

ARTICLE

## The Process of Tiger Disappearance in Guizhou

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### ABSTRACT

In this paper, the authors collected officially published literature on the South China tiger (*Panthera tigris amoyensis*) in Guizhou from 1900 to 1980, from which we extracted information on its historical distribution and population size, and collected data on the tiger skin trade after 1950, the change in subtropical broad-leaved evergreen forest cover, and demographic data in the relevant databases. GIS mapping was used to visualize the distribution range of the South China tiger in Guizhou Province during the period 1900–1980 and to discuss the history of its disappearance in Guizhou and its driving factors. The results show that in 1900, the South China tiger was distributed throughout 82 cities and counties in nine prefectures and municipalities in the province; the number of documented South China tiger distribution sites in 1900–1950 decreased to 48 compared to 1900; the number of counties with South China tigers in 1950–1980 further decreased and became extinct in some areas; and in the 1990s, the South China tiger became extinct in the wild in Guizhou. The main reasons for the extinction of the South China tiger in the wild in Guizhou are: on the one hand, with the socio-economic development of Guizhou Province, the population has increased dramatically, the magnitude of the demand for natural resources has increased, and in order to satisfy this demand, human activities, such as coal mining and clearing of mountains for planting, have been intensified, resulting in the reduction of the coverage rate of the subtropical broad-leaved evergreen forests, which has resulted in the extreme loss of the habitat of the South China tiger; on the other hand, the insufficient protection efforts and protection measures for this species in the country before the 1980s, which were subjected to anthropogenic hunting, were also factors leading to the extinction of this species in the wild in Guizhou Province. As a big cat at the top of the food chain, the distribution of the South China tiger can reflect the history of the natural environment in the region. By analyzing and discussing the distribution history of the South China tiger population in Guizhou Province, the significance of this case is to provide a scientific basis for the future conservation of biodiversity and the development of ecological restoration measures in the karst mountains of southern China.

**Keywords:** The South China tiger; Disappearance; Broad-leaved evergreen forests

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## 1. Introduction

Guizhou Province is located in the hinterland of southwest China's inland region. The terrain of the territory is high in the west and low in the east, with an average elevation of about 1,100 meters above sea level, and 92.5% of the province's area is mountainous and hilly. Karst landscape occupies more than 76% of the land area of Guizhou Province, and its typical vegetation types are mainly subtropical evergreen broad-leaved forests. Widely distributed subtropical evergreen broad-leaved forests provide abundant food resources and a good habitat for wildlife, with up to 1,000 species of wildlife resources within the territory, among them *Neofelis nebulosa*, *Trachypithecus francoisi*, and *Moschus berezovskii* et al. 17 species are at the national level of key wildlife protection: *Macaca mulatta*, *Manis pentadactyla*, *Viverricula indica*, et al. 83 species are national second-class protected animals <sup>[1]</sup>.

The tiger is a rare wild animal endemic to Asia. From a taxonomic system point of view, there is only one species, including nine subspecies, three of which are extinct, viz., *Panthera tigris balica*, *Panthera tigris sondaica*, and *Panthera tigris virgata* <sup>[2,3]</sup>. Currently, only three subspecies can be recognized as widely distributed in China, namely the Amur tiger (*P. t. altaica*), Bengal tiger (*P. t. tigris*) and Indochinese tiger (*P. t. corbetti*) <sup>[3]</sup>. The South China tiger (*P. t. amoyensis*), a subspecies endemic to China, has become extinct in the wild, with only a population of 246 *Panthera tigris amoyensis* (*P. t. amoyensis*) held in captivity in 22 zoos or breeding centers in China <sup>[4]</sup>. At the beginning of the 20th century, the Amur tiger was widely distributed in the Daxing'anling, Xiaoxing'anling, Zhang Guangcailing, and Changbai Mountains of China, with a population of about 3,000 tigers <sup>[5]</sup>. Since 1952, the development of modern industrialization has drastically changed the original ecological environment, and the fragmentation of habitats and hunting by human beings have led to a sharp decrease in the number of Amur tigers <sup>[6]</sup>, and their distribution range has begun to recede <sup>[7]</sup>. In 2000, the Amur tiger was distributed only in the

