

Testing Metal Removal Strategies in the Equity Silver Pit Lakes Using Limnocorrals

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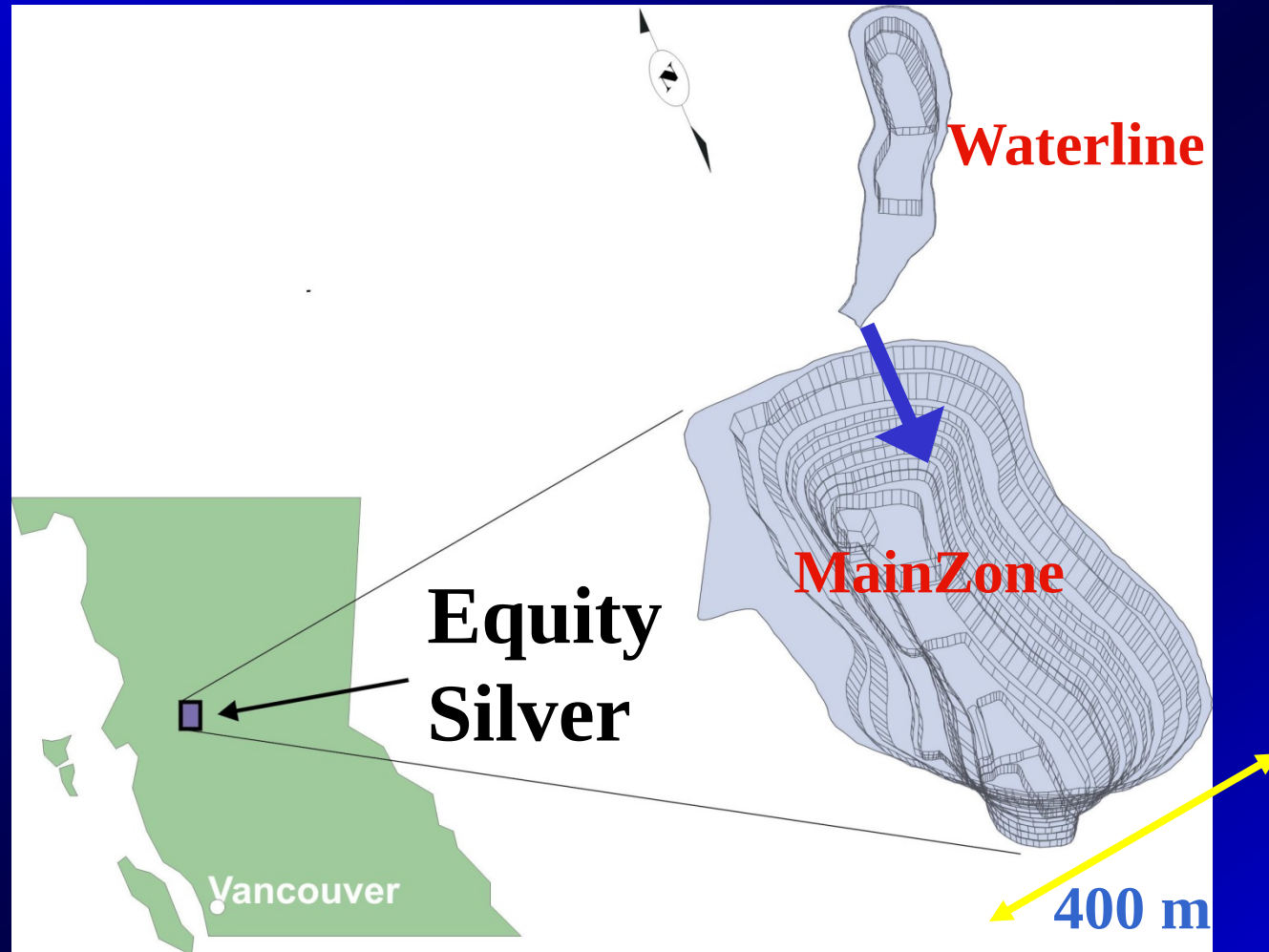
and industry



Outline

- **3-year research program overview**
- **remediation experiment design**
- **metal removal via algal blooms**
 - **surface-water metal removal
Main Zone pit**
 - **surface- and deep-water metal
removal, Waterline pit**

Site Location



Research Program Components

- **Two-year whole-lake field survey**
- **Lake manipulation in experimental enclosures (limnocorrals)**
- **Validation and improvement of coupled physical geochemical pit lake model**

Metals in Equity Pit Lakes

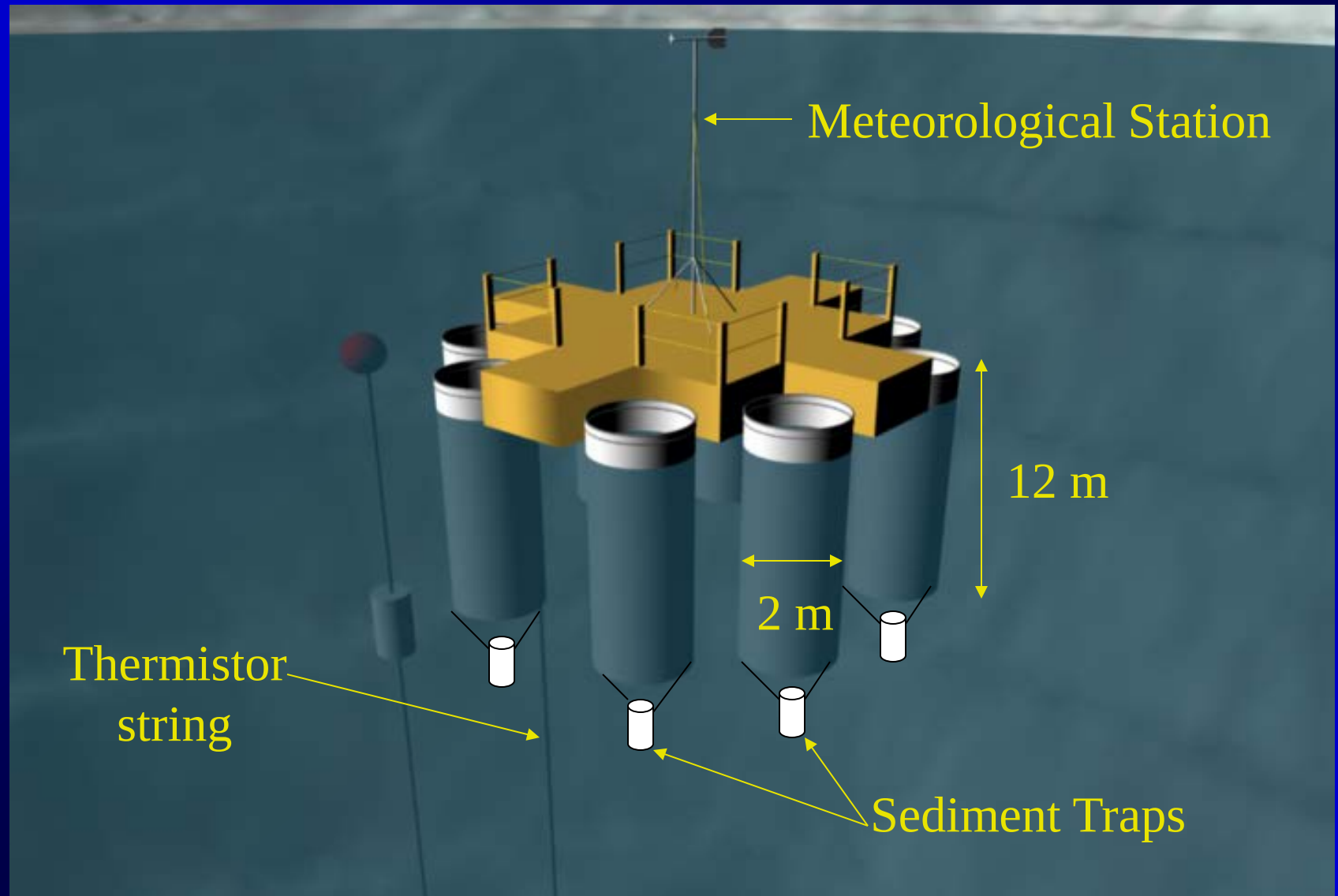
MainZone pit

- weakly stratified (seasonally)
- well oxygenated year-round
- elevated concentrations of Zn, Cd, Cu, Ni
in surface waters (seasonally)

Waterline pit

- more strongly stratified
- mildly reducing (suboxic) deep waters
- elevated concentrations of Zn, Cd, Ni
in surface waters
- elevated As & Zn concentrations in deep waters

