

# Hypoxia in Lake Erie: An Overview

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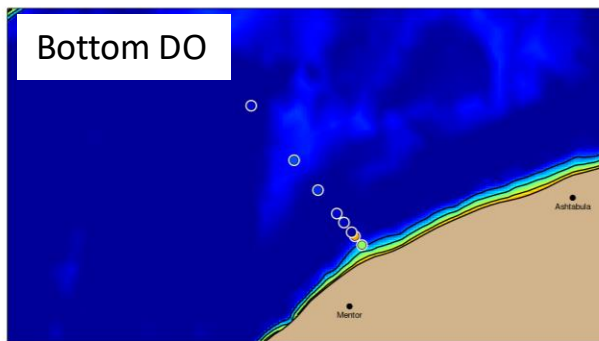
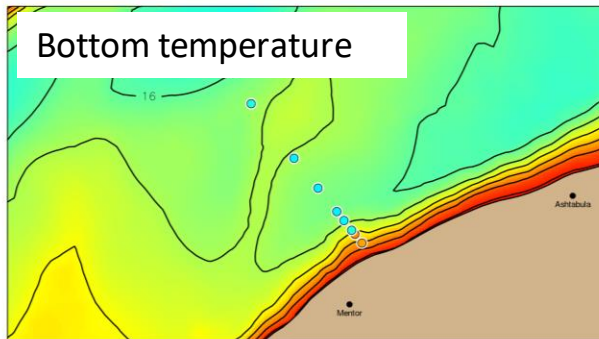


