International Journal of Primatology, Vol. 26, No. 2, April 2005 (© 2005)
DOI: 10.1007/s10764-005-2933-x

Hainan Black-crested Gibbon Is Headed For Extinction

Jiang Zhou,[1,2] **Fuwen Wei,**[1,5] **Ming Li,**[1] **Jianfeng Zhang,**[3] **Deli Wang,**[2] **and Ruliang Pan**[1,4]

Received April 28, 2004; revision May 28, 2004; accepted June 4, 2004

Although Hainan black-crested gibbons have been on the list of the most endangered primate species in the world for many years, their environment is still deteriorating, especially on Hainan Island. Our findings indicate that the species is unlikely to survive the next decades unless efficient conservation policies and strategies are put in place immediately. Census data show that populations of the species used to occur across the whole island, but in 2003 only 13 individuals could be found, confined to a small region, the Bawangling Natural Reserve (19° 02′–19° 08′N and 109° 02′–109°13′ E), in the western part of the island, covering only 14–16 km^2. In other words, ca. 99% of the habitat has vanished in the past 300 years. Such dramatic change has pushed the species to the edge of extinction; only 2 groups and 2 solitary adult males, remained in 2003. Two adult females, 2 juveniles and one infant comprise Group A, in Dong'er, the core area of the western part of the reserve; and 1 adult male, 2 adult females, 1 juvenile and 1 infant formed another group (B), confined to another core area (Nanchahe) in the northern part of the reserve. The dramatic decline in the gibbon population has occurred due to vegetation reduction, ecological deterioration and extensive human impact. The forest cover was reduced from 95.5% 2000 years ago to

[1]Institute of Zoology, the Chinese Academy of Sciences, 25 Beishihuan Xilu, Haidian, Beijing, 100080, China.
[2]Institute of Grassland, Northeast Normal University, 128 Renmin Street, Changchun, Jilin, 130024, China.
[3]Bawangling National Nature Reserve, Changjiang, Hainan, 572722, China.
[4]School of Anatomical Sciences, Faculty of Health Sciences, University of the Witwatersrand, 7 York Road, Parktown, Johannesburg, South Africa.
[5]To whom correspondence should be addressed at Institute of Zoology, the Chinese Academy of Sciences, 25 Beishihuan Xilu, Haidian, Beijing, 100080, China; e-mail: weifw@ioz.ac.cn.

just 4% in 1999; and the human population in 2003 was 330% larger than in 1950.

KEY WORDS: Hainan black-crested gibbon; distribution shrinking; habitat deterioration; conservation.

INTRODUCTION

Although Hainan black-crested gibbons (*Nomascus hainanus*) have been on the list of the most endangered primates for decades, there has still been little research on their biology, except for a few recent studies on classification (Zhang, 1997; Su *et al.*, 1995; Groves, 2001) and on ecology, social structure and food choice (Liu *et al.*, 1989; Liu and Tan, 1990; Zhang *et al.*, 1995). The size of their territory (200–500 ha) appears to be larger than that of any other gibbon species. According to Liu *et al.* (1989), the species is unique among gibbons in terms of social structure, with a polygamous mating system, which is different from that of other gibbon species, which are characterized by a socially monogamous pattern.

The Hainan black-crested gibbons once had a wide distribution on Hainan Island, but they are currently restricted to a single narrow tropical rain forest (Bawangling Nature Reserve). Without an integral understanding of why the species has been pushed to the margin of extinction, how many external factors impacted on their survival and development, and when such a catastrophic decline occurred, there cannot be an effective strategy to protect them. In addition to fieldwork, retrospective records of environmental and ecological changes, and human impact over the past several hundred years should be taken into account in research aimed at a comprehensive conservation strategy.

We examined records on changes in the environment, ecology and demography of Hainan Island that affected Hainan black-crested gibbons over the past 300 years, and conducted a detailed field investigation in order to investigate the factors relevant to their survival, we sent suggestions based on the results to the Chinese government in order to plan future conservation for the gibbons.

