Status of Major Invasive Fish in Chaohu Lake and Prevention and Control Strategies

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Abstract: To promote biodiversity conservation and reduce the phenomenon of biological invasion, thereby protecting the ecological balance of Chaohu Lake, this passage summarized the biological characteristics, invasion hazards and status of the main invasive fishes in Chaohu Lake at the present stage by compiling relevant literature. Prevention and control strategies were also proposed to provide reference for future management, development, and sustainable use of invasive fish in Chaohu Lake.

1. Introduction

With the deepening of global economic integration and frequent domestic and foreign trade, the presence of invasive alien organisms is increasing and the harm caused is becoming more and more serious. Biological invasion has become one of the global ecological and environmental hotspots, and is an important factor affecting the structure, function and biodiversity of the global ecosystem. In order to strengthen the management of invasive alien organisms, on February 11, 2022, China's Ministry of Agriculture and Rural Affairs drafted “Measures for the Management of Invasive Alien Species (Draft for Comments)”, which requires safeguarding the sustainable development of agriculture, forestry, animal husbandry and fisheries as well as protecting biodiversity.

Invasion of alien fish is one of the main reasons for the decline of biodiversity in freshwater ecosystems [1]. With the large-scale promotion of water conservancy projects in recent years, the invasion of exotic fish caused during the construction and operation of the projects has received more and more attention. Invasion of exotic fish is an ecological phenomenon in which a certain kind of fish enters a new habitat from its origin under the influence of human activities, and gradually occupies the habitat through settlement, establishment and dispersal, therefore negatively affects the local indigenous fish and ecosystem [2].

As one of the five major freshwater lakes in China, the ecological management of Chaohu Lake is not only related to the ecological balance of its waters, but also affects the life of the residents in the area. By summarizing the invasion status and prevention and control strategies of several invasive fishes in Chaohu Lake, we can provide supporting materials for subsequent studies, fill the gap of the current governance status and prevention and control strategies, and lay the foundation for further research.

2. Overview of Chaohu Lake

Chaohu Lake (see in Figure 1) is located in the middle of Anhui Province between Yangtze River and Huai River, whose basin is 53 km long from east to west. The east and west ends of the lake extend to the north and the middle protrudes towards the south, forming a “concave” shape just like a bird's nest. The total length of the lake shoreline is 184.7km. The length of the lake is 54.5km, with its maximum width being 21.0km and the average width being 15.1km. The water area covers around 756.2km^2 when the water level is 7.5-7.8m, making it one of the five famous freshwater lakes in China. The river system formed from the topography and geomorphology of the Chaohu Lake valley is well developed, and is richly recharged with water. The lake area has a north

subtropical monsoon climate [3].

The fish system of Chaohu Lake is mainly composed of sedentary species, and the major famous aquatic species are silver fish, white shrimp and lake crabs, which are known as the “three delicacies of Chaohu Lake”. In addition, lake anchovy, among the fish resources, dominates the fishery production of Chaohu Lake. Furthermore, redfin, “four major Chinese carps”, cyprinoid and crucian are all high-quality fish in Chaohu Lake.

With the rapid development of social economy, the phenomenon of biological invasion is becoming more and more serious. According to relevant reports, the invasion of western mosquitofish, freshwater white pomfret and bearded worm goby in Chaohu Lake basin is becoming more and more frequent. And Chaohu Lake, as one of the five major freshwater lakes in China, its richness in water resources renders itself vulnerable to be invaded by outsiders. Therefore, in order to protect local biodiversity and reduce the degree of threat caused by exotic species to indigenous species, it is crucial to learn more about the invasive fishes in Chaohu Lake.

