

Distribution and conservation status of *Hoolock leuconedys* in China

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Abstract: We conducted an intensive survey of *Hoolock leuconedys* covered all known possible gibbon populations in the west bank of Salween River in China. The total population was estimated to less than 50 groups. Seven out of 9 groups observed comprised one adult pair and 0-3 offspring, while another two groups comprised 1 adult male and 2 adult females. The mean group size was 3.88 individuals. Therefore, the total population was less than 200 individuals. The population was severely fragmented in 21 localities with the biggest subpopulation was 5 groups. Compared with the population in 1985 and 1994, 5 populations have been declining and gibbons extirpated from 9 other localities. But 2 other population seemed to be increasing. And we discovered 2 new populations during this survey. Commercial logging, illegal hunting, agricultural encroachment and isolated small population posed a serious negative effect on the future of *H. leuconedys* in China. An integrative conservation plan including new nature reserve establishment, conservation oriented research and conservation awareness education is urgent needed to ensure the survival of *H. leuconedys* in China.

Keywords: white-browed gibbon; *Hoolock leuconedys*; population; distribution; conservation; China

Introduction

China supports one of the world's richest gibbon faunas with 3 genus (Hylobates, Nomascus, and Hoolock) and 6 species (*Hylobates lar*, *Nomascus concolor*, *N. nasutus*, *N. hainanus*, *N. leucogenys*, and *Hoolock leuconedys*) (Geissmann et al., 2007), and topped only by Indonesia (Grueter et al., 2009). But all of these species are on the edge of extinction in China. *H. lar* was presumed to be extinct from China (Grueter et al., 2009). A recent interview survey showed that *N. leucogenys* has a very small population with maybe less than 10 individuals in China and could not survive in a long time (Fan and Huo, 2009). The other two species, *N. nasutus* and *N. hainanus*, each has only one population in the world and both has ca 20 individuals in China (*N. nasutus*: Chan et al., 2008; Fan et al., unpublished data; *N. hainanus*: Zhou et al., 2005). *N. concolor* has the biggest population with only ca 1000 individuals and fragmentally distributed in several mountain areas (Jiang et al., 2006). The population of *H. leuconedys* was estimated to be 50-100 groups in the last survey between 1992 and 1994 (Lan et al., 1995). Scientists warn that the loss of the *H. lar* is an omen of things to come. It may just be the beginning of an unprecedented wave of extinctions that threatens to purge out most or all of China's ape species (Geissmann et al, 2007). Therefore, it is urgent to assess population and conservation status of the gibbon taxa in China. We focus on *H. leuconedys* in this study.

H. leuconedys and *H. hoolock* are traditionally thought to belong the same species as two subspecies (eastern subspecies: *H. h. leuconedys* and western subspecies: *H. h. hoolock*) occurs in India, Bangladesh, Burma and China, but now are recognized as two different species based on distinct features in fur coloration (Geissmann, 2007). The eastern species (*H. leuconedys*) distribute in China, Myanmar and India, east of the river Chindwin, while the western species (*H. hoolock*) distribute in Myanmar, India and Bangladesh, west of the river Chindwin (Groves, 1967, 1972; Das et al., 2006). The adult male of western species are jet black with perputial tuft black or only faintly grizzled; white brow streaks close together, connected by white hairs; a little on chin or under eyes (Groves, 2001). The hair of

adult females' hands and feet are generally the same color as the body hair (Groves, 1972). The adult male of eastern species have black coat with white perputial tuft and brow streaks well separated with no white hairs between, and adult females have distinctly lighter hands and feet (Groves, 1972; Das et al., 2006).

H. leuconedys is threatened mainly by habitat loss and hunting and is "Vulnerable" according to IUCN (Geissmann, 2007). The past distribution of this species within China covered several counties in the west bank of Salween River: Lushui, Baoshan, Tengchong, Longling, Lianghe, Yingjiang, Longchuan, Luxi, and Ruili (Fig. 1) (Li and Lin, 1983; Tan, 1985; Fooden et al., 1987; Ma and Wang, 1986, 1988; Yang et al., 1985, 1987; Lan et al., 1995). *H. leuconedys* still occurred in 7 counties by 1985 (Yang et al., 1985). However, gibbons were thought be extinct in Luxi, Lushui, and Longling before 1994 (Lan et al., 1995). The most recently published census, carried between 1992 and 1994, reported 50-100 groups distributed mainly in three forest patches: Gaoligongshan Nature Reserve, a forest patch including three towns (Houqiao, Zhina and Sudian) along Chinese-Burma border, and Husha in Longchuan (Fig. 1) (Lan et al., 1995). Habitat loss and fragment are the major threats for the gibbon's survival (Lan et al., 1995). Forest has been threatened by commercial logging and at least 20 roads crossed the forest in Sudian to Myanmar fragmented the gibbon habitat (Lan et al., 1995). However, besides the population inside Gaoligongshan Nature Reserve, the rest two populations are still unprotected at present. No data were available on current existence, status, and population size of *H. leuconedys* in China since the last survey between 1992 and 1994. Our objective was to conduct an intensive census of *H. leuconedys* in China. We aimed to determine whether gibbons are still present, to assess their population size and distribution, and compile a list of factors threatening their survival.

