

# Spatial System of National Parks and Protected Areas in the Qinba Mountain Area

Zhou Yuxia, Liu Hailong, Zhao Zhicong, Yang Rui

Tsinghua University, Beijing 100084, China

**Abstract:** To ensure sustainable ecology in central China in terms of biodiversity and water conservation, the ecological spatial pattern in the Qinba Mountain Area needs to be optimized. In particular, the spatial system of the protected areas centering on the national parks needs to be improved and implemented. This study spatially identifies the main ecological corridors in the Qinba Mountain Area by analyzing suitable habitat conditions of the indicator species and using minimum cost-path calculations. Then, it was possible to clarify the protection gaps according to the distribution of the existing protected areas. The study proposes that national parks need to be built in the Funiu Mountain area and the Qinling Mountain area covering the Shaanxi Province area of the existing Panda National Park. This means that the spatial layout is formed out of the four national parks. Based on this, natural parks of other types can be built to further improve the existing gaps in the protection of important and rare species and water sources.

**Keywords:** Qinba Mountain Area; national park; protected area system; protection gap; ecological corridor

## 1 Introduction

The concept and practice of national parks originated from the United States in the 19th century. The first national park (Yellowstone National Park) was established in 1872. Certain concepts related to national parks are “national parks and protected areas,” “world heritage,” and “biosphere protection.” The International Union for the Conservation of Nature (IUCN) defines a “national park” as a “protected area system” and a large natural or near-natural area set aside to protect large-scale ecological processes as well as the species and ecosystems characteristics of the area. A national park also provides a foundation for environmentally and culturally compatible spiritual, educational, recreational, and visitor opportunities.”

After the United States, Canada began to construct national parks in 1885; Australia began in 1879 and New Zealand in 1887. South Africa established national parks in 1926, and Japan established national parks in 1931. After the Second World War, with the gradual recovery of the postwar economy, many developing countries in South America, Asia, and Africa began to develop their own national park systems. According to the statistics provided by the World Database on Protected Areas, by the mid-1970s, 1204 national parks were built globally. By June 2009, 158 countries built 3417 national parks spanning a total area of  $4.2 \times 10^6$  km<sup>2</sup> [1]. A national park is widely accepted and promoted in the world as an important category of protected area.

At the Third Plenary Session of the 18th Central Committee of the Communist Party of China (CPC) in 2013, China first proposed to establish the national park system. In 2015, the 13th Five-year Plan established a number of pilots for the national park system. In 2017, the 37th meeting of the leading group of the CPC central committee

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**Corresponding author:** Yang Rui, Professor of Tsinghua University and President of the Institute for National Parks, Tsinghua University. Major research fields include national parks and protected areas, world heritage, theory and education of landscape architecture. E-mail: yrui@mails.tsinghua.edu.cn

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for comprehensively deepening reforms deliberated and approved the *Overall Plan for Establishing the National Park System*; the plan clearly defined the establishment of the national park system. A national park is a natural reserve that implements the principles of “ecological protection first, national representativeness, and public welfare,” and it is the main body of China’s protected area system that represents the highest level of China’s natural heritage. In the report of the 19th National Congress of the CPC, it was proposed to establish a protected area system with the national park as the main body. The construction of the national park system is under exploration; it will be an important step for system reform in the ecological civilization construction in China.

To further implement the major reform task of ecological civilization construction proposed by the 19th National Congress of the CPC, a document titled *Guidance on the establishment of the protected area system with national parks as the main body* was issued in 2019. The document proposed that by 2020, the national park pilots would be complete, and a number of national parks would be integrated and set up. A unified management system was established at different levels, and the overall layout of national parks was initially formed. By 2025, the national park system will be improved, the spatial system of protected area will be integrated and optimized, and the laws and regulations of the protected area system will be gradually improved. By 2035, a protected area system will be built with national parks as the main body, and the scale and management of the protected area will be one of the best in the world. China has set up 11 national park pilots. The definition of a national park in China is the same as that given by IUCN [2]; the emphasis is on the fact that a national park is the main body of the protected area system. However, ecological protection is more rigorous and will guide the reconstruction of the national protected area system, which is the most important part in the construction of the national ecological security pattern.

The Qinba Mountain Area, which is the focus of this research, is located in the geographical center of China; this area covers five provinces and one city. It is the nation’s important water conservation area, biological gene pool, and ecological barrier. It also possesses a rich high-quality natural heritage cluster, which is one of the hot spots of China’s national park construction. The Shennongjia National Park and Giant Panda National Park pilots are all located in this area. This means that the future development of the Qinba Mountain Area will be based on ecological protection, and the construction of the protected area system is not only a powerful measure to protect the ecosystem, but it is also an important opportunity for future green development. Therefore, this study starts by describing the outstanding natural values of the Qinba Mountains. First, the current situation of the protected area and the existing protection gap for the values is analyzed. Second, the main ecological corridors of this area are calculated by indicating the species. Finally, based on the corridors, the protected area system is constructed with the national park as the main body to fill and improve the existing gaps.

