

# Biodiversity research and conservation in Cat Ba National Park with updated records from recent field surveys

*Tổng quan tình hình nghiên cứu và bảo tồn đa dạng sinh học ở Vườn Quốc gia Cát Bà với những ghi nhận cập nhật qua điều tra thực địa*

Research article

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Among the protected area system of Vietnam, Cat Ba appears as an ideal national park for biodiversity research and conservation. It covers a large area of karst landscape including islands and different ecosystems ranging from forests, wetland, mangroves, caves and others. Since the establishment of Cat Ba National Park in 1986, biodiversity research and conservation within the park have been strongly promoted and raised. The park has been well known as home to highly diverse flora and fauna with many species endemic to the archipelago and Vietnam. A series of projects and programmes have been effectively implemented for urgent and long-term conservation of threatened species. However, results from scientific research also indicated that many sites and species are still almost unstudied while several sections of the park's buffer zone are affected by human activities including unscientific development of ecotourism. We recently conduct a field survey and recorded 2 bat species and echolocation calls in their natural habitats. This paper provides an overview of achievements with recent records and recommendations for strengthening conservation of biodiversity and habitats in the park and surroundings.

*Trong hệ thống khu vực bảo vệ của Việt Nam, Cát Bà là một vườn quốc gia có điều kiện thuận lợi đối với công tác nghiên cứu và bảo tồn đa dạng sinh học. Vườn quốc gia này bao gồm diện tích lớn cảnh quan núi đá vôi với các đảo và hệ sinh thái đặc trưng như rừng trên núi, đất ngập nước, rừng ngập mặn, hang động và nhiều hệ sinh thái khác. Từ khi thành lập Vườn Quốc gia Cát Bà năm 1986, công tác nghiên cứu và bảo tồn đa dạng sinh học được quan tâm và thực hiện ngày càng nhiều. Vườn quốc gia cũng chứa đựng khu hệ động vật và thực vật đa dạng với nhiều loài đặc hữu cho quần đảo và Việt Nam. Nhiều dự án và chương trình đã được thực hiện nhằm bảo tồn cấp bách và lâu dài những loài bị đe dọa. Tuy nhiên, những kết quả nghiên cứu khoa học cũng cho thấy nhiều khu vực trong phạm vi vườn quốc gia gần như chưa được nghiên cứu trong khi một số tiểu khu thuộc vùng đệm đang bị ảnh hưởng bởi hoạt động của con người như sự phát triển du lịch. Chúng tôi đã ghi nhận được 2 loài dơi cùng với tiếng kêu siêu âm trong môi trường sống tự nhiên của chúng qua thời gian điều tra thực địa vừa qua. Bài báo này cung cấp dẫn liệu tổng quan và cập nhật về những kết quả đã đạt được với những thông tin cập nhật và đề xuất nhằm thúc đẩy công tác bảo tồn đa dạng sinh học và sinh cảnh ở vườn quốc gia và vùng phụ cận trong tương lai.*

**Keywords:** biodiversity, Cat Ba, conservation, ecosystems, karst islands.

## 1. Introduction

Cat Ba National Park (CBNP) is located in the Gulf of Tonkin and covers a total area of 16,196.8 ha comprising 5,265.7 ha of the surrounding marine waters and 10,931.1 ha of islands [5]. The park is a “major tourist destination in

northern Vietnam” [7]. The number of foreign and domestic visitors have been annually increased since 2000 and particularly since the Tan Vu-Lach Huyen bridge was built for connection between the mainland and Cat Hai island. Within 2017, a total of 2,160,000 tourists visited Cat Ba islands with an estimation of approximately 2,600,000 tourists in 2018 and continuously increased in following