METHODS

This project comprised 2 parts: one was to search for the data and records relevant to environmental change on Hainan Island; the other was to carry out a field investigation in order to understand current habitat, distribution and social structure of the gibbons in Bawangling Natural

Reserve—the only site where they could be found, when this project was conducted from September 2002 to November 2003.

We collected information in libraries and government agencies, and by interviewing local people, especially hunters among ethnic minorities and workers at conservation stations.

Seventeen pairs of observers conducted the field investigations, which commenced at 0600 h and continued until 1100 h and sometimes until 1400 h. We described and recorded group structure and group size and mapped activity sites via triangulation fixed points at Nanchahe, Dong'er, Heiling, Qichadaling, and Yajiadaling, where gibbons had lived. We applied the spot-site observation method to collect data (Brockelman and Srikosamatara, 1993).

The unique call patterns of adult males and females, which occur at alternative times and are audible $\leq$2–3 km (Marshall and Marshall, 1976; Caldecott, 1980; Marsh and Wilson, 1981; Haimoff *et al.*, 1986; Brockelman and Srikosamatara, 1993), enable observers to identify the sexual composition and size of the group and to trace their home range. We surveyed 14 sites in the core area and another 3 in the buffer zones of the Reserve. We also investigated 13, are as outside of the reserve that were areas of potential activity. Were interviewed local farmers and workers at the Reserve Station to check particular scenarios in the literature and to obtain supplementary information.

RESULTS

Shrinkage of Gibbon Distribution

Figure 1 is a distribution profile of gibbons on the island from 1688 to 1950. They formerly inhabited the whole island, with a total area of 27,784 km^2, 300 years ago (Table I). The populations in Qiongshan and Danzhou began to disappear in the middle of the last century. The process accelerated thereafter, so that by 1978 gibbons remained only in a few regions: Lingshui, Ledong, Baisha, Changjiang, Qiongzhong, Dongfang, an area of about 12,543 km^2. Less than 10 years later another significant wave of habitat diminution occurred, and gibbons were recorded from only 5 mountainous regions—Wuzhishan, Limushan, Jianfengling, Bawangling and Diaoluoshan—covering just 965 km^2. This already catastrophic distribution was further diminished in the following 10 years, after which, except for Bawangling, no trace of gibbons remained in 1995. According to our study in 2003, gibbon distribution shrank still further until they were confined to a core area of Bawangling Natural Reserve, with a total area of 66 km^2 (Table I, Figs. 1 and 2).

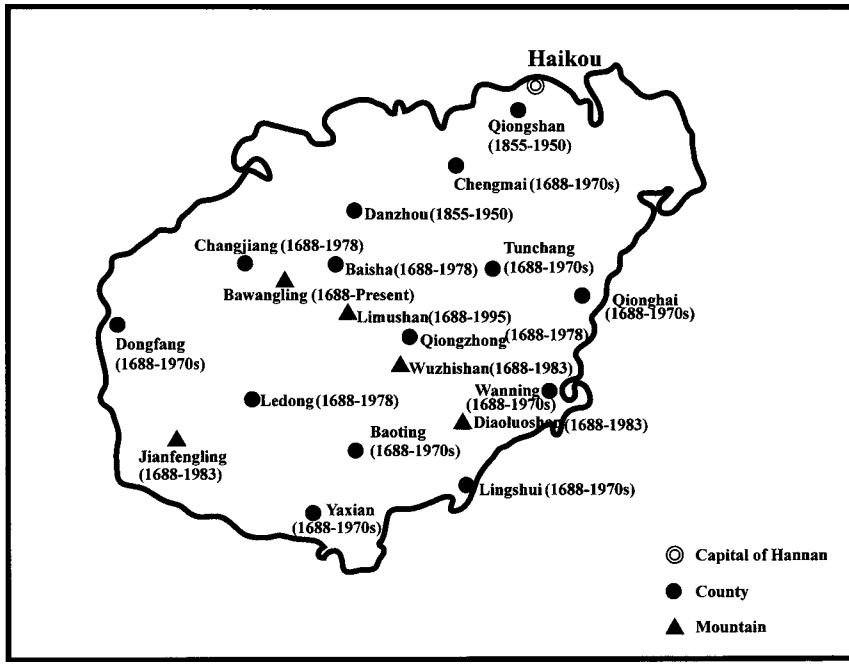

Fig. 1. Distribution of Hainan black-crested gibbons on Hainan Island over the past 300 years.

