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Results of a gibbon survey in the Kim Hy Nature Reserve (Bac Kan province) in northeastern Vietnam

Thomas Geissmann[1], Vu Ngoc Thanh[2] , Michael C. Dine[3] and Tu Minh Tiep[3]

[1] Anthropological Institute, University Zürich-Irchel,
Winterthurerstr. 190, CH–8057 Zürich, Switzerland.
E-mail: thomas.geissmann@aim.uzh.ch

[2] Zoological Museum, Hanoi University of Science, Vietnam National University,
334 Nguyen Trai Street, Thanh Xuan District, Hanoi, Vietnam.
E-mail: vnthanh@fpt.vn

[3] People Resources and Conservation Foundation Vietnam, Hanoi, Vietnam.
E-mail: michael.prcf@gmail.com; E-mail: minhtiep@prcfunion.org

The cao-vit crested gibbon (*Nomascus nasutus*) is one of the wold's most endangered primate species, with one single protected forest patch in the border area between Cao Bang province (Vietnam) and Guangxi province (China) supporting the last known population. No other locality is known to support a population of this species, however, some gibbons are rumoured to have survived in Kim Hy Nature Reserve of Bac Kan province (northeastern Vietnam). Although several previous surveys in Kim Hy failed to find direct evidence for the continued occurrence of gibbons there, each provided interview information indicating that Kim Hy still supported a few gibbons. In order to resolve the contradiction, we conducted a two-week survey in Kim Hy in June 2009. We recorded intrusion of agriculture in the periphery of the nature reserve, massive logging going on mostly, but not exclusively, in the periphery of the reserve, and hunting and gold mining in all areas including the core zone of the reserve. The gold mining in particular had taken on enormous dimensions, with some valleys in the centre of the primary forest reported to harbour over 100 miners. We manned four listening posts in each of two survey areas in the very centre of the remaining forest in the core zone and monitored gibbon calls. The habitat consisted of steep karst hills covered with primary and secondary forest. Much of the forest in the survey area was selectively logged. Gunshots from illegal hunters were heard almost daily. Explosions from gold mining were heard daily and in large numbers from up to three different directions per listening post. In addition, motors of water pumps used for gold mining were also audible from some listening posts. No gibbons were seen or heard calling. In contrast to earlier surveys in Kim Hy, several interviewees suggested that gibbons were extinct in the area. On average, their most recent evidence for the occurrence of gibbons in Kim Hy dated from 2001. The only interviewee who reported having heard gibbon calls one year ago may not have been reliable as he claimed that gibbons occurred in groups of 30-40 individuals. As a result, we conclude that cao-vit crested gibbons of the Kim Hy Nature Reserve probably became extinct early in this century. On the other hand, we found that macaques – probably stump-tailed macaques (*Macaca arctoides*) – and Francois's leaf monkeys (*Trachypithecus francoisi*) still occur in Kim Hy.

Introduction

The cao-vit crested gibbon (*Nomascus nasutus*) is a Critically Endangered ape (Geissmann, 2007b) originally distributed over large areas on northeastern Vietnam and southern China east of the Red River (Geissmann *et al.*, 2000). Today, the only confirmed population occurs in a single patch of forest that covers parts of the Phong Nam, Ngoc Khe and Ngoc Con communes in Trung Khanh district of Cao Bang province (NE Vietnam) and a bordering area of Jingxi county in Guangxi province of southwestern China. The total population is estimated at about 18 groups (Fan and Yan, 2007; Le Trong Dat and Le Huu Oanh, 2007).

Another area that has long been rumoured to support some cao-vit crested gibbons is the Kim Hy forest in Bac Kan province, northeast Vietnam (Fig. 1). Kim Hy was originally proposed as a protected area in 1997. A management board for Kim Hy was formally established in 2003, and in December 2004, Bac Kan province declared the area as the Kim Hy Nature Reserve. It covers roughly 150 km^2 (15,461 ha) and is surrounded by a buffer zone of roughly 200 km^2 (20,528 ha) (Furey and Tu Minh Tiep, 2007). It includes several communes of the Bach Thong and Na Ri districts. Of these, sections of the Kim Hy, Luong Thuong, An Tinh, Con Minh, Cao Son and Vu Muon communes are located within the core zone. The nature reserve is located at elevations ranging from 250 to 938 m above sea level. The core zone encompasses a heavily karstified and uplifted limestone massif surrounded by lowland agricultural areas. The latter areas are dominated by a mosaic of slash-and-burn cultivation and few remnants of lowland forest (Wikipedia authors, 2009).

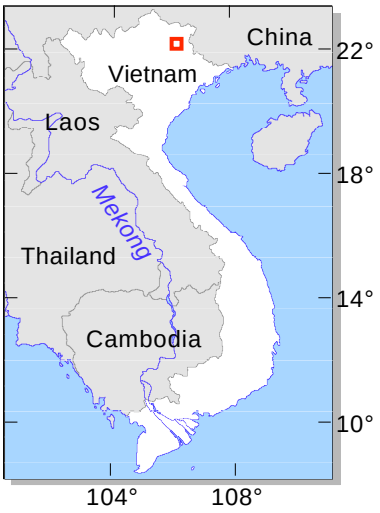


Fig. 1. Location of the study site within Vietnam.

Surveys indicate that Kim Hy supports a range of internationally important biodiversity, including Francois's leaf monkey (*Trachypithecus francoisi*), a globally threatened primate endemic to north Vietnam and southern China, and potentially also a population of the cao-vit crested gibbon (*N. nasutus*).

At least nine previous surveys were conducted in the Kim Hy area trying to find the elusive cao-vit crested gibbon, including one conducted in 1998 by two authors of the present report (Le Xuan Canh and Pham Nhat, 1997; Lormée and Ngo Van Tri, 2000; Ngo Van Tri and Lormée, 2000a, b, c; Phung Van Khoa and Lormée, 2000; Tordoff *et al*., 2000; Geissmann and Vu Ngoc Thanh, 2001; La Quang Trung and Trinh Dinh Hoang, 2001a, b; Trinh Dinh Hoang and La Quang Trung, 2001; Dang Ngoc Can *et al*., 2002; Frontier Vietnam and Hardiman *et al*., 2002; Goldthorpe *et al*., 2002). Virtually all of the survey teams met local people who reported having observed gibbons, heard their calls, or even shot gibbons in recent times (i.e. less than one year prior to the corresponding surveys). Some survey teams were shown skins or bones of gibbons that reportedly were hunted shortly before the survey (Dang Ngoc Can *et al*., 2002; Frontier Vietnam and Hardiman *et al*., 2002; Goldthorpe *et al*., 2002). None of the survey teams were, however, able to provide direct evidence of gibbons still living in the area (i.e. none of the teams were able to observe the gibbons or hear their calls).