Methods

Survey area

Although number of researchers reported the distribution of white-browed

gibbons in China (Li and Lin, 1983; Tan et al., 1985; Fooden et al., 1987; Ma and Wang, 1986, 1988; Yang et al., 1985, 1987; Lan et al., 1995), only Yang et al (1985) and Lan et al (1995) have reported the detail information of distribution localities. We determined survey area by combining the distribution information from Yang et al (1985) and Lan et al (1995). We also contact the Forestry Bureau or Nature Reserve Management Bureau of Lushui, Longling and Ruili. No gibbon was seen or heard in recent years in Longling and Ruili. There was some uncertain information response from Lushui, but we could not obtain the distribution information. Therefore, our main survey area was Baoshan (eastern slope of Gaoligongshan Nature Reserve), Tengchong (western slope of Gaoligongshan Nature Reserve and Houqiao), Yingjiang, and Longchuan (Fig. 1).

White-browed gibbons live in the warm evergreen broad-leaved forest between 1650-2600 m above sea level in the survey area (Yang et al., 1985). The overwhelming trees are from the family Fagaceae. The annual temperature is 12-18 °C and the relative moisture is 70-85% (Yang et al., 1985). Lisu minority and Han people make the majority of the population, and Jingpo, Dai, Achang, Deang and Wa minority also occurred in the west bank of Salween River.