Population Reduction

The total estimated population between 1950 and 1964 was >2,000 individuals (Table I). This number dropped to 450–500 between 1964 and 1978; and to 40–50 by the end of 1983, when they lived only in the mountainous regions of Wuzhishan, Limushan, Jianfengling and Bawangling. The speed of reduction appeared to stabilize somewhat in the following 10 years, and 30–40 individuals still lived in Bawangling and Limushan by the end of 1995. In recent years another significant population diminution occurred leading in 2003 to only 13 individuals, which are confined to Bawangling Reserve, the last habitat left for them (Table II). In other words, *ca.* 99.4% of the population disappeared during the second half of the 20th century (from 1950 to 2003).

In Bawangling Reserve, there were *ca.* 150–200 gibbons in 1963 at 3 sites: Yajiadaling, Qichadaling and Futouling (Liu, pers. comm.). In 1988 only 21, divided into 4 groups, were left (Liu *et al.*, 1989), among which *ca.*

Table I. Historical range and estimated population size of the Hainan black-crested gibbon on Hainan Island

Year	Location	Distribution area estimated (Km^2)	Population size (individual)	Reference
1688–1950	Qiongshan, Lingshui, Danzhou, Yaxian, Tunchang, Qionghai, Baisha, Changjiang, Dongfang, Baoting,Qiongzhong, Wanning, Chengmai, Ledong	27,784	Unclear	Liu *et al.*, 1984, 1987; this study
1950–1964	Lingshui, Ledong, Yaxian, Tunchang, Qionghai, Baisha, Changjiang, Dongfang, Baoting, Qiongzhong, Wanning, Chengmai	22,499	*Ca.* 2000	Liu *et al.*, 1984; Xu *et al.*, 1983; this study
1964–1978	Lingshui, Ledong, Baisha, Changjiang, Qiongzhong, Dongfang	12,543	450–500	Liu *et al.*, 1984; this study
1978–1983	Wuzhishan, Limushan, Jianfengling, Bawangling, Diaoluoshan	965	40–50	Liu *et al.*, 1984; this study
1984–1995	Bawangling, Limushan	130–200	30–40	Liu *et al.*, 1984, 1989; Zhang and Sheeran, 1994; Zhang *et al.*, 1995; this study
1995–2003	Bawangling natural reserve	66	13–21	Song *et al.*, 1999; this study

18–19 lived in the rain forest core of the reserve in 1998 (Song *et al.*, 1999). In 2003 we saw only 11 individuals in 2 groups, and 2 solitary males. Group A, in Dong'er (western reserve), comprised 1 adult male, 2 adult females, 2 juveniles and 1 infant (Table II, Fig. 2); and Group B, in Nachahe region (northern reserve), included 1 adult male, 2 adult females, 1 juvenile and 1 infant. The 2 solitary individuals in Nachahe and Dong'er.

