Sulfide Flux as a Function of Temperature in the Severn River

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ABSTRACT

We present a study of sulfide flux from the sediment into the water column at a zone of localized euxinia as a function of temperature in the Severn River. The combination of persistent anoxic conditions and the availability of sulfate generate an environment that allows sulfate reducing bacteria to thrive. The reduction of sulfate to sulfide by sulfate reducers is a metabolic pathway used to obtain energy and secrete sulfide as waste. Steady state sediment core experiments were conducted at 9 °C and 28 °C to explore changes in sulfide flux between the winter and summer conditions. At steady state the sulfide flux out of the sediment in to the water column is -2.30±0.06 mmol m^{-2} d^{-1} at 28 °C in comparison to -0.16±0.02 mmol m^{-2} d^{-1} at 9 °C. The results of this study can be used to predict the influence of temperature on the benthic community in the Severn River and similar systems suffering from the effects of eutrophication.

Introduction

Eutrophication

Microbial sulfate reduction

$$2CH_2O + SO_4^{2-} \rightarrow 2HCO_3^- + H_2S$$

Low Levels of dissolved O_2 and high levels of organic matter

Euxinia

Figure 1: *Localized euxinia decreases habitable area for benthic organisms in the Severn River (Severn Riverkeeper Program).*

Results

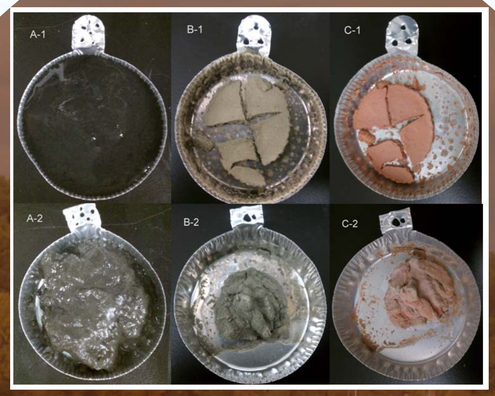

Figure 2: *Top vs. bottom sediment layer changes during loss on ignition analyses. A) wet sample B) sample dried at 80 °C overnight C) sample ignited to 550 °C for 4 hours.*

Table 1 & 2: *Sulfide flux results from sediment core incubation experiments.*

Core #	9° C Sulfide Flux (mmol m^{-2} d^{-1})					Average	STD
1	- 0.183	- 0.187	- 0.173	- 0.180	- 0.183	- 0.181	0.005
2	- 0.145	- 0.138	- 0.141	- 0.148	- 0.131	- 0.140	0.007
3	- 0.148	- 0.152	- 0.148	- 0.141	- 0.141	- 0.146	0.005
						- 0.16	0.02

Core #	28° C Sulfide Flux (mmol m^{-2} d^{-1})						Average	STD
2	- 2.25	- 2.29	- 2.33	- 2.38	- 2.23	- 2.30	- 2.30	0.06

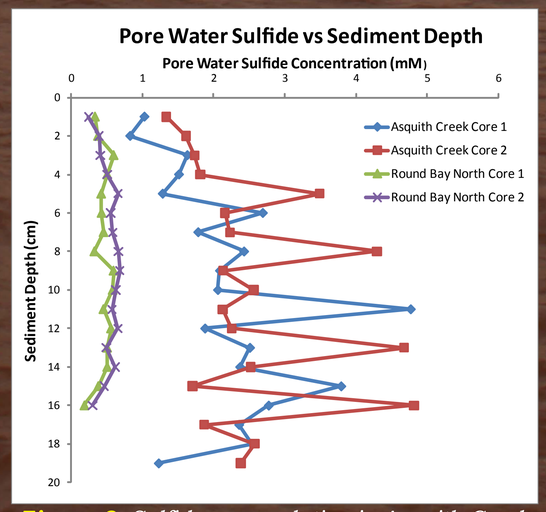

Figure 3: *Sulfide accumulation in Asquith Creek is higher than in Round Bay North due to a lower mixing frequnecy of salt and fresh water.*

Methods

Sediment core sampling at the Round Bay North station with Dr. James Farquhar.

Equations:

Sulfide Concentration (μM) = Dilution × C. Factor × Abs

$$\text{Sulfide Flux } (\text{mmol } m^{-2}\ d^{-1}) = \frac{[\text{Sulfide measured}] \times \text{Flow rate measured}}{\text{Area of sediment surface}}$$

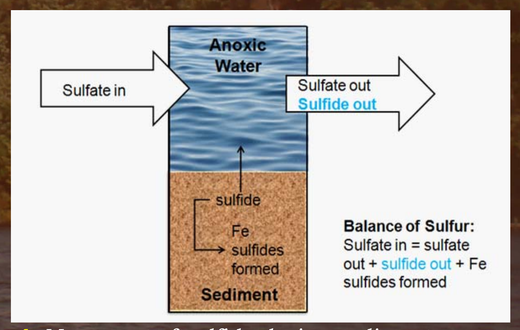

Figure 4: *Movement of sulfide during sediment core incubation.Sulfide out concentrations were measured spectrophotmetrically. 6.2 ± 0.5 mM sulfate in water reservoir.*

Conclusion

The combination of hypoxia and micromolar concentrations of hydrogen sulfide is toxic to benthic organisms; reducing their survival time by 30%[1].Therefore the euxinic state at Round Bay North and Asquith Creek during the summer is harsh enough to kill benthic organisms.

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References

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[1]Vaquer-Sunyer, R., & Duarte, C. M. (2010). Sulfide exposure accelerates hypoxia-driven mortality. *Limnology and Oceanography*, 55(3), 1075-1082.