

# Achievements and challenges of primate conservation in China

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## ABSTRACT

The dual impact of climate change and human activities has precipitated a sharp decline in primate biodiversity globally. China is home to the most diverse primate species in the Northern hemisphere, which face severe ecological threats due to the expansion of modern agriculture, extensive exploitation and consumption of natural resources, and excessive land development during its transition from an agricultural to a modern society. In

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response, China has implemented various ecological conservation measures, including habitat restoration and protection. These efforts have made substantial strides in biodiversity conservation, with certain regions witnessing an increase in primate populations. In the current study, we conducted a systematic review of historical documents and field research data related to Chinese primates, evaluating the endangered status of primate species in China. Despite improvements in the habitats of most primate species and some population growth, many species still face severe threats, including declining and

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small populations. Species such as the Myanmar snub-nosed monkey (*Rhinopithecus strykeri*), eastern black crested gibbon (*Nomascus nasutus*), and Hainan gibbon (*N. hainanus*) remain particularly vulnerable due to their limited distribution ranges and extremely small populations. Insufficient scientific data, fragmented information, and not enough studies in conservation biology further compound the challenges. Moreover, there is a notable lack of detailed population monitoring data for species such as the Bengal slow loris (*Nycticebus bengalensis*), pygmy slow loris (*N. pygmaeus*), Indochinese gray langur (*Trachypithecus crepusculus*), Shortridge's langur (*T. shortridgei*), and capped langur (*T. pileatus*), which hinders the development of practical and targeted conservation management strategies. Therefore, for national biodiversity conservation, there is an urgent need for specialized primate surveys, enhancing habitat protection and restoration, and increasing focus on cross-border conservation strategies and regional cooperation. There is also a need to establish a comprehensive and systematic research database platform, conduct continuous and in-depth research in primate biology, and actively engage in the scientific assessment of ecotourism. Additionally, strengthening public awareness and education on wildlife conservation remains essential. Such integrated and systematic efforts will provide scientific support for the current and future conservation and management of primate species in China.

**Keywords:** Primates; Biodiversity; Habitat fragmentation; Habitat restoration; Conservation strategies

## INTRODUCTION

Primates are the most evolutionarily advanced group in the animal kingdom and the third most diversified group of mammals, after Rodentia and Chiroptera (Estrada et al., 2022). Non-human primates are the closest relatives of humans, forming an essential part of tropical, subtropical, and temperate ecosystem communities and playing a pivotal role in displaying irreplaceable parts in ethnic and religious cultures (Estrada et al., 2017; Li et al., 2018). Primates also provide unique research counterparts for research exploring human evolutionary development, social civilization, and medical sciences (Pan et al., 2016; Zhao et al., 2021).

There are 521 primate species globally, belonging to 16 families and 79 genera, distributed in 91 countries in South America, Mexican lowlands, Central America, Africa, Madagascar, Asia, and the European Mediterranean (Estrada & Garber, 2022; Estrada et al., 2022). However, they face a severe extinction crisis, with more than 60% currently classified as vulnerable, endangered, or critically endangered taxa, and 75% experiencing declining populations (Estrada et al., 2017).

China is home to 28 extant primate species belonging to three families and eight genera (Wei et al., 2021). Recent historical events in China have severely impacted these species, especially the catarrhines (gibbons, colobines, and macaques) after the 1800s. This period aligns with substantial social transformations and anthropogenic activities,

particularly during the First and Second Opium Wars (1800–1849 and 1850–1899), Second World War and Civil War in the first half of the last century, and the post-war period after 1950, characterized by unparalleled environmental degradation and natural resource depletion (Li et al., 2018; Pan et al., 2016; Zhang et al., 2022). Consequently, these primates represent a critical focus for global conservation efforts. Of concern, approximately 80% of these species are currently categorized as threatened taxa (Critically Endangered, Endangered, and Vulnerable taxa according to the IUCN Red List). It is estimated that 15–18 species have population sizes of fewer than 3 000 individuals, and two species of gibbons have not been observed in the wild for many years (Li et al., 2018; Pan et al., 2016). Almost all their habitats have undergone significant fragmentation and isolation, severely restricting opportunities for inter-population migration and genetic exchange (Li et al., 2020; Zhang et al., 2022).

The primary driving factors of these adverse outcomes include habitat loss and fragmentation, over-exploitation of resources, and global climate change (Li et al., 2020; Zhang et al., 2022), stemming from anthropogenic activities, increased human population, rapid depletion of natural resources, expansion of agriculture, excessive use of biological resources, lack of public education, and inadequate application of laws and regulations (Dirzo et al., 2014). Most critically, the absence of a comprehensive national conservation platform has greatly exacerbated these issues (Pan et al., 2016).

