

Microbial sulfate reduction in littoral sediments of the intermittent Pescadero Estuary

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Pescadero Estuary is an extensive marshland ecosystem and complex intermittent estuary located along the Pacific coast of California. The estuary experiences physical separation from the ocean (closed state) and later reconnects with the ocean (open state), so it is susceptible to fluctuations in sulfur (S) oxidation state and concentration, salinity, biogeochemical conditions, sedimentation, and hydrologic regimes [1]. Die-offs of federally protected and threatened steelhead trout have drastically increased annually since 1995, occurring unexpectedly with the first breach of the sandbar closure [2]. These kill events have been more regular in Pescadero than in nearby California estuaries [1, 3, 4]. Based on previous works [1, 5], we hypothesize that hydrogen sulfide (H_2S) resulting from microbial sulfate (SO_4^{2-}) reduction, in addition to low dissolved oxygen, low pH, and reduced iron sulfides are implicated in these deaths.

To develop a complete understanding of the geochemical and biological interactions in the Pescadero Estuary and to identify the mechanisms and conditions resulting in fish die-offs, the kinetic parameters of microbial sulfate reduction (maximum reaction rate, R_{max} , and half-saturation constant, K_m) were determined on littoral sediments in eight sites spanning various biogeochemical conditions. Sulfate reduction rates (SRR) and sulfide release to the water column were measured on undisturbed sediment cores using a novel flow-through approach [6]. Sediment and water were also analyzed for their physical and biogeochemical characteristics, including pH, salinity, sulfate concentration, total sulfide, and abundance of sulfate-reducing bacteria.

R_{max} was highest ($152.9 \text{ nmol cm}^{-3} \text{ h}^{-1}$) in the site associated with high counts of dead fish, and characterized by high sulfate concentration (1.1 mM) and low soil pH (6.1), whereas the lowest R_{max} ($19.2 \text{ nmol cm}^{-3} \text{ h}^{-1}$) was observed in the site with the lowest sulfate concentration in water. These results suggest that there is a correlation between high SRR and the fish kill events in the Pescadero Estuary.

[1] Sloan (2006) *Master's Theses* 3032. [2] Swenson (1999) *Environ. Biol. Fish.* **55**, 99-114. [3] Atkinson (2010) *Master's Theses* 3746. [4] Martin *et al* (2007) *Calif. Fish Game* **93**, 214-223. [5] Luther III *et al* (2004) *Estuaries* **27**, 551-560. [6] Pallud *et al* (2007) *Mar. Chem.* **106**, 256-271.