# Eutrophication impact on lake fish diseases

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**Abstract**

Eutrophication is a serious environmental issue affecting many freshwater ecosystems worldwide. It occurs when excess nutrients, such as nitrogen and phosphorus, enter the water body, leading to growth of algae and other aquatic plants. Although it appears to be a harmless natural process, eutrophication can significantly impact physical, chemical, and biological properties of lake ecosystems. One of the most concerning effects of eutrophication is its impact on fish diseases. This essay will examine the relationship between eutrophication and fish diseases and discuss strategies to mitigate its effects.

**Keywords:** Fish diseases, Impacts of Eutrophication, Environmental issues, Biological characteristics

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## Introduction

Eutrophication is a complex process that occurs when excess nutrients enter a water body, increasing the growth of algae and other aquatic plants. This increase in plant growth can negatively impact water quality and aquatic life (Kies, 2018; Kies *et al*., 2020). As algae and plants die and decompose, they consume oxygen, leading to oxygen depletion in the water. This can result in fish killings and other negative impacts on aquatic life (Abu-Elala *et al*., 2016). Additionally, excess nutrients can promote the growth of harmful algal blooms, releasing toxins harmful to fish and other aquatic species. A lake ecosystem's physical, chemical, and biological characteristics can also change due to eutrophication, leading to a decrease in water clarity, an increase in sedimentation, and a shift in the composition of the aquatic community (Fig. 1).

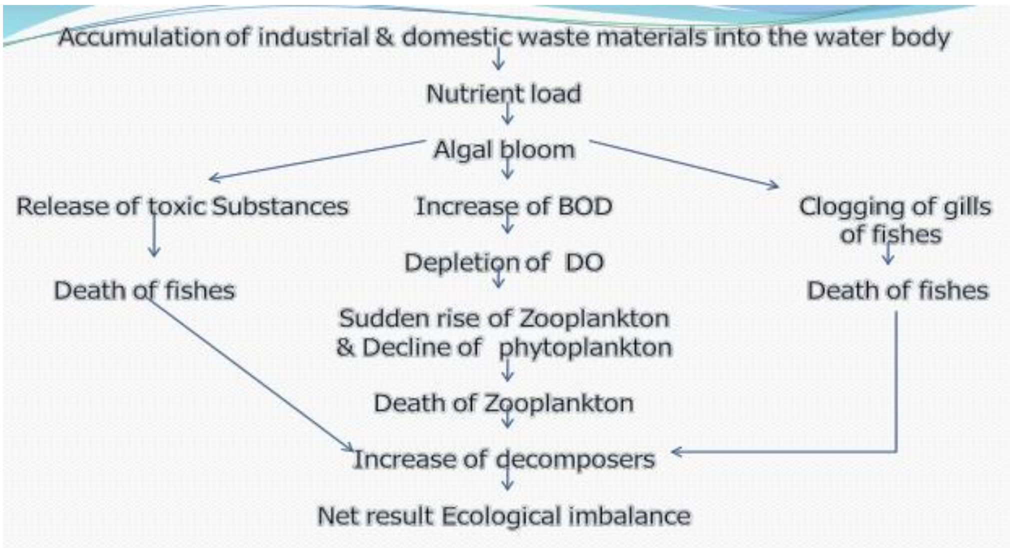


**Figure 1: Flow chart of eutrophication (Chakrabarti, 2018).**

Fish diseases are a widespread problem in freshwater ecosystems, and their prevalence and severity can be affected by eutrophication. Eutrophication can increase the risk of fish diseases in several ways. First, nutrient pollution can promote the growth of harmful algal blooms, releasing toxins harmful to fish and other aquatic species (Kazmi *et al*., 2022). These toxins can cause a range of health problems, including skin irritation, respiratory distress, and even death. Second, eutrophication can lead to a decrease in water quality, which can weaken fish's immune systems and make them more susceptible to infections. Finally, eutrophication can alter the food web of a lake ecosystem, leading to changes in the abundance and distribution of fish species and their prey (Jenny *et al*., 2020).

*What is eutrophication and how does it affect lake ecosystems?*

Eutrophication is a process that occurs naturally by nutrient accumulation in lakes or bodies of water or can be accelerated by human activities that increase nutrient input into the water (Smith and Schindler, 2009; Devlin and Brodie, 2023). The N:P ratio determines whether the water body is nitrogen or phosphorus-limited, and algal growth is limited by the available supply of either phosphate or nitrate (Van Cappellen, 2023).