China established its first natural reserve, Dinghushan National Nature Reserve, in 1956 in Guangdong Province (Gao, 2021). Since then, there has been considerable progress, including the implementation of legislation and international cooperation in conservation efforts (Li & Pimm, 2020; Primack, 2021). Over the past 40 years, China has explicitly engaged in environmental conservation initiatives, including ecological restoration, rehabilitation, and habitat protection (Huang et al., 2021). As of 2019, China has established 11 800 nature reserves (sites), covering 18% of national territory and 89% of national priority animal species (Huang et al., 2021; Jiao et al., 2022). In addition, China has established various parks, including forest, geographic, wetland, desert, and national protected areas (PAs) to achieve multiple conservation goals (Huang et al., 2021; Primack, 2021). These initiatives have played a critical role in the conservation of primates and other wildlife. Concurrently, China has also intensified its focus on environmental and conservation research, alongside investments in these areas. This has led to the development of extensive databases and an increase in researchers engaged in fieldwork. They have access to cutting-edge research facilities, are involved in the development of extensive internet databases, and employ advanced methods in genetic and molecular biology, taxonomic identification, and genealogy (Li et al., 2021).

Following a comprehensive assessment of the conservation status of 28 primate species as part of a collaborative national effort, this paper briefly summarizes key points and findings and proposes a national primate conservation strategy.

## CURRENT PRIMATE CONSERVATION STATUS IN CHINA

### Lorisidae

China is host to two loris species: the Bengal slow loris

(*Nycticebus bengalensis*) and the pygmy slow loris (*N. pygmaeus*) (Wei et al., 2021). These species are primarily distributed in the western, southern, and central regions of Yunnan and the southwestern area of Guangxi (Figure 1) (Yu et al., 2013). Both species are characterized by their small size and arboreal and nocturnal nature (Kumara et al., 2021; Nekaris et al., 2020). The Bengal slow loris population is estimated at approximately 1 300 individuals (Yu et al., 2013), while the pygmy slow loris population ranges between 100 and 150 (Chen et al., 2014; Yu et al., 2013). Studies on their behavior, ecology, and conservation are remarkably deficient. Thus, there is a pressing need for further research to understand the mechanisms underlying their natural selection and environmental adaptation, identify the major factors impacting their preservation and prospective development, provide conservation strategies or suggestions for two loris species.

### Cercopithecinae

Eight *Macaca* species are found in China (Wei et al., 2021), widely distributed in central and southern regions of the country (Figure 2) (Li et al., 2020; Zhang et al., 2022). The population sizes of these species exhibit significant variation. For instance, rhesus macaques (*M. mulatta*) have an estimated population of approximately 100 000 (Jiang et al., 2021), with an annual growth rate of 2% (Zhang, 2002). Xizang macaques (*M. thibetana*) numbered 17 960 in 2002 (Zhang, 2002), with recent estimates suggesting the population has reached around 20 000 (Li, 2015; Li et al., 2017). The population of Taiwan macaques (*M. cyclops*) remains stable, consisting of 10 500 groups and 262 500 individuals (Fan et al., 2021). In contrast, the stump-tailed macaque (*M. arctoides*) population has declined sharply in

some areas, now numbering around 3 700 individuals (Chetry et al., 2020). The northern pig-tailed macaque (*M. leonina*) is much less studied, with no recent survey records of its population size, although its distribution is known to be extensive (Boonratana et al., 2022). Information on the population size of Assam macaques (*M. assamensis*) remains scarce, although their population structure is considered relatively stable (Sun et al., 2020). The white-cheeked macaque (*M. leucogenys*) was first described in 2015 in Medog, Xizang (Chetry et al., 2015; Li et al., 2015), and recently discovered in Gaoligong Mountains, Yunnan (Hu et al., 2023); however, its population assessment remains uncompleted. The Arunachal macaque (*M. munzala*), another species reported in southern Xizang (Sinha et al., 2005), has approximately 41 groups totaling about 1 000 individuals (Sarania et al., 2017).

In comparison to other primate groups in China, Cercopithecinae demonstrates considerable adaptability to various environments and habitats. Most species within this group maintain large population sizes and are assigned relatively lower conservation priorities. However, further studies on white-cheeked and Arunachal macaques are required.