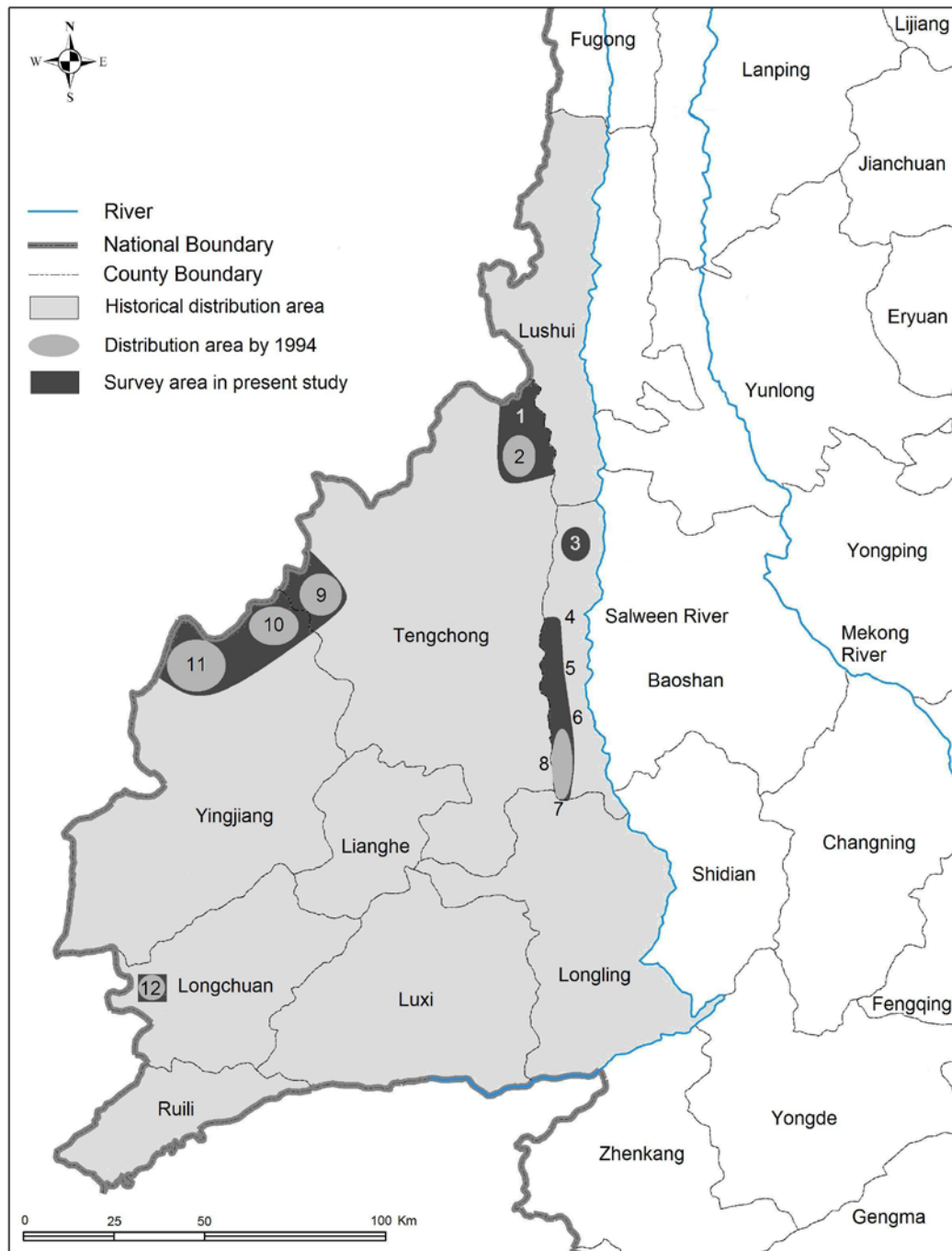


Fig.1 Distribution map of *Hoolcok leuconedys* in west of Salween River, Yunnan, China: 1. Zizhi; 2. Datang; 3. Mangkuan; 4. Baihualin; 5. Saige; 6. Bawan; 7. Nankang; 8. Dahaoping; 9. Houqiao; 10. Zhina; 11. Sudian; 12. Husa. The first 8 localities are inside Gaoligongshan Nature Reserve.

Survey methods

Interview with local people, especially old hunters, who know their surrounding environments well, has been done in the villages near to the historic distribution area of gibbons between October 19th and November 4th 2008. During the interviews, we aimed to obtain information of current and historical distribution, hunting, local extinction, and relevant environmental catastrophes in recent history, both natural and anthropogenic. If gibbons are still present, we tried to identify potential areas of current gibbon distribution.

Field surveys have been conducted between March 17th and April 17th, and between September 8th and 15th 2009. Detail information about the survey period for each site has been showed in Table 1. Field survey areas were determined based on the information obtained from the interview survey. Only those areas where gibbon calls were heard during the recent 5 years and the forest still looks suitable for gibbon living has been surveyed. Informal interview has also been conducted during the field survey for collecting more information of gibbon distribution. Due to the calling behaviour of gibbons, monitoring of loud calls from so-called listening posts was used. This method was developed by Brockelman and Srikosamatara (1993) and has been proven efficient and is currently the standard procedure and widely applied in many gibbon surveys (e.g. Jiang et al., 2006; Das et al., 2006; Geissmann and Nijman, 2006; Buckley et al., 2006; Grueter et al., 2009). We established 36 listening posts on ridge tops from where surveyors monitored gibbon vocal activity for at least 4 consecutive days/listening post (Table 1). In the bigger forest patches with more than 1 group, we established at least 2 listening posts, and distance between listening posts was 1 km or less (Table 1). But in those isolated small forest patches with maybe only 1 group, we established only 1 listening post. One exception was Nankang Park. The gibbon population in this park has been monitored since 2004. An intensive transect line survey focused on primate diversity has been conducted from March 10th to 20th, 2008. All gibbon groups have been observed during this period.

In each listening post, we have at least two surveyors, one student or teacher

from Dali University and the other is ranger or staff from the nature reserve or forestry bureau, and sometimes a more local guide. All students and teachers from Dali University and most rangers and staffs from nature reserve or forestry bureau have been trained the survey techniques and gibbon singing bouts before the field work. Because white-browed gibbons' singing bouts is very loud and special, it is very easy to distinguish gibbon calls from other animal's call in the forest. Surveyors occupied the listening post from sunrise, around 0630 am to 1200 am. Geographical coordinates of listening posts, direction and estimated distance to the calling gibbons, starting and stopping time of singing bouts, numbers of singing individuals per group if possible has been recorded. We also tried to observe gibbons and record their group composition when they produced calls near to our listening posts.