Experimental Design



"Limnocorrals" from Raft



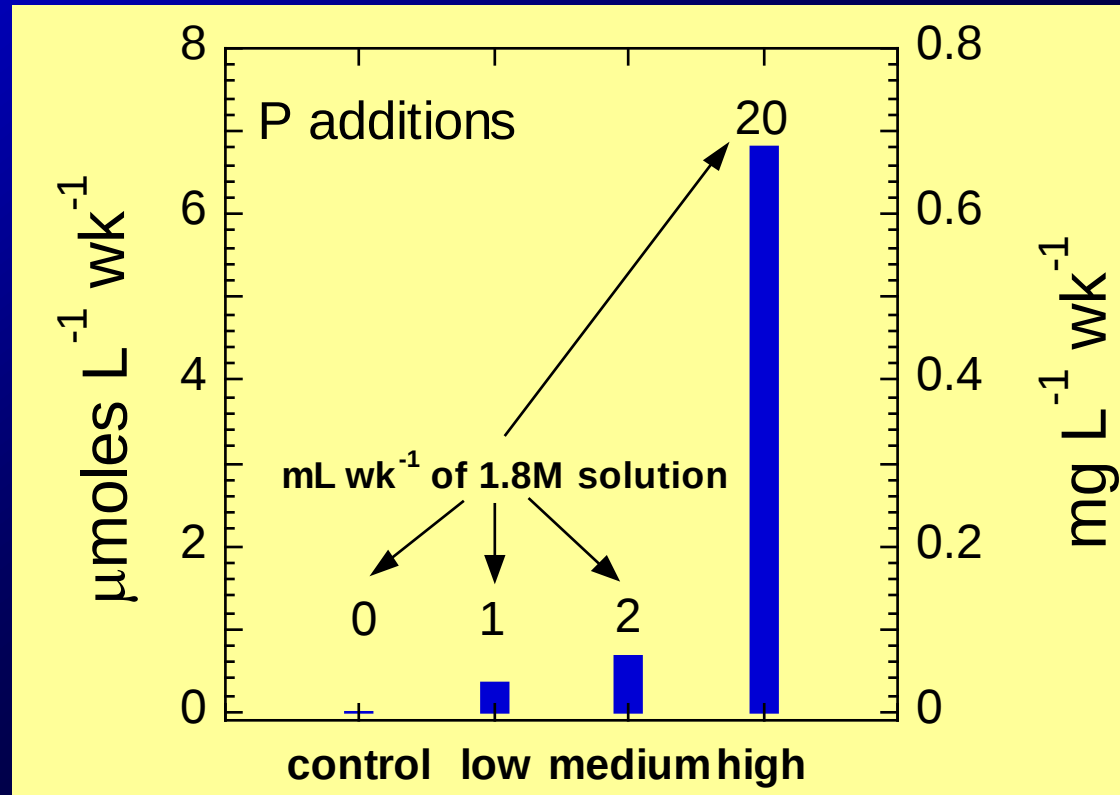
Goal - Stimulating Algal Blooms

- **metal removal from surface waters via**
 - active metal uptake by algae
 - passive metal adsorption to algae
- **metal removal from deep waters via**
 - metal sulphide precipitation (Waterline only)
- **addition of P**