Photo: Gus Chan, The Plain Dealer

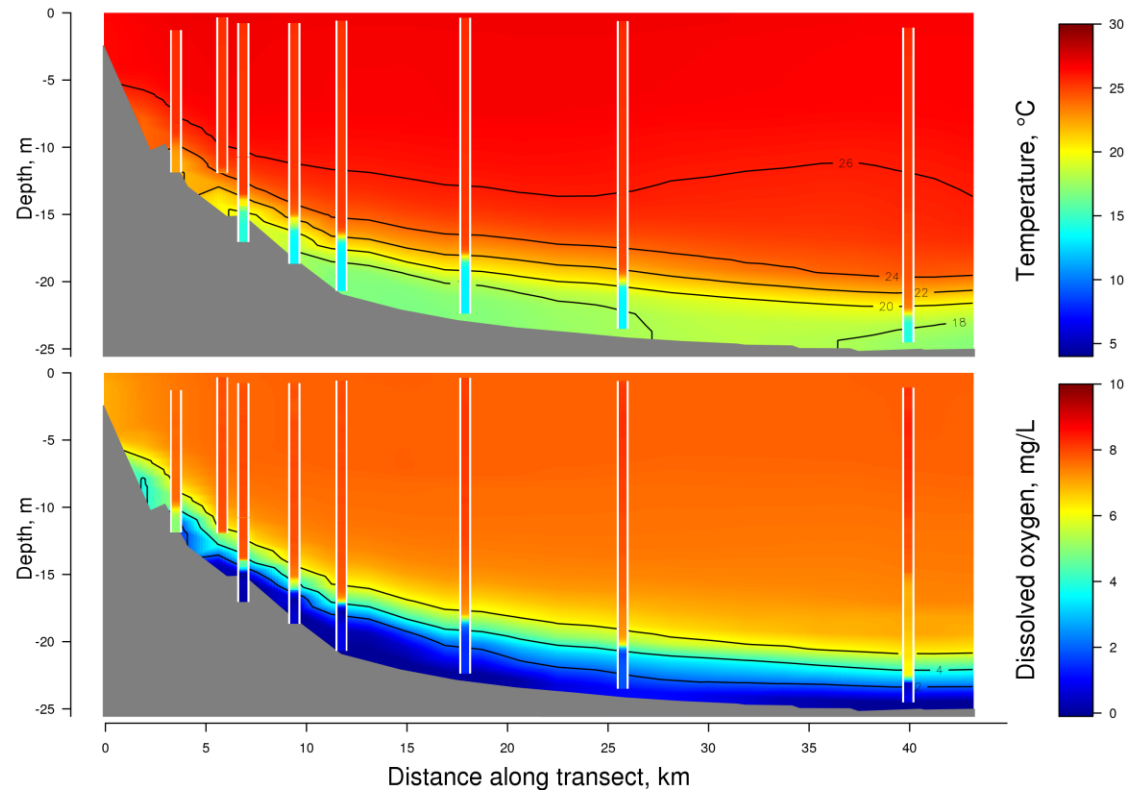


# The “**Dead Zone**” in the central basin of Lake Erie occurs when dissolved oxygen falls below 2-4 mg/L

2016-08-30 15 GMT



2016-08-30 15 GMT

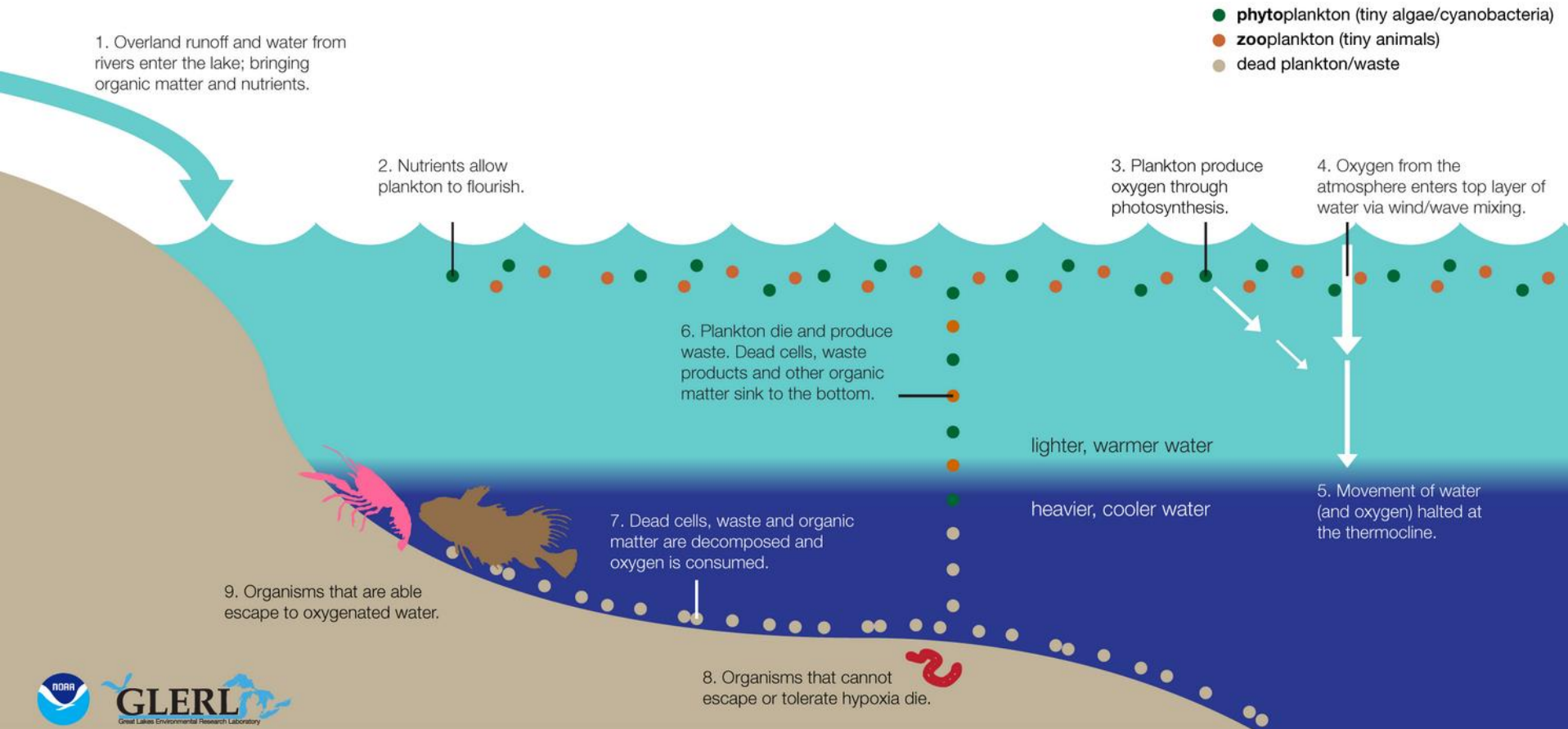


Map view and cross-sectional view of a transect from Fairport, Ohio, showing measured and modeled temperature and dissolved oxygen

