

Landscape planning and ecology construction of wetland comprehensive protected area system in the Sanjiang Plain

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Abstract: Wetland is one of the richest biodiversity areas in the earth. The main purpose of establishing wetland protected area is to protect biodiversity, and the protection of ecosystem diversity and landscape diversity is the key to protect biodiversity. In order to protect regional ecosystem and landscape, it is a good way to establish wetland comprehensive protected area which connected wetland nature reserves by habitat corridors. The Sanjiang Plain as a study area, its landscape evaluation index system on wetland protected area was studied, and some problems on landscape planning and ecology construction were further approached in this paper. It showed that establishing wetland comprehensive protected area is very important to protect regional wetlands, to maintain ecological balance, and to improve the sustainable development of agriculture and industry in this region.

Key words: landscape planning; ecology construction; wetland protected area

Introduction

Wetland is one of the richest biodiversity areas in the earth. Biodiversity should include four levels: heredity diversity, species diversity, ecosystem diversity and landscape diversity. Speaking from certain angles, the protection of ecosystem diversity and landscape diversity is the key to protect wetland biodiversity. The reason is that the protection of all species and habitats, which rely on wetlands, can come true only when the ecosystems are protected. Ecosystem and landscape are environments of species' existence and, to some extents, their structures and functions determine diversity of species. As a results, the protection of their habitats is the essential way to retard extinction of species and protect heredity diversity. Establishing nature reserves is the most effective method to protect wetland biodiversity, which play an important role in maintaining of the health of regional ecosystem and biodiversity. The landscape planning on wetland comprehensive protected area is, from the angle of the landscape ecology and conservation biology, to make a plan among the relationship of wetland area, distribution and corridors in regional size. The establishment of the comprehensive protected area is the foundation of and key to the protection of ecosystem diversity and landscape diversity, which is also the foundation of rational utilization of natural resources and the maintenance of regional sustainable development. This paper will, taking the Sanjiang Plain as a study area and at the scale of region and landscape, approach the subjects of landscape planning and ecological construction on the wetland comprehensive protected area system.

1 Current situation and existing problems about the Sanjiang Plain wetland nature reserves

1.1 General condition of the region

The Sanjiang Plain, located in the northeast of Heilongjiang Province, consists of two plains. One is the low alluvial plain formed by Songhua River, Heilongjiang River and Wusuli River. It is on the north of Wanda Mountain. The other, which was formed by South Wusuli River and its branches and Xingkai Lake, is on the south of Wanda Mountain. The region totally covers 108900 km² and 51300 km² are plain. Wetlands are widely distributed in the plain. Among them, marsh-wetland cover 11300 km² (Liu, 1996), rivers and lakes cover 4300 km². There are 190 rivers

(Guo, 1986) and 16 wetlands nature reserves with different levels. It is the largest area of fresh water wetlands that join together.

1.2 Current situation and existing problems about wetland nature reserves

The Sanjiang Plain is one of the five Chinese biodiversity key areas of wetlands and fresh waters (Chen, 1998). It is the center of waterfowls reproduction in Northeast Asia and the necessary region moving to the south for waterfowls in North Asia. The main characteristics of wetland in the Sanjiang Plain are: (1) marsh wetland is the largest one in China; (2) most plain rivers are seasonal rivers; (3) a large number of pool marshes distributed in lower places; (4) marsh wetlands mainly distribute along rivers; (5) marsh vegetation is of rich diversity which mainly includes *Ass. Carex lasiocarpa*, *Ass. Carex pseudocuraica*, *Ass. Glyceria spiculosa*, *Ass. Phragmites communis*, *Ass. Trapa spp*, *Ass. Carex meyeriana*, *Ass. Carex appendiculata*, *Ass. Deyeuxia angustifolia*, and about 620 species of wetland higher plants; (6) marsh animals and fish are of rich diversity which include red-crowned crane (*Crus japonensis*), Great White Crane (*Grus leucogeranus*), Whooper Swan (*Cygnus cygnus*), Large Egret (*Egretta alba alba*), and about 53 species of waterfowls and 80 species of wetland fish in 1992 (Liu, 1998). But, the Sanjiang Plain has been developed for several times in a large-scale exploitations with the beginning of reclamation wasteland and establishing farms in 1956. As a results, the wetlands were increasingly fragmented and more than half of the area of the marsh wetland disappeared. The species of plants and animals, which rely on wetland for habitat, have been reducing significantly, and many rare waterfowls have become extinct, and, because of the use of agriculture fertilizer and pesticides, wetland pollution becomes a serious problem. In order to protect the biodiversity of wetland, 16 wetland nature reserves have been established and 13 of them are mainly for the protection of waterfowls. Certainly, these reserves have played an important role in protecting biodiversity, but for the reason of poor management, pollution, catching and hunting randomly especially for the fragmentation and destruction of habitats which affected on ecosystem diversity and landscape diversity, wetlands and their biodiversity are threatened seriously (Fig. 1).

