

Distribution and conservation status of the Vulnerable eastern hoolock gibbon *Hoolock leuconedys* in China

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Abstract We conducted an intensive survey of the Vulnerable eastern hoolock gibbon *Hoolock leuconedys* along the west bank of the Salween River in southern China, covering all known hoolock gibbon populations in China. We found 40–43 groups, with a mean group size of 3.9, and five solitary individuals. We estimated the total population to be < 200. In the nine groups for which we recorded composition, seven comprised one adult pair and 0–3 offspring and the other two groups both comprised one adult male and two adult females. The population is severely fragmented, in 17 locations, with the largest sub-population containing only five family groups. Compared with the population in 1985 and 1994 five subpopulations have declined and gibbons have been extirpated from nine localities, although we discovered two previously unknown subpopulations. Commercial logging, illegal hunting, agricultural encroachment and population fragmentation pose serious threats to the future of *H. leuconedys* in China. An integrated conservation plan, including nature reserve establishment/expansion, enforcement of existing laws, conservation education, translocation and conservation-oriented research are needed to ensure the survival of *H. leuconedys* in China.

Keywords China, distribution, eastern hoolock gibbon, *Hoolock leuconedys*, population, primate, Yunnan

Introduction

Eastern hoolock *Hoolock leuconedys* and western hoolock gibbons *Hoolock hoolock* were considered a single species before 2005. They are now recognized as separate species based on distinctive fur colouration (Mootnick & Groves, 2005; Geissmann, 2007). The eastern species occurs in China, Myanmar and India east of the Chindwin River and the western species in Myanmar, India and Bangladesh west of the Chindwin River (Groves, 1967, 1972; Das et al., 2006).

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Several recent studies have described the eastern hoolock gibbon populations outside China. Das et al. (2006) identified the eastern species for the first time in the Lohit district of Arunachal Pradesh in India. Chetry et al. (2008) found an additional 150 groups between Dibang and Lohit in Arunachal Pradesh, India. Brockelman et al. (2009) estimated the population size in Mahamyaing Wildlife Sanctuary in Myanmar to be c. 5,900. Walker et al. (2009) estimated that the Hukaung Valley Reserve in northern Myanmar could support tens of thousands of eastern hoolock gibbons, potentially the largest population in the world.

No recent data are available on the current distribution, status and population size of *H. leuconedys* in China. Early studies found that the eastern hoolock gibbon was distributed in nine counties along the west bank of the Salween River: Lushui, Baoshan, Tengchong, Longling, Lianghe, Yingjiang, Longchuan, Luxi and Ruili (Fig. 1; Li & Lin, 1983; Tan, 1985; Yang et al., 1985, 1987; Ma & Wang, 1986, 1988; Fooden et al., 1987). A census carried out during 1992–1994 recorded 36–67 groups in only four counties: Baoshan, Tengchong, Yingjiang and Longchuan (Lan et al., 1995).

The eastern hoolock gibbon is categorized as Vulnerable on the IUCN Red List (Brockelman & Geissmann, 2008) and as a Class I species under the Chinese animal conservation laws. Despite this, in China, only the population inside Gaoligongshan Nature Reserve is legally protected. In the study reported here we resurveyed the eastern hoolock gibbon in China, assessing its current population size and distribution, and examined the factors threatening the species.

Methods

Although a number of researchers have written about the distribution of the hoolock gibbon in China (Li & Lin, 1983; Tan, 1985; Yang et al., 1985, 1987; Ma & Wang, 1986, 1988; Fooden et al., 1987; Lan et al., 1995), only Yang et al. (1985) and Lan et al. (1995) reported detailed location information. We determined our survey area by combining the historical information from Yang et al. (1985), Lan et al. (1995) and information obtained from interviews.

In October and November 2008 we conducted interviews with local people, especially nature reserve rangers and old hunters, in the historical range of gibbons in China. During the interviews we asked for information about the current and historical distribution, hunting, local extinction

