THE COMPETITION BETWEEN MACAQUES AND CAO VIT GIBBON IN TRUNG KHANH SPECIES & HABITAT CONSERVATION AREA, CAO BANG PROVINCE

Nguyen Dac Manh[1], Tran Van Dung[1], Vu Tien Thinh[1]
[1]*Vietnam National University of Forestry*

SUMMARY

In the study, we surveyed the habitat characteristics of the Rhesus macaque (*Macaca mulatta*), Assamese macaque (*Macaca assamensis*) and Stump-tailed macaque (*Macaca arctoides*), and Cao vit gibbon (*Nomascus nasutus*), and their diet in Trung Khanh Species & Habitat Conservation Area from October to December 2018. Based on the comparison of food components (species and the parts of tree), and nine ecological niche factors (elevation, slope, the location of slope, aspect, the distance to water resource, vegetation type, tree density, distance to farm, distance to residential area), we assessed the competition levels on food and living space between each macaque and Cao vit gibbon. The results of the study showed that the competition on food between Rhesus macaque and Cao vit gibbon is very high while between Assam macaque, Stump-tailed macaque, and Cao vit gibbon is high. Three macaques and Cao vit gibbon compete for living space, in which Assam macaque is the most competitive species. Distance to a residential area, distance to farms, aspect, elevation, slope, and distance to water sources are the environmental factors in which the Cao vit gibbon and macaque are more competitive in fall-winter season. Finally, we have proposed the solutions to manage the macaque population and their habitat to decrease the competition between macaques species and gibbon in Trung Khanh Species & Habitat Conservation Area.

Keywords: Cao vit gibbon, food overlap, interspecific competition, niche overlap, Trung Khanh species and habitat conservation area.

1. INTRODUCTION

In 2002, after about 40 years without information on the existence of the Cao Vit gibbon (*Nomascus nasutus* Kumckel d'Herculair, 1884), also known as Eastern black-crested gibbon, FFI's scientists discovered a small population in the remote forests of Trung Khanh district, Cao Bang province, at the border of China (La Quang Trung and Trinh Dinh Hoang, 2002). Since the rediscovery of the rarest ape in the world, FFI and governmental agencies of Vietnam enacted a lot of conservation measures to keep the remnant population from immediate extinction. As a result, the Cao Vit gibbon population in the Trung Khanh Species and Habitat Conservation Area (SHCA) gradually recovered from 26 individuals in 2002 up to about 130 individuals in 2016 (Trinh Dinh Hoang et al., 2016).

The successful conservation of Cao Vit gibbons and their habitat has been generating benefits for other wild animals living in the Trung Khanh SHCA, including macaques. It is believed that there are three species of macaques, namely Rhesus macaques (*Macaca mulatta*), Assamese macaques (*Macaca assamensis*) and Stump-tailed macaques (*Macaca arctoides*) in the Trung Khanh SHCA. The total number of these macaques has been estimated to be higher to the number of Cao Vit gibbons in the Trung Khanh SHCA, and these macaques are competing with Cao Vit gibbons for food and habitat. The objectives of this study, therefore, are assessing the competition (food and living space) between each macaque and Cao vit gibbon in different ecosystems at Trung Khanh SHCA. Baseline information for macaques and Cao vit gibbon will be one of the scientific foundations to build success primates conservation plans.

2. RESEARCH METHODOLOGY

2.1. Study area

Trung Khanh SHCA (also known as Cao Vit SHCA) is located in three communes (Ngoc Khe, Ngoc Con, and Phong Nam), Trung Khanh district, Cao Bang province. It is about 355 km from Ha Noi capital. The protected area ranges from $22^0$53'74" to $22^0$57'63" North, and from $106^0$30'53" to $106^0$33'07" East.

