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RESEARCH ON THE ECOLOGICAL CHARACTERISTICS OF THE SYSTEM FOR PRIMATES IN BAC HUONG HOA NATURAL RESERVE AREA , QUANG TRI PROVINCE

Specialized on: Silviculture
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SUMMARY OF DOCTORIAL THESIS ON SILVICULTURE

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PREAMBLE

Bac Huong Hoa Nature Reserve, Quang Tri Province, established in 2007, is the only nature reserve in the territory of Vietnam to the west of Truong Son, with two prominent peaks: Sa Mu (1,550 m) and Voi Mep Peak. (1,771 m). With the diversity of topography, the forest types have created Bac Huong Hoa important conservation value not only in Vietnam but also of the Region.

Primate plays an important role in the ecosystem of Bac Huong Hoa Nature Reserve. According to previous research, Bac Huong Hoa Nature Reserve has recorded 7 species of primate. However, there are many contradictions in the data on species recognition through field surveys and results of interviews with people ... leading to different conclusions about the list of primate species in the Bac Huong Hoa nature reserve.

Along with the disagreement on the number, name of primate species, the ecological characteristics of primates in Bac Huong Hoa Nature Reserve have not been studied. The characteristics of forest vegetation, carpet type, elevation belts, living habitat, food and nesting, shelter, etc. of primates are a question that needs to be explained. Especially, the relationship between ecological features and diversity of species composition, abundance and distribution ... makes primate systems in Bac Huong Hoa different from other Nature Reserves and National Parks in the Region. Moreover, according to previous studies, the mammal fauna in general and primate species are under pressure from human activities such as illegal logging and hunting. Therefore, the study of human impacts affecting the diversity of species composition, abundance and distribution of primates will be an important basis for proposing conservation solutions in next time.

From the above reasons, it is necessary to implement the project " ***Research on the ecological characteristics of primate system in Bac Huong Hoa Nature Reserve, Quang Tri Province*** ".

The goal of the subject

1) Identify species composition and develop distribution maps of primate species in Bac Huong Hoa Nature Reserve.

2) Assess the densities of Ha Tinh Langur *(Trachipithecus hatinhensis*) and siki gibbon (*Nomascus siki*) in Bac Huong Hoa Nature Reserve.

3) Assess the ecological characteristics of primate system in Bac Huong Hoa Nature Reserve and the relationship between them.

4) Identify threats and propose some solutions towards sustainable conservation of primate species in Bac Huong Hoa Nature Reserve.

Scientific significance

Providing new data on species composition, distribution as well as ecological characteristics of primates. The results of the thesis research are the basis for continuing primate studies in Bac Huong Hoa Nature Reserve.

Practical significance

Nine primate species have been recorded once again, confirming the importance of Bac Huong Hoa NR for conservation of primates in North Central and Vietnam in general.

New contributions of the thesis

- Develop a primate list for Bac Huong Hoa Nature Reserve including 9 species. In particular, it has confirmed the presence of Macaca assamensis *(Macaca assamensis)* in Bac Huong Hoa Nature Reserve.

- Develop distribution maps of primates in the NR for research, management and conservation of species in the coming future.

- Provide data on the ecological characteristics of primates such as frequency of occurrence, density and relationship between habitat structure and distribution of primates in the NR. In particular, determine the population density of Ha Tinh Langur *(Trachipithecus hatinhensis*) and siki gibbon (*Nomascus siki*) in Bac Huong Hoa Nature Reserve.

The structure of the thesis

The thesis consists of 121 pages, 31 tables, 15 graphs, illustrative maps, reference of 107 documents in which 57 documents in Vietnamese and 53 documents in foreign languages and 36 photos illustrating the results of the survey. The thesis is structured into the following sections and chapters:

Chapter 1
OVERVIEW OF RESEARCH ISSUES

1.1. Overview of studies on primate taxonomy in Vietnam

Research results of many authors indicate that: Primate in Vietnam ranges from 24 to 26 species and subspecies, belonging to 3 families: The loris (Loridae), the monkey family (Cercopithecidae), and the gibbon family (Hylobatidae).

Groves (2001) suggested that primate of Vietnam includes 24 species, belonging to 3 families. Pham Nhat (2002) added another primate species, Pileated Gibbon *Hylobates pileatus* (Gray, 1861). However, after many surveys conducted in the years 2002-2004, scientists have confirmed that this species is not distributed in Vietnam, but only in the western part of the

Mekong (Roos, 2004). , (Groves, 2004). Thus, Vietnamese primates return to 24 species.

Van Ngoc Thinh et al. (2010) used DNA analysis, bioinformatics and morphology to describe a new species of gibbon on the Truong Son Mountain Range, known as the Central Gibbon (*Nomascus annamensis).* Thus, the list of primate in Vietnam has been added one more species to 25 species. Blair et al. (2011) suggested that Vietnamese primate consists of 26 species, due to the addition of the Con Dao island long-tailed macaque (Macaca fascicularis condorensis).

Nadler (2012), Roos et al. (2014) suggested that Vietnamese primates include 25 species, belonging to 3 families including: The loris (Loridae) , the monkey (Cercopithecidae) and the gibbon (Hylobatidae). The Con Dao island long-tailed macaque (*Macaca fascicularis condorensis)* in the taxonomy of Blair et al. (2011) was removed due to the fact that The Con Dao island long-tailed macaque is only a subspecies of the long-tailed macaque. Therefore, in the framework of this thesis, the author uses the classification system of Roos et al (2014) to study.

1.2. Overview of primate ecology studies

Plants play an important role in animal's life, in addition to a kind of food, plants also affect the growth, development speed, fertility and longevity of animals. In addition to supply food, plants provide habitat and shelter, a place to hide from predators and a hideout to catch animals (Le Dinh Thuy, 2009).

So we can affirm that, if we want to preserve primate well, it is important to understand the ecology of each species so that we can have effective management and conservation measures. Without a suitable, good living habitat, primate conservation will certainly be difficult, because the evolution of the species always depends on the environment (living habitat).

The study of living habitat of primates system has been studied quite specifically by the authors, mostly by OTC survey method. However, a number of studies have used vegetation survey by route methods or based on vegetation map and forest current status (Dong Thanh Hai, 2015; Hoang Anh Tuan, 2016; Tran Quoc Toan 2009), this method is subjective by the way of dividing that each author applied, especially the results also depend on the experience of each author. Therefore, in this thesis, the PhD student will use the OTC method to investigate primate ecology.

1.3. Overview of primate studies in Quang Tri

More than 10 studies conducted between 2006 and 2016 have recorded 8 primate species, but the primate list is inconsistent. Some studies suggest

that the gibbon in Bac Huong Hoa Nature Reserve is the white- cheek*black gibbon* (*Nomascus leucogenis)*, others think it is the siki gibbon *(Nomascus siki)*. In the study of the Center for Natural Resources and Forest Environment, the Macaca assamensis of Bac Huong Hoa was recorded while other reports has no recognition of them. There have also been studies that have made a primate list but the record is through interviews so the reliability, accuracy is not high, not convincing.

Although the authors have different points of view, most authors agree that the gibbon in Quang Tri province is the siki gibbon *(Nomascus siki)*. On the other hand, based on in-depth studies on primate in Vietnam such as Pham Nhat (2002) and Nguyen Xuan Dang and Le Xuan Canh (2009) as well as the latest classification system of Primate in Vietnam by Roos et al. . (2014), the gibbon in Quang Tri province is the siki gibbon *(Nomascus siki)* . In this study, the topic does not study molecular genetics and will consider the gibbon in Bac Huong Hoa Nature Reserve to be the siki gibbon *(Nomascus siki)* according to a number of prestigious documents published previously (Pham Nhat, 2002 ; Nguyen Xuan Dang and Le Xuan Canh, 2009; Roos et al ., 2014)

In order to confirm that, as well as create a complete list of primates in Bac Huong Hoa, the author will endeavor to carry out more field surveys, conducting surveys at various times. During the year, the number of repetitions was large enough and use many different methods to collect pictures and samples to confirm the primate species found in Quang Tri. At the same time, analyzing and assessing the primate ecological characteristics in Bac Huong Hoa Nature Reserve to explain the question "Why is the primate system in Bac Huong Hoa so diverse in species, richer in density to compare with primate system in another National Park Reserve in the North Central Region, "and this study also aims to assess threats, affect on primates ecology in general and propose some solutions to protect Primate survival in the future.