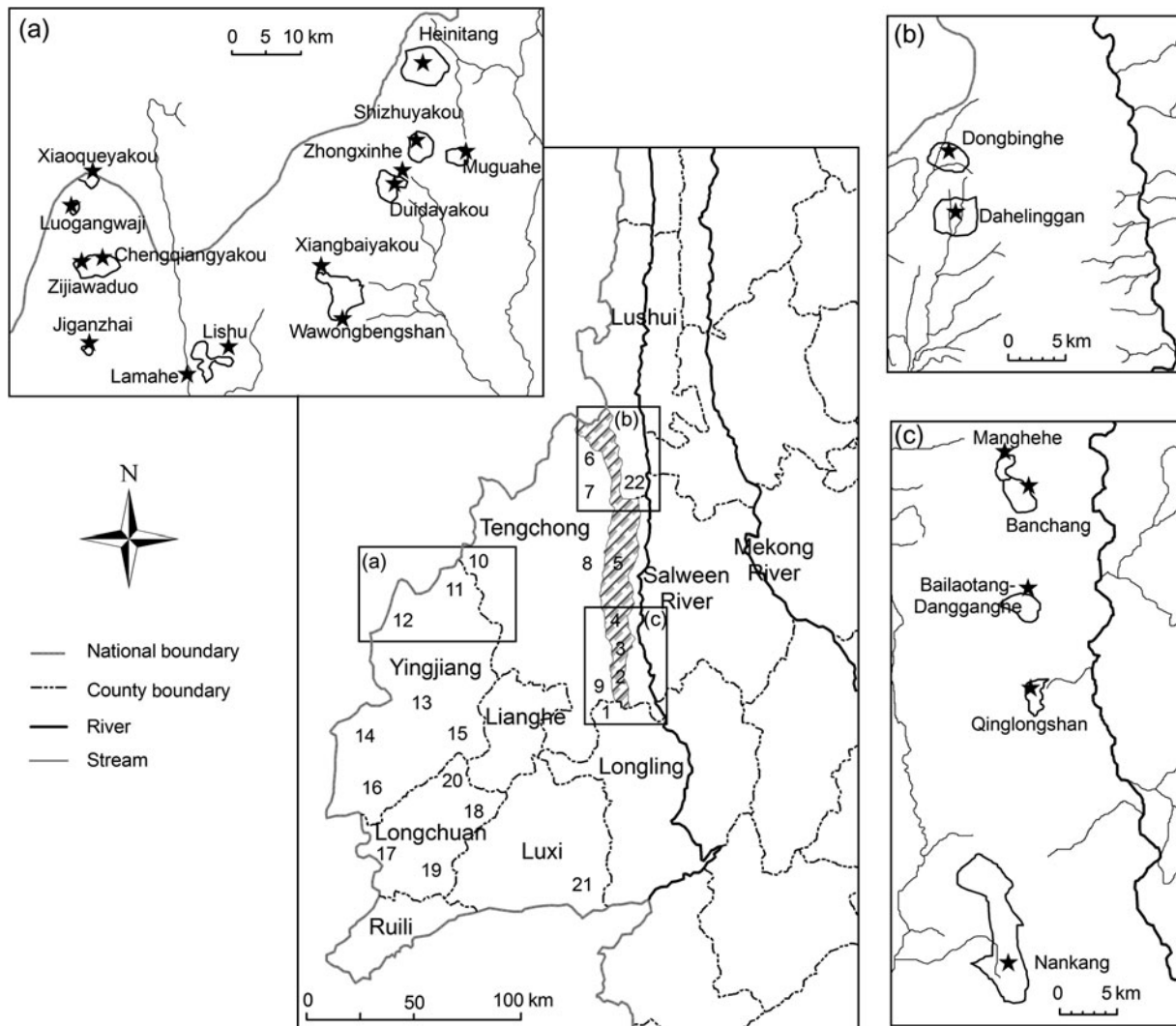


FIG. 1 Historical and current distribution area of *Hoolock leuconedys* west of the Salween River in Yunnan, China: 1, Nankang; 2, Bawan; 3, Saige; 4, Baihualin; 5, Mangkuan; 6, Zizhi; 7, Datang; 8, Jietou; 9, Dahaoping; 10, Houqiao; 11, Zhina; 12, Sudian; 13, Menglong; 14, Xima; 15, Jiucheng; 16, Jiemao; 17, Husa; 18, Wangzishu; 19, Bangwa; 20, Fuguo; 21, Zhongshan; 22, Shangjiang. Localities 1–9 are within Gaoligongshan Nature Reserve.

and any relevant environmental catastrophes in recent history, both natural and anthropogenic. Additional informal interviews were also conducted opportunistically during the field surveys.