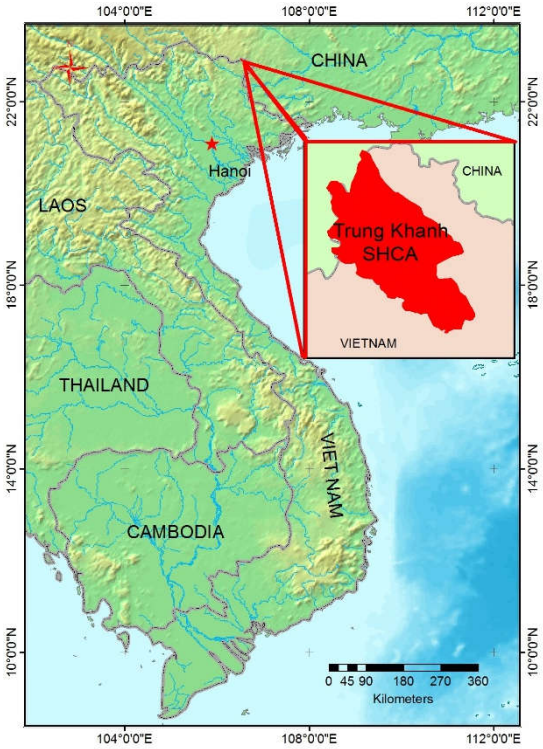

Figure 1. The location of Trung Khanh SHCA in Vietnam

The total area of Trung Khanh SHCA is 1,656.8 ha. The topography of the study area is dominated by karst limestone mountain. Therefore, there are temporary small water ponds in the nature reserve in the rainy season, instead of the stream. Trung Khanh SHCA is located in a subtropical climate zone; directly affected by monsoon (the Northeast monsoon). The annual average precipitation is from 1500 – 1900 mm; the rainy years often cause local flooding.

The vegetation in the study area includes four types: woody forest on the limestone mountain; shrub on the limestone mountain; regrowth forest in the valley, (include wood-bamboo mixed forest); and agricultural land. The forest habitats on the limestone mountain are not pristine, mainly the common trees with a diameter less than 30 cm, even many mountains only remain shrubs. The reasons of the phenomenon are which the exploiting activities to select rare and precious wood species for selling to China in a long time. The valleys are more impacted due to easy access, forming the secondary forest. Even in some valleys (Rung, Hoai, Day, Qua, Si valleys), the vegetation type is mainly agricultural plant (in cultivation season), and shrub (not in cultivation season).

2.2. Method

2.2.1. Field survey

We surveyed 20 transects through 25 valleys (Rung, En, Kha Min, Hoai, Day, Vi, Nhuong, Co, Tam Deng, Gu, Dac, Dac dai, Chi, Chi Roong, Kep That, Day, Ngoc Man, Tap Toan, Che, Hoai, Phai Tao, Nguom, Kỳ Gia, Bong Bip, Tua Noc) in three communes (Ngoc Khe, Ngoc Con, and Phong Nam). The total length of transects was 35.038 km; the whole survey time was 128.31 hours. During field survey time, surveyors observed 14 times and listened 28 times of macaques in the wild; observed 03 times and listened 08 times of gibbon.

During the field survey, the surveyors strolled along the mountainside and observed to the opposite cliffs to find macaques and gibbon

groups. When detecting the macaque or gibbon groups and their signal (calls, feedings, feces...) in the field, the surveyors also collected the information relate to the species including the name of species, GPS coordinate, distance to the group, the number of individuals. Macaques identification mainly followed the documents of Pham Nhat (2002); Francis (2008) and Smith (2008).

During the survey time, the surveyors also interviewed forest rangers và local guides to determine the occurrences of macaques or gibbon in fall-winter season (from October/2018 to December/2018). At each location of primates detection, we investigated the sample plot (size 20 x 25 m) to collect nine environmental factors (elevation, slope, slope position, distance to water sources, vegetation type, tree density, distance to farms, distance to the residential areas.

Furthermore, the study also investigated the food ingredients of macaques through the observation in the field and information from the local guide. The unknown specimens would be collected to identify in the laboratory.

2.2.2. Data analyzing

2.2.2.1. Classification of ecological niche characteristics of macaques and Cao vit gibbon to assess the living space competition

a) Definition and classification ecological niche characteristics

The study calculated and classified nine environmental factors following the approach:

(1) Elevation: GPS 78CSX was used to obtain the altitude above sea level, and location of surveyors, then, the topography map and compass also used to interpolate the elevation of macaques and gibbon groups. The factor was divided into three levels: < 500 m; 500 -700 m and, > 700 m.

(2) Slope: the surveyors calculated directly in the field by compass or estimated the slope of opposite cliffs. There are three levels of slope including, gentle (< 30^0); Steep (30^0 -45^0); and very steep (> 45^0).

(3) The location of slope: the location of the sample plot on the mountain, including mountain foot, mountainside, the peak.

