บทความวิจัย

การกำหนดพื้นที่ลาดตระเวนโดยทำนายจากการกระจายตัวของชะนีมงกุฎในลุ่มน้ำตาหริ่ว เขตรักษาพันธุ์สัตว์ป่าเขาสอยดาว ประเทศไทย

อินทนนท์ กลศาสตร์เสนี*

บทคัดย่อ

การกำหนดพื้นที่ที่มีการล่าสัตว์เป็นสิ่งจำเป็นสำหรับการเพิ่มความแม่นยำของการลาดตระเวนซึ่งทำได้ยากในพื้นที่ที่มีการลาดตระเวนจำกัด ในขณะที่การสำรวจประชากรชะนีสามารถทำได้ในงบประมาณและกำลังคนที่จำกัด ดังนั้นการประยุกต์ใช้การกระจายตัวของชะนีในการทำนายพื้นที่ดังกล่าวน่าจะช่วยเพิ่มประสิทธิภาพของพื้นที่อนุรักษ์ให้มากขึ้น การกระจายตัวของชะนีมงกุฎในลุ่มน้ำตาหริ่วเหนือและใต้ของเขตรักษาพันธุ์สัตว์ป่าเขาสอยดาวได้ถูกสำรวจโดยวิธีการฟังเสียง ตำแหน่งที่พบชะนีมงกุฎได้ถูกนำไปอนุมานถึงพื้นที่อาศัยของชะนีมงกุฎและสร้างแผนที่ที่ทำนายถึงโอกาสที่น่าจะมีชะนีมงกุฎอาศัยอยู่ในแต่ละลุ่มน้ำโดยทำนายจากความสูงและความชันของพื้นที่ ผลการวิเคราะห์พบพื้นที่ที่น่าจะมีการล่าสัตว์ 2 พื้นที่ และพื้นที่ที่น่าจะมีการฟื้นตัวของประชากร 1 พื้นที่ในลุ่มน้ำตาหริ่วเหนือ สำหรับลุ่มน้ำตาหริ่วใต้ พื้นที่บริเวณหุบเขาถูกจัดเป็นพื้นที่ที่มีการล่าสัตว์และได้พบพื้นที่ที่น่าจะมีการฟื้นตัวของประชากรอีก 2 พื้นที่ พื้นที่ที่ทำนายส่วนใหญ่มักตรงกับการล่าและการฟื้นตัวของประชากรที่เกิดขึ้นจริง จึงมีแนวโน้มว่าวิธีการทำนายนี้น่าจะสามารถนำไปใช้ได้จริงโดยเฉพาะกับพื้นที่ที่มีการลาดตระเวนน้อยและขาดแคลนข้อมูลเกี่ยวกับการล่าสัตว์

คำสำคัญ: ชะนีมงกุฎ เขาสอยดาว การทำนายแผนที่การกระจายตัว

ภาควิชาชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ

*ผู้นิพนธ์ประสานงาน, e-mail: intanonk@g.swu.ac.th

Patrol Area Determination using the Prediction from Pileated Gibbon (*Hylobates pileatus*) Distribution in Ta-riu Watershed, Khao Soi Dao Wildlife Sanctuary, Thailand

Intanon Kolasartsanee*

ABSTRACT

Hunting area determination is necessary for increasing the precision of patrol which is difficult to be conducted if the patrol is limited. While survey on gibbon population can be conducted under the limited budget and man power, applying distribution of gibbon for predicting on hunting area should be explored. Pileated Gibbon (*Hylobates pileatus*) distributions in North and South Ta-riu watershed, Khao Soi Dao wildlife sanctuary were surveyed using Triangulation method by listening to the duet calls. Center of the occupied plots were used to estimate the occupied area and simulate the prediction map that predicted probability of occupation based on elevation and slope of the watershed. Two possible hunting areas and one possible re-colonizing area were found in North Ta-riu watershed. The valley of South Ta-riu watershed was the hunting area. Two possible re-colonizing areas were found in the watershed. Most predictions from this method were relevant to the real situations. This method should be able to use in the area with limited patrol and information on hunting pressure.