As a result, eutrophication causes an increase in algae in lakes, leading to scum formation, which decreases recreational value and clogs water-intake pipes[1]. Algae blooms reduce the population of submerged aquatic plants in the lake, decreasing the overall fish population and increasing the algal population[2]. Decaying mats of dead algae can produce foul tastes and odors in the water and consume dissolved oxygen, sometimes causing fish kills (Chakrabarti, 2018). Eutrophication also causes a reduction in the area covered by submerged aquatic plants in the lake, leading to a decrease in dissolved oxygen levels in water bodies (Withers *et al*., 2014; Dai *et al*., 2023). Low oxygen conditions can cause deep-water living fish to come to open water, resulting in hybridization with open-water fish and decreasing fish community diversity[3]. Oxygen depletion in eutrophic lakes makes it difficult for fish populations to survive, and highly eutrophic lakes are dominated by ferocious fish species such as carp, which are more adapted to poorly oxygenated environments and are voracious predators of zooplankton (Abu-Elala *et al*., 2016).

Eutrophication also affects lake ecosystems by altering the nutrient balance and leading to the overgrowth of algae and other aquatic plants, which can contain toxic algae. Toxins produced by algae can harm water consumers, including humans (Kazmi *et al*., 2022). The source and effect of eutrophication can pose challenges for aquaculture (Withers *et al*., 2014). Phosphorus fertilizer has contributed to the eutrophication of freshwater ecosystems, and the reduction of external P loading to surface waters through conservation programs has not resulted in significant water-quality improvements. Remobilization of accumulated legacy P within the terrestrial aquatic con can help explain the lack of water-quality response. Overall, eutrophication negatively affects lake ecosystems (Smith and Schindler, 2009; Devlin and Brodie, 2023).

*How does eutrophication contribute to the occurrence and severity of fish diseases in lakes?*

One of the most significant negative impacts of eutrophication on lake ecosystems is the loss of available

[1] Eutrophication: A powerful poison to aquatic life - eFolio. (n.d.) Retrieved November 10, 2023, from www.efolio.soton.ac.uk

[2] Eutrophication Can Have a Harmful Effect on Dissolved .... (n.d.) Retrieved November 10, 2023, from www.fishsens.com

[3] Eutrophication Can Have a Harmful Effect on Dissolved .... (n.d.) Retrieved November 10, 2023, from www.fishsens.com

oxygen, known as anoxia (Van Cappellen, 2023). This is particularly harmful to fish populations, as it can result in fish kills and the death of species that require prominent levels of dissolved oxygen (Ina-Salwany *et al*., 2019; Peng *et al*., 2023). Additionally, eutrophication alters the entire biological structure of a lake ecosystem, including the physico-chemical conditions that regulate fish health (Ina-Salwany *et al*., 2019; Jacobson *et al*., 2017). The increasing levels of nutrients in the water adversely affect the fish species inhabiting it, leading to death and migration of survivors (Zymaroieva *et al*., 2023). Furthermore, the decreasing trend of the overall fish population along with the rising algal population as oxygen levels drop is one pronounced impact of lake eutrophication (Abu-Elala *et al*., 2016).

This is particularly concerning for aquaculture operations, as eutrophication can cause dissolved oxygen to crash, directly threatening their success (Withers *et al*., 2014). Additionally, pelagic fish species are more resistant to eutrophication compared to benthopelagic species. The economic impacts of eutrophication can also be significant, with commercial shellfisheries losing millions of dollars annually due to its effects on aquatic ecosystems (Smith and Schindler, 2009).

Eutrophication poses a significant threat to the health and survival of fish populations in lakes, highlighting the need for effective strategies to manage and prevent its occurrence (Zymaroieva *et al*., 2023). Significant increases in algae caused by eutrophication also harm water quality, food resources, and decrease the oxygen that fish, and other aquatic life need to survive (Abu-Elala *et al*., 2016; Wang *et al*., 2021).

What are the specific fish diseases that are commonly associated with eutrophication?

Eutrophication, the excessive enrichment of water with nutrients, has been linked to a variety of negative impacts on lake ecosystems, including increased incidence of fish diseases. The overabundance of nutrients, such as nitrogen and phosphorus, fuels the growth of algae and other aquatic plants. This leads to decreased water clarity and reduced oxygen levels, creating conditions that are conducive to the proliferation of pathogens and parasites that can harm fish[2].

The impact of eutrophication on invertebrate biodiversity in lakes can be explained by how excess nutrient levels caused diversity loss of diversity, community simplification, and zoobenthos decrease compared to zooplankton (Malits *et al*., 2021). Some of the specific diseases that have been linked to eutrophication such as:

**Viral infections:** The development of vibriosis in fish is a common disease that causes high mortality rates in cultured shrimp, fish, and shellfish in Asia. Numerous factors contribute to the occurrence of the disease, such as the source of fish, environmental factors, and the virulence factors of Vibrio. The affected fish show symptoms such as weariness, skin and appendage necrosis, slow growth, organ liquefaction, blindness, and mortality (Wang *et al*., 2018; Hwang, 2020).

