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Full-Scale Bioremediation Experiment in a Small Pit Lake Using Wood Ash

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In this study, a full-scale bioremediation experiment was conducted in the Åsen pit lake using wood ash, a nutrient-rich and alkaline residue of forest biomass combustion. The lake, located in northern Sweden, is characterized by elevated concentrations of metals such as Cu (~50-300 µg/L) and Zn (~700-1300 µg/L). By supplying nutrients through wood ash (mainly phosphorus), the aim was to stimulate algal growth to raise pH and decrease metal concentrations. Åsen is a relatively small and shallow lake with a surface area of ~21 000 m^2, a volume of ~81 000 m^3, and a maximum depth of 11.4 m. The region experiences long daylight hours during summer, and the lake remains ice-covered during winter.

During summer and autumn (May–October) of 2025, the water quality of the lake was monitored, and wood ash was applied on two occasions: 2.7 tons on June 11, and 4 tons on September 2. The pH, dissolved oxygen (DO), specific conductivity (SpC), and temperature (T), were measured along depth profiles using a multiparameter sonde and continuously monitored using sensors installed at depths of 1 and 9 m (logging intervals of 5-15 min). Water samples were collected at depths of 1, 5, and 9 m, and analyzed for element concentrations, nitrogen speciation, and chlorophyll-a. From May to August, water samples were collected for phytoplankton analysis.

Phytoplankton biomass increased exponentially, from ~30 µg/L in May to ~2500 µg/L by August. Green algae dominated and their relative abundance increased from <10% in May to >80% in August. A pH spike was observed at the time of wood ash addition, followed by diurnal variations and an increasing trend that were attributed to algal growth (Figure 1). Filtered concentrations (<0.2 µm) of Cd, Co, Cu, Ni, and Zn decreased considerably during the experiment. For example, Zn concentrations at depths of 1 and 5 m decreased from ~700 µg/L in May to minimum values of ~30-40 µg/L illustrating the promising results from a bioremediation perspective (Figure 2). However, continued monitoring over the winter and in the long term is needed to better understand the system and the factors controlling water quality.