### Colobinae

Eleven species of Colobinae are found in China (Figure 3), including three genera (Wei et al., 2021). Within the genus *Rhinopithecus*, the Sichuan snub-nosed monkey (*R. roxellana*) has shown significant conservation progress, comprising approximately 188 to 220 groups containing 22 710–26 130 individuals (Yu et al., 2022). Consequently, it has been proposed that the conservation status of *R. roxellana* be downgraded from Endangered to Vulnerable (Yu

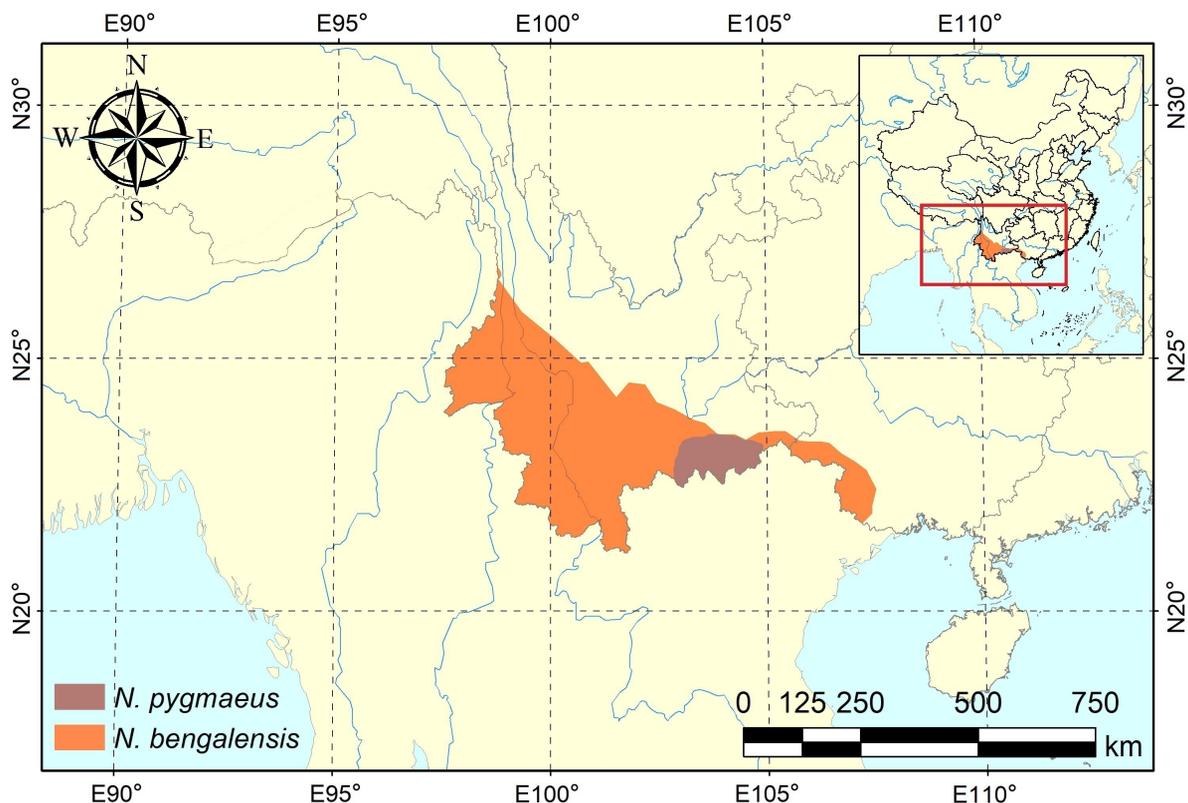


Figure 1 Distribution of Lorisidae in China

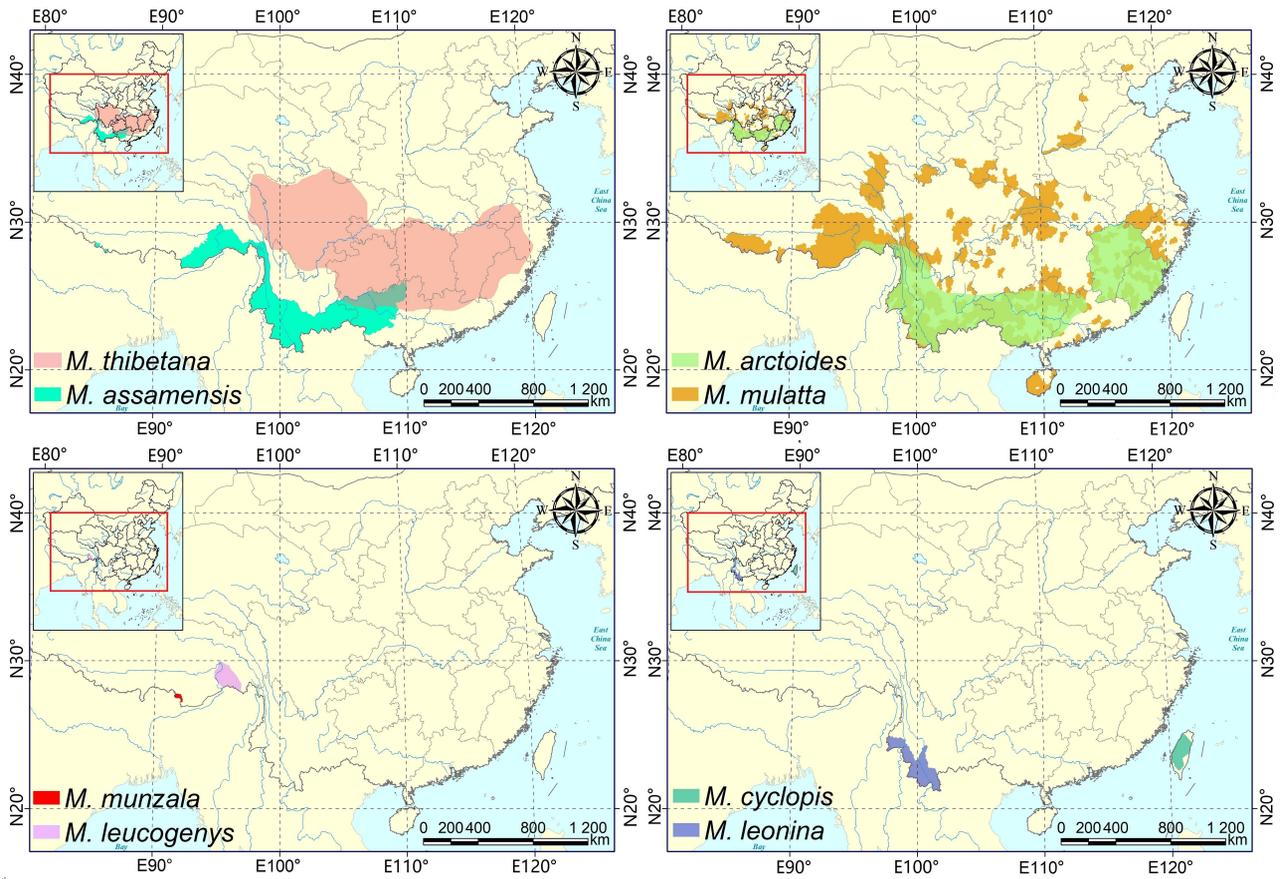


Figure 2 Distribution of Cercopithecinae in China

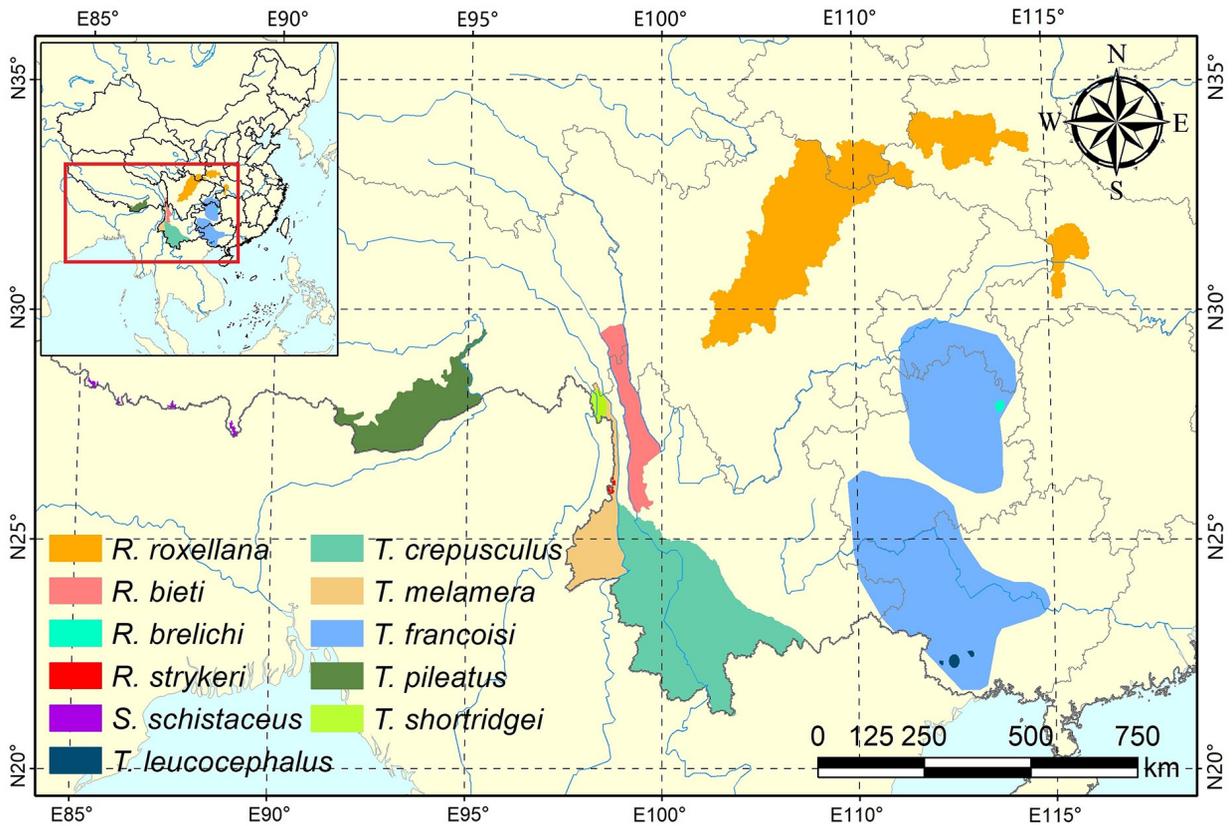


Figure 3 Distribution of Colobinae in China

et al., 2022). Another species experiencing notable population growth is the Yunnan snub-nosed monkey (*R. bieti*), which now contains 23 groups with 3 845 individuals (range 3 360–4 330 individuals) (Xiao, 2021). In contrast, the Guizhou snub-nosed monkey (*R. brelichi*), found only in the Fanjingshan National Nature Reserve in Guizhou, faces severe habitat fragmentation and reduction (Guo et al., 2020) and is currently categorized as a Critically Endangered primate by the IUCN. At present, its population has declined to fewer than 400 individuals, accompanied by low genetic diversity (Guo et al., 2020; Long et al., 2022). In addition, the Myanmar snub-nosed monkey (*R. strykeri*), first reported in 2010 from the