Mass Fish Die-Off Below Ulog Hydropower Plant (September 2025) – Urgent Call for Immediate Investigation and Environmental Impact Review

On 12 September 2025, a large-scale fish die-off was observed in the Neretva River immediately downstream of the Ulog hydropower plant (HPP). First-hand accounts documented hundreds of dead fish and crayfish, including the red-listed Softmouth Trout (*Salmo obtusirostris*) and the red-listed White-clawed Crayfish (*Austropotamobius pallipes*), floating on the surface and along the riverbanks in the river section between the powerhouse of Ulog HPP and the Ljuta River confluence (Fig. 1). Combined with the observation of this massive fish die-off, witnesses reported a strong odor of rotten eggs. All these observations were made shortly after a series of three flood waves, caused by the first operational water releases from Ulog HPP, were recorded by the Kašići gauging station downstream of Glavatičevo.

Fig. 1: Dead specimens of salmonids including *Salmo obtusirostris*, *Cottus gobio* and *Austropotamobius pallipes* observed in the Neretva River section between Ulog HPP powerhouse and Ljuta River confluence on September 13, 2025.

The event in September 2025 was not the first instance of a fish die-off downstream of the dam. In September 2023, during intensified construction works on the Ulog HPP, several fish kills were documented in concert with turbid and polluted water by local fishermen and NGO representatives. The Center for the Environment submitted an urgent notice on 28 September 2023 to the Inspectorate of the Republic of Srpska, which was followed by a visit in the field on 16 October 2023, resulting in the report of no pollution of the Neretva River and a “good condition” of both water and fish populations. Shortly after the test filling of the Ulog reservoir in October 2024, observers noted a dramatic change in water color in the impoundment from emerald green towards a blackish appearance.

The construction of Ulog HPP created a deep reservoir (max. 51 m, 6.5 million m^3) in place of a fast-flowing mountain river, introducing physical and chemical processes typical for standing water bodies. During warmer periods, the reservoir undergoes stratification, with oxygen depletion in the deeper hypolimnion intensified by the large load of organic matter from 123 ha of flooded land. This leads to anaerobic decomposition and the build-up of harmful gases such as greenhouse gases (N_2O, CH_4) and hydrogen sulfide (H_2S), a mechanism well documented in reservoirs and lakes in the region and elsewhere (e.g., Zmajevo oko, Lake Averno). Commonly, turbine intakes draw water from deeper layers of a reservoir, thus releasing colder water deficient in oxygen but enriched with those harmful gases into the downstream river ecosystem.

Fig. 2: Drawdown area at the fringes of the reservoir of Ulog HPP (22 September 2025), showing desiccated soil emitting a “rotten eggs” odor, which was also reported by witnesses during the fish die-off event.

We, a consortium of river ecology experts, many of us with long-standing knowledge of the River Neretva and the Ulog HPP, state unequivocally that, given the currently existing evidence, the scientifically most plausible explanation for the observed massive fish die-off downstream of the Ulog reservoir is the release of severely oxygen-depleted and hydrogen sulfide–enriched deep water from the Ulog reservoir.

While data about potential stratification and hypolimnetic oxygen conditions as well as the dam's operation procedures are not accessible to us, multiple lines of evidence support our reasoning:

- The fish die-off was observed in coincidence with the first large volume water releases from Ulog HPP in several months. We note that such sudden releases of high volumes of water do not comply with a „run-of-the river" operation regime.
- The occurrence of massive amounts of dead fish was observed together with fish gasping for air, crayfish crawling on shore, and an intense smell of rotten eggs, indicating the presence of hydrogen sulfide and severely oxygen-deficient conditions. Anoxic sediments were also observed in the drawdown area of the reservoir (Fig. 2).
- Dead fish were observed exclusively in the section immediately downstream of the powerhouse, i.e., the expectedly most stressed river section. Further downstream, tributaries like the Krupac spring stream and the Ljuta River will have diluted the released deep water, and exchange with the atmosphere through turbulence can be expected to resupply the flowing water with oxygen.
- Following the peak discharge events, aerial photographs show a distinctly blackened water body in even far downstream river sections (Fig. 3). This black water color likely originates from precipitated manganese oxides and shows active reduction-oxidation processes commonly known to co-occur with variable oxygen conditions. While manganese is easily dissolvable and colorless under reduced, oxygen-free conditions in hypolimnetic deep water, it will oxidize and form black precipitates in the well-oxygenated river environment.

