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CASE REPORT: FISH MORTALITY CAUSED BY SEVERE POLLUTION IN THE BAHARSHOR RESERVOIR, AZERBAIJAN

Siala I. Rustamova, Afet V. Suleymanova, Mehdi A. Ali*, Tahir Sh. Agaliyev, Elvina B. Rustamova

Veterinary Research Institute, Ministry of Agriculture, Baku, Azerbaijan

Abstract. Artificial reservoirs in urban ecosystems are considered vulnerable to pollution from poor oxygen circulation and wastewater discharge. In this paper, we investigated the mass mortality of fish in the artificial reservoir Baharshor (Kichik Gyzylnohur), located near the Mahammedli settlement in Azerbaijan. From June 1 to 4, 2025, we observed a mass mortality of European perch (*Perca fluviatilis*), with mortality rates reaching 100%. A complete parasitological dissection of the dead fish was conducted. Also, water samples were analysed to assess physicochemical and ecotoxicological conditions. The parasitological examination did not reveal any dangerous species. The toxicological study results revealed a significant deviation from generally accepted water quality standards. The first sign of hypoxia in the water was turbidity, reaching 57.9 FTU (limit: <5); dissolved oxygen levels were depleted to 0.7 mg/L (limit: >4.0). The ammonium level was 8.45 mg/L (over 17 times the permissible concentration). These data indicate severe organic pollution. A strong sewage odour confirmed a likely domestic wastewater input. Most heavy metals were within limits, but manganese exceeded the threshold. Although acute toxicity tests did not classify the water as toxic, the combination of low oxygen and high ammonium caused the mass fish mortality. The findings highlight the ecological risks posed by untreated wastewater in urban water bodies. This case highlights the importance of continuous monitoring of wastewater pollution. Preventive measures are essential to protect aquatic ecosystems and public health in rapidly urbanising environments.

Keywords: *Wastewater pollution, fish mortality, artificial reservoirs, ammonium toxicity, oxygen depletion, water quality assessment, urban aquatic ecosystems.*

Corresponding Author: *Mehdi A. Ali, Veterinary Research Institute, Ministry of Agriculture, Baku, Azerbaijan, Tel.: +994503820634, e-mail: azvetpar@gmail.com*

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1. Introduction

Artificial reservoirs play a crucial role in supporting aquaculture and ecosystems. The total volume of these artificial lakes in the territory of the Azerbaijan Republic is 22.66 km^3, but only 11.24 km^3 is usable water (Ali *et al*., 2004). However, the rising discharge of untreated or inadequately treated wastewater into these systems has become a serious environmental problem.

The effects of wastewater pollution on fish are complex and multifaceted. Wastewater introduces a complex mixture of pollutants and other destabilising factors, including organic matter, nutrients, pathogens, heavy metals, invasive fish species and emerging contaminants, which can disrupt aquatic ecosystems (Suleymanova, 2021; Suleymanova & Ali, 2023). Furthermore, eutrophication from nutrient-rich effluents promotes harmful algal blooms, some of which (e.g., *Chlorella vulgaris*) can decrease water transparency and provoke dissolved oxygen depletion (Kong *et al*., 2023). One of the most alarming outcomes of water pollution is severe fish mortality. Large quantities of potentially harmful substances may provoke fish kills. Lower levels of these compounds accumulate in aquatic organisms. However, the link between water quality and fish diseases is not correctly proven (Austin, 1998).

Additionally, ammonia is highly toxic to fish at concentrations exceeding 0.5 milligrams per litre (mg/L). This compound interferes with gill function and causes systemic toxicity (Camargo & Alonso, 2006). Motamedi-Tehrani et al. (2025) found that ammonia-N toxicity significantly increased liver enzymes and oxidative stress markers in Nile tilapia. While higher salinity levels helped reduce ammonia's harmful effects, the combined stress of ammonia and salinity still had overall negative impacts on fish health within 96 hours (Motamedi-Tehrani *et al*., 2025).

Aliyev et al. (2018) investigated environmental pollution by heavy metals, hydrocarbons and surface-active agents in the Absheron Peninsula of Azerbaijan. Analysis of the calculated values of significant pollution parameters indicates the contribution of anthropogenic sources to heavy metal accumulation in the soils and sediments of the study area (Aliyev *et al*., 2018).

Artificial basins are highly susceptible to pollution due to limited circulation and proximity to various effluents (Paerl & Otten, 2013). They are especially valuable in urbanised ecosystems where rapid runoff increases pollutant load (Camargo & Alonso, 2006).