Gaoligong Mountains along the China-Myanmar border (Geissmann et al., 2011; Long et al., 2012), is also currently assessed as Critically Endangered by the IUCN. In China, two of the six known groups contain fewer than 280 individuals (Chen et al., 2022; Ren et al., 2017; Yang et al., 2022).

The Nepal gray langur (*Semnopithecus schistaceus*) in China is exclusively found along the southern flank of the Himalayas (Hu et al., 2014; Hu et al., 2016). Despite its relatively stable population size, comprehensive knowledge about this species remains limited (Hu et al., 2017). The population of Francois' langurs (*Trachypithecus francoisi*) in China has increased from around 1 300 before 2000 to over 1 900 in recent years (Deng et al., 2019; Zeng et al., 2013; Zhou & Huang, 2021). The white-headed langurs (*T. leucocephalus*) population has steadily increased (Huang et al., 2008; Huang et al., 2017), although they face severe habitat fragmentation (Huang et al., 2017; Li et al., 2022b). The conservation status of the Indochinese gray langurs (*T. crepusculus*) in China is comparatively positive, showing a

steady increase in population size, now exceeding 5 000 individuals (Ma et al., 2015). The Shan state langurs (*T. melamera*) in China are estimated to number no more than 2 500 individuals (Ma et al., 2017). Both the capped langurs (*T. pileatus*) and Shortridge's langurs (*T. shortridgei*) are facing the highest extinction threat in China (Jiang