Keywords: Pileated Gibbon, Khao Soi Dao, Distribution map prediction

Department of Biology, Faculty of Science, Srinakharinwirot University

*Corresponding author, email: intanonk@g.swu.ac.th

Introduction

Besides poaching suppression, patrolling has been used to determine hunting areas for increase the precision of patrol. Distribution of wildlife and information on hunting pressure, e.g., food sources, camps, trails, hunting signs, etc., obtained from the patrol have been used to determine the hunting areas. Therefore, if patrol effort is limited, conservation actions are conducted with low precision. Since limited patrol has been the long-term problem in many protected areas [1], alternative method for hunting area prediction under limited effort should be explored. A population survey on gibbon (Fam. Hylobatidae) can be conducted under the limited effort by applying its distinct behavior of duet call. A duet call is a loud call of female and male gibbon in the family group that usually calls in the morning for territorial defense [2]. Since the duet call can be heard for long distance which direction of the call can locate its group location, gibbon population can be surveyed by listening to duet calls at the listening posts on the mountain around the watershed.

Khao Soi Dao wildlife sanctuary, Chantaburi province, Thailand is one of important habitats for an endangered Pileated Gibbon (*Hylobates pileatus*). The population survey in 1977 revealed that population density in North and South Ta-riu watershed were the highest in Khao Soi Dao wildlife sanctuary [3]. Since the limited patrol [4], the population survey in 2008 revealed that about 70% of Pileated Gibbon in North Ta-riu watershed was hunted down [4, 6]. Population was remained only on high mountains around the watershed while groups in the valley were lost because of high hunting pressure. A loss of Pileated Gibbon groups in the valley revealed the valley as the hunting area. The ground survey revealed high density of trail in the valley which could indicate high hunting pressure. After the community-based conservation project was conducted in 2009 to mitigate hunting pressure on Pileated Gibbon, the area in the valley was re-colonized by six new groups in 2012 [2, 6]. Although lost groups can be used to indicate the hunting area, in the area that Pileated Gibbon population has not been surveyed or historical data was unavailable, only current survey cannot reveal the lost groups. Therefore, instead of comparing between current and historical data, probability of Pileated Gibbon occupation in the watershed was predicted to compensate the historical data. Area that was predicted as low probability of occupation and Pileated Gibbon was absence was the hunting area. Area that was predicted as high probability of occupation but Pileated Gibbon was absence was the possible hunting area. Elevations and slopes of current Pileated Gibbon occupied areas should be able to indicate the current hunting pressure and predict probability of Pileated Gibbon occupation. The occupied areas of Pileated Gibbon in North Ta-riu watershed in 2008 were significantly positive correlated with elevations and slopes of the watershed. Pileated Gibbon groups under hunting pressure distributed at high elevation and slope area while

re-colonized at lower elevation and slope area when hunting pressure was mitigated [2]. In this study, Modeling of species geographic distribution method [7] was used to predict probability of Pileated Gibbon occupation in the watershed. By inputting the presence-only data of Pileated Gibbon obtained from the current survey and the environment layers, i.e., elevation and slope of the watershed, prediction map of the probability of Pileated Gibbon occupation in the watershed based on elevation and slope of Pileated Gibbon occupied area can be simulated. The prediction map can represent how distribution pattern of Pileated Gibbon should be, under the current hunting pressure. Because historical data of Pileated Gibbon distribution in North Ta-riu watershed was available [2], lost and new groups from 2012 were used to test the precision of this method. Then this method was applied in South Ta-riu watershed which patrol effort, information on hunting pressure and data on distribution in the past were limited.