The failure of previous surveys to provide evidence for the continued occurrence of living gibbons in Kim Hy may have several causes, including one or several of the following: (1) teams may not have been experienced enough with methods of gibbon surveys; (2) teams were not deep enough in the forest or not in the right part of the reserve; (3) teams were not long enough in any one part of the forest to have much chance of hearing a song bout; (4) the gibbon population density in Kim Hy may be so low that gibbon songs are very rare, making it necessary to stay in the forest even longer to make sure to hear one of the song bouts; (5) gibbons may have become extinct in Kim Hy even while local people continued to report otherwise. Whatever the cause, the rumour that gibbons may still occur in Kim Hy persists (Mittermeier *et al*., 2007, p. 28). At the same time, there are recent reports that Kim Hy Nature Reserve is threatened due to illegal logging by local residents in the reserve's buffer and core zones (Viet Nam News, 2008). In response to these reports, and because of the small total global population size of this critically endangered gibbon species, we carried out a further gibbon survey in the core zone of the Kim Hy Nature Reserve during May-June of 2009. The results of this survey will also be compared to findings of our earlier survey in Kim Hy of 1998 (Geissmann and Vu Ngoc Thanh, 2001), many elements of which have not been published previously.

Study site and methodology

Itinerary and survey participants

An itinerary of the survey is presented in Table 1, and maps showing the location of Kim Hy Nature Reserve within Vietnam and the location of the study area within the Kim Hy Nature Reserve are shown in Fig. 2.

Participants in the field survey included:

- Vu Ngoc Thanh (Hanoi University of Science)
- Thomas Geissmann (Zürich University and Gibbon Conservation Alliance)
- Tu Minh Tiep, and Michael Dine (People Resources and Conservation Foundation [PRCF] Vietnam)
- Nguyen Van Nhuan, field survey assistance to PRCF
- Forest Protection Department (FPD) Rangers from Kim Hy Nature Reserve (Nguyen Van Tuyen, Hai, and Nhat), and Ba Be National Park (Duong Xuan Tu, and Duong Hong Hai), Bac Kan Province.

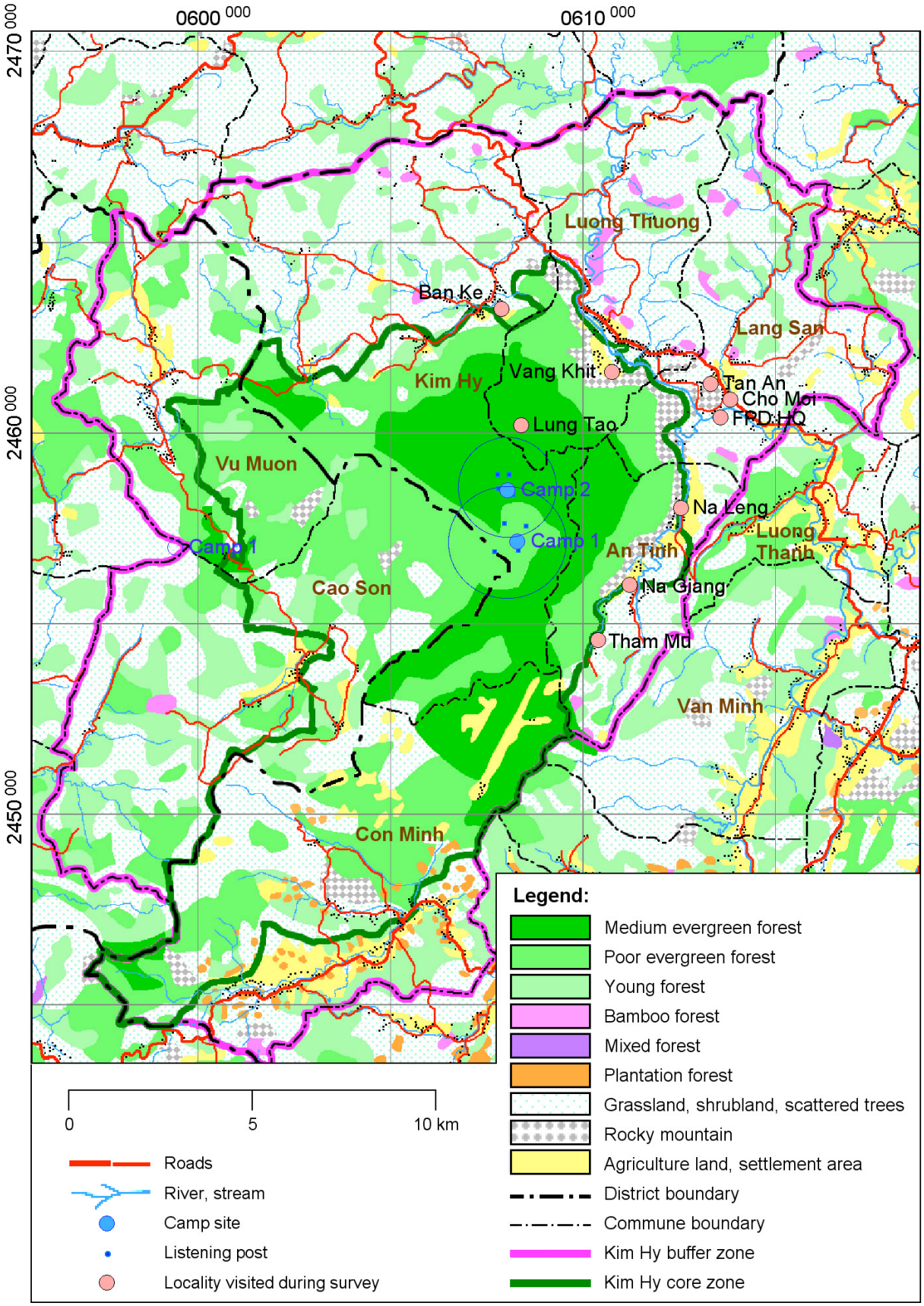


Fig. 2. Map of the Kim Hy Nature Reserve showing locations of campsites and listening posts (LPs) used in this study. Locations of villages visited for conduction interviews are also indicated. The blue circles around the campsites indicate an approximate listening radius of 1 km around the combined listening posts of each campsite. Source for land cover data: Landsat 7 ETM+ 2003. Map projection: UTM, zone 48, datum WGS1984.

Table 1. Itinerary of the survey in May-June 2009.

Date	Topic	Days
29 May	Travel from Hanoi to Kim Hy Nature Reserve and conduct first interviews at Forest Protection Department (FPD) of Kim Hy Nature Reserve, and in Vang Khit village.	1
30 May	Gibbon survey training course to FPD staff and survey team members and further interviews in Vang Khit village and Tan An town.	1
31 May	Interviews in Ban Ke, Na Giang, Tham Mu, and Na Leng villages.	1
1 June	Walk to Lung Hop in Kim Hy Nature Reserve, establish Camp 1.	1
2 June	Establish four listening posts around Camp 1.	1
3-7 June	Survey work around Camp 1 (Rain on 3 and 6 June). Afternoon of 6 June: walk to Lung Tacke, establish Camp 2.	4
8 June	Establish four listening posts around Camp 2.	1
9-14 June	Survey work around Camp 2 (Rain on 9, 11, and 13 June). On 13 June, a small team visits Lung Tao, a valley reported to be used by gold miners, north of Camp 2. Interview with one of the local guides. Afternoon of 14 June: walk back to Camp 1.	6
15 June	Walk from Camp 1 to Tham Mu, and then travel back to Hanoi.	1
Total		17

Training course

As an introduction to the survey, a one-day training course was held by the authors at the headquarters of Kim Hy Forest Protection Department (FPD) near Tan An town on 30 May 2009 (Fig. 3). The participants included participants of the survey and rangers of the FPD.