eastern part of Wanda Mountain, the southern part of Laoya Ling, the northern part of Laoya Ling, and the southern part of Zhang Guangcai Ling <sup>[8]</sup>. According to statistics, in the 1960s, the number of Amur tigers in China did not exceed 30 <sup>[9]</sup>; at the end of the 20th century, the population of Amur tigers in China was only 10–20 <sup>[10]</sup>. The Bengal tiger was widely distributed in broad-leaved forests in southeastern Tibet, China, at elevations below 2,500 meters before 1990, and its distribution was recorded in eight townships under the jurisdiction of Motuo County, Tibet <sup>[11]</sup>. In 1996, the State Forestry Administration released data estimating that there were 11 Bengal tigers in Murdock County, but there have been no definite reports from the region since 2002 <sup>[12]</sup>. It was not until 2019 that some scholars took live photographs of Bengal tigers in Murdock, confirming the existence of wild Bengal tigers in the region <sup>[13]</sup>. From 1900 to 1950, the South China tiger was widely distributed in central, eastern, southern and southwestern China, with a distribution range close to one-third of the national territory and a population of more than 4,000 individuals <sup>[14]</sup>. After the 1950s, the South China tiger was declared a pest by the government and was allowed to be hunted by private individuals, coupled with the rapid loss of its habitat, its distribution range and population size have been shrinking. As the Chinese government increased its efforts on biodiversity and ecological environmental protection and realized the importance of ecosystem balance, in the 1990s, the State Forestry Administration (SFA) organized and carried out surveys in the main distribution areas of the South China tiger, which did not find any traces of the South China tiger in the wild <sup>[15]</sup>.

The South China tiger is a subspecies endemic to China, and its morphological characters are head and body length 140.0–280.0 cm; tail length 91.0–110.0 cm; hind foot length 23.4–42.0 cm; and total cranial length 25.2–33.3 cm; and its body weight is 90.0–306.0 kg <sup>[16]</sup>. The hairs on the whole body are brownish-yellow and streaked with black, and the abdomen is interspersed with cream-colored hairs <sup>[17]</sup>. The South China tiger is a typical mountain forest-

dwelling animal, mainly living in subtropical broad-leaved evergreen forests in southern China, and its main prey includes hoofed species and hares, such as *Sus scrofa*, *Muntiacus reevesi*, *Muntiacus muntjak*, *Rusa unicolor*, *Elaphodus cephalophus*, *Cervus nippon*, *Capricornis sumatraensis*, and *Lepus capensis*<sup>[18]</sup>.

There are records of tigers and leopards in all generations of local records of physical properties in Guizhou Province since its administrative establishment. However, Guizhou Province has never conducted any specialized research on the distribution and historical population dynamics of the South China tiger in the region, resulting in a lack of scientific basis for planning the nature reserve network system and formulating biodiversity conservation policies, as well as a lack of countermeasures to deal with the emergence of new ecological problems in Guizhou Province. In this study, the process and causes of the extinction of the South China tiger in the wild in Guizhou Province are described by analyzing the historical distribution and population dynamics of the South China tiger in Guizhou Province from 1900 to 1980. In addition, using the South China tiger as a case study, a preliminary discussion on the ecological issues arising from the extinction of large top predators in the wild in southern China is presented.

## 2. Data sources and research methodology

### 2.1 Data collection

The data required for the study are mainly administrative boundary data of Guizhou Province, derived from the geospatial data cloud (<https://www.gscloud.cn>). The historical distribution data of the South China tiger and the fur data of other animals were mainly obtained by consulting the local records of Guizhou Province, the statistical yearbook of Guizhou Province from 1952 to 1980, the statistical information of the government, and from the National Digital Library, the China Knowledge Network database, the China Science Periodical Database, and libraries.

