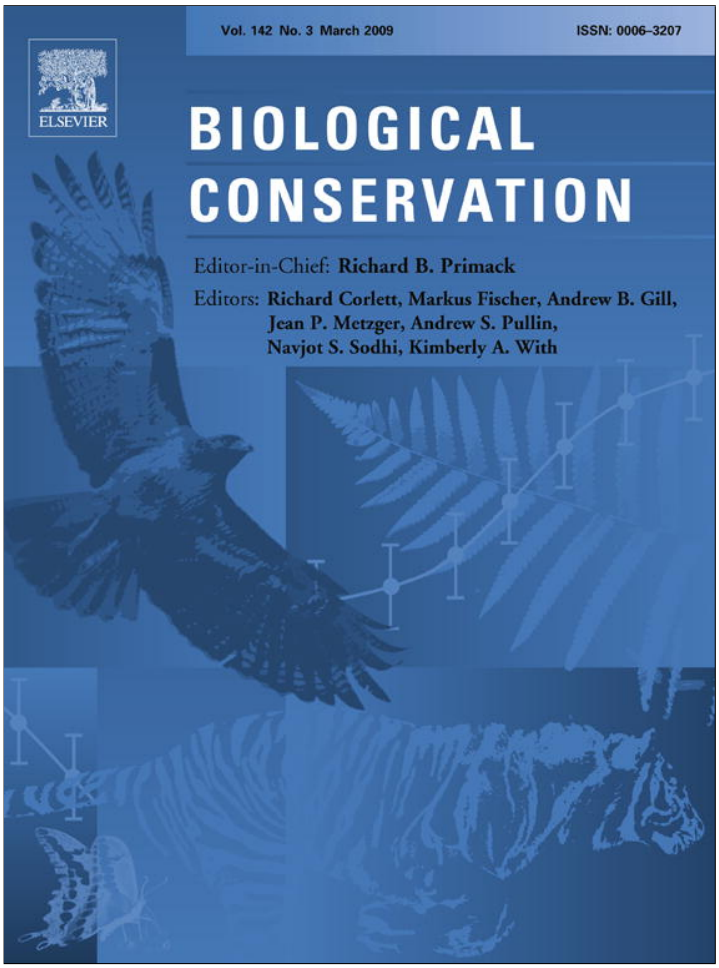

BIOLOGICAL CONSERVATION 142 (2009) 469–476

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Review

Current status and conservation of the gray snub-nosed monkey *Rhinopithecus brelichi* (Colobinae) in Guizhou, China

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ARTICLE INFO

Article history:
Received 23 September 2008
Received in revised form
18 November 2008
Accepted 23 November 2008
Available online 21 January 2009

Keywords:
Rhinopithecus brelichi
Conservation status
Current status
Gray snub-nosed monkey
Habitat loss

ABSTRACT

Gray snub-nosed monkeys *Rhinopithecus brelichi* (Colobinae), categorized as endangered on the IUCN Red List, are endemic to Guizhou, China. To evaluate the species' current status we surveyed five sites in the Mt Fanjing area between August 2007 and June 2008. These sites were identified from previous surveys and interviews with local officials and villagers. Four sub-populations, with a total of *ca.* 750 individuals, were located in mixed deciduous and evergreen broad leaf forest at 800–2200 m asl. Identified threats to the species include (1) accidentally injured or killed by poaching, (2) loss or alteration of habitat through wood extraction, and (3) loss or alteration of habitat through economic activities, such as building projects and illegal mining. We recommend that several actions can be taken to alleviate the anthropogenic pressure on the ecosystem including: (1) designating specific forest reserve for sustainable wood extraction, (2) utilizing biogas to reduce firewood demands, (3) introducing local people to bamboo utilization for generate greater cash income, (4) educating for young people and encouraging them to work in developed areas, and (5) encouraging the villagers to move out the mountain.

Contents

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doi:10.1016/j.biocon.2008.11.019

1. Introduction

The gray or Guizhou snub-nosed monkey *Rhinopithecus brelichi* (Colobinae) was categorized as an endangered species by The World Conservation Union (IUCN, 2007), and was also listed as a Category I species under the Chinese Wild Animal Protection Law. At present, *R. brelichi* is restricted to a small region at Mt. Fanjing in northwest Guizhou province, China, with a total range of 275 km^2 in Fanjingshan National Nature Reserve (FNNR) (Yang et al., 2002).

