

Network in Nature Reserves of Fujian and Its Current Management

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Abstract—On the basis of the collection of pertinent data and statistical processing of nature reserves in Fujian Province, this paper expounds the current situation of the construction and management of nature reserves in Fujian Province, and puts forward corresponding development countermeasures and measures for the main problems.

Keywords—Fujian; nature reserves; existing problems; countermeasures

I. INTRODUCTION

The enhancement of the construction and management of reserves is our government's undisguised commitment to the Convention on Biological Diversity and the Agenda 21 [1]. By the end of 2018 [2], China has established 2750 nature reserves of all kinds of types (excluding Hong Kong and Taiwan), with a total area of 1.47 million square kilometers, accounting for 14.8% of the total national territorial area. These nature reserves protect most of significant ecological systems and rare and endangered species in China. Their construction and development play a crucial role in protecting biodiversity, national ecological safety and promoting the construction of ecological civilization.

Fujian is located in the southeast coast region of China and the west coast of the Taiwan Strait. The coastline is 3752 km long, with numerous coastal harbors, islands and mud flats. The forest coverage rate has reached 66%, ranking first in China. The vegetation forms are abundant, and the plant species are mainly subtropical flora. The vegetation in Fujian Province is divided into two parts by Mount Wuyi and Daiyun mountain running from northeast to southwest: the southern subtropical monsoon evergreen broad-leaved forest zone in the southeast coastal area (from the coastal herring bone in the east of Fujian to the inner mountain system of Jiufengshan mountain - Daiyun mountain - Bopingling - Xianshan mountain) and the northwest mid-subtropical evergreen broad-leaved forest zone. Due to the complex topography, warm climate and abundant rainfall, there are significant differences in species composition and community surface structure in Fujian Province; consequently, it has special value in the protection of forest vegetation and marine organism. This paper intends to research the spatial distribution characteristics, problems and management status of nature reserves in Fujian Province, in order to provide basic support for the optimization of the network system of nature reserves in Fujian Province.

II. NATURE RESERVE SYSTEM IN FUJIAN

A. Number, Type and Area

Since the establishment of Wanmulin Nature Reserve, the first nature reserve in Fujian Province in 1957, after more than 60 years of construction, 92 nature reserves of all kinds of types have been built[2], with a total area of 4.45×10^5 hm², of which 79 is terrestrial nature reserves, with an area of 4.08×10^5 hm². The reserves are throughout the province, and the network in the nature reserves with relatively reasonable spatial arrangement and relatively complete types of protection has been basically formed.

According to the current classification standard of the Regulations of the People's Republic of China on Nature Reserves [3], Fujian has boasted 17 national nature reserves, with an area of 2.50×10^5 hm², accounting for 13.04% and 40.73% of the total number and area of nature reserves in the province, respectively; 21 provincial-level nature reserves, with an area of 80227.68 hm², accounting for 27.17% and 27.54% of the total number and area of nature reserves in the province, respectively; 55 municipal and county-level nature reserves, with an area of 1.07×10^5 hm², accounting for 59.78% and 31.73% of the total number and area of natural reserves in the province, respectively. The Mount Wuyi National Nature Reserve is a nature reserve with early establishment, larger area and very high value in China, which has joined the World Network of Biosphere Reserves in 1987.

According to the differences of protection objects, landscape natures and natural attributes [4], the 92 nature reserves in Fujian Province can be divided into 7 types, that is, forest ecosystem type, wild animals and plants type, inland wetland and aquatic ecosystem type, marine and coastal ecosystem type, and geological relic type (See "Table I"). It can be seen from the table that the overwhelming majority of nature reserves in Fujian Province are nature reserves of forest ecotype, and are dominated by the mid-subtropical forest ecosystem type, while the nature reserves of coastal wetland type see slow development. In addition, there are a large number of nature reserves that belong to the polytype. For example, Tianbaoyan National Nature Reserve is not only a forest ecosystem protection type, but also an important protection area for wild animals and plants such as

Tsuga longibracteata Cheng, rhododendron simiarum, sphagnum, etc.

TABLE I. TYPE DISTRIBUTION OF NATURE RESERVE IN FUJIAN

Category	Type	Number	Area/hm2	Area Proportion /%
Natural ecosystems	Forest ecosystem	61	326577.40	53.23
	Inland wetland and aquatic ecosystem	2	7030.00	31.80
	Marine and coastal ecosystem	9	61417.04	0.84
Wildlife	Wild plants	7	18711.47	13.47
	Wild animals	9	24125.03	
Natural relics	Geological relic	2	1 360.00	0.66
	Ancient organism relics	2	3 300.00	
	Total	92	445478.94	100.00

B. Regional Distribution

It can be seen from "Table II" that Ningde City enjoys the largest number of established nature reserves (33), but the area of individual reserve is generally too small, and the smallest one is only 3hm2 (Kengdilou Reserve). There are few nature reserves in coastal cities such as Xiamen, Putian, Quanzhou, etc. Fuzhou, Putian and Ningde have not yet

established national nature reserves, because most coastal areas, especially those located in the south subtropical zone, enjoy relatively developed local economy, and there is a large population with relatively little arable land. Due to the development of economy, the land is used in a large scale, and they have scruples or do not pay attention to the establishment of nature reserves, which limits the development of coastal nature reserves.