Model data: Experimental Lake Erie Operational Forecasting System Model

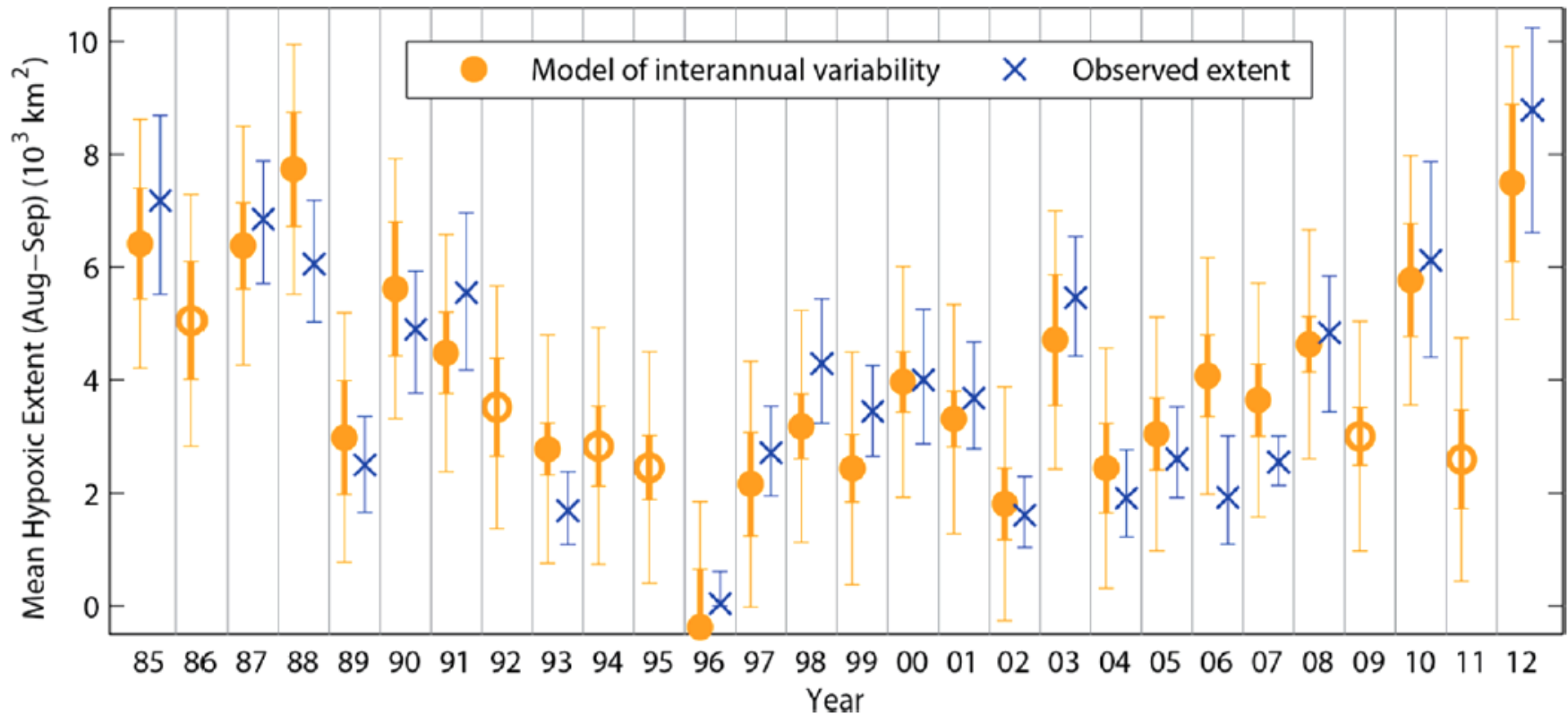
Measured data: Scott Winkler, Ohio EPA

# Hypoxia requires stratification and oxygen demand



- Two factors required for hypoxia
  - Biochemical oxygen demand
  - Stratification of the water column

# Annual Hypoxic Extent in Lake Erie



Annual hypoxic extent reached a minimum in the mid 1990s, has subsequently increased, and shows inter-annual variability

RECOMMENDED

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# PHOSPHORUS LOADING TARGETS

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FOR LAKE ERIE

Annex 4 Objectives and Targets Task Team Final Report to the Nutrients Annex Subcommittee