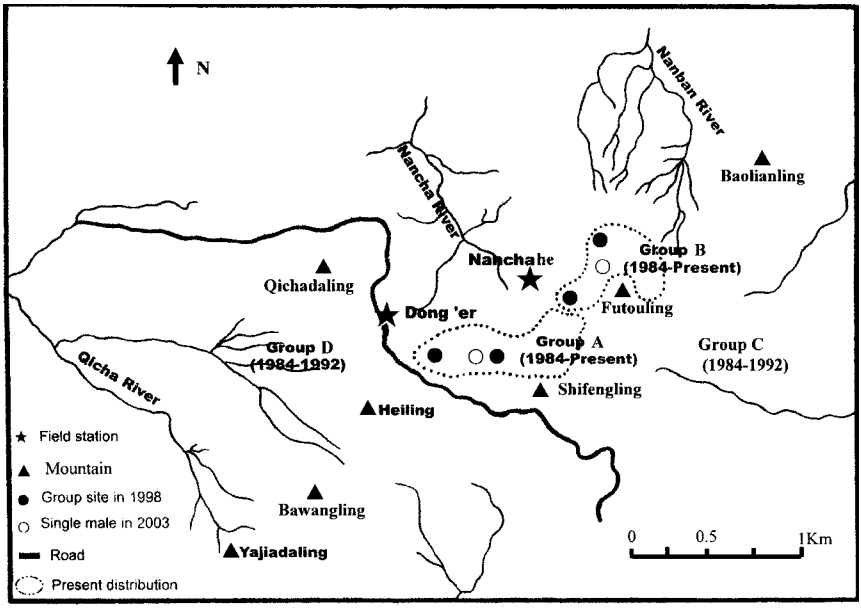

Fig. 2. Regions in Bawangling Natural Reserve in which gibbons were found since 1984.

DISCUSSION

Hainan black-crested gibbons have been listed as one of the most endangered animal species in China for many years (Mammalogical Society of China, 2002). Their critical conservation status was acknowledged by the IUCN in 2003 and placed on the list of the most critically endangered species in the world (Geissmann and Nguyen, 2000). Our study clearly indicates that the last population of the species in Hainan Island has a chance to survive the next decades providing effective measures are put in place immediately.

The results also show that shrinkage of gibbon distribution and habitat can be traced back for 300 years, and the most devastating reduction commenced just in the last century, and was further accelerated since the 1950s (Fig. 3). This scenario is very similar to that which occurred to the 3 endemic Chinese species of the snub-nosed monkeys (*Rhinopithecus*), whose ranges covered the whole of southern China about 400 years ago, but which now live only in isolated mountainous regions (Li *et al.*, 2002).

There was not much change in vegetation structure on the island during the first 100 years; tropical forests covered the whole island (Fig. 4). The tranquility interrupted in the second hundred years and deforestation

Table II. Individuals and group structure of the Hainan black-crested gibbon in Bawangling Natural Reserve

Survey time	Habitat location	Population size and structure	Reference
1963	Yajiadaling; Qichadaling; Futouling	150–200 individuals	Liu, 2003 Pers. comm.
1988	Nanchahe-Futouling-Dong'er	Group A: 1 adult male; 2 adult females; 3 juveniles; 1 infant Group B: 1 adult male; 2 adult females; 2 juveniles; 1 infant	Liu *et al.* 1989
	Zibao	Group C: 1 adult male; 1 adult females; 2 juveniles	
	Heiling	Group D: 1 adult male; 1 adult females; 2 juveniles Total 21 individuals	
1998	Nanchahe-Futouling-Dong'er	Group A: 1 adult male; 2 adult females; 2 infants; 1 infant Group B: 1 adult male; 2 adult females; 1 infant; 1 infant Group C: 1 adult male; 2 adult females; 2 infants Group D: unclear, estimated 1 adult male; 1 adult female, and possibly 1 infant Total 18–19 individuals	Song *et al.*, 1999
2003	Nanchahe-Futouling-Dong'er	Group A: 1 adult male; 2 adult females; 2 juveniles; 1 infant Group B: 1 adult male; 2 adult females; 1 juvenile male; 1 infant 2 solitary adult males Total 13 individuals	This study, Joint survey by our group, Kadoorie Farm and Botanic Garden, Hainan Forestry Bureau

accelerated in the 20th century, so that *ca.* 95.5% of the natural vegetation disappeared, and only 4% of the primary forest remained by 1999 (records from Hainan Provincial Government). This was mainly due to the timber industry's policy since 1950 (Liu, pers. comm.) of clear cutting and the specific policy of developing a rubber industry, for which many forests were replaced with rubber plantations. Thus, the original vegetation was progressively replaced by secondary forests consisting mainly of pure pine or fir trees. As a result, favorite environments and food resources for gibbons and other animals were gradually destroyed. It began in the middle of the