et al., 2021), with the former consisting of fewer than 500 individuals (Hu et al., 2017) and the latter, found only in the Dulong River area in Gongshan and Nujiang, Yunnan, has an estimated population size of only 250–370 individuals (Cui et al., 2016).

Overall, the conservation status for the Colobinae subfamily in China is showing signs of improvement. However, certain species, such as the Guizhou and Myanmar snub-nosed monkeys and capped and Shortridge's langurs, face severe conservation pressures and small populations of less than 500 individuals, indicating a critical need for focused conservation efforts.

#### Hylobatidae

All species within the Hylobatidae family in China are classified as Critically Endangered (Li et al., 2018; Pan et al., 2016), facing considerable survival challenges, including restriction to sporadic locations in southwest China and Hainan Island (Figure 4) (Zhang et al., 2022). Among these species, the western hoolock gibbons (*Hoolock hoolock*), distributed between Danbaqu and the Tsum River in Chayu, southern Xizang, number about 450 individuals (Chetry et al., 2008, 2010; Das et al., 2006). The Gaoligong hoolock gibbons (*H. tianxing*) are confined to only 15 fragmented areas in Yingjiang (Dehong), Longyang, and Tengchong (Baoshan), with an estimated 32–34 families and 11 solitary adults, totaling fewer than 150 individuals (Fan et al., 2017, 2022; Zhang et al., 2020). The western black crested gibbons