### 2.2 Study methods

(1) The electronic literature search method was used, and the search terms “South China tiger”, “broad-leaved evergreen forest”, and “population change” were used as search terms in the search item. The results were then searched twice with keywords such as “historical distribution”, “habitat”, and “human activities”. Through the above two searches, after removing the documents with no scientific value, 186 documents were finally identified, including 143 academic journals, 17 doctoral dissertations, and 26 master’s degree dissertations.

(2) Utilizing the Excel to table method of the conversion tool in ArcGIS software to obtain the historical distribution maps of the South China tiger in 1900, 1900–1950, and 1950–1980;

(3) Using Excel 2016 software to draw statistical maps of population size, forest area coverage, and other animal hides;

(4) Using SPSS 22.0 statistical software to conduct binary variable correlation analysis of the relationship between the number of population, forest area, and the number of tiger skins in Guizhou Province, using a two-tailed test.

## 3. Results

### 3.1 Disappearance of South China tigers in Guizhou

#### *Distribution records of the South China tiger in Guizhou Province in 1900*

In 1900, the South China tiger was widely distributed in Guizhou Province, covering 82 cities and counties in nine prefectures and municipalities in the administrative establishment of Guizhou Province after the establishment of New China (**Figure 1**). Through checking the local records of Guizhou Province, it was found that there are more records about the South China tiger in the central, southeastern, and northern parts of Guizhou Province. Among them, the southeastern and southern parts of Guizhou Province provide a suitable habitat for the South China tiger because of its favorable natural

environment, abundant water resources, and dense forests. Therefore, the number of counties with a South China tiger distribution in these two regions accounts for 34.1% of the province. Before 1900, local records recorded that the Zunyi area in northern Guizhou had many tigers. In the Zunyi Prefecture Records of 1845, it was recorded that “Suiyang County in Zunyi has more South China tigers, and in two days the South China tiger ate 37 people”. The southwestern part of Guizhou and Liupanshui in the west, on the other hand, where rocky desertification is beginning to appear due to anthropogenic forest clearing, has to a certain extent destroyed the survival environment of the South China tiger, and therefore the number of South China tigers recorded is not as high as in other regions [20].

**Distribution of South China tigers in Guizhou from 1900 to 1950**

From 1900 to 1950, records of the South China tigers in Guizhou Province still covered nine prefectures and cities, but the number of counties with a specific South China tiger distribution decreased to 48 compared to the pre-20th century (Figure 2). Among them, Liupanshui, Anshun, and Qianxinan showed a larger decline, by 75%, 66.7%, and 62.5%, respectively.

**Distribution of South China tigers in Guizhou from 1950 to 1980**

From 1950 to 1980, the number of counties with tiger distribution in Guizhou Province further decreased, and compared with the past 50 years, tiger records in Guiyang, Liupanshui, Qianxinan, and Anshun had disappeared (Figure 3), and the number of South China tiger distribution sites in every city and prefecture, except for Qiandongnan Prefecture, dropped to single digits, with only 37 counties in the province having South China tigers in their distribution (Figure 4). In the 1980s, the only six places in the province where wild traces of the South China tiger could be found were Yanhe, Jiangkou, Suiyang, Zheng’an, Tongzi, and Sandu. It was not until 1978 that the first nature reserve approved by the Guizhou Provincial People’s Government, Fanjingshan Nature Reserve, was established, which opened the prelude to the development of nature reserves in the province [21]. After 1980, nature reserves of various levels and types were also established in the province. Although the government has realized the importance of protecting biodiversity, due to the insufficient protection measures for the South China tiger before the 1980s and the late establishment of these reserves, the fate of the species’ extinction in the wild could not be changed in the end.

