Postprint: Assessment of In-Situ Conservation Status of Mammals in China

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Abstract

Nature reserves are widely recognized as one of the most effective means for the in-situ conservation of biodiversity. Based on a national baseline survey of nature reserves, this study assessed the in-situ conservation status of 591 mammal species within China' s nature reserves at the national scale by analyzing the distribution of wild mammal population numbers. According to the evaluation index system, the in-situ conservation level of mammals in China was classified into seven categories: "effective protection" , "good protection" , "general protection" , "minimal protection" , "unprotected" , "unclear protection status" , and "not evaluated" . The results indicated that, excluding the 35 unevaluated species, 534 of the remaining 556 evaluated species received some degree of protection within nature reserves, accounting for 90.36% of the total. Among these, 145, 60, 100, and 229 species were classified as effectively protected, well protected, generally protected, and minimally protected, respectively, representing 24.53%, 10.15%, 16.92%, and 38.75% of the total. Additionally, 22 species had unclear protection status. The assessment of in-situ conservation status of mammals across different protection systems involved 140 nationally key protected wildlife species and 427 species listed in the China Species Red List, of which 109 and 409 species, respectively, received varying degrees of protection within reserves. Overall, although 90.36% of mammals received some protection within nature reserves, the proportion with favorable protection status (including effective and good protection) was notably low, indicating that the conservation situation remains concerning and that protection efforts need to be strengthened; for species with unclear protection status, it is necessary to conduct more comprehensive and detailed scientific investigations in reserves to further determine their conservation status; for species that are indeed not receiving in-situ protection in nature reserves, they need to be incorporated into the nature conservation system by improving the reserve network.

Full Text

Evaluation of In-Situ Conservation of Mammals in China

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Abstract

The establishment of nature reserves is recognized as one of the most effective approaches for the in-situ conservation of biodiversity. Based on data from basic investigations of nature reserves across the country, we analyzed populations of wild mammals and their distribution in China' s nature reserves and evaluated the in-situ conservation status of 591 species on a national scale. According to the evaluation index system, we divided the conservation of wild mammals in nature reserves into seven levels: "Effectively Protected,""Well Protected,""Moderately Protected," "Less Protected," "Status Unknown," "Not Protected," and "Not Evaluated." Results showed that among the 591 species of wild mammals, 556 were evaluated and 35 were not. We found that 534 species were protected to different extents, accounting for 90.36% of the 591 species of wild mammals in this study. Among these 534 species, 145 were "Effectively Protected," 60 were "Well Protected," 100 were "Moderately Protected," and 229 were "Less Protected," accounting for 24.53%, 10.15%, 16.92%, and 38.75%, respectively. However, 22 species were classified under "Status Unknown."For different protection systems, the conservation status of wild mammals was evaluated, including the 140 and 427 species listed under national key protection and the China Species Red List, respectively, of which 109 and 409 were protected to varying degrees. Although most wild mammals had been placed under conservation in nature reserves, and most key protected wild mammals were well protected, their protection status was still not optimal and their conservation needed to be further intensified as the percentage of efficient protection of wild mammals, including "Effectively Protected" and "Well Protected," was still significantly lower. Regarding species with unknown protection levels, it is necessary to carry out more comprehensive and detailed scientific investigations to further determine their conservation status in nature reserves. For species of wild mammals that are unprotected by nature reserves, it is essential to include them in the protection system by improving the network of nature reserves in China to fill the gaps.

Keywords: mammals; in-situ conservation; nature reserve; evaluation

Introduction

China has a vast territory with diverse landforms, and differences in temperature and precipitation determine the distribution patterns and diversity of vertebrates in the country. According to the *China Biodiversity Red List* (Vertebrates Volume) jointly released by the Ministry of Environmental Protection and the Chinese Academy of Sciences in 2015, the number of mammal species in China is [MATH_0], ranking first in the world in mammal richness (including synonyms). As one of the world's most biodiverse countries, China is also among those most severely threatened. Protecting wild animals and their habitats has become an important component of biodiversity conservation. Establishing nature reserves serves as the primary means of in-situ wildlife conservation, and evaluating wildlife conservation effectiveness represents a crucial indicator for measuring whether nature reserve functions are fully realized, providing an important basis for further conservation planning.