Materials and Methods

Khao Soi Dao wildlife sanctuary (745 km^2) locates in Chantaburi province which is a part of Thai Eastern Forest Complex. Most terrains of Khao Soi Dao are mountains that covered by evergreen forest. There are two peaks of Khao Soi Dao, North Soi Dao (approx. 1500 m a.s.l.) and South Soi Dao (approx. 1700 m a.s.l.). North and South Ta-riu watersheds are locate in the middle of the sanctuary next to the South Soi Dao peak in the West. Pileated Gibbons in both watersheds were surveyed using Triangulation method [8]. Three listening posts were set up as triangle on the mountain around the watershed. Two rangers were stayed at each listening post from 08.00 to 12.00 AM to record azimuth angles, times and approximate distance of Pileated Gibbon calls. The survey in North Ta-riu watershed (9 km^2) was conducted for five days in January 2016. Since the unfamiliar trail and long distance from the protected area border, survey time in South Ta-riu watershed (4 km^2) was reduced to four days in February 2016. Accumulated number of detected groups was recorded in each survey. The absence of new detected group can be implied that most groups in the watershed were surveyed already. Azimuth angles from every listening post that heard the call at the same time, considered as the same call, were drawn on the contour map which one hectare plots were set up. The cutting point from three listening posts was the approximate location of Pileated Gibbon group. The plot that the cutting point located in was recorded as occupied plot. A male solo call which is the call from a male individual when it encounters other groups close to its territory was used to determine whether the occupied plots that were close to each other were from the same or different group. Centers of occupied plots were mapped in QGIS 2.12.2 program (www.qgis.org). The center of occupied plots each group were used to calculate the center of each group using the mean coordinate tool. An estimated occupied area was created by buffering the center of each group to

36 hectares, as the home range of Pileated Gibbon group in 1979 [5], using the buffer tool.

The center of the occupied plot coordinates were then input to Maxent 3.3.3k program (www.cs.princeton.edu) along with elevations and slopes of the watershed to predict probability of Pileated Gibbon occupation in the watershed. The prediction was done for 15 replicates while 25 percent of the input coordinates was randomly used to test the accuracy of prediction in each replicate. Receiver Operating Characteristic (ROC) plot was used to evaluate the prediction. If Area Under the ROC Curve (AUC) value was lower than 0.5, the prediction would less accurate than the random phenomenon and considered uninformative [9]. The highest value of AUC is 1 which indicates the perfect prediction. Predicted probability of occupation in the estimated occupied area was considered as high probability of occupation. Area that the predicted probability of occupation was not significantly different from Predicted probability of occupation in the estimated occupied area should be occupied by Pileated Gibbon, unless that area should be under hunting pressure. Prediction map was used to determine each kind of areas (Figure 1) as below.

1. If the predicted probability of occupation was not significantly different from the predicted probability of occupation in the estimated occupied area, and Pileated Gibbon was presenting, the area was determined as “occupied area” in which a level of hunting pressure should be low.

2. If the predicted probability of occupation was significantly lower than the predicted probability of occupation in the estimated occupied area, but Pileated Gibbon was presenting, the area was determined as “possible re-colonizing area” in which a level of hunting pressure should use to be high.

3. If the predicted probability of occupation was not significantly different from the predicted probability of occupation in the estimated occupied area, but Pileated Gibbon was absent, the area was determined as “possible hunting area” in which a level of hunting pressure should use to be low.

4. If the predicted probability of occupation was significantly lower than the predicted probability of occupation in the estimated occupied area, and Pileated Gibbon was absent, the area was determined as “hunting area” in which a level of hunting pressure should be high.