## 2 Main natural value of the Qinba Mountain Area

Qinba Mountains are the central mountain range in China. The ecosystem, ecological process, rare animals, and plant resources in this region are the national representatives of the natural heritage of China and the world. They should be strictly protected. Environmental education and recreation opportunities should be provided for the public to enhance their environmental protection consciousness and national pride. To construct the spatial system of the protected area in this region, the natural values of the Qinba Mountains were elaborated using the following aspects: hydrology, biodiversity, ecosystem, geology, and geomorphology.

### 2.1 Central water conservation area

Qinba Mountains are rich in water resources; they are part of the nation’s water-rich area and are located at the intersection of the Yangtze River, Yellow River, and Huaihe River Basin. The Qinling Mountain is one of the watersheds between the Yangtze River and the Yellow River. The regional water system is very rich, where 86 rivers are distributed with a catchment area of more than 1000 km<sup>2</sup>. The Qinba Mountain area is also the birthplace of many important river tributaries. Its annual catchment accounts for 15%, 11%, and 1.23% of the total annual runoff of the Yangtze River, the Yellow River, and the Huaihe River, respectively [3]. It is the birthplace of the Jialing River, Hanjiang River, and Minjiang River, which have respectively the largest tributary area, length, and water volume in the Yangtze River Basin; it nourishes “half of the Yangtze River source.” Qinba Mountains are the water supply area and conservation area of the South-to-North Water Diversion Project in China. The region is rich in water resource and annually supplies 71% water for the water source of the South-to-North Water Diversion Project of the Danjiangkou Reservoir. These mountains play a key role in alleviating the water shortage in the northern area and support the economic development of the Beijing–Tianjin–Hebei Metropolitan Region.

However, the water is good quality. The region's forest coverage rate reaches 57.3%; the aquatic environment is healthy, and most of the water quality meets the class II water standard. A variety of river ecological environments represented by the mountain streams and rapids in this area breed numerous highly diverse and rare species of fish, amphibians, and waterfowl, which shape a highly integrated water ecosystem.

## 2.2 Central biological gene pool

The Qinba Mountain Area is the geographical boundary of many important plants and animals in China. Its complex topography, diverse climate, and soil types provide a rich ecological environment for biological survival, and it has become a shelter for many rare and old species in the long geological changes. It has abundant biological resources and is characterized by rich floristic components; the new and old coexist, and the collection is multi-component. The Shennongjia area is a world-class biodiversity representative region [4]. Through comparing the species numbers of Qinba Mountains with other mountains in the same biogeographical province and the priority areas of biodiversity conservation in China, it is concluded that Qinba Mountains have three values in biodiversity: (1) *Global representatives of temperate zone biodiversity*. This is the treasure house of the temperate-zone flora and fauna. It is the birthplace of the temperate-zone flora, which is the most abundant area of deciduous woody plants and also an area with the richest biodiversity in the warm temperate zone and north subtropical zones of China and East Asia [5].

(2) *World-class refuge of relict and endangered species*. This region has the largest number of the nation's key protected animals and plants. It also has very high densities of animals and plants conserved in each priority area of biodiversity protection in China. It has remnants of ancient seed plants and is the origin of many plant species in China. This area is the habitat of world-class relicts and endangered species. Its rare plants have the features of antiquity, remnant, and primitivism.

(3) *Gathering area of important endemic species in China*. The high biodiversity area of Shennongjia National Park was taken as an example; this park is located in the central area of East Sichuan and West Hubei district, which is one of the three distribution centers of China's seed endemic genus. It is characterized by prominent endemic phenomena with rich endemic animals and plants; the number of endemic species of mammals and birds accounts for respectively 15.38% and 22.64%, respectively, in China [6].

## 2.3 Central biological barrier

Qinba Mountains are the green barrier of China's geographical center with the following main properties.

(1) In the horizontal space, it is the intersection area of the nation's various flora regions, which constitutes a rich ecosystem. The northern slope of the Qinling Mountain is steep and has a warm temperate climate (heavy rainfall and low temperature) because of the influence of the northwest continental climate. The southern slope is gentle with a long water system and a subtropical climate (i.e., sufficient rainfall and high temperature) because of the influence of the southeast monsoon. In a relatively small horizontal distance, the characteristics of the subtropical, warm temperate, temperate, and cold temperate ecosystems are concentrated; this is an outstanding example of investigating the vertical differentiation law and ecological process of the mountain ecosystem under global climate changes.

(2) In the vertical space, the region has the most complex and complete vertical vegetation spectrum in the transition area of the north subtropical and warm temperate zone. The vertical natural belt spectrum was based on the north subtropical zone in the south and the warm temperate zone in the north. In comparison with the vegetation on the same latitude area in China, the vertical distribution characteristics of the vegetation in the Qinba Mountains are typical, and the vegetation type is the most complex and complete, which is a rarity worldwide [7].