(4) Aspect: The surveyors used the compass to determine the direction of the slope. The results were divided into four directions: East (45^0 - 135^0); South (135^0 - 225^0); West (225^0 - 315^0); North (315^0 - 360^0 and 0 - 45^0).

(5) The distance to the water source: the GPS and topographic maps were used to determine the minimum distance from sample plot to water resource (stream or pond), including three levels: short distance (< 100 m), medium (100 – 500 m) and long distance (> 500 m).

(6) Vegetation: the forest types of the study area were divided into four categories: The forest on the limestone mountain, the shrub on the limestone mountain; the regrowth forest in the valley; agriculture land.

(7) The density of trees: the number of the trees in the sample plot (20 x 25 m) was classified into three levels: low (<10 trees); medium (10 - 20 trees) and high (> 20 trees).

(8) The distance to farms: The surveyors used GPS and topographic maps to determine the minimum distance from sample plots to the farms: short distance (< 100 m); medium (100 – 500 m); long distance (> 500 m)

(9) The distance to the residential area: The surveyor also determined the minimum distance from sample plots to the residential area and classified to three levels: short distance (< 100 m); medium (100 – 500 m) and long distance (> 500 m).

b) Calculating the ecological niche

With each environmental factors, the study used the following formulas to calculate the ecological niche of macaques and Cao vit gibbon.

+ The niche breadth (Levins, 1968):

$$B_{ik} = 1/(S\sum_{k=1}^{s} P_{ik}^2), P_{ik} = N_{ik} / Y_i$$

B_{ik} is niche breadth of species i in resource states k; N_{ik} is the number of individual of species i in or using the resource state k; Y_i is the total number of individuals of species i; P_{ik} is proportion of the number of individuals of species i using the resource state k; S is the number of levels of resource state.

+ The niche overlap (Pianka, 1973):

$$\alpha_{ij} = (\sum_{k=1}^{s} P_{ik} P_{jk})/(S \sum_{k=1}^{s} P_{ik}^2)$$

α_{ij} is the niche overlap of species i with species j;

α_{ji} is the niche overlap of species j with species i;

$\alpha_{ij} \neq \alpha_{ji}$

+ The competition coefficient (May, 1975):

$$Q_{ij} = (\sum_{k=1}^{s} P_{ik} P_{jk}) / (\sum_{k=1}^{s} P_{ik}^2 \sum_{k=1}^{s} P_{jk}^2)^{1/2}$$

Q_{ij} is the competition between species;

$Q_{ij} = Q_{ji}$

+ Calculating the aggregate value: the study used the cumulative calculation for independent resource factors, and average calculation for dependent resource factors (Pianka, 1973; Schoener, 1974).

2.2.2.2. Comparing the food components between each macaque species and Cao Vit gibbon to assess the level of food competition

Based on the data from field survey, the study established the list of on the food component of macaques and Cao vit gibbon in Fall-Winter season. The specimens were identified following the http://www.plantphoto.cn and plant experts. The classification system, scientific name, common name of the plant specimens were followed the document of Nguyen Tien Ban et al. (2000).

The result of the study determined 24 plant species and their parts (leaves/ stems/ tubers/ young leaves/ flower/ fruit) which the macaques and gibbon use as food. The competition level is evaluated quantitatively by giving a score and calculating a cumulative score (the details was showed in table 1).

Table 1. Score&cumulative score of competition levels between macaques and Cao vit gibbon

The number of plants species are the food of macaques and gibbon (A)	Score (i)	The number of plants that macaques and gibbon eat the same parts (B)	Score (j)	Cumulative score (k=i*j)
1 - 5 species	0,25	< 35% A	0.33	0.083
		35 - 70% A	0.66	0.165
		>70% A	0.99	0.248
6 - 12 species	0,50	< 35% A	0.33	0.165
		35 - 70% A	0.66	0.330
		>70% A	0.99	0.495
13 - 18 species	0,75	< 35% A	0.33	0.248
		35 - 70% A	0.66	0.495
		>70% A	0.99	0.743
19 - 24 species	1,00	< 35% A	0.33	0.330
		35 - 70% A	0.66	0.660
		>70% A	0.99	0.990

The values of cumulative scores (k) were devided into four levels, including: k = 0.083 - 0.309: low competition level between macaque species and gibbon; k = 0.309 - 0.537: medium competition level; k = 0.537 - 0.763: high competition level; k = 0.763 - 0.990: very high competition level.