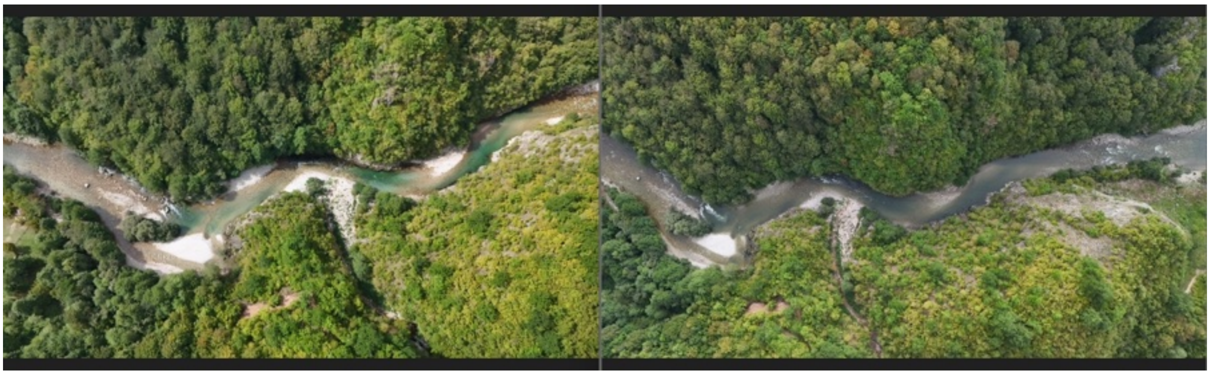

Fig. 3: Aerial photograph of the Neretva River upstream of Glavatičevo; left: prior to discharge surge by water released from Ulog HPP (10.09 2025, 11:09 AM), right: after passage of released water and re-establishment of clear, but blackish water body (10.09.2025, 14:41 PM).

Urgent recommendations

We strongly suggest an immediate investigation into possible reasons for the observed fish die-off along our lines of reasoning. Immediate actions must include:

- Determining current temperature stratification of the reservoir´s water body.
- Measurements of water chemical conditions in the reservoir hypolimnion and in water released from the dam including concentrations of oxygen, redox-relevant ions and gases, and organic matter.
- Securing of fish specimens and tissue samples for a pathological assessment of reasons for death.
- In addition, we advise to monitor discharge and oxygen conditions in the downstream Neretva River over multiple cycles of 24 hours, under operating conditions (i.e., dam releases), and under consideration of potential dilution by water from Krupac spring stream and Ljuta River.

Given that HPP Ulog operates along an ecologically highly sensitive river course hosting multiple threatened species, it is imperative that the Environmental Impact Study and the project's ecological permits be urgently reviewed and revised. In line with legal obligations, it is crucial to assess:

- the risk of hypolimnetic oxygen deficiency, hydrogen sulfide buildup and formation of greenhouse gases.
- the risk of release of oxygen-depleted hypolimnetic water to the downstream river ecosystem.
- the spatial and temporal extent of possible impacts similar to the one observed and/or likely under future operation conditions and the concomitant risk to affected threatened species, in particular threatened species like the Softmouth Trout and Marble Trout (*Salmo marmoratus*).
- potential technical measures capable of mitigating ecological impacts such as depth-selective water withdrawal systems to prevent anoxic water from being discharged into the river or artificial oxygenation of the hypolimnion without disrupting stratification.

The Ulog Hydropower Plant stands as a concerning example of a project implemented without detailed ecological planning or modeling. We regard the above explained scenario to be a realistic ecological risk that is highly likely to recur in the coming years. The Environmental Impact Study does not present any modelling of the reservoir's ecological dynamics in the context of stratification and thus fails to assess this ecological risk entirely. It further suggests monitoring of vertical profiles of the reservoir and the air above it, yet fails to explain how such generated data will be used for HPP Ulog´s operation and management, that could limit impacts on the downstream Neretva River ecosystem.

We, the signatories, hold the professional opinion that a safe future operation of HPP Ulog requires management of the reservoir in an ecologically responsible manner, i.e. based on (i) predictive ecological modeling including simulations of stratification, hypolimnetic oxygen consumption, and reservoir turnover dynamics, in concert with (ii) systematic monitoring of conditions throughout the reservoir's water column and in the immediate downstream river section. The usage of hydropower in the 21st century must not come along with repeated ecological catastrophes.

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