Fig. 3. Training workshop held at the beginning of the survey at the headquarters of the Forest Protection Department (FPD) near Tan An town, 30 May 2009. Photo: Michael Dine.

Training topics included:

- What are gibbons? Introduction to gibbon biology
- Gibbon conservation issues
- Introduction to crested singing behaviour
- Survey techniques for gibbons
- Introduction to compass and GPS handling
- Interview techniques
- Plotting and triangulation gibbon song data

Interview survey

Interviews were conducted at the following locations: Kim Hy Nature Reserve Headquarters, in the Ban Ke, Vang Khit, Cho Moi, Na Giang, Tham Mu, and Na Leng villages and Tan An town of the Kim Hy, An Tinh,

Lang San and Luong Thuong communes. A list of the interviews conducted is presented in Table 2. The location of the villages visited for interviews within the study area are shown in Fig. 2. Interviewees were asked to tell what they knew about gibbons (where to find them in Kim Hy, how many they thought there were, when they last heard or saw gibbons, etc.), what other forest mammals they knew, and what they knew about hunting, logging, and gold mining in Kim Hy. During the first three interviews conducted in the An Tinh commune on 31 May 2009 (see Table 2), the colour plates of south-east Asian mammals published by Francis (2007) were presented to hunters as an aide to identify animals the interviewees were familiar with from the Kim Hy area (Fig. 4).

The results of the interviews were also used to select the locations of campsites for the field survey.

Table 2. Interviews conducted during this survey.

Interview date	Interview location	Interviewees (age)
29 May 2009	Vang Khit village, Luong Thuong commune	Nong Thiem Khuyen (62)
30 May 2009	Vang Khit village, Luong Thuong commune	1 hunter and 2 mine workers (names and age not recorded)
30 May 2009	Tan An town and Cho Moi village, Lang San commune	Lam Ngoc Canh
31 May 2009	Na Giang village, An Tinh commune	Nguyen Van Khanh (54), Nguyen Van Vinh (45), Hoang Nguyen Vuong (21)
31 May 2009	Tham Mu village, An Tinh commune	Ban Van Sang, Ban Van Tuat, Nguyen Van Dinh
31 May 2009	Na Leng village, An Tinh commune	Than Hay Man [66], Ha Van Thuan (48), Than Dinh Huyen (Mau) (47) (grandson of Than Hay Man)
31 May 2009	Na Leng village, An Tinh commune	Ha Van Thuai
31 May 2009	Ban Ke village, Kim Hy commune	Phong, Nguyen Cong Danh
13 June 2009	During field survey to Lung Tao in Kim Hy NR	Ban Van Tuat (39) from Tham Mu village, An Tinh commune
15 June 2009	Cho Moi village, Lang San commune	Lam Ngoc Canh

(a)

(b)

Fig. 4. Survey team members conducting interviews in Na Giang village (a) and Tham Mu village (b) of the An Tinh commune on 31 May 2009. Photos: Thomas Geissmann.

Field survey methods

Our study effectively covered a very large area of the reserve's core zone, where we used two campsites (Fig. 5), one in Lung Hop (Camp 1) and one in Lung Tacke (Camp 2). Around each campsite, we established four listening posts (LP). The coordinates of the campsites and listening posts are listed in Table 3, and their locations are indicated in the map shown in Fig. 2.

Fig. 5. The campsites used during this survey: Camp 1 (Lung Hop) on 2 June 2009 (left) and Camp 2 (Lung Tacke) on 9 June 2009 (right). Photos: Thomas Geissmann.

Table 3. Listening post coordinates and survey time. In the last column, the numbers in parenthesis indicate the hours spent on each listening post for each individual survey day.

Campsites and listening posts	UTM coordinates	Altitude [m above sea level]	Survey dates	Total hours spent at listening posts	
Camp 1 (Lung Hop)	0608379, 2457357	567 m	2-7 June 2009[1]		
LP1-1	0608527, 2457561	719 m		19 h	(1+0+6+6+6+0 h)
LP1-2	0607982, 2457622	754 m		17.5 h	(1+0+6+4.5+6+0 h)
LP1-3	0607714, 2456885	797m		19 h	(1+0+6+6+6+0 h)
LP1-4	0608332, 2456903	790 m		19 h	(1+0+6+6+6+0 h)
Camp 2 (Lung Tacke)	0608026, 2458591	641 m	8-14 June 2009[2]		
LP2-1	0607828, 2458541	752 m		21 h	(1.5+0+6+1.5+6+0+6 h)
LP2-2	0608102, 2458909	801 m		21 h	(1.5+0+6+1.5+6+0+6 h)
LP2-3	0607801, 2458745	780 m		21 h	(1.5+0+6+1.5+6+0+6 h)
LP2-4	0608197, 2458404	770 m		24.5 h	(1.5+0+6+5+6+0+6 h)
Total				162 h	

[1] Establishing LPs on morning of 2 June. Rain on mornings of 3 and 7 June makes LP survey impossible.

[2] Establishing LPs on morning of 8 June. Rain on mornings of 9, 11, and 13 June makes LP survey impossible or partially impossible.

Field survey techniques most suitable to locate gibbons and estimate densities of gibbon populations are variants of the fixed point method, whereby the loud morning songs of the gibbons are monitored from fixed listening posts (Brockelman and Ali, 1987; Brockelman and Srikosamatara, 1993).

At each campsite, four teams monitored gibbon calls synchronously from all four listening posts. The survey hours spent on each of them are also listed in Table 3. Listening posts were about 1 km apart and less than 1 km from the campsites. They were located on hilltops in order to enable the survey participants to hear gibbons from as many directions as possible. Each LP was elevated by more than 100 m above the surrounding

landscape (see elevation information in Table 3) and offered an audibility (and sometimes a view) in several or all directions.

Crested gibbon song bouts are typically given by mated pairs (Geissmann *et al.*, 2000) and typically carry for up to 2 km (Brockelman and Ali, 1987). Therefore, from one listening post it is theoretically possible to sample a circular area of up to roughly 12.6 square kilometres for gibbon presence, although density estimates are usually calculated using a shorter radius (e.g. 0.6 km), as the probability of detecting calls decreases with distance. Furthermore, the audibility of gibbon calls rapidly diminishes soon after dawn when other animals such as cicadas call also begin to call.

As crested gibbons tend to start the majority of their songs at dawn time (Geissmann, 2007a; Geissmann *et al.*, 2007), we made sure to be ready on the listening posts by that time. Dawn was defined as the time when color was first discernible in leaves near the forest ground, and it occurred at 05:02 hr local time (standard deviation = 4.5 min, $n = 6$). Listening for gibbon songs was carried out from 05:00 to 11:00 hr at each listening post, and all four listening posts at a camp site were manned on every morning that we spent at the site except on rainy days or when a team member fell sick.

Gibbons typically call during periods of "good weather," which are characterized by cloud cover of less than 50%, no rain, and little or no wind (Brockelman and Ali, 1987). Monitoring was conducted in May–June 2009, just prior to the Bac Kan rainy season, July–August. Although good weather conditions were still prevalent during the survey, it was raining on some days of this study (see Table 2). We planned to conduct five days of listening post surveys at each campsite, but because of rain, it was only possible to survey 3 full mornings at Camp 1 and four full mornings at Camp 2.