Operative compiled case reports about the dangerous influence of the above-mentioned factors support early warning systems and influence environmental policy (Paerl & Otten, 2013). Thereby, the present investigation was initiated to assess the physicochemical and ecotoxicological parameters of the reservoir water in urbanised territory, identify possible causes of the event and evaluate its ecological implications.

2. Materials and Methods

Between June 1 and 4, 2025, severe fish mortality was observed in one of the water basins in urbanised territories near the Mahammedli settlement. The mortality rate was 100%; approximately six tons of dead fish were found along the shores of the reservoir. Photographs (Figure 1A and 1B) and samples of water and European perch (*Perca fluviatilis*) were provided by the epidemiological team at the site. A water sample was collected in 500-ml and 1000-ml volume bottles from the Baharshor (Kichik Gyzylnohur reservoir) near “Omar Atchilyg” Resort (40.54° N, 49.89° E, Figure 2) and submitted to the “AzeLab” on June 5, 2025.

Samples from the dead fish were examined at the laboratory of the Veterinary Research Institute (Ministry of Agriculture). The dissection of the fish was carried out according to complete parasitological protocols (Bikhovskaya-Pavlovskaya, 1969) (Figure 1C). All specimens were examined using a stereomicroscope (*Phenix*) and a biological microscope (BEL SOLARIS).

All data presented by the “AzeLab” laboratory were obtained using standardised environmental monitoring protocols widely accepted in water quality assessment. Organoleptic and physical parameters, including odour, turbidity, pH, conductivity and transparency, were assessed using internationally recognised techniques. Odour was likely evaluated by trained personnel through organoleptic methods, while turbidity was measured using a turbidimeter. The hydrogen ion concentration (pH) was determined using a calibrated pH meter and the measurement was confirmed by electrical conductivity using a conductometer. Transparency was probably assessed using a Secchi disk or an equivalent optical method.

Figure 1. A) The site around the Baharshor artificial water basin; B) The dead fish on the shore; C) Dissected fish in the laboratory

Figure 2. The urbanised territories around the Baharshor reservoir

Chemical parameters, including dissolved oxygen, water hardness and various ions (ammonium, nitrate, nitrite, phosphate and sulphate), were measured using standardised spectrophotometric and titrimetric methods. Dissolved oxygen concentrations were determined using a portable DO probe.

The analysis of inorganic ions, including ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), phosphate (PO_4^{3-}) and sulphate (SO_4^{2-}), is performed using a photometric (colourimetric) method. Oil and petroleum hydrocarbons were analysed using the infrared spectrometry method.

The heavy metal content was likely assessed using atomic absorption spectrometry (AAS). To achieve this, the water probes were subjected to acid digestion using the EPA 3050B method (USEPA, 1996).

The ecotoxicological assessment was performed using acute toxicity tests involving model aquatic organisms.

3. Results

The conducted parasitological investigations did not reveal any dangerous pathogens. The analysis of water revealed several significant deviations from acceptable water quality standards (Table 1). The water had a strong sewage odour, indicating possible contamination with domestic or industrial waste.

Table 1. Results of the conducted analyses

Indicators	Unit of Measurement	Results	MPC
Odour, organoleptic method	Score	Sewage-like odour	–
Turbidity	FTU	57.9	<5
Hydrogen index, pH	–	7.7	3.5–6.5
Electrical conductivity	µS/cm	3,080	–
Dissolved oxygen	mgO_2/l (%)	0.7 (8.0%)	>4.0
Transparency	cm	19.0	>30
Hardness	mg-eq/l	11.94	7.0
Calcium ion, Ca^{2+}	mg/l	124.64	–
Magnesium ion, Mg^{2+}	mg/l	69.07	–
Sulfate ion	mg/l	95.0	500
Ammonium ion, NH_4^+	mg/l	8.45	0.5
Nitrite ion, NO_2^-	mg/l	0.01	3.3
Nitrate ion, NO_3^-	mg/l	2.46	45.0
Orthophosphate ion, PO_4^{3-}	mg/l	0.01	3.5
Total nitrogen	mg/l	7.11	–
Oil and petroleum products	mg/l	0.02	0.05
Ecotoxicological analyses	–	Not toxic	–
Copper, Cu	µg/l	<LOD	1000
Iron, Fe	µg/l	23.5	300
Manganese, Mn	µg/l	175	100
Lead, Pb	µg/l	<LOD	30
Zinc, Zn	µg/l	3.53	1000
Nickel, Ni	µg/l	3.29	100
Molybdenum, Mo	µg/l	<LOD	250

The analysis of the water sample shows that the dissolved oxygen level is below the standard. Turbidity exceeds the permissible limit by 11.6 times, water hardness by 1.7 times, ammonium ion by 17 times and manganese by 1.8 times, respectively, according to the Maximum Permissible Concentrations (MPC)*. Transparency was recorded at 19 cm, far below the minimum requirement of 30 cm, indicating high suspended solids that impair light penetration and photosynthesis.