R. brelichi was originally described from a single hunter's skin, which was probably collected from the Mt Fanjing area by Henry Brelich and later described by Thomas (1903), but see (Allen, 1938). It was later thought to be extinct as no further information was reported following its initial discovery. The confirmation that the species was extant came in 1962 when a skull was obtained (Peng et al., 1965), and in 1967 one female specimen. However, conservation-related work on *R. brelichi* was not implemented until the FNNR was founded in 1978. Although a few population surveys were carried out in the early 1980s (Quan and Xie, 1981; Xie et al., 1982; Xie et al., 1986; Li and Huang, 1993), none were conducted over the entire range of the species until 1988. From 1988 to 1993, one systematic survey, which focused on population distribution, size and ecology, was carried out by the FNNR (Yang et al., 2002). Nevertheless, no further surveys have been conducted over the last 15 years. Mt. Fanjing is a popular Chinese tourist center and many people travel there to holiday. Even given the protected status of other sub-nosed monkeys in China, there are still potential threats on *R. bieti* (Xiao et al., 2003; Xiang et al., 2007) and *R. roxellana* (Li et al., 2003), including poaching and habitat destruction. However, there is little information on the conservation status of *R. brelichi*, and the susceptibility of this species needs to be evaluated.

Here we: (1) provide information on the distribution and size of *R. brelichi* populations, (2) evaluate the present conservation status and factors threatening *R. brelichi*, and (3) recommend conservation strategies for a sustainable ecosystem where both people and *R. brelichi* can coexist. These results will be fundamental to the understanding and protection of the gray snub-nosed monkey.

2. Materials and methods

2.1. Study area and habitat

This study was conducted in the Mt Fanjing area (Fig. 1, 27°40′–28°10′N, 108°30′–108°55′) in northeast Guizhou province, China, in which may be the only remaining site for *R. brelichi*. Fanjingshan National Nature Reserve (FNNR) was founded in 1978 and accepted as a member of Man and Biosphere Program by the United Nations Educational, Scientific and Cultural Organization in 1987 (Yang et al., 2002). FNNR, focusing on conservation of *R. brelichi*, Dove trees (*Davidia involucrata*) and its representative terrestrial ecosystems, consists of 41,900 ha of mountainous terrain stretching from below 800 to 2570 m asl, with a 26,667 ha core area. In fact, FNNR is the only good conservation site in the Mt Fanjing area and like an island is surrounded by the villages and fragmented forest. In addition to some secondary woodland patches (700–900 m asl), there are five primary forest types in the FNNR (Zhou et al., 2006). The different strata include: (i) natural bamboo and/or artificial fir forest (<900 m asl)–with dominant species moso bamboo (*Phyllostachys pubescens*) and/or China fir (*Cunninghamia lanceolata*); (ii) evergreen broad leaf forest (900–1300 m asl)–with *Cantanopsis* spp., *Cyclobalanopsis* spp. and *Lithocar* spp.; (iii) evergreen-deciduous broad leaf forest (1300–2200 m asl)–including *Fagus* spp., *Eurya* spp. and *Schima* spp.; (iv) subalpine conifer–evergreen forest (2200–2350 m asl)–with *Abies georgei*, *Abies fanjingshanensis*, *Acer flabellatum*, and *Enkianthus chinensis*; and (v) subalpine brushes and meadow (2300–2570 m asl)–featuring *Rhododendron guizhouense*, *Rhododendron oreonastes*, and *Bashania fangiana*. Dwarf bamboo (*Sinarundinaria* spp.), whose density can reach 1,000,000/ha, forms a dense and nearly impenetrable ground cover in many areas. Generally, the monkeys utilize evergreen broad leaf forest and evergreen–deciduous broad leaf forest (Yang et al., 2002). The monkeys have seldom observed to use the habitats where human activities regularly occur, or secondary forest (Xiang ZF, personal observation).

2.2. Population status and threats

The primate survey method was similar to that used in examinations of the black-and-white snub-nosed monkey (*R. bieti*) (Long et al., 1994; Xiang et al., 2007). A random transect method was deemed ineffective for *R. brelichi* because: (1) low monkey density render a very low possibility of meeting the groups by transect; (2) steep topography and dense bamboo shrub make it difficult to set transect lines; and (3) the large group/band social organization of snub-nosed monkeys makes it easy to detect them in protruding trees, cliffs, and mountain ridges. Generally, the survey was performed along existing trails or ridges where it was relative easy to find traces (e.g., feces of the gray snub-nosed monkeys look like abacus beads and are easy to distinguish from the droppings of other animals).