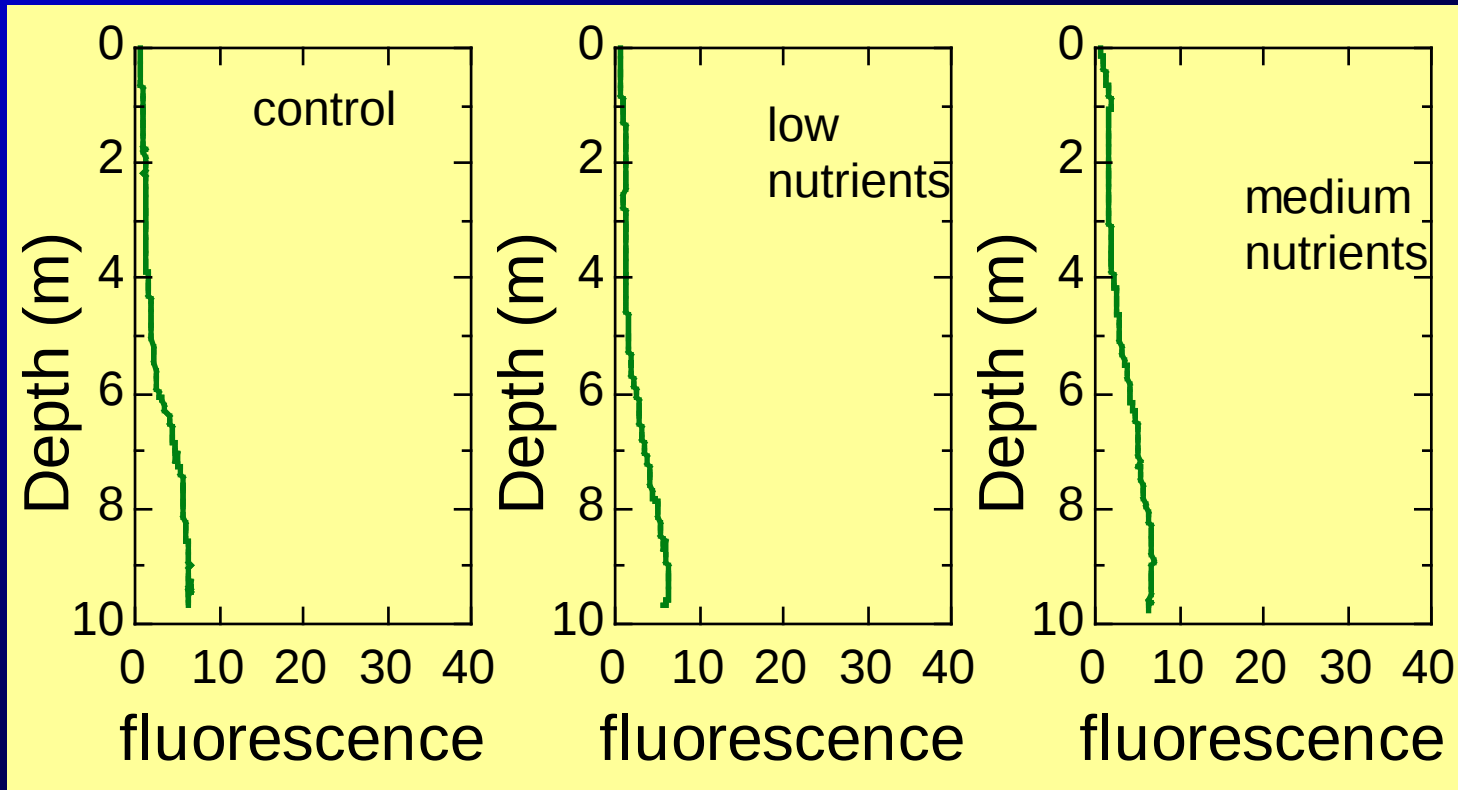
algal molar ratios

C: N : P
106: 16: 1

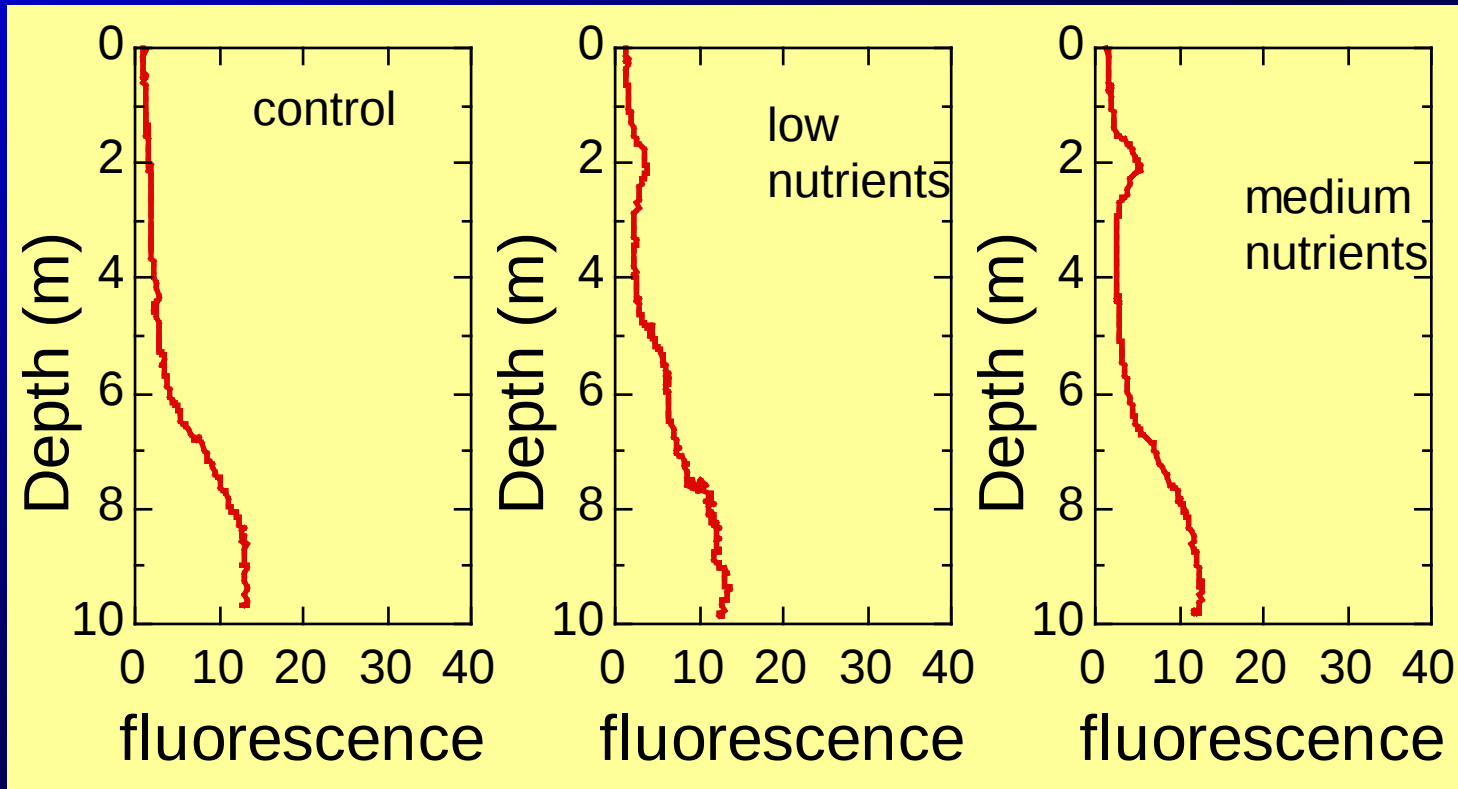
Goal- Stimulating Algal Blooms



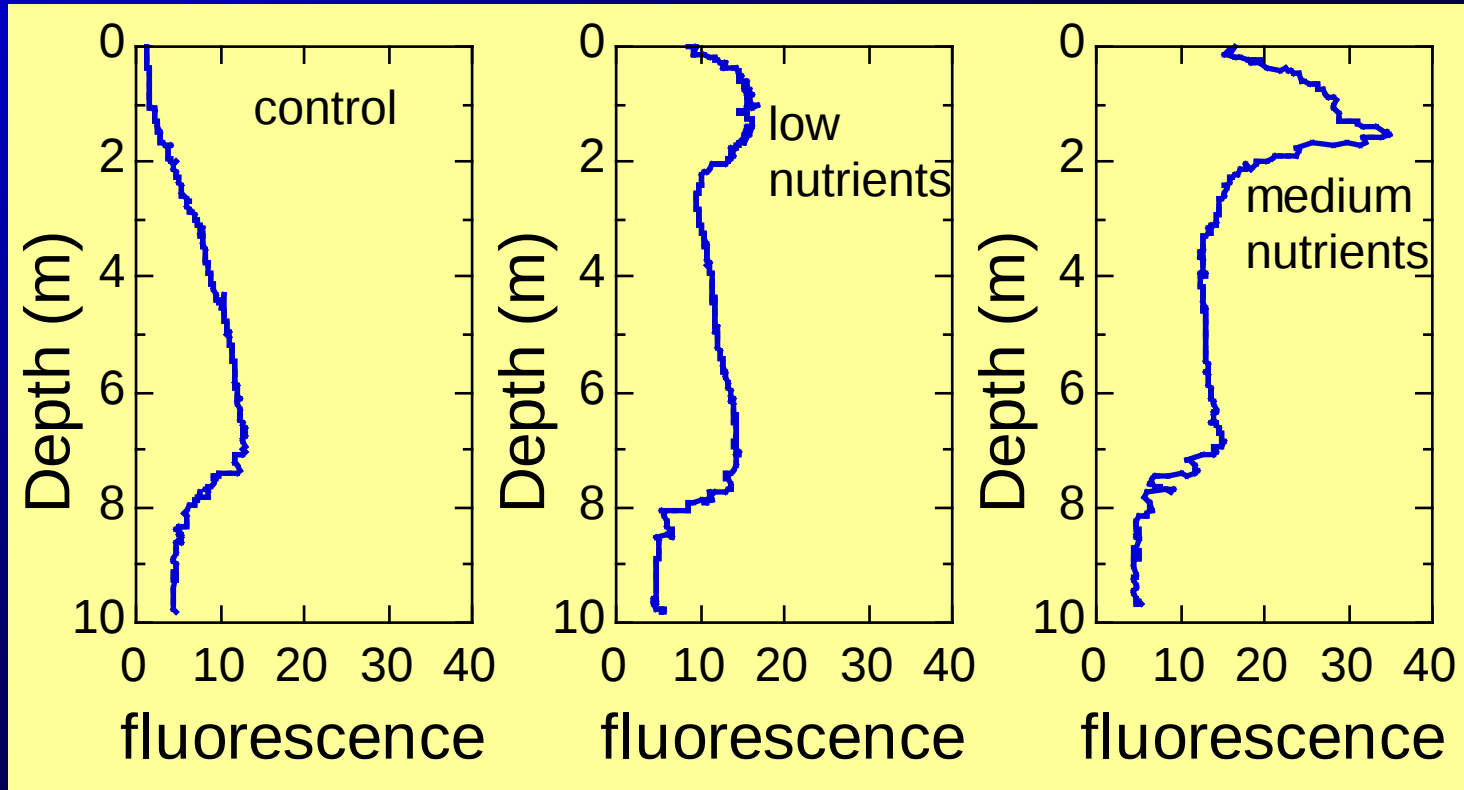
MainZone Algal Bloom- June 28



MainZone Algal Bloom- July 2