Using the information obtained during the interviews we conducted field surveys between 17 March and 17 April 2009 and during 8–15 August 2009. Groups of hoolock gibbons heard by rangers or staff of the nature reserve or forestry bureau 1 month before or 1 week after the survey periods are also included in the results. We recorded the species' presence by monitoring its distinctive calls from 38 listening posts on ridge tops. This method was developed by Brockelman & Srikosamatara (1993) and is widely used in gibbon surveys (Johnson et al., 2005; Buckley et al., 2006; Das et al., 2006; Jiang et al., 2006; Phoonjampa & Brockelman, 2006; Brockelman et al., 2009). At least two surveyors monitored gibbon vocal activity from sunrise, c. 06.30, to 12.00 for a minimum of 4

consecutive days (Table 1). These listening posts covered all potential ranges. During each survey the geographical coordinates of listening posts, direction and estimated distance to the calling gibbons, starting and stopping time of calling bouts, and number of singing individuals per group were recorded when possible. We used triangulation to estimate the location of each singing group. We also tried to observe gibbons directly and record their group composition when they called near the listening posts. During 10–20 March 2008 we conducted an intensive line transect survey focused on primates in Nanking Park, and the data obtained for hoolock gibbons in that survey are also included here.

Results

We heard 32–34 groups and five solitary individuals of *H. leuconedys* (Table 1). Another 8–9 groups were recorded by

TABLE 1 Locations, survey date, survey details and number of groups and individuals of *Hooock leuconedys* heard and/or seen in the species' range west of the Salween River in Yunnan (Fig. 1) in 2008–2009.

Township or ranger station (by County)	Localities ¹	Latitude, longitude, altitude (m)	Date	No. of surveyors	No. of listening posts	Survey area (km ²)	No. of groups heard	No. of solitary individuals heard	No. of other groups heard ²
Baoshanv									
Nankang ³	<i>Nankang Park</i>	N 24°49'45", E 98°46'24", 2,045	10–20 Mar. 2008	16		35.0	1	1	
Bawan	<i>Qinglongshan</i>	N 25°03'00", E 98°47'31", 2,235	8–15 Apr. 2009	4	2	4.5	1		1
Saige	<i>Bailaotang-Dangganghe</i>	N 25°08'15", E 98°47'05", 2,140	8–15 Apr. 2009	7	3	6.9	1		1
	<i>Banchang</i>	N 25°13'37", E 98°46'58", 2,049	8–15 Apr. 2009	6	4	6.6	4	1	1
Baihualin	<i>Manghehe</i>	N 25°15'27", E 98°45'34", 2,685	8–15 Apr. 2009	7	4	3.4	3	1	2
Tengchong									
Datang	<i>Dahelinggang</i>	N 25°45'10", E 98°42'05", 2,324	29 Mar.–7 Apr. 2009	8	3	10.5	3–4		
Zizhi	<i>Dongbinghe</i>	N 25°48'06", E 98°41'41", 2,433	29 Mar.–7 Apr. 2009	5	2	6.4	2	2	
Houqiao	Heinitang	N 25°20'47", E 98°06'38", 2,318	24–28 Mar. 2009	3	3	9.0	3–4		
Yingjiang									
Zhina	Xiangbaiyakou	N 25°11'55", E 98°01'52", 1,848	11–15 Aug. 2009	2	1	6.7	2		
	Wawongbengshan	N 25°09'50", E 98°02'48", 1,596	11–15 Aug. 2009	2	1		1		
	Muguahe	N 25°16'48", E 98°08'32", 2,140	11–15 Aug. 2009	2	1	2.0	1		
	Shizhuyakou	N 25°16'02", E 98°05'10", 1,902	11–15 Aug. 2009	2	1	3.7	1		
	Duidayakou	N 25°15'26", E 98°05'13", 2,057	11–15 Aug. 2009	2	1	3.5	1		
	Zhongxinhe	N 25°15'58", E 98°05'36", 1,674	11–15 Aug. 2009	2	2		1		
Sudian	Lamahe	N 25°07'34", E 97°55'55", 1,808	19–22 Mar. 2009	4	3	3.0	3		
	Lishu	N 25°08'39", E 97°57'47", 1,909	19–22 Mar. 2009	2	1		1		
	Jiganzhai	N 25°08'40", E 97°51'33", 1,803	11–15 Aug. 2009	2	1	0.4	1		
	Zijiawaduo	N 25°12'03", E 97°51'02", 2,082	11–15 Aug. 2009	3	1	4.5	1		
	Chengqiangyakou	N 25°12'12", E 97°51'58", 2,214	11–15 Aug. 2009	4	2		1		1
	Luogangwaji	N 25°14'23", E 97°50'23", 1,667	11–15 Aug. 2009	3	1	0.6	0		1
	Xiaoqueyakou	N 25°15'49", E 97°51'09", 2,378	11–15 Aug. 2009	3	1	1.1	0		1–2
Total				89	38	107.8	32–34	5	8–9

¹Localities in italics lie within Gaoligongshan Nature Reserve

²Other groups heard by rangers or staff of nature reserve or forestry bureau 1 month before or 1 week after the survey

³Surveyed by line transects

rangers or staff from the nature reserve or forestry bureau (Table 1). The total recorded population was therefore 40–43 groups and five solitary individuals. By multiplying the mean group size obtained from this survey, 3.9, by the number of groups, we estimate the total population to be < 200 individuals.