Chapter 2
AUDIENCE, CONTENT, RESEARCH METHODS

2.1. Research subjects

- Primate species and ecological characteristics of primates in Bac Huong Hoa Nature Reserve in Quang Tri Province.

2.2. Research duration : From 2014 - 2018

2.3 Research content

- Studying on primate species composition, distribution and density of siki gibbon (*Nomascus siki*) and *gibbon* langur (*Trachypithecus hatinhensis*) in BHH Nature Reserve

- Research on the ecological characteristics of primates in BHH Nature Reserve

- Studying on human impacts on primate system and propose some solutions to sustainably preserve primate species in BHH Nature Reserve

2.4. Research Method

The research methods used in the thesis are traditional and popular animal survey methods that are widely used in Vietnam and around the world. These methods have also been successfully used by some authors for studies of primate.

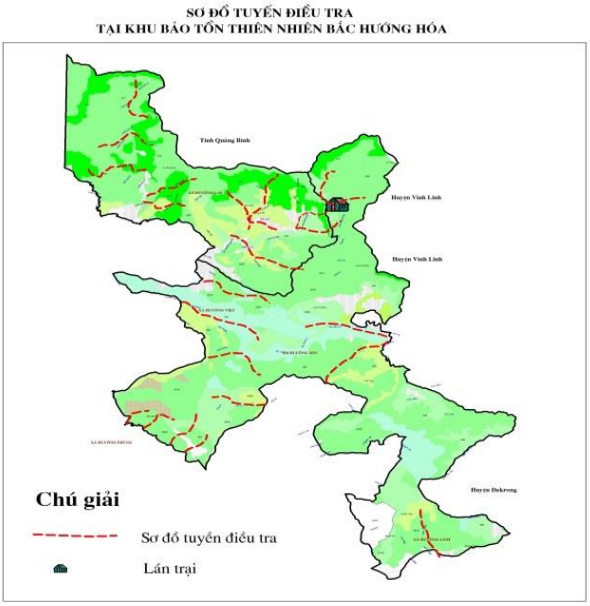
2.4.1. Interview method

A total of 85 questionnaires were distributed to 5 Technical staff of Bac Huong Hoa Nature Reserve Management Board, 10 rangers of Huong Hoa Forest Protection Department, 20 people from forest protection groups, and 50 people of 5 communes (10 people /commune).

2.4.2. Field survey methods

*** Point listening method**

A total of 22 survey points are set up at the peaks of the NR. At one listening point, there are 3 independent listening groups. Listening time starts from 05:00 - 9:30 in the summer, and 5:30 to 10:00 in the winter. Each listening point was investigated 3 times / 3 days.



*** Investigation by route**

The route was established with a length of 1.5-5 km passing through different living habitat types (Figure 2.1). The routes are set at 1-2 km intervals and cover the NR. A total of 22 investigated routes, with a total length of 68.75 km, were prepared for primate investigation.

*** Investigating routes at night**

Based on the survey routes set up for day surveys, conducting night surveys to investigate nocturnal species.

*** Investigating by camera trap**

A total of nine Bushnell Trophy Cam-type camera trappers have been installed at various locations in the Bac Huong Hoa Nature Reserve with over 55,427 hours of camera trapping in the forest and more than 7,000 images have been obtained.

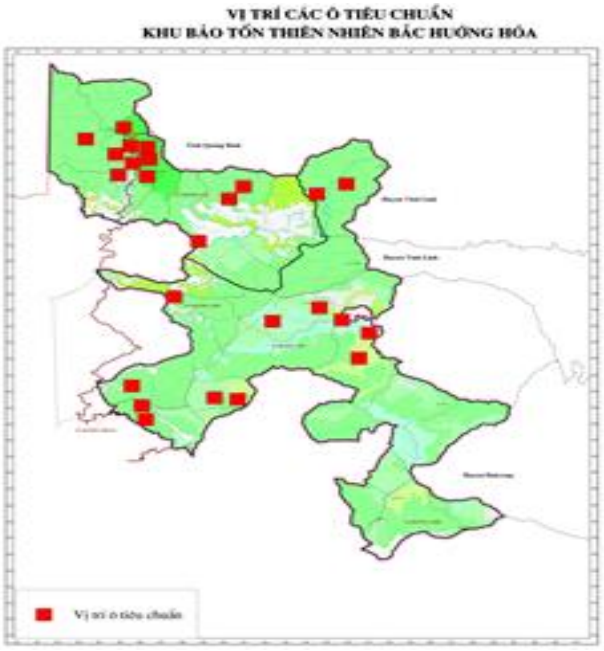
2.4.3. Ecological investigation method of primates

*** Identification of habitat types and forest vegetation**

Using the classification system of Thai Van Trung (1978), the 2016 forest inventory map and the direct observation process on the investigation route.

*** Surveying primates ecology according to the standard plots**

The thesis has established 25 standard plots (OTC) with dimensions of 25mx40m in Bac Huong Hoa Nature Reserve.



2.4.4. GIS method

Applying ecological classification of Thai Van Trung, data on topography, climate, rainfall, soil, forest vegetation and using GIS analysis methods to analyze and build ecological maps.

2.4.5. Method of assessing threats to Primate species

Using the method of (Margoluis and Salafsky, 2001)

2.4.6. The documents used to identify scientific names, classification ...

For plants: Vietnamese plants (Pham Hoang Ho, 1993); Vietnamese timber resources (Tran Hop, 2002); Taxonomy of vegetation of Thai Van Trung (1978); A handbook for biodiversity research "by Nguyen Nghia Thin, (1997) ...

For primates: Decree No. 160/2013/ND-CP dated November 12nd, 2013; Decree 06/2019/ND-CP dated January 22nd, 2019; Ministry of Science and Technology (2007); IUCN (2019); Convention on International Trade in Endangered Species of Wild Animals (CITES).

Chapter 3
RESULTS AND DISCUSSION

4.1. Primate species composition in Bac Huong Hoa Nature Reserve

The survey results have recorded a total of 09 species, accounting for 36% of the total number of primate species in Vietnam. Results are in table 4.1.

Table 4.1. Primate species composition in the Research Area

No	Family name / species		Local name	Source
	Vietnamese name	**Scientific nomenclature**		
I	**The Loris family**	**Lorisidae**		
1	Great loris	*Nycticebus bengalensis*	Lình lâm	PV,TL
2	Small loris	*Nycticebus pygmaeus*		QS
II	**Monkey family**	**Cercopithecidae**		
3	Red faced monkey	*Macaca arctoides*	Xi ắc	QS, BA
4	Golden Monkey	*Macaca mulatta*	Ta mư Rđô	QS, BA
5	Pig-tailed monkey	*Macaca leonina*		QS, BA
6	*Macaca assamensis*	*Macaca assamensis*		QS
7	Pygathrix nemaeus	*Pygathrix nemaeus*	Xá vá, Dooc	QS
8	Ha Tinh Langur	*Trachypithecus hatinhensis*	And	QS
III	**The gibbon family**	**Hylobatidae**		
9	Siki ape	*Nomascus siki*	Quành	TK

Note: *BA = Camera trapping; QS = observation; PV = interview, TL = documents; TK = Cry,scream*

During field investigations, the researcher observed and heard the cries of 8 primates and 1 species recorded through interviews and documents. Among the direct observation species, the Pygathrix nemaeus (a kind of brown legs langur) is the most recorded species.

During the period from 2005 to 2016, the number of primate species in Bac Huong Hoa has changed (Results in Table 4.2). Accordingly, a study by the Forest Inventory and Planning Institute in 2005 recorded four species, Center for Forest Resources and Environment, 2015; Ngo Kim Thai et al, 2015; Khong Trung, 2014., all recorded 8 species and by this study, the author asserted there are 9 species, especially the Macaca assamensis recorded by image.

Table 4.2. Primate species composition in the Reserve over time

No	Name		Source				
	Vietnamese name	**Scientific nomenclature**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
I	**The Loris family**	**Lorisidae**					
1	Great loris	*Nycticebus bengalensis*	X	X	X	X	
2	Small loris	*Nycticebus pygmaeus*	X	X	X	X	
II	**Monkey family**	**Cercopithecidae**					
3	Red faced monkey	*Macaca arctoides*	X	X	X	X	X
4	Golden Monkey	*Macaca mulatta*	X	X	X	X	
5	Pig-tailed monkey	*Macaca leonina*	X		X	X	
6	Macaca assamensis	*Macaca assamensis*	X	X			
7	Pygathrix nemaeus	*Pygathrix nemaeus*	X	X	X	X	X
8	Ha Tinh Langur	*Trachypithecus hatinhensis*	X	X	X	X	X
III	The gibbon family	Hylobatidae					
9	Siki ape	*Nomascus siki*	X	X	X	X	X
Total number of species			9	8	8	8	4

(1) This study; (2) Center for Forestry Resources and Environment, 2015; (3) Ngo Kim Thai et al, 2015; (4); Khong Trung, 2014; (5) Forest Inventory and Planning Institute , 2005.