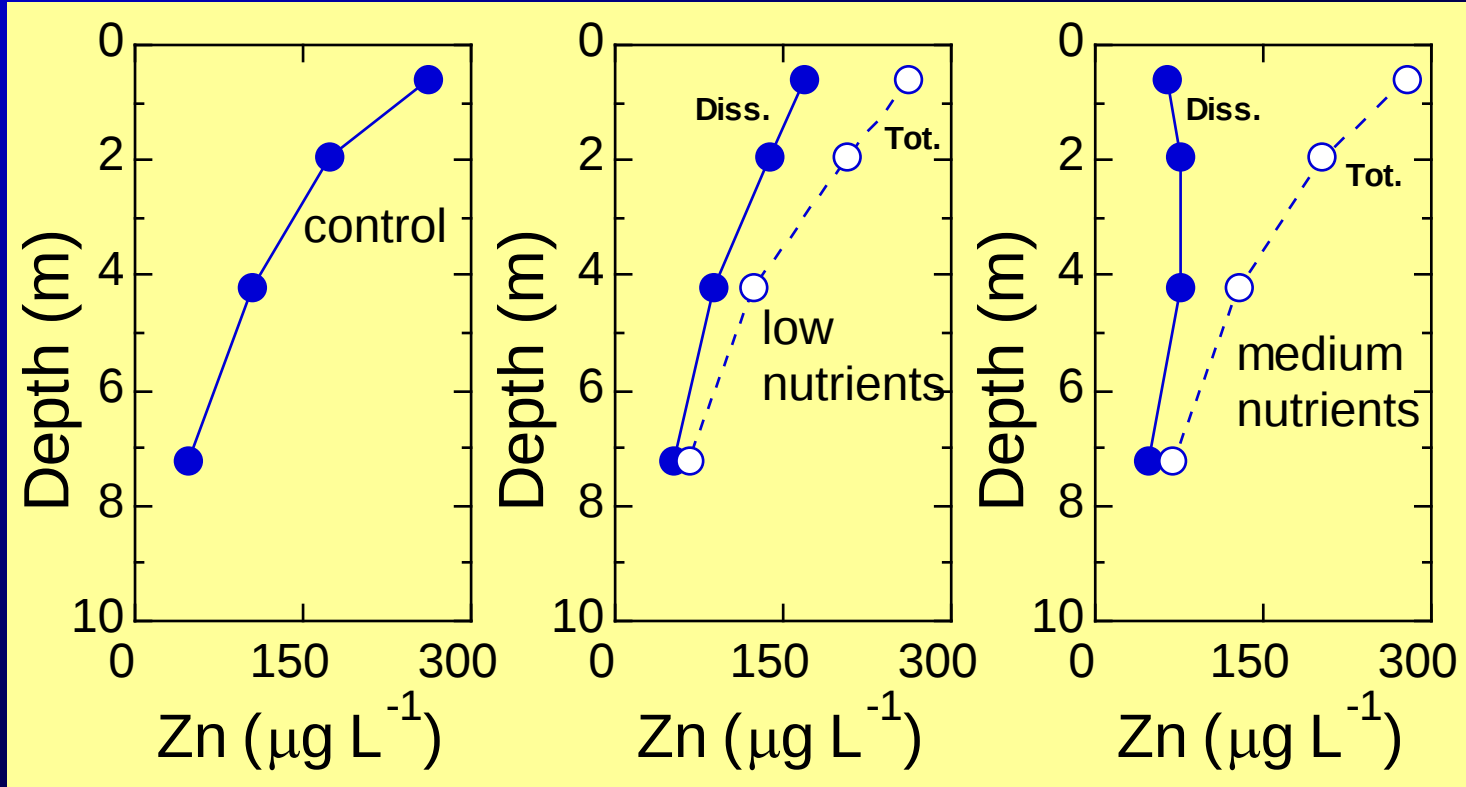
MainZone Algal Bloom- July 8



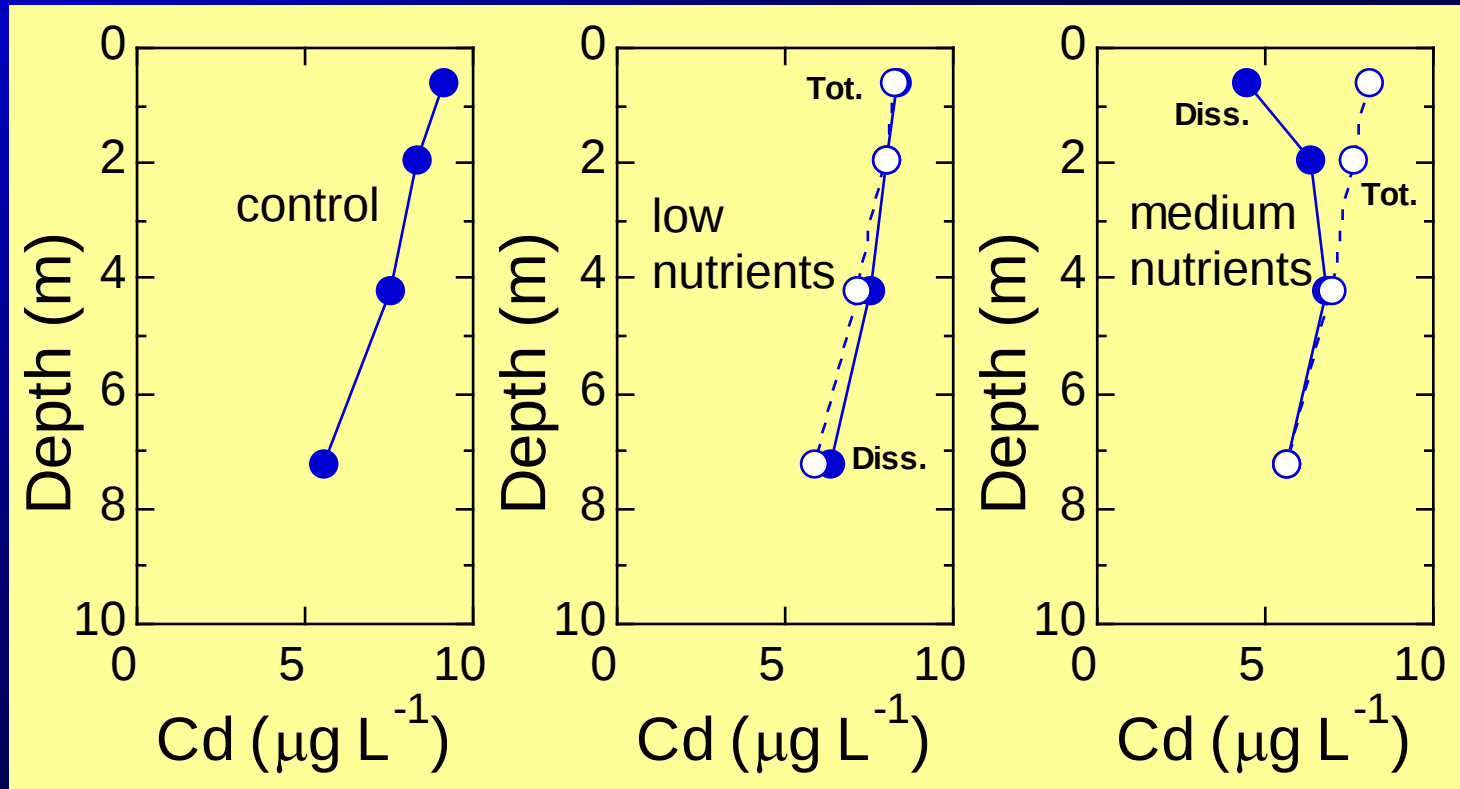
A "Eutrophic" Limnocorral



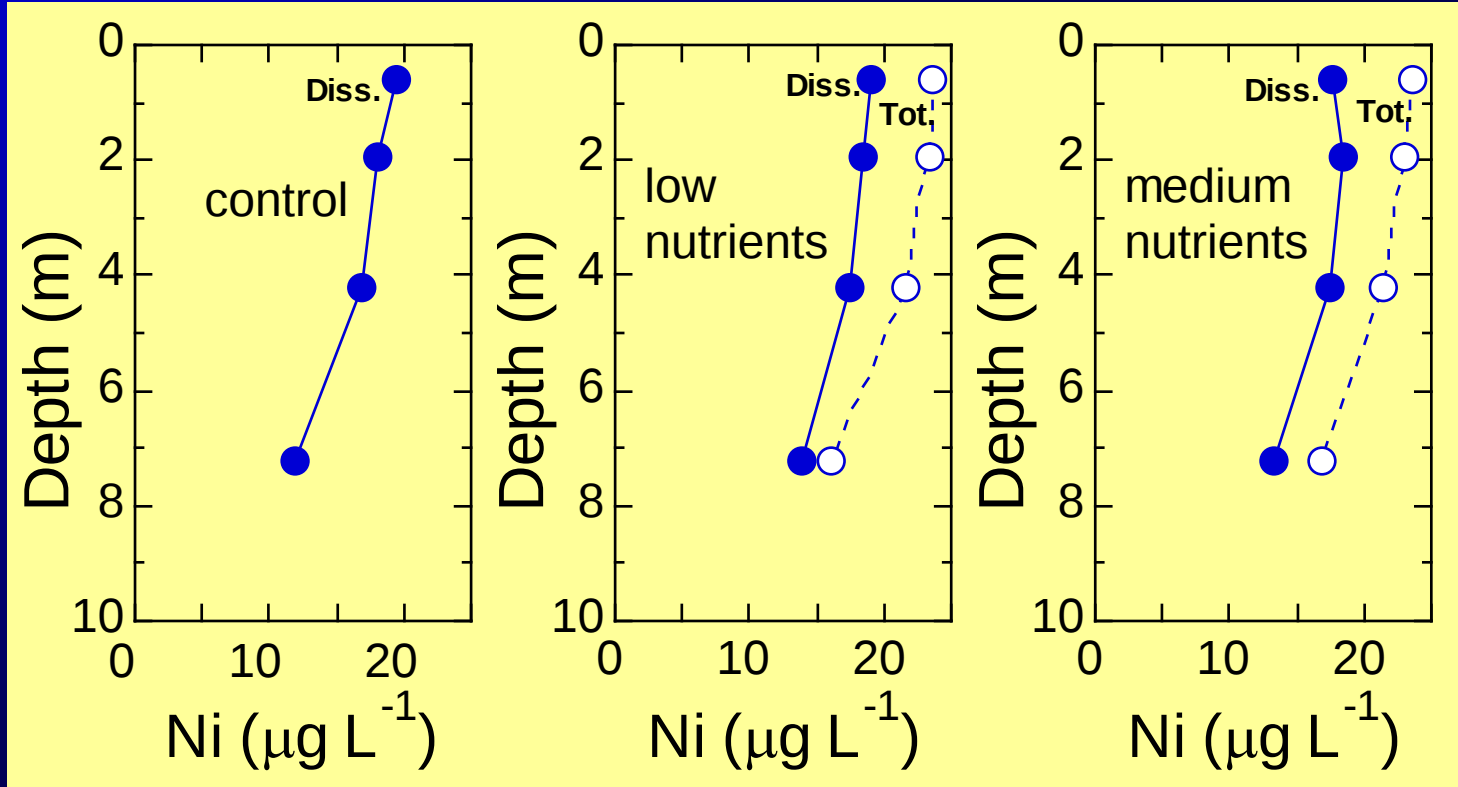
MainZone July 24- After ~4 weeks



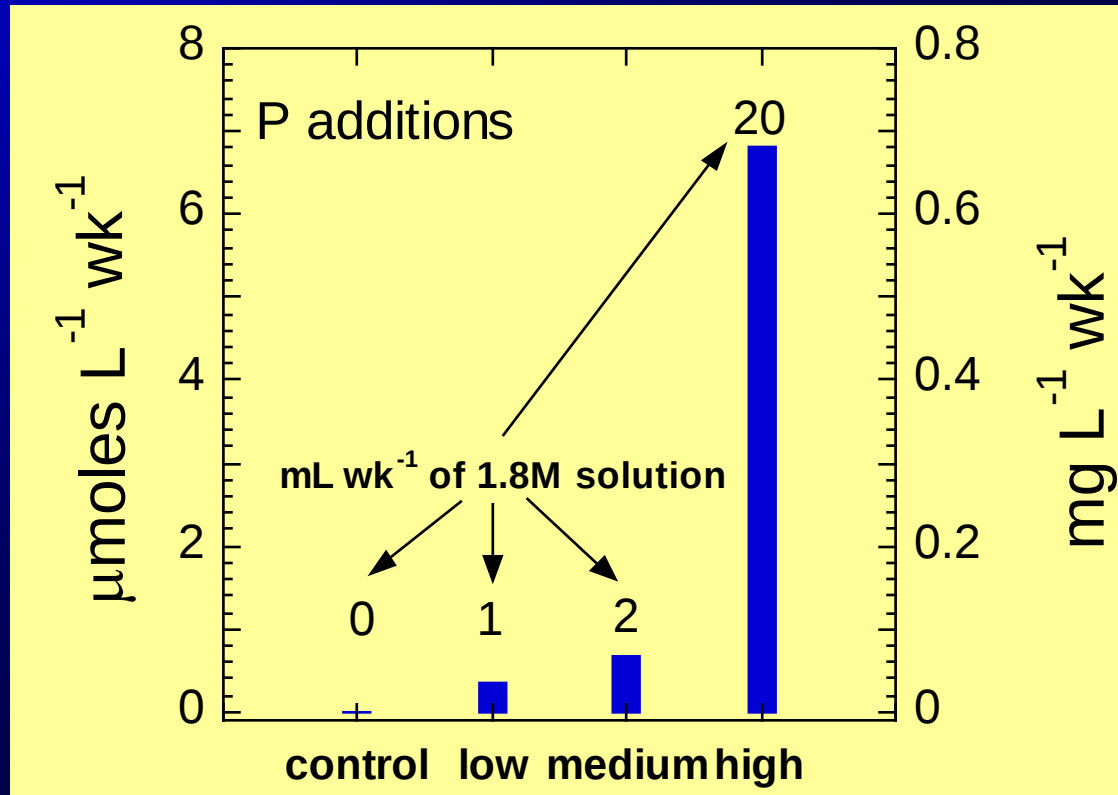
