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Temporal and spatial rules of fish eggs drifting in the upper reaches of Yangtze River and corresponding protection measures

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Abstract

The Yangtze River basin is a treasure house of freshwater fish resources in our country. As far as the upper reaches of the Yangtze River are concerned, the endemic fish account for about half of the total fish. However, with the construction of water conservancy and hydropower projects at all levels, overfishing and other human activities have caused damage to the fish resources in the upper reaches of the Yangtze River. Among them, the drifting egg-producing fish were the most affected. The study of the temporal and spatial characteristics of fish egg drifting is very important for the construction and development of ecological restoration projects in the upper reaches of the Yangtze River. In this paper, we summarize the relevant researches and conclusions of many scholars on the characteristics of fish egg drifting and their model tests in recent years, and make a detailed analysis on the motion characteristics of fish egg drifting, the temporal and spatial distribution of fish egg drifting and the influence of wading engineering on fish egg drifting. The results show that the daily variation of fish egg drift in the upper reaches of the Yangtze River is significant in terms of time law. In terms of spatial law, the horizontal distribution of egg drifting is more obvious. Finally, based on the existing research, this paper puts forward five measures to reduce the impact of water wading projects on the drift of fish eggs and larvae in the upper reaches of the Yangtze River.

Keywords

Egg drift, Upper reaches of Yangtze River, Wading project, Space-time law.

1. Introduction

The Yangtze River Basin is one of the most abundant freshwater fish germplasm resources in China, with a total of more than 378 species of freshwater fish, including more than 149 species of endemic fish, which is the largest natural freshwater fish germplasm bank in China, and has extremely important scientific research and conservation value. As far as the upper reaches of the Yangtze River alone are concerned, there are more than 267 species of subspecies of fish, of which there are as many as 117 species of endemic fish in the upper reaches of the Yangtze River, accounting for nearly 45% of the total number of fish in the upper reaches, and its proportion of endemic fish is the highest in the national waters. However, in recent years, human activities such as the development of water conservancy hubs at all levels, the construction of waterway regulation projects, and the overfishing of various fish resources have greatly changed the original hydrological situation of rivers, thus hindering the production and reproduction of fish or the migration of bait, resulting in a sharp decrease in the number of fish. Nowadays, in order to strengthen the protection of fish resources in the upper reaches of the Yangtze River, many ecological habitat restoration projects have been proposed. In the upper reaches of the Yangtze River, most of the floating fish eggs were hatched in the process of drifting with the current. The water flow path, water quality conditions, seasonal changes of

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water flow conditions and drifting distance of fish eggs will directly affect the success or failure of fish eggs hatching.

This paper analyzes the history and results of many scholars' investigation and research on fish resources in the upper reaches of the Yangtze River, summarizes the temporal and spatial rules of fish larvae drifting in the upper reaches of the Yangtze River, and puts forward measures to reduce the impact of wading projects on drifting fish eggs.

2. Time and space law of fish eggs drifting

2.1. The time pattern of fish eggs drifting

In the upper reaches of the Yangtze River, the floating time of fish eggs and larvae basically presents the characteristics of daily change and uneven distribution of day and night. The daily variation of fish spawn drift is mainly due to the daily variation of water level, transparency and river runoff. In the study of the spatial and temporal distribution characteristics of early fish resources in the Jiangjin River section of the upper reaches of the Yangtze River, the peak value of fish larvae appeared three times in the Jiangjin River section during the monitoring process, respectively from May 13 to 15, and the average density of eggs and seedlings was 26.3ind / $100m^3$. From June 2 to 4, the average density of eggs and seedlings was 19.9ind / $100m^3$. From June 7 to 10, the average density of eggs and seedlings was 18ind / $100m^3$. The average density of fish eggs and larvae flowing through Jiangjin Section of the upper reaches of the Yangtze River from May to July was 9.36ind / $100m^3$, and the maximum density was 37.73ind / $100m^3$. Compared with the diurnal variation of fish egg and larvae drifting, the uneven distribution of fish egg and larvae density between day and night is not particularly significant, which is mainly manifested by the diurnal variation of egg and larvae density. No significant difference was found in the egg density calculated between the south bank and the north bank during the normal water period.

2.2. The spatial law of floating fish eggs.

The spatial law of fish eggs and larvae drifting in the upper reaches of the Yangtze River can be divided into horizontal distribution law and vertical distribution law.

As far as the horizontal distribution rule is concerned, there are many reports on the horizontal distribution of passively drifting fish eggs and larvae. Some relevant studies show that the drift density along the coast is obviously higher than that in the river, and sometimes the drift density in the river is much higher than that along the coast, which has a great relationship with the distribution of river morphology and velocity and even the development period of the fish eggs and larvae collected.

used markers to study the drifting mode of drifting fish eggs in the upper reaches of the Yangtze River, and the corresponding conclusion was drawn from the experiment: excluding the influence of weak swimming ability of early larvae, the drift density distribution caused by channel morphology and hydraulics is higher in the mainstream waters of the river than in the coastal still water area. The experiment conducted in Jiangjin Section of the upper reaches of the Yangtze River shows that there are significant differences in the density of fish eggs and larvae between the two banks and the middle of the river, which is more than that in the middle of the river. The reason for this difference can be attributed to the rapid flow of the upper reaches of the Yangtze River and the large sediment content.