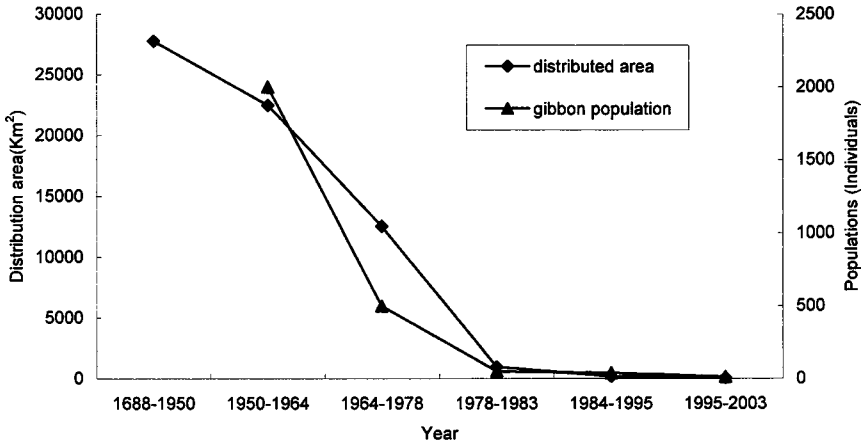

Fig. 3. Reduction of distribution and population of gibbons on Hainan Island during the past 300 years.

20th century, especially after the 1980s following the open-door policy in the Chinese economic arena; in particular after the formation of the Hainan Provincial Government in 1988, which was followed by numerous waves of human migrants to the island (Fig. 5). Such a huge impact remarkably accelerated the destruction of the natural environment and landscape; every thing was, and is, giving way to economic development. Thus, many regions

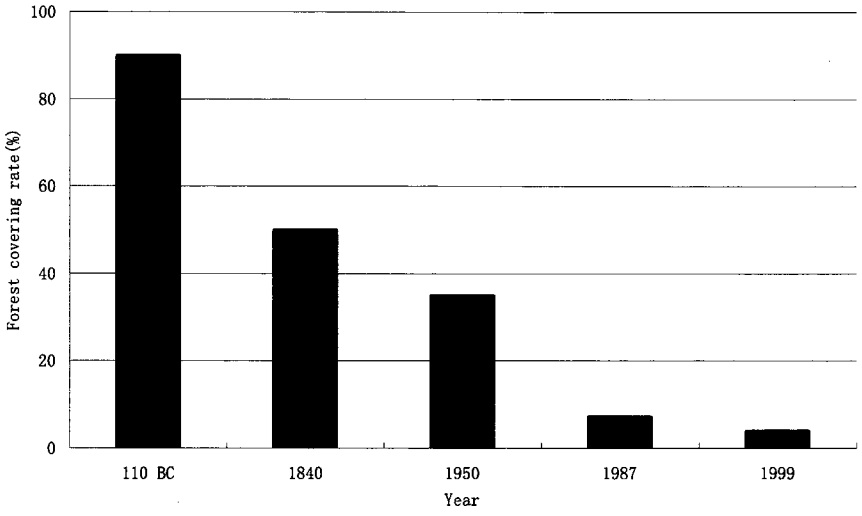

Fig. 4. Dramatic reduction of forest cover on Hainan Island in the past 300 years.