Table 1 – Details of the four sub-populations of gray snub-nosed monkeys (*Rhinopithecus brelichi*) in the Fanjingshan National Nature Reserve, Guizhou.

Site	Location	Survey date	Days in field	Days spent tracking	Identified individual		Estimated population size
					Adult male	Adult female	
Yangaoping[a]	27°58'N, 108°45'E	2 Aug–30 Dec, 2007; 3 April–30 June, 2008	231	121	59	134	>450
Dongpengshan[b]	27°57'N, 108°41'E	2–11 Nov, 2007	10	4	c. 21	c. 35	c. 150
Huixiangping[c]	27°54'N, 108°43'E	15 Sep–15 Oct, 2007	30	20	16	27	> 100
Gaofeng[c]	27°43'N, 108°40'E	5–15 June, 2008	8	1	c. 7	13	c. 50
Total	–	–	279	146	c. 103	c. 209	c.750

a Survey carried out by Nie SG and field assistants.
b Survey carried out by Xiang ZF and field assistants.
c Survey carried out by Lei XP.

We carried out 186 interviews in more than 37 villages in the Mt Fanjing area and made direct observations to determine the presence of *R. brelichi* in the forest. Interviews were used to obtain preliminary information on *R. brelichi* (the local name, *niuweihou*, refers to the monkey's tail, which resembles that of cattle). This included details on the distribution of the monkeys and human activities in the forest. In addition, these discussions were hoped to increase local awareness and pride regarding the importance of *R. brelichi* as a unique species endemic to Guizhou, China. Interviews were carried out in a brief, unstructured and informal fashion covering the following issues: (1) presentation of pictures of local primates (including two macaques, *Macaca mulatta* and *M. thibetana*) to ensure that respondents could identify *R. brelichi*, and (2) discussing activities that could threaten the primate.

Based on these interviews, 12 people were divided into three survey teams, and carried out detailed surveys at Dongpengshan, Huixiangping, Yangaoping, Gaofeng and Wuluo. Generally, surveys were performed between 0900 and 1700 in tandem with field work. These surveys were carried out over 296 days, with 146 days of tracking, from August 2007 to June 2008 (Table 1). The presence or absence of ranging and foraging signs (e.g. feces, broken branches) was used to estimate the species' range. Once the presence of *R. brelichi* was confirmed at a site we tried to approach them to count group members. As the social organization of the snub-nosed monkey was formed with one male, multi-female units (OMUs, Fig. 2), and many OMUs traveled together in a band (*R. brelichi*: Bleisch et al., 1993; *R. bieti*: Kirkpatrick et al., 1998; *R. roxellana*: Tan et al., 2007), therefore, the number of adult males (N_m) was used as an indication of OMUs when the counting procedure was impossible. Using $N_m \times N_{OMU}$, we estimated the sub-population size, where N_{OMU} is the OMU size of the Yangaoping sub-population (means = 7.6 individuals, range 4–11; this study). We evaluated the current poaching threat by the frequency of leg-hold traps encountered in the forest (not along trails). We also carried out surveys in the areas between four sub-populations to look for indirect evidence (ranging/foraging signs) of *R. brelichi* to verify the possible existence of a habitat corridor. Interviews with local hotel keepers along the travel road in the species' assumed range were used to identify the possible use of this corridor by the monkeys.

We evaluated threats to *R. brelichi* using direct observations of human activity and interviews with local officials, guides, and villagers. Mt Fanjingshan is a famous religious and ecological tourist center. Visitors enter FNNR through two gateways (Fig. 1): Zhangjiaba station in Yinjiang County and Heiwanhe station in Jiangkou County. For economic stimulation, two 1-week-holidays (on 1–7 May and 1–7 October), which also called golden-week-holiday for tourism, were initiated by the general office of State Council of China beginning October, 1999. Therefore, we take the number of tourists visiting the FNNR between the 1–7 October as representative sample of peak-season tourism. This information came from the gateway station and/or holiday office of government department of Tongren prefecture, Guizhou. We also estimated the annual cash income of local people in the reserve by sampling the 60 households in Niujiaodong village (Fig. 1), and approximated the forest's value to villagers. Interviews with local officials and residents, and an inspection of the historical literature (e.g., newspapers and popular journals), were used to identify other threats on *R. brelichi*, including hunting events.