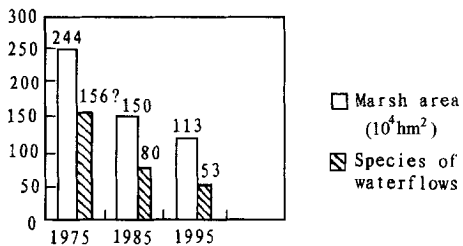


Fig. 1 The changes of marsh area and species of waterfowl

According to the non-balance the ory, the goal of protecting biodiversity can not be achieved by simply closing reserves to eliminate human disturbance. Even though many wetland nature reserves were built on the Sanjiang Plain, they are scattered. The wetland reserves that are built for protecting waterfowls, can not meet the requirement of waterfowl conservation because some waterfowls have strong ability on diving and swimming and thus can move about in a very wide extent. For example, egret class waterfowls look for food in spring within a radius of more than 5 km and the extent will be

larger in breeding season (Ma, 1992). Therefore, the goal of protection can not be reached only by building scattered reserves. The key to resolve the problem is to connect the habitats and build the comprehensive protected area system within the region.

2 Establishing of landscape evaluation index system on wetland comprehensive protected area

Wetland is a special nature landscape. The landscape evaluation index system on wetland comprehensive protected area includes three parts: (1) the landscape suitability index that reflects the landscape planning of wetland protected area; (2) the ecosystem index that inflects the structure and function of landscape ecosystem; (3) the social economy index that reflects the

benefits to social economy (Table 1).

Table 1 Index system on the landscape evaluation of wetland comprehensive protected area

Component	Sub-component	Detail
Landscape suitability index	Topography suitability index	Geomorphologic types (flood land, riverine, depression)
	Hydrology suitability index	Water quality and quantity can satisfy wetlands demands
	Soil suitability index	Mineral soils, organic soil content, nitrogen (N) content
Ecosystem index	Rarity of wetlands and habitats	Geographic rarity of wetland types, rare species, waterfowl staying and breeding, fish habitat, ecosystem age
	Biodiversity	Number of wetland types, diversity of surrounding habitat, vegetation communities, species of animals, wildlife population
	Primary production	Wetland type, soil type, sitetype (isolated, palustrine, riverine, lacustrine)
	Plant cover	25%—75%
	Size	Number of wetland types, vegetation communities, diversity of surroundings open water
	Habitat connectivity	Proximity to other wetlands, connection of wetlands, fragmentation of wetland
	Disturbance	Human disturbance, nature disturbance
Social-economic index	Economical index	Economically valuable products (wood products, fish, rice)
	Safety and healthy index	Wetland's environment benefit (flood attenuation, ground water recharge/discharge, downstream water quality improvement)
	Aesthetics and culture index	Recreational activities (nature appreciation, hunting), landscape aesthetics, education and public awareness

3 Landscape evaluation on the wetland comprehensive protected area

According to the evaluation index system above, the Sanjiang Plain was evaluated in qualitative and quantitative methods.

3.1 Evaluation on landscape suitability

The Sanjiang Plain is a low alluvial plain formed by Songhua River, Heilongjiang River and Wusuli River. The general slope of the plain is 1/500—1/1000 and it is 45—80m above sea level. There are more than 20 seasonal-rivers in the plain with the characteristics of small slope, big curve coefficient and wide flood land covered by marsh-vegetation. The climate of the plain is continental monsoon humidity and semi-humidity with annual precipitation of 500—700 mm that distribute unevenly according to seasons. The main wetland soil types are podzolic soil, meadow soil, and marsh soil. The characteristics of the soil are clay soil with poor permeability and high fertility which is favorable to marsh vegetation growing prosperously. This region, with light pollution, is far away from industrial cities. Both the indexes of fertilizer pollution and agricultural chemical pollution accord with the water quality standards of the water used by living things. Therefore, the natural geographical condition of this region can satisfy the needs of wetland resources' sustainable development and the region is suitable to be built as a wetland protected area in the landscape scope.

3.2 Evaluation on ecosystem index

Landscape is regional mosaics formed by different ecosystems. The evaluation on landscapes is

generally reflected by the index of ecosystem evaluation. The wetland landscape in the Sanjiang Plain has characteristics of diversity and rarity of habitat and consequently ecosystem diversity and species diversity. The Sanjiang Plain has high primary production. The net primary production can reach 800—4000 g/m² (dry weight). The plant cover of marsh is 70%—80%. Natural river corridors connect different habitats and thus the landscape has the characteristics of integrity, stability and effectiveness.

