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A Study on the Fish Diversity of Sanhuanpao Wetland in Heilongjiang Province

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Abstract The current situation of fish in Sanhuanpao Wetland was investigated for the first time in this paper. In May (Spring), July (summer), September (autumn) 2016, it was sampled three times for investigation, and based on the investigation data about the fish caught by net 45 times in 9 sampling points, the species composition of fish community in the water was analyzed. The results showed that a total of 12 fish species were caught in this investigation, belonging to 4 orders, 6 families and 12 genera. There were five fish species for Cyprinidae, accounting for 41.7% of total species, followed by Cobitidae with three species, accounting for 25% of total species; Siluridae, Esocidae, Eleotridae and Channidae each had 1 species, accounting for 8.3% of total species. The fish with index of relative importance (*IRI*) greater than 1000 is the dominant species, and it was calculated that the dominant species were *Carassius auratus gibelio*, *Rhynchocypris percnurus*, *Misgurnus mohoity*, *Cobitis taenia* Linnaeus, and *Perccottus glenii*. In this paper, based on the number of individuals, by calculating Margalcf abundance index (*D*), Shannon - Wiener diversity index (*H'*) and Pielou evenness index (*J'*) for the fish in the water, the current situation of fish resources in Sanhuanpao Wetland was analyzed and the corresponding protection recommendations were put forward.

Key words Sanhuanpao Wetland, Fish, Diversity

1 Introduction

Heilongjiang Sanhuanpao National Reserve is located in the hinterland of Sanjiang Plain, one of the few original wetlands, with extremely important protection value. Its geographical coordinates are 132°12′ - 132°55′E, 46°44′ - 46°50′N, and the protected area is 56 km from east to west, 11 km from north to south, with a total area of 27687 ha.

The rivers and bogs are massively distributed in the region, and it is one of the typical wetlands in Sanjiang Plain. Sanhuanpao Wetland is the inland wetland ecosystem which can provide habitat and stopover for the rare waterfowl, and the main source of food for waterfowl is fish. The *in situ* conservation of waterfowl is essentially to implement intensive management of fish resources in the region. In recent years, the comprehensive and systematic data about the fish in Sanhuanpao Wetland have not been reported.

This paper investigated and analyzed the fish composition and seasonal variation of diversity in Sanhuanpao Wetland for the first time, in order to understand the fish community composition and fish utilization mode in Sanhuanpao Wetland, and provide basic information for the fish resource protection and the rational development and utilization of Sanhuanpao Wetland.

2 Research methods

2.1 Data sources Based on the requirements and principles of *Investigation Manual on Fishery Natural Resources in Inland Waters*, taking into account the ecological characteristics and geographical conditions of Sanhuanpao Wetland National Nature Reserve in Fujin City, we did field sampling three times in May, July and September 2016 (spring, summer, autumn).

Using cage, ground anchor and other tools, we selected a number of sampling points for field survey, and at each sampling point, we conducted fixed-point catching, fish sample collection, data collection, and analyzed the fish community structure characteristics.

Some samples collected were stored with 8% formalin solution, and then classified and identified. The sample identification was based on *Heilongjiang Ichthyography*[1]. We measured the body length, body height (accurate to 0.1 mm), body weight and total weight (accurate to 0.1 g) of the fish caught and the fish number was counted.

2.2 Data analysis methods According to the ecological characteristics of Sanhuanpao Wetland and the data obtained, this paper used Pinkas index of relative importance (*IRI*), Margalcf abundance index (*D*), Shannon - Wiener diversity index (*H'*), and Pielou evenness index (*J'*) to analyze and study the fish species diversity, and the main formulas are as follows:

(i) Pinkas index of relative importance (*IRI*):

$$IRI = (N\% + W\%) \times F\%$$

where $N\%$ is the proportion of one species number to total number; $W\%$ is the proportion of weight of one species to total weight; $F\%$ is the proportion of number of the sampling points where one species appears to total number of the sampling points.

(ii) Margalcf abundance index (*D*):

$$D = (S - 1)/\log_2 N$$

where S is the number of species ; N is the number of individuals of a species.

(iii) Shannon - Wiener diversity index (*H'*):

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$$H' = -\sum_{i=1}^{s} P_i \log_2 P_i$$

where P_i is the share of number of individuals of species i in the total number of individuals; S is the number of species.

(iv) Pielou evenness index (J'):

$$J' = H'/\ln S$$

where H' is the Shannon-Wiener index; S is the number of species.

3 Results and analysis

3.1 Fish community composition In this paper, we conducted systematic sampling and investigation of the fish in Sanhuanpao Wetland for the first time, and most of the fish types in Sanhuanpao Wetland were included in the catch.

