

# Research Progress on Issues Faced by Aquaculture Animals in High-Temperature Seasons

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**Abstract:** The intensification of global climate change has made the impact of high-temperature seasons on aquaculture increasingly significant. Aquaculture animals face a series of physiological, ecological, and behavioral challenges in high-temperature environments. These issues not only affect their growth, development, and reproductive capabilities but also lead to large-scale mortality. This article reviews recent research progress on the impact of high-temperature seasons on aquaculture animals, focusing on the mechanisms of how high temperatures affect major cultured species such as fish, shrimp, and shellfish, and summarizes strategies and methods to address the problems faced by aquaculture animals during high-temperature seasons.

**Keywords:** High-Temperature Season; Aquaculture Animals; Physiological Stress; Aquaculture Management Measures

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## Introduction

Global climate change has led to an increase in the frequency of extreme weather events, the extended durations and increased intensity of high-temperature seasons, which have posing unprecedented challenges to the aquaculture industry. Aquaculture animals are highly sensitive to environmental changes, high temperatures can directly affect their survival and may also indirectly impact their health by altering the physicochemical properties of the water body. Therefore, studying the impact of high-temperature seasons on aquaculture animals and their countermeasures is of great significance for ensuring the sustainable development of the aquaculture industry.

## 1. The Impact of High Temperature on Aquaculture Animals

### 1.1 Physiological Stress Response

The metabolic rate of aquaculture animals may increases significantly In high-temperature environments, triggering a series of complex physiological stress responses. Specifically, fish may exhibit a range of clear physiological changes when faced with high temperatures, such as a marked increase in respiratory rate. This is because high temperatures reduce the dissolved oxygen in the water, and fish need to breathe faster to obtain enough oxygen. High temperatures can also decrease the appetite of fish, leading to a reduced demand for food and a decrease in the amount consumed. Additionally, their growth rate may be negatively affected, for the high-temperature environments can inhibit the normal growth rate of fish.

In addition, high temperatures can also have adverse effects on the immune system of aquaculture animals, leading to a decline in immune function. A weakened immune system makes aquaculture animals more susceptible to pathogen invasion, thereby increasing the risk of disease. This not only affects the health and survival of aquaculture animals but also poses economic losses to the entire aquaculture industry. Therefore, maintaining suitable water temperatures during the aquaculture process is crucial to ensure the health of the animals and the sustainable development of the aquaculture industry.

### 1.2 Ecological Niche Changes

During the high-temperature season, the dissolved oxygen content in the water body often decreases significantly. This is mainly because high temperatures accelerate the escape of oxygen from the water, and at the same time, high temperatures also increase the metabolic activity of microorganisms in the water, further consuming dissolved oxygen. This reduction in dissolved oxygen can lead to water quality deterioration, which is specifically manifested by accelerated decomposition of organic matter in the water body, producing a large amount of harmful substances, such as ammonia nitrogen and hydrogen sulfide. The deterioration of water quality has a severe impact on the living environment of aquaculture animals, thereby affecting their ecological niche.

For species that have higher requirements for temperature and dissolved oxygen, the environmental changes in the high-temperature season may beyond their physiological adaptive. These species may not be able to breathe and metabolize normally in an environment with

low dissolved oxygen, leading to increased survival pressure. As their living environment deteriorates, the living range of these species may gradually shrink, and they may even risk to extinction. Therefore, the impact of the high-temperature season on aquatic ecosystems cannot be ignored, and appropriate measures need to be taken to mitigate and respond to these environmental changes in order to protect the biodiversity of aquatic life and the health of the ecosystem.

### **1.3 Decreased Reproductive Capacity**

High-temperature environments can have a significant negative impact on the reproductive capacity of aquaculture animals, which is particularly evident in many fish species. Under high-temperature can change the reproductive cycles of many fish, causing them to spawn earlier or later than usual. Furthermore, some fish may lose their reproductive capacity entirely under its influence. This alteration in the breeding period does not only affect the aquaculture yield of that year but also poses a potential threat to the long-term survival of the entire population. The disruption of the breeding period can lead to a decrease in hatching rates of fish fry, which in turn affects the quantity and quality of the next generation. Ultimately, this could lead to a reduction in population numbers and even the risk of extinction. Therefore, protecting the aquatic environment and preventing excessive warming is of vital importance for maintaining the reproductive capacity and population health of aquaculture animals.