May 11, 2015

- To minimize Lake Erie hypoxia and harmful algal blooms, a goal 40% reduction in phosphorus loads to Lake Erie was established in 2016 under the US-Canada Great Lakes Water Quality Agreement
- A draft US Action Plan for Lake Erie describes plans to achieve the goal

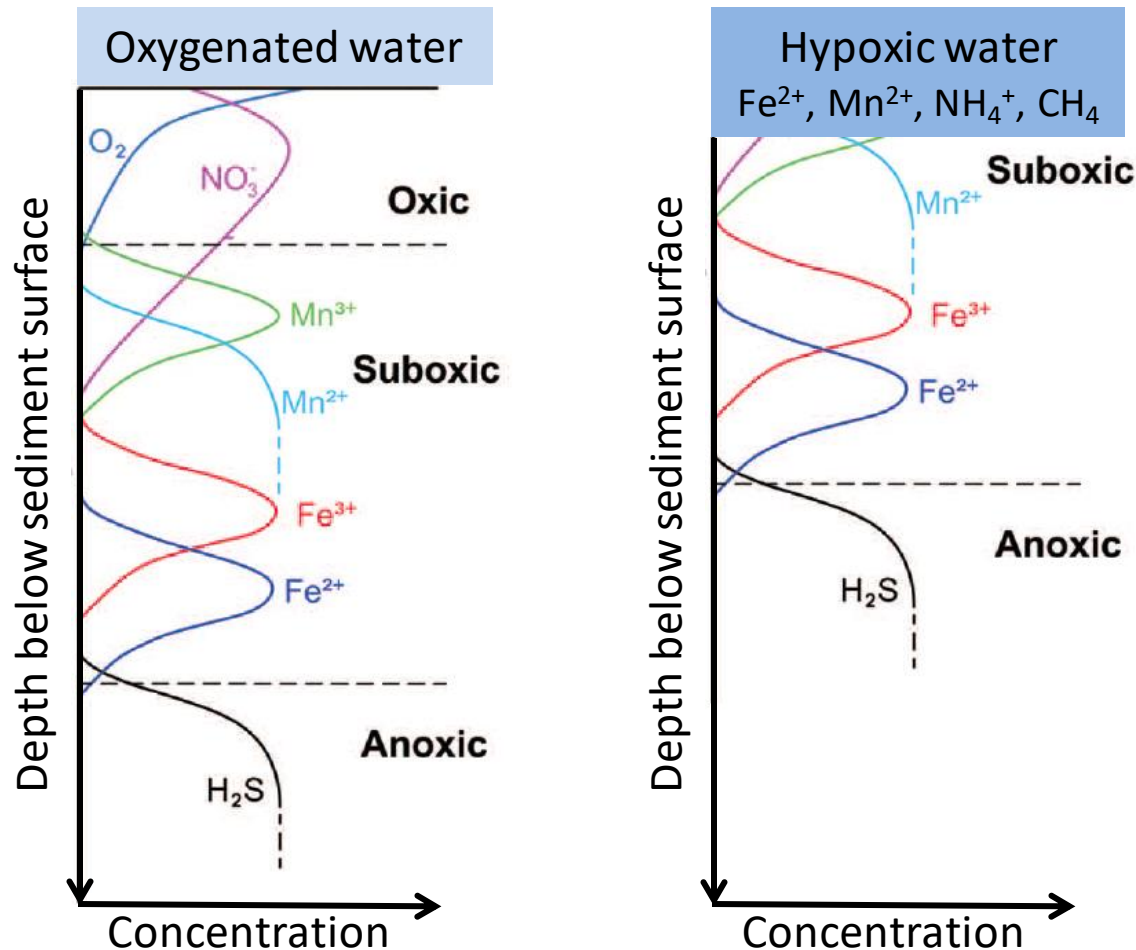
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# How does hypoxia affect water quality?