3.3 Evaluation on social economy index

The establishment of wetland comprehensive protected area in a landscape scale has many benefits. Firstly, it can enlarge the area of wetland protection and protect the landscape diversity of wetland. Secondly, it can improve wetland functions and can get positive effects on the development of agriculture, industry, fishery, forestry and husbandry. After that, it will play an important role in maintaining regional ecological balance, degradation of pollutants, water storage and flood control. Finally, it will effectively improve tourism and entertainment, strength education and scientific research, and create natural beauty.

In conclusion, the landscape planning of wetland protected area can build regional landscape system on wetland conservation with the characteristics of harmony in spatial structure, ecological stability and ideal social economic benefits.

4 Landscape planning and ecology construction on wetland protected area

Landscape planning and ecology construction pay attention mainly to the resource distribution in macroscopic scale. The landscape design should provide sustainable living condition to various living things with not only the current pattern but also the future pattern. Its central task is to create an ecosystem of the whole region with the trait of sustainable development.

4.1 Landscape planning model

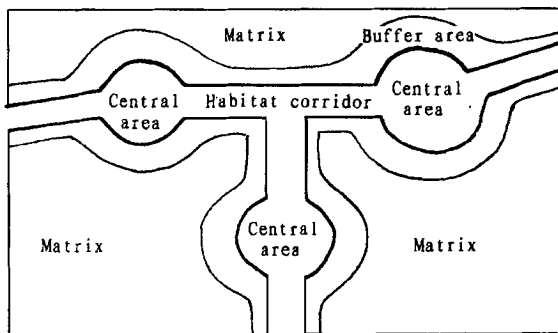


Fig.2 Model of comprehensive protected area

The wetlands on the Sanjiang Plain are distributed mainly beside seasonal rivers. The wetland nature reserves are scattered in these wetlands in shape of patch. Due to the geographic feature of the Sanjiang Plain, prosperous vegetation are growing along the rivers, which become the habitat of wetland animals for resting, feeding and breeding. On the landscape background of the Sanjiang Plain, rivers should (and did in the past) act as habitat corridors. For the reason of reclamation, wetland fragmentation causes breaks in river corridors. As

a result, habitats were isolated and biodiversity was reduced. Therefore, the purpose of regional wetland biodiversity protection can be reached only by forming an entirety or a net (We call it the "Comprehensive protected area") through the connection of nature reserves by habitat corridors.

The model of the comprehensive protected area is Reserve-Habitat corridor-Reserve. The spatial structure of wetland protected area landscape is formed in this way (Fig.2).

4.2 The problems on landscape ecology construction

4.2.1 Establishing new nature reserve to form reserve net

At present the main reason which lead to a decline of wetland biodiversity is that the number of wetland nature reserve is not enough to protect wetland area. Firstly, the area affects the distribution of nutrition and energy. Secondly, the area affects the number and types of species. Generally, the larger of the area, the more stable of ecosystem is, the more safety of biological

aspects: (1) to connect different ecosystem, maintain the integrity of ecosystem and landscape function; (2) to provide a suitable habitat for wetland wildlife; (3) as corridors to help wetland animals eating and migrating; (4) suitable to spread of animals and genetic flow among species, avoid the extinct of small communities; (5) allow species to migrate from far distance and adapt to the environment changes at any time (such as waterlogging, drought).

To guarantee the efficiency of habitat corridor, the farther the distance between nature reserves, the wider the habitat corridors, according to the characteristics of wetland animals especially waterfowl's activity. It is favorable to choose an area 50m width from the river bank as the center area of habitat corridors, its width of buffer zone may be decided according to the situation of wetland distribution, in generally, it is about 50—100m width. River corridors as nature habitat corridors, their ecology construction includes three parts: (1) to connect the breaks of river corridors, (2) to restore the deteriorate wetlands of river banks, (3) to monitor the surroundings pollution especially paddy-field pollution. According to the present situation of the Sanjiang Plain, there are 6 wetland protected areas planned to be established: (1) the wetland protected area in Wutong and Dulu River basin; (2) the wetland protected area in Lianhua River basin; (3) the wetland protected area in Nenjiang and Yalu River basin; (4) Bielahong River—Sanjiang wetlands protected area; (5) the wetland protected area in Naoli and Qixing River basin; (6) Downstream in Mulin River basin-Xingkai Lake wetlands protected area (Fig.3).

5 Conclusion

These nature reserves are connected by habitat corridors to establish wetland comprehensive protected area system, it is the essential way to make up the habitat fragment which threatened biodiversity, and also to protect the decreasing marsh, river and lake wetlands. It will play a great role in developing regional environment function of wetlands, maintaining ecological balance, improving sustainable development of agriculture and industry.

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