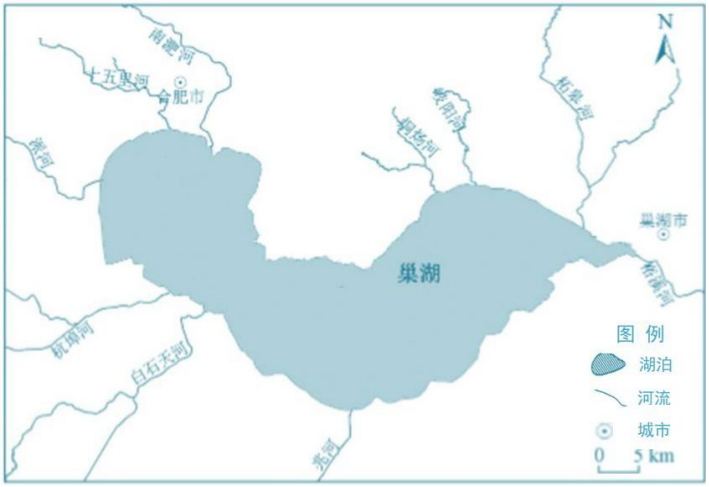

Fig.1 Chaohu Lake

3. Invasive Fish in Chaohu Lake

3.1 Western Mosquitofish

3.1.1 Biological Characteristics of Western Mosquitofish

Western mosquitofish (*Gambusia affinis*) belongs to the genus *Gambusia*, family *Poeciliidae*, order *Cyprinodontiformes*, class *Scleractinia*, and it is native to North America. This kind of fish is small in size, with a flattened head and a relatively rounded abdomen, and its body is usually silvery, sometimes with green patches and gray and black spots. It has a single dorsal fin, multiple fins, and a rounded caudal fin. It has been introduced worldwide as a mosquito-control tool because it feeds on mosquito larvae. But now, it has invaded more than 60 countries around the globe and is listed as one of the top 100 invasive species in the world [4]. In 2016, China included it in the List of Invasive Alien Species in Natural Ecosystems of China (4th batch).

3.1.2 Hazards of Western Mosquitofish Invasion

Western mosquitofish can pose a threat to indigenous fish on the invasion site. Its large-scale reproduction has caused the decline of available resources on site, thus reducing the number of indigenous species with similar ecological niches, such as the endangered indigenous species Chinese medaka. It has obvious aggressive behavior and is capable of attacking larger fish, tearing their scales, fins or other body parts. Due to its small size, western mosquitofish cannot directly prey on larger local indigenous fish and amphibians, yet it can directly feed on their larvae. As a result, These species are unable to maintain there normal population, leading to endangerment and even extinction. Moreover, the predation risk posed by western mosquitofish may cause some indigenous fishes to change their habitat selection [5].

By suppressing and crowding out indigenous species in the invaded area, western mosquitofish changes the local food chain or food web, and further affects and destroys the local water environment and the original structure and function of the ecosystem through bottom-up or top-bottom effects. It prefers zooplankton, which feeds on phytoplankton (various algae) [5]. With the successful invasion of western mosquitofish into its new habitat, the zooplankton population has lowered distinctively. Due to the decrease in predators, phytoplankton proliferates in the water column, resulting in decrease of the transparency of the waterbody and dissolved oxygen.

3.2 Freshwater White Pomfret

3.2.1 Biological Characteristics of Freshwater White Pomfret

Freshwater white pomfret (*Colossoma brach ypomum*), whose scientific name is short-covered giant fatty carp, belongs to genus *Colossoma*, family *Characidae*, order *Characiformes*, class *Actinopterygii*, and is a type of tropical and subtropical fish native to the South American Amazon River. It is one of the fishable freshwater species and possesses high edibleness and ornamental value [6]. Its appearance is similar to that of the marine pomfret: laterally flattened into a disk shape, with a thicker dorsum, a terminal mouth, no beard and a small head (the length of head equal to its height) [7]. Freshwater pomfret is an omnivorous species. It has strong and powerful teeth and a well-developed digestive system. As a result, it can feed widely, and has almost no natural enemies in freshwater water. The freshwater white pomfret was introduced to China in 1985 for research. Later on, its artificial breeding became successful.