Mammals, as species with relatively high trophic levels and relatively fixed habitats in food chains, can directly and indirectly achieve protection of other species in the region when protected themselves, serving as umbrella species. Due to their special status, mammal populations and their protection status receive more attention than other species. Threat level and protection status represent two perspectives for evaluating species status. In terms of species threat assessment, the IUCN (International Union for Conservation of Nature) Red List criteria represent the most widely used species endangerment assessment system worldwide. China has successively conducted species endangerment assessments using relevant standards, including the *China Biodiversity Country Report*, which identified that [MATH_1] of mammals were endangered, while the *China Species Red List* showed the proportion of endangered mammals rapidly rising to 22.06%. The 2015 *China Biodiversity Red List* (Vertebrates Volume) assessment report indicated that after years of effort, the proportion of endangered mammals had decreased to [MATH_2], though the situation remains concerning.

In terms of species protection status assessment, current evaluations of wildlife conservation effectiveness, particularly for mammal in-situ conservation, remain largely qualitative descriptions focusing primarily on nationally key protected species. This study attempts to quantify in-situ conservation status by analyzing the population distribution of each mammal species in nature reserves, evaluating mammal in-situ conservation status at the national scale to comprehensively understand mammal protection status, optimize nature reserve network layout, and provide a scientific basis for concentrating limited resources on priority protection of rare and endangered species and formulating corresponding protection measures and management policies.

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1 Data Sources and Database Construction

To comprehensively understand and master the distribution status of mammals in China, we established a national mammal basic classification information database primarily based on the *China Mammal Species and Subspecies Catalog and Distribution* and supplemented by other research findings. This database includes species distribution across nature reserves, wild population sizes, and whether normal reproduction can occur. We compiled and organized in-situ conservation information to establish an in-situ conservation database that meets the needs of conservation effectiveness evaluation.

Based on the *China Key Terrestrial Wildlife Resources Survey* and comprehensive scientific investigations, master plans, and related thematic survey reports from nature reserves collected by the Nanjing Institute of Environmental Sciences' Nature Reserve Research Center, we extracted mammal distribution information. Referring to the national mammal basic classification information database, we constructed a nature reserve mammal in-situ conservation status database. The database catalogued [MATH_3] mammal species, accounting for 87.82% of mammal species in China (including synonyms). By the end of 2014, the database included [MATH_4] nature reserves, covering 53.43% of China' s total nature reserves, including national, provincial, municipal, and county-level reserves (excluding Hong Kong, Macau, and Taiwan), encompassing all [MATH_5] nature reserve types with scope covering the entire country.

Although data for some protected areas are difficult to update in a timely manner due to funding and research capacity limitations, and some species' in-situ conservation data may have biases, these data all come from first-hand materials and long-term monitoring by nature reserve management agencies and relevant research units, basically reflecting the status of mammals in nature reserves and ensuring research result reliability.

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2 Assessment Methods

Threat and protection represent two perspectives for evaluating species status. Numerous endangered species classification and assessment standards exist internationally and domestically, including IUCN, CITES, and China Species Red List criteria, which are widely accepted by researchers and managers. These methods all use species populations and habitats as important evaluation indicators. Nature reserves are recognized as the most effective means of biodiversity in-situ conservation, and their establishment quantity, management status, and species population changes and distribution areas can represent conservation effectiveness.

Based on mammals' biological and ecological characteristics and their wild population sizes in nature reserves, ability to reproduce normally, and other conditions, this study divides the assessed endangered mammals' in-situ conservation

levels into seven categories: "Effectively Protected," "Well Protected," "Moderately Protected," "Less Protected," "Status Unknown," "Not Protected," and "Not Evaluated." Specific parameter requirements are as follows:

- **Effectively Protected**: More than 2/3 of the wild population is located within nature reserves and can reproduce normally in nature reserves; or the species' wild population is distributed in more than 20 nature reserves, and the distribution area is small with more than 2/3 of the population distributed within protected areas.
- **Well Protected**: The species' wild population in nature reserves can basically ensure normal reproduction; or the species is distributed in 10-20 nature reserves, or the species' wild population distribution area is relatively small with 1/2-2/3 of the population distributed within protected areas.
- **Moderately Protected**: 1/3-1/2 of the wild population is distributed in nature reserves with general protection levels; or the species is distributed in 5-10 nature reserves.
- **Less Protected**: Less than 1/3 of the wild population is distributed in nature reserves; or the species is only distributed in 1-5 nature reserves with fewer protected areas.
- **Status Unknown**: There is information indicating the species should be distributed in China (excluding Hong Kong, Macau, and Taiwan), but its wild population is not distributed in nature reserves; or there are records of discovery but no distribution records in nature reserves.
- **Not Protected**: No populations of the species are found in nature reserves; or there are no distribution records of the species in nature reserves, divided into cases where the species is indeed not protected or where existing data cannot prove its distribution in nature reserves.
- **Not Evaluated**: The species has no distribution records in mainland China; or the species is a migratory animal; or the species is only distributed in Hong Kong, Macau, and Taiwan; or there is evidence that the species' wild population is extinct.