MainZone July 24- After ~4 weeks



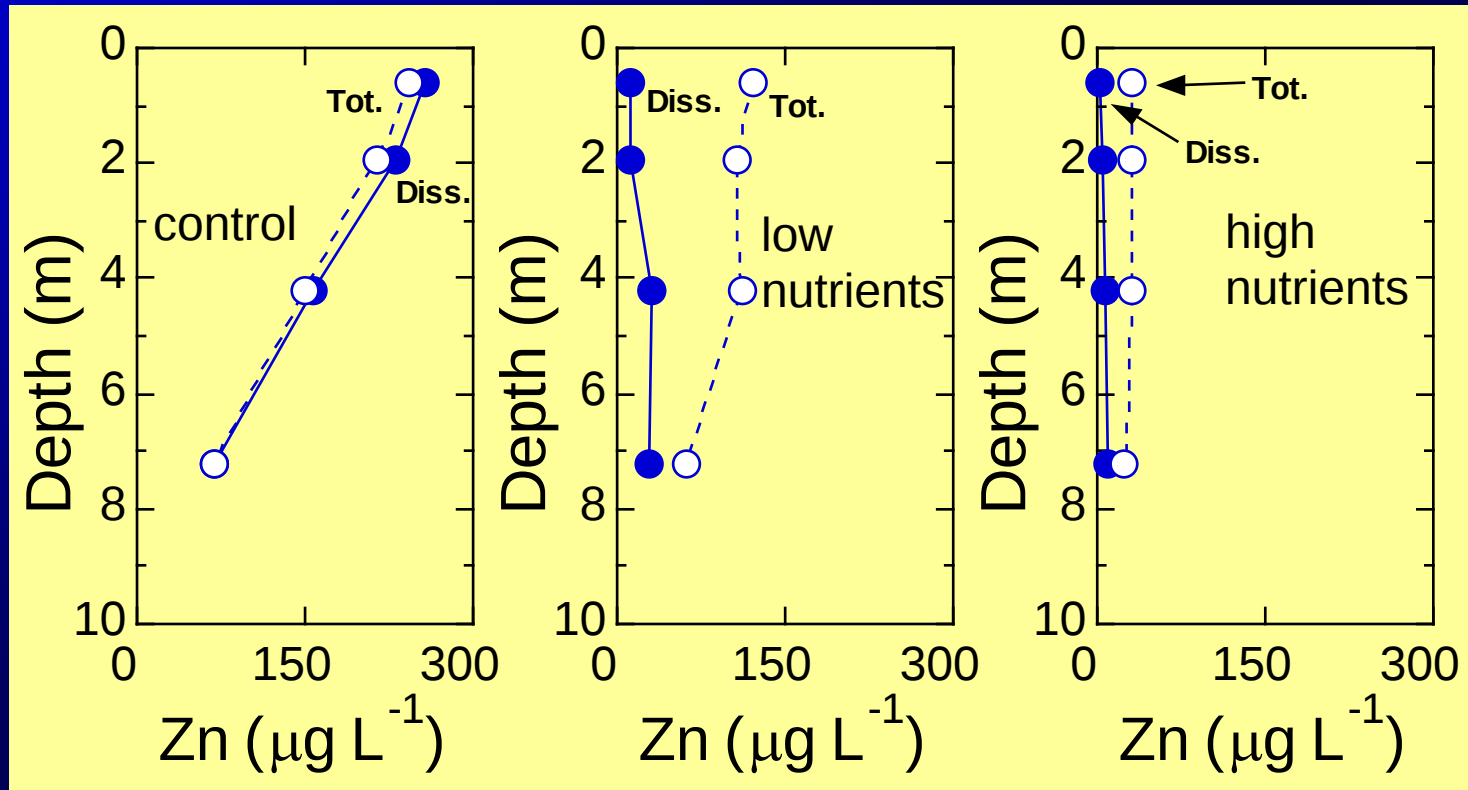
MainZone July 24- After ~4 weeks



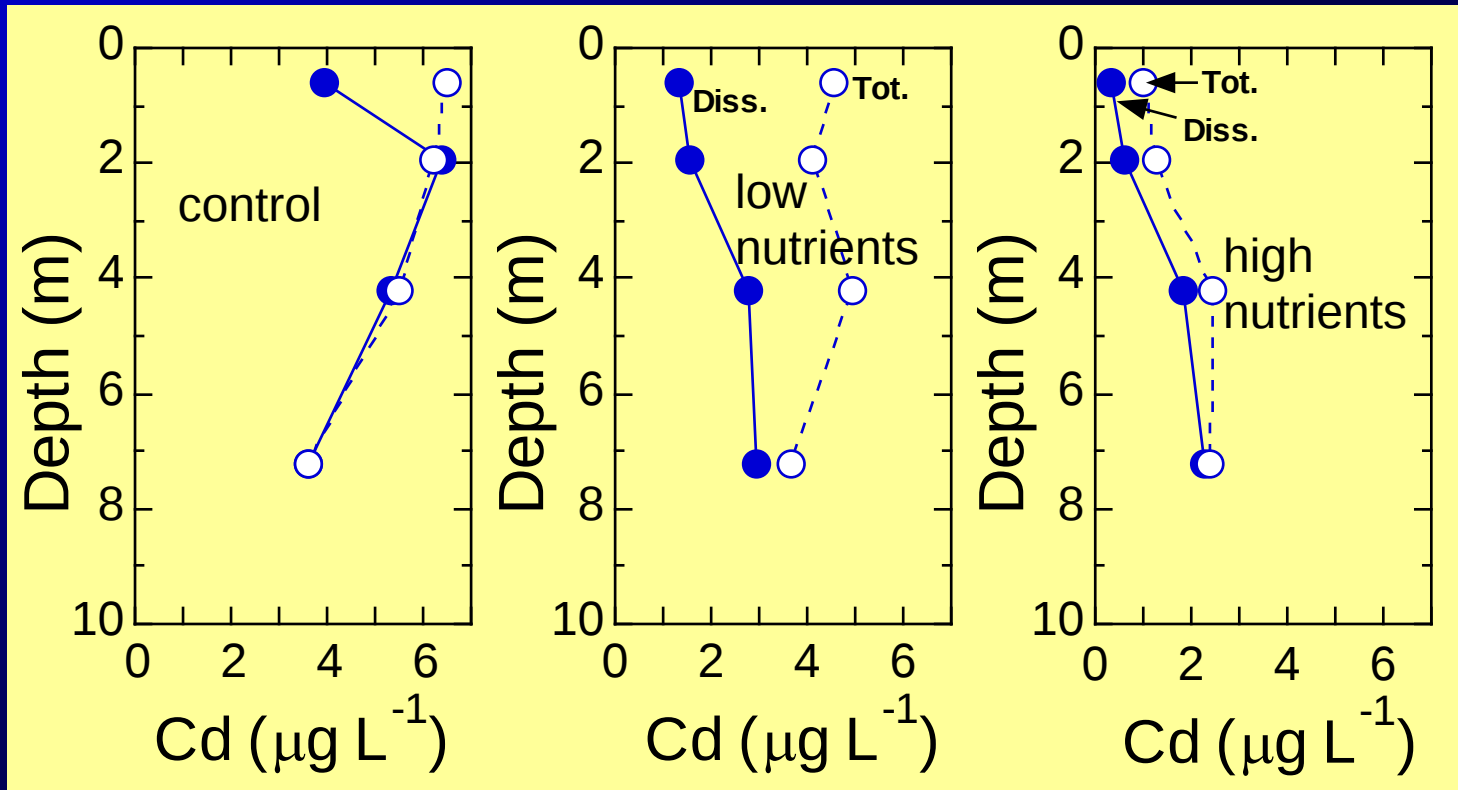
Goal- Stimulating Algal Blooms



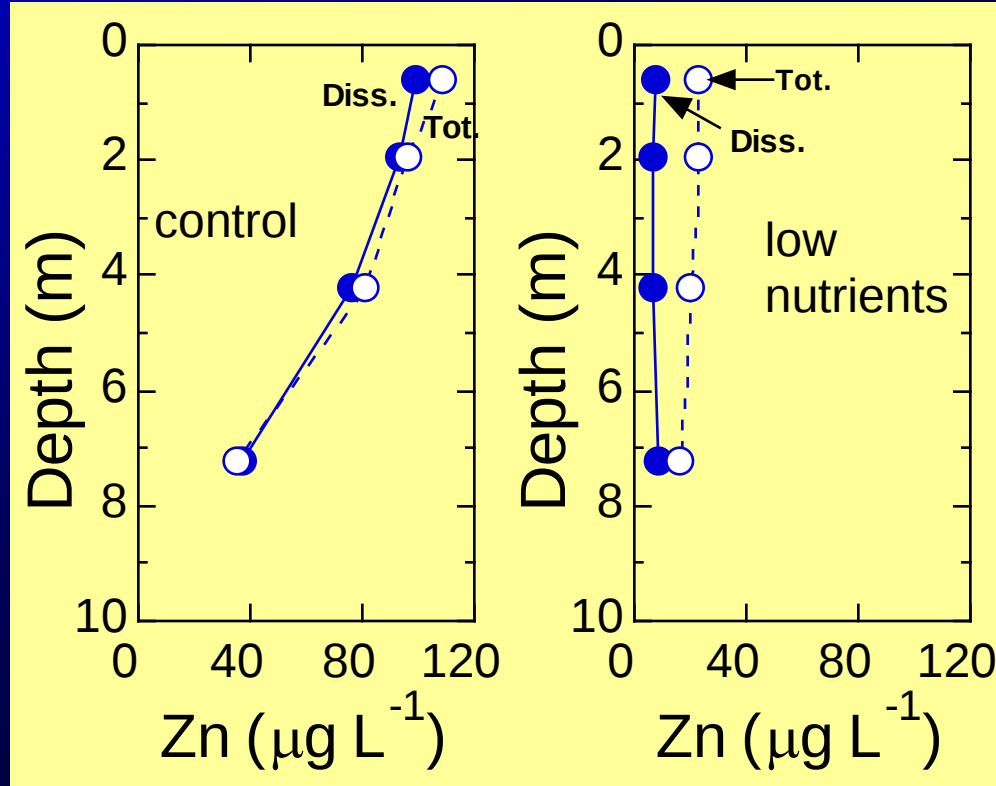
MainZone August 22 - After ~2 months



