

## A Grave Situation: Mysterious Fish Mortality in Dal Lake

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### Introduction:



Dal Lake is one of the most beautiful and enchanting lakes in India and the world. It is also referred to as the "Jewel in the crown of Kashmir" because of its picturesque beauty. Apart from being an iconic tourist attraction, this lake also became a home for a diverse range of aquatic flora and fauna. But recently, thousands of fish have been found dead in Dal Lake, prompting concerns among its inhabitants. Dal Lake dwellers voiced their concern over the fish mortality, attributing it to the alarming levels of pollution in the lake. In contrast, some experts argue that the major cause of fish deaths is attributed to thermal stratification, presenting a divergent perspective on the issue. "This situation is not an imminent threat; rather, it is an annual affair. The fish mortality is typically associated with the thermal stratification occurring in the lake," said Bashir Ahmed Bhat (vice chairman of LCMA). On the flip side, locals said that "The lake suffers from the discharge of untreated polluted and sewage water, with houseboats (shikhara) contributing 0.8 MLD of sewage and surrounding



communities adding 44.5 MLD, resulting in a significant deterioration of water quality that leads to fish mortality".

According to a recent study, there has been a substantial increase in the concentration of harmful substances such as nitrates, phosphate, and chloride in Dal Lake over the last 25 years. The concentration of total phosphorus has increased significantly from 0.1–0.4 mg/lit in 1997 to about 6mg/lit in 2017. Similarly, chloride increased from 2–2.7 mg/lit in 2007 to 10.3mg/lit in 2017. The levels of calcium and magnesium also increased. Dissolved oxygen (DO) levels, on the other hand, have shown a significant decline in the Dal Lake. The annual DO level of the lake decreased from 7.4mg/lit in 1997 to 6.9mg/lit in 2017. Fish mortality events can occur due to a variety of factors, and without specific information about the incident, it becomes challenging to pinpoint the exact cause accurately. Based on the assumptions of both experts and locals, there appear to be two major causes attributed to fish death incidents: thermal stratification and the influx of sewage into the Dal lake. In addition to these factors, another potential cause of fish mortality in the lake could be the high concentration of microbial load, which may contribute to various health problems and diseases in fish.

#### **Consequences of Thermal Stratification:**

Thermal stratification in lakes refers to the layering of water with different temperatures in a vertical direction. It occurs due to differences in water density at various temperatures. This process is driven by the heating of the lake's surface by solar radiation and the cooling of the lake at depth during cooler seasons. During the warmer months, the sun's energy warms the surface water, creating a warm upper layer called epilimnion. Below this layer, there is a transition zone known as the metalimnion or thermocline, where the temperature changes rapidly with depth. Below the thermocline lies the hypolimnion, which is a colder and denser layer of water. The distinct thermal layer creates different habitats for aquatic organisms, but the thermo cline acts as a barrier to the vertical movement of nutrients, dissolved oxygen, and organisms. There are diverse impacts of this thermal stratification on fish, such as the formation of thermal layers through stratification in the lake, which results in restricted habitat availability for fish. Due to variations in thermal preferences and requirements among fish species, the stratified lake may fail to offer suitable conditions across the entire water column. Consequently, certain fish species may be constrained to

specific layers, impairing their access to essential resources such as food, shelter, and suitable spawning areas. It can also contribute to oxygen depletion leads to hypoxia. As organic matter accumulates and decomposes in this layer, oxygen levels decrease, creating hypoxic or anoxic conditions. Fish heavily rely on dissolved oxygen for respiration, and prolonged exposure to low oxygen levels can induce stress, hinder growth, and elevate the susceptibility of fish to diseases or mortality.



**Image 1: Fish mortality due to thermal stratification in Dal (photo by JK chrome)**

Thermal stratification can affect the timing and success of fish reproduction. Certain fish species rely on specific temperature ranges for optimal spawning conditions, and if their preferred temperature zones are limited to certain layers, it may restrict their reproductive opportunities. Additionally, stratification can also affect the transportation of gametes and the survival of early life stages such as fry or larvae. Fish in stratified lakes may experience changes in their feeding patterns due to the segregation of prey organisms across thermal layers. Planktonic organisms may concentrate in specific layers, influencing the distribution and availability of food resources for fish. This can impact the growth of the fish population. Thermal stratification can influence the vertical distribution of fish, potentially leading to changes in predator-prey interactions. Fish concentrated in a specific layer may be more vulnerable to predation by species that can access those layers more effectively. This can impact the population dynamics and structure of fish communities within the lake. When fall turnover or spring turnover occurs, the layers of stratification in the lake mix together, disrupting the thermal gradients. If hypolimnion contains depleted oxygen levels or harmful substances, the mixing process can expose fish in other layers to these adverse conditions, posing a risk of fish mortality.