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2 Results and Analysis

2.1 Overall Mammal In-Situ Conservation Effectiveness

According to assessment criteria, among the [MATH_6] mammal species, except for [MATH_7] species distributed in Hong Kong, Macau, and Taiwan that were not evaluated, [MATH_8] species had records in nature reserves and received varying degrees of protection, accounting for 90.36%; [MATH_9] species had no records in nature reserves, accounting for 3.72%. Among protected species, 145

species including rhesus macaque (*Macaca mulatta*) and giant panda (*Ailuropoda melanoleuca*) were "Effectively Protected," accounting for 24.53%; 60 species including giant squirrel (*Ratufa bicolor*) and white-lipped deer (*Cervus albirostris*) were "Well Protected," accounting for 10.15%; 100 species including slow loris (*Nycticebus coucang*) and Przewalski' s steppe lemming (*Lagurus przewalskii*) were "Moderately Protected," accounting for 16.92%; and 229 species including white-browed gibbon (*Hylobates hoolock*) and black musk deer (*Moschus fuscus*) were "Less Protected," accounting for 38.75%. Additionally, 22 species including Indian pangolin (*Manis crassicaudata*) and common dolphin (*Delphinus delphis*) had "Status Unknown," accounting for 3.72%; and 35 species including Taiwan serow (*Capricornis swinhoei*) and fuscus bent-winged bat (*Miniopterus fuscus*) were "Not Evaluated," accounting for 5.92%.

2.2 Analysis of In-Situ Conservation Effectiveness for Nationally Key Protected Wild Mammals

The *National Key Protected Wildlife List* was approved and promulgated by the State Council in 1988. This mammal in-situ conservation status assessment includes the vast majority of nationally key protected wild mammals. Using the species in-situ conservation status evaluation index, we assessed [MATH_10] nationally key protected wild mammal species. Among them, 38 species were "Effectively Protected,"11 were "Well Protected,"14 were "Moderately Protected," 46 were "Less Protected,"16 had "Status Unknown,"and 16 were "Not Evaluated." Specific results are as follows:

1. **Effectively Protected**: 38 nationally key protected species including forest musk deer (*Moschus berezovskii*) and sable (*Martes zibellina*) received effective protection from nature reserves, accounting for 27.14% of evaluated nationally key protected species (including 7 Class I and 31 Class II key protected species).

2. **Well Protected**: 11 nationally key protected species including Assam macaque (*Macaca assamensis*) and Tibetan gazelle (*Procapra picticaudata*) received good protection from nature reserves, accounting for 7.86% of evaluated nationally key protected species (including 5 Class I and 6 Class II key protected species).

3. **Moderately Protected**: 14 nationally key protected species including Tibetan wild ass (*Asinus kiang*) and wolverine (*Gulo gulo*) received moderate protection from nature reserves, accounting for 10.00% of evaluated nationally key protected species (including 4 Class I and 10 Class II key protected species).

4. **Less Protected**: 46 nationally key protected species including dugong (*Dugong dugon*) and bottlenose dolphin (*Tursiops truncatus*) received less protection from nature reserves, accounting for 32.86% of evaluated nationally key protected species (including 8 Class I and 38 Class II key protected species).

5. **Status Unknown**: 16 nationally key protected species including Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) and long-tailed parakeet (*Psittacula longicauda*) had unknown protection status, accounting for 11.43% of evaluated nationally key protected species (including 3 Class I and 13 Class II key protected species).

6. **Not Evaluated**: 16 nationally key protected species including Fraser' s dolphin (*Lagenodelphis hosei*) and right whale (*Eubalaena glacialis*) were not evaluated, accounting for 11.43% of evaluated nationally key protected species (including 8 Class I and 8 Class II key protected species).

2.3 Analysis of In-Situ Conservation Status for Mammals Listed in the China Species Red List

This in-situ conservation status assessment involved [MATH_11] mammals listed in the China Species Red List, accounting for 72.25% of evaluated mammals. Among them, [MATH_12] were extinct (EX), [MATH_13] were critically endangered (CR), [MATH_14] were endangered (EN), [MATH_15] were vulnerable (VU), [MATH_16] were near threatened (NT), [MATH_17] were least concern (LC), and [MATH_18] were data deficient (DD). Specific results are as follows:

1. **Effectively Protected**: 103 China Species Red List mammals including Eurasian otter (*Lutra lutra*) and tufted deer (*Elaphodus cephalophus*) received effective protection from nature reserves, accounting for 24.12% of evaluated China Species Red List mammals (including 16 critically endangered, 22 endangered, 31 vulnerable, 18 near threatened, and 16 least concern species). The proportion of critically endangered and endangered species reached 16.50%.