- Dead zone water characteristics
  - Low dissolved oxygen
  - Low temperature
  - Low pH
  - High organic content
  - High dissolved Mn and Fe
- Issues for water treatment
  - Discolored water (Mn)
  - High chlorine demand and disinfection byproducts (dissolved organics)
  - Low pH



# How does hypoxia affect water quality?

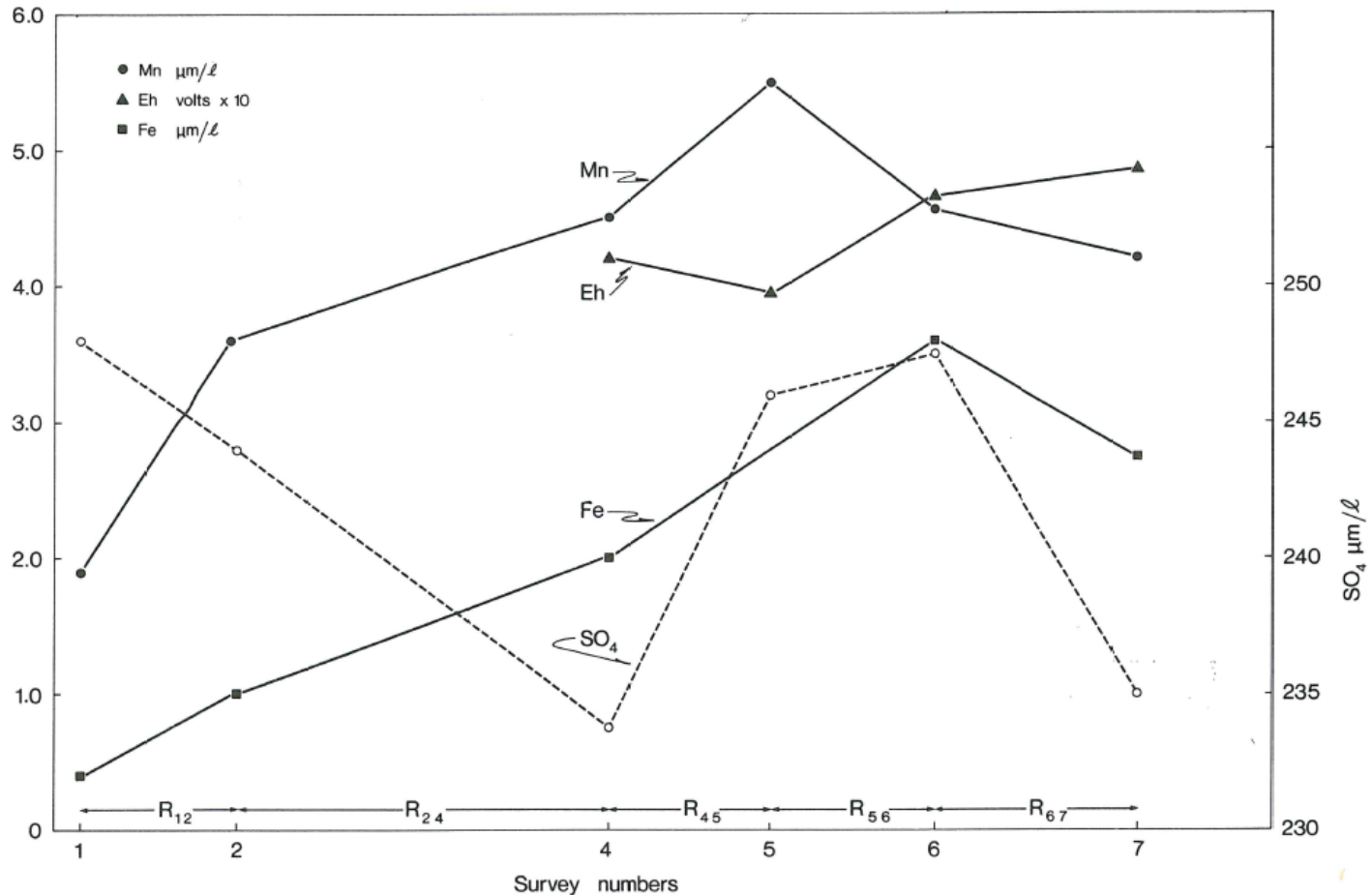


In sediment below oxygenated water, reduced substances are oxidized below the sediment surface oxic layer

Under hypoxic water, reduced substances diffuse out of the sediment into the water ( $Fe^{2+}$ ,  $Mn^{2+}$ ,  $NH_4^+$ ,  $CH_4$ )

# How does hypoxia affect water quality?

~0.33 mg/L



Gradual increase in Mn and Fe in Lake Erie bottom water over the month of August, 1970



# How does hypoxia affect water quality?

Lake Erie surface  
sediment in June, 1970,  
showing reddish-brown  
ferric hydroxide



Sediment core showing  
red ferric hydroxide  
layer over black Fe, Mn  
sulfide layer