4.2. Diversity taxonomy of primates

With the recognition of 09 primate species of 3 families, it has confirmed that the diversity of families, primate species in Bac Huong Hoa Nature Reserve are also the diversity of families of Vietnamese primates..

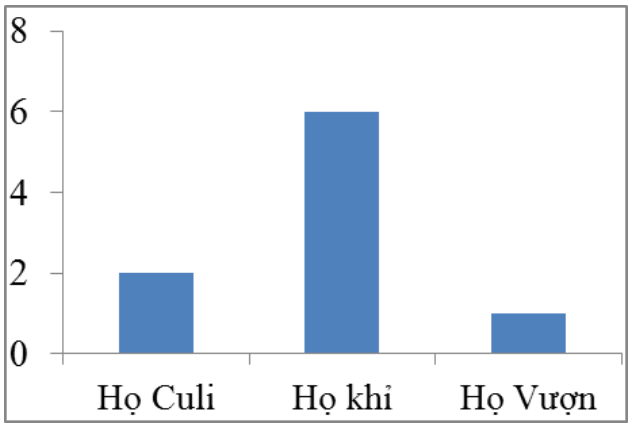


Figure 4.1. Diversity of taxonomy

The comparison of the total number of primate species recorded in Bac Huong Hoa with the total number of species and varieties recorded in Vietnam shows that: Monkey family has 06 species (accounting for 66.67% of the total number of species recorded, The loris (Loridae) family has 02 species, accounting for 22.22% and the gibbon family has 01 species, accounting for 11.11%. Thus, it can be seen that the level of taxonomic diversity in Bac Huong Hoa is quite high compared to some other Protected Areas in the Region.

4.3. Comparison of the composition of primates in diversity

In terms of species diversity, Bac Huong Hoa has a lower diversity than Phong Nha-Ke Bang National Park. The total number of species in Bac Huong Hoa is equal to Dakrong Nature Reserve and more than the legendary Ho Chi Minh Road Nature Reserve. Results are in table 4.3.

Table 4.3. Comparison of primate species composition with some other areas

No	Place	Families	Species	Source
1	Bac Huong Hoa	3	9	(1)
2	Dakrong Nature Reserve	3	9	(2)

3	Phong Nha-Ke Bang National Park	3	10	(3)
4	The legendary Ho Chi Minh Road Nature Reserve	3	4	(4)
5	Nationwide	3	25	(5)

Notes : (1) This study; (2) Nguyen Dac Manh et al (2009); (3) List of primates - Technical thesis of Phong Nha - Ke Bang National Park; (4) List of animal- Legendary Ho Chi Minh Road Reserve Investment Project; (5) Roos et al., 2014.

4.4. Conservation value of primate system

The assessment results of the conservation value of the primates fauna of Bac Huong Hoa Nature Reserve indicate that this area is not only a high biodiversity in species composition but also a high value in biodiversity conservation.

Table 4.4. Preservation status of primates

No	Families - Species	Conservation status				
	Vietnamese name	Red Book of VN 2007	Decree 160	Decree 06	CITES	IUCN 2019
I	**The Loris family**					
1	Great loris	VU	+	IB	I	VU
2	Small loris	VU	+	IB	I	VU
II	**Monkey family**					
3	Red face monkey	VU		IIB	II	VU
4	Golden Monkey			IIB	II	
5	Pig-tailed monkey	VU		IIB	II	VU
6	Macaca assamensis	VU		IIB	II	NT
7	Pygathrix nemaeus	EN	+	IB	I	EN
8	Ha Tinh Langur	EN	+	IB	II	EN
III	**The gibbon family**					
9	Siki ape	EN		IB	I	EN

The table above shows that a total of 9 primate species are endangered, precious and rare. According to Decree No. 06/2019, all primate species are endangered and rare, including 5 species of group IB including Large loris, small loris, the Pygathrix nemaeus (a kind of brown legs langur), Ha Tinh langur, siki gibbon and The remaining 4 species are Golden Monkey, Red-faced Monkey, Macaca assamensis and the Pig-tailed Monkey belonging to Group IIB.

In addition, there are 4 species included in appendix I and 5 included in appendix II of CITES, these are species that need conservation priority. There are 04 species on the list of endangered precious and rare species prioritized for protection in Decree 160.

4.5. Abundance of some primate species belonging to the NR

The abundance of primates in the Study Area is shown by the frequency of encountering species on the route. Survey data show that the frequency of encountering primates on surveying routes is different. Results are in table 4.5.

Table 4.5. Frequency of encountering species on the survey route

Route	Species encountered	Times	Length route (km)	Frequency of encounter (times/km)
1	Siki ape	1	5.74	0.17
	Pygathrix nemaeus	1	5.74	0.17
2	Siki ape	1	12.24	0.08
	Pygathrix nemaeus	3	12.24	0.25
	Red faced Monkey	1	12.24	0.08
3	Pygathrix nemaeus	3	3.92	0.77
	Siki ape	1	3.92	0.26
4	Pygathrix nemaeus	3	12.24	0.25
	Golden Monkey	1	12.24	0.08
	Siki ape	1	12.24	0.08
5	Golden Monkey	1	3.32	0.30
	Siki ape	2	3.32	0.60
	Pygathrix nemaeus	1	3.32	0.30
6	Siki ape	2	3.32	0.60
	Pygathrix nemaeus	1	2.56	0.39
7	Golden Monkey	1	4	0.25
	Siki ape	2	4	0.50
	Pygathrix nemaeus	1	4	0.25
8	Siki ape	3	5.26	0.57
	Golden Monkey	1	5.26	0.19
	Pygathrix nemaeus	1	5.26	0.19
9	Pygathrix nemaeus	3	2.2	1.36
10	Pig-tailed monkey	1	3.57	0.28
	Siki ape	1	3.57	0.28
	Ha Tinh langurs	1	3.57	0.28

Route	Species encountered	Times	Length route (km)	Frequency of encounter (times/km)
	Pygathrix nemaeus	2	3.57	0.56
11	Golden Monkey	1	4.7	0.21
	Siki Gibbon	1	4.7	0.21
	Pygathrix nemaeus	1	4.7	0.21
12	Pygathrix nemaeus	1	4.2	0.24
	Siki ape	1	4.2	0.24
13	Pygathrix nemaeus	1	4.3	0.23
	Siki ape		4.3	0.23
14	Golden Monkey	1	5.1	0.23
	Pygathrix nemaeus	1	5.1	0.20
	Siki ape	1	5.1	0.20
15	Red faced Monkey	1	15.5	0.06
	Golden Monkey	2	15.5	0.13
	Pygathrix nemaeus	2	15.5	0.13
	Ha Tinh langurs	1	15.5	0.06
16	Golden Monkey	1	7.42	0.13
	Pygathrix nemaeus	3	7.42	0.40
	Ha Tinh langurs	1	7.42	0.13
	Siki ape	1	7.42	0.13
18	Red faced Monkey	3	23.4	0.13
	Ha Tinh langurs	5	23.4	0.21
	Siki ape	2	23.4	0.09
	Small loris	1	23.4	0.04
	Macaca assamensis	2	23.4	0.09
19	Pygathrix nemaeus	1	6.2	0.16
22	Red faced Monkey	1	4.74	0.21
	Ha Tinh langurs	1	4.74	0.21
	Siki ape	1	4.74	0.21
	medium			0.27 times/km