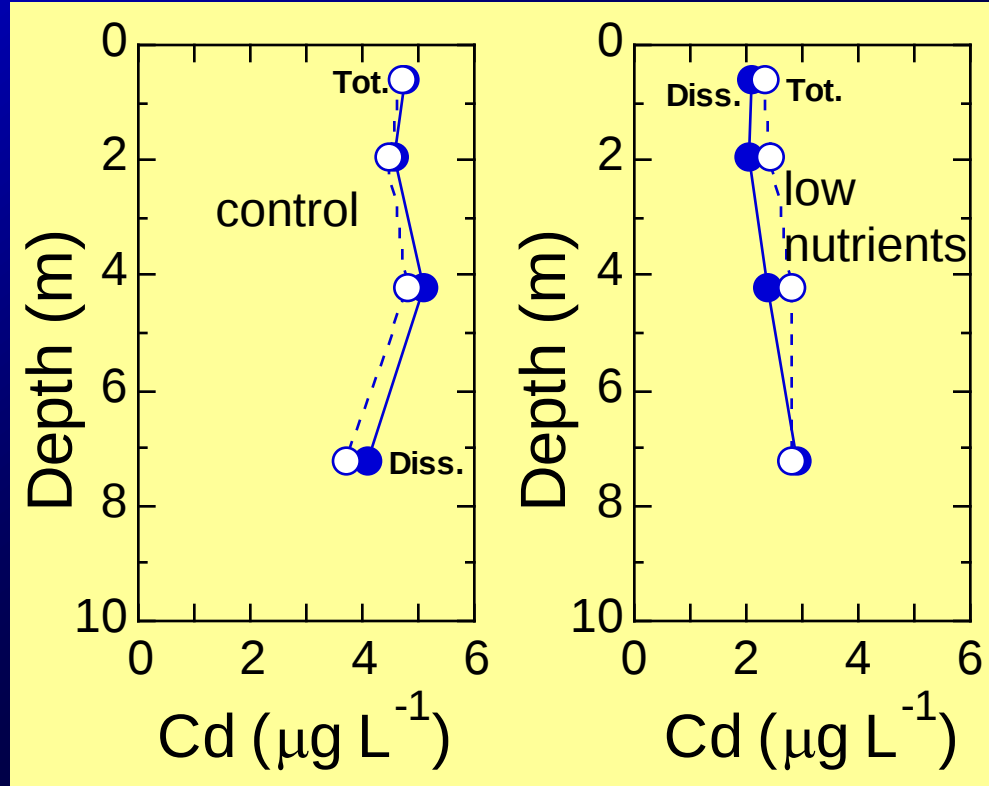
MainZone August 22 - After ~2 months



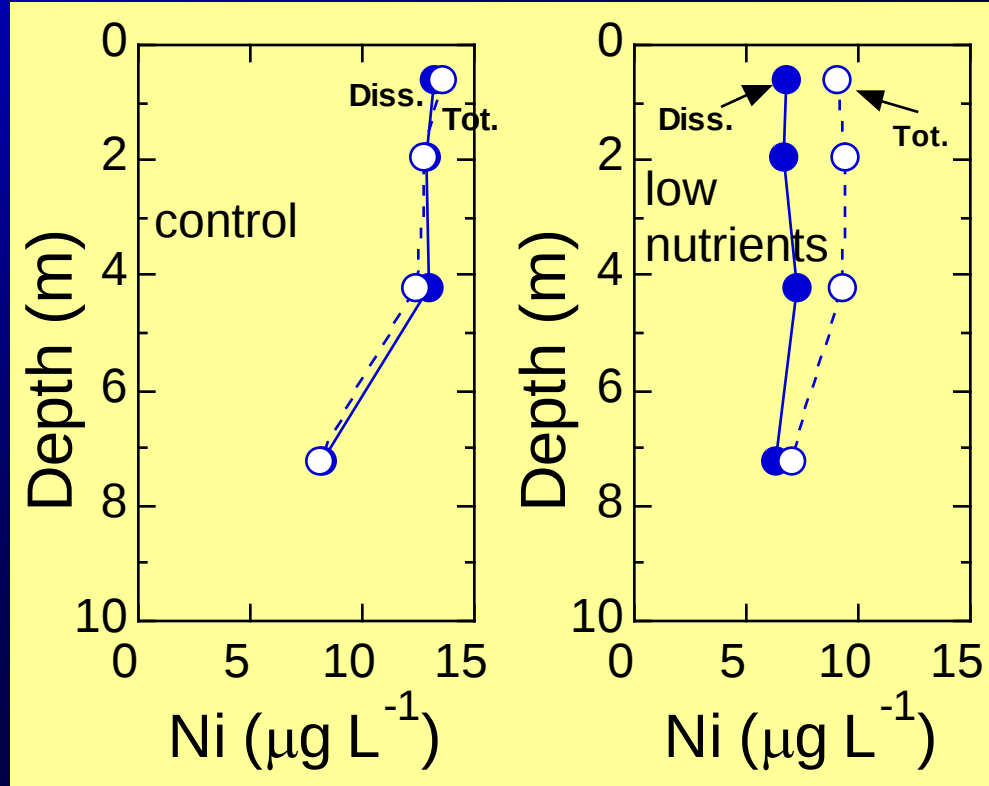
MainZone September 20 - After ~3 months



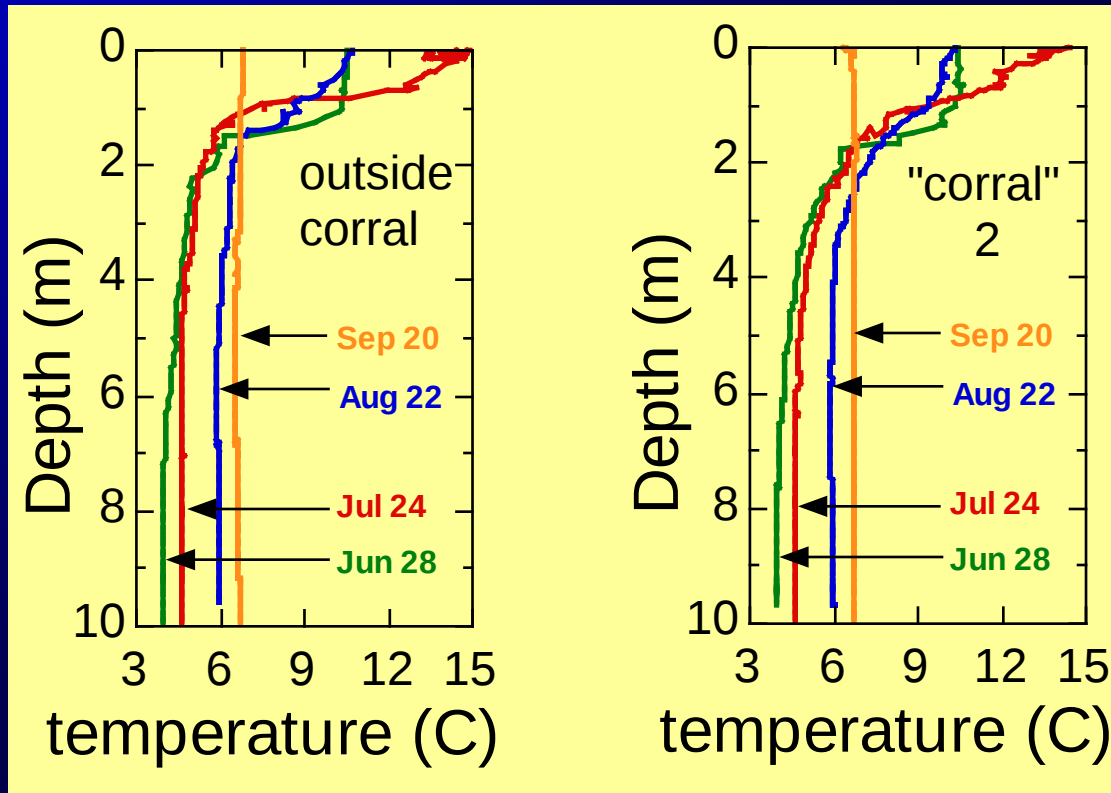
MainZone September 20 - After ~3 months



MainZone September 20 - After ~3 months

