Effects of hypoxia and anoxia on sediment-water nutrient exchange: Insights from long-term analyses in Chesapeake Bay

CBEO
Chesapeake Bay Environmental Observatory

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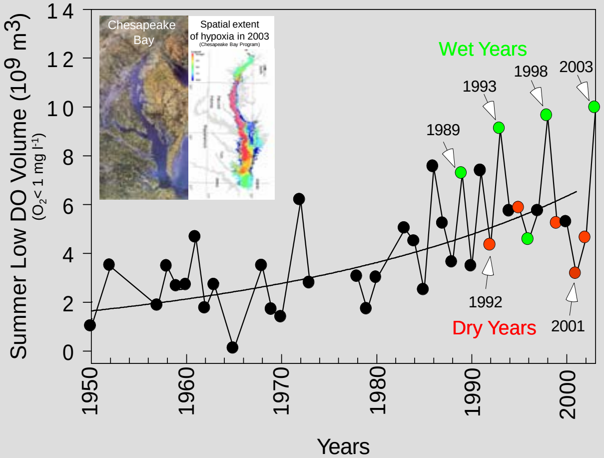
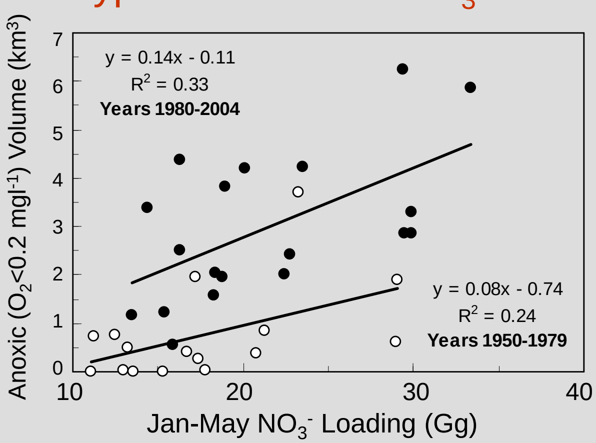
I. History of Chesapeake Bay Hypoxia



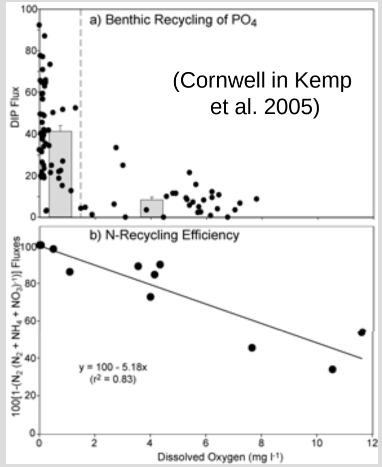
- Hypoxic volume has appeared to increase since 1950
- This increase is clear, despite the strong effect of river flow on hypoxia (Hagy et al. 2004)

II. Hypoxia related to NO_3^- load



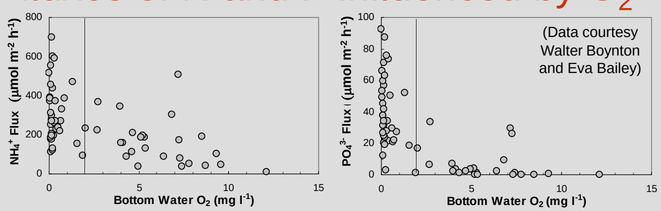
- Despite reductions in NO_3^- loading in recent decades, hypoxia has continued to increase (Hagy et al. 2004)
- What is driving the sustained hypoxia – hypotheses?

III. Hypothesis: Reduced O_2 allows more N and P release from sediments, which fuels increased primary production and hypoxia

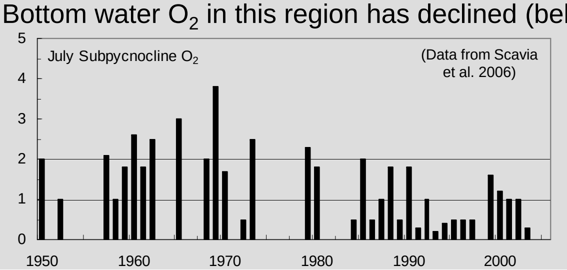


- Previous studies show that NH_4^+ and PO_4^{3-} recycling are sensitive to low O_2 in Chesapeake Bay
- Mechanisms include release of DIP from Fe and reduced coupled nitrification-denitrification under low O_2

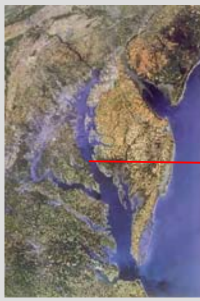
IV. Hypothesis Test: Sediment-water fluxes of N and P influenced by O_2



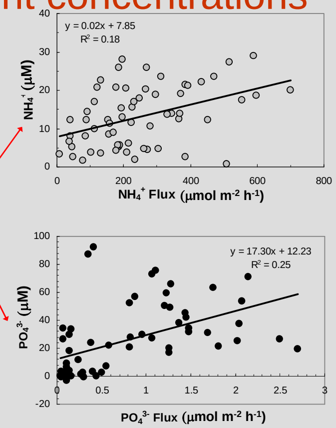
- NH_4^+ and PO_4^{3-} fluxes from sediment substantially elevated under low O_2 in mid-Chesapeake Bay
- Bottom water O_2 in this region has declined (below)



V. Sediment-water NH_4^+ and PO_4^{3-} release correlates with bottom water nutrient concentrations

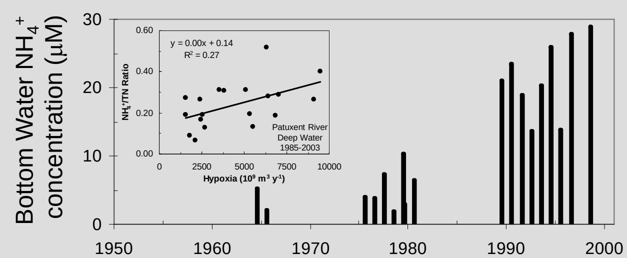


(Data courtesy Walter Boynton and Eva Bailey)



- Low O_2-induced increases in sediment-water nutrient flux can elevate water column N and P concentrations

VI. Sediment-water DIN release may have been lower before 1980 than from 1980 to 2000



- Deep water NH_4^+ increased despite recent, slight N-loading declines since 1980, suggesting that recycling may be elevating water-column NH_4^+ (Inset: NH_4^+ is a larger fraction of TN under hypoxia)
- Hypoxia-induced reduction in benthic invertebrates may be responsible – see *Bosch and Kemp* poster