In addition to gibbon song data, surveyors also recorded direct observations of birds and mammals, other wildlife signs (scats, tracks, scratchings etc.), evidence for hunting (hunters, gun shots, traps, snares), and gold mining (explosions, noise from water pumps, visible tracks of mining activity) and logging, both at the listening posts and on the way to and from the posts each morning. For identification of birds, we followed Robson (2008), and for mammals Francis (2007).

The earlier survey of 1998 was also carried out in the reserve's core zone and also used two campsites (Geissmann and Vu Ngoc Thanh, 2001). One campsite of 1998 was located only 1 km northeast of Camp 1 of the present survey, the other was located about 3 km northeast of Camp 1.

Results

Habitat

Buffer zone

Most of the buffer zone of the Kim Hy Nature Reserve consists of villages, agricultural land and limestone hills covered with shrubs and patches of secondary forest (Fig. 6). Even the first chain of limestone hills that mark the boundary of the reserve's core zone are only covered by highly degraded secondary forest.

(a)

(b)

Fig. 6. The buffer zone of the Kim Hy Nature Reserve. (a): View from the headquarters of the Forest Protection Department (FPD) to the west (29 May 2009). The river in the foreground is the Bac Giang. The chain of limestone hills visible in the background mark the boundary of the reserve's core zone. (b): View from Tham Mu village to the north (31 May 2009). The steep limestone hills seen on the left half of the picture again mark the boundary of the core zone. Photos: Thomas Geissmann.

Camp 1 (Lung Hop)

Both campsites were located deep within the core zone of the Kim Hy Nature Reserve.

Lung Hop is a relatively wide valley with considerable amounts of flat ground. The forest on the valley floor had been cleared extensively and selectively logged in the mid to late 1990s by gold miners who had lived there according to local guides, for about 5 years (see section on Gold Mining further below). Most forest in the valley was secondary, however, some large remnant trees remained.

At the campsite, a discernable small clearing had been maintained where trees had just started regrowing, suggesting that the clearing had only recently been used. In addition, a small, well-preserved platform with a partial roof was found. The site appeared to be used as a camp on a regular basis, probably for hunters and loggers.

On the steep limestone hills surrounding the valley, trees were smaller and thinner (Fig. 7a). From the listening posts, it was possible to efficiently monitor gibbon calls in an area of 1 km radius. Some listening posts offered a free view of 360°, showing that suitable gibbon habitat still occurred in some parts of the area (Fig. 7b).

(a)

(b)

Fig. 7. Forest in the survey area around Camp 1. (a): View from the listening post LP 1-1 (2 June 2009). (b): View from the listening post LP1-4 (6 June 2009). Photos: Thomas Geissmann and Vu Ngoc Thanh, respectively.

Camp 2 (Lung Tacke)

Camp 2 was located about 1.5 km to the north of Camp 1.

The Lung Tacke valley is named after the tokay gecko (*Gekko gecko*). In this valley and (when we were on the listening posts) from the neighbouring valleys, we heard the tokay calls every day. This valley is narrower than Lung Hop. As a result, direct sunlight to the valley floor in Lung Tacke occurs for a shorter daily duration than at Lung Hop, and both air and soil are very humid. Furthermore, it is more difficult to walk in this valley because of the abundance of sharp limestone that covers virtually every part of the ground.

According to our interview informants, few people visit this valley, as compared to Lung Hop. Indeed, we saw hardly any evidence that people had modified that habitat. Although some gold mining reportedly occurred in Lung Tacke, mining was abandoned there at least since the mid-1990s.

Many trees in this valley were old and large, suggesting that this forest could support gibbons if they were not hunted (Fig. 8). As in Lung Hop, trees were smaller and thinner on the steep limestone hills surrounding the valley (Fig. 9a). From the listening posts, the views and the gibbon monitoring conditions were very similar to those of Lung Hop, showing suitable gibbon habitat in many places (Fig. 9b).

Fig. 8. Forest in the survey area around Camp 2 (11 June 2009). In the valleys, bigger trees occur than on the steeper limestone slopes. Here, one of these big trees was probably felled by a storm. It's fall created a clearance of considerable dimensions in the forest. Photo: Thomas Geissmann.

(a)

(b)

Fig. 9. Forest in the survey area around Camp 2. (a): On the slope below listening post LP 2-1 (12 June 2009). (b): View from the listening post LP2-4 (8 June 2009). Photos: Thomas Geissmann and Vu Ngoc Thanh, respectively.

Human threats to the reserve

Gold mining

We observed both manual as well as industrial gold mining along the Bac Giang river in the buffer zone of Kim Hy Nature Reserve (Fig. 10). However, large-scale gold mining reportedly also occurs within the core zone of the reserve.

Explosions were heard from all listening posts on almost every day, often coming from different directions. Up to 24 and 21 explosions were heard from three different directions during a single survey morning at listening post LP 2-1 and LP 1 – 3 respectively. As the explosions carry very far, it was difficult to estimate the distance. Some rangers suggested that the explosions were created from road building, however, our local guides said no roads were being built around the reserve and that gold miners produced the explosions.

In addition, chugging machine noises were heard from some listening posts. Our local guides identified these as water pumps used in the gold mining operations.

Fig. 10. Manual (left) and industrial gold mining (right) in the buffer zone of the Kim Hy Nature Reserve, along the Bac Giang river in Luong Thuong commune, on 30 Mai 2009. Photos: Michael Dine and Thomas Geissmann, respectively.

According to our interview informants, gold mining occurred in various places located within the core zone of the reserve. Virtually all interviewees mentioned Lung Luc being one of these locations. Reportedly, more than 100 gold miners are working there. Explosions we heard on LP 1-1 from a northwestern direction were identified by one of our local guides as coming from Lung Luc.

In order to have a more precise understanding of the dimensions the of gold mining operations in the Kim Hy NR and their impact on the environment, we decided to send one of the team members with one local guide to Lung Luc, because we were made to believe that this excursion could be carried out within one day. Upon their return from the excursion, the team reported that they did not go to Lung Luc because none of the local guides knew how to get there. Instead, the team visited a locality known as Lung Tao (Fig. 11). It was located about 1.5 km to the north of Camp 2. No mining operations were observed in Lung Tao. Instead, our team found a small campsite and a running pump. The pump transported water from a source to a large, artificial pool, and from there it travelled in two parallel pipelines over the next mountain chain to an unknown destination. A second, apparently broken pump was also found in the camp. No people were encountered at the site during that short visit. The local guide explained that the water was used for gold mining operations. Due to time restrictions, it was not possible to follow the pipeline to its end point across the mountains.

Fig. 11. Reservoir pool, water pumps, and camp (left) and water pipelines going up the mountain in Lung Tao (right) in the core zone of the Kim Hy Nature Reserve, on 13 June 2009. Photos: Nguyen Van Nhuan.

The holes of former reservoir pools were also found around Camp 1, and an abandoned broken water pump was found along the trail between Camp 1 and Camp 2. Our interview informants reported that, about ten years ago, gold mining was also undertaken in Lung Hop, the valley were our Camp 1 was located. Because the area did not yield enough gold, it was abandoned after some time.