The sampling results showed that we collected 12 species of fish belonging to 4 orders, 6 families and 12 genera in Sanhuanpao Wetland (Table 1):

Carassius auratus gibelio in the Cyprininae subfamily; *Phoxinus percnurus* in the Leuciscinae subfamily; *Rhodeus sericeus* in the Acheilognathinae subfamily; *Pseudorasbora parva* in the Gobioninae subfamily; *Hemiculter Leuciclus* in the Culterinae subfamily; *Misgurnus mohoity* in the Cobitinae subfamily; *Cobitis lutheri* and *Cobitis lutheri* in the Cobitinae subfamily; *Nemacheilus toni* in the Nemachilinae subfamily; *Silurus asotus* in the Siluridae family; *Esox reicherti* in the Esocidae family; *Perccottus glenii* in the Eleotridae family; *Channa argus* in the Channidae family.

Table 1 Fish investigation results in Sanhuanpao Wetland

Order	Family	Subfamily	Genera	Species
Cypriniformes	Cyprinidae	Cyprininae	*Carassius*	*Carassius auratus gibelio*
		Leuciscinae	*Phoxinus*	*Phoxinus percnurus*
		Acheilognathinae	*Rhodeus*	*Rhodeus sericeus*
		Gobioninae	*Pseudorasbora*	*Pseudorasbora parva*
		Culterinae	*Hemiculter*	*Hemiculter Leuciclus*
	Cobitidae	*Cobitinae*	*Misgurnus*	*Misgurnus mohoity*
			Cobitis	*Cobitis lutheri*
		Nemachilinae	*Nemacheilus*	*Nemacheilus toni*
Siluridae	*Siluridae*		*Silurus*	*Silurus asotus*
Salmoniformes Esocidae			*Esox*	*Esox reicherti*
Perciformes	Eleotridae		Perccottus	*Perccottus glenii*
	Channidae		Channa	*Channa argus*

3.2 Dominant species composition of fish community According to the fish resource investigation results in spring, summer and autumn, the bottom fish resistant to low temperature and low oxygen were the dominant species in Sanhuanpao Nature Reserve, mainly including Carassius auratus gibelio, Rhynchocypris percnurus, Misgurnus mohoity, Cobitis taenia Linnaeus and Perccottus glenii, which accounted for most of the catch, with dominance of 3396, 3029, 1845, 1837 and 9575, respectively (Table 2).

Table 2 The dominance of fish catch in Sanhuanpao Wetland

Fish species	*N*//%	*W*//%	*F*//%	Dominance(*IRI*)
Carassius auratus gibelio	7.14	26.82	100	3396
Phoxinus percnurus	17.51	12.78	100	3029
Rhodeus sericeus	0.034	0.013	33.33	1.5665
Pseudorasbora parva	0.046	0.007	66.66	3.533
Hemiculter Leuciclus	0.012	0.003	33.33	0.500
Misgurnus mohoity	5.979	12.47	100	1845
Cobitis lutheri	14.59	3.781	100	1837
Nemacheilus toni	0.023	0.003	66.66	1.733
Silurus asotus	0.195	1.356	100	155.1
Esox reicherti	0.023	0.652	66.66	45.00
Perccottus glenii	54.32	41.43	100	9575
Channa argus	0.13	0.69	66.66	54.66

The dominant fish species were almost all over the waters in a large number and high frequency. The number of Rhodeus sericeus and Pseudorasbora parva is small, with low frequency of occurrence, and they live in the upper and middle part of the water, intolerant of hypoxic environment.

The marsh wetland is not suitable habitat for them, and they are typical sporadic species, and it was found in the investigation that they might flow accidentally into the wetland with the river water. Table 3 lists the body length and weight of the main fish dominant species caught in Sanhuanpao Wetland.

3.3 Biodiversity of fish community Based on the year data, it was calculated that there was no large fluctuation in D, J', H' values of the fish in Sanhuanpao Nature Reserve in March, May and July (*i. e.*, spring, summer, autumn), showing an overall upward trend (Table 4).

Table 3 The body length and weight of the main fish dominant species caught in Sanhuanpao Wetland

Species	Standard length//cm			Total weight//g		
	Min.	Max.	Average	Min.	Max.	Average
Carassius auratus gibelio	3.5	15.2	8.22	0.5	183	21.910
Phoxinus percnurus	3.5	10.5	6.27	0.5	22	5.642
Misgurnus mohoity	1.3	18.5	13.28	1.0	27	46.980
Cobitis lutheri	0.9	7.4	3.82	0.5	3	1.320
Perccottus glenii	3.2	17.0	8.18	1.0	49	11.230

Table 4 Seasonal variation of fish community diversity index

Month	Abundance index (D)	Evenness index (J')	Shannon – Wiener diversity index (H')
May	0.7200	0.8214	1.3162
July	0.6604	0.8625	1.4428
September	0.7678	0.9003	1.5278

According to the relevant departments, it is found that the water is channeled into Sanhuanpao Wetland from other sources in spring, with high water level and good water quality, and after the ice is thawed in spring, the fish comes into the active period, followed by the breeding season, so the fish activity is frequent and the catch is relatively abundant, and D, H', J' index is relatively high.