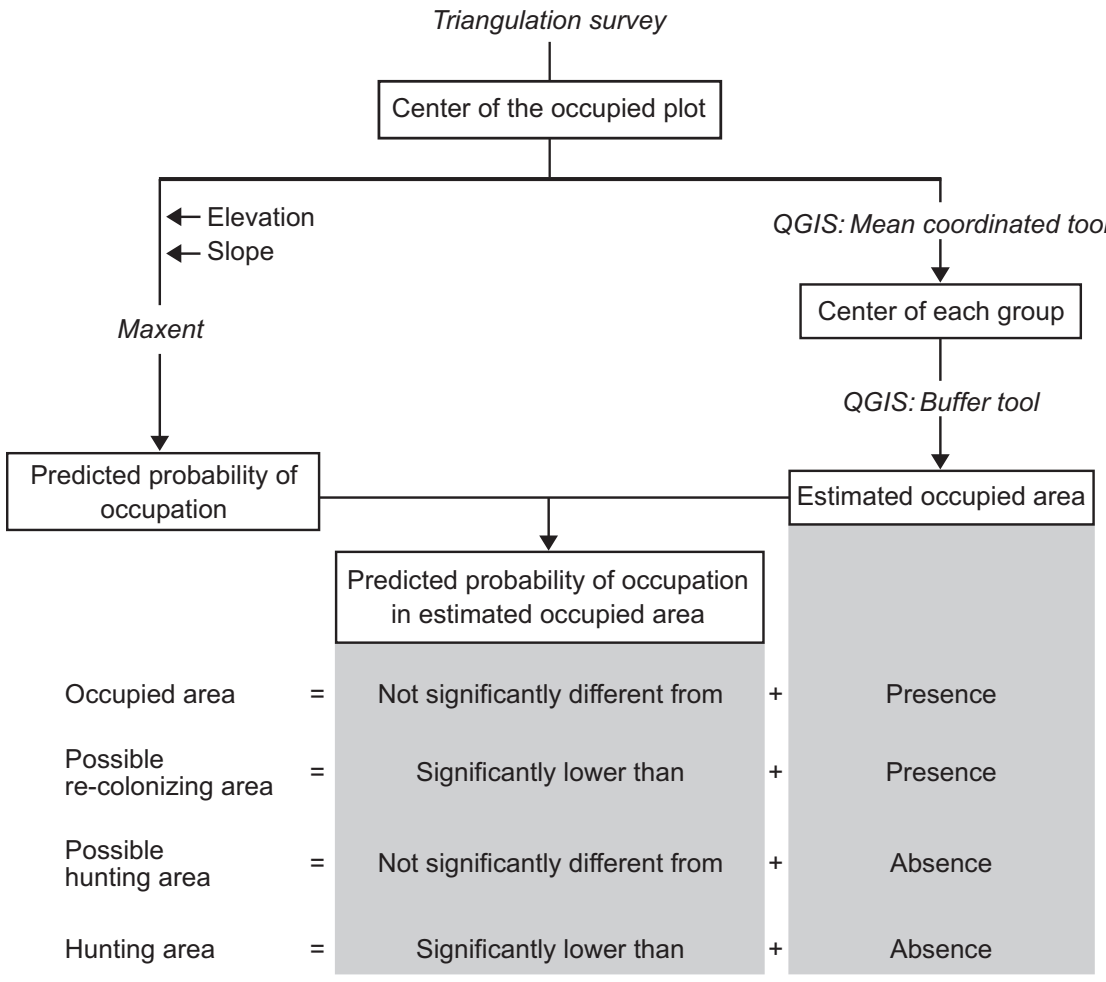

Figure 1: Flow chart of the method to determine occupied area, possible re-colonizing area, possible hunting area and hunting area. The italic letters represented survey method and data analysis tools.

The Mann-Whitney U test at the significant level of 0.05 in R 3.3.0 program (www.r-project.org) was used to test the difference.

Results

In both watersheds, no new Pileated Gibbon group was detected in the last survey day which can be implied that most Pileated Gibbon groups were surveyed already. Twenty-nine groups were found in North Ta-riu watershed (3.22 groups per square kilometer) while 13 groups were found in South Ta-riu watershed (3.25 groups per square kilometer). In North Ta-riu watershed, comparing with the data in 2012 [6], seven new groups were found while three groups were lost (Figure 2). The AUC of North Ta-riu watershed prediction map was 0.601