The duets given out simultaneously or partially overlapping in time are easily distinguished as different groups. However, sounds heard at different times need to be distinguished with a combination of direction, distance, and duet features of singing groups (Jiang et al., 2006). Based on the preliminary observation in Nankang Park, one white-browed gibbon group occupied a home range about 100 ha. And black-crested gibbons in Wuliang Mountain, living a similar habitat and altitude with white-browed gibbon in Gaoligong Mountain, occupied home range more than 100 ha (Fan and Jiang, 2008). Therefore, we applied a rule that duets located more than 1,000 m apart were considered to given by separate groups. If groups singing at less than 1000 m apart and at different times, these might also be separated as two groups, based on confirmation from more sample days and other information, such as duet features. Because gibbon density was low in every site, we did not hear more than 4 groups in any single listening post, it was relatively easy to distinguish different groups.

Results

Current population and distribution

During this survey, we heard 32-34 groups and 5 solitary individuals (Table 1). Another 8-9 groups have been recorded by rangers or staff from the nature reserve or

forestry bureau 1 month before or 1 week later the main survey period (Table 1). Therefore, the total population was 40-43 groups distributed in 3 counties, 9 towns and 21 localities (Table 1).

Gibbons live in the forest between 1,600 -2,600 m above sea level. The whole population was severely fragmented at present. Each site just holds not more than 5 groups. And in many places, there was only 1 group and was isolated from other population by roads and villages (Table 1). The forest inside reserve is very good, but the gibbon population is not uninterrupted. The mountain ridges of Gaoligongshan, usually higher than 3,000 m, might have separated the population in east and west slope to two subpopulations. The distance between the five distribution localities in the east slope in Baoshan, and between the two localities in the west slope of the mountain in Tengchong (Fig. 1 and Table 1) was more than 3 Km.

Group composition

We observed 9 groups in 8 localities during the survey. Each group consisted of 1 single adult male, 1-2 adult females, 1-2 juveniles and 0-1 infant (Table 2). The average group size was 3.9 individuals.

Table 2. Group composition of 9 *Hoolock leuconedys* groups in Yunnan, China.

Localities	Adult male	Adult female	Juvenile	Infant	Total
Nankang	1		1		3
Dangganghe	1	2	1		4
Bancang	1	1	1	1	4
Datang1	1	1	2		4
Datang2	1	1			2
Heinitang	1	1	2		4
Xiangbaiyakou	1	2	2	1	6
Lamahe	1	1	2	1	5
Jiganzhai	1	1	1		3

Table 1. The population and distribution of *Hoolock leuconedys* in China in 2009.

County	Town	Localities ³	Coordinate and altitude	Survey period	Surveyors	LPs	Groups heard	Solitary individual heard	Other groups heard ²
Baoshan	Nankang ¹	Nankang Park	N24°49'45", E98°46'24", H2045m	2008.3.10-20	16		1	1	
	Bawan	Qinglongshan	N25°03'00", E98°47'31", H2235m	2009.4.8-15	4	2	1		1
	Saige	Bailaotang- Dangganghe	N25°08'15", E98°47'05", H2140m	2009.4.8-15	7	3	1		1
		Banchang	N25°13'37", E98°46'58", H2049m	2009.4.8-15	6	4	4	1	1
	Baihualin	Manghehe	N25°15'27", E98°45'34", H2685m	2009.4.8-15	7	4	3	1	2
Tengchong	Datang	Dahelinggang	N25°45'10", E98°42'05", H2324m	2009.3.29-4.7	8	3	3-4		
	Zizhi	Dongbinghe	N25°48'06", E98°41'41", H2433m	2009.3.29-4.7	5	2	2	2	
	Houqiao	Heinitang	N25°20'47", E98°06'38", H2318m	2009.3.24-28	3	3	3-4		
Yingjiang	Zhina	Xiangbaiyakou	N25°11'55", E98°01'52", H1848m	2009.9.11-15	2	1	2		
		Muguahe	N25°16'48", E98°08'32", H2140m	2009.9.11-15	2	1	1		
		Duidayakou	N25°15'26", E98°05'13", H2057m	2009.9.11-15	2	1	1		