years (Hai Phong People Committee, 2018). The Cat Ba Protected Area was established in 1983 by the Ministry of Forestry and became a national park in 1986 [7]. The population of Cat Ba island had also been rapidly increased over the past 20 years, from 10,700 people in 1999 to over 20,000 people in 2017. The local people in Cat Ba island gain major outcomes from trade, fishing farming and other activities. Of which, fishing and farming form the largest livelihoods in the islands (Furey, 2002; this study). Topography of Cat Ba island is characterised by limestone karst outcrops with the highest peak of ca. 50-331 metre above sea level interspersed with valleys. “Between the karst outcrops, the limestones are overlaid by patches of sandstone and shale as well as marine sediments (semi-consolidated to unconsolidated) laid down over the course of several fluctuations in sea level during the Quaternary and Holocene periods” [7]. Vegetation of the park is still poorly studied. Jong-Won Kim and Nguyen Nghia Thin (sensu [7]) identified the vegetation of the park as 7 main

vegetation types. With the diversity of topography, geography and vegetation, Cat Ba National Park is recognised as an ideal home for biodiversity research and conservation [16]. This paper provides a precise overview of historical research and conservation of general biodiversity within the park with valuable records from recent surveys in both biodiversity and environment aspects.

## 2. Materials and methods

### 2.1. Study sites

Recent field surveys were carried out in two periods: October–November 2017 and April 2018 in 7 sites, including Cat Ba town and 6 communes (Gia Luan, Hien Hao, Phu Long, Tran Chau, Viet Hai and Xuan Dam) (table 1). These communes belong to the core and buffer zones of Cat Ba National Park. They contain different habitats and ecosystems ranging from plantation to primary forests.

**Table 1. Time and study sites**

No.	Study sites	Time
1	Cat Ba town, the buffer zone and surroundings of Cat Ba National Park, Cat Hai district, Hai Phong city	October, 04 <sup>th</sup> -18 <sup>th</sup> , 2017 November, 03 <sup>rd</sup> -10 <sup>th</sup> , 2017 April, 05 <sup>th</sup> -10 <sup>th</sup> , 2018
2	Gia Luan commune, Cat Hai district, Hai Phong city	October, 19 <sup>th</sup> -21 <sup>st</sup> , 2017 November, 11 <sup>th</sup> -13 <sup>rd</sup> , 2017 April, 11 <sup>th</sup> -13 <sup>rd</sup> , 2018
3	Hien Hao commune, Cat Hai district, Hai Phong city	October, 22 <sup>nd</sup> -24 <sup>th</sup> , 2017 November, 14 <sup>th</sup> -17 <sup>th</sup> , 2017 April, 14 <sup>th</sup> -15 <sup>rd</sup> , 2018
4	Phu Long commune, Cat Hai district, Hai Phong city	October, 25 <sup>th</sup> -26 <sup>th</sup> , 2017 April, 18 <sup>th</sup> -20 <sup>th</sup> , 2018
5	Tran Chau commune, Cat Hai district, Hai Phong city	April, 21 <sup>st</sup> -24 <sup>th</sup> , 2018
6	Viet Hai commune, Cat Hai district, Hai Phong city	November, 18 <sup>th</sup> -19 <sup>th</sup> , 2017
7	Xuan Dam commune, Cat Hai district, Hai Phong city	October, 27 <sup>th</sup> -31 <sup>st</sup> , 2017 November, 01 <sup>st</sup> -02 <sup>nd</sup> , 2017

### 2.2. Materials

The surveys focused on general assessment of ecosystems and biodiversity conservation efforts within the park. Materials include published literatures and selected taxa inhabiting cave and mangrove ecosystems. The caves of Cat Ba were surveyed because they are home to many species endemic to either Cat Ba or Vietnam. On the other hand, many caves in the park are affected by tourism development while mangroves have been disturbed narrowed by aquatic cultivation. Literatures are saved at the Institute of Human Geography, Vietnam Academy of Social Sciences, animal specimens from caves were identified by experts of the Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Hanoi, Vietnam.