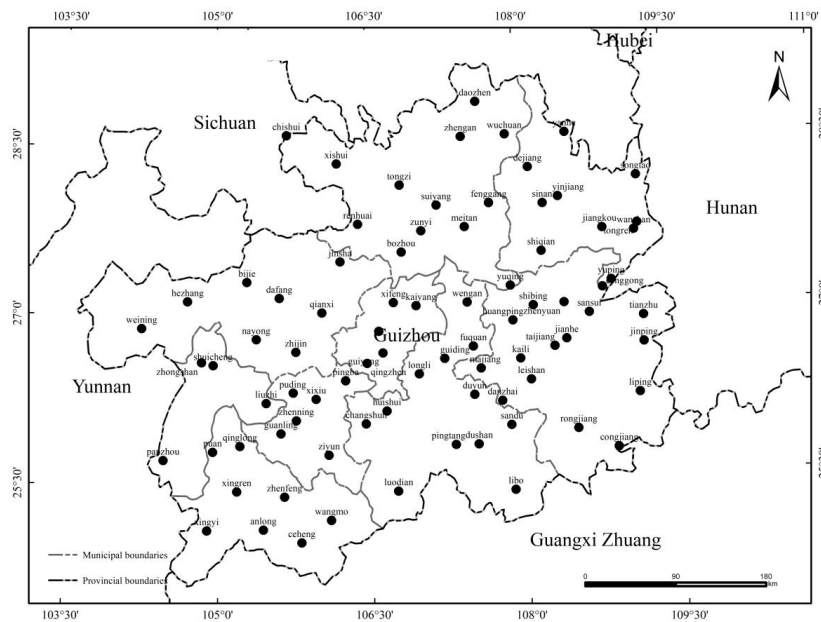


Figure 1. Record distribution of *Panthera tigris amoyensis* in Guizhou in 1900.

Source: [19].





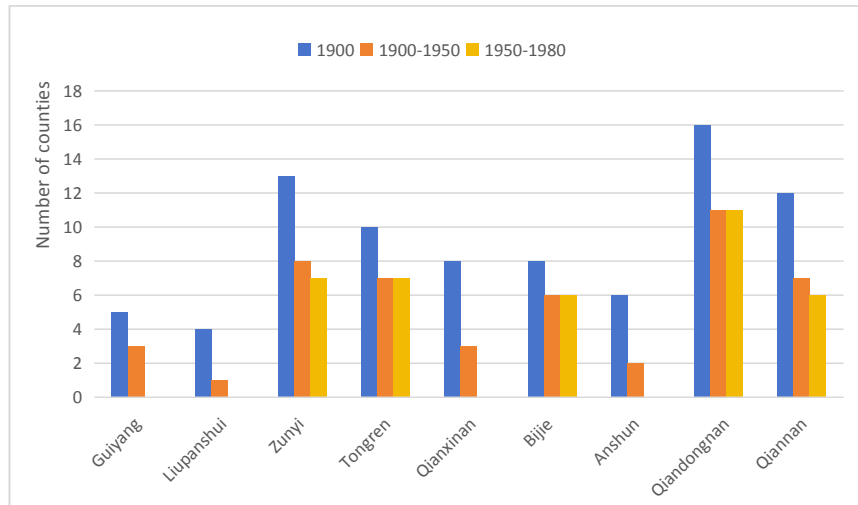


Figure 4. Historical changes in the number of *Panthera tigris amoyensis* distribution sites in various cities and towns in Guizhou.