**Parasitic infections:** One of the most significant impacts of eutrophication on lake fish diseases is the increase in the prevalence and severity of parasitic infections. The excessive growth of algae and aquatic plants provides a suitable environment for the proliferation of parasites that infect fish. For example, the increased abundance of snails, which serve as intermediate hosts for certain fish parasites, can lead to higher rates of parasitic infections in fish. Additionally, the reduced water clarity and oxygen levels associated with eutrophication can further stress fish, making them more susceptible to parasitic infections (Zymaroieva *et al*., 2023).

**Harmful algal blooms (HABs):** Furthermore, eutrophication can also lead to an increase in the occurrence of harmful algal blooms (HABs), which can produce toxins that are detrimental to fish health. These toxins can directly impact fish by causing damage to their gills, liver, and nervous system, leading to increased mortality, and reduced overall fitness. Moreover, fish that are exposed to these toxins may experience long-term health effects, including impaired growth and reproductive success (Kazmi *et al*., 2022).

**Bacterial diseases:** In addition, Eutrophication, the excessive enrichment of water by nutrients, has been linked to the proliferation of bacterial diseases in aquatic ecosystems. The increased levels of nutrients, particularly nitrogen and phosphorus, create favorable conditions for the growth of harmful bacteria such as E. coli and Vibrio. These bacteria can cause a range of diseases in both humans and aquatic organisms, including gastrointestinal illness, skin infections, and even life-threatening conditions such as cholera (Wang *et al*., 2018).

The impacts of eutrophication on fish diseases are not limited to direct physiological effects; they can also have broader ecological implications. For instance, the increased prevalence of diseases in fish populations can lead to population declines and alter the structure and function of aquatic food webs. This can have cascading effects on other organisms within the ecosystem, leading to a decline in overall ecosystem health.

*Strategies used to mitigate the impact of eutrophication on fish diseases.*

One of the key strategies for mitigating the impact of eutrophication on fish diseases is to reduce nutrient inputs into aquatic ecosystems (Preisner *et al*., 2021). It is important to take steps to reduce eutrophication, such as reducing the amount of nutrients that enter lakes from agricultural runoff and sewage treatment plants (Sinclair *et al*., 2023).

In addition to reducing nutrient inputs and restoring natural habitats, it is also important to monitor water quality and fish health to promptly detect and respond to eutrophication's impacts. This can involve regular water quality testing and monitoring fish populations for signs of disease or stress. By identifying and addressing water quality issues early on, it is possible to minimize the impact of eutrophication on fish health and prevent the spread of diseases (Kies *et al*., 2020).

Additionally, several strategies can be used to mitigate the impact of eutrophication on fish diseases (Sinclair *et al*., 2023). One of the most important is nutrient management practices, which aim to reduce nutrient inputs to lakes. This can include reducing agricultural runoff, limiting the use of fertilizers, and implementing best management practices in urban areas (Kies *et al*., 2020). Another strategy is aquatic vegetation management, which involves the use of plants to reduce nutrient uptake by algae. This can include the use of floating wetlands, which can absorb excess nutrients and improve water quality.

At the regional and global levels, cooperation and coordination among different stakeholders are essential for addressing the complex challenges of eutrophication and its impacts on fish diseases. This can involve the development of integrated water management plans that consider the needs of both human communities and aquatic ecosystems, as well as the implementation of policies and regulations aimed at reducing nutrient pollution and protecting water quality (Kies, 2018; Kies *et al*., 2020).

Finally, monitoring and early detection of fish diseases is essential to prevent and control outbreaks. This can include regular water quality testing, fish health assessments, and the use of disease-resistant fish species.

## Conclusion

Eutrophication is a significant environmental issue that can have a range of negative impacts on lake ecosystems, including an increase in the prevalence. Therefore, reducing nutrient pollution and restoring the ecological balance of aquatic ecosystems are essential for protecting fish health and biodiversity. Eutrophication poses significant challenges to the health of fish populations in lakes, leading to an increase in parasitic infections, harmful algal blooms, and the spread of bacterial and viral diseases. These impacts not only affect the physiological well-being of individual fish but also have broader ecological implications for freshwater ecosystems. Addressing the impact of eutrophication on lake fish diseases requires coordinated efforts to reduce nutrient inputs into lakes, improve water quality, and promote sustainable land use practices. By taking proactive measures to mitigate eutrophication. In conclusion, eutrophication poses a significant threat to fish health, but by implementing a combination of strategies at the local, regional, and global levels, it is possible to mitigate its impacts on fish diseases. By reducing nutrient inputs, restoring natural habitats, monitoring water quality and fish health, educating stakeholders, and promoting cooperation and coordination, we can work towards protecting our aquatic ecosystems and ensuring the health and resilience of fish populations in the face of eutrophication. We can work towards preserving the health and integrity of freshwater ecosystems for future generations.

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