(3) These mountains have a representative ecosystem of the most well-preserved evergreen deciduous broad-leaved mixed forest in the northern hemisphere. The Shennongjia National Nature Reserve is an example; its evergreen deciduous broad-leaved mixed forest is the most well-preserved evergreen deciduous broad-leaved mixed forest in the northern hemisphere. Therefore, this reserve is the most typical representative of the evergreen deciduous broad-leaved mixed forest ecosystem in the northern hemisphere. This reserve shows the bioecological process and becomes an indispensable bridge between the warm temperate deciduous broad-leaved forest and subtropical evergreen broad-leaved forest [8].

(4) Qinba Mountains are the center of the forest carbon sink and plant oxygen supply. These mountains have a variety of ecosystems with 7 IUCN/SSC first-class ecological environment types that account for 39% of the global first-class ecological environment types. Among them, the forest ecosystem accounts for 66% of the land

area, which is the most extensive ecosystem type in the Qinba Mountains. The forest area is vast and reaches  $2.089 \times 10^7 \text{ hm}^2$ , which accounts for 10% of the total forest area in China. The regional average forest coverage rate is 57.3%.

## 2.4 Central large orogenic belt

The Qinba Mountains are a huge mountain system running from the east to the west in the middle of China. In geology, Qinling Mountain and Bashan Mountain belong to one mountain system, and they are the main parts of the Qinling orogenic belt. In geomorphology, Qinba Mountains are subject to strong rising neotectonic movements, and characterized by huge mountains. Obviously, there are vertical zoning changes in the climate, soil, and vegetation. The Qinba Mountains have multi-layered geomorphic landscapes with four main types of mountains: high mountains, medium mountains, low hills, and basins [9]. Qinba Mountains are an important orogenic belt in China and worldwide. The development of its complex tectonic movement has laid the foundation for Qinling as the south–north boundary of the water system, climate, and vegetation in China. There are complete geological traces from Sinian to Quaternary in this area, which includes the Shennongjia forest area, one of the most complete areas of the Cambrian strata preservation. The various rock traces are complete, which includes sedimentary rocks and metamorphic rocks. The structural traces, such as the structural joints, faults, and folds, are outstanding and record a large amount of natural change information in the process of geological history evolution. Geological action gives rise to abundant animal and plant fossils, mineral resources, and various geological relic landscapes, which include angular peaks, trough valleys, ice buckets, ice banks, glacial terraces, moraine landforms, fold traces shaped by the fold and fault structure, unique landforms (such as mountains cut into cliffs), and the largest karst cave groups in the north.

## 3 Status quo and vacancy analysis of protected areas in the Qinba Mountains

### 3.1 Status quo of protected areas in Qinba Mountains

Qinba Mountains have a large number of protected areas that are highly diverse; these are the highest density areas in China. Approximately 240 types of protected areas (Table 1) cover the natural resources with the highest ecological value and landscape value in China's geographical center (Fig. 1). At the same time, most parts of the Shennongjia National Park and Giant Panda National Park (which are China's pilot national parks) come in the Qinba Mountains.

**Table 1.** Qinba Mountains protected areas statistics.

Protected areas type	Number
National Natural Reserve	46
World Biosphere Reserve	6
World Heritage	5
World Geopark/National Geopark	3/18
International Important Wetland/National Wetland Park	1/42
National Forest Park	65
National Scenic Spot	15
National Water Conservancy Scenic Spot	44

### 3.2 Vacancy analysis of protected areas in Qinba Mountains

The most important ecological values of the Qinba Mountains are the biodiversity and water conservation; however, the habitats and water sources of rare and endangered species are not well protected. The core of biodiversity is the species and their habitat environment. The analysis using takin, the golden monkey, and musk deer as the representative species showed that the protection of ecosystem integrity in the Qinba Mountains still required further optimization and improvement.

#### 3.2.1 Habitat fragmentation of rare animal species

Qinba Mountains (including the Qinling Mountain and Daba Mountain) have been prioritized for biodiversity protection; these mountains have been earmarked as one of the 24 national key ecological functional areas because this habitat has many rare and endangered wild species, including giant pandas, crested ibis, golden monkeys, antelopes, and musk deer. There are more than 120 national protected animal and plant species. It is an important

biological gene pool in China and occupies a significant position in the world's species gene protection [10]. However, the habitats of the rare and endangered species in the Qinba Mountains have not been effectively protected, and some of them are even seriously fragmented. Human activities, such as settlements, farming, tourism, and road construction continue to separate the habitats. The natural reserves of rare species urgently need to fill the gaps and strictly enforce the management system in the reserves to reduce the interference by human activities. For example, because of deforestation and hunting, the habitats of the Qinling takin have been shrinking every year. Statistics show that the takin population has been reducing sharply to approximately 4000–5000. In spring and autumn, the range of activities of takins are concentrated at a lower altitude, where human activities interfere and limit the coverage area of the protected area, which increases the conflicts between takins and locals [11]. There are also still some scattered patches unconnected in the Sichuan golden monkey habitats in the Qinba Mountains. The areas lower than 1000 m above sea level form obvious isolation zones in the Chengxian and Lueyang counties. The habitats in the Shennongjia area are also relatively fragmented, which distributes irregularly along the high-altitude area [12]. The habitat of the musk deer is very sensitive to interference by humans. The numerous road construction activities in the Qinba Mountains have seriously disturbed the existing habitats of the musk deer. The current distribution areas of musk deer are approximately two thirds of the areas in the 1950s. At present, the habitats of the musk deer have been divided into 12 independent patches from the previous four main distribution areas, which faced a serious degree of fragmentation [13].