3. Results

3.1. Sub-population size and population trends

Our surveys confirmed the existence of four sub-populations of *R. brelichii* at Mt Fanjing area (Fig. 1), with an estimated total population of *ca*. 750 individuals (Table 1). All are confined to mixed deciduous and evergreen broad leaf forest at 800–2200 m asl. The Yangaoping sub-population was estimated at >418 individuals. Fifty nine adult males, 134 adult females, 180 juveniles and 45 infants were counted when the monkeys were crossing an open area. As we probably missed some individuals during counting it is reasonable to assume that this sub-population exceeds 450 individuals. More than twenty adult males were observed in different trees at Dongpengshan, the estimate sub-population size was c. 150. Based on the counted number of 91 individuals (16 adult males, 27 adult females, 39 juveniles and 9 infants of both sexes) crossing a tour road in Huixiangping, the size of this sub-population was estimated to be >100. About seven adult males were observed in different trees at Gaofeng, the sub-population size was estimated at c. 50 (this is the only

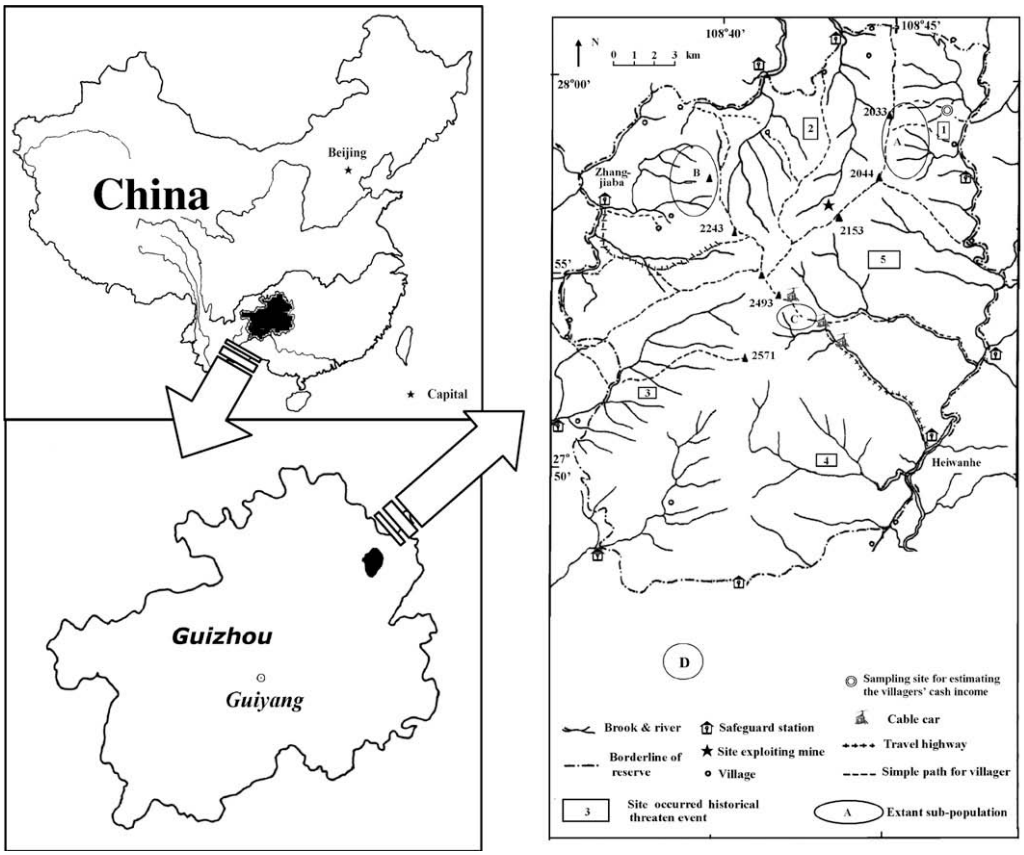

Fig. 1 – Fangjingshan National Nature Reserve, showing the historical and current occurrence of *Rhinopithecus brelichi*. Sub-populations of *R. brelichi* are located in: A Yangaoping; B Dongpengshan; C huixiangping; D Gaofeng. Sites where *R. brelichi* was historically hunted: (1) Paomuba; (2) Shizijie; (3) Jinzhanping; (4) Panxi; (5) Macaohe.