### 3.2 Drivers of change in the distribution area of the South China tiger in Guizhou Province

#### Population growth in Guizhou Province

In 1900, the population of Guizhou Province had reached 4,859,400 people (Figure 5), and in the following 50 years, the population increased rapidly, and in 1950, the total population of Guizhou Province had increased to 14,172,000 people, and the total population had increased by nearly two times from the 1900 level. Although the population decreased in individual years due to wars, the overall population trend was still growing. Over the next 30 years, the population continued to grow, and in 1980, the total population of Guizhou Province had reached 27,767,000, with an average annual increase of 453,170, or an average annual growth rate of 3.3%. Further population growth, coupled with increased productivity levels, led to increased land resettlement, resulting in large areas of virgin forest being reclaimed as farmland. At the same time, the arable land area of Guizhou Province showed a significant increase; in 1887, the province’s arable land was only 184.4 thousand hectares; in 1949, it reached 1,834.9 thousand hectares, with an average increase of 26.621 thousand hectares per year; in 1978, it increased to 1,905.4 thousand hectares; and the arable land area of the province increased by about 10 times in less than 100 years<sup>[22]</sup>.

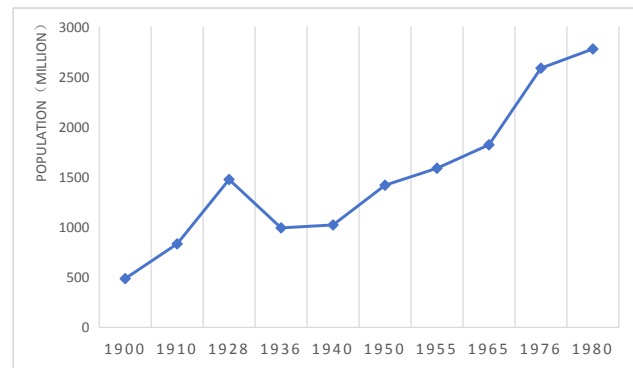


Figure 5. Population development in Guizhou Province from 1900 to 1980.

Source: <sup>[23,24]</sup>.

#### Changes of forest resources in Guizhou Province

From 1900 to 1980, the area of cultivated land in Guizhou Province increased, while forest resources showed a decreasing trend (Table 1). Since the 1950s, the relevant state departments have done a lot of development and exploration work in the Liupanshui area, which is rich in coal mining resources. The process of mining and beneficiation is difficult, as it requires “chiseling through the rocks” in places with good vegetation cover, i.e., the vegetation in the mines has to be cleared first, which is quite serious in terms of damage to the vegetation. At the same time, timber is needed to support the pits during the mining process, and large-scale mining will undoubtedly consume a large amount of timber, which is a considerable depletion of forests<sup>[25]</sup>,

leading to the intensification of the phenomenon of rocky desertification. Due to the changes in the rural economic system from 1965 to 1980, the primary forests in Guizhou Province suffered damage again, and the coverage rate declined again [26]. In 1984, the primary forest coverage rate in Guizhou Province declined by 8.4% to only 12.6%.

**Table 1.** Overview of forest resources in Guizhou from 1900 to 1984.

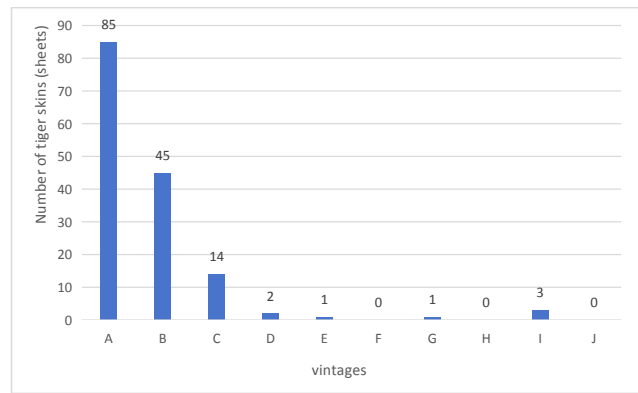
vintages	Area of forested land (10 <sup>4</sup> ha)	Primary forest cover (%)
1900	369	21
1950	340	19.3
1955	325.9	18.5
1965	299.5	17.0
1976	256.4	14.5
1984	222.0	12.6

Source: [27,28].