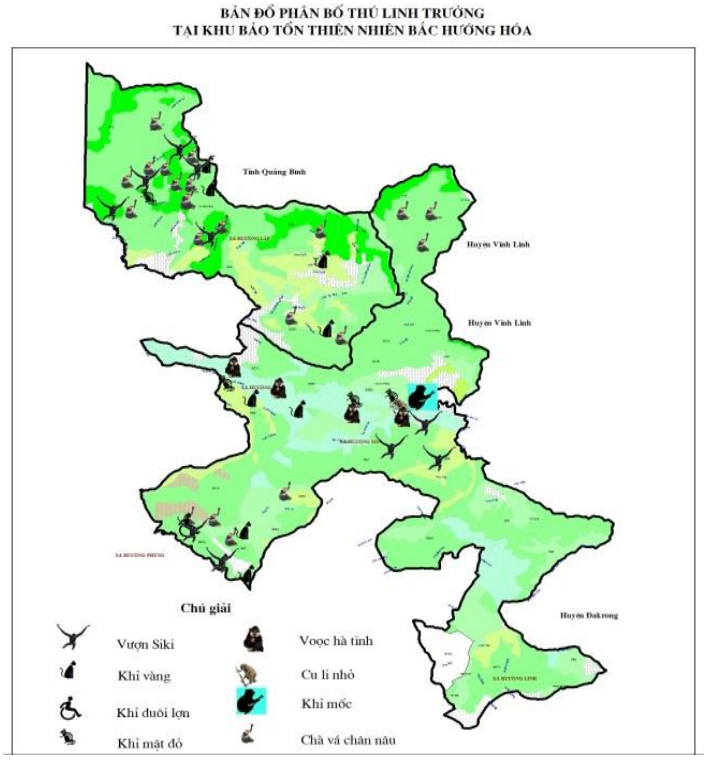
Thus, with a total of 22 survey routes and N_{km} = 68.75 have been established at the Nature Reserve to investigate Primate System, only 03 routes cannot observe primate (17, 20 and 21), among which at the same time, the remaining 19 survey routes have observed primate species with different frequency of encounters. The frequency of encountering the the

Pygathrix nemaeus at the ninth route is the highest with 1.36 times / km while the frequency of encountering small loris at the 18th route is the lowest with 0.04 times / km. Average for all species is 0.27 times / km.

The investigation process caught the Pygathrix nemaeus on most routes and repeated on subsequent surveys. From that, it can be concluded that the Pygathrix nemaeus is a species with the population size is larger than other species in the Reserve, or living habitat, the species encounter is also in diversity, the number of individuals in the herd is also higher than other species. While the small loris can be only observed once, the large loris were recorded only through interviews, suggesting that the loris family is facing threats that affect its population density and population size. Therefore, it is necessary to prioritize solutions and plans to conserve loris family over other primates in Bac Huong Hoa Nature Reserve.

4.6. Distribution of primates in Bac Huong Hoa Nature Reserve

The survey results show that living habitat and environment are determinants of distribution, species are only distributed in favorite habitat types. In particular, siki gibbon and Pygathrix nemaeus are concentrated in the northern part of the nature reserve, which has thick forest vegetation, high canopy, abundant food, large population size and is not affected by High mountains indicating that the habitat of the siki gibbon and the Pygathrix nemaeus is always connected to the forest area of the Dong Chau and Lao Nature Reserve which will be favorable conditions for species conservation.



4.7. Ha Tinh langur species density

Ha Tinh langur was recorded on 4 survey routes 10, 15, 16 and 18 with a total of 4 groups, 52 individuals including juveniles. The observation area is 18.83 km ^{2} . The thesis has determined that the population density of Ha Tinh langur is 0.21 herd/km^2, the individual density is 2.76 individuals / km^2, equivalent to 0.028 individuals / ha.

Compare density with some other Areas (Figure 4.3) shows that the density in the Study Area is lower than in Dong Hoa and Thach Hoa Commune Area with 0.522 individuals/ha (Thao A Tung, 2018), but higher than the Research result by Haus T., et al (2009).

Commenting on the low density, the author considers that the area of rocky areas, the favorite habitat of Hatinh langurs in Bac Huong Hoa is small, quarrying activities during construction of HCM road and hunting are the main causes of migration of the langurs, resulting in lower species densities than other regions.

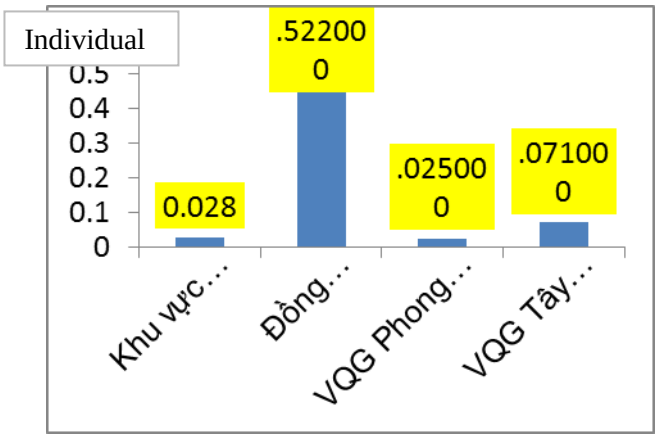


Figure 4.3. Density comparisons with some species of *Trachypithecus*

4.8. Siki gibbon population density

The survey results in Bac Huong Hoa have recorded 28 groups of gibbon and an estimated 78 adults of gibbon identified by thier cry or scream. The total habitat area of the gibbon is 125.8km^2 . The thesis has identified the population density of 0.22 (herd/km^2) and the individuals density is of 0.62 (individuals/km^2).

There are 6/22 survey points that do not record gibbon cry or scream, of which 4 are at height level > 1,000 m above the sea surface level. Most habitats > 1,000 m of vegetation are dwarf forest, strong winds, year-round wet and 2 low-altitude points and evergreen forest flora, but siki gibbons were not recorded.

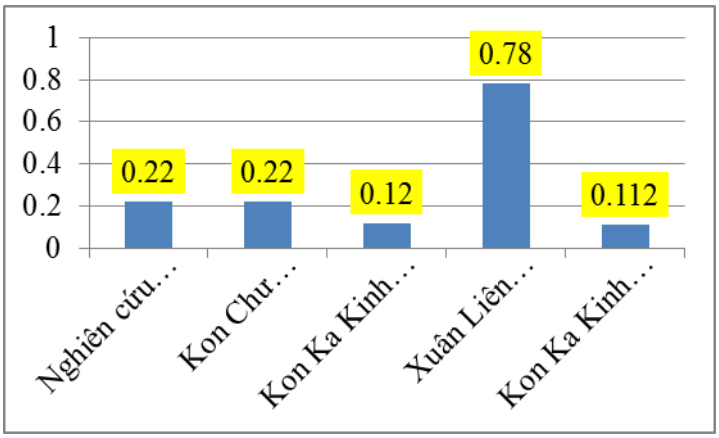


Figure 4.4. Comparison of population density of some gibbon species in Vietnam

4.9. Distribution characteristics of primates by height

Low belt: Distributed mainly in sub-zones 611, 612, 613, 614A 617A, 618, 622, 623, 628 and 629 to the north of the Reserve, the transitional zone of the two high mountains Voi Mep - Vang Vang, Dinh 1001 .. and partly to the east (sub-zones 628, 629), this is a mountain range adjacent to Vinh Linh district.

In the low-mountainous terrain, 4/9 primate species have been recorded (Golden macaque, red-faced macaque, pygathrix nemaeus and the Siki gibbon), which are important terrain in the conservation of primate of Bac Huong Hoa Nature Reserve, because this form of terrain in addition to a large area, it is evenly distributed, and surrounded by high mountains very convenient for primates to move and seek for food as well as shelters.

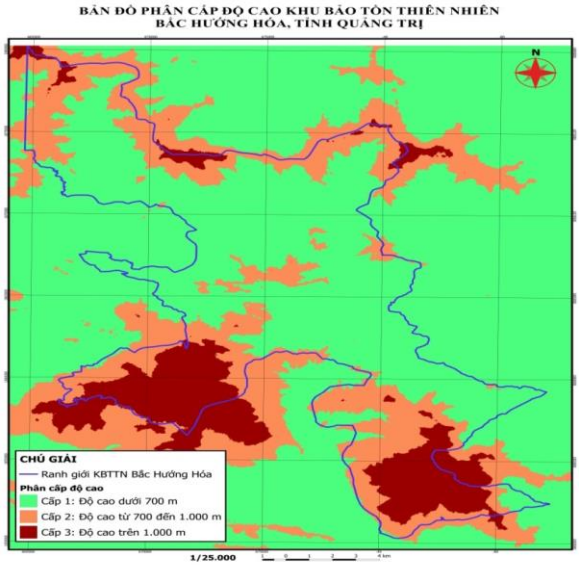


Figure 4.5. Height distribution map of the study area

Medium belt : Distributed mainly in sub-zones 636A, 636B, 637,638, 641, 642, 643,652A and 652B. At this elevation belt, there is a large number of species, because in addition to a large area occupying more than 60% of the nature reserve, this type of terrain also has the advantage of being a transitional zone between the two types of low mountains and high mountain. The low mountains act as a buffer zone to prevent negative impacts on the average mountain habitat, less affected forest vegetation, abundant food sources all year round, and a suitable river environment with the ecological characteristics of the spiritual environment. In particular, in

this form of terrain with many rocky mountains, this is an excellent environment for the shelter and reproduction of some primates.