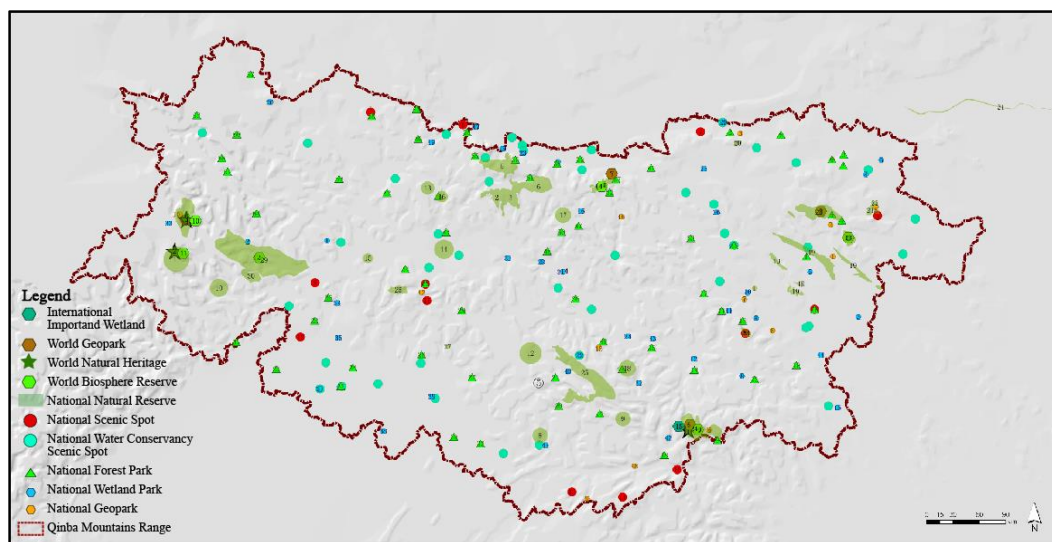


Fig.1.

Qinba Mountains protected areas distribution.

### 3.2.2 Insufficient space for rare species protected areas

The establishment of the Giant Panda and Shennongjia National Park in the Qinba Mountains integrated the surrounding protected areas and improved the integrity of the wildlife habitats to some extent. However, there are still many protection gaps in the Qinba Mountains. From 1965 to the end of 2004, Shaanxi Province has built 17 natural reserves in the Qinling Mountain, with a total range of 3953.11 km<sup>2</sup>. However, the reserves only cover approximately 15.96% habitats of takins. The disturbances caused by human activities and the lack of several important migration ecological corridors have resulted in low habitat connectivity of takins in the Qinling Mountain; their protection status is still not good [14]. Sichuan golden monkey habitats are mainly distributed in the central and western regions of the Qinling Mountain, which cover an area of 8853.8 km<sup>2</sup>. However, only 31.6% of the Sichuan golden monkey habitats have been protected in the existing protected areas. It is still necessary to build or expand the protected areas of the Sichuan golden monkeys, which will improve the habitats connectivity and promote the exchange and migration of species [15]. The habitats of the forest musk deer in the Qinling Mountain were mainly concentrated to the main peak of the Taibai Mountain and the surrounding high-altitude forest area with a total ecological environment area of 10 764.4 km<sup>2</sup>. The existing protection areas have protected 3500.9 km<sup>2</sup> of forest musk deer habitats, and 67.5% of their habitats are still under protection vacancy [16].

### 3.2.3 Lack of protection of rivers' natural and scenic values

In the Qinba Mountains, there are seven national natural reserves related to aquatic biological protection, six

national geoparks related to river geomorphic protection, six national scenic spots related to river scenic value protection, and 45 national water conservancy scenic spots. Although Qinba Mountains have protected areas related to river protection, the rivers are still facing threats from tourism development and water resources development. The protection of the natural and scenic value of the rivers in water conservation areas are obviously insufficient, and the construction of illegal water conservancy facilities still exists. The rivers in the protected areas are faced with developmental risks, and the related small hydropower problems are prominent. For example, there are 38 diversion-type small hydropower stations in the Shennongjia National Park pilot area, which leads to the problem of the river bed drying up and soil eroding under the dam, which threatens the survival of rare and endangered aquatic species [17]. Meanwhile, the recreational infrastructure constructions also bring certain risks to river protection. Some riverbanks in the protected areas have different degrees of hardness because of the construction of recreational trails and platforms; this affects the free-flow status of rivers and the natural status of the river shores. The catering building, service center, and other infrastructures built for recreational activities also destroy the integrity and continuity of river landscapes. Tourism wastes also negatively impact the vegetation, water environment, and wildlife. In general, Qinba Mountains lacks the overall recognition of rivers' natural and scenic values and there are still some rare free-flowing rivers outside the protected areas. The protection of rivers having natural and scenic values is discontinuous, incomplete, and unsystematic.