We located the species in 17 forest patches in nine townships over three counties (Fig. 1, Table 1). Each forest patch contained up to five groups, although five patches contained only one group (Table 1). Within Gaoligongshan Nature Reserve, although the forest between subpopulations were seemingly of adequate quality for *H. leuconedys* (with the exception of Bangchang and Manghehe), the patches were separated from each other by > 3 km (Fig. 1). The population appears to have become separated into three isolated subpopulations: Sudian–Zhina–Houqiao along the China–Myanmar border, Datang and Zizhi on the west slope of Gaoligongshan, and the east slope of Gaoligongshan (Fig. 1). We found gibbons at altitudes of 1,600–2,600 m, representing the highest altitude recorded for either western or eastern hoolock gibbons.

We observed nine groups in detail, in eight locations. Each group consisted of one single adult male, 1–2 adult females, 1–2 juveniles and 0–1 infants (Table 2). Mean group size was 3.9.

Commercial logging has been banned since 1998 in most of China, including the area of this study. However, it still occurs at a small scale. Commercial logging, both historical and current, has resulted in habitat destruction, degradation and fragmentation, and is the main threat to gibbons living outside Gaoligongshan Nature Reserve. Five small isolated forest patches outside the Reserve support only one group (Table 1). According to our interviews with local people commercial logging was the main reason for gibbon extirpation in Mulonghe in Sudian, which held the largest gibbon population in 1994 (Lan et al., 1995), and was possibly the main reason for the large population decline in Heinitang in Houqiao.

Hunting is also a threat. Although the management and patrolling of Gaoligongshan Nature Reserve has improved

recently, some illegal hunting still occurs there. We heard gunshots in Qionglongshan and Banchang during our survey. The rangers involved in the survey reported that at least three gibbons have been killed by hunters in the past 15 years. We presume that the decline of the gibbon in Bawan and extirpation in Jietou and Dahaoping were caused by hunting because the forests in these areas are still intact and apparently suitable for gibbons. Lan et al. (1995) reported that the Lisu people in Sudian and Heinitang do not have a tradition of killing gibbons. In our interviews we were told of only a few reported cases of people shooting gibbons in these areas. This might be the main reason why gibbons have survived in the small unprotected forest patches where they are easy to detect and shoot. Because local people still hunt other primates the gibbon was the only primate we found in most of the patches.

Agricultural encroachment, especially for tsaoko cardamom *Fructus tsaoko* planting, is another threat. Tsaoko cardamom is a culinary and medicinal herb and its collection is the main livelihood for local people in this region. Cardamom plantations occur throughout the gibbons' habitat at altitudes of 1,800–2,200 m outside Gaoligongshan Nature Reserve. To plant cardamom, trees are felled in moist valleys to reduce canopy density to 50–70% and small trees and lianas are cleared. In addition to cardamom plantations the Lisu practice rotational agriculture in Sudian. They cut down primary forest for plantations every year. This has also resulted in destruction and fragmentation of the species habitat.

Discussion

Estimates of 41–48 groups of *H. leuconedys* in 1985 (Yang et al., 1985), 36–67 in 1994 (Lan et al., 1995) and 40–43 in our 2008–2009 survey suggest that the species' population is stable in China (Table 3). However, our surveys were more intensive than previous studies and it is possible that the earlier research underestimated population size. There are indications that the gibbon population may be declining, including the fact that populations in Nankang, Bawan, Houqiao, Datang and Sudian have declined by $\geq 50\%$ since 1994. Furthermore, nine subpopulations, in Mankuang, Jietou, Dahaoping, Menglong, Xima, Jiucheng, Jiema, Husa and Anding, have been extirpated in the past 2 decades (Table 3).

Hoolock gibbons usually live in groups containing one adult pair (Islam & Feeroz, 1992) and our study confirmed this. Seven out of nine groups observed comprised one adult pair and 0–3 offspring and another two groups comprised one adult male and two adult females. However, a multi-female group has also been recorded in *H. hoolock* (Ahsan, 1995).