### 2.3. Methods

Interview and meetings were implemented over the survey periods (Table 1). Managers and rangers of Cat Ba National Park as well as selected local people were invited to informal meeting for interviewing and discussion on the status of biodiversity from the past to present, impact of

implemented projects and programmes on biodiversity conservation, possible solutions must be carried out in coming time. All available documents containing data and information about diversity of the park were also gathered. To obtain data on impact on ecotourism on environment and biodiversity, observation and photographing were employed at almost all tourism caves within Cat Ba National Park. On the other hand, the field surveys also focused on bats to assess the impact of ecotourism on cave systems of the park since they are very sensitive to environment.

Bats were captured in the field following Thong (2011) [17], Thong et al. (2012a [23], 2012b [24], 2012c ) and Thong (2016). Mist nets in various sizes (12.0 m x 2.4 m; 12.0 m x 4.0 m; 6.0 m x 2.4 m; 6.0 m x 3.2 m; 3.0 m x 3.2 m; 3.0 x 2.4 m) and harp traps (1.2 m x 1.5 m) were opened between 17:00 and 22:30 pm. Each captured bat was individually placed in a cotton bag and handheld following Sikes et al. (2011) [11]. Age and reproductive status were assessed following Brunet-Rossinni and Wilkinson (2009) [4] and Racey (2009) [10], respectively. Juveniles, pregnant and lactating females were released immediately at the capture sites to avoid negative impact in the conservation status of bats in their natural habitats.

Echolocation calls of bats were recorded in inside a flight tent (3.0 m [length] x 3.0 m [width] x 2.0 m [height]) following Thong et al. (2011) using the PCTape system (480 kHz, 16 bit). Selected call sequences with a good signal-to-noise ratio was analysed using the Selena software. Both PCTape and Selena are custom-made at the University of Tübingen, Germany. Signals were displayed as sonograms with a FFT (Fast Fourier Transformation) of 256, Hann-window and zero-padding. Recordings from natural habitats of bats were also analysed for comparison with the calls of each species recorded inside flight tent as well as to assess foraging activities.

### 3. Results and discussion

#### 3.1. An overview of biodiversity

To our knowledge, Bourret (1942a [2], 1942b [3]) appeared as the first publications containing scientific data on biodiversity of Cat Ba island and surroundings with records of bat and other mammal species. Furey et al. appeared as one of the documents containing scientific results of a general survey on both flora and fauna [8]. Subsequently, a number of surveys on biodiversity of the park. However, almost all surveys were emphasized on selected taxa, including mammals, reptiles, amphibians and marine animals ([1]; [19]; [8]; [26]; [12]; [15]). To date, 1,585 plant species belonging to 850 genera, 187 families, 5 phyla are recorded from Cat Ba National Park (Table 1) [5]. Of which, 245 species are agriculture plants including *Capsicum undatum*, *Ipomoea balatas*, *Ipomoea aquatica*, *Manihot esculenta*, *Oryza sativa*, *Capsicum frutescens* and 6 species originated from other areas: *Annona aquamosa*, *Croton oblongifolius*, *Delavaya toxocarpa*, *Polyalthia benth*, *Rhus semialata*, *Taractogenos* sp. [5]. The known flora comprises 10 abundant families and 10 genera with considerably high number of species (Table 2).

Cat Ba National Park is also known as a home to a highly diverse mammal fauna comprising 58 species belonging to 19 families, 7 orders: Insectivora (1 family, 1 species), Scandenta (1 family, 1 species), Chiroptera (6 families, 23 species), Primates (1 family, 2 species), Carnivora (4 families, 11 species), Artiodactyla (1 family, 1 species) and Rodentia (5 families, 19 species) [CBNP]. However, several species listed in previous publications are still unconfirmed such as *Neofelis nebulosa*, *Manis pentadactyla*, *Muntiacus mantjak*. It must be considered that, due to legal exploitation of the Cat Ba Enterprise before 1986, forest and other natural resources on the islands were critically decreased. Therefore, populations of many species including Cat Ba Langur, which is endemic to CBNP was decreased critically from an estimate of “2500-2700 individuals during the 1960s down to 54-56 individuals in 2017 [8].