#### **4 Establishing protected areas with national parks as the main body**

The basic attributes of a national park, such as the protection intensity, protection range, and protection nature, must be fully guaranteed and strengthened for the protected areas establishment in the Qinba Mountains. Two steps need to be taken for this. The first step is to clarify the category system (i.e., improve the category standard of the protected area system in the Qinba Mountains) and divide them into four types: national park, natural reserve, scenic spot, and natural park. The second step is to optimize the spatial layout, that is, the spatial layout of the protected areas in the Qinba Mountains should be integrated for the integrity and authenticity protection of the Qinba Mountains ecosystem. This optimization would include building new natural reserves in the vacancy areas for protecting the ecological system and rare species and adjusting the previous boundary of the protected areas.

##### **4.1 Path: Qinba Mountains ecological corridor construction across districts**

There are numerous studies on the protection gaps in the Taibai Mountain, Minshan Mountain, Shennongjia area, and Funiu Mountain. However, the construction of the district-scale corridors plays a limited role in alleviating the fragmentation of the overall habitats in the Qinba Mountains; therefore, the cross-district ecological corridors should be further constructed. By comparing the spatial overlapping relationship between the ecological corridor and the existing protected areas, the protection gaps can be analyzed. The national parks could be important nodal districts of the corridors that provide a relatively complete habitat environment for rare species; the newly added nature reserves will further fill the gap area of the corridors and improve and optimize the connectivity of the corridors.

Based on the literature review, this study analyzes the conditions suitable for the ecological environment for the main rare wildlife in the Qinba Mountains; their distribution status, suitable altitudes, gradients, slope directions, vegetation types, distance from the road, water sources, and residential areas are examined. For this study, leopards, forest musk deer, and black bears have been chosen as the indicator species to define the core wildlife corridor of the Qinba Mountains because their suitable habitats could cover other major rare wildlife. According to the suitable ecological environment conditions of the indicator species, a minimum cost-path corridor calculation was performed to identify the potential ecological corridor range, which could integrate the protected areas system of the Qinba Mountains and improve the connectivity of the regional ecosystem ecology (Fig. 2). In Fig. 2, Level 1 corridor is the core area with the highest level of regional protection, and Level 2 corridor includes the peripheral buffer areas; Level 3 corridor is the potential protected areas, where the low-altitude and high-altitude areas could be managed as ecological function patches and could be further cultivated as protected areas. Level 4 corridor is a vast forest management area, which is the ecological base of the Qinba Mountains. Limited control of ecological functions could be ensured for maintaining the area and quality of the forest using low construction intensity in the surrounding industries.

## 4.2 Scheme: Qinba Mountains protected areas system improvement with national parks as the main body

### 4.2.1. Two new national parks

There are two national park system pilots in the Qinba Mountains: Giant Panda and Shennongjia National Park. The study on the overall spatial layout of the China National Park [18] showed that there are four candidate areas in the Qinba Mountains: Sichuan Min Mountain Giant Panda National Park, Hubei Shennongjia National Park, Shaanxi Qinling National Park, and Henan Funiu Mountain National Park. Based on the protection gap analysis of the ecological corridor in the Qinba Mountains, the following suggestions have been made for the spatial layout of national parks in this region:

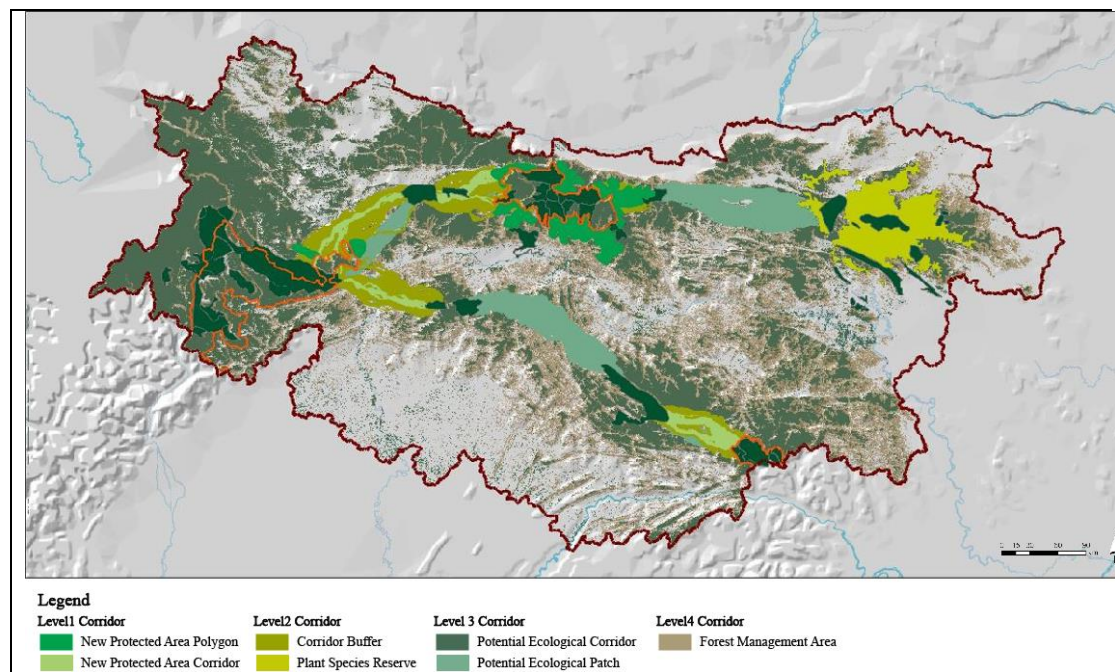


Fig. 2. Qinba Mountains ecological corridor.

#### (1) Establishing Funiu Mountain National Park in Henan Province

According to the research of Chinese Academy of Environmental Sciences on the suitable ecological environment of plant protection in the Qinling Mountain in 2014, the Funiu–Xiong'er Mountains (including Funiu Mountain, Yao Mountain, Laojun Mountain, Baiyun Mountain, Baotianman Mountain, and Laojieling Mountain) have the best plant diversity protection in the Qinling Mountain range and is the most important hot-spot area with a great lack of protection [18]. According to the study on the overall layout of China's national parks, the spatial planning of the Funiu Mountain is one of the three plans proposed for the mixed forest ecological geographical area of the Qinling and Daba Mountains in the north subtropical zone and the ecological red line of 12.63% proposed for the Funiu Mountain Ecological Area in Henan Province [19]. We suggest the establishment of the Funiu Mountain National Park with an area of 6000 km<sup>2</sup>. This national park will integrate the national natural reserves of the Funiu Mountain, Baotianman, Nanyang dinosaur fossil group, Xiong'er Mountain, Xixia giant salamander, national geoparks of Xixia Funiu Mountain, Baotianman, Ruyang dinosaur, Yao Mountain, national forest parks of Baiyun Mountain, Longyuwan, Si Mountain, and Shiren Mountain National Scenic Spot.

#### (2) Establishing Qinling Mountain National Park in Shaanxi Province

The Giant Panda National Park pilot covers the Shaanxi, Gansu, and Sichuan provinces, with a total area of 27 134 km<sup>2</sup>; it has 3 provinces, 12 cities (prefectures), 29 counties, 160 towns, 233 500 people, and 80 protected areas. The Shaanxi district has an area of 4386 km<sup>2</sup>, which accounts only for approximately 56% of the planning area of the Qinling National Park (7754 km<sup>2</sup>) proposed in the study on the overall layout of the China National Park [19]. Although the Shaanxi district of the Giant Panda National Park covers the core areas of the candidate Qinling National Park, namely, the national natural reserves of the Taibai Mountain, Taibai River, Huangbaiyuan, Zhouzhi, Old County, Changqing, Foping, Guanyin Mountain, Sangyuan, Huangguan Mountain, and Tianhua Mountain, it is still insufficient for the representativeness and integrity of the Qinling ecosystem protection. The

important natural reserves of Niubeiliang, Pingheliang, and Hanzhong Crested Ibis and the main river sources of Jialing River, Hanjiang River, and Danjiang River are not included in the current protection range. There are still deficiencies in the protection of rare animal habitats and water source areas in the Qinling Mountain. Furthermore, Qinling Mountain is not only the center of China’s geography, but it also has a long history and culture, which is considered as the main mountain of the Chinese nation and the spiritual highland of Chinese civilization. Qinling Mountain has incomparable important marks and representativeness both geographically and culturally, and it should have its own national park. In addition, the Giant Panda National Park pilot covers three provinces with cross-provincial collaborative management mechanism; however, there is scope for improvement in this pilot project. Therefore, this study proposes to integrate and expand the Shaanxi district of the current Giant Panda National Park into the Qinling Mountain National Park; therefore, the Giant Panda National Park mainly includes the current Gansu and Sichuan districts.

#### 4.2.2 Proposal for national park construction

This study proposes to build four national parks in the Qinba Mountains. In addition to the existing Giant Panda and Shennongjia National Parks, two new national parks (Funiu Mountain and Qinling Mountain) are proposed. It is recommended that the Shaanxi district of the Giant Panda National Park be made an independent Qinling Mountain National Park, and the protection range be appropriately expanded. First, we improve the water source conservation and rare aquatic species protection of the Qinling Mountain National Park. The source areas of the main tributaries of the Yangtze River Basin, such as the east source of Jialing River, the north source of Han River, and the Danjiang River source, should be included inside the boundary of the national park. Second, four important natural reserves, namely, Niubeiliang, Pingheliang, Hanzhong Crested Ibis, and Zibai Mountain, are to be included in the Qinling Mountain National Park to further improve the protection of rare wildlife habitats in Qinling (including the crested ibis and Niubeiliang takin (Fig. 3)). The Qinling Mountain National Park needs to be expanded from 4386 km<sup>2</sup> (an area of the Shaanxi district of the current Giant Panda National Park) to 19 080 km<sup>2</sup>. Therefore, the total area of the national parks in the Qinba Mountains will be approximately 46 907 km<sup>2</sup>, accounting for approximately 14.75% of the total land. The advantage of this plan is that the Shaanxi district of the Giant Panda National Park contains the most core natural resources in this area. If the protected area can be appropriately expanded to make it an independent Qinling National Park, it would be conducive for the management of the Shaanxi Province. However, without cross-provincial coordination, it can completely represent the unique ecosystem of the Qinling Mountain. The challenge lies in the need for system coordination and adjustment of the boundary of the current Giant Panda National Park. If it cannot be adjusted, the alternative is to keep the existing boundary and set up a new Qinling Mountain National Park adjacent to the Shaanxi district. However, the new Qinling Mountain National Park is too close to the Shaanxi district of the Giant Panda National Park, and the conservation resources are homogenized. Therefore, the rationality of latter proposal requires further investigation.