Sudian	Wawengbengshan	N25°09'50", E98°02'48", H1596m	2009.9.11-15	2	1	1		
	Shizhuyakou	N25°16'02", E98°05'10", H1902m	2009.9.11-15	2	1	1		
	Zhongxinhe	N25°15'58", E98°05'36", H1674m	2009.9.11-15	2	1	1		
	Lamahe	N25°07'34", E97°55'55", H1808m	2009.3.19-22	4	3	3		
	Lishu	N25°08'39", E97°57'47", H1909m	2009.3.19-22	1	1	1		
	Jiganzhai	N25°08'40", E97°51'33", H1803m	2009.9.11-15	2	1	1		
	Zijiawaduo	N25°12'03", E97°51'02", H2082m	2009.9.11-15	3	1	1		
	Luogangwaji	N25°14'23", E97°50'23", H1667m	2009.9.11-15	3	1	0	1	
	Xiaoqueyakou	N25°15'49", E97°51'09", H2378m	2009.9.11-15	3	1	0	1-2	
	Chengqiangyakou	N25°12'12", E97°51'58", H2214m	2009.9.11-15	4	1	1	1	
Total	3	9	21	88	36	32-34	5	8-9

1. Gibbon population in Nankang Park was survey by transect line method.
2. Other groups heard by rangers or staff of nature reserve or forestry bureau 1 month before or 1 week later the survey period.
3. The localities in shadow are inside Gaoligongshan Nature Reserve.

Table 3. Population and distribution of *Hoolock leuconedys* in 1985, 1994 and 2009 in China.

County	Town	Population		
		1985	1994	2009
Baoshan	Nankang ¹	5		1
	Bawan	8		2
	Saige			7
Tengchong	Baihualin ²	2		5
	Mangkuan	1	0	0
	Jietou	1		0
	Houqiao ³	2	6-12	3-4
	Datang		5-10	3-4
	Zizhi			2
	Dahaoping		1-5	0
Yingjiang	Menglong	2		0
	Xima	5-7		0
	Jiucheng	1-2		0
	Jiema	1-2		0
	Zhina		1	7
	Sudian		21-32	10-11
Longchuan	Husa	1	3-8	0
	Wangzishu	1	0	
	Bangwa	1	0	
	Fuguo	1	0	
	Bangwai	1		
Luxi	Zhongshan	3-4	0	
Lushui	Shangjiang	4-6		?
Longling	Anding	1	0	0
Total		41-48	36-67	40-43
References		Yang et al., 1985	Lan et al., 1995	This study

1. Population information of Nankang in 1985 was obtained from interviewees during this study.
2. Baihualin includes Ganding in Yang et al., 1985.
3. Houqiao is a new name of Guyong in Lan et al., 1995.

Discussion

Group composition and group size

White-browed gibbons usually live in one adult pair groups (Islam and Feeroz,

1992), though a multi-female group has also been recorded (Ahsan, 1995). Our observations during this study confirmed this idea. Seven out of 9 groups observed comprised one adult pair and 0-3 offspring, while another two groups comprised 1 adult male and 2 adult females.

The reproduction of gibbons both live inside and outside the reserve seemed not worse than those groups reported in Islam and Feeroz (1992). And the mean group size (3.88) was larger than that of white-browed gibbons in India (3.32) and in Bangladesh (3.03) (Das et al., 2003). But we needed to explain that the large group in Xiangbaiyakou and Lamahe (Table 2) lived in an isolated forest patch, the large group size might due to the later dispersal of subadult or big juveniles.

Population dynamics

During this survey, 40-43 groups and 5 solitary gibbons have been recorded. It is possible that some other groups remain undetected during the survey, but the undetected population should be very small. The total population of white-browed gibbon was, therefore, estimated to be less than 50 groups in China. By multiplying the mean group size 3.88 obtained from this survey, the population was less than 200 individuals.

Compared with the total population in 1985 (Yang et al., 1985), 1994 (Lan et al., 1995) and this survey, white-browed gibbon population seemed to be stable in China (Table 3). However, gibbon population in Nankang, Bawan, Houqiao, Datang, and Sudian has declined 50% or more. And 9 populations in Mankuang, Jietou, Dahaoping, Menglong, Xima, Jiucheng, Jiema, Husa, and Anding were presumed to be extirpation in the past 2 decades (Table 3). Two populations in Baihualin and Zhina seemed to have been increasing, but this was also possibly due to the more intensive survey in this study. Two new populations, Saige and Zizhi, also contributed to the stability of the total population.