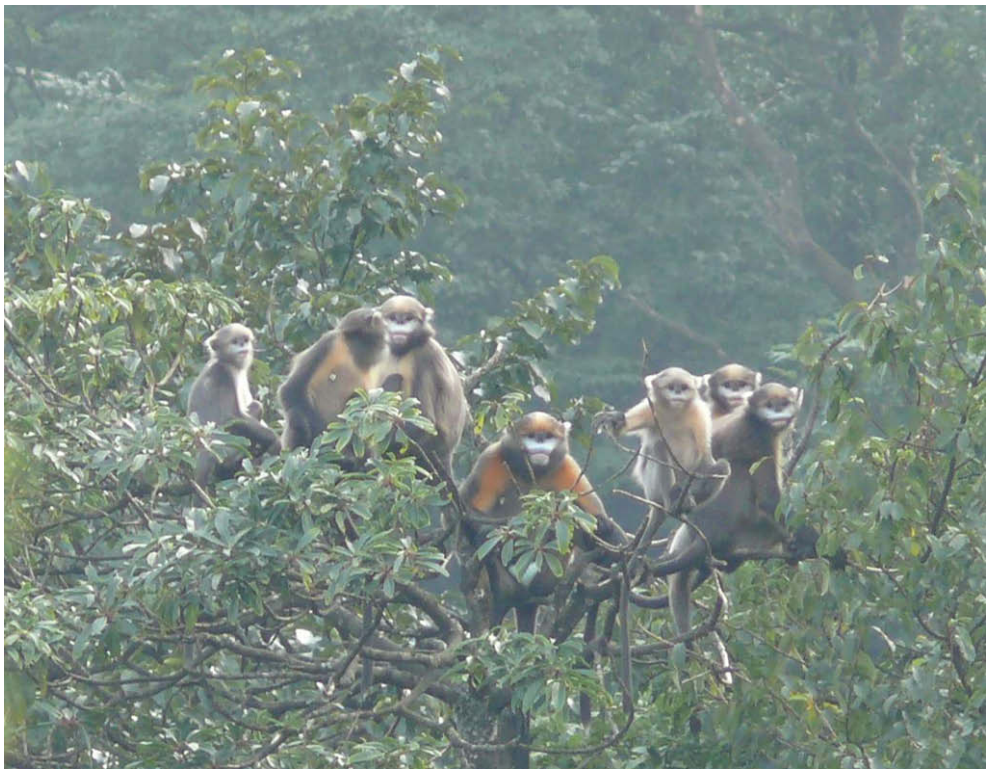

Fig. 2 – A one male, multi-female unit of *R. brelichi* in the evergreen broad leaf forest of Fangjingshan National Nature Reserve, China.

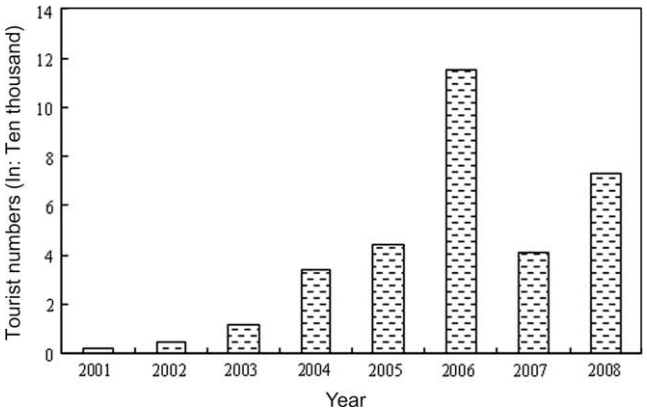

Fig. 3 – Tourist numbers (in ten thousands) that visited Fangjingshan National Nature Reserve during 1–7 October from 2001 to 2008.

sub-population located out of the FNNR, Fig. 1). Of identified OMUs at Huixiangping and Yangaoping, the mean size of OMU is 7.6 individuals (*range* = 4–11, *sd* = 1.7, $n = 64$) with no significant difference between the two sites ($t_{12,\ 52} = 0.893$, $df = 62$, $p > 0.05$). Habitat corridors likely exist as the local people report observing the monkeys crossing the travel path.

