Fish kill in the Upper Neretva: What happened and what must change

Findings based on field measurements, hydrographic data, and remote sensing

What happened on 12 September 2025?
A large fish kill occurred on the Neretva River, downstream of the Ulog Hydropower Plant (HPP). Dead fish and crayfish were found along the banks, and the water smelled strongly of "rotten eggs." This happened shortly after **three sudden water releases** from the Ulog hydropower plant.

Species affected: hundreds of dead fish, including the rare softmouth trout (Critically Endangered) and European bullhead as well as white-clawed crayfish (Endangered).

What caused it?
The powerplant released oxygen-poor water from a deeper layer in the reservoir during an illegal, prolonged series of 'hydropeaks', i.e. sudden water releases from the reservoir. During summer, the deeper layers of the reservoir experience a strong decline in oxygen concentration. This happens because:

- Warming surface water floats on top of cold deep water. Due to this temperature stratification, the two layers no longer mix, and oxygen from the atmosphere cannot reach the deep layer.
- Isolated deep water becomes increasingly oxygen-poor as bacteria respire organic material from the submerged former forest and sinking algae.
- Prolonged decomposition of this material without oxygen leads to the formation of hydrogen sulfide (which smells like "rotten eggs") and potent greenhouse gases.

What evidence supports this?
Our scientific team combined **on-site measurements, flow data from a public hydrographic station,** and **satellite images**:

- In coincidence with the timing of the fish kill, downstream hydrographic data show a series of at least three clear 'hydropeaks'.
- A partial overlay of the hydropeaks with a natural flood prompted a flow partitioning analysis, which suggests that the third hydropeak was caused by an unusually long water release.
- Satellite data show a **significant drop in reservoir level** during the time of observed hydropeaking. Water volumes lost in the reservoir fit the estimates of runoff volumes associated with the hydropeaks.

Deep water in the reservoir had **extremely low oxygen levels**, and the HPP intake draws water from this depth.

All lines of evidence point to the **same cause: Improper release of deep, oxygen-poor water from the Ulog HPP.**

Why this matters
If nothing changes, this is **likely to happen again**, especially in late summer and earlya utumn when oxygen levels in deep water k are lowest.

On the day of the fish kill, **the HPP released oxygen-depleted and chemically altered water** from these deep layers. Fish and crayfish cannot survive sudden drops in oxygen.

What needs to be done immediately

The 12 September **fish kill was preventable.** It occurred due to the release of deep, oxygen-depleted water. It occurred due to poor management and failure to follow state-of-the-art hydropower operating principles.

To protect the Neretva and avoid future incidents, the Ulog HPP operators must:

- **Operate in accordance with the environmental permit** in **run-of-river** mode,
- **Stop hydropeaking,**
- **improve monitoring**, and
- introduce technical solutions that **ensure safe water quality downstream**.

Monitoring

The hydropower plant must monitor and report, in real time, the:

- reservoir level;
- discharge of water release; and
- oxygen concentration and water temperature (i) along a depth profile in the reservoir, (ii) of the released water, (iii) in the recipient downstream Neretva.

Technical improvements

- Install equipment that allows releases from different depths.
- Improve deep-water oxygen levels.

Safe operation

- Adhere to the legal requirements according to the permit of operation. The **mode of operation of HPP Ulog must be run-of-river**.
- Employ state-of-the-art ecological and environmental models to forecast risks of damage to downstream habitat and organisms.
- Do **not** release deep, oxygen-poor water during stratified periods and establish minimum oxygen requirements for any release.
- Monitor and manage nutrient inputs to avoid algal blooms in the reservoir.

November 2025