### ***The population size of South China tiger in Guizhou province decreased sharply from 1950 to 1980***

Before 1980, due to the existence of China’s planned economy system, the acquisition of wildlife hides and skins belonged to governmental behavior; therefore, the data on the acquisition of skins by supply and marketing societies can be used as a reflection of the trend of population size changes of the South China tiger in Guizhou Province from 1950 to 1980.

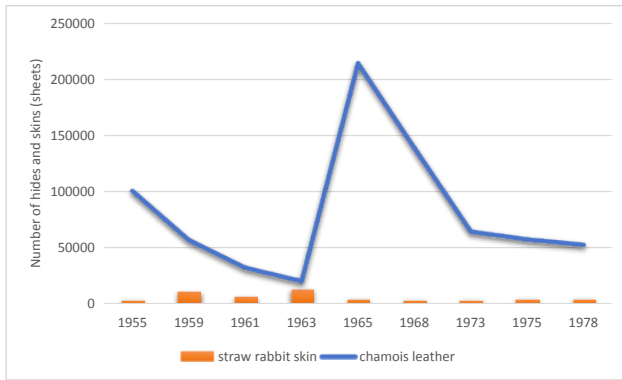
In 1951–1960, the average number of tiger skins acquired in Guizhou Province amounted to more than 80 per year, and thereafter, the number of tiger skins acquired showed a decreasing trend (**Figure 6**). In 1961–1965, the number of tiger skins purchased in the province decreased by nearly half compared with that of 1951–1960; in 1966–1970, the average number of tiger skins purchased in the province each year was less than 1/3 of that of the previous period; after the 1970s, the number of tiger skins received in individual years was only 1–2; and after the 1980s, there were almost no tiger skins received. It can be seen that the population size of the South China tiger in Guizhou province declined sharply from 1961 to 1980.



**Figure 6.** The average number of tiger skins purchased annually in Guizhou province from 1950 to 1980. Note: A: 1951–1960; B: 1961–1965; C: 1966–1970; D: 1971–1975; E: 1976; F: 1977; G: 1978; H: 1979; I: 1980.

Source: [29].

The reduction in the size of the South China tiger population in Guizhou Province also affects the ecosystem in which it is located. According to the average number of tiger skins acquired each year from 1951–1960, it can be seen that 85 South China tigers were still hunted each year, and the population size of the South China tiger was relatively sizable, while the number of South China tiger skins acquired after 1961 showed a decreasing trend, indicating that the population size of the South China tiger declined at this time. By comparing **Figure 7**, it can be seen that when the population size of the South China tiger was relatively large in 1951–1960, the number of pelt sheets of grass rabbits and other phytophagous animals showed a decreasing trend, while after 1961, while the population size of the South China tiger decreased, the number of pelt sheets of grass rabbits and other phytophagous animals showed a short-lived upward trend due to the lack of natural enemies. However, with the rapid population growth in Guizhou Province after 1965, the demand for natural resources increased, resulting in the continuous development of large areas of mountainous terrain, habitats becoming homogeneous, and the forests on which grass hares and others depended were destroyed. Ultimately, the number of these wild mammals would gradually decline (**Figure 7**).



**Figure 7.**Quantity of grass rabbit skins and suede acquired in Guizhou Province, 1955–1978.

Source: [29].

In order to analyze the relationship between the population size, forest area, and the number of tiger skins in Guizhou Province, the correlation analysis between the population, forest area, and the number

of tiger skins in Guizhou Province from 1900 to 1976 was selected, and the results obtained are as follows (**Table 2**): The correlation coefficient between the number of people and forest area is  $-0.979$ , the P value is 0.001, and  $P < 0.01$ , indicating that there is a significant negative correlation between population and forest area, i.e., from 1900 to 1976, as the number of people in Guizhou Province increased, the forest area was decreasing. The correlation coefficient between forest area and the number of tiger skins was 0.889, with a P-value of 0.018 and a  $P < 0.05$ , indicating that there was a significant positive correlation between forest area and tiger skins, i.e., from 1900 to 1976. With the decrease in the forest area of Guizhou Province, the number of tiger skins, i.e., the size of the population of South China tigers, was also decreasing accordingly.