Sediment surface in  
July-August, showing  
green settled algae, and  
black sulfide layer  
emerging at the surface

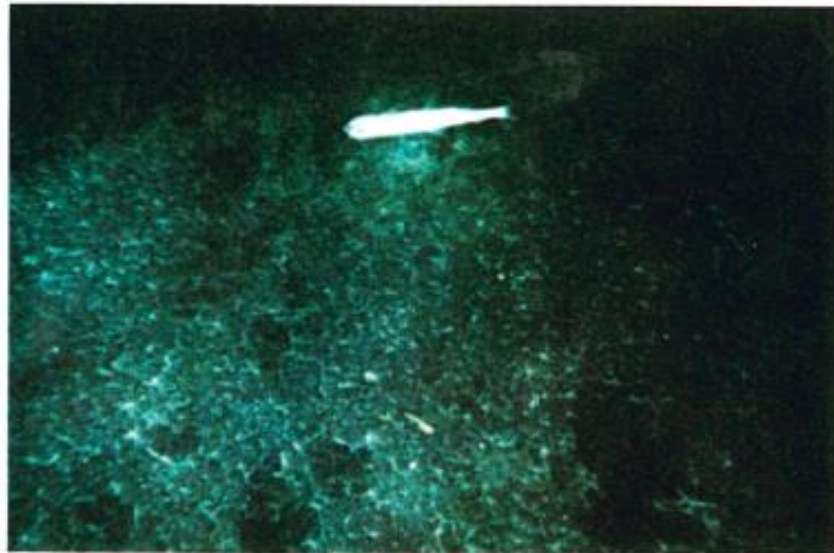


# How does hypoxia affect water quality?

Fluffy green covering of settled algae in August, 1970



Sediment surface on September 2, 1970, showing black Fe, Mn sulfide layer at the surface



Project Hypo. 1972. Canada Center for Inland Waters, US EPA

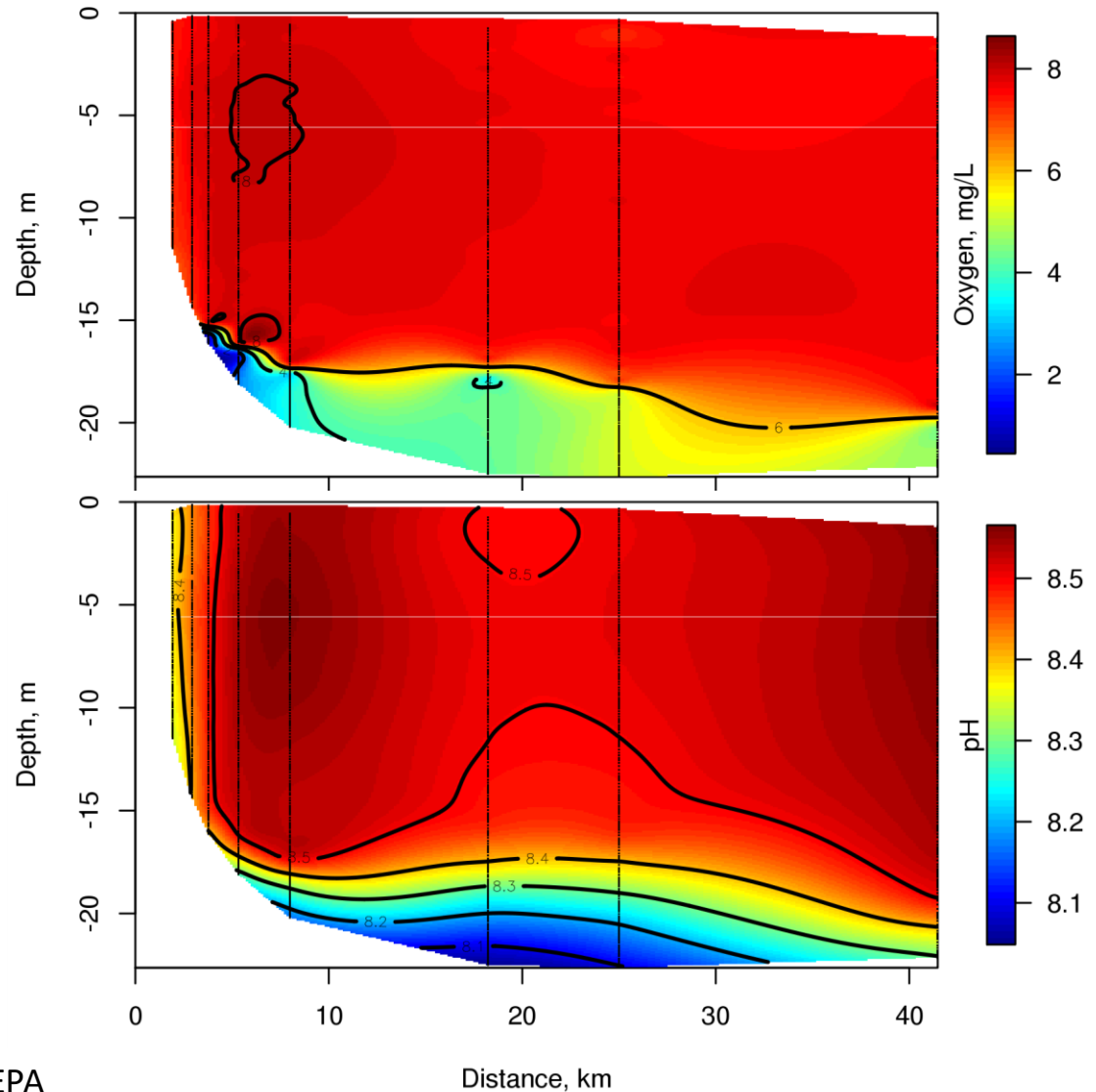
# How does hypoxia affect water quality?