TABLE II. REGIONAL DISTRIBUTION OF NATURE RESERVES IN FUJIAN

	Number of Reserve	Area of Reserve/Hm2	Average Number of Reserve per County	Number of Counties with Reserves
Total	92	445478	1.35	50
Ningde	33	83731	3.30	8
Fuzhou	11	67 135	1.22	7
Putian	2	2848	1.00	1
Quanzhou	5	27 926	0.56	5
Xiamen	1	33 088	1.00	1
Zhangzhou	15	27938	1.50	7
Longyan	3	42 301	0.43	3
Sanming	10	62582	1.18	9
Nanping	12	97929	1.09	9

In order to reflect the distribution characteristics of the reserves in the inter-city range, the geographic concentration index is adopted to study the concentration distribution degree of the reserves. The calculation formula [5] is as follows:

$$C = \sqrt{\frac{\sum_{i=1}^n (\frac{x_i}{T})^2}{n}} \times 100$$

In the formula, C represents the geographic concentration index of reserves in Fujian Province; n is the total number of prefecture-level cities in Fujian Province; Xi is the number of reserves in the ith city; T is the total number of reserves in Fujian Province; and Co is the geographic concentration index of reserves averagely distributed in nine cities in Fujian Province. If C > Co, it means that the reserves are intensively distributed, otherwise, it means that the reserves are dispersedly distributed.

It can be seen from the calculation that the average number of reserves in nine cities of Fujian Province is 10.22, while the geographic concentration index of reserves is 45.05. C is larger than Co, which indicates that the distribution of the nature reserves in Fujian Province is relatively concentrated on the inter-city scale. In general, the construction of all kinds of nature reserves in Fujian has played a commendable role in protecting the middle and

south subtropical evergreen broad-leaved forest, various migratory birds, beasts, reptiles, amphibians, shellfish, especially rare and endangered wild animals and plants, natural historical relics and other resources.

C. Management System of the Reserves

According to the principles and goals determined by the Outline of China Nature Reserve Development Plan (1996-2010), Fujian Province has compiled the Development Plan of Nature Reserves in Fujian Province, which provides the development direction and policy guarantee for the construction and management of the province's nature reserves. In 1995, Fujian Province has formulated the Regulations on the Management of Forest and Wildlife Type Nature Reserves in Fujian Province and has revised in 2017, with more strict restrictions on behaviors prohibited by laws and regulations. A series of regulations, notices and normative documents on the management of nature reserves within the jurisdiction have also been issued in succession. On this basis, the People's Congress of Fujian Province has passed the Measures for the Management of Nature Reserves in Fujian Province, which has improved the legal system of nature reserves in Fujian Province, improved the operability of relevant laws and regulations, and played a commendable

role in regulating the construction and management of natural reserves.

The nature reserves in Fujian implement the management system that combines integrated management and department management, and the management work is basically standardized. The provincial-level nature reserves have gradually seen the improvement in terms of the overall planning formulation of construction management, exploration of community co-management mechanism and publicity and education; the construction and management of the municipal and county-level nature reserves are in the primary stage, which still needs some development to satisfy the relevant standards. Fujian Provincial Department of Environmental and Conservation shall be responsible for the integrated management of natural reserves in Fujian Province, and organize the establishment and review for promotion of natural reserves. Relevant administrative departments such as Fujian Provincial Forestry Department, Ocean and Fishery Bureau, Tourist Administration, Land and Resources Office shall be responsible for the construction, management and protection of natural reserves within their respective responsibilities. Among the nature reserves in Fujian Province, 82 natural reserves are managed by the Department of forestry, with an area of 367941 hm² and 7 natural reserves are managed by the State Oceanic Administration, with an area of 75977 hm², except that Pinghai Beach Rock Dune Rock Reserve, Sanshiliujiao Lake Reserve and Hucun Fossil Reserve are under the charge of the Department of Land and Resources, Water Department and Geological and Mineral Department, respectively.

III. PROBLEMS EXISTED IN THE CONSTRUCTION AND MANAGEMENT OF NATURE RESERVES IN FUJIAN PROVINCE AND DEVELOPMENT COUNTERMEASURES

A. *The Networked Layout Is Not Obvious*

The cause of nature reserves in our province is still in the stage of continuous expansion and improvement. The number of nature reserves shows an overall increasing trend as evidenced by the number of nature reserves has increased from 68 in 2004 to 92 today. However, with the increase of the number of reserves, the area of reserves shows a downward trend as evidenced by the area of reserves has decreased from 473131.2 hm² in 2003 to 445478 hm². With the increased pressure of population and economic development, numerous rare or strategically important natural resources still need to be safeguarded through the establishment of certain reserves. For example, there are still 12 vacant species in reserves in our province, such as *pelochelys bibroni*, tire track eel, tiger frog, etc. [7]. In terms of the area of the reserves, they are mainly small and medium-sized island-type nature reserves, while the area of wetland type ecosystem is relatively small. It is suggested that several reserves with the same function should be formed into the reserve networks and habitat corridors [8] to promote the migration and exchange of regional species.