3. RESULTS AND DISCUSSION

3.1. The competition for living space between each macaque species and Cao vit gibbon

According to the competition principle, the macaques and Cao vit gibbon distribute in the same area, the ecological niche of each species will be more or less different (Wissinger, 1992).

The phenomenon will help them to reduce the pressures in term of resources utilisation such as food, territory. Therefore, to assess the competition level for living space between macaques and gibbon the study analyzed their ecological/spatial niche through three indexes, including niche breadth, niche overlap, and competition coefficient. The results were shown in table 2 and table 3.

Table 2. The niche breadth and competition coefficient between macaques and Cao vit gibbon

TT	Factor	B_{KV}	B_{KM}	B_{KC}	B_{VCV}	$Q_{KV\text{-}VCV}$	$Q_{KM\text{-}VCV}$	$Q_{KC\text{-}VCV}$
1	Elevation	0.798	0.821	0.600	0.661	0.888	0.979	0.916
2	Slope	0.960	0.970	0.923	0.761	0.867	0.937	0.897
3	The location of slope	0.758	0.627	0.600	0.938	0.966	0.889	0.887
4	Aspect	0.818	0.471	0.716	0.496	0.843	0.988	0.917
5	The distance to the water source	0.987	0.711	0.930	0.475	0.739	0.931	0.808
6	Vegetation type	0.827	0.889	0.631	0.356	0.821	0.793	0.676
7	Tree density	0.864	0.821	0.923	0.585	0.946	0.779	0.909
8	The distance to farms	0.997	0.711	0.694	0.333	0.623	0.913	0.925
9	The distance to residential areas	0.666	0.627	0.429	0.333	0.735	0.857	0.989
	Total	**0.654**	**0.465**	**0.445**	**0.256**	**0.622**	**0.793**	**0.707**

***Legend**: B_{KV} = the niche breadth of Rhesus macaque; B_{KM} the niche breadth of Assam macaque; B_{KC} the niche breadth of Stump-tailed macaque; $Q_{KV\text{-}VCV}$ The competition coefficient between Rhesus macaque and gibbon; $Q_{KM\text{-}VCV}$ The competition coefficient between Assam macaque and gibbon; $Q_{KC\text{-}VCV}$ The competition coefficient between Stump-tailed macaque and gibbon.*

The niche breadth is a measurement of the population's capacity to use the space of the area. It also presents the environmental adaptability and distribution range of the species (Colwell & Futuyma, 1971). The results of the study revealed the ecological niche of Cao vit gibbon (0.256) is narrower than those of three macaques. Also, the ecological niche of Rhesus macaque is the largest (0.654), and the following are Assam macaque and Stump-tailed macaque with 0.465 and 0.445, respectively. It means that the distribution area of Rhesus macaque might be larger than those of other macaque and gibbon, and the adaptability to habitat qualification of Rhesus macaque is also higher. The niche overlap between Rhesus macaque and other primate species is quite high. Therefore, the areas have appeared ecological separation phenomenon (i.g Rhesus macaque can distribute in the forest of the protected area as well as the forest near the farm of local people). This phenomenon leads to the decreasing of niche overlap and reduces the competition pressure between species.

For each separate factor, the largest ecological niche of Cao vit gibbon is the location of slope (0.938). It means that the gibbon adapts widely to the factor, the species can move flexibly between mountain foot, mountainsides and the mountain peak in Fall-Winter season. Besides, the largest ecological niche of Rhesus macaque, Assam macaque, and Stump-tailed macaque are the distance to the farm of local people (0.997), slope (0.970), and the distance to the water resource (0.930), respectively. By contrast, the narrowest ecological niche of gibbon is the distance to the farm – residential areas. Cao vit gibbon is very sensitive to the activities of human. The calculation result also showed that the species distributes only in the area where far from farm-residential regions over 500 m. The distance to the residential area also is the narrowest ecological nice of Rhesus macaque (B = 0.666) and Stump-tailed macaque (B = 0.429). Therefore, the species distributed mainly in the

region far from residential areas (> 500 m). However, the species might appear in the areas from 100 – 500 m where is the farm of local people. For Assam macaque, the narrowest ecological niche is aspect (B = 0.471), the species distributes mainly in the South aspect.