## **2. Coping Strategies and Management Measures**

### **2.1 Aquaculture Environment Regulation**

To ensure that aquaculture animals can thrive and reproduce under optimal growth conditions, the regulation of the aquaculture environment is particularly important. During the season of high-temperature, aquaculture animals are often affected by heat stress, leading to slow growth, decreased immunity, and even mass mortality. Therefore, improving the aquaculture environment can effectively mitigate the adverse effects of high temperatures on aquaculture animals.

Firstly, increasing the circulation and exchange of water bodies is one of the important means of regulating the aquaculture environment. By installing efficient water pumps and pipeline systems, the continuous flow of water can be promoted, thereby carrying away excess heat and maintaining stable water temperatures. In addition, regularly replacing part of the aquaculture water body and introducing fresh water sources also helps to reduce the overall water temperature, providing a more comfortable living environment for aquaculture animals. Secondly, using shading nets or cooling systems is another effective method of cooling. Shading nets can be directly covered above the aquaculture ponds to block the direct sunlight, reducing the heat absorbed by the water body. Cooling systems can directly lower the water temperature through mechanical refrigeration, which is especially suitable for areas with prolonged high temperatures. These two methods can be selected and used in combination according to the actual aquaculture environment and economic costs. Lastly, the use of oxygenation equipment is also an indispensable part of regulating the aquaculture environment. High temperatures can lead to a decrease in the dissolved oxygen content in the water body, and aquaculture animals are prone to stress reactions and even suffocation in an oxygen-deficient environment. By installing oxygen pumps, aerators, and other equipment, the dissolved oxygen content in the water body can be significantly increased, ensuring that aquaculture animals can obtain sufficient oxygen supply under high-temperature conditions, thereby maintaining normal physiological activities.

In summary, by comprehensively applying methods such as increasing water circulation and exchange, using shading nets or cooling systems, and oxygenation equipment, the aquaculture environment can be effectively improved. This alleviates the impact of high temperatures on aquaculture animals, promotes their healthy growth, and enhances aquaculture efficiency and economic benefits.

### **2.2 The Importance of Breed Improvement and Selection**

Breeding heat-tolerant varieties or conducting genetic improvements to cultivate aquaculture species that can adapt to high-temperature environments is a long-term strategy to address the challenges of high-temperature seasons. This strategy not only helps to increase the survival rate of aquaculture animals but also ensures the stable development of the aquaculture industry. Moreover, selecting breeds suitable for cultivation during the high-temperature season is also an effective method to improve the success rate of aquaculture. It is possible to ensure that aquaculture animals maintain good growth conditions in high-temperature environments by scientific selection and breeding, thereby enhancing the overall economic benefits of the aquaculture industry. Therefore, breed improvement and selection hold significant strategic importance in meeting the challenges of high-temperature seasons.

### **2.3 Innovation in Aquaculture Models**

Adopting new types of farming models has become an important development trend in the field of aquaculture. For instance, innovations such as multi-tiered farming and recirculating aquaculture systems (RAS) can effectively control and optimize the farming environment. These advanced aquaculture technologies can significantly reduce the negative impacts of high temperatures on aquaculture animals. Multi-

tiered farming maximizes the use of vertical space by setting up multiple layers of farming tanks within a limited area, increasing the production per unit area. Recirculating aquaculture systems, on the other hand, maintain water quality stability by recycling water resources and reducing water pollution, thereby providing a more suitable growth environment for aquaculture animals.

In addition to adopting new aquaculture models, arranging farming density and feeding strategies reasonably is also crucial. Excessive farming density can lead to insufficient dissolved oxygen in the water and water quality deterioration, which in turn increases the stress response in aquaculture animals and reduces their immunity. Therefore, scientifically controlling the farming density to ensure that each animal has enough space and resources is one of the effective ways to alleviate the stress of high temperatures. Moreover, reasonably arranging feeding strategies and adjusting the type and quantity of feed according to the growth stage and seasonal changes of aquaculture animals can meet their nutritional needs while avoiding water quality deterioration caused by overfeeding.

In summary, The efficiency and quality of aquaculture can be significantly improved by adopting new aquaculture models and scientific management strategies, while effectively addressing environmental pressures such as high temperatures and ensuring the healthy growth of aquaculture animals.

### 3. Conclusion

In conclusion, the impact of high-temperature seasons on aquaculture animals is multifaceted, involving physiological, ecological, and behavioral aspects. By conducting in-depth research on the mechanisms of how high temperatures affect aquaculture animals and combining this with integrated measures such as aquaculture environment regulation, breed improvement and selection, and innovation in aquaculture models, the challenges posed by high-temperature seasons can be effectively met, ensuring the sustainable development of the aquaculture industry.

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