while that of South Ta-riu watershed was 0.661. The median of predicted probability of occupation in the estimated occupied area of North Ta-riu watershed was 0.496 while of South Ta-riu watershed was 0.551. In North Ta-riu watershed, two possible hunting areas were detected (Area A and B in Figure 2). The median of predicted probability of occupation of both areas (0.485 and 0.486, respectively) were not significantly different from in the estimated occupied area (p-value = 0.158, 0.531, respectively) but Pileated Gibbon groups were absent. One possible re-colonizing area was detected which new group No. 6 has occupied the area that was predicted as low probability of occupation (No. 6 in Figure 2). The median of predicted probability of occupation of this area (0.413) was significantly lower than in the estimated occupied area (p-value < 0.001) but Pileated Gibbon group was presenting. In South Ta-riu watershed, the median of predicted probability of occupation in the valley (0.155) was significantly lower than in the estimated occupied area (p-value < 0.001) and Pileated Gibbon groups were absent which indicated the valley as hunting area. Two possible re-colonizing areas were detected (Area C and D in Figure 2). The median of predicted probability of occupation of both areas (0.270 and 0.236, respectively) were significantly lower than in the estimated occupied area (both p-value < 0.001) but Pileated Gibbon groups were presenting. All predicted areas were concluded in table 1.

Table 1: Median of predicted probability of occupation in the estimated occupied area and in the predicted area. Presence of Pileated Gibbon in each area was abbreviated by "P" and Absence was abbreviated by "A". Star (*) symbol indicated the significantly lower of the median of predicted probability of occupation in predicted area than in estimated occupied area.

North Ta-riu			South Ta-riu		
Predicted probability of occupation in	**Median**	**P/A**	**Predicted probability of occupation in**	**Median**	**P/A**
Estimated occupied area	0.496	P	Estimated occupied area	0.551	P
Possible hunting area A	0.485	A	Hunting area: the valley	0.155*	A
Possible hunting area B	0.486	A	Possible re-colonizing area C	0.270*	P
Possible re-colonizing area No. 6	0.413*	P	Possible re-colonizing area D	0.236*	P

