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INVESTIGATION OF THE ROLE OF WETLAND FAUNA IN MANAGING AQUATIC ECOSYSTEMS

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Abstract: Wetland animals are crucial to the improvement of wetland water quality and ecological stability. This paper briefly describes the main characteristics of wetland animals including wetland birds, fish, amphibians, reptiles and zooplankton, summarizes the main functions of wetland animals in water quality purification, water environment biological monitoring and maintaining water ecological balance, and puts forward the wetland Strategies for animal protection, and suggestions and prospects for future research and development of wetland animals.
Keywords: Wetland animals; Water environment management; Water quality purification; Biological monitoring

1 WETLAND ANIMAL SPECIES

Wetland is one of the important ecosystems in nature on earth. It has ecological functions such as improving water quality, water storage and flood interception, and is known as the "kidney of the earth" [1]. In recent years, the deterioration of water environment quality has become increasingly serious. Wetlands have attracted much attention in the field of water environment management because of their various service functions such as improving regional water environment quality.

Wetland animals play an important role in wetland water environment management [2]. Wetlands have unique natural landscapes and contain many types and quantities of wetland animals [3]. Rich wetland animal resources are conducive to improving wetland water quality and maintaining the long-term stability of wetland water ecology.

Current research and reviews on wetland organisms in water environment management mostly focus on wetland plants and microorganisms [4]. In contrast, there are fewer studies on wetland animals and no review reports. This article reviews the main animal species in wetlands, summarizes the functions of wetland animals in water quality improvement, water quality biological monitoring, and maintaining the stability of wetland aquatic ecosystems, proposes wetland animal protection strategies, and makes contributions to their research on water environment management.

Wetlands broadly refer to artificial or natural peat, swamps, etc. with a certain water body. They also include shallow sea areas where the low-tide water depth does not exceed 6 m, and are widely distributed [5]. Wetlands are the transition zone between aquatic ecosystems and terrestrial ecosystems, and are rich in animal species.

Wetland animals mainly include wetland birds, amphibians and reptiles, fish and zooplankton. These animals are closely related to the quality of wetland water environment [6]. Table 1 is the basic situation of these wetland animals in my country.

Table 1 Wetland animal species

Main wetland animals	Definition and Characteristics	Number of wetland animal species in my country (National key protected animal)
wetland birds	Also known as wetland waterbirds, they refer to birds whose life activities depend entirely or partially on wetlands and are adapted to wetlands in form and behavior; my country's wetland waterbirds are mainly migratory birds and traveling birds.	12 orders, 32 families, 271 species (10 orders, 18 families, 56 species)
reptiles	Typical wetland animals, cold-blooded vertebrates evolved from amphibians, fully adapted to terrestrial life	122 species in 3 orders, 13 families (12 species in 3 orders, 6 families)
Amphibians	Amphibians are all wetland animals, cold-blooded vertebrates that rely on water bodies for reproduction. The aquatic larvae use gills to breathe, and after metamorphosis, they become adults that use lungs to breathe.	300 species in 3 orders, 11 families (7 species in 2 orders, 3 families)
wetland fish	Most of them are ectothermic aquatic vertebrates; wetland fish in my country account for one-third of the number of fish species in my country, with more than 1,000 species	Inland fish species include: 770 species in 13 orders, 38 families
Zooplankton	Small heterotrophic invertebrates or chordates that float in water and primarily feed on phytoplankton	—

2 WETLAND ANIMALS IMPROVE WETLAND WATER PURIFICATION CAPABILITIES

Wetland animals directly remove water pollutants through adsorption and enrichment, or use life activities to optimize the habitat and distribution of microorganisms and plants, indirectly improving the absorption and degradation efficiency of pollutants. Wetland animals also control the number of algae and other plants in the wetland through predation and competition, reducing risks to the water environment.