The bird fauna of Cat Ba National Park is still poorly studied. Results from a survey in 2011 by Do Quang Huy (sen su Cat Ba National Park 217), a total of 205 bird species belonging to 51 families, 17 orders are recorded from the park [5]. Reptiles and amphibians of the park were well studied over the past 15 years. To date, 47 reptile species belonging to 40 genera, 16 families, 2 orders and 23 amphibian species belonging to 15 genera, 5 families and 1

order are known from Cat Ba National Park. Of which, several species were recently described and would be endemic to the park: *Goniurosaurus catbaensis*, *Liuixalus calcarius* and *Philautus catbaensis* ([12]; [15]).

Fishes of the park received little attention from scientist. Almost all surveys on fishes of the park were carried out at saltwater lakes and submerged caves in the buffer zone of the park. Results from the surveys indicated that at least 30 fish species of 25 genera, 22 families are recorded from the park and surroundings. Of which, a number of fish species are considered for their high economic values such as *Scatophagus argus*, *Siganus sutor*, *Lethrinus nebulosus*.

Thung (2017) provided a review of research on marine plants and animals in the Cat Ba – Ha Long complex with records of 2147 species from Cat Ba National Park [26]. Among these marine species, 114 are listed in the IUCN Red List of the Threatened Species at different conservation levels.

Cat Ba National Park and Ha Long Bay appear as one of the most ideal landscape complex in Vietnam for bat research and conservation. Conservation actions of bats in the park has been initiated since 2006 [16]. This special mammal species in the park have received a long historical research. As mentioned above, the first data on bat fauna on Cat Ba was published in Bourret (1942) with a new subspecies of little leaf-nosed bat (*Hipposideros larvatus alongensis*) based on the classification of 10 specimens collected in Ha Long. However, the author did not specify the sampling location. Possibly, 10 specimens were collected in Cat Ba island. In 1975, Topal compared the morphological characteristics of penile cartilage in some species of Leaf-nosed Bats family (Hipposideridae); among them “*alongensis*” was recorded as *Hipposideros alongensis* [13]. However, in 1993, Topal has identified “*alongensis*” as a subspecies of *Hipposideros turpis alongensis* when he analyzed and compared bat specimens collected in Vietnam, Japan and Thailand [14]. In 1997, a result of investigation and summation of information on mammal resources in Cat Ba and its vicinity was published with the record of 6 species of bats: *Cynopterus sphinx*, *Hipposideros armiger*, *H. larvatus*, *Pipistrellus javanicus*, *Scotophilus heathii*, *S. kuhli*. Remarkably, on the first page of the document, the authors provided image of *Aselliscus stoliczkanus* but in the part of notification, it was identified as *Pipistrellus javanicus*. Hendrichsen et al. (2001) recorded Andersen’s Leaf-nosed Bat (*Hipposideros pomona*) in Cat Ba. From 2002 to 2007, there had been some research results on bats of Cat Ba and they were published on different scientific reviews, such as: the field survey report of the organization Frontier - Vietnam (classified the specimen of *Hipposideros alongensis* and *Hipposideros turpis*); the results of field investigation and updating species component of bats distributing in Cat Ba; describing meticulously ultrasound of *Rhinolophus marshalli*; the first record of *Hipposideros khaokhouayensis* in Vietnam and named it in Vietnamese Catba’s leaf-nosed bat. Cat Ba National Park was also the first place to study the ultrasounds of *Murina harrisoni* and some other bat species and also the standard location of Griffin’s Leaf-nosed Bat (*Hipposideros griffini*) [18].