2. **Well Protected**: 42 China Species Red List mammals including root vole (*Microtus oeconomus*) and marbled polecat (*Vormela peregusna*) received good protection from nature reserves, accounting for 9.84% of evaluated China Species Red List species (including 4 critically endangered, 8 endangered, 12 vulnerable, 8 near threatened, and 10 least concern species). The proportion of critically endangered and endangered species reached 19.05%.

3. **Moderately Protected**: 75 China Species Red List mammals including Chinese vole (*Eothenomys chinensis*) and least horseshoe bat (*Rhinolophus pusillus*) received moderate protection from nature reserves, accounting for 17.56% of evaluated China Species Red List species (including 9 critically endangered, 13 endangered, 22 vulnerable, 15 near threatened, and 16 least concern species). The proportion of critically endangered and endangered species reached 22.67%.

4. **Less Protected**: 181 China Species Red List mammals including Cachin vole (*Eothenomys cachinus*) and dwarf blue sheep (*Pseudois schaeferi*)

received less protection from nature reserves, accounting for 42.39% of evaluated China Species Red List species (including 1 extinct in the wild, 1 regionally extinct, 16 critically endangered, 27 endangered, 58 vulnerable, 33 near threatened, 40 least concern, and 5 data deficient species). The proportion of critically endangered and endangered species reached 22.65%.

5. **Status Unknown**: 7 China Species Red List mammals including Brahma rat (*Niviventer brahma*) and leaf muntjac (*Muntiacus putaoensis*) had unknown protection status, accounting for 1.64% of evaluated China Species Red List species (including 1 vulnerable and 6 least concern species).

6. **Not Evaluated**: 19 China Species Red List mammals including Taiwan leaf-nosed bat (*Hipposideros terasensis*) and Taiwan mouse-eared bat (*Myotis taiwanensis*) were not evaluated, accounting for 4.45% of evaluated China Species Red List species (including 1 extinct, 1 critically endangered, 1 endangered, 2 vulnerable, 11 least concern, and 3 data deficient species). The proportion of critically endangered and endangered species reached 42.10%.

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3 Discussion

From the overall in-situ conservation status of mammals in nature reserves, after [MATH_19] years of development of the nature reserve system, significant achievements have been made in mammal conservation, with [MATH_20] species receiving some degree of protection in nature reserves. However, the proportion of "Effectively Protected" and "Well Protected" species is significantly low at only 17.99%, while "Less Protected" species reach 41.19%. Species with no records in nature reserves account for only 3.72% of evaluated species, while those with "Status Unknown" account for 36.87% of evaluated species, indicating that the protection status of some species within the 534 protected species remains unstable and the conservation situation is still concerning.

From the threat perspective, the IUCN Red List classifies species in the critically endangered, endangered, and vulnerable categories as threatened species. The *China Biodiversity Red List* (Vertebrates Volume) assessment report identified [MATH_21] threatened mammal species in China, with [MATH_22] mammals requiring attention and protection, accounting for 60.18% of evaluated species in the report. Species in the near threatened and data deficient categories also require attention. From the protection status perspective, species classified as "Not Protected" and "Status Unknown" in this study similarly require focused attention and strengthened protection, accounting for 63.13% of evaluated species in this study. The results from the two perspectives are very close, providing mutual verification regarding the proportion of species requiring attention and protection.

The *China Biodiversity Red List* (Vertebrates Volume) adjusted taxonomic units for some mammals and included new species and new records, resulting in higher numbers of evaluated mammals and species requiring attention and protection than obtained in this study. For species with unknown protection status, these species were not found in the [MATH_23] reserves with collected data, but should be distributed in nature reserves. Due to incomplete survey data, their specific distribution status cannot yet be determined, necessitating more comprehensive and detailed scientific investigations in nature reserves to further determine their in-situ conservation status.

For species that are indeed not protected by nature reserves, it is necessary to improve the reserve network to include them in the protection system. The evaluation in this study is primarily based on collected baseline data from nature reserves. Due to outdated data from some reserves and coarse compilation materials, data sources have certain limitations. Therefore, monitoring capacity and levels for biodiversity in nature reserves should be strengthened, combining regular comprehensive scientific investigations with long-term thematic surveys to establish a reasonably laid out, advanced-technology mammal monitoring system to provide data quality assurance for scientific assessment of mammal in-situ conservation status and accumulate relevant data.

References

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Note: Figure translations are in progress. See original paper for figures.