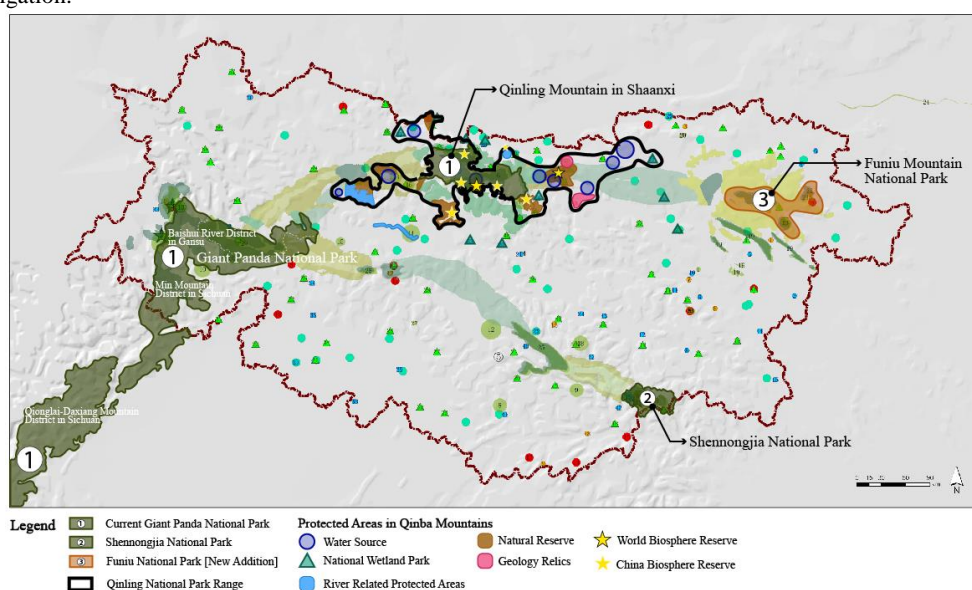


Fig. 3. Proposal for Qinba Mountain National Park construction.



#### 4.2.3 Improvement and addition of other types of protected areas in Qinba Mountains

Using the above national parks scheme as the premise, the improvement and addition of other types of protected areas in the Qinba Mountains were kept mainly within the Qinba Mountains ecological corridor according to the targeted natural and cultural resources. Therefore, the connectivity of the Qinba Mountains ecological corridor with four national parks and existing protected areas was realized. The national park scheme basically realizes the complete protection of important natural resources in the Qinba Mountains, which includes the habitats of the giant panda, takin, golden monkey, musk deer, crested ibis, and other rare wild animals. The main types of the new protected areas are the scenic spots and natural parks, which are 10 in number.

*Scenic spots.* In the areas where there is no protection of cultural and natural values, new scenic spots have been established by expert argumentation. This study proposes to add four scenic spots: Chongqing Ning Chang salt industry scenic spot, Gansu province Xinxu Baishui Lu cliff scenic spot, Shangluo cliff tomb scenic spot, and Donglong Mountain scenic spot.

*Natural parks.* The protection of the water conservation area in the Qinba Mountains is particularly important. In view of the lack of protection of the river's natural scenic value in the existing protected areas, the addition of national or provincial natural parks with river source protection could become the main goal. This study proposes the addition of six natural scenic river parks, which include the Shu River natural park, Xiaokou River natural park, Muma River natural park, Yudai River natural park, Yanzi River natural park, and Mo River natural park.

#### 4.2.4 Summary of Qinba Mountains protected areas system

By improving the connectivity of the Qinba Mountains ecological corridor, the spatial systems of the national parks and protected areas in the Qinba Mountains were combined and optimized. The suggestions proposed in this paper can be divided into four categories: national parks, natural reserves, scenic spots, and natural parks. Based on the corridor analysis of the indicator species suitable for the ecological environment, this study suggested the addition of the Funiu Mountain National Park, which optimized the current Shaanxi district of the Giant Panda National Park to make it the Qinling National Park. In addition, the addition of 10 new scenic spots and natural parks were proposed to further fill the gaps in the protected areas. As a result, the spatial connectivity of the corridor can be improved, and the overlapping areas of nature reserves be integrated; the types of nature reserves be defined, and the spatial system of the protected areas in the Qinba Mountains be formed (Fig. 4). By integrating and improving the protected areas system, a new spatial distribution relationship of the protected areas in the Qinba Mountains will be formed, with the proportion being adjusted to 42.2% (Table 2).