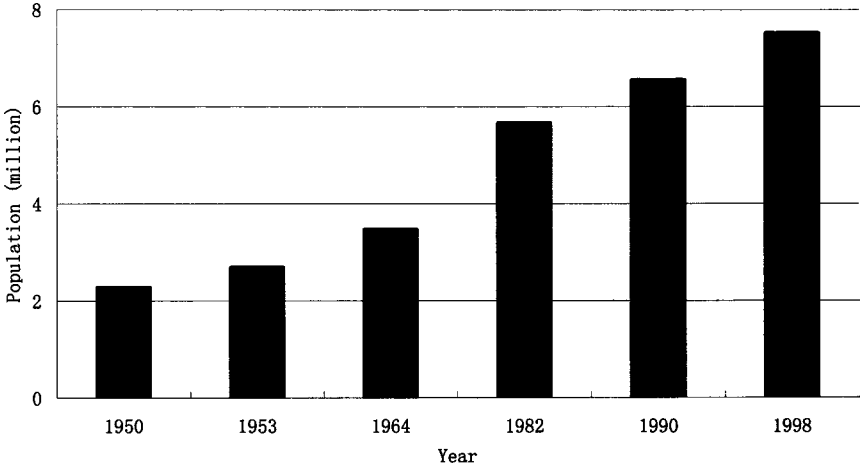

Fig. 5. Human population increase on Hainan Island in the past 50 years.

where gibbons had lived have were surrounded or split by roads, factories and villages, becoming more isolated with smaller groups. Another significant form of vegetation destruction was the burning of forests for farm plantations: a traditional means, among many minorities to maintain soil fertility. In addition, the farming communities rely on the forests for fuel and other sources of income.

Bawangling Reserve, where the last 13 gibbons live, is now enclosed by 28 villages with 40,000 inhabitants of Li and Miao minorities. Although Hainan is regarded as one of the most developed provinces in China, many inhabitants live on the edge of poverty; the annual average income is about US$60, and they depend on firewood for cooking and heating. Digging up herbs for medicinal and economic purposes, and especially collecting sandalwood bark *(Aquilaria sinensis)* and magnolia seeds (*Parakmeria lotungensis*) for Chinese medicine, has had a further negative impact on conservation.

The critical situation of gibbons has attracted the attention of both public and government, inducing the provincial government to enact laws and regulations to protect the them from further harm. For example, the timber industry was banned in 1995, and humans were forbidden to approach gibbons. Nonetheless it is very hard to conduct effective measures to conserve gibbons and other animals because of significant impacts from the burgeoning human population. Suitable habitat for gibbons in the reserve is a tiny region of *ca.* 14–16 km^2. Further, although the government has also issued specific policies to extend the boundaries of the reserves thereby creating

more habitat for the gibbons and other animals, there is still a long way to go before this idea can be achieved.

As is the case elsewhere in China, hunting animals for meat, medicine and fur is another significant threat to their survival and conservation (Wei *et al.*, 1999; Huang *et al.*, 2002; He *et al.*, 2004). Tragically, gibbon bones are regarded as more valuable than any others in Chinese traditional medicine; a special cream—Houzi Cream—which is made from the bones of the gibbons, is generally believed to cure arthritis and to accelerate recovery. According to Liu *et al.* (1984), some memorable episodes of the slaughter of gibbons were related to such a belief: (1) >l00 individuals were killed between the 1960s and 1980s in the Guangba area of Dongfang, by 2 Miao hunters; (2) >50 were hunted in Ma'anling in the 1970s; (3) almost the whole population on Jiangfengling Mountain, was eradicated in the 1970s by employees of the 5th Logging Company, Jianfengling Forestry Bureau; and (4) >40 gibbons were slaughtered in Bawangling during the processes of road construction and logging in the 1970s. Those and numerous similar events obviously accelerated the disappearance of gibbon populations; such as the disappearance in 1994 of Group D, which lived on the western slope of Heiling Mountains (Fig. 2) (Zhang and Sheeran, 1994), and many individuals in Groups A and B have vanished since 1989 (Zhang JF and Chen Q, pers. comm.).