Table 3. The niche overlap of ecological niche of each macaque and Cao vit gibbon

TT	Factor	Rhesus macaque – Cao vit gibbon		Assam macaque – Cao vit gibbon		Stump-tailed macaque – Cao vit gibbon	
		α_{KV-VCV}	α_{VCV-KV}	α_{KM-VCV}	α_{VCV-KM}	α_{KC-VCV}	α_{VCV-KC}
1	Elevation	0.325	0.269	0.364	0.293	0.291	0.321
2	Slope	0.325	0.257	0.353	0.277	0.329	0.271
3	The location of slope	0.289	0.358	0.242	0.362	0.236	0.370
4	Aspect	0.271	0.164	0.241	0.254	0.275	0.191
5	Distance to the water source	0.355	0.171	0.380	0.253	0.377	0.192
6	Vegetation type	0.313	0.135	0.313	0.125	0.225	0.127
7	Density of tree	0.384	0.259	0.308	0.219	0.381	0.241
8	Distance to the farm	0.359	0.120	0.444	0.208	0.445	0.214
9	Distance to the residential area	0.346	0.173	0.392	0.208	0.374	0.291
	Total	**0.177**	**0.086**	**0.184**	**0.096**	**0.179**	**0.110**

Legend: α_{KV-VCV} *the niche overlap between Rhesus macaque and Cao vit gibbon;* α_{VCV-KV} *the niche overlap between Cao vit gibbon and Rhesus macaque;* α_{KM-VCV} *the niche overlap between Assam macaque and Cao vit gibbon;* α_{VCV-KM} *the niche overlap between Cao vit gibbon and Assam macaque;* α_{KC-VCV} *the niche overlap between Stump-tailed macaque and Cao vit gibbon;* α_{VCV-KC} *the niche overlap between Cao vit gibbon and Stump-tailed macaque.*

The niche overlap index presents the levels in using the spatial living between other species and the ability of potential competition of the species (Wissinger, 1992). The index is often used to assess the competition levels among close relative species (Colwell & Futuyma, 1971). In the study, the niche overlap index and competition coefficient were used to calculate the niche overlap levels of primate species.

The results in table 3 showed that there are eight factors (except the location of slope) that Cao vit gibbon is dominated by Rhesus macaque and Assam macaque in using the living space. In addition, the Stump-tailed macaque dominates the gibbon in seven factors (except slope location and elevation). In general, the niche overlap indexes between Cao vit gibbon and each macaque are lower than those of between each macaque and Cao vit gibbon (see detail in table 3). The results prove that most of the Cao vit gibbon distribution area has the presence of macaque species, while, the territory of macaques have not the occurrence of gibbon yet. Therefore, to decrease the competitive pressures for living space between macaques and gibbon, we should implement the solutions to expand the suitable habitat for gibbon.

The results from table 2 showed that the competition coefficient for living space between Rhesus macaque and Cao vit gibbon is the lowest (0.622), while the highest is the competition between Assam macaque and Cao vit gibbon with Q = 0.793. For each environmental factors, the level of the competition in the living space between Assam macaque and Cao vit are arranged from high to low including aspect, elevation, the distance to water sources, the distance to the farm, location of slope, the distance to the residential area,

vegetation type and the density of tree, respectively. For Stump-tailed macaque and gibbon, there are the distance to the residential areas, distance to the farm, aspect, elevation, density of the tree, slope, location of slope, distance to water sources, and vegetation type, respectively. The result showed that distance to residential areas, distance to the farm, aspect, elevation, slope, and distance to the water sources are competed significantly between macaques and Cao vit gibbon in the Fall-Winter season at Trung Khanh SHCA. Therefore, to decrease the pressures for living space between macaques and Cao vit gibbon, we should concentrate considerably on the factors, including aspect, elevation, and slope to conserve their suitable habitat. In addition, we should have more powerful impacts on the distance to the residential area, farm, and water source to improve the habitat of primate species in the area.

3.2. The competition for food between each macaque species and Cao vit gibbon

Based on the data from field survey, the study builds the diet of macaques and Cao vit gibbon in a fall-winter season. The results were shown in table 4.