3.2.2 The Invasion Hazard of Freshwater White Pompano

In recent years, a large number of artificially bred freshwater white pompret have entered Chaohu Lake due to flooding. With the characteristics of omnivory, fast growth, large size and not vulnerable to illness, it is especially easy to survive and can be extremely harmful to indigenous species in Chaohu Lake. Freshwater white pomfret feeds on animals such as small fish, shrimps and benthic animals, as well as plants such as water grass, vegetables and algae. In times of starvation and food scarcity, it will eat the eggs of large fish, causing a reduction in their numbers and squeezing the ecological niches of other species. Therefore, the invasion of a mass of freshwater white pomfret will cause a decrease in species biomass and near extinction of already endangered species in the waters of Chaohu Lake, resulting in ecological damage.

3.3 Bearded Worm Goby

3.3.1 Biological Characteristics of the Bearded Worm Goby

Bearded worm goby (*Taenioides cirratus*) belongs to genus *Taenioides,* family *Gobiidae*, order *Perciformes*, class *Scleractinian*, and it is a warm water small bottom fish. Its body length is generally not more than 20cm and it appears a bit like the loach. It is reddish and translucent, with funnel-like or trumpet-shaped translucent red fins on its neck and abdomen. Its needle-like eyes have already degraded, making it almost blind. The bearded worm goby mainly feeds on small fish, juvenile shrimp, copepods and other benthic invertebrates [8-9]. In addition, it prefers to inhabit mangroves, estuaries, and mudflats in inlets of tropical areas and is often hidden in caves.

3.3.2 Invasive Damage of Bearded Worm Goby

In recent years, bearded worm goby has invaded inland lakes such as Chaohu Lake, Gaoyou Lake, Dianshan Lake, Nansi Lake, etc. Its rapid reproduction and high fecundity leads to rapid population growth. Coupled with its ugly appearance, fishermen in the invaded areas often dare not eat it, so the fishing pressure it faces is relatively low. The bearded worm goby has quickly become a common species in the invaded water bodies, negatively affecting the local freshwater ecosystem [10-11]. Additionally, it is a benthic fish that often lives in caves. Since it is slightly toxic and difficult to catch, once invaded, the bearded goby is prone to proliferate and difficult to manage.

4. Status and Prospect of Management

After reviewing a large amount of relevant literature, it can be seen that in recent years, there are a large number of fish invasions in the waters of Chaohu Lake, and many exotic species exist to date. The relevant departments have carried out a series of measures, and the current management methods and solutions are as follows: Firstly, the genetic diversity of invasive fish is studied and analyzed by using molecular markers, so as to understand the survival of invasive fish in the Chaohu Lake basin in terms of genetic structure and genetic differentiation, and grasp its invasive mechanism. Secondly, the invasive fish in different geographical environments should be controlled in light of local conditions. Thirdly, the invasive fish can be captured and then made into some delicious dishes. Finally, introducing natural enemies of invasive fish that are not harmful to the local area will increase the survival pressure of invasive fish, thus achieving the goal of controlling their population [12].

As one of the important water systems in China, the ecological management and protection of Chaohu Lake is urgent from both ecological and socioeconomic perspectives. This paper takes this as a starting point to make several suggestions for the prevention and control of invasive fish in the Chaohu Lake basin: firstly, a pre-introduction survey should be conducted to investigate comprehensively the biological characteristics, ecological niches, and effects of the introduced species on the indigenous species and biological environment of the introduced area in its place of origin. At the same time, long-term small-scale anti-disturbance tests should be carried out in the introduced area to assess the impact of the introduced species and the risk of introduction, so as to avoid unpredictable ecological damage and economic loss caused by blind introduction. Moreover, it is necessary to strengthen regional inspections, improve the quarantine system, as well as enhancing the training of local managers. In addition, it is crucial to strengthen the prevention and control of existing invasive species and regular inspections. Last but not least, relevant departments need to be united for the strict control of illegal release.

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