Illegal logging

The immediate site of our Camp 1 had been logged some time ago, probably by gold miners (see above). Numerous trees species had started to regenerate at the site, however, were still only a few metres high.

During a short excursion to Lung Tao (about 1.5 km north of Camp 2), the forest became severely degraded after about 1 km, and instead of forest like in the surrounding areas, large stands of bamboo, banana trees and grass were observed (Fig. 12). It had obviously been logged a few years ago, possibly by gold miners or for timber extraction.

According to one of our interview informants, logging in the Kim Hy Nature Reserve is very common, and unfortunately had intensified in its seriousness since November of 2008.

Fig. 12. Degraded forest on the way to Lung Tao in the core zone of the Kim Hy Nature Reserve, on 13 June 2009. Photo: Nguyen Van Nhuan.

Recent logging activities were observed at a number of locations within the core zone and normally pertained to certain species of high economic value. A very rare tree called Red Mountain Thong (Cay Thong Nui Do) was observed to be the only tree species cut down and milled at the top of the mountains at a number of the listening posts at Camp 1.

Logged trees and logged areas were also encountered at various locations between Tham Mu village and Camp 1, all in the core zone of the Kim Hy Nature Reserve (Fig. 13). The loggers appeared to target only iron wood trees (*Burretiodendron hsienmu or B. tonkinense*). The former is listed as Vulnerable, the latter as Endangered in the IUCN Red List of Threatened Species (IUCN, 2009). As these trees represented a high proportion of the forest at some localities, felling resulted in almost entire small valleys being destroyed along with fauna habitat. The trees were apparently felled to be made into floor tiles with a thickness of about 18 cm thickness and a diameter of about 40 cm. Only “perfect” trees are used. After felling, each tree is sawed in half at mid-length in order to assess its quality. Trees exhibiting cracks or even holes in the cross-section are left to rot. The trees of sufficient quality are cut into sections of suitable dimensions for later conversion into tiles. Some tree logs and products confiscated by Kim Hy Nature Reserve rangers some time previously were piled up in the front yard at the Forest Protection Department Headquarters, however, they only represent a tiny proportion of what we observed to have been felled in the core zone and being stored underneath houses in buffer zone villages. It appears that forest protection and law enforcement activities are only minimal. Survey team guides confirming that they had neither encountered nor observed Forest Protection Department rangers in the core zone prior to this survey activity confirmed this assertion.

Fig. 13. Logged trees at various locations between Tham Mu village and Camp 1, all in the core zone of the Kim Hy Nature Reserve, on 15 June 2009. The loggers left tree stems that were not of sufficient quality for tile production in the forest. Photo: Vu Ngoc Thanh.

Hunting

Gunshots were heard on almost every survey day in the field, sometimes even close to our camps.

Two hunters were encountered by one of our survey teams near Camp 2. They carried a live tokay gecko (*Gekko gecko*), which they had caught in this area. The ranger accompanying our team confiscated the tokay gecko and we released the animal in the habitat at night. Further, during the short excursion to Lung Tao (about 1.5 km north of Camp 2) mentioned previously, five snare traps were observed (Fig. 14).

Both in Lung Hop and on the way between Tham Mu village and Camp 1, we found a small wooden platform with a partial roof. These places appeared to be used as a camp on a regular basis, probably by hunters and loggers.

During our interview surveys in an around the buffer zone of the nature reserve we repeatedly saw captive or dead animals that were reported to have been caught or hunted in the reserve. The mammals among them will be discussed in the Other Mammals section further below.

Fig. 14. One of several snare traps on the way between Camp 2 and Lung Tao, in the core zone of the Kim Hy Nature Reserve, on 13 June 2009. The pencil serves as a size indicator. Photo: Nguyen Van Nhuan.

Agriculture

A number of cleared agricultural fields, mostly planted with corn and soya, were observed within the core zone of the nature reserve, although mostly in its periphery (Fig. 15).

Fig. 15. Freshly planted field of soya within the core zone of Kim Hy Nature Reserve, between Tham Mu village and Camp 1, on 1 June 2009. Photo: Thomas Geissmann.

Gibbons

During two weeks of field survey, no gibbons were seen, or heard calling. As our eight listening points were all located over 100 m above the surrounding landscape and offered unobstructed visibility and listening possibilities in all directions, we can assume that we would have heard any gibbon calls for a distance of at least 1 km.

The following information on the fate of gibbons in Kim Hy Nature Reserve was collected during our interviews with people living in the buffer zone of the reserve. We asked people when they last hunted, saw or heard gibbons in Kim Hy.

- Vang Khit (29 May): 1 man says that gibbon calls could still be heard at the village about five years ago.
- Vang Khit (30 May): 1 man hunted gibbons about 20 years ago, during about five years. Once, he even caught a young gibbon alive, however, it died after one week in captivity because he didn't know what to feed the infant and assumed that it died from starvation.
- Na Giang (31 May): 3 hunters (age 54, 45, and 21 years, respectively) last saw gibbons over 10 years ago and think gibbons may be extinct in this region.
- Tham Mu (31 May): 3 men reported that they had not heard any gibbon songs since about 2000, however, one local hunter was reported to having shot a female cao-vit crested gibbon in Khua Mu (about two hours walking from Tham Mu) in 2004, and one of the three interviewees shot one black gibbon in Khua Mu in 2006. Of the other two interviewees, one stated that it had been such a long time ago since he last saw gibbons that he can't remember when that was, and the other said that he had never seen any gibbons.
- Na Leng village (31 May): 1 old man said that gibbons could be heard at the village over ten years ago. He says he had in his possession a skull and skeleton of a gibbon shot by his grandson together with another man in 1990. The skeleton did not survive very long, however, the skull was photographed during the Frontier Vietnam (2002) survey, as he remembers. The skull was taken to the house of the village head to be photographed there, and does not know what happened to it after that.
- Na Leng village (31 May): The man who assisted the shooting of the gibbon mentioned in the previous paragraph said that the gibbon was shot in Lung Muoy valley (An Tinh commune), located at a walking distance of about 2.5 hours from this village. Gibbons are very rare now but he still heard gibbon calls last year (2008) in Lung Muoy. However, the same man also reported that gibbons occurred in groups of 30-40 individuals.

A local guide who was interviewed during our field survey in Kim Hy Nature Reserve (13 June) had previously specialized in hunting gibbons. He last hunted a gibbon in 1997, and knew of reports that somebody in Con Minh commune last hunted a gibbon after 2000.

On average, the year when the informants last saw or heard a gibbon or heard that someone else had hunted one was 2001 (standard deviation 4 years, range 1994-2008, $n = 10$). In this calculation, people who participated together in a group interview were counted only once if they agreed on the year.

Several interviewees agreed that gibbons in the Kim Hy area were shot primarily for the meat, not for traditional "medicine". The meat is reported to be delicious by one interviewee. After the meat has been consumed, however, the bones are often boiled down to produce a balm that is believed to be beneficial to general health.

Most interviewees agreed that gibbons are sensitive and disappear when there is a lot of disturbance and noise in the forest, and most mentioned that the activity of illegal loggers and especially gold miners (habitat clearance, noise, accommodation building, associated hunting activities etc.) in the forest had increased in recent years, and that they recognized these activities as potential yet significant threats to the gibbons' survival.