**Hypoxic water is associated with low pH**

Photosynthesis in the surface mixed layer consumes dissolved carbon dioxide, which raises pH

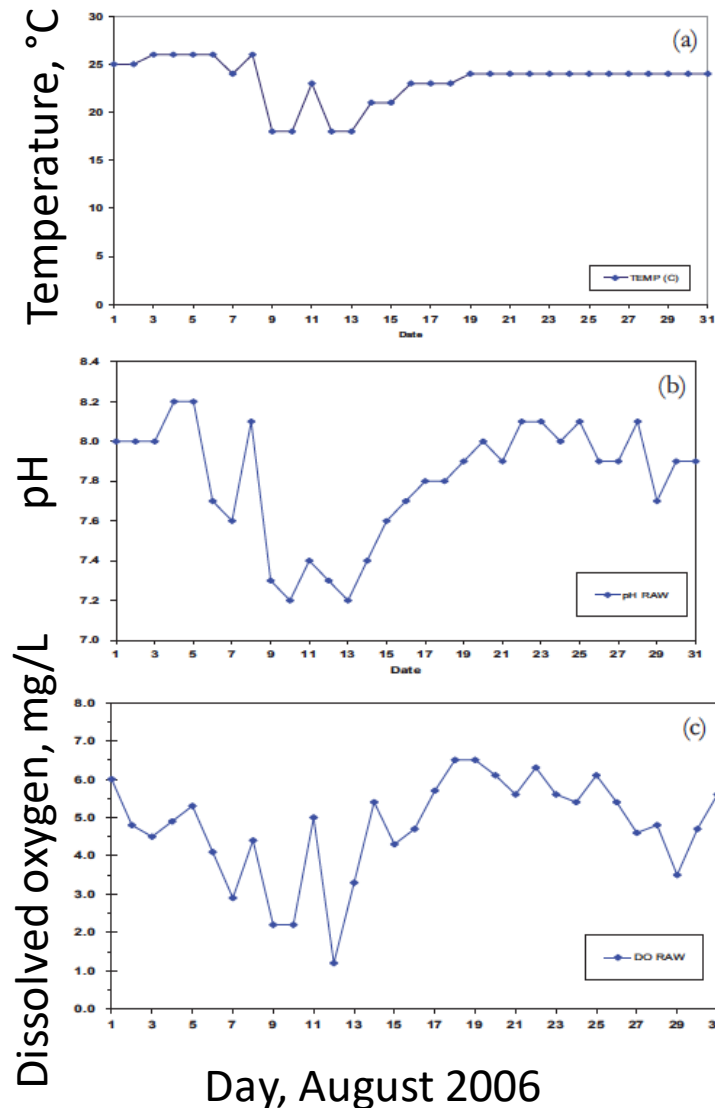
Respiration in the hypolimnion and sediment consumes oxygen, and produces carbon dioxide, which lowers pH

