faiostricta*
25	Grey-eyed Bulbul	*Iole propinqua*
26	Hainan Blue Flycatcher	*Cyornis hainanus*
27	Hill Myna	*Gracula religiosa*
28	Laced Woodpecker	*Picus vittatus*
29	Large Scimitar Babbler	*Pomatorhinus hypoleucos*
30	Olive-backed Sunbird	*Nectarinia jugularis*
31	Orange-breasted Trogon	*Harpactes oreskios*
32	Oriental Pied Hornbill	*Anthracoceros albirostris*
33	Plain Flowerpecker	*Dicaeum minullum*
34	Puff-throated Babbler	*Pellorneum ruficeps*
35	Puff-throated Bulbul	*Alophoixus pallidus*

Appendix1. List of bird species (cont.)

No.	Species	Scientific Name
36	Red Junglefowl	*Gallus gallus*
37	Ruby-cheeked Sunbird	*Anthreptes singalensis*
38	Scaly-breasted Partridge	*Arborophila chloropus*
39	Scaly-crowned Babbler	*Malacopteron cinereum*
40	Scarlet Minivet	*Pericrocotus speciosus*
41	Striped Tit Babbler	*Macronous gularis*
42	Stripe-throated Bulbul	*Pycnonotus finlaysoni*
43	Thick-Billed Green Pegion	*Treron curvirosta*
44	Tickell's Blue Flycatcher	*Cyornis tickelliae*
45	Vernal Hanging Parrot	*Loriculus vernalis*
46	White-bellied Yuhina	*Yuhina zantholeuca*
47	White-crested Laughingthrush	*Garrulax leucolophus*
48	White-rumped Shama	*Copsychus malabaricus*