Trading of animals by locals is a further threat to gibbon survival. The price for an adult female gibbon is *ca.* US$300 (Peng WY, pers. comm.), which is a great temptation considering annual incomes. We heard gunshots in the field, especially during the period from December to February, when locals, liberated temporarily from farming duties, have more spare time. We also found >56 traps were found during our fieldwork.

Impact from nonhuman predators is also a factor in gibbon decline; infants are sometimes taken by hawks. We observed 2 hawk attacks on Group B in March 2003, lasting about 15 min each. Fortunately, the adults successfully protected their youngsters.

Because of the severity of these external impacts and threats, and the tiny size of the population, the gibbons of Hainan Island are unlikely to survive the next few decades unless actions are undertaken immediately

1. Continuous monitoring of the population. Any external impact, in particular on infants, could thus be noted straightaway. It is also necessary to verify rumors that gibbons were observed recently elsewhere on the island, in Wuzhi Mountain, Diaoluo Mountain, and Jianfengling, but for which documented records are still not available. Our data and those which will be gathered in the future, including demography, modifications of the fauna and flora, and

alterations to cultivated lands and industry, should be used to set up a GIS database, so that any external harmful event could be identified and analyzed immediately.

2. Prevention of further environmental damage caused by poaching, logging, forest clearance and road infrastructure in the regions in which the gibbons live. All boundaries of the reserve should be clearly marked and made known to the to public. Public infrastructure, e.g., distribution of the power lines, and some human activities, especially road traffic and plantation management, should be reassessed in order to determine whether their current operations influence survival and development of the animal populations. Any further plans for plantations in the region must be evaluated thoroughly before implementation.
3. Afforestation of degraded habitat to allow for expansion of the gibbon population. This will involve planting species that gibbons use for food and shelter, including figs (*Ficus altissima; F. langkokensis; F. variegata*), litchi (*Litchi chinensis; Nephelium topengii*) and myrtles (*Cleistocalyx operculatus; Syzygium cumini*), especially in the areas connecting the parts of the reserve, the lowlands adjoining the gibbon territories, and the roadsides and lower slopes in Nanchahe, where Group B is distributed. In general, all afforestation should simulate the natural environment of the gibbons and other animals.
4. Stricter laws and regulations must be implemented. This could provide a strong deterrent to wilful acts of destruction and activities such as disturbing the environment and hunting.
5. Enhancement of public education. Although this has been done for some years, awareness of the endangered animals in Hainan is insufficient. High-level programs of public education, specifically focusing on the gibbons, are necessary.

ACKNOWLEDGMENTS

The study was supported by the National Natural Science Foundation of China for Distinguished Young Scholars, obtained by Fuwen Wei (30125006), and the Sate Forestry Administration, China. We are very grateful to the following institutions and people for their enthusiastic support: Hainan Forestry Bureau; Kadoorie Farm and Botanic Garden; Messrs. Chen Qin, Chen Shaowei, Feng Zhenglin at the Bawangling Nature Reserve; Zhang Jingshuo at the Institute of Zoology, the Chinese Academy of Science; Drs. Bill Bleisch and Zhang Yingyi at Fauna & Flora

International. Special thanks to Prof. Colin Groves for editing the English and providing critical comments to improve the previous drafts of the manuscript.

REFERENCES

Brockelman, W., and Srikosamatara, S. (1993). Estimation of density of gibbon groups by use of loud songs. *Am. J. Primatol.* 29: 93–108.

Caldecott, J. (1980). Habitat quality and populations of two sympatric gibbons (Hylobatidae) on a mountain in Malaya. *Folia Primatol.* 33: 291–309.

Geissmann, T., and Nguyen, X. D. (2000). *Vietnam Primate Conservation Status Review 2000, Part 1 Gibbons,* Fauna & Flora International, Indochina Programme, p. 92.

Groves, C. (2001) *Primate Taxonomy,* Smithsonian Institution Press, Washington and London, p. 296.