**Table 2.** Correlation analysis of population size, forest area and number of tiger sheets in Guizhou Province, 1900–1976.

		Population size	Area of woods	Tiger skin
Population size	Pearson correlation	1	$-0.979^{**}$	$-0.861^*$
	Significance		0.001	0.028
Area of woods	Pearson correlation	$-0.979^{**}$	1	0.889*
	Significance	0.001		0.018
Tiger skin	Pearson correlation	$-0.861^*$	0.889*	1
	Significance	0.028	0.018	

\*\* Significantly correlated at the 0.01 level (bilateral).

\* Significantly correlated at the 0.05 level (bilateral).

## 4. Discussion

Guizhou Province is one of the historical distribution areas of the South China tiger and is also experiencing a historical phase of rapid socio-economic development, suggesting that the South China tiger has suffered large-scale habitat loss and hunting in the region. Big cats play an important ecological and biological role in maintaining the stability and integrity of ecosystems, as well as enhancing their resistance to disturbance and recovery.

The process of extinction of South China tigers in the wild in Guizhou Province has gone through two stages of slow decline and rapid extinction. The slow decline occurred in the late 1950s and 1960s and was

attributed to the relative lag in industrial development and low population growth in Guizhou [30]. Rapid Extinction Stage Since 1970, with the state’s attention and investment in the southwest region, Guizhou’s industry has developed rapidly, especially in the coal, electric power, chemical, and machinery industries. The landmark event was the establishment of Southwest Coal Mine Construction Command in Liuzhi, the construction of Liuzhi Coal Mine, and the construction of Liuzhi Lightweight Railway; during the construction process, a large amount of deforestation was required as fuel and raw materials, resulting in the reduction of subtropical broad-leaved evergreen forest resources, ecological deterioration, so the South China tiger in southwest Guizhou Province was the first to go extinct in



the wild; after the reform and opening up in 1978, the economy of northwestern Guizhou Province began to develop rapidly, and coal resources were vigorously developed, with the province's raw coal production reaching 16.69 million tons<sup>[31]</sup>; however, activities such as land excavation and waste stockpiling during coal mining led to the destruction of vegetation and the decline of biodiversity. In addition, atmospheric pollutants generated by coal combustion also negatively affect the surrounding forest ecosystems, and thus the South China tiger in northwest Guizhou Province became extinct in the wild. From 1970 to 1980, the index of deforestation in Qiandongnan region was 6,939,000 m<sup>2</sup><sup>[32]</sup>, and the large-scale deforestation made the subtropical evergreen broad-leaved forest further fragmented, leading to the extinction of South China tiger in the wild in Qiandongnan area after the 1990s.

In 1959, the Ministry of Forestry explicitly stipulated that the northeastern tiger was a rare animal and should not be hunted arbitrarily; however, the South China tiger was declared a pest, which subjected it to anthropogenic hunting<sup>[33]</sup>. People used the obtained skins as commodities; tiger bones, etc. were made into traditional Chinese medicine<sup>[34]</sup>. In 1977, the Ministry of Agriculture and Forestry proposed to classify the South China tiger as the second category of protected animals in the country<sup>[35]</sup>. About 3,000 South China tigers were hunted during a 30-year period, when the national population of South China tigers was distributed in scattered forests in the south, with a population of less than 200 individuals<sup>[15,36]</sup>. In 1978, China established 34 nature reserves with a total area of 12,650 km<sup>2</sup>, accounting for 0.13% of the national territory<sup>[37]</sup>. However, a single South China tiger has a large range and generally requires 100–200 km<sup>2</sup> of large, contiguous forest<sup>[18]</sup>, and even considering all the protected areas in the country, only about 60 South China tigers can be supported. What's more, at that time, the South China tiger survived only in the forests of southern China, which further limited their living space. The government's inadequate protection of the South China tiger before 1978 and

the allowance of human hunting affected its natural reproduction, thus leading to the rapid disappearance of the South China tiger population in Guizhou Province between 1970 and 1980.