B. *The Current Management System and Management Level Limit the Development of the Reserves*

There is room for further improvement in the effective management of nature reserves in Fujian Province. In terms of management objects, 15% - 25% of the reserves fail to delimit the core area, buffer area and experimental area as required [9]. In terms of management actions, the relative shortage of professional and technical personnel in the administrative personnel leads to the failure of effective resource investigation, scientific research cooperation and dynamic monitoring in most nature reserves. Most nature reserves fail to well handle the relationship between the reserve management and the development and utilization of resources, which makes the main protection objects to face a huge threat. In terms of management mechanism, there are the following prominent problems in the nature reserves of our province:

- Multiple management, unclear rights and responsibilities. For example, Mount Wuyi National Nature Reserve is jointly managed by Fujian and Jiangxi Provinces;
- The establishment of rules and regulations for the management mechanism of nature reserves are not perfect;
- The management level of nature reserves is significantly different among different nature reserves;
- The management mode of the nature reserve is lack of connection with the surrounding social and economic environment, and is divorced from the reality. The conflict between the reserves and the local residents is frequent;
- "Nominal hierarchical management" between the management organization of the nature reserves and the local government results in the lack of administrative power of the nature reserves;
- The operation efficiency of management mechanism is low, and the mechanism of public participation and supervision is not perfect;
- The expenditures related to the nature reserves cannot meet the needs of the work of the reserves;
- The management of nature reserves has the problem of putting more emphasis on management than on operation;
- The application of classified management in the management of nature reserves is less;
- The management system of the whole nature reserve lacks effective coordination mechanism and relevant institutions.

In view of the above problems, a large number of scholars put forward the following solutions: first, rationalize the management system of the nature reserves, define the institutional positioning and management responsibilities; second, define the ownership of the nature reserves to make

the right to use and management rights are coordinated; third, strengthen the training of administrative staff, improve the quality of managers. Regularly organize experts to carry out background investigation and comprehensive scientific investigation, establish database, determine protection priorities and build backbone team. Strengthen publicity and education, promote public participation, carry out community co-management, and build a multi-type and all-dimensional natural resource protection as soon as possible; fourthly, establish and improve the policy and regulatory system on biodiversity protection and development in nature reserves. In addition, it can attempt to integrate a variety of management and operation to implement classified management for different types of nature reserves, and promote the surrounding communities to participate in the management of nature reserves. In short, the management of nature reserves can be strengthened through four ways, that is, legal restriction, administrative management, scientific means and market-oriented operation.

C. Insufficient Financial Fund Investment Limits the Management

The absence of financial support is one of the major problems faced by nature reserves around the world, and the situation in our province is even more severe. The undertaking expenditures of institutional personnel in provincial (district)-level nature reserves are included in the provincial (district)-level financial budget, while the expenditure investments of municipal and county-level nature reserves are very limited, and some of them are even difficult to maintain the basic wages of the employees in nature reserves. The cost of facility construction accounts for the overwhelming majority of the invested funds, and there is little or no fund for daily patrol, monitoring and law enforcement, which seriously impedes the implementation of daily work in the reserves. This is one of the important reasons for the poor management of nature reserves in our province. Secondly, in the absence of an increase in financial support at all levels, the rapid growth of the number and area of nature reserves makes the problem of insufficient funds of nature reserves in our province more prominent. In addition to the source of funds, the lack of management and supervision mechanism of various funds is also a very serious problem. In order to solve the financial pressure of nature reserves in our province, many reserves try every means to use resources to obtain funds to reduce their burden, which results in the destruction of biological resources due to unreasonable tourism development activities.

The above-mentioned problems need to be solved in combination with the improvement of the fund investment mechanism of nature reserve in our province. The mechanism of fund investment is one of the critical factors for the healthy, sustainable and quick development of nature reserves. Therefore, it is necessary to ensure that there is a long-term stable source of fund for nature reserves. In order to solve the problem of fund investment on nature reserves, the following methods can be adopted [10]. Firstly, it can broaden the channels of fund investment, including attracting foreign investment and social donation on the basis of

government investment, and establishing ecological compensation fund for nature reserves; secondly, it can properly develop ecological tourism, science popularization education, scientific research and other activities, and collect accommodation fee, catering fee and other license fees; thirdly, the fund can be solved by adopting wild animals and plants, holding special marketing and promotion activities, implementing natural protection membership system and attracting personal or social investment.

IV. CONCLUSION

After many years of construction and management, the cause of nature reserves in Fujian Province has achieved remarkable results, which forms a natural reserve system with ecological service functions that takes the protection of the forest ecology in the middle and south subtropical zones, including various types of wild animals and plants, natural relics and marine coastal ecosystem, and the biological resources as its main tasks. However, due to the influence of social and economic factors, there are still many problems in the work of the reserves, especially in the protection objects and management mechanism, which need to strengthen the optimization of the reserve network in the future construction.

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