2.1 Adsorption and Enrichment of Water pollutants

Wetland animals themselves can directly adsorb and enrich water pollutants [7]. In the study of Sun et al., it was found that zooplankton can directly enrich microplastics in the water body, and the average enrichment amount reached (12. 24 ± 25. 7) pieces/m3 [8]; in the study of Park et al., oysters were used The shell is used as a wetland matrix to absorb pollutants, and the TN and TP removal rates are 85. 7% and 98. 3%, indicating that the mollusk shell has an obvious adsorption effect on N and P in the water [9]. Animals at high trophic levels are enriched through the food chain [7]. Research by Dong Yuanhua and others shows that night herons enrich DDT in water bodies through the food chain, and the concentration of DDT detected in their eggs is more than 10,000 times higher than that in the water environment [10].

2.2 Improve Wetland Microhabitat

Through disturbance, wetland animals improve the water microenvironment, optimize the distribution of plants and microorganisms, and indirectly improve the water purification effect of wetlands [11]. At present, there are many studies on benthic animals in this aspect [12].

Benthic animals mainly live in the sediment layer at the bottom of the water, and have a significant impact on the diffusion of materials and microbial communities in the sediment layer. In the study of Niemistδ et al., benthic animal activity increased the oxygen absorption of the sediment layer by 33% to 35% and reduced the NH3-N release by 48%, which had a significant impact on the nutrient distribution of the water body [13]; in the study of Papaspyrou et al. In the study, the bacterial abundance in the cave produced by the two benthic animals was 1.8 and 2.3 times that of the surrounding area, respectively, and the mineralization rate of organic matter in the cave increased [14].

2.3 Reduce Water Environment Quality Risks

Wetland eutrophication will lead to the explosive growth of wetland algae and phytoplankton, and the rapid deterioration of water quality. Wetland animals can prey on algae and phytoplankton, control their numbers, and reduce the risk of eutrophication of water bodies [15].

Wetland herbivorous fish play the most significant role in this aspect [15]. Data show that releasing more than 500 million silver carp and bighead carp in the Taihu Lake wetland to control eutrophication consumes about 6.58 million tons of algae and reduces the density of phytoplankton by an average of 42.67%; it is estimated that the input-output ratio of the project is about 1:10, good economic benefits [16].

Wetland animals also reduce the risk of biological invasion by preying on invasive plant species. In the research of Wang Xiaoping and others, the predation effect of grass carp reduced the relative growth rate of Eichhornia crassipes by 68.3%, avoiding the water pollution caused by the wild growth of Eichhornia crassipes. Ecological damage[17].

2.4 Animals and Plants Jointly Purify Water Quality

The combination of animals and plants for water body restoration is an effective wetland water environment restoration strategy. Table 2 summarizes the effect of wetland animals and plants jointly purifying water bodies.

Table 2 Water quality purification effect of wetland animals and plants combined

Animal and plant combination	water type	Permanganate index reduction/%	TN removal rate/%	TP removal rate/%	Algae density reduction/%	Chlorophyll a reduction/%	other	refer to literature
Aquatic plants + silver carp: bighead carp = 4: 1	Reservoir water body	48	about 70	about 74		61.4		[18]
Eichhornia crassipes + grass carp	Tap water + lake water		66	58			Eichhornia biomass (-50. 8%)	[17]
Silver carp: bighead carp = 3: 1	Reservoir water body	6. 9～22. 4	8. 9～32. 1	14. 6～29. 7	48.4～69.3			[19]
Water hyacinth + silver carp	Eutrophic water body		41. 52	40.86	83.2			[20]
Water peanut + silver carp	Eutrophic water body		32.2	41.94	79.3			
Silver-grained cattail + silver carp and bighead carp + triangular clam	Eutrophic river water	35	60.7	43.7		38.2		[twenty one]
Blood grass + silver carp and bighead carp +	Eutrophic river water	42.5	55.2	37.2		44.3		

spinnaker clam							
Pear-shaped ring snail	Breeding pond		32.88	75.7	80		[twenty two]
Water spinach + silver carp and bighead carp + pomfret	lake water	31.3	48.8	35.3	33.5		[twenty three]
Water spinach + silver carp and bighead carp + spinnaker clam	lake water	37	46.5	47.1	55.3		
Water spinach + silver carp and bighead carp + pomfret + spinnaker clam	lake water	41.2	55.7	44.7	58.5		
Waterwheel front + hornwort + sturgeon	Breeding pond		12.53			Heavy metal lead (-34. 48%)	[twenty four]

Wetland fish and benthic animals live entirely in the water and are closely related to aquatic plants. Their breeding, release and collection are relatively easy and have economic value. They are the main animal species used in wetland water animal restoration.