High belt: Including the two large blocks of rocky mountain: Sa Mu Cave (1,550m) and Voi Mep cave (1,771m). In this type of terrain, only Siki gibbon is recorded. The recorded position also fluctuates in the range of 1,000-1,300m, but in higher mountains such as Pa Thien (1,540m), Sa Mu (1,550m), Voi Mep (1,771m), completely unrecognized any resident or just visiting primates. Commenting on this absence, the author believes that limited food resources, extreme hard weather, cloudy year-round, low temperatures, strong winds are the main cause of the absence of primates.

In the area outside of the hills, most of the land and mountains are dominated by two limestone mountain ranges in Huong Viet commune in which there are many small caves forming idea shelter and hideout for Red face monkey, golden monkey or Ha Tinh langurs.

4.10. Distribution characteristics of primates according to microclimate and hydrological conditions

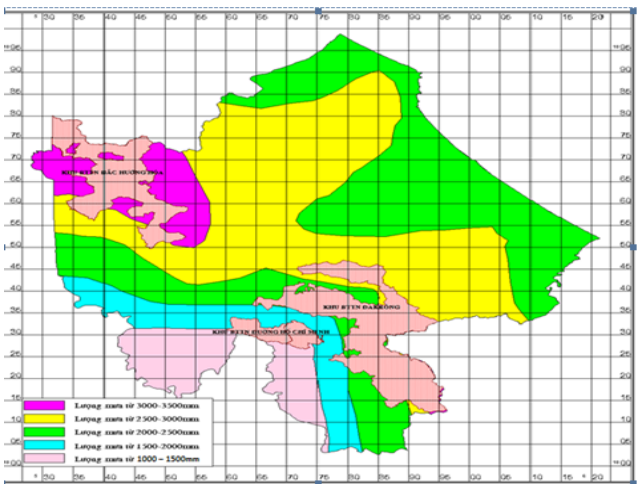


Figure 4.6. Rainfall distribution map by Region of Quang Tri Province

The special feature of climate and hydrology in Bac Huong Hoa Nature Reserve is that there are two different climatic types in the same time. Specifically, on the western slope, the basin of the Rao Quan hydroelectric lake is in the dry, hot and sunny season, with a few rainy days but it is not far from the upstream of the Sen But Stream and Song Se Pang Hieng river is one of branch of the Mekong River which has cool weather conditions, the

number of rainy days in a month is a lot. This shows that this is an ideal condition for primates to find water and food to overcome the hot and dry weather of the year. The study also shows that with small rivers and streams, covered by canopy does not affect the movement nor limit the species distribution in Bac Huong Hoa Nature Reserve.

4.11. Distribution characteristics of primate species according to soil conditions

It can be commented that the geology and soil conditions of Bac Huong Hoa Nature Reserve have different characteristics compared to the Dakrong Nature Reserve, the legendary nature reserve of Ho Chi Minh road in Quang Tri by the final distribution of the limestome mountain range. This is also a favorite habitat of the Ha Tinh langur, in addition to the mountain geology, it will also create many caves that provide shelters for primates such as the red-faced macaque, golden monkey or Hatinh langurs.

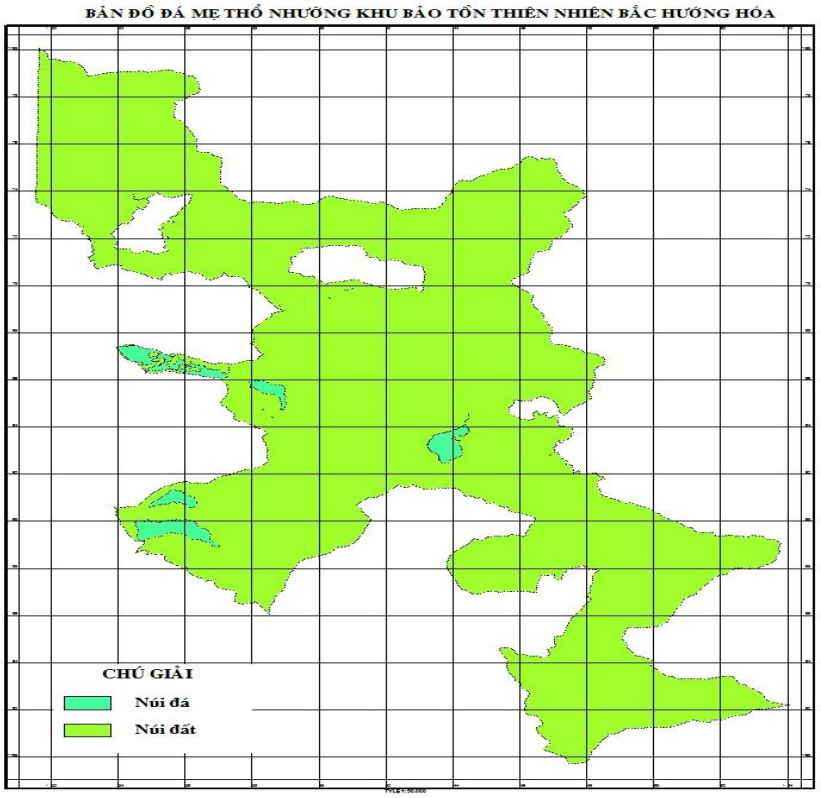


Figure 4.7: Map of soil and rock conditions Research area

4.12. Distribution characteristics of primates under the form of vegetation

4.12.1. Diversity of families and plants

Initial results have collected, collected and identified 1008 species belonging to 548 branch, 138 families, of 4 flora branches: Ground pine (Lycopodiophyta), Fern (Polypodiophyta), Pine (Pinophyta) and magnolia (Magnoliophyta). The results are in the following table 4.10.

Table 4.10: Diversity of flora in Bac Huong Hoa NR

No	Plant industry	Families	Branch	Species
1	Ground pine (Lycopodiophyta)	2	2	6
2	Horsetail or equisetum Industry (Equisetophyta)	1	1	1
3	Fern Industry (Polypodiophyta)	14	34	79
4	Pine (Pinophyta)	5	7	12
5	Magnolia branch (Magnoliophyta)	116	504	910
	total	**138**	**548**	**1008**

Note: Khổng Trung (2014)

The forest eco-structure with more than 70% of woody trees, plus biological geographic features that intersect many vegetation flows, in addition to the buffer zone area with similar habitat types is also food source, important river region while primates grow to a large number of individuals.

4.12.2. Diversity of forest vegetation types

The survey process, combined with previous studies by Khong Trung and Ha Manh Truong (2014), shows that the nature reserve consists of 13 types of vegetation and 1 community of water surface. However, in this study, the only limit is the vegetation. The two types of vegetation Agriculture and fields in the mountains have many things in common. Therefore, the author lumped together and called the agricultural vegetation, the water surface community is not the vegetation nor the living habitat of primate, so the water surface community is not proposed by the author in this study.

Table 4.9: Forest vegetation types

Unit: ha

No	Forest vegetation type	Acreage
	Total natural area	**23,300.0**
1	The evergreen primary forest is less affected	1,063.8
2	Evergreen forest is less affected	111.4
3	The tropical and subtropical dry broadleaf forests are strongly affected	206.0
4	Evergreen primary broadleaf forests	7,044.1
5	The evergreen broadleaf is less affected	8,076.0
6	Evergreen broad leaves are strongly impacted	2,717.0
7	Secondary grass-plot	125.9
8	Secondary shrub- plot	1,076.8
9	Secondary scrub plot with scattered woody trees	745.7
10	Secondary shrubs with scattered timber trees	572.3
11	Scattered woody trees	1,370.8
12	Agriculture	6.3

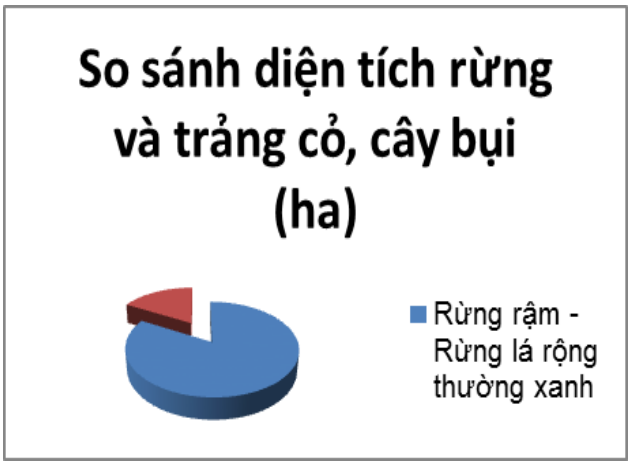


Figure 4.8. Area of forest, grass-plot, scrub plot.