3.2. *Human activities in forest and annual cash income of villager*

There are about 50 villages and over 5000 people around the reserve, mostly representing minorities such as Toujia and Miao, who depend on a subsistence economy dominated by planting rice, corn, pachyrhizus, and other crops. The local people also use stems and roots of moso bamboo for cash income.

There are many human economic activities which take place in the forest; stock grazing and wood extraction, for example, occur year-around. Many local people produce charcoal within the reserve's buffer zone and collect herbs throughout the forest from April to October. Although mining, such as exploitation of wolfram, molybdenum and nickel, is forbidden in FNNR, however, the high value of certain goods (e.g., wolfram can fetch as much as USD 5–6 per kg), results in some illegal activity in the core zone.

The number of tourists has, in general, increased annually since the golden-holiday-week system began in October 1999 (Fig. 3). After 115,300 tourists (Fig. 3) visited FNNR during 1–7 October, 2006, the government funded the construction of two simple highways and one cable car (Fig. 1) to meet demands. As highway and cable construction at Heiwanhe and Yuao forbid tourists into FNNR, there was a temporary tourist's drop for on 1–7 October, 2007. However, in October 2008, it increased in spite of the highway and cable not being finished (Fig. 3).

Data from 60 households indicates that 65% of total cash income for villagers derives from non-forest sources (e.g., as laborers in factories at south and east of China) (Fig. 4). A further 29.8% derives from forest products including bamboo stems and shoots, charcoal, and timber. With Chinese economic development in the 1990's, more villagers (especially young people) are working in developed areas such as Guangdong, Shanghai, Fujian province.

3.3. *Threats to R. brelichi*

Significant threats to *R. brelichi* were identified as: (1) accidental injury or death caused by poachers targeting other species, (2) habitat destruction/degradation through wood extraction, and (3) habitat destruction/degradation through economic activities through building projects and illegal mining in the core area (Fig. 1).

Leg-hold traps were encountered at four sites as well as actual poachers at Yangaoping. The primary targets of hunting in and around the FNNR include Chinese muntjac (*Muntiacus reevesi*), forest musk deer (*Moschus berezovskii*), tufted deer

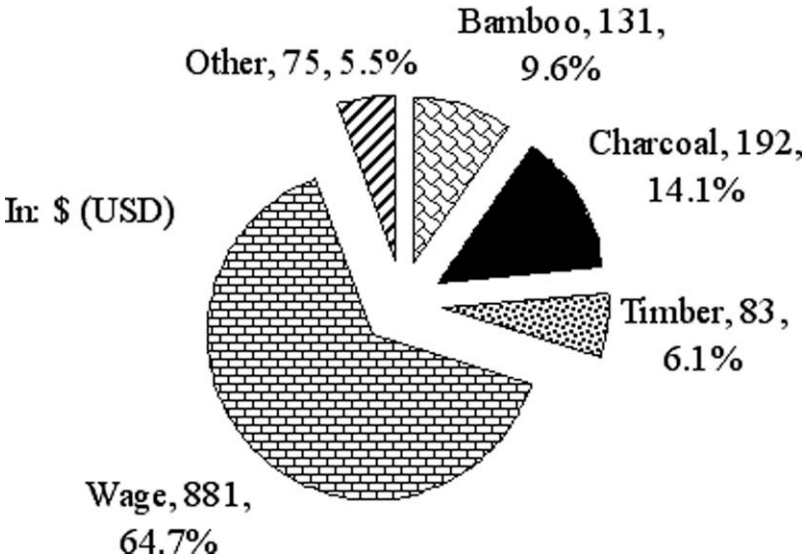

Fig. 4 – Annual cash income per household (converted to USD) from forest and non-forest products, assessed from a sample of 60 households in Niujiaodong village (Fig. 1) in 2007.

Table 2 – Events of kill or capture on gray snub-nosed monkeys (Rhinopithecus brelichi) in Fanjingshan National Nature Reserve (FNNR) from 1962.