When asked how many gibbons were still living in Kim Hy, we were told "very few" (most common answer), "maybe one or none" (1 interviewee) and "none" (3 men that were interviewed as a group).

Other mammals

Mammals or mammal tracks, faeces, or calls recorded during this survey are listed in Table 4.

Macaque calls (probably stump-tailed macaque, *Macaca arctoides*) were heard reliably just once (2 June) near LP 1-4. Several old faeces were found there, as well. According to our interview informants, this macaque appears to be the most common non-human primate in Kim Hy.

Calls of a group of Francois's leaf monkey (*Trachypithecus francoisi*) were heard only once (10 June). They were audible from LPs 2-1, 2-3, and 2-4, but audibility was best from LP 2-1, from where a total of 12 loud calls were heard in the time period of 08:20-08:42 a.m. Three of these were recorded on video and one on audio-cassette. The animals were located at a distance of about 500 m, at a direction of 206° SSW, in the valley below LP 2-1. This langur appears to be rare in Kim Hy. One interviewee reported that there were still two groups with a total of about 15 individuals living in the vicinity of Camp 2 (i.e. the centre of the reserve's core zone). There might be additional groups or individuals in other parts of the nature reserve, however, this is both unconfirmed and unlikely, as the forest outside of the centre of the core zone is believed to be more degraded.

Table 4. List of mammals observed during the survey.

Species		Evidence	Location
Binturong	*Arctictis binturong*	Direct observation	Camp 1 (once)
Stump-tail Macaque	*Macaca arctoides*	Faeces and calls	Camp 1 (once)
Francois's Leaf Monkey	*Trachypithecus francoisi*	Calls	Camp 2 (once)
Hog Badger	*Arctonyx collaris*	Faeces	Camp 1 (once)
Red Muntjac	*Muntiacus muntjak*	Calls	Camp 1 (once, unsure)
Chinese Serow	*Capricornis milneedwardsi*	Feeding place	Camp 2 (once)
Brush-tailed Porcupine	*Atherurus macrourus*	Direct observation + Feeding or digging place	Camp 1 (once)
Black Giant Squirrel	*Ratufa bicolor*	Direct observation and calls	Camps 1 and 2 (observed repeatedly, heard almost daily, more often around Camp 2)
Pallas's Squirrel	*Callosciurus erythraeus*	Direct observation and calls	Camps 1 and 2 (observed three times, heard daily)

Both primate species mentioned above are hunted not only for their meat, but also as raw materials to produce a balm of traditional "medicine" reported to boost general health, and as ingredients for special rise wines (see further below in this section).

During the first three interviews conducted in the An Tinh commune on 31 May 2009 (see Table 2), a total of nine interviewees were asked to identify mammals occurring in the Kim Hy area using the colour plates published by Francis (2007). The resulting species list is presented in Table 5. Although animal lists based on interviews should always be regarded with caution, three of the reported species are of particular interest:

(1) The Sunda colugo (*Galeopterus variegatus*) should not occur in northern Vietnam, according to the distribution maps published in Francis (2007, p. 76). Although it is possible that interviewees mistook the pictures of the Sunda colugo for those of flying squirrels, it is notable that all interviews agreed that this species occurs in the Kim Hy area.

(2) The clouded leopard (*Neofelis nebulosa*) should not occur in northern Vietnam, according to the distribution maps published in Francis (2007, p. 110), but the species was reported in 2 of 3 interviews.

(3) Tigers (*Panthera tigris*) are nearly extinct in northern Vietnam. It is surprising that all informants report having heard tiger calls in Kim Hy Nature Reserve within the last three years. However, when asked specifically if they knew the difference between a tiger growl and that of other larger Felidae species found in the reserve e.g. clouded leopard and Asian golden cat, they were unable to discern and describe any differences.

During our interview surveys in the villages around the Kim Hy Nature Reserve, we did not ask to see captive animals or remains of hunted animals, except for gibbon remains (of which we found none). Yet, we repeatedly encountered evidence that various animals are hunted or captured in the reserve.

Captive stump-tailed macaques (*Macaca arctoides*) were encountered on two occasions (Fig. 16). The owners of the two macaques reported that both were caught in the Kim Hy Nature Reserve. One of the macaques was caught in an iron trap by a hunter of the Hmong ethnic group. The current owner bought it from the hunter at the end of 2008 because he said he felt sorry for the animal, which was going to be killed if he had not bought it. The other macaque was also purchased from Hmong hunters, and its current owner said he intended to make a balm out of it that is traditionally believed to have invigorating medical qualities. For the same purpose, this man had also bought a common palm civet (*Paradoxurus hermaphroditus*) – reportedly from a more southern locality – and a brush-tailed porcupine (*Atherurus macrourus*).

Table 5. Mammals recorded during the interview survey.

Order, Family	Species	Interview[1] 1	2	3	Additional comments by interviewees
Pholidota					
Manidae	Chinese Pangolin (*Manis pentadactyla*)	+	+		1: Rare
Dermoptera					
Cyno-cephalidae	Sunda Colugo (*Galeopterus variegatus*)	+	+	+	1: Common
Primates					
Loridae	Slow Loris (*Nycticebus* sp.)	+	+	+	1: Prefers lowland to limestone areas
Cerco-pithecidae	Stump-tailed Macaque (*Macaca arctoides*)	+	+		2 + 3: local Tai name = Cang Ding
	Northern Pig-tailed Macaque (*M. leonina*)			+	3: local Tai name = Cang Khi
	Francois's Leaf Monkey (*Trachypithecus francoisi*)	+	+		2: local Tai name = Tu Cang
Hylobatidae	Cao-Vit Crested Gibbon (*Nomascus nasutus*)	+	+	+	2: local Tai name = Cao Vit, Chao Vat
Carnivora					
Canidae	Dhole (*Cuon alpinus*)	+			[May no longer survive in the area]
Ursidae	Asian Black Bear (*Ursus thibetanus*)	+	+	+	1: Not sure which bear species occurred in the area and whether it was one or two species. 2: local Tai name = My Ma
	Sunbear (*Helarctos malayanus*)		+	+	1: See note above
Mustelidae	Yellow-throated Marten (*Martes flavigula*)		+		
	Ferret-Badger (*Melogale* sp.)	+	+		
	Hog badger (*Arctonyx collaris*)	+	+	+	
	Yellow-bellied Weasel (*Mustela kathiah*)		+		
	Otter, probably Eurasian Otter (*Lutra lutra*)		+		2: Now extinct in the area
Viverridae	Small Indian Civet (*Viverricula indica*)	+	+		
	Large-spotted Civet (*Viverra megaspila*)		+	+	
	Large Indian Civet (*V. zibetha*)	+	+	+	
	Masked Palm Civet (*Paguma larvata*)	+		+	
	Common Palm Civet (*Paradoxurus hermaphroditus*)	+	+		
	Small-toothed Palm Civet (*Arctogalidia trivirgata*)	+	+		
	Spotted Linsang (*Prionodon pardicolor*)	+	+	+	
	Owston's Civet (*Chrotogale owstoni*)		+		
Herpestidae	Crab-eating Mongoose (*Herpestes urva*)		+		
Felidae	Clouded Leopard (*Neofelis nebulosa*)	+	+		
	Tiger (*Panthera tigris*)	+	+	+	1: Calls heard 1 year ago. 2: Calls heard 2-3 years ago in Coi Xay (Kim Hy NR). Someone shot a tiger 7-8 months ago in Kim Hy NR. 3: Calls heard 2-3 years ago in Lung Muoy (Kim Hy NR)
	Asian Golden Cat (*Catopuma temminkii*)	+	+		[May no longer survive in the area]
Artiodactyla					
Suidae	Eurasian Wild Pig (*Sus scrofa*)	+	+		
Cervidae	Red Muntjac (*M. muntjak*)	+	+		
	Sambar (*Rusa unicolor*)	+			[Questionable information]
	Chinese Serow (*Capricornis milneedwardsii*)		+		
Rodentia					
Sciuridae	Black Giant Squirrel (*Ratufa bicolor*)	+	+		
	Eastern Striped Squirrel (*Tamiops maritimus*)	+			
	Perny's Long-nosed Squirrel (*Dremomys pernyi*)	+			
	Red-cheeked Squirrel (*D. rufigenis*)	+			
	Indian Giant Flying Squirrel (*Petaurista philippensis*)	+			
Spalacidae	Bamboo Rat (*Rhizomys* sp.)	+	+		1: Male with longer tail than female
Hystricidae	Malayan Porcupine (*Hystrix brachyura*)	+	+		