With more than 80% of the area covered by thick, closed and canopy forest vegetation, it formed an ideal condition for the living habitat of

primates. The survey process recorded primate species living and seeking for food on 6/12 forest vegetation point including: (1) Low-impact evergreen primary evergreen forest (2) Low-impact evergreen forest (3) High-impact broadleaf evergreen forest (4) Primary evergreen broadleaf (5) Primary evergreen broadleaf(6) Evergreen broadleaf is heavily impacted; Whereas 5/12 vegetation did not record the presence of primate species, including (7) Secondary grass plot (8) Secondary shrub plot (9) Secondary shrub plot with scattered timber trees (10) Secondary shrubs with scattered timber trees and (11) Scattered wood trees.

4.12.3. Diversity of primate habitat

When group 7 criterias of forest classification into habitats suitable for the study of the primates, there were 4 main habitat types: (1) Habitat in poor forest condition. (2) Habitat in medium forest status. (3) Habitat in rich forest status. (4) Habitat of rocky forest with trees.

Results of GIS analysis on forest vegetation show. The habitat area of rich, medium-sized evergreen broadleaf accounts for the majority of the NR, which is a decisive factor for the distribution of primate in the living habitats.

The area of evergreen broadleaf rocky mountain forest occupies a small part and is distributed to the north of the Nature Reserve but plays an important role in the distribution and survival of the Ha Tinh Langur.

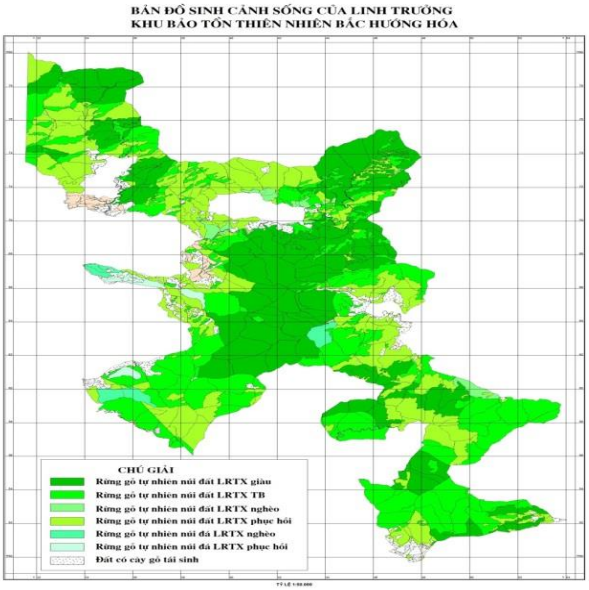


Figure 4.9: Habitat map of primates in the Study Area

4.12.4. Structure of the living habitat

**** The basic structural indicators***

The combined results from the three main forest states include: Poverty, average, rich and easier to understand when analyzing forest status indicators, the author has converged the forest status into forest habitats and added forest habitats on rocky mountains with trees so that further analysis of livelihoods, feeding and sleeping activities of primate through forest habitats. Basic structure criteria of Bac Huong Hoa Nature Reserve are presented in detail in Table 4.11.

Table 4.11. The basic structural indicators according to 4 types of habitat

No	Index	SC1 (N)	SC2 (B)	SC3 (G)	SC4(ND)
1	Number of OTC	5	11	5	4
2	Number of species	132	178	112	107
3	The number of trees	597	986	442	373
4	Average canopy cover	0.64	0.69	0.76	0.62
5	Fluctuation of canopy cover	0.55-0.75	0.65-0.75	0.75-0.8	0.55-0.75
6	Density of timber trees (trees/ha)	1194	896.3	1108	932

The above table shows that SC2 (medium forest) has identified the most tree species with 178 species, accounting for 33.6% of the habitat types; followed by SC1 habitat (poor forest) identified 132 species (accounting for 24.9%); SC3 (rich forest with 112 species (21.1%) and SC4 (rocky forest) recorded the fewest species with 107 species accounting for 20.2% of the habitat types.

The average canopy cover between habitat types ranging from 0.62 to 0.76 is not large, suggesting that the surface area of the habitats is covered by forest vegetation. Very few discontinuous gaps between the forest patches show that this is an ideal condition for primates to move, seek for food, hide, reside ... The average canopy cover in 4 types of habitat fluctuates rather large from 0.55 to 0.80; The highest canopy variation is in SC1 and SC4 .. from 0.55 to 0.75 this also shows the randomness when setting up the survey in the standard plots, the habitats are poor forests and mountains have the

different canopy cover with rich, medium forest habitats, showing the rule of timber reserves in habitats.

Density of woody trees fluctuates not too large in all 4 habitat types. The largest of these is poor forest habitats with 1,194 (trees/ha), while rocky habitats with trees have the smallest tree density of 932 trees / ha.

**** The composition of tree layer is high according to the percentage of the tree species***

Special-used forests have the function of nature conservation, standard models of national forest ecosystems, genetic resources of forest organisms, scientific research, protection of historical sites, and scenic spots for combined tourism with protection of ecological environment protection. Therefore the percentage (N%) of species in the population has an important significance in the biodiversity conservation value. Based on the analysis results in the table below shows: complex composition of woody tree layers, dominant tree species account for a high proportion, the composition is quite diverse and abundant.

Table 4.13. Formation of tall tree layere by the number of trees

No	Status	Total number of species	The dominant species	Other species groups (%)	Dominant species composition (%)	N%
1	The poor forest	132	Chân chim	57.29	42,71	17.25
			Dẻ			6.20
			Bọt ếch			3.18
			Quế rành			3.02
			Trâm tía			3.02
			Kháo nhậm			2.85
			Săng ớt			2.18
			Mật xạ			1.68
			Thành ngạnh đẹp			1.68
			Vạng trứng			1.68
2	Medium	178	Han			5.17
			Quế rành (Re)			4.56

No	Status	Total number of species	The dominant species	Other species groups (%)	Dominant species composition (%)	N%
	Forest		Trâm sp.	65.52	34,48	4.16
			Chân chim			3.96
			Chít cau			3.75
			Bới lời			2.94
			Mât sp			2.84
			Bưởi bung			2.64
			Bã đậu			2.23
			Thau lĩnh			2.23
3	Rich forest	112	Cóc đá	62.67	37,33	5.43
			Găng sp.			5.19
			Chân chim			5.18
			Dung			4.27
			Bưởi bung			2.69
			lưỡi nai			2.68
			Trâm han			2.68
			Trâm			2.45
			Dâu da			2.22
			Nhục tử Kontum			2.22
			Quế rành			2.21
4	Rocky mountain forest	107	Mòng	58.71	41,29	8.04
			Mao hoa			7.24
			Cách hoa			5.63
			Bời lời			4.02
			Sung			3.49
			Sến			3.22
			Đuôi trâu			2.68
			Lòng mang			2.41
			Khổng			2.41
			trường			2.14

Calculation results also show that species with N%> 5 account for a low proportion of 10 common species of 4 habitat types: Poor forests of which the largest numbers are rich and rocky habitats (3 species) and lower are poor habitat (2 species) and medium (1 species). The total composition of the dominant species in all four habitat types is not greater than the total number of other species composition, respectively: Poor 42.71/57.29; Average of 34.48/65.52; Rich 37.33/ 62.57; Rocky mountain 41.29/58.71.

From the above analysis, the author commented that the layer of the tall tree is very complicated, the number of tree species present in the forest is large, the number of species and the number of individuals in each dominant tree species appearing in each OTC are different, the N% indicator of the dominant species mostly is not enough to participate in the species structure, which shows that the forest structure in Bac Huong Hoa is very diversìied and has a very stable feature. .