The reproduction of gibbons both within and outside Gaoligongshan Nature Reserve seems to be healthy. Eight

TABLE 2 Composition of nine groups of *H. leuconedys* observed in detail.

Localities	Adult male	Adult female	Juvenile	Infant	Total
Nankang	1	1		1	3
Dangganghe	1	2	1		4
Banchang	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 3 Number of family groups of *H. leuconedys* recorded in 1985, 1994 and 2009 in each township with known populations in China. A blank indicates the site was not visited in that year.

County	Township or ranger station	Number of groups		
		1985	1994	2009
Baoshan	Nankang ¹	5		1
	Bawan	8		2
	Saige			7
	Baihualin ²	2		5
Tengchong	Mangkuan	1	0	0
	Zizhi			2
	Datang		5–10	3–4
	Jietou	1		0
	Dahaoping		1–5	0
Yingjiang	Houqiao ³	2	6–12	3–4
	Zhina		1	7
	Sudian		21–32	10–11
	Menglong	2		0
	Xima	5–7		0
	Jiucheng	1–2		0
	Jiema	1–2		0
	Longchuan	Husa	1	3–8
Wangzishu		1	0	
Bangwa		1	0	
Fuguo		1	0	
Bangwai ⁴		1		
Luxi	Zhongshan	3–4	0	
Lushui	Shangjiang	4–6		?
Longling	Anding ⁴	1	0	
<i>Total</i>		41–48	36–67	40–43
References		Yang et al. (1985)	Lan et al. (1995)	This study

¹Information for Nankang in 1985 was obtained from interviewees during the present study

²Baihualin includes Ganding in Yang et al. (1985)

³Houqiao is the new name of Guyong in Lan et al. (1995)

⁴We could not confirm the locations of Bangwai and Anding and they are therefore not shown on Fig. 1

of nine groups had juveniles or infants (Table 2). The mean group size (3.9) is within the range of the mean group sizes of western hoolock gibbons in India and in Bangladesh (Das et al., 2009), and is greater than that of eastern hoolock gibbons in Mahamyaing Wildlife Sanctuary in Myanmar (Brockelman et al., 2009).

Although we found hunting of hoolock gibbons to be rare, even low levels of hunting can have a serious impact on small populations of gibbons (Fan & Jiang, 2007). Seal (1994) suggested that a 3% annual harvest could drive a gibbon population to local extinction. Although hunting has been banned, a total cessation of hunting activities can be difficult to achieve in these poor areas where there are limited livelihood opportunities. Conservation awareness education about the conservation status of gibbons and improving the livelihood options for local people are essential for conservation of this gibbon and its habitat. We found that most local people did not know that the

hoolock gibbon is a threatened species or that it is listed as a Class I species under Chinese animal conservation laws, which accords it the highest protection available. Besides education, stricter enforcement of existing laws and increased frequency of patrols by nature reserve staff and local forestry bureaus could decrease the impact of hunting on the gibbon population.

Another potential threat to *H. leuconedys* is its small effective population size and possibly a lack of gene flow. Gibbons usually only disperse over short distances (Brockelman et al., 1998; Lappan, 2007). A severely fragmented population can suffer from 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). Long-term population monitoring is needed to clarify if hoolock gibbons disperse between scattered forest patches. Translocations can be a good way to save small isolated populations that are at risk of extirpation. The forest inside Gaoligongshan Nature Reserve appears adequate to support a large number of gibbons but the gibbon population within the Reserve is small. It may be advisable to translocate isolated gibbons into the Reserve.

Tsaoko cardamom plantations reduce the density of the hoolock gibbon's food trees and may cause gibbons to use more energy in foraging because of the discontinuous canopy. These plantations can also decrease long-term forest regeneration because of the clearing of small trees. However, cardamom plantations have the potential to have a positive effect on gibbon conservation. Because cardamom needs to be planted under a canopy, local people preserve forests near their villages for planting. In interviews local people admitted that they might have cut down all of the trees in the area if the forest had not been suitable for cardamom plantation. These preserved forests provide refuge for gibbons. Future comparative studies focused on the behaviour of the hoolock gibbon in forests with and without cardamom plantations could provide important insights for the conservation of the species.

Based on our findings we recommend that the habitat in Houqiao, Zhina and Sudian, along the China–Myanmar border, which holds half of the total population of *H. leuconedys* in China should be protected. Yingjiang Forestry Bureau is planning to expand Tongbiguan Nature Reserve to cover this area and Fauna & Flora International China has secured funding for a transboundary conservation project for the hoolock gibbon along the border with Myanmar.

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