### Consequences of the influx of sewage into Dal lake:

The Dal Lake has the maximum influx of sewage from Shikara boathouses and surrounding communities, which degrades the water quality of the lake. This discharge has significant consequences for both the lake ecosystem and human health. Some major impacts are that sewage comprises a diverse array of contaminants, including organic substances, nutrients, pathogens, and chemicals. Once sewage infiltrates a lake, it imparts pollution to the water, causing a heightened concentration of organic pollutants, bacteria, viruses, and other hazardous agents. This contamination undermines the quality of the water, rendering it unsafe for human consumption and detrimental to the aquatic ecosystem. Sewage carries a high concentration of nutrients, primarily nitrogen and phosphorus, which, upon entering a lake, can initiate an overgrowth of algae, causing eutrophication. The excessive proliferation of algae can deplete dissolved oxygen levels in the water, giving rise to oxygen-depleted zones that pose harm to fish and other aquatic organisms. As a consequence, this can lead to fish mortality, a decline in biodiversity, and disturbances to the equilibrium of the entire ecosystem



*Image 2: Influx of sewage in Dal (photo by Kashmir Age)*

Sewage harbours disease-causing pathogens, which can present health hazards to humans. In the event that Dal lake water becomes contaminated with sewage, it heightens the potential for waterborne illnesses, including gastrointestinal disorders, skin infections, and respiratory infections, among individuals who come in contact with the polluted water during activities like boating and fishing. The introduction of sewage can also lead to disagreeable odours, the formation of unappealing scum and foam on the lake's surface, and the presence

of floating debris. These visual and olfactory disturbances detract from the Dal Lake's aesthetic charm, diminishing its recreational allure and potentially impacting tourism and local economics. The decomposition of organic matter in sewage consumes oxygen, leading to the depletion of DO levels in the water. This can create hypoxic or anoxic zones devoid of oxygen, which are detrimental to fish in the lake and potentially lead to mortality.

#### **Consequences of faecal contamination by microbial biota on fish:**

As a lake has such an influx of sewage, it also contains faecal contamination, which can have significant impacts on fish populations and aquatic ecosystems. The presence of faecal contamination in the aquatic environment can introduce harmful bacteria, causing bacterial infection in fish of Dal Lake. Fish can be affected by diseases such as gill disease, fin rot, and septicemia, which weaken their overall health, compromise their immune system, and potentially result in mortality if appropriate treatment is not administered. Faecal contamination can harbour parasites or their eggs, which can infect fish through ingestion or direct contact. Fish may contract parasitic diseases like Ichthyophthiriasis, Gyrodactylus infection, or monogenean infections, which can result in notable harm like skin lesions, fin erosion, and organ dysfunction. Severe infestations, particularly in fish that are stressed or immunocompromised, can escalate to mortality. The occurrence of faecal contamination can serve as a means of transmission for certain fish viruses as well. One notable example is viral hemorrhagic septicemia (VHS), a highly contagious viral disease that can afflict a range of fish species. The presence of faecal contamination in the Dal lake can facilitate the rapid dissemination of these viruses, resulting in devastating consequences such as mass mortality events and significant economic losses.

#### **Conserving Dal Lake Strategies:**

Conserving the Dal Lake and addressing issues such as thermal stratification, fish disease outbreaks, and the influx of sewage water requires a comprehensive approach involving various stakeholders and strategies.

- To ensure the preservation of the water quality of Dal Lake, it is crucial to consistently monitor parameters such as temperature, DO levels, pH, and nutrient concentration. By implementing robust water quality management plans, which include the establishment of monitoring stations, regular sampling, and data analysis, we can effectively identify and mitigate concerns associated with thermal stratification and pollution in Dal Lake.

- Thermal stratification can result in oxygen depletion in the lower regions of Dal lakes, adversely affecting fish and other aquatic organisms. To alleviate this, methods such as lake oxygenation systems like diffused aeration or surface aerators can effectively enhance DO levels and mitigate thermal stratification.
- Taking steps to tackle the problem of sewage water influx in Dal Lake is imperative for the conservation of the lake. By implementing efficient waste management systems, which include the establishment of appropriate sewage treatment facilities, we can substantially decrease the discharge of untreated water into the Dal Lake. This could entail the construction of sewage treatment plants, advocacy for the adoption of eco-friendly sanitation systems, and the enforcement of stringent regulations pertaining to waste disposal.
- Preserving the integrity of the catchment area is essential for sustaining the ecological equilibrium of the Dal Lake. Adopting initiatives aimed at the restoration and conservation of the catchment area can effectively minimize the entry of pollutants and sedimentation into the lake. Such efforts may include initiatives like afforestation, implementing soil conservation practices, and raising awareness through campaigns to encourage responsible land and lake use practices.

**Conclusion:**

The Dal lake being the most iconic tourist attraction recently suffered from a mysterious problem where thousands of fish found dead on the surface and periphery of the lake. After this incidence, dwellers voiced their concern over fish mortality, attributing it to the alarming levels of pollution in the Dal lake. Additionally, some experts argue that major cause of fish mortality in Dal lake was annual affair of thermal stratification. But apart from these two, there is another potential factor i.e. high concentration of microbial load which may impact the health and mortality of fish. The consequences of thermal stratification are diverse which may include habitat limitations of aquatic organisms, depletion in oxygen level in water, elevation in pollution and contaminants in lake, alteration in feeding patterns and vulnerability to predation, reduction in reproductive success and ultimately leads to disease outbreak and fish mortality. Apart from this the impact of influx of sewage water in Dal lake are also severe and may include water pollution, eutrophication, human health risks, alteration in aquatic habitats and other negative aesthetic impact,



In addition to this, the impact of sewage microorganisms on fish can also be significant and leads to various consequences such as disease transmission, stress and immune suppression, changes in behaviour and feeding pattern of the Dal lake's fish. Some bacterial, parasitic and viral infection may also affect the fish population of the Dal lake. In order to avoid these issues there is a need of comprehensive approach involving various stakeholders and strategies. Some measures to be taken in conserving the Dal lake are monitoring and managing water quality, mitigating thermal stratification, sustainable waste management, restoring and conserving the catchment area and promoting the sustainable fishing practices.