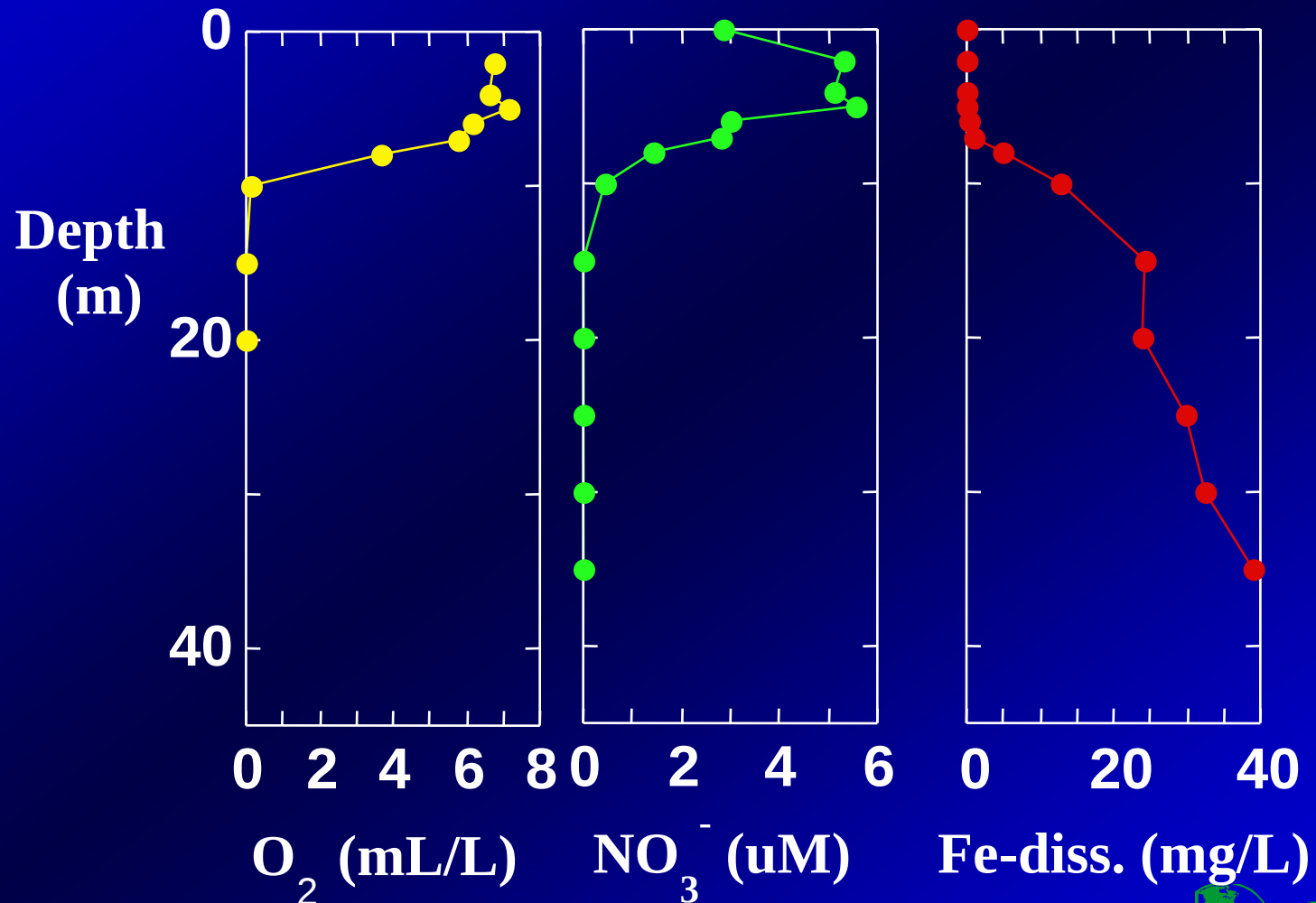


Downward Mixing

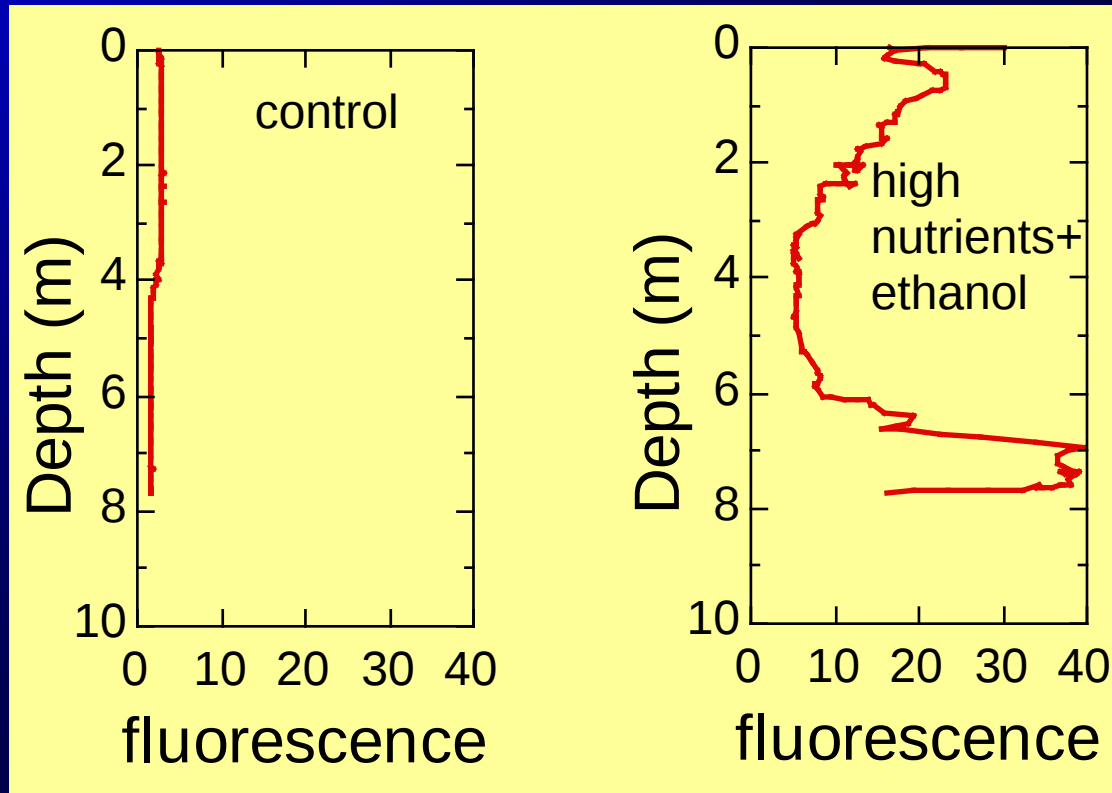


Waterline Pit Redox Conditions

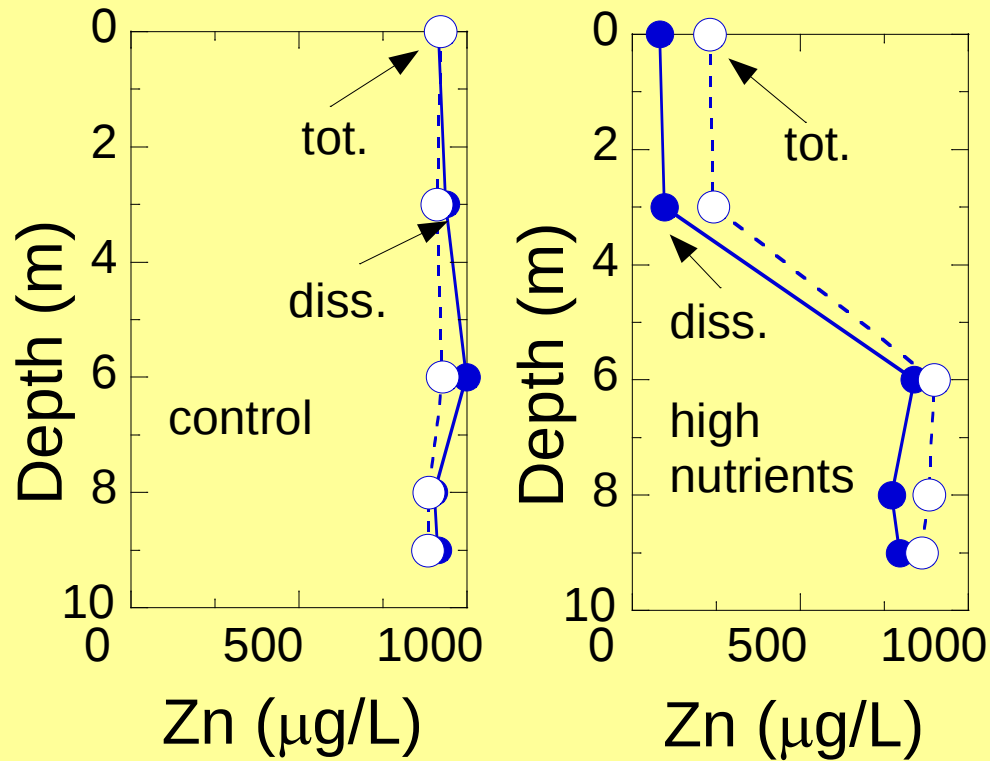
October



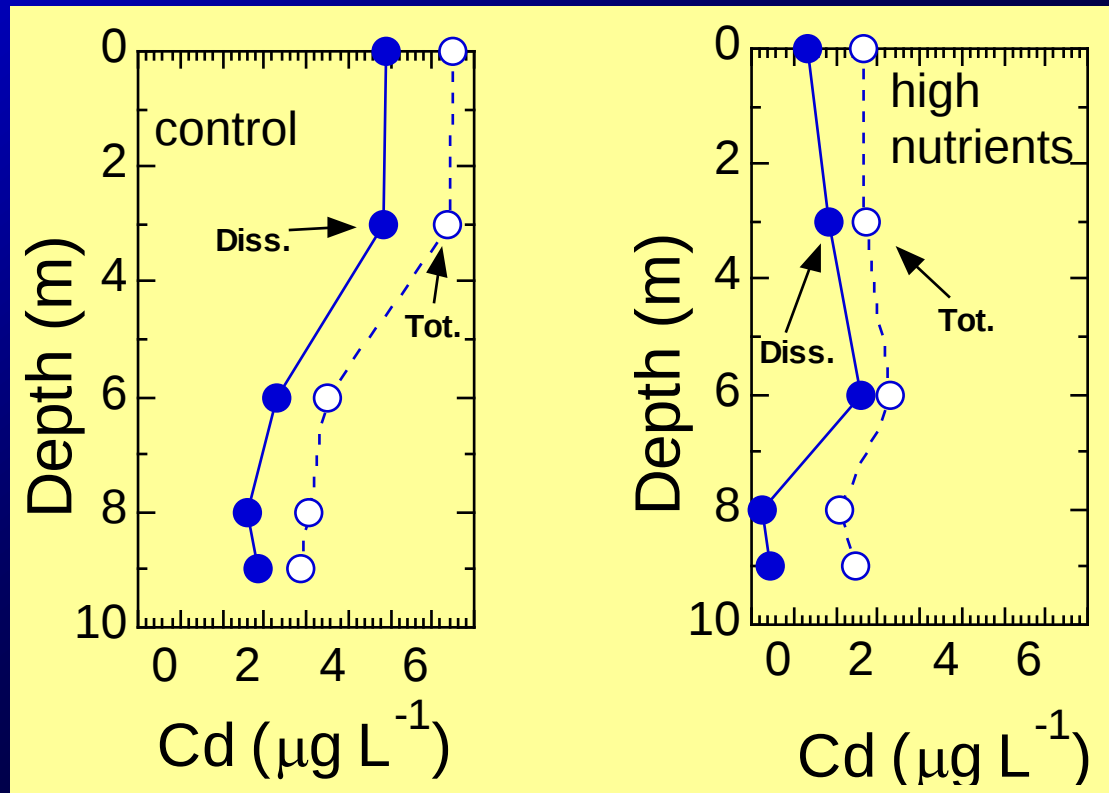
Waterline Algal Blooms (Aug 28)