Over time, the Chinese government has begun to realize the importance of environmental protection and animal conservation and has taken a series of measures to improve the environment and protect wildlife. In 1988, China promulgated the Law of the People's Republic of China on the Protection of Wild Animals, with the aim of protecting wild animal resources, maintaining ecological balance, and promoting sustainable socio-economic development. The establishment of various types of nature reserves at all levels in Guizhou Province after 1980 has stifled the disappearance of subtropical broad-leaved evergreen forests, and the forest coverage rates in Guizhou Province in 1995, 2000, and 2006 were 22.9%, 25.3%, and 31.8%, respectively<sup>[28]</sup>, which has given great importance to the conservation of biodiversity. The gradual increase in forest cover has led to a continuous improvement in the ecological environment, but once the food chain in the subtropical broad-leaved evergreen forest ecosystem lacks a senior consumer such as the South China tiger, the populations of reproductive primary consumers such as wild boars, rhesus monkeys, and rabbits will increase dramatically due to the loss of control<sup>[38]</sup>. The density of wild boars distributed in areas with better forest vegetation, such as nature reserves in Guizhou Province, can reach  $6.94 \pm 0.31$  head/km<sup>2</sup>, with a cumulative total of nearly 600,000 heads in the province<sup>[39]</sup>. This has caused a lot of negative impacts on ecosystems, social life, agricultural activities, and economic losses<sup>[40]</sup>.

According to the results of the National Terrestrial Wildlife Survey conducted by the State Forestry Administration from 1995 to 2000, as well as the special surveys on the South China tiger in Jiangxi, Hunan, Fujian, Zhejiang, and Guangdong conducted by Chen Guoliang<sup>[41]</sup> and Huang Xiangyun<sup>[42]</sup>, South China tiger wild populations in Jiangxi, Hunan, Fujian, Zhejiang, and Guangdong have all been shown to have disappeared. Although the South

China tiger has become extinct in the wild, according to the data from the China Association of Zoological Gardens, as of 2021, 246 South China tigers were kept in captivity in zoos in China, and four South China tiger rewilding training and breeding bases have been built, with the rewilding training continuing to advance and the breeding technology becoming more and more mature<sup>[4]</sup>. Meanwhile, the nature reserves in Guizhou Province have played an important role in protecting biodiversity and improving the quality of the ecological environment after more than 40 years of construction. Therefore, in order to maintain the stability of the subtropical broad-leaved evergreen forest ecosystem, we can consider releasing the captive South China tigers in zoos back to the forest to play a role in regulating the ecosystem. However, wild South China tigers not only have high requirements for habitat area but also have high requirements for food abundance in the habitat. Since the South China tiger has been extinct in the wild, there is a lack of research on its predation, which can only be estimated by borrowing the results of the predation study of the Bengal tiger, which has a similar living environment and biological characteristics. According to research, on average, each adult Bengal tiger needs to consume 3000 kg of phytophagous animals per year<sup>[43,44]</sup>. Based on a predation success rate of 10%–20%<sup>[45]</sup>, the biomass of phytophagous animals in the habitat of each South China tiger should be maintained at 15,000–30,000 kg per year. Therefore, after confirming the protected area where the South China tiger will be released, it is also necessary to estimate the population density of South China tiger prey in the protected area and then assess the number of wild releases in that protected area. In addition to this, since captive South China tigers are bred in captivity, they should undergo rewilding training at the rewilding base before release to exercise their ability to recognize and catch wild food. At the same time, it is necessary to determine the sex ratio of males and females of wild South China tigers and implement a strict breeding system to reduce the negative impact of inbreeding on population decline.

Finally, real-time monitoring of South China tigers continues after their release.

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