Compared with the horizontal distribution of fish eggs and larvae, the vertical distribution is not so significant, which can be attributed to the complex hydrological conditions in the upper reaches of the Yangtze River and the fish eggs and larvae themselves. Because the fish that produce drifting eggs usually absorb water rapidly and expand after production, forming a large peri-egg space, so that the proportion of eggs is slightly greater than that of water, and it

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must not sink in an environment with a certain flow rate. Zhang Xianbing et al. studied the stillwater settling characteristics of drifting fish eggs from Yibin to Fengdu River in the upper reaches of the Yangtze River, collected the drifting fish eggs, measured the particle size and density of the eggs, and then measured the stillwater settling velocity of the fish eggs by using settling column and PTV particle tracking velocity measurement technology.

3. The corresponding protection measures are put forward

3.1. Construction of ecological channel

First of all, in the construction of wading projects, we should choose a scientific and appropriate time to carry out engineering construction, try to avoid the breeding season of fish or the drifting time of fish eggs, and greatly reduce the disturbance of the movement of drifting fish eggs and habitat destruction. Secondly, the setting of ecological channels should be fully considered to ensure the smooth passage of fish eggs and seedlings through the engineering area, ecological channels can use fish channels, imitation natural side channels, fish gates, fish elevator, fish collection system and other technical means to help fish eggs and seedlings smoothly through the engineering area, so as to ensure the continuity of its drifting process.

3.2. Improve ecological scheduling

For wading projects involving reservoirs, scientific and reasonable reservoir operation should be carried out to ensure that the storage and release of water in the reservoir will not adversely affect the drift process of fish eggs and larvae. When storing and releasing water, it is necessary to make reasonable arrangements according to the breeding season of fish and the law of drifting, and minimize the current impact and drifting distance. Dai Lingquan et al. proposed a long-short-term coupled double-layer optimal scheduling model in their study on ecological scheduling of cascade hydropower stations that took into account the spawning needs of four major fish. Long-term optimal scheduling could make overall scheduling plans, while short-term optimal scheduling focused on short-term benefits. For four major fish spawning, an optimal scheduling method with daily intervals was developed. A multi-objective long-short-term coupled double-layer model of cascade hydropower station was constructed, which took into account the spawning and breeding of four downstream rivers, and the daily time-scale variation of water level and discharge of cascade reservoir was proposed.

3.3. Artificial proliferation and release

In order to reduce the impact of wading projects on drifting fish eggs, artificial breeding and release can also be used to restore and repair the corresponding method, that is, artificial means are used to supplement a certain number of fish fry in a certain fish habitat waters, in order to protect and restore its population. Artificial breeding and release need to understand the natural conditions of the water area and the current situation of fish resources, and need to study the domestication technology of parent fish, oxytocin hatching technology, seed cultivation technology, release and effect evaluation technology. At the same time, artificial breeding and release measures can also solve the problem of fish migration.

3.4. Other comprehensive measures

As a supplement to the above measures, the corresponding comprehensive measures can also effectively reduce the impact of wading projects on drifting fish eggs, for example, in the construction of wading projects, increase project investment, improve the quality of engineering projects at the same time, but also to ensure that the relevant protection measures are put in place. Secondly, due to the complex hydrological situation in the upper reaches of the Yangtze River, long-term monitoring of the ecological environment and fish resources in the

corresponding basin can provide a solid theoretical and factual basis for the scientific formulation of ecological protection plans.

4. Conclusion

The study on fish spawn drift in the upper reaches of the Yangtze River will help us to have a clearer understanding of the temporal and spatial distribution of fish spawn drift in the upper reaches of the Yangtze River and make more specific analysis and judgment on the protection of fish resources in the upper reaches of the Yangtze River and the reduction of the impact of wading structures on the drifting fish spawn. Therefore, the correct understanding of the temporal and spatial distribution of fish eggs drifting is of great significance for the planning, design and construction of water conservancy and hydropower projects and the restoration of natural habitats in the upper reaches of the Yangtze River. This paper mainly summarizes a series of research results of many scholars in recent years, which are roughly divided into two parts: characteristic study and model test study. From the aspects of distribution density of drifting fish eggs and larvae, natural hydrological conditions of the reach of the Yangtze River, and the impact of wading projects on fish resources, a variety of numerical simulation methods and model layout schemes for the study of drifting fish eggs and larvae are analyzed.

From the most basic theoretical analysis to physical experiment verification, as well as the methods based on big data and computer numerical calculation, the relevant research and model test research on the space-time characteristics of fish eggs and larvae drifting in the upper reaches of the Yangtze River are constantly moving forward. People use their wisdom to constantly understand nature, adapt to nature, and finally live in harmony with nature. Therefore, it has broad application prospect and scientific value to study the drift characteristics of fish eggs in the upper reaches of Yangtze River and reduce the influence of wading projects on them.

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