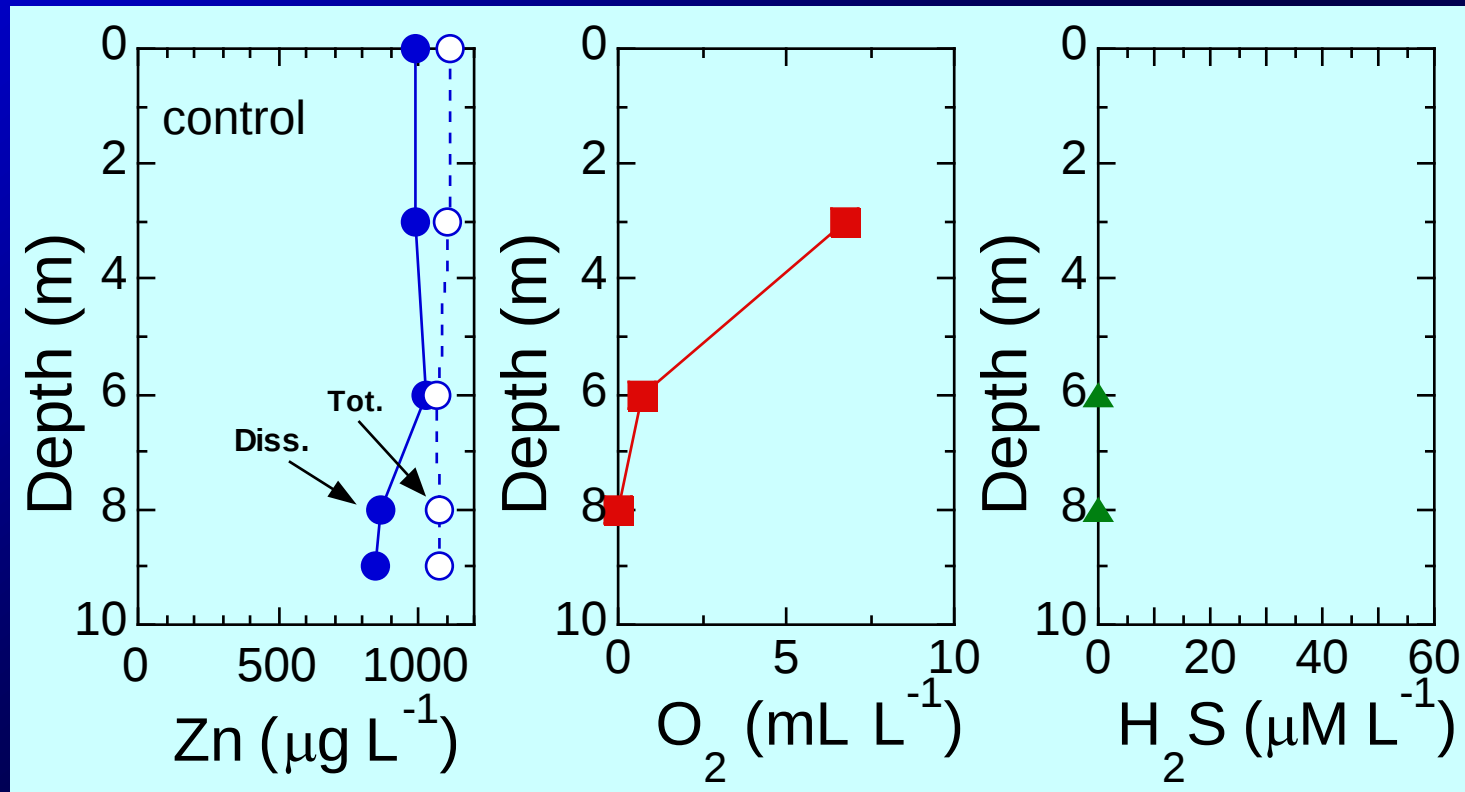
Waterline- August 28



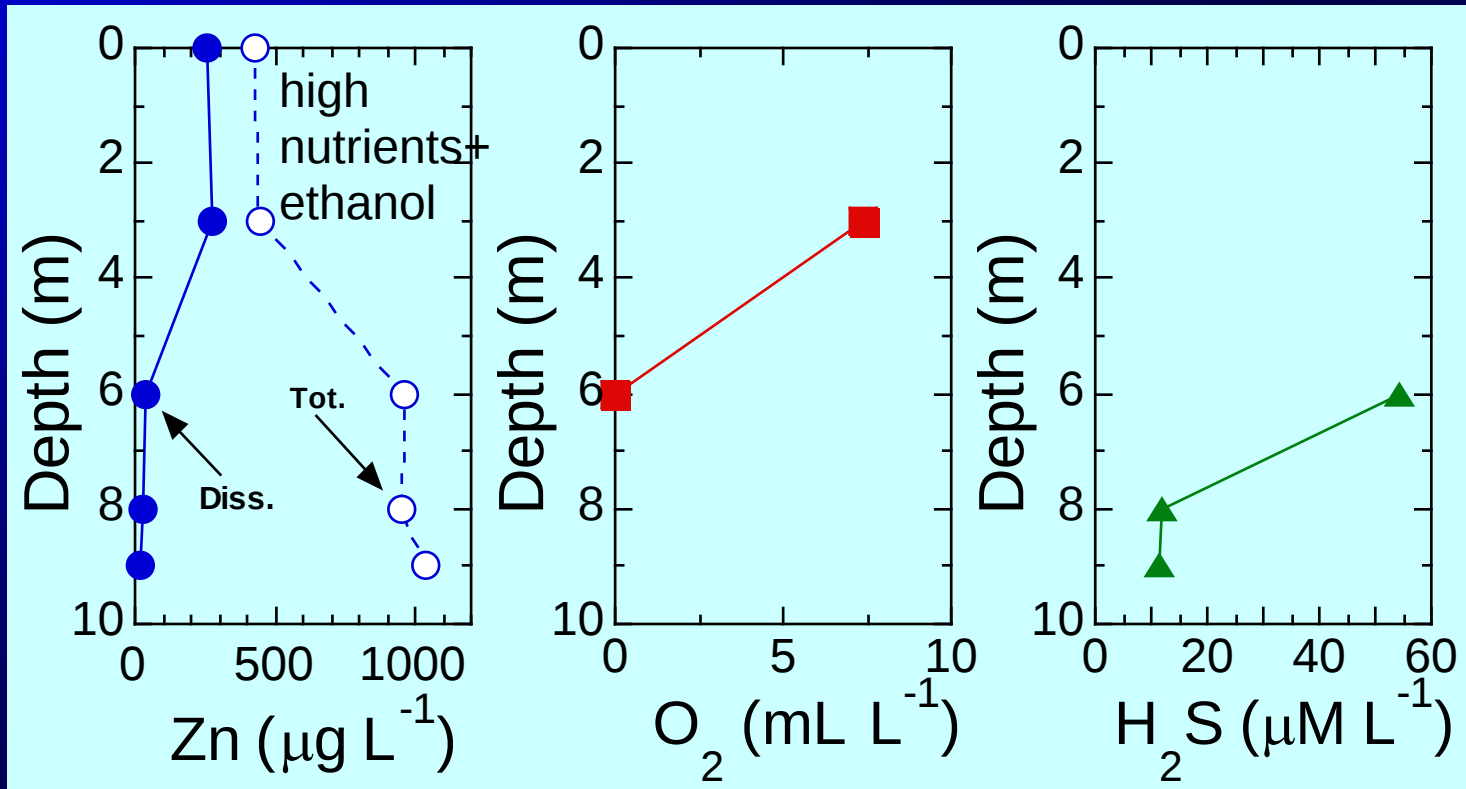
Waterline- August 28



Waterline Control- 17 September



Waterline High Nutrients- September 17



Costs

Costs

Summary

- algal blooms initiated with additions of small amounts of P (and N)
- significant removal of Zn and Cd from surface waters of Main Zone and Waterline
- little export of C_{org} (to date) to deep waters of Waterline
- hydrogen sulphide produced by additions of nutrients (to surface water) and ethanol (to deep water) leading to substantial removal of Zn from deep waters
- no removal (yet) of As from deep water due to limited sinking of C_{org} , high [Fe] in deep water