2016-08-17 Geneva

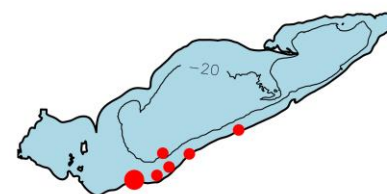
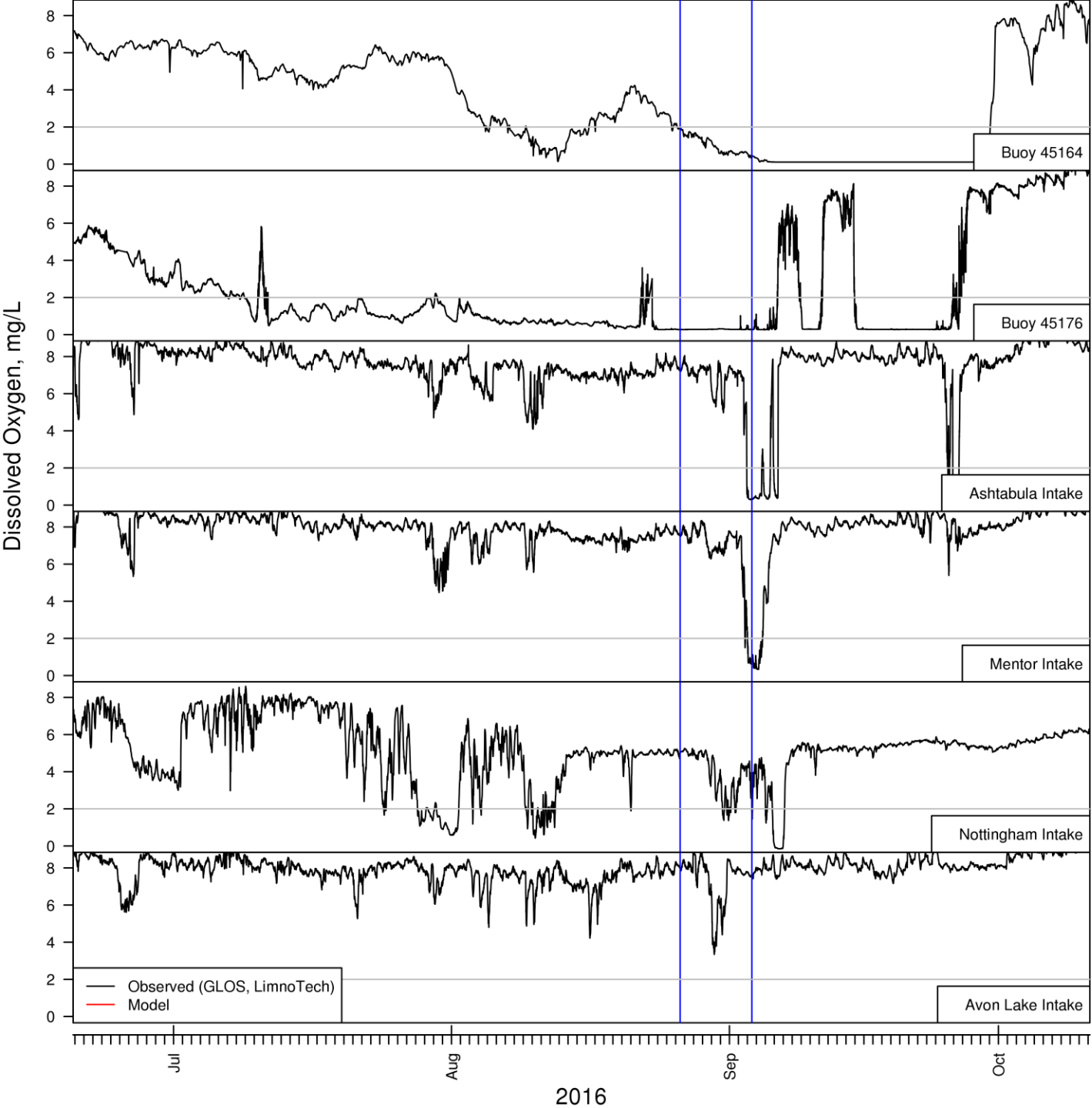


Measured data: Scott Winkler, Ohio EPA

# Upwelling events can cause sudden changes in water quality at water intakes



Intake water  
quality at  
Cleveland Ohio



What is your experience  
with hypoxia?