3 WETLAND ANIMALS ARE USED FOR BIOLOGICAL MONITORING OF WATER QUALITY

Wetland animals are highly sensitive to the environment. Monitoring water quality by observing their performance traits is an effective way to quickly discover and confirm wetland water environment problems [25].

3.1 Monitoring Water Quality Using Wetland Animal Behavior

Pollution of the wetland water environment will cause stress reactions in animals and affect their behavior. Fish are the most commonly used animals in wetland water body behavior monitoring. Li Zhiguo designed an online monitoring system for flowing water bodies that uses the fluctuations of low-voltage and high-frequency electric fields to reflect the intensity of the killifish's avoidance behavior against polluted water bodies; the system detects 0.4 mg/L dinitrochlorobenzene at 60 min alarm (surface Class III water standard 0.5 mg/L), and also successfully analyzed the alarm concentrations of 7 other heavy metals and 11 refractory organic compounds at 10, 30 and 60 min [26].
There are also researchers who use fish chasing behavior to establish a behavioral monitoring system, and use fish head and tail image recognition methods to reduce the difficulty of identification, etc. [27, 28]. In addition to fish, there are also researchers monitoring wetland water environment quality through the behavior of birds and other wetland animals [29].

3.2 Monitoring Water Quality Using Community Structure

Environmental changes have a great impact on changes in the structure and quantity of wetland animal communities [30]. Therefore, changes in the structure and quantity of wetland animal populations or communities can be monitored for changes in wetland water quality. Wetland zooplankton has a simple structure and weak migration ability. Its community structure can usually sensitively reflect the quality of the water environment, and it is the most commonly used animal species for wetland water quality monitoring [31]. In the research of Hu Changjing et al., various zooplankton such as crystal rotifers and bell worms were used as indicator species to determine and verify the degree of eutrophication of the water body based on dominance [32]. In the study of Li et al., it was found that the number of zooplankton is related to NH3-N and NH3-N in the water[33].

3.3 Monitoring Water Quality Using Pollutant Content in Animals

Wetland animals enrich persistent organic matter, heavy metals and other refractory substances in the water environment. The concentration of pollutants in their bodies is usually greater than that in the water environment. Therefore, the pollution status can be evaluated by measuring the pollutant content in wetland animals. Research by Dong Yuanhua and others found that the concentration of DDT in night heron eggs can reach more than 10,000 times that in environmental water bodies, and can be used for biological monitoring of wetland water environments [10].

3.4 Using Wetland Animals to Monitor Emerging Pollutants

Emerging pollutants, including persistent organic compounds (POPs), pharmaceuticals and personal care products (PPCPs), endocrine disrupting chemicals (EDCs), etc., are currently the focus of water environment management. Many studies have shown that wetland animals are highly sensitive to some emerging pollutants. Perea et al. found that polychlorinated biphenyls and DDT metabolites in pond water can affect the secretion of wax esters from blackwater chicken tail glands, and long-term exposure can cause Reduce the content of long-chain wax esters [34]. Other studies have found that these pollutants can affect the sex hormone levels of wetland animals [35-37]. In addition, Sun et al. found that zooplankton can accumulate microplastics [8].

Wetland animals have great potential as biological indicators of emerging pollutants in wetland water bodies. Exploring the correlation between emerging pollutants in wetlands and the behaviors and physical signs of wetland animals can quickly discover and grasp the pollution status of emerging pollutants in wetlands.