Year	Sites	Numbers	Threaten Events	Data resources
1962	Yuao	2	Two individuals killed by leg-hold trap	Yang et al. (2002)
1962	Unclear	4	Four individuals shot by local hunter	Tang (1982)
1964	Unclear	1	One individual killed by leg-hold trap	Tang (1982)
1965	Jinzhanping	1	One female killed by local hunter	Peng et al. (1965)
1967	Jinzhanping	3	Two individuals shot by local hunter; several individuals injured; and one female captured and sent to Beijing Zoo	Yang et al. (2002)
1969	Unclear	1	One individual killed by local hunter	Tang (1982)
1970	Panxi	1	One male captured and sent to Beijing Zoo	Yang et al. (2002)
1973	Shizhijie	2	One male and one female killed by member of a geological investigation team	Yang et al. (2002)
1975	Unclear	1	One skin found.	Quan and Xie (1981)
1975	Huixiangping	2	Two individuals shot by local hunter	Tang (1982)
1975	Core zone of FNNR	2	Two females killed by Guizhou Normal University	Zhou J (personal communication)
1977	Unclear	3	Killed by leg-hold traps	Tang (1982)
1981	Paomuba	1	One male killed by investigate team for gray snub-nosed monkeys	Yang et al. (2002)
1984	Machaohe	2	Two males clipped by leg-hold traps. One died, and the other rescued by administration of FNNR	Zhang (1985)
1985	Unclear	1	One male killed by local people	Yang et al. (2002)
1986	Heshui	2	Two males shot after roaming out of the FNNR	Zhao (1986)
1992	Unclear	1	One female captured by local people	Zhou and Chen (1996)
1991–1994	Core zone of FNNR	9	Three males, six females captured by administration of FNNR for captive breeding	Zhou and Chen, 1996; Lei XP (personal communication)
1996	Core zone of FNNR	1	One female killed by leg-hold trap	Yang et al. (2002)
2002	Xinye	1	One old male killed by local people after roaming out of FNNR	Yang et al. (2002)
2007	Huixiangping	1	One 2–3 years old male firstly provisioned by the worker building cable car, and then it rescued by FNNR	This study

(*Elaphodus cephalophus*), serow (*Naemorhedus sumatraensis*), wild boar (*Sus scrofa*), masked palm civet (*Paguma larvata*), black bear (*Ursus thibetanus*), Chinese ferret badger (*Melogale moschata*), and hog badger (*Arctonyx collaris*). Although poachers do not pursue the snub-nosed monkey directly, they are sometimes accidentally injured or killed by leg-hold traps (Table 2). Between 1962 and the present, a minimum of 32 *R. brelichi* individuals have been killed in hunting events, and the actual number may be substantially greater. Although the number of hunting events per year is significantly lower since the establishment of FNNR in 1978 ($t = -2.241$, $df = 41$, $p = 0.005$), poaching is still occurring in the core zone. Of known instances, one female monkey was killed by a leg-hold trap in 1996, and others monkeys were also killed when they roamed out of the FNNR in 1986 and 2002-local people are often unaware that the species is rare and under protection. A male observed without his left-forearm in the Yangaoping sub-population suggests that poachers are a continuing threat to the snub-nosed monkeys.

Extracted wood is mainly used for firewood, timber, and charcoal production. With economic development in the area, people are requiring more timber for building larger houses. Although firewood is the primary energy source for heating and cooking, electricity is a preferred alternative when family income permits. Firewood collection and charcoal production often occurs at the forest edge and results in a gradual shrinking of woodland, while timber extraction likewise contributes to forest degradation.

Most activities represent an indirect threat to *R. brelichi*. For example, the building of a travel highway and cable car not only results in habitat degradation, but also provides convenient access to the FNNR. Unlike macaques, gray monkeys are very shy of humans, and usually do not use the habitats where human activities regularly occur (Xiang ZF, personal

Table 3 – Population size of gray snub-nosed monkey (Rhinopithecus brelichi) from 1980's.

Survey time	Population size	Census method	Data resource
1980–1983	450–500	Estimated based on simple investigation	Ma et al. (1988); Quan and Xie (2002)
1987	500–670	Unclear	Eudey (1987)
1991–1993	ca. 800	Estimate based on simple investigation	Bleisch (1995); Yang et al. (2002)
2000	ca. 800	Estimate from monitoring the Fanjingshan Nature Reserve	Lei XP (personal communication)
2007	ca. 750	Estimate based on comprehensive survey	This Study

observation). This reduces the potential habitat for the species. Although local businesses and hotels benefit from visitors, however, the incomes have not shared with local community at present (Xiang ZF, personal observation). Therefore, tourism, especially highway and cable building, likely poses as a threat to the monkeys' survival.