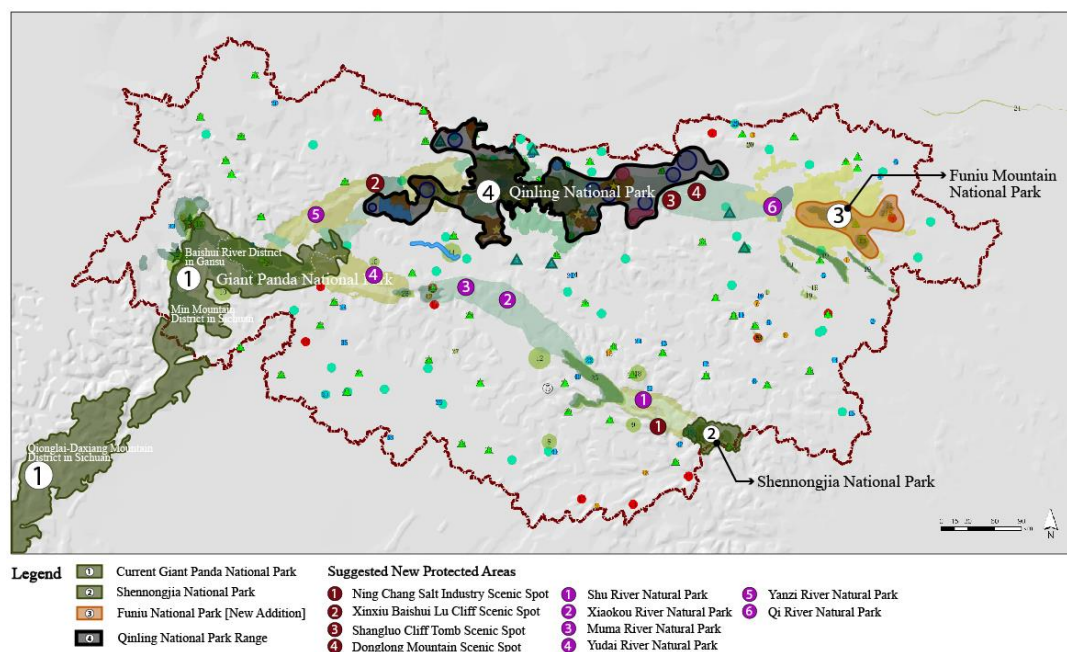


Fig. 4. Qinba Mountains protected areas system schematic diagram.

**Table 2.** Status quo, planning area, and proportion of Qinba Mountains protected area system.

	Current Situation		Planning	
	Area (km <sup>2</sup> )	Proportion (%)	Area (km <sup>2</sup> )	Proportion (%)
National Park pilot	28 304.0	8.90	46 907.0	14.75
Natural Reserve	8598.6	2.70	7562.6	2.40
Scenic Spot	30 063.4	9.45	32 863.0	10.30
Natural Park	42 140.6	13.20	46 765.0	14.70
Total	109 106.0	34.30	136 190.0	42.20

*Note:* The planned area is only a preliminary estimate, and the accurate area needs further demonstration and delimitation of the space scope of the new protected area for calculation.

## 5 Conclusion

Qinba Mountains, as an important ecological barrier in central China, should be the model and representative of the national park and protected area system. The problems of habitat fragmentation, rare wildlife protection vacancy, important water source protection vacancy should be filled and optimized by establishing the National Park pilots and adding the protected areas, thus to increase the connectivity of the regional ecological corridors. The new scheme of the Qinling Mountain National Park is the key to the spatial layout of regional national park. In terms of spatial layout, Qinling Mountain National Park should be one of the four main protection areas in the Qinba Mountains, and its area should be expanded on the existing basis. In terms of cultural cognition, it should fully tap the historical and cultural resources endowment of Qinling, thereby realizing the full integration of the ecological and cultural values and further enhancing the cultural confidence establishment of the national parks in China through the process. It is necessary to realize that spatial integration and structure is only the first step for the establishment of the Qinba Mountains protected area system, and there still needs to be implementation of the protection system. First, the management system needs to be improved, that is, the management and coordination mechanism of cross-provincial protected areas in the Qinba Mountains needs to be explored and appropriate management policies need to be formulated. Sufficient personnel and funds are required. Second, the economic development needs to be coordinated, that is, the relationship between the ecological protection and sustainable economic development in the Qinba Mountains needs to be coordinated. The coordination includes the surrounding urban agglomerations and villages and the relationships between the protected areas and the local communities. Only by dealing with the relationship between the people and the protected areas, the contradiction between the ecological protection and the development goals can eventually be mitigated. Then, we can truly achieve the protected areas system's long-term protection mechanism.

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