Main threats

Commercial logging, resulting in habitat destruction, degradation and fragmentation was the main threat to gibbons living outside Gaoligongshan Nature Reserve. Lan et al (1995) reported at least 20 roads have been constructed crossing the forest in Sudian to Burma and most forest has been destroyed in Zhina and Houqiao during their 2 years survey period. When we visited these areas during this study, many forests has been destroyed by commercial logging. The remnant forest has been severely fragmented by log transportation roads. The isolated small forest patches usually support only 1 group (Table 1). Commercial logging was thought to be the main reason in gibbon extirpation in Mulonghe, where ever held the biggest gibbon population when Lan and his colleagues conducted their survey in 1993 and 1994, and possible the main reason in population decline in Heinitang.

Hunting was another important threat. Lan et al (1995) reported that Lisu people in Sudian and Heinitang has a traditional custom in protecting gibbons. It was confirmed in this study. Most of Lisu people in Sudian, Zhina and Houqiao never shoot gibbons, though very few people still shot gibbons. This might be the main reason why gibbons could survive in those small unprotected forest patches where they were easy to be detected and then to be shot. Because the local hunted other primates, gibbon is the only non-human primates in most of these patches. Although the management and patrol has been significantly improving in recent years, illegal hunting maybe still occur inside the reserve. We heard gunshots in Qionglongshan and Bancang during the survey. And the rangers involved in the survey reported that at least 3 gibbons have been killed by hunters in recent 15 years. It has been suggested that even a 3% harvest per year might drive a gibbon population to local extinction (Seal 1994). Hunting might has a more serious impact on the small population (Fan and Jiang, 2007). The population decline and extirpation in Bawan, Jietou, and Dahaoping was presumed to be caused by hunting because the forests in these areas are still very good and suitable for gibbon living.

Agriculture encroachment, especially tsaoko planting, was another threat

influencing gibbons' long time survival. Tsaoko plantation occurred in all gibbons' habitat except Xiaoqueyakou and Chengqiangyakou outside reserve, and also in Nankang and a small part in Bancang inside reserve. It made the main, nearly all economic source for the local Lisu minority people. For tsaoko plantation, local people cut down some trees in the moist valley to reduce the canopy density to 50-70%. And they also clear off the small trees and lianas in the valley. It thus reduced gibbons' food tree densities and increased gibbon's forage effort because of the discontinuous canopy. It would also influence the forest regeneration in long time because of clearing small trees. On the other hand, tsaoko plantation has a positive effect on the gibbon conservation in short time. Because tsaoko need to be planted under canopy, local people preserve some forest near to their villagers where is suitable to plant tsaoko. These preserved forest provided the last refuge for gibbons in many sites. In some sites, local people admitted that they might cut all trees if the forest was not suitable for tsaoko plantation. Comparative studies focus on the gibbons' behaviour living in forest with and without tsaoko plantation should provide important insights on the gibbon conservation.

Besides tsaoko plantation, rotation agriculture still occur in Sudian where Lisu minority living. They cut down primary forest for plantation every year. This also resulted in gibbons' habitat destruction and fragmentation. Population decline in Nankang was thought to be caused by the combined effects of hunting and tsaoko plantation.

Another potential threat is small effective population size and lack of gene flow within populations. The population is severely fragmented with less than 4 groups, even only 1 group in isolated forest patches outside the reserve. This may lead to a suite of problems, such as low availability of suitable mates, loss of genetic variability, inbreeding depression, and other cumulative effects of population fragmentation (Jiang et al., 2006). The population is also fragmented inside the reserve. Because gibbons usually dispersal for a short distance (Brockelman et al., 1998; Lappan, 2007). If white-browed gibbon could dispersal between these localities in the same slope of

the mountain is uncertain at present.

Conservation suggestions

1. Based on this survey, we strongly suggested the government establishing a new nature reserve along the Chinese-Burmese border to protect the population in Houqiao, Zhina and Sudian. This area holds half of the total population of *H. leuconedys* in China. But the forest has been destroying by commercial logging and agricultural encroachment. A very small gibbon population may still occur in the Burma side close to this area. Establishment a nature reserve will also contribute the trans-boundary conservation in future.

2. Though hunting of gibbons is very rare at present. But it still poses a serious potential threat on gibbons' survival. It should be prohibited but it is very difficult to achievement.

3. Conservation oriented research focused on the effect of tsaoco plantation on the gibbons' behaviour will provide important information to formulate an effective conservation action plan. A long term population monitoring will prove if gibbons could dispersal from one patch to another patch.

4. Conservation awareness education on gibbons' conservation status, sustainable economy will be much helpful for the conservation. During this survey, we also conducted brief gibbon conservation education in the villages where we visited. Many local people did not know white-browed gibbon is an endangered species and listed as class I in Chinese animal conservation law.

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