The pH value was 7.7 (within the normal range). Electrical conductivity reached 3080 μS/cm, suggesting high mineralisation. Dissolved oxygen levels were critically low at 0.7 mg/L, far below the threshold of 4.0 mg/L, indicating severe oxygen depletion. The concentration of ammonium ions was alarmingly high at 8.45 mg/L, more than 17 times the MPC, which strongly suggests the presence of organic contamination. Elevated levels of calcium (124.64 mg/L) and magnesium (69.07 mg/L) were also found.

Most heavy metals were within acceptable ranges, except for manganese, which exceeded the norm as mentioned above (175 μg/L). Notably, copper, lead and molybdenum were not detected. The concentration of nitrogen and phosphorus-containing compounds did not exceed the permissible limits. The ecotoxicological analysis classified the water as non-toxic for aquatic organisms.

4. Discussion

The findings indicate a critical pollution at the Baharshor Reservoir. The combination of high turbidity, severe oxygen deficiency and high ammonium levels leads to hypoxia and high fish mortality.

The study emphasises that such ecological degradation can have a negative impact not only on aquatic biodiversity but also on local fishery resources. Ammonium pollution, in particular, poses a direct threat to fish health, while reduced oxygen levels impair metabolic and reproductive functions in aquatic organisms. The absence of acute heavy metal toxicity suggests that the immediate threat arises from organic pollution rather than industrial discharges. Nevertheless, ongoing monitoring is essential to detect potential future contamination.

Recorded cases from the past decade underscore the global significance of the issue. In South Korea, Bae et al. (2023) investigated mass fish deaths in the Andong-si reservoirs and identified wastewater contamination as the key cause. Their findings highlighted the role of local pollution sources and inadequate mitigation systems in contributing to recurring fish mortality events (Bae *et al*., 2023). The same studies were conducted in the South Caucasus and transboundary countries (Swartz *et al*., 2003; Salamat *et al*., 2014; Lomsadze *et al*., 2016; Gevorgyan *et al*., 2016; Namsaraev *et al*., 2020; Öktener & Bănăduc, 2023).

These reports are not isolated. Across Asia, Africa and Latin America, wastewater-fed aquaculture systems and urban reservoirs have experienced periodic fish kills, often linked to infrastructure failures, sudden inflows of untreated sewage or climatic stress, which exacerbates pollutant concentrations (Oliver *et al*., 2019; Morin-Crini *et al*., 2022).

Although the ranges of most super-dangerous heavy metals (As, Hg, Cd, Zn) were acceptable, the occurrence of manganese is quite severe. According to its impact on the ecosystem, this element is considered moderately hazardous (Aliyev *et al*., 2018). The cases of manganese migration to the Baharshor reservoir would be a subject for future study.

*The MPC for superficial water was adopted from the document "Rules for the Protection of Surface Water from Pollution by Wastewater", approved by Order No. 01 (January 4, 1994), of the State Committee for Ecology and Control over the Use of Natural Resources, Republic of Azerbaijan.

Moreover, the ecological imbalance resulting from fish mortality affects the broader aquatic food web, reducing biodiversity and altering the structure and function of reservoir ecosystems. To prevent further fish mortality incidents in artificial reservoirs, comprehensive strategies must be implemented. These include strict regulation and treatment of wastewater before discharge into aquatic systems; continuous water quality monitoring, especially for dissolved oxygen, ammonia and heavy metals; early warning systems and biomonitoring using sensitive aquatic species; public awareness campaigns to reduce pollutant discharge at source and investment in green infrastructure, such as constructed wetlands and buffer zones, to naturally filter contaminants.

In summary, we believe that only international cooperation of the scientific community and stakeholders in developing countries can improve wastewater management and environmental monitoring.

5. Conclusion

A critical level of ecological stress was recorded in Baharshor Reservoir. Analysis indicates that the most severe issues are the dangerously high concentration of ammonium ions, which reached 8.45 mg/L, the extremely low level of dissolved oxygen (0.7 mg/L) and turbidity values more than eleven times above the permissible limit. These parameters demonstrated the recent high mortality of fish caused by a lack of oxygen and organic pollution. Due to untreated wastewater or runoff, the presence of a sewage odour confirms significant contamination.

These results underline the urgent need to investigate pollution sources and restore ecological balance. Furthermore, consistent monitoring and tighter controls on water quality must be established to prevent similar environmental incidents in the future. The findings support the broader need for science-based strategies and modern veterinary preventive measures to protect aquatic resources and ensure the sustainability of commercial fisheries.

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