Haimoff, E. H., Yang, X. J., He, S. J., and Chen, N. (1986). Census and survey of wild black-crested gibbons *(Hylobates concolor concolor)* in Yunnan province, People's Republic of China. *Folia Primatol.* 46: 205–214.

He, L., García-Perea, R., Li, M., and Wei, F. W. (2004). Distribution and conservation status of the endemic Chinese mountain cat *Felis bieti. Oryx* 38: 55–61.

Huang, C. M., Wei, F. W, Li, M., Quan, G. Q., and Li, H. (2002). Current status and conservation of white-headed langur *(Trachypithecus leucocephalus)* in China. *Biol. Conserv.* 104: 221–225.

Li, B. G., Pan, R. L., and Oxnard, C. E. (2002). Extinction of snub-nosed monkeys in China during the past 400 years. *Int. J. Primatol* 23: 1227–1244.

Liu, Z. H., Yu, S., and Yuan, X. (1984). The resource of the Hainan black gibbon at its present situation. *Chinese Wildlife* 6: 1–4 (in Chinese).

Liu, Z. H., Jiang, H., Zhang, Y, Liu, Y, Chou, T., Manry, D., and Southwick, C. (1987). Field report on the Hainan Gibbon. *Primate Conserv.* 8: 49–50.

Liu, Z. H., Zhang, Y., Jiang, H., and Southwick, Ch. (1989). Population structure *of Hylobates concolor* in Bawangling Nature Reserve, Hainan, China. *Am. J. Primatol* 19: 247–254.

Liu, Z. H., and Tan, C. (1990). An analysis on habitat structure of the Hainan gibbon. *Acta Theriologica Sinica* 10: 163–169 (in Chinese).

Mammalogical Society of China. (2002). *Caring for Primates: Abstracts of the XlXth Congress of the International Primatological Society,* 4th–9th August, Institute of Zoology, Beijing, China.

Marsh, C., and Wilson, W. (1981). *A Survey of Primates in Peninsular Malaysia,* University Kebangsaan Malaysia, Kuala Lumpur.

Marshall, J., and Marshall, E. (1976). Gibbons and their territorial songs. *Science* 193: 235–237.

Song, X., Jiang, H., Zhang, J., Chen, Q., Wang, C., and Lin, W. (1999). A survey of the Hainan gibbon *(Hylobates concolor hainanus)* in Hainan. In Chinese Zoology Society (ed.), *Zoological Studies in China*, pp. 696–701 (in Chinese).

Su, B., Monda, K., Wang, W, Jiang, X., Wang, Y, Woodruff, D. S., and Zhang, Y. (1995). Molecular phylogeny of Chinese concolor gibbons (subgenus *Nomascus)-using* noninvasive DNA genotyping. In Xia, W., and Zhang, Y. (eds.), *Primate Research and Conservation,* China Forestry Publishing House, Beijing, pp. 55–63 (in Chinese).

Wei, F. W., Feng, Z. J., Wang, Z. W., and Hu, J. C. (1999). Current distribution, status and conservation of wild red pandas *Ailurus fulgens* in China. *Biol. Conserv.* 89: 285–291.

Xu, L., Liu, Z., and Yu, S. (1983). *The Birds and Mammals of Hainan Island.* Science Press, Beijing, pp. 314–316 (in Chinese).

Zhang, Y. Z., and Shreeran, L. K. (1994). Current status of the Hainan black gibbon *(Hylobates concolor hainanus). Asia Primates* 3: 3.
Zhang, Y. Z., Quan, G. Q., Yang, D., Liu, Z., and Sheeran, L. K. (1995). Population parameters of the black gibbon in China. In Xia, W., and Zhang, Y. (eds.), *Primate Research and Conservation,* China Forestry Publishing House, Beijing, pp. 203–220 (in Chinese).
Zhang, Y. P. (1997). Mitochondria DNA sequence evolution and phylogenetic relationships of gibbons. *Acta Genetica Sinica* 24: 231–237 (in Chinese).