Table 4. The plants are the food of macaques and Cao vit gibbon in fall-winter season at Trung Khanh SHCA

TT	The food species		The primate species			
	Vietnamese name	Scientific name	Rhesus macaque	Assam macaque	Stump-tailed macaque	Cao vit gibbon
1	Móc bắc sơn	*Caryota bacsonensis*	Q,N	Q	Q	Q,H
2	Si lá nhọn	*Ficus stricta*	L,Q	Q	L,Q	Q
3	Si quả nhỏ	*Ficus microcarpa*	L,Q	Q	Q	Q
4	Dướng	*Broussonettia papyrifera*	L,Q	L,Q	L,Q	L,Q
5	Sung lá lệch	*Ficus cyrtophylla*	L,Q	L,Q	L,Q	Q
6	Sung lá nhẵn	*Ficus glaberrima*	L,Q	L,Q	L,Q	Q,H
7	Ngái	*Ficus spp*	Q		Q	
8	Đa lá to	*Ficus hookeriana*	Q,N	Q	Q	Q,H
9	Re	*Cinnamomum spp*	N		N	
10	Dâu da xoan	*Spondias lakonensis*	Q	Q	Q	Q
11	Xoan nhừ	*Choerospondias axillaris*	L,Q	Q	Q	Q
12	Cốt cắn	*Nephrolepis cordifolia*	C		C	
13	Gấc rừng	*Momordica cochinchinensis*	Q	Q	Q	Q
14	Khổ áo	*Thladiantha spp*	L,Q	Q	Q	Q
15	Qua lâu	*Trichosanthes kirilowii*	L,Q	L,Q	L,Q	Q
16	Tầm gửi	*Scurrula parasitica*	N	N		H
17	Tứ thư	*Tetrastigma pubinerve*	L,Q	Q	Q	Q
18	Mạy puôn	*Cephalomappa sinensis*	L,N	L	L	N
19	Chua ngút dai	*Embelia undulata*	L,Q	L,Q	L,Q	Q
20	Nghiến	*Burretiodendron hsienmu*	L, N			N
21	Nóng sổ	*Saurauia thyrsiflora*	L,Q	Q	Q	Q
22	Xây lá to	*Myrsine kwangsiensis*	Q	Q	Q	Q
23	Chuối tây	*Musa nana*	Q,N	Q,N	Q,N	
24	Ngô (bắp)	*Zea may*	Q		Q	
	Total		**24**	**19**	**22**	**19**

***Legend**: L- Leaf; N- young leaf; C- Tuber; Q- Fruit; H- Flower*

The result of our study showed that macaques and Cao vit gibbon fed 24 plants in the fall-winter season. The parts of the plant are commonly taken as the food of macaques and gibbon including leaf, young leaf, clove, tuber, fruit, and flower. The study also calculated the overlap of plants and feeding part between three macaques and Cao vit gibbon. The results are shown in table 5.

Table 5. The classification of competition levels on food between macaques and Cao vit gibbon in fall - winter season at Trung Khanh SHCA

TT	The indicator	Rhesus macaque -Cao vit gibbon	Assam macaque -Cao vit gibbon	Stump-tailed macaque - Cao vit gibbon
1	The number of plants that the macaques and gibbon fed on	19	18	17
	Score (i)	1	0.75	0.75
2	The number of plants that the macaques and gibbon take a same part as food (B)	18	16	16
	Score (j)	0.99	0.99	0.99
3	Accumulated score (k = i*j)	**0.99**	**0.743**	**0.743**
	The competition level	**Very high**	**High**	**High**

3.3. Solution for conservation Cao vit gibbon and macaques in Trung Khanh SHCA

3.3.1. Managing the primate populations and their habitats

The ecological niche breadth of Cao vit gibbon, and Assam macaque, and Stump-tailed macaque are quite narrow. In addition, the competition between the species is high. It can lead to decreasing in the niche breadth and cause adverse effects on the long-term survival of the species. Therefore, protecting the suitable habitats of the species is very necessary and essential. Based on the results of the study, we have proposed for the manager of the protected area to conduct the solutions for protecting habitat and decreasing the competition between primate species.

(1) Re-planning the forest protection patrol routes in the NR and combining with the Macaques and gibbon investigation. It means that the survey transects and survey points should set up on the mountainside or on top of the mountain to observe the opposite ridge. In addition, the transects should avoid going down the valleys because vines and ombrophilous plants (the food of primates) are very diverse in the Fall-Winter season.

(2) Planning and constructing the natural water storage points (rainwater) to supply water for macaques species in the dry season. In addition, we should set up the camera traps next to the water store points for monitoring the macaque populations. In the future, the management broad might plan the areas to establish the ecotourism spots for watching wildlife.

(3) It is necessary to protect the original status of the habitats in core zones of the protected area. Encouraging the local people to plant the native species for fruits at the old farms near the protected area.