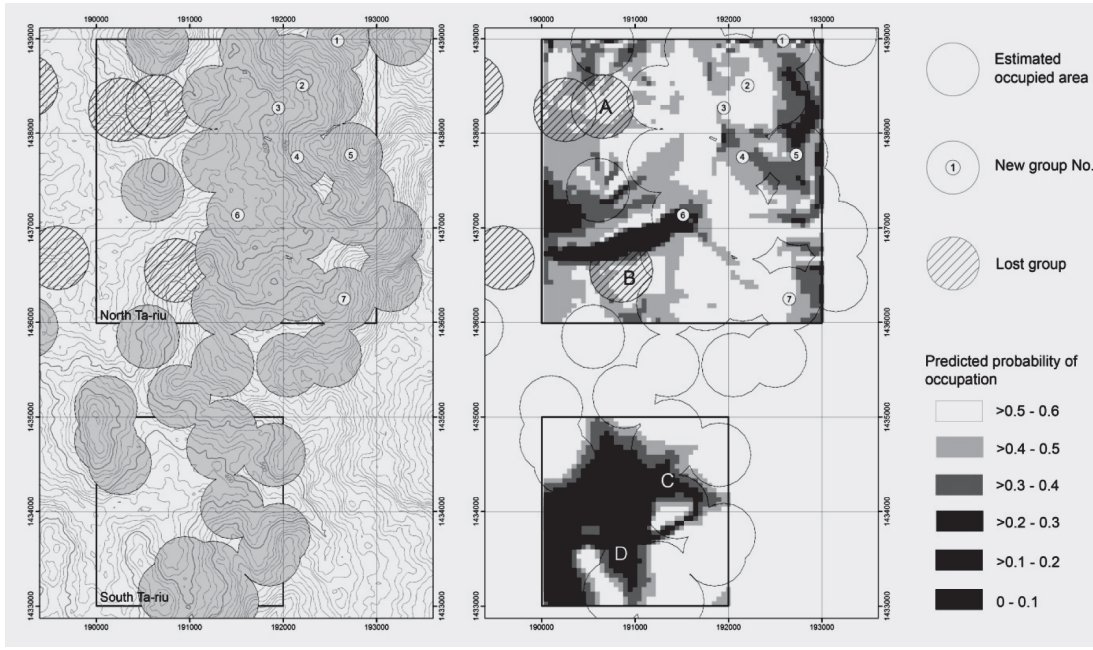

Figure 2: Contour map of North and South Ta-riu watershed with the estimated occupied area and lost groups from 2012 (left side) and prediction map (right side). Numbers in white circles represented the numbers of new groups. Letter A and B were the possible hunting areas and letter C and D were the possible re-colonizing areas.

Conclusion and Discussion

All predictions in North Ta-riu watershed were relevant to the real situations. For North Ta-riu watershed, hunting pressure was from the nearby watersheds while that within the watershed was mitigated since seven new groups were found. At present, the possible hunting area A and watershed next to North Ta-riu watershed in the West, Klong Na watershed, are being patrolled. Rangers used to collect the wild pig traps in the possible hunting area A. Compared with the data in 2012, two groups of Pileated Gibbon were lost in this area (Figure 2). For the possible hunting area B (Figure 2), two local-made gun shots were heard near this area during the survey in North Ta-riu watershed and a camp near this area was found. There was a bag of rice in the camp which still fresh and should be brought to this camp about the day that the gun shots were heard. Compared with the data in 2012, one group of Pileated Gibbon was lost in this area. The poachers in the possible hunting area A and B were believed to be the different groups. An area that was predicted as low probability of occupation should be the low elevation and slope area since high ability of human accession. However, the prediction map of North Ta-riu watershed also revealed low probability of occupation predicted at the high elevation area which hunting pressure should not occur since low ability of accession. A quality of food tree should be

the cause of this situation. The study on White-handed Gibbon (*H. lar*) in Malaysia revealed that low-quality food trees were distributed at higher elevation areas which could limit the gibbon distribution [10]. Therefore, the lower limit on elevation of Pileated Gibbon occupied area should be the hunting pressure while the higher limit should be the quality of food tree. For South Ta-riu watershed, the distribution pattern was as same as in North Ta-riu watershed before conservation which high level of hunting pressure was in the valley [6]. Only information on possible re-colonizing area D was available. A Pileated Gibbon group in this area was directly found by the team during the survey. One female and two male sub-adults were found foraging. After the group moved out from the observers' visions, duet calls were heard from that direction. According to Tilson 1981 [11], after a young gibbon turned into a sub-adult, it was got rid of its natal group to establish a new group. A place for establishing new group could either be the area between its neighbor groups or a vacant area that available nearby. This sub-adult was solitary and silently foraged outside its natal group, called floater, until it found another floater and established a new group. The mating success in the new established group can be indicated by their duet calls. Therefore, the Pileated Gibbon group that was found in possible re-colonizing area D should be the new established group since the presence of sub-adults and possible duet calls. However, about one month old trail was found in this area which indicated the presence of human accession in this area.

Since most of the possible hunting and re-colonizing areas were relevant to the real situation, this method should be able to use especially for the area under a limited patrol. In this study, Pileated Gibbon was used as proxy for other wildlife which should be able to indicate the hunting pressure since it was opportunistically hunted for food as same as most wildlife that were hunted in this area. However, since this method is the prediction, directly determination on hunting area based on distribution of wildlife and information on hunting pressure obtained from the patrol is certainly better if the patrol could be conducted efficiently. After using this data to discuss with the manager of Khao Soi Dao wildlife sanctuary, a possible hunting area B was added in the patrol schedule. For South Ta-riu watershed, although the valley and the area D should be patrolled, in practical, long distance from guard station is the major impeding factor for effective patrol in this area.

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ได้รับบทความวันที่ 6 ตุลาคม 2559
ยอมรับตีพิมพ์วันที่ 9 พฤศจิกายน 2559