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Variations in sediment oxygen demand as a function of sediment loading, oxygen concentration and diffuser-induced turbulence

Overview: **Sediment oxygen demand (SOD) is a key parameter governing hypolimnetic dissolved oxygen (DO) levels and sediment-water biogeochemical fluxes.** Sediment loading, hypolimnetic DO concentrations and turbulence may have a strong influence on both SOD and chemical cycling. Oxygenation systems, used increasingly to replenish hypolimnetic DO, can cause increased SOD due to elevated DO concentrations and diffuser-induced mixing.

Spring Hollow Reservoir

Carvin's Cove

This research focuses on how SOD and trace metal (Fe, Mn) fluxes are impacted by diffuser-induced changes in near-sediment DO and turbulence levels. We are working with two drinking-water-supply reservoirs, Spring Hollow Reservoir (SHR) and Carvin's Cove (CC) (above), both equipped with bubble-plume oxygenation systems (bubbles from diffuser evident in CC photo, above).

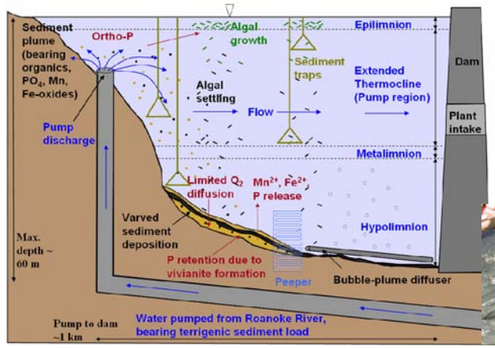
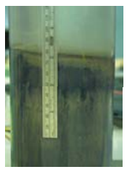
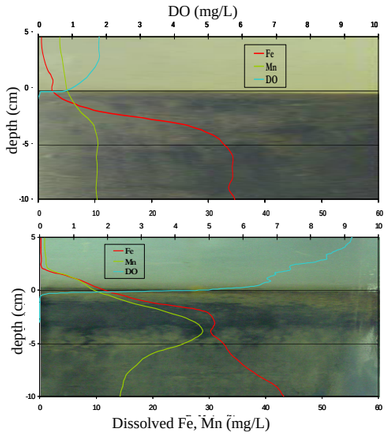


Diagram of SHR (left), shows processes impacting SOD and fluxes. Inset photo shows strong layering of terrigenous sediment and organic matter in SHR.



Dissolved metal profiles obtained in-situ using "peepers" (left). DO microsensor profiles obtained from sediment cores (below left). Photos below show changes in O, Fe and Mn profiles and in appearance of sediment surface during diffuser operations.

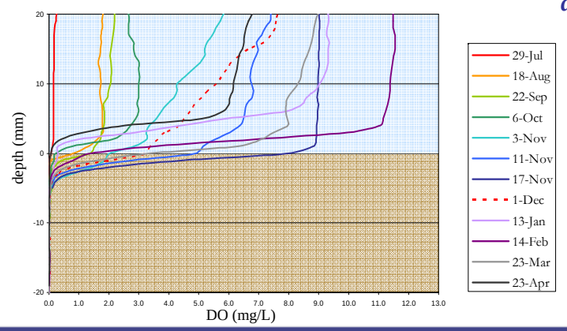


8/8/05 - After 1 week of diffuser operations

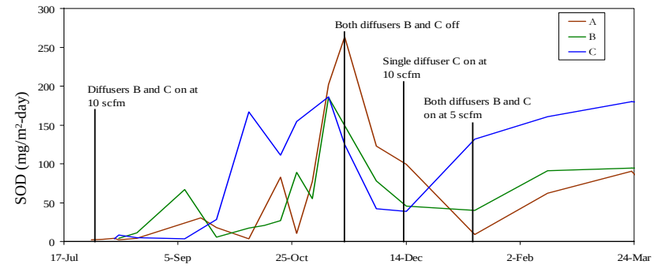
11/11/05 - After 3.5 months of diffuser operations

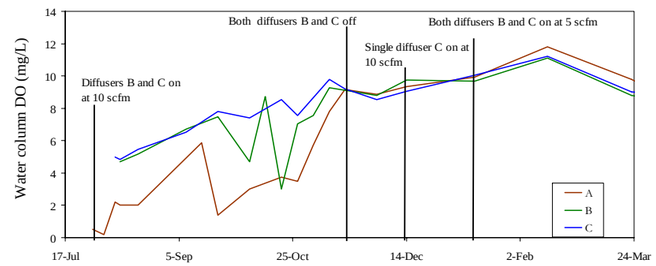
Using DO microsensor profiles (below) of sediment cores, SOD values (right) are calculated based on Fick's Law:

$$SOD = -\phi D \left.\frac{dC}{dz}\right|_{z\,=\,surface}$$



Results: Comparing SOD (top plot) with water column DO concentrations (bottom plot) as a function of diffuser use shows both SOD and DO increase significantly during diffuser use. **During period when diffuser is off, the importance of turbulence is revealed by a sharp decrease in SOD even though near-sediment DO stays high.**





Additional analyses performed during this research project will include:

- Conducting analogous experiments on fluxes of Fe and Mn.
- Obtaining data on sediment loading rates and sediment composition (Fe, Mn, P, organic matter) using sediment traps.
- Characterizing changes in sediment microbial populations using 16S-rRNA and fluorescent in-situ hybridization (FISH) analyses.

Understanding how transient processes impact sediment-water fluxes is crucial for accurately quantifying SOD, optimizing water quality and enhancing our ability to manage lakes and reservoirs.

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