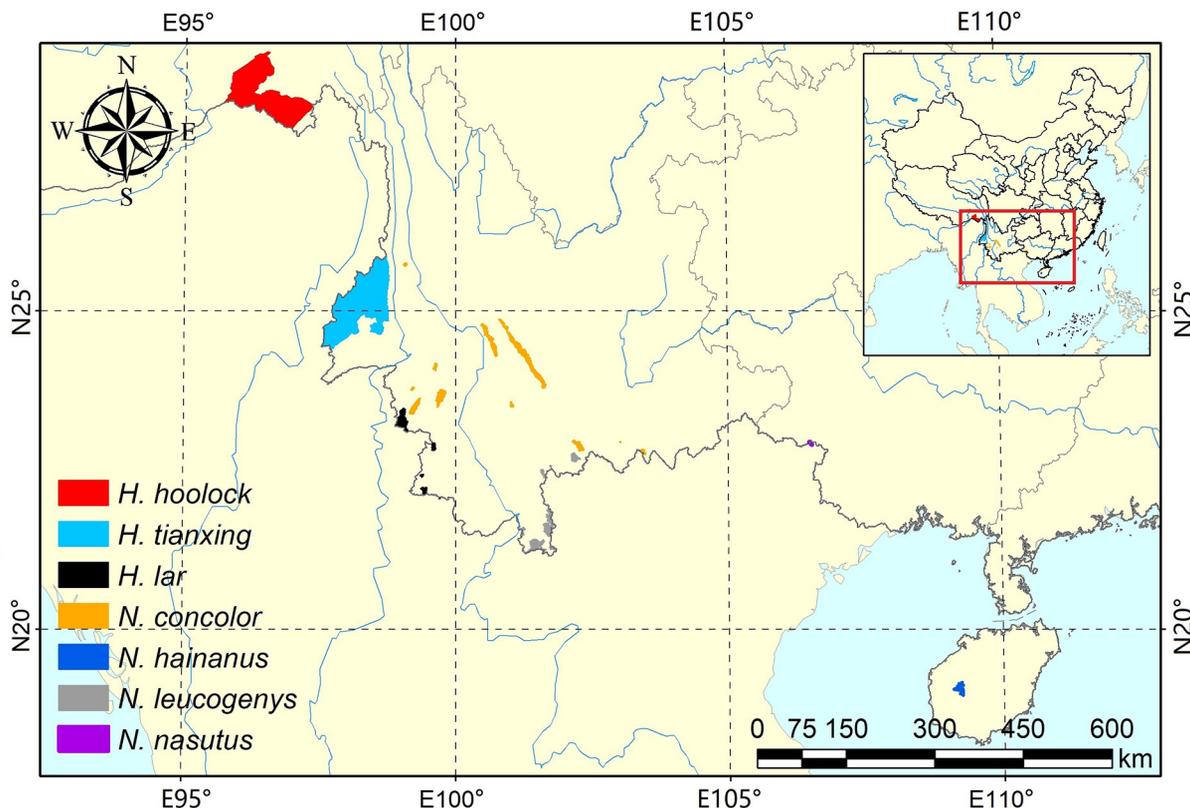


Figure 4 Distribution of Hylobatidae in China

(*Nomascus concolor*) are currently the most abundant species within the Hylobatidae family in China (Fang et al., 2020), with approximately 310 families, containing about 1 300 individuals in the Wuliang and Ailao mountains in central Yunnan (Fan et al., 2022; Li et al., 2011, 2023; Luo et al., 2007). However, in western and southern Yunnan, their numbers have declined dramatically to scattered patches, with some areas reporting single-digit populations, placing them on a trajectory towards extinction (Dooley & Judge, 2015). The Hainan gibbons (*N. hainanus*), endemic to Hainan Island (Deng et al., 2017; Du et al., 2020), have a population of about 36 individuals (Liu et al., 2022). The eastern black crested gibbons (*N. nasutus*) are confined to a small karst forest area on the border between Guangxi (China) and Vietnam (Lok et al., 2008; Fan et al., 2010) and consist of only about 60–66 adults (Fan et al., 2010, 2013), with only 15–20 adults recorded in China, making them, alongside the Hainan gibbon, the most critically endangered primate taxa (Mootnick et al., 2012). Regarding the white-handed gibbon (*Hylobates lar*) and northern white-cheeked gibbon (*N. leucogenys*), no evidence of their presence has been found in fieldwork conducted over the last 15 years (Fan et al., 2014; Grueter et al., 2009; Li et al., 2018).