**** Frequency of timber trees according to trunk diameter and tree height***

(1) Frequency of trees according to trunk diameter

The frequency of timber trees by diameter decreases from small to large, in particular, the largest diameter ranges from 6-18 cm , accounting for 69.13% of the total number of trees in the standard plots; the diameter of 18-30 cm accounts for 19.18% of the total number of trees and the diameter is 90-102 cm and the smallest is the diameter of 102 cm with 0.21% of the total number of trees.

The frequency of tree by diameter in habitats decreases from small diameter classes to large diameter classes. Habitat 1 with the largest diameter class of 6-18 cm accounts for 77.55% of the total number of trees in the habitat, the smallest diameter class is from 78-90 cm , accounting for 0.34%; Habitat 2 has the largest diameter of 6-18 cm , accounting for 62.5% of the total number of trees in the habitat, the smallest diameter is 90-102 cm , accounting for 0.3%; Habitat 3 with the largest diameter class of 6-18 cm accounts for 63.12% of the total number of trees in the habitat, the smallest diameter class is from 90-102 cm , accounting for 0.45%; Habitat 4 with the largest diameter class of 6-18 cm accounts for 80.43% of the total number of trees in the habitat, the smallest diameter class is from 54-66 cm accounting for 0.27% OTC (Figure 4.10, 4.11).

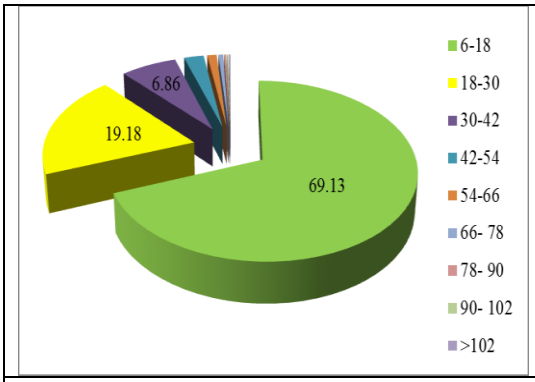


Figure 4.10. Distributing the number of trees according to trunk diameter class in the total OTC

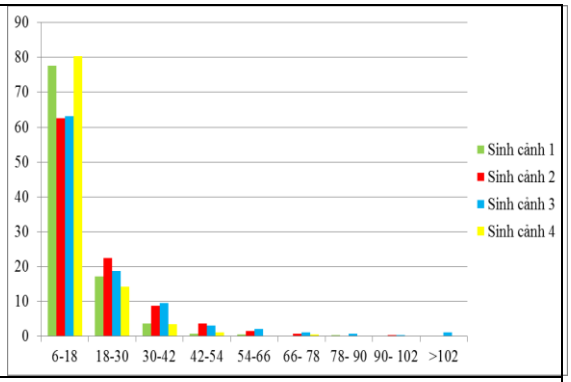


Figure 4.11. Distribution of number of trees according to stem diameter class in the habitat types

(2) Frequency of woody trees according to height level

The frequency of trees according to height levels decreases from small to large, particularly the height of 5-10m, the largest, accounting for 44.63% of the total number of trees in the standard plots; The height level above 30m accounting for the smallest proportion with 0.04% of the total number of trees in the OTC (Figure 4.12; 4.13).

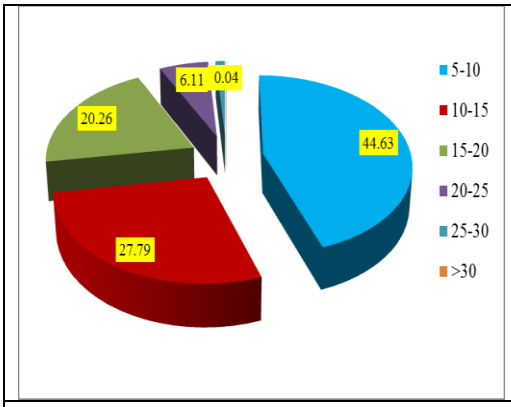


Figure 4.12. Distributing the number of trees by height level in the total number of OTC

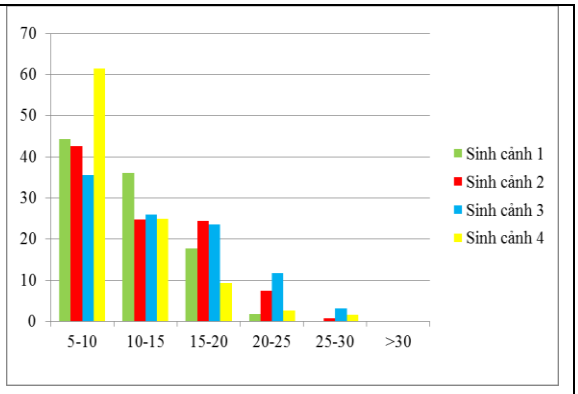


Figure 4.13. Distributing number of trees according to height level in habitat types

The frequency of woody trees according to height levels in habitats decreases from small diameter class to large diameter class, specifically: Habitat 1 has the largest height of 5-10m, accounting for 44.39% of the total number of trees, the smallest height is from 20-25m, accounting for 1.84%;

Habitat 2 has the largest height of 5-10m, accounting for 42.54% of the total number of trees, the highest height is over 30m, 0.1%; Habitat 3 has the largest height of 5-10m, accounting for 35.52% of the total number of trees, the smallest height is from 25-30m, accounting for 3.17%; Habitat 4 has the largest height of 5-10m, accounting for 61.39% of the total number of trees, the smallest height is from 25-30m, accounting for 1.61%.

4.13. Primate's food

4.13.1. Relationship between food and plant families in Bac Huong Hoa Nature Reserve

Although the study of food is difficult and unallowed, but the PhD student has endeavored to investigate and compare with the research results on families and species of plants that feed the primate, which has been approved by scientist Pham Nhat. published in 2002. Results showed that among 72 plant families as primate food (Pham Nhat, 2002), 59 species were recorded in Bac Huong Hoa, equivalent to 81.9% of the species that were published by Pham Nhat. . The number of species used for food in the 10 dominant families in Bac Huong Hoa is shown in Figure 4.14.

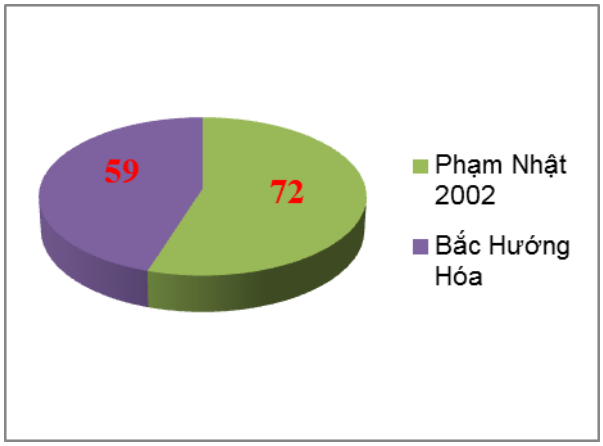


Figure 4.14: The number of plants for primate's food

Continuing to compare the number of plant families used for primates' food (59 families) to the total number of plant families recorded in Bac Huong Hoa (138 families) shows that the number of them used for food accounting for only 50% of the plant families in Bac Huong Hoa. On the other hand, the published 72 food item list are not enough for research. Therefore, if investigating specific research on primate food in Bac Huong Hoa, it is sure that it may also record more families of plants that primate uses as food.

4.13.2. Relationship between food and number of plant species in the BHH Nature Reserve

Based on the results of habitat fragmentation and the establishment of standard plots to investigate primate ecology through forest structure. Phd student has identified a list of plants in 4 habitat types of primate, and used this list to compare with the list of plants for food of 3 important primate species including Ha Tinh langur, siki gibbon and Pygathrix nemaeus. The comparison results are shown in Figure 4.15.

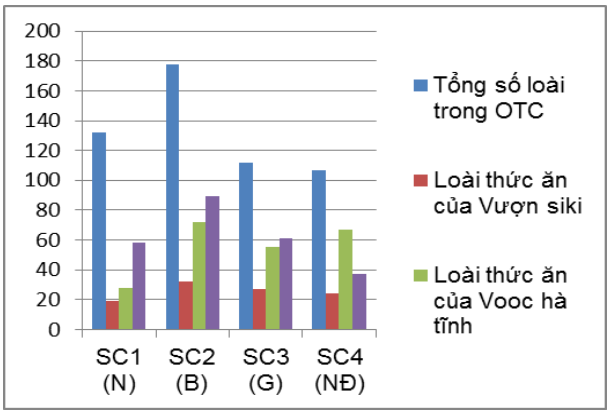


Figure 4.15: Number of plants for food in 4 habitat types

The results show that, in all 4 habitat types, there are plants that feed 3 important primates. But they have the largest number of species that feed, Dâu tằm (Moraceae), Dẻ (Fagaceae), Long não (Lauraceae), Thầu dầu (Euphorbiaceae).