(4) Building the legal framework to promote the expansion of the protected area to the southwest (Ngoc Chung commune) to increase the area for conserving Cao vit gibbon as well as macaque species.

3.3.2. The following study activities in the future

The following study activities in the future:

1) To provide complete information for

conservation plans, and decisions, it is necessary to develop and implement monitoring programs for Macaques population and their habitats. Furthermore, the field and monitor activities need to combine with patrolling of forest protection group in communes.

2) Studying the social and humanities characteristics of local communities in buffer zones to identify the impacts of non-friendly behaviour of local people on primates species allow to improve the effectiveness of community education conservation.

3) Applying GIS and Analytic Hierarchy Process – AHP to model the ecological niche of each macaque and Cao vit gibbon for planning the green corridors and expanding the area of Trung Khanh SHCA.

4. CONCLUSIONS

The ecological niche of Rhesus macaque is larger than two remaining macaques and Cao vit gibbon. The level of environmental niche overlap between each macaque and Cao vit gibbon is higher than that of between Cao vit gibbon and each macaque. Assam macaque is the most competitive species with Cao vit gibbon about living space.

Distance to the residential area, distance to farm, aspect, elevation, slope, and distance to a water source are the main environmental factors in which the Cao vit gibbon and macaque are more competitive in Fall-Winter season in Trung Khanh SHCA.

The competition on food between Rhesus macaque and Cao vit gibbon is very high while between Assam macaque, Stump-tailed macaque and gibbon were assessed with high level.

The based on research results, we have been proposed appropriate recommendations for conservation primates in Trung Khanh SHCA.

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CẠNH TRANH GIỮA CÁC LOÀI KHỈ VÀ VƯỢN CAO VÍT TẠI KHU BẢO TỒN LOÀI VÀ SINH CẢNH TRÙNG KHÁNH, TỈNH CAO BẰNG

Nguyễn Đắc Mạnh[1], Trần Văn Dũng[1], Vũ Tiến Thịnh[1]
[1]Trường Đại học Lâm nghiệp

TÓM TẮT

Trong nghiên cứu này, chúng tôi đã tiến hành khảo sát đặc điểm sinh cảnh nơi cư trú của các quần thể Khỉ vàng (*Macaca mulatta*), Khỉ cộc (*Macaca arctoides)*, Khỉ mốc (*Macaca assamensis)* và Vượn cao vít (*Nomascus nasutus*); cũng như danh mục các loài thực vật làm thức ăn của chúng tại Khu bảo tồn loài và sinh cảnh Trùng Khánh, tỉnh Cao Bằng từ tháng 10 đến tháng 12 năm 2018. Thông qua việc so sánh phổ thức ăn (loài và bộ phận ăn) và 9 yếu tố hoàn cảnh nơi cư trú (độ cao, độ dốc, vị trí dốc, hướng phơi, cự ly đến nguồn nước, kiểu thảm, mật độ cây gỗ, cự ly đến nương rẫy, cự ly đến khu dân cư), chúng tôi đã đánh giá được mức độ cạnh tranh về thức ăn và không gian sống giữa từng loài Khỉ với Vượn cao vít. Kết quả của nghiên cứu cho thấy: cạnh tranh về thức ăn giữa Khỉ vàng với Vượn cao vít ở cấp độ Rất cao, còn cạnh tranh giữa Khỉ mốc và Khỉ cộc với Vượn cao vít đều được đánh giá ở cấp độ Cao; cả ba loài Khỉ đều lấn át không gian sống của Vượn cao vít, trong đó Khỉ mốc là loài cạnh tranh kịch liệt nhất với Vượn cao vít; cự ly đến khu dân cư, cự ly đến nương rẫy, hướng phơi, độ cao, độ dốc và cự ly đến nguồn nước là các yếu tố hoàn cảnh mà Vượn cao vít và các loài Khỉ cạnh tranh kịch liệt hơn trong mùa Thu - Đông. Cuối cùng, nghiên cứu đã định hướng một số giải pháp nhằm quản lý sinh cảnh sống và giảm thiểu mức độ cạnh tranh giữa các loài Khỉ với Vượn cao vít.

Từ khóa: Cạnh tranh giữa loài, Khu bảo tồn loài và sinh cảnh Trùng Khánh, trùng lặp ổ sinh thái, trùng lặp phổ thức ăn, Vượn cao vít.

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