### CONSERVATION STRATEGIES

As reviewed above, primate conservation in China has made substantial progress in certain regions and among certain species. A notable example is the Sichuan snub-nosed monkey, whose conservation status may soon be downgraded from Endangered to Vulnerable (Yu et al., 2022), reflecting the successful implementation of several major ecological and environmental protection projects, including the Natural Forest Conservation Program, National Wildlife Protection, and Nature Reserve Project (Huang et al., 2021). However, most primate taxa in China continue to face significant conservation challenges, largely due to increased habitat fragmentation and isolation resulting from extensive human activities. This is especially true for the Bengal slow lorises, pygmy slow lorises, Myanmar and Guizhou snub-nosed monkeys, and all gibbon species (Li et al., 2018; Zhang et al., 2022). To alleviate these

conservation pressures and achieve effective primate conservation, we propose the development of an integral national primate conservation strategy.

### National conservation platform

In line with broader animal conservation efforts, the preservation of primates requires the participation of all sectors of society, with primatologists playing a leading role in generating guidelines to ensure conservation efforts are scientific, tangible, and practical. Thus, we propose establishing a database-driven platform to monitor ecological sustainability, environmental changes, primate demographic fluctuations, and human impacts across various primate distribution areas (Figure 5). The objective of this national strategy is to generate a transparent primate conservation network that links research and education institutes, conservation organizations, media, and both local and central government bodies.

This proposed platform will mobilize alternative resources, raise awareness, and increase investment in primate conservation in China, leading to a more practical conservation network. It will provide timely and simplified visual representations and accurate data on changes in primate distribution, demographics, and human activities across different species and regions. This will enable dynamic assessment of their conservation status. The platform will also play a crucial role in disseminating conservation-related information and knowledge to the community and provide robust scientific evidence and data to government authorities at both the local and central levels, emphasizing the importance of integrating primate conservation into economic and social development planning, especially the formulation of each Five-Year Plan. The platform will facilitate a balanced approach to ecological and environmental considerations, human development, and primate conservation. For such a national strategy, databases associated with primate demographic profiles and fluctuations must be updated periodically, with special regard to highly threatened species such as pygmy slow lorises, stump-tailed macaques, Assam macaques, northern pig-tailed macaques, white-cheeked macaques, Arunachal macaques, Indochinese gray langurs,

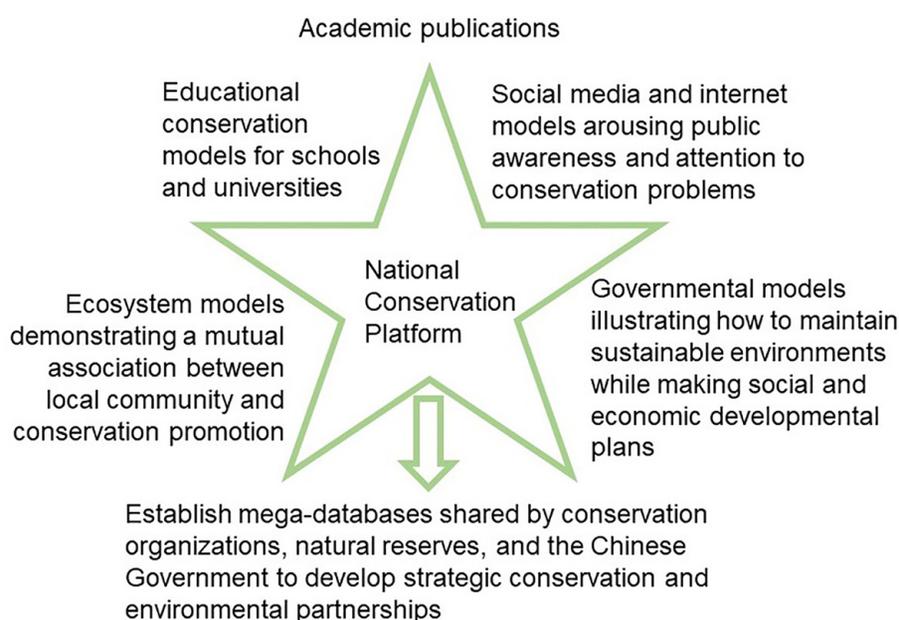


Figure 5 National conservation platform from Pan et al. (2016) with some modifications

Shorridge's langurs, Gaoligong hoolock gibbons, Hainan gibbons, and eastern black crested gibbons.

Based on the platform, we propose adopting an emblem featuring either gibbons or snub-nosed monkeys and establish a primate conservation day to raise public awareness about their conservation crisis. Additionally, we encourage the development of commercial films, toys, and other merchandise themed around these primates to further promote awareness and support for conservation efforts.