[1] This table summarizes information obtained during the first three interviews conducted in the An Tinh commune on 31 May 2009 (see Table 2). A plus sign identifies species that were reported to occur in the Kim Hy NR.

Fig. 16. Captive stump-tailed macaques (*Macaca arctoides*). Left: adult female at Cho Moi village, Lang San commune, 15 June 2009. Right: caged individual at Tan An town, Lang San commune, 31 May 2009. Photos: Thomas Geissmann (left) and Vu Ngoc Thanh (right).

One interviewee, Mr Dong Bach from Tan An town (near FPD headquarters), Lang San commune, was working in the timber import/export business. He offered rice wine from a huge jar that contained one hand and one foot of a Francois's leaf monkey (*Trachypithecus francoisi*) (Fig. 17), as well as remains of other animals including a cobra and two feet of a young Chinese serow (*Capricornis milneedwardsii*). Rice wine stored in jars with animal remains is a custom that is widespread in Vietnam (Geissmann and Vu Ngoc Thanh, personal observations). In this particular case, all animals were reportedly collected in the Kim Hy Nature Reserve. The hand and foot of a Francois's leaf monkey were obtained from a hunter from An Tinh commune two months prior to our visit.

Fig. 17. Right hand and foot of a Francois's leaf monkey (*Trachypithecus francoisi*) used as a special ingredient of rice wine at Tan An town, Lang San commune, 31 May 2009. The owner bought them from a hunter in An Tinh commune, two months prior to our survey. Photo: Vu Ngoc Thanh.

Birds

Although birds were not systematically observed, a few species were identified and photographed during this survey (Table 4). A few of the birds are shown in Fig. 18.

Table 4. List of birds observed during the survey.[1]

Species		Location		
		Buffer zone	Core zone, Camp 1	Core zone, Camp 2
Silver Pheasant	*Lophura nycthemera*			+
Chinese Pond-Heron	*Ardeola bacchus*	+		
Spotted Dove	*Streptopelia chinensis*	+		
Eurasian Cuckoo	*Cuculus canorus*		(+)	
Indian Cuckoo	*Cuculus nigropterus*		(+)	(+)
Common Kingfisher	*Alcedo atthis*	+		
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*			+
Grey-headed Woodpecker	*Picus canus*		+	
Black-naped Monarch	*Hypothymis azurea*		+	
Black Drongo	*Dicrurus macrocercus*		+	+
Greater Racket-tailed Drongo	*Dicrurus paradiseus*		+	
Red-billed Blue Magpie	*Urocissa erythrorhyncha*			+
Mrs Gould's Sunbird	*Aethopyga gouldiae*			+
Plain Flowerpecker	*Dicaeum minullum*		+	
White-rumped Munia	*Lonchura striata*	+		
Eurasian Tree-Sparrow	*Passer montanus*	+		
Olive-backed Pipit	*Anthus hodgsoni*		+	
White Wagtail	*Motacilla alba*	+		
Oriental Magpie-Robin	*Copsychus saularis*	+		
Yellow-cheeked Tit	*Parus spilonotus*			+
Sultan Tit	*Melanochlora sultanea*			+
Red-whiskered Bulbul	*Pycnonotus jacosus*	+		
Puff-throated Bulbul	*Alophoixus pallidus*			+
Chestnut-collared Yuhina	*Staphida torqueola*			+
Whiskered Yuhina	*Yuhina flavicollis*		+	
Chestnut-collared Yuhina	*Staphida torqueola*			+
Pin-striped Tit-Babbler	*Macronus gularis*	+		
Streaked Wren-Babbler?	*Napothera brevicaudata*			+
Black-hooded Laughinthrush	*Garrulax milletti*	In captivity		
Greater Necklaced Laughinthrush	*Garrulax pectoralis*		+	
Common Tailorbird	*Orthotomus sutorius*	+		

[1] Legend: + Visual record; () = heard only.

Chinese Pond-Heron
(*Ardeola bacchus*)

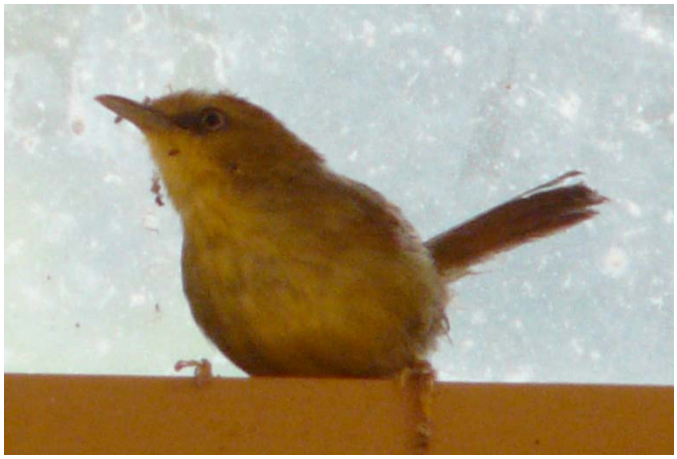
Red-whiskered Bulbul
(*Pycnonotus jocosus*)

Puff-throated Bulbul
(*Alophoixus pallidus*)

Oriental Magpie-Robin
(*Copsychus saularis*)

Streaked Wren-Babbler
(*Napothera brevicaudata*)

White-rumped Munia
(*Lonchura striata*)



Pin-striped Tit-Babbler
(*Macronus gularis*)

Common Tailorbird
(*Orthotomus sutorius*)

Fig. 18. Some of the birds observed during the survey. Photos: Thomas Geissmann.

Discussion

At least two of the team members had conducted various gibbon surveys in the past (TG, VNT). Prior to this field survey, we held a one-day gibbon survey training course for the other survey team members. During three days, we also conducted an extensive interview survey among hunters and other people living in the buffer zone of the nature reserve that were well familiar with the forest.