**Table 2. Plant species recorded from Cat Ba National Park [5]**

No.	Phyla	Families		Genera		Species	
		Number of speices	Percentage	Number of genera	Percentage	Number of species	Percentage
1	Lycopodiophyta	2	1.07	3	0.35	6	0.38
2	Equisetophyta	1	0.53	1	0.12	1	0.06
3	Polypodiophyta	16	8.56	32	3.76	63	3.97
4	Pinophyta	6	3.21	14	1.65	24	1.51
5	Angiospermae	162	86.63	800	94.12	1,491	94.07
	<b>Total</b>	<b>187</b>		<b>850</b>		<b>1,585</b>	

**Table 2. Common families and genera of plants in Cat Ba National Park [5]**

No.	Families	Number of speices	Percentage	Genera		
				Number of speices	Percentage	Percentage
1	Euphorbiaceae	81	15.67	Ficus	30	25.21
2	Poaceae	78	15.09	Bauhinia	11	9.24
3	Fabaceae	73	14.12	Ardisia	11	9.24
4	Rubiaceae	59	11.41	Symplocos	11	9.24
5	Moraceae	43	8.32	Castanopsis	10	8.40
6	Caesalpiniaceae	42	8.12	Lithocarpus	10	8.40
7	Lauraceae	40	7.74	Bambusa	10	8.40
8	Asteraceae	40	7.74	Ormosia	9	7.56
9	Rutaceae	31	6.00	Cinnamomum	9	7.56
10	Meliaceae	30	5.80	Elaeocarpus	8	6.72
	<b>Total</b>	<b>517</b>			<b>119</b>	

### 3.2. Recent records of bats

Over the recent surveys, we recorded many species of bats in different habitats ranging from mangrove to karst forest. Remarkably, we recorded to rarely documented species: Black-bearded Tomb Bat (*Taphozous melanopogon*) and Eastern bent-winged Bat (*Miniopterus fuliginosus*). This study results confirm the distribution of these two species in the park. Details of the records in previous publications and from recent survys are given as follows:

#### 3.2.1. Black-bearded Tomb Bat (*Taphozous melanopogon*)

Dang Ngoc Can et al. (2008) recorded the distribution of Black-bearded Tomb Bat (*Taphozous melanopogon*) in Cat

Ba National Park [6]. However, the record was attributed to a technical error during the compilation process and the authors had no previous proof that recorded Black-bearded Tomb Bat in Cat Ba National Park (information confirmed by Vu Dinh Thong). The species of Black-bearded Tomb Bat was first recorded in Cat Ba National Park by Vu Dinh Thong et al. (2016). This species of bat was recorded in Hang Quan Y area and some study sites in Phu Long commune (Figure 1). Specimens are kept at the Department of Zoological Museum, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology. The species emit “quansi-constant-frequency” echolocation calls with energy focuses on the second harmonic.



**Figure 1. Morphology of face and ear of *Taphozous melanopogon* (left) and *Miniopterus fuliginosus* (right).**

### 3.2.2. Eastern bent-winged Bat (*Miniopterus fuliginosus*)

A record of 1 species belonging to the family of Long-winged Bat (Miniopteridae) in Abramov and Kruskop (2012) [1] was based on references of two previously published documents ([16]; Vu Dinh Thong and Furrey 2008). Results from the recent survey confirm the distribution of *Miniopterus fuliginosus* in the park. In fact, the classification of species belonging to the family of bent-winged bat (Miniopteridae) in Vietnam in general and individuals of bent-winged bat in Cat Ba National Park in particular require more research results with a combination of morphology, ultrasound and molecular biology in near future. This species emits “frequency-modulated” echolocation calls with energy focuses on the first harmonic.

## 4. Conclusion

Cat Ba National Park is an ideal for biodiversity research and conservation. Many species of plant and animals are recorded from the park, including the ones listed in the 2007 Red Data Book of Vietnam and the current IUCN Red List of the Threatened Species. Cat Ba Langur and Halong Leaf-nosed Bat are two of the species endemic to the Cat Ba National Park and Vietnam. Conservation of these species requires continuous action plans based on ecological research. The regulations and law systems for biodiversity conservation have been applied successfully by the authorities and managers of Cat Ba National Park.

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