#### Enhancing habitat protection and restoration

Habitat fragmentation, isolation, and degradation are the primary driving forces impacting biodiversity and contributing to environmental deterioration. Therefore, it is imperative to strengthen conservation efforts, building upon the progress and achievements made over recent years. Special attention should be paid to creating corridors between isolated habitats to provide sufficient space for migration and genetic exchange (Li et al., 2018). Simultaneously, it is necessary to expand and enhance PAs, particularly for species such as the Sichuan snub-nosed monkeys and Gaoligong hoolock gibbons, to ensure their continued survival.

#### Enhancing cross-border cooperation with neighboring countries

The distribution areas of most primate species in China, including macaques, colobines, lorises, and gibbons, overlap with neighboring countries, such as Vietnam, Laos, Myanmar, India, and Nepal. This poses challenges in implementing effective primate conservation, particularly due to the increased hunting and poaching of wild animals, including primates, in these border areas (Fan et al., 2022). In response to these difficulties, we strongly advocate for the establishment of multinational cooperation, especially the creation of a mutually beneficial platform for scientific investigation and research data sharing, cross-border wildlife conservation, management, crime prevention, and cross-border migratory corridors. Such an international endeavor would significantly promote the conservation status of Myanmar snub-nosed monkeys in the Gaoligong Mountains of northwestern Yunnan and adjoining Myanmar; the eastern black crested gibbons found in Guangxi, China, and Gaoping, Vietnam; and the western hoolock gibbons and eastern hoolock gibbons (*H. leuconedys*) located in Myanmar (Lwin et al., 2011).

#### Enhancing primatological research

Beyond the establishment of a shared database platform, as discussed above, there remains a need for further studies on primates, including identifying extinction risk factors and processes, examining the impacts of climate change and drought, and assessing evolutionary resilience based on fossil distribution, historical geographic change trajectories, and prospective development paths. Such efforts will allow us to design and modify conservation strategies frequently and dynamically (Zhang et al., 2022).

#### Monitoring ecotourism

Primate-related ecotourism has significantly increased in recent years (Russon & Wallis, 2014; Zhao et al., 2021), with examples in China including Mt. Huangshan (Li et al., 2022a), and Shennongjia National Nature Reserve (Zhang et al., 2017). However, without appropriate management, such developments can cause severe disturbances to primate populations and their habitats (Li et al., 2022a). Various

issues, such as poor design, unscientific planning, and disorganized management, can adversely impact the reputation of ecotourism and threaten the survival and expansion of primate populations (Li et al., 2022a; Zhao et al., 2021). Thus, we recommend conducting regular scientific assessments to understand the impact of ecotourism on local primate populations. Such assessments are essential for the sustainable development of primate-centric ecotourism in China.

#### CONCLUSIONS

Through comprehensive analysis and discussions among primatologists, this paper provides a holistic review of the conservation status of primates in China and the factors contributing to their significant decline over the years. This review also highlights prominent achievements following the implementation of key environmental protection and conservation projects in China, which have positively impacted several species, including the rhesus macaque, Xizang macaque, Taiwan macaque, Sichuan snub-nosed monkey, Yunnan snub-nosed monkey, and Francois' langur. Nonetheless, China still faces significant conservation challenges for certain species, such as the pygmy slow loris, Guizhou snub-nosed monkey, Myanmar snub-nosed monkey, capped langur, Shorridge's langur, and gibbons, all of which remain listed as Critically Endangered. Furthermore, increased attention is needed on biological studies, particularly the dynamic demographic changes of species such as the Bengal slow loris, pygmy slow loris, northern pig-tailed macaque, white-cheeked macaque, Arunachal macaque, and Nepal gray langur. For the development of a sustainable and practical conservation strategy in China, the creation of a research database-driven platform is crucial. This platform should unite a diverse array of stakeholders, including scholars, conservationists, government entities, social media channels, educational institutions, and international partners, which is vital to achieving conservation objectives.

#### COMPETING INTERESTS

The authors declare that they have no competing interests.

#### AUTHORS' CONTRIBUTIONS

B.G.L., R.L.P., and H.Z., wrote and edited the manuscript. M.L., X.L.J., P.F.F., J.Z., S.T.G., X.G.Q., J.H.L., J.Q.L., D.P.X., L.W.C., Z.F.X., Q.H.Z., Z.P.H., C.M.H., W.X., H.J.H., Z.X.Z., M.Y.C., D.Y.L., P.L.F., and Y.Y. discussed the study, provided suggestions to revise the manuscript. All authors read and approved the final version of the manuscript.

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