Several interviewees reported having hunted gibbons in the past. On average, interviewees last hunted, heard or saw gibbons, or heard about someone else hunting a gibbon, in 2001 (standard deviation 4 years, range 1994-2008, $n = 10$). Only one informant claimed he heard a gibbon within the last two years (2008), but the same man also claimed that gibbons occurred in groups of 30-40 individuals.

One of the main goals of the interviews was to discover which parts of the reserve were most likely to still support gibbons. All interviewees agreed that the best localities to survey were concentrated to the centre of the core zone of the nature reserve. We selected two of these locations from which we were able to survey acoustically all the other recommended locations, using a field survey with four listening points that were simultaneously manned on every morning without rain.

In spite of the time, knowledge, and personnel that were involved in this survey, we found no direct evidence that gibbons were still found in this area. In this respect, the result of our survey was identical to the various earlier mammal or primate surveys of the Kim Hy forest (see Introduction).

There was one significant difference between this survey and earlier ones. Usually, interviewees living in areas where gibbons have become rare or possibly extinct still keep reporting that gibbons occur in the forest. When asked why their calls are not heard anymore or why hunters had no success in hunting them in recent years, interviewees usually suggest that gibbons have stopped calling for some reason or they have moved to another area. One of team member has previously surveyed for gibbons in a wide variety of locations in multiple countries where they were extremely rare or extinct (TG, unpublished observations), and this interview result formed a consistent pattern at every location. This survey in Kim Hy was special, however, because several of our informants thought that no gibbons remained in Kim Hy and that they were extinct.

The habitat consisted of steep karst hills covered with primary and secondary forest, but much of the forest in the survey area was selectively logged. We recorded intrusion of agriculture in the periphery of the nature reserve, massive logging going on mostly, but not exclusively, in the periphery of the reserve, and hunting and gold mining in all areas including the core zone of the reserve. The gold mining in particular had taken on enormous dimensions, with some valleys in the centre of the primary forest reported to harbour over 100 miners. Gun shots from illegal hunters were heard almost daily. Explosions from gold mining were heard daily and in large numbers from up to three different directions per listening post. In addition, motors of water pumps used for gold mining were also audible from some listening posts.

The destructive human activities in the core zone we witnessed are worrying. More so is the conclusion that we probably saw only the “tip of the iceberg”. Because our priority was to find gibbons, we selectively surveyed the most remote areas with the best forest. We did not survey any of the heavily disturbed areas.

We made an attempt to visit Lung Luc on one of the rainy days, but could not get there, because all our local guides said they did not know where it was. This was probably not true. Virtually every interviewee had mentioned Lung Luc prior to the field survey. This is now a famous site in Kim Hy. Our guides appear to know every waterhole in the Kim Hy reserve, and they even can tell you how big the waterhole is depending on season. It is unlikely that they would have trouble finding their way to a valley that they say houses more than 100 miners. Maybe they did not want to go there because miners do not like visitors. On the other hand, the miners operate in all openness and don’t seem to have any problems with the authorities. It is unlikely that they would regard two visitors from our camp as a problem.

Gold mining had been very popular in Kim Hy prior to its declaration as a nature reserve. At some point, certain areas were overrun by what can only termed a gold rush. The following paragraphs summarize some of our only partially published interviews conducted in Kim Hy in 1998 and survey findings of that year (Geissmann and Vu Ngoc Thanh, 2001):

> Gold mining had been very popular in the Kim Hy area since about 1980, especially in the area known as Lung Cout (“Fern Valley”) in the reserve’s core zone of Kim Hy commune. The original vegetation of this valley appears to have been unusually rich in ferns and lichens, but today is preserved only in a small part of the area. Within a few years, the population of gold miners increased dramatically and culminated in the years 1987-1988. At that time, about 3’000 gold miners were working in Lung Cout, ten times the resident population of Kim Hy commune. The ground of the valley was tunnelled under so heavily by mining activities that it collapsed in several places, leaving several artificial depressions in the valley.
>
> Similar gold rush-like activities occurred in many other areas of Vietnam. Many communes hoping for an industrial boom had originally welcomed the arrival of gold miners and encouraged their activities. In many cases, the gold mining brought many less attractive activities to the villages such as prostitution, drug abuse and an increase in crime.

More visible are the dramatic effects of mining activities on the environment, especially when conducted by large groups of miners. Vegetation is destroyed and replaced by a landscape of craters. In addition, the chemicals (most notably quicksilver) used to bind the gold poison the rivers.

The government tolerated wild mining as long as complaints about negative incidents did not accumulate excessively. When exactly this happened, Kim Hy commune was ordered to stop mining activities in the area. Gold mining was declared illegal in the Kim Hy forest, but several attempts to drive the gold miners away failed. On 1 January 1998, the Kim Hy commune took a drastic measure and imposed an "embargo" upon Lung Cout. It was forbidden to bring any food to the valley or sell it to non-community members. As a result, virtually all gold miners were finally driven away from the area early in 1998. In all probability, this measure drastically increased the hunting pressure during the final days of the gold miners in Lung Cout.

In 1998, we discovered various abandoned camps of hunters, loggers and gold diggers in the surveyed areas. We met few miners, hunters, and loggers in Kim Hy. Most of them were working alone are in small groups, and most of them were relatively close to the village of Ban Ke from which we had entered the forest. All mining was done manually.

The most valuable trees have apparently already been removed from the Kim Hy forest by selective logging, making Kim Hy less attractive for loggers.

In 1998, we were told that a gold miner may earn an estimated amount of about US$ 5 per day, which is more than the income of a hunter and considerably more than that of a rice farmer. This makes gold mining economically very attractive to many people.

If we compare these findings from 1998 to our new survey results, it appears that history repeats itself, as large mining sites such as Lung Luc are reported to have grown in the core zone of Kim Hy once again.

Also worrying is the realisation that the scale of the destructive activities is increasing. Some interviewees reported that illegal logging in Kim Hy had reached previously unknown dimensions. This is corroborated by the following recent newspaper report. "In the past, loggers in Kim Hy felled trees manually, which didn't seriously damage the reserve, but now they log by sawmill" (Viet Nam News, 2008). According to the same source, there are 50 sawmills and five timber-yards operating in the area, of which only one is licensed.

Gold mining today has also more destructive potential than in 1998. Traditionally, gold mining in limestone areas such as Kim Hy was limited to locations that had a water source. Water is the limiting resource of the karst habitat. This limitation no longer seems to apply. As described in this report, the miners now install water pipelines with pumps that can transport the water across the karst mountains. This essentially means, that the miners now are able to mine wherever they like. There are no safe places in Kim Hy anymore and this obviously forebodes negatively upon the future conservation and management of biodiversity within the Reserve.

Large mining camps also need a high amount of food provision. If these camps are located in the middle of the forest, this usually means that the hunting pressure goes up. This may explain why we heard gunshots in the core zone almost every day.

In summary, we conclude that cao-vit crested gibbons of the Kim Hy Nature Reserve probably became extinct at the beginning of this century. In view of the increasing amount of damaging human activities in the nature reserve, we find little comfort in our result that macaques – probably stump-tailed macaques (*Macaca arctoides*) – and Francois's leaf monkeys (*Trachypithecus francoisi*) still occur in Kim Hy, because we do not think that these primates can withstand the increasing hunting pressure for long.

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