Strip mining is well-known for its adverse effects on vegetation and local ecosystems in general. As illegal mining continues to occur in the core zone of FNNR, the potential habitat for the gray snub-nosed monkey is concurrently being reduced.

4. Discussion

Comparing this work with previous surveys (Table 3), it could be argued that the total population size of *R. brelichi* has been relatively stable at *ca.* 800 individuals since 1981. According to our two counts, the ratio of mature (adult of both sexes) to immature (juvenile and infant of both sexes) monkeys is nearly 1:1. An equal adult-to-juvenile ratio is indicative of a stable population, and earlier census methods may have underestimated total numbers of *R. brelichi*. However, in contrast to the other Chinese snub-nosed monkeys (*R. roxellana* and *R. bieti*), *R. brelichi* has a temporary-fusion social system with about 500–600 individuals in a band during March and August (Bleisch et al. 1993; Yang et al. 2002). As this observation was not collected synchronously with surveys of Dongpengshan and Huixiangping during the presumed fusion season, therefore, we are unsure if these two sub-populations come from the same group or not.

In Chinese traditional medicine, the bones of many primates are used to marinate wine which is believed to be good for rheumatism and overall health (i.e. *R. bieti*: Xiang et al., 2007; *Trachypithecus leucocephalus*: Huang et al., 2002). Fortunately, the bones of *R. brelichi* are not used in this alleged medicine. One direct threat to *R. brelichi* is accidental injury or death by poachers in their pursuit of animal other than snub-nosed monkeys. Habitat destruction and degradation, however, are likely more pertinent dangers to the species' survival. As the Mt Fanjing area is characterized by low income and high population density, there may be a greater human pressure here than on the ecosystem of any other region in China.

Based on our results and analysis we make the following management recommendations for the conservation of *R. brelichi*:

(i) The administrative bureau of the reserve should: (1) control the illegal poaching by increased patrolling and law enforcement, (2) carry out an education program involving conservation awareness to ensure that villagers do not kill *R. brelichi* when the monkeys roam out of the reserve, (3) stop the illegal exploitation of mines, (4) try to extend the FNNR including the Gaofeng sub-population, and (5) carry out a community co-management program with the help of NGOs and GOs.

(ii) International NGOs could extend their conservation program for this species and use *R. brelichi* as a catalyst for regional biodiversity conservation. These programs could be implemented as support for the ongoing Project for Protecting Natural Forest and Returning Field to Forest/Grassland, launched by the Chinese government in 1998. Such programs could include capacity building for the reserve, educational activities, and research actions for improving management measures.

(iii) For the long-term conservation of *R. brelichi* management actions are required to develop a sustainable ecosystem. To reduce firewood usage and ensure greater habitat protection, we propose several activities to lower the anthropogenic pressure on the ecosystem: (1) designating specific forest reserve areas for sustainable wood extraction, (2) utilizing biogas to reduce firewood demands, (3) instructing local people on how to utilize bamboo stems and shoots to generate greater cash income, (4) educating young people and encouraging them to work in developed areas, and (5) encouraging the villagers to move out the mountain. Especially, as biogas is renewable resources, it obviously will reduce the pressure on the forest ecosystem.

5. Conclusions

Four sub-populations, with a total of *ca.* 750 individuals, were located in mixed deciduous and evergreen broad leaf forest at 800–2200 m asl in the Mt Fanjing area. Only one sub-population (*ca.* 50 individuals) was located out of the FNNR. The stable population for the last three decades suggests that the population may be near the reserve's carrying capacity. Threats to the species include accidental injury or death by poaching and loss or alteration of habitat through wood extraction and economic activities. Future conservation measurements should be based on alleviating the anthropogenic pressure on the ecosystem and community participatory conservation. Meanwhile, as a long-term conservational plan for the gray snub-nosed monkeys to survival, the villager should be encouraged to move out the mountain.

Acknowledgements

This study was supported by National Basic Research Program of China (2007CB411605), National Natural Science Foundation of China (30630016, 30870375), Innovation Project of the Chinese Academy of Sciences (KSCX2-YW-R-091), China Postdoctoral Science Foundation, National Geographic Society (8575-08), Rufford Small Grants for Nature Conservation, and Primate Conservation Inc. (20070410634). We thank Ken Sayers for useful suggestions and editing the English of the manuscript, the Administrative Bureau of Fanjingshan Nature Reserve for their support, and Yang XG, Yang SJ and Dong XH for their field assistance.

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