Among the 3 primate species studied, the food for siki gibbon is lowest in all 4 habitats, the number of species is Poor = 19/132, Average = 32/178, Rich = 27/112 and Rock Mountain = 10/247. while the Pygathrix nemaeus has the largest number of food species in all 4 habitat types, the number of species is poor = 58/132, average = 89/178, rich = 61/112, rocky mountains = 37/107, so it can be seen that apart from the rocky landscape, the remaining habitats have approximately 50% of the species for food recorded in the habitat. This is consistent with the opinion of Dr. Tran Dinh Nghia on the Pygathrix nemaeus.

Characterized by evergreen broadleaf forests, less deciduous, woody plants are predominate, rapid plant growth .., this is a rich source of food, this is a scientific basis to explain to the number of primate species is larger and the population size is larger than other Protected Areas in the Region.

4.13.3. The relationship between food and 10 families of plants predominates in Bac Huong Hoa Nature Reserve.

The survey results have identified 10 dominant plant families in terms of the number of species in Bac Huong Hoa Nature Reserve.

To analyze the relationship between the food source and the 10 dominant plant families, the PhD student used the list of species as primate's food published by Pham Nhat in 2002 to compare with the list of plant species. investigated in standard plots. Details are shown in Table 4.12.

Table 4.12: The dominant plant families in Bac Huong Hoa Nature Reserve

No	Full name		Total number of species	Primates (species)		
	Common	Science		BHH	Pham Nhat	Ratio
1	Cinnamomum camphora	Lauraceae	19	8	17	47.1
2	Chestnuts	Fagaceae	17	2	9	22.2
3	Mulberry	Moraceae	13	13	32	40.6
4	Ricinus communis	Euforbiaceae	13	9	16	56.3
5	Sterculia foetida	Sterculiaceae	13	1	1	100.0
6	Mangosteen	Clusiaceae	12	1	5	20.0
7	Rhodomyrtus tomentosa	Myrtaceae	11	4	5	80.0
8	Diospyros decandra	Ebenaceae	10	3	4	75.0
9	hinaberry or Bead tree	Meliaceae	9	3	4	75.0
10	The coffee	Rubiaceae	8	5	8	62.5

The above table shows that Camphor family has the most diverse species composition with a total of 19 species; followed by the chestnut with 17 species; 13 species of mulberry, Ricinus communis, and Sterculia foetida; Mangosteen family with 12 species; Rhodomyrtus tomentosa family with 11 species; Diospyros decandra family with 10 species; hinaberry with 9 species and 8 species coffee family.

The analysis showed that 6/10 dominant plants have a proportion (%) of plants for food greater than 50% of the published plants. In which Sterculia foetida family has 1/1 species = 100%; The Diospyros decandra and hinaberry families have 3/4 types = 75%; Mulberry has 13/32 species = 40.6%. However, a special feature is that 13 of the recognized mulberry family are included in the list of primate species for food published by Pham Nhat.

Thus, it can be seen from the table above that the above 10 families of plants are the dominant tree species that play an important role in creating forest canopies in the habitats of primates and at the same time feeding place for primates. The list of plants for food is in the appendix.

4.14. Threats to the Primate System

Habitat hunting and habitat destruction are the two main threats to Primate System in the Study Area.

In particular, the hunting threat group includes: Hunting and trapping; Threats of habitat destruction include: illegal logging, non-timber forest product exploitation, slash and burn for cultivation, forest fires and ore exploitation. Results are in table 4.16.

Table 4.16. Result of assessing threats

No	Threats	Ranking criteria			total	Ranking
		Area of influence	Intensity of influence	Urgency		
1	Hunting	5	3	5	13	I
2	Illegal logging	3	5	4	12	II
3	Non forest product exploitation	2	2	2	6	IV
4	Deforestation for cultivation	4	4	3	11	III
5	Grazing	1	1	1	3	V
total		15	15	15		

Summary and ranking shows that hunting is the most serious threat to primate species in the NR, followed by illegal logging. Threats to influence in a gradual manner are deforestation, exploitation of non-timber forest products and grazing activities with the least impact on the primate system.

4.15. Proposing solutions for primate conservation in Bac Huong Hoa Nature Reserve .

To improve the effectiveness of biodiversity conservation and primate system conservation. Priority should be given to the following two immediate solutions:

- Control illegal hunting and logging. Specifically, it is necessary to coordinate with Huong Hoa ranger department, local authorities to organize patrols, remove traps, camps of hunters, and log timberS.

- Protect and connect habitats It is necessary to manage and limit the encroachment of forest land for shifting cultivation and restore poor forest areas, increase the planting of native species in the bare land areas to connect and create large area enough for conservation of wild animals.

- In addition, it is also necessary to content such as: Build supervising program for species, enhance public awareness, Improve livelihoods for local people…

CONCLUSIONS, EXISTENCE AND RECOMMENDATIONS

1. Conclusion

1.1. Status and abundance

1) With 9 primate species recorded in the current study, it can be confirmed that Bac Huong Hoa Nature Reserve has a high diversity of primate species composition compared to other reserves / national parks in the country. In particular, the result confirmed the presence of the Macaca assamensis species through the images.

2) Among primate species recorded on the route, the Pygathrix nemaeus is the most abundant species compared to other primates in the NR with the highest frequency of 1.36 times/km^2 and 17/22 survey routes appear.

3) The thesis has recorded 4 groups of Ha Tinh langur, 28 groups of siki gibbon and the density of Ha Tinh Langur 2.76 individuals / km² equivalent to 0.028 individuals/ha. Siki gibbon density is 0.62 individuals/km^2, equivalent to 0.0062 individuals/ha.

1.2. About ecological characteristics of primate system

1) Food source is the determinant of distribution. The number of species and size of primate population decreases from Rich, Medium, Rocky Mountains and poor.

2) Cross section, coverage is related to the distribution of primates. Coverage, large cross section has the highest frequency encountering primate.

3) Altitude influences the distribution of the primate system, most distributed at an altitude of 700-1,000m, greater than 1,000m recorded only siki gibbon.

4) Primate species distribution depends on human impact. The most distributed area belongs to the sub-areas of Huong Lap and Huong Son communes.

5) There are 59/72 plant families used by primate as food when compared to the list published by Pham Nhat in 2002.

6) The number of plant species that feed on the primate in the four habitat types is respectively. Poor = 132 species; Average = 178 species; Rich = 112 species, and rocky mountains with trees = 107 species.

7) Among the 4 habitat types, the number of plant species for food of the siki gibbon *(Nomascus siki)* is Poor = 19, Average = 32, Rich = 27, Rock mountains = 24; Ha Tinh langur *(Trachipithecus hatinhensis)* are: Poor = 28, Average = 72, Rich = 55, Rock mountain = 67; *Pygathrix nemaeus (Pygathrix nemaeus)* is Poor = 58, Average = 89, Rich = 61, Rock mountains = 37.

1.3. About threats, affecting primate system

Two threats to primates in Bac Huong Hoa Nature Reserve are: Hunting (hunting and trapping) and habitat destruction (illegal logging, deforestation, non-timber forest product exploitation and cattle grazing). In particular, hunting is the most serious threat to primate species in the NR. The area being hunted and strongly captured is located in Cựp, Cuồi, and Huong Lap commune and the forests of Ho, Moi, Cat and Huong Son commune.

2. Existence

1) Bac Huong Hoa Nature Reserve has a relatively complex topography with many high and dangerous mountains which become difficult condition for the surveyor during the investigation and approach to primate species.

2) Small loris species have not been recorded in photos to confirm for certain species that appears in Bac Huong Hoa.

3) The social structure of primate species has not been identified at Bac Huong Hoa Nature Reserve, leading to no comments and predictions on the possibility of a speciesdevelopment. .

3. Request

1) It is necessary to continue to expand the study to add more survey routes and longer study time to fully capture species information.

2) Conduct studies on the status and number of individuals of primate species as a basis for proposing conservation solutions.