In summer, the plants flourish in the protection zone, and due to increased farmland water consumption, the overall water level drops, and some sampling points are canceled because the vessels can not enter them, so the catch is relatively reduced, but the new species is found (such as *Channa argus* and *Esox reicherti*), hence the abundance index (D) is decreased, while evenness index (J') and diversity index (H') are slightly increased.

There is no significant difference between autumn and summer, there is no new species to be found, and all indices show an upward trend.

4 Discussions

Sanhuanpao Wetland is mainly composed of alluvium and marsh sediments, and the landform type is low river floodplain. Overall, the terrain is flat, and the surface is covered with herbaceous vegetation and marshes. Studies have pointed out that the distribution and structure of fish species is closely related to the surrounding water environmental factors[2].

Fish is an important part of the wetland ecosystem, feeding on plankton, algae, and aquatic plants[3-4], and it can also provide food for wetland migratory birds[5]. Many types of fish have very important economic value, and due to the sensitivity of fish to water bodies, it is also considered to be one of important indicator organisms in wetland ecosystems[6].

The investigation results show that the fish in Sanhuanpao Wetland belongs to 4 orders, 6 families, 12 genera and 12 species, and there is no big change in the species composition and dominant species composition of fish community in spring, summer and autumn. The fish of Sanhuanpao Wetland is dominated by Cypriniformes (a total of eight species), which is related to the location of protected area and the habitats in the area[7].

The water is shallow (0.5 m – 3.5 m), the annual average temperature is low, and the fish wintering conditions are poor, so the fishes are mostly the bottom and middle and lower fishes, while there is a shortage of upper fishes, and the dominant species of fish are mostly omnivorous, which is also related to the ecological environment and geographical location of the nature reserve.

In summer, the vegetation is abundant, and the food is adequate in the waters, but it is a frozen period in winter when the food within the waters is significantly reduced. It is also a factor affecting the composition of fish community.

In recent years, due to environmental and climatic impact as well as increasing population and agricultural development pressure[8], the waters of the protected area is strongly disturbed by human activities, land reclamation, water pollution, overfishing and other activities have caused dramatic changes in the habitat of Sanhuanpao Wetland, so that Sanhuanpao Wetland is threatened by degradation, and the ecological balance is also compromised[9].

During the course of the investigation, it is found that there is still fishing in the protected area. There are wild fishes sold in the market, and some farmers live around the protected area and raise poultry in the protected area, feeding on the small premature fish.

These are the factors affecting the structure and diversity of fish communities in Sanhuanpao Wetland. We conducted a basic investigation aimed at paving the way for in-depth investigation and study of fish in Sanhuanpao Wetland.

5 The factors that affect the fish resources in Sanhuanpao Wetland

Human disturbance and agricultural production are the main factors affecting the fish resources in Sanhuanpao Wetland.

During the investigation, by visiting various farmers' markets in Fujin City, it is found that the phenomenon of unauthorized trafficking in wild fish is often seen, and it is the wild fish caught

from the wetlands by the confirmation, including Carassius auratus gibelio, Misgurnus mohoity, Silurus asotus and Perccottus glenii. Water pollution and habitat destruction are also important factors affecting the fish resources, and the protection of fish habitat is also an important way to protect fish resources, so as to achieve sustainable use of fish resources.

In recent years, the intensified farmers' activities, the discharge of agricultural waste water and other factors have caused an increasingly serious damage to the ecological environment of Sanhuanpao Wetland, so that the water quality in the protected area is obviously deteriorated. The unreasonable fishing will cause some harm to the fish. These issues should cause the attention of the relevant departments.

6 Resource protection measures

Sanhuanpao Wetland is a habitat and stopover for fishes, birds and amphibians, and fishes are the main source of food for the migratory birds.

Therefore, in order to protect the supply of avian food, it is recommended that fishing should be prohibited in the protected area, which can not only protect the ecological structure of fish communities in protected area, but also be conducive to the recovery and expansion of bird populations.

It is also necessary to implement strict control of water pollution in the protected area, and control the farmland wastewater into the protected area from the source. There is a need to persuade the local farmers to return farmland to wetland, to ensure that the wetland environment can be optimized, and is no longer subject to pollution.

The government departments should regularly organize the wetland protection publicity in the countryside, so that the farmers' awareness of protecting wetlands is gradually increased.

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