4 WETLAND ANIMALS MAINTAIN THE WATER ECOLOGICAL ENVIRONMENT

Wetlands contain rich animal resources. Generally, the higher the biodiversity, the stronger the stability of the wetland water ecosystem. Wetland animals are crucial to increasing wetland biodiversity and optimizing the distribution pattern of wetland ecological landscapes [38]. In the study by Correa et al., it was found that frugivorous fish can spread 52% of the fleshy fruit vegetation in the Pantanal wetland [39]. The study by Kleyheeg et al. also emphasized the impact of wetland bird propagation on the distribution of wetland vegetation patterns. importance[40].

In addition, wetland animals help maintain a good natural wetland landscape. In the study of Severiano et al., zooplankton can inhibit the growth of algae or bacteria such as cyanobacteria, control non-filamentous algal blooms, and protect wetland water landscapes [41].

5 WETLAND ANIMAL PROTECTION STRATEGIES

Wetland destruction will cause a sharp decrease in wetland biodiversity and ecological functions, and will bring about a series of environmental problems. Wetland animals, as an important part of the wetland ecosystem, are crucial to wetland protection.

Wetland habitats, including climate conditions, pH and water quality, hydrology, water flux and wetland landscape, have the most significant impact on wetland animals [42-44]. Reducing human interference in wetlands and protecting the habitats of wetland animals is the most effective way to protect wetland animals. Wetlands are seriously damaged, and wetland restoration has always attracted the attention of many researchers. Table 3 summarizes and compares several currently commonly used wetland restoration strategies.

Table 3 Comparison of three common wetland restoration strategies

Restoration of wetlands, near-natural wetlands, constructed wetlands	
	Weak Strong
degree of human intervention	Completely restore the original wetland water quality and take into account the improvement of sewage treatment and water quality improvement.
The main function	Ecology and Natural Landscapes Ecology and Landscapes
main content	The premise of completely restoring the original stability to meet human needs mainly serves human beings, and achieves new ecological stability to meet various human needs under the ecological system.
basal restoration	The original base is restored using local materials, using natural materials that are not easy to clog and absorb.
Maintenance method	Recruit materials for base improvement and restore base materials with good adhesion
	Temporary maintenance, temporary maintenance of wetlands, regular and long-term artificial restoration of wetlands
	No maintenance required after repair No maintenance required after repair Maintenance required

Traditional wetland restoration is time-consuming, costly, and prone to secondary degradation [45]. Although artificial wetlands are widely used, they cannot provide a better habitat for animals and are not the preferred strategy for wetland restoration [46]. Near-natural wetland restoration is considered a compromise wetland restoration strategy [47], which takes into account wetland ecology, landscape, habitat protection and water quality improvement, and is more in line with current environmental needs.

6 CONCLUSION

Wetland animals mainly include wetland birds, amphibians and reptiles, fish, and zooplankton; wetland animals can directly improve wetland water quality by adsorbing and enriching pollutants by themselves, and preying on excessively proliferating algae and phytoplankton. They can also improve wetland water quality by changing wetland habitats. The life activities of plants and microorganisms achieve the effect indirectly. Humans can use wetland animal behavior, community structure, and pollutant enrichment content to monitor wetland environmental quality levels, and wetland animals show enrichment and bioindicator potential for a variety of emerging pollutants such as POPs, PPCPs, and EDCs. In addition, wetland animals are very important for maintaining the stability of the wetland water ecological environment. In the future protection of wetland animals, we should also pay attention to the protection of wetland animal habitats.

However, at present, there are still many problems in the research on the water environment management functions of wetland animals: 1) A low-cost, high-efficiency, and reliable wetland biological monitoring system needs to be developed and established; 2) There is insufficient research on the use of wetland animals for water body restoration.,

mostly limited to wetland fish and benthic animals; 3) Wetland animals have shown great potential for early warning and enrichment of emerging pollutants. Research on the stress of wetland animals to emerging pollutants should be widely carried out to provide guidance for future wetland water quality evaluation. Provide more references on wetland animal protection.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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