Patterns of Mercury Cycling in the Profundal Zone of Hodges Reservoir, California

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Presentation Outline

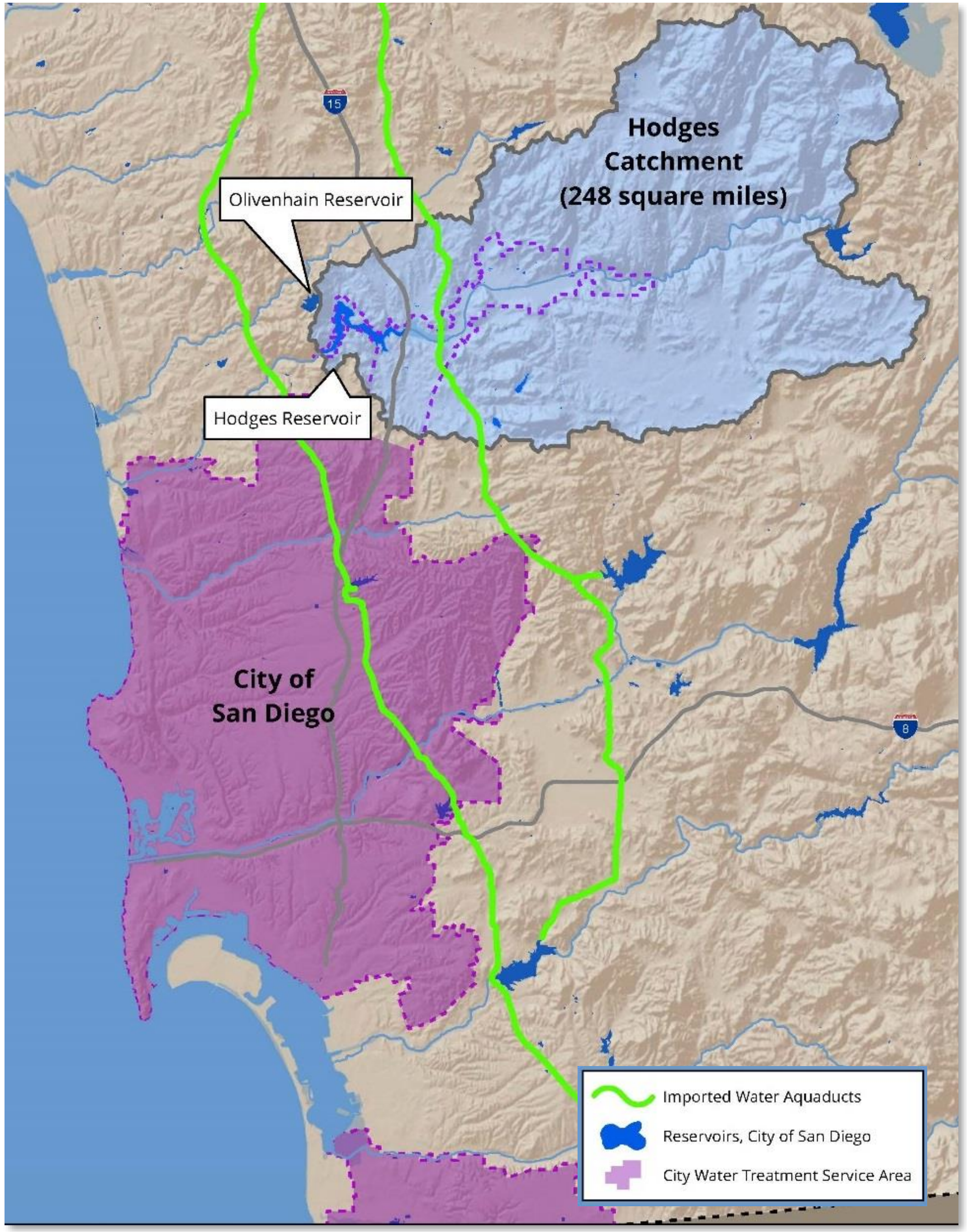
- Project Background & Objectives
- Study Site
- Mercury Cycling
- Experimental Results
- 2017 In Situ Monitoring Results
- Conclusions

Project Background & Objectives

- California regulators are implementing a **Statewide Mercury Control Program for Reservoirs** to protect human and wildlife health
- State is asking reservoir managers to implement **pilot studies** to reduce mercury in fish focusing on managing water chemistry and food webs
- San Diego is implementing an **oxygenation project in Hodges Reservoir** as part of comprehensive water quality improvement program
- We performed a **laboratory sediment flux study** to assess response of profundal sediment under oxic versus anoxic conditions
- We are also performing an **ongoing field studies** to assess impacts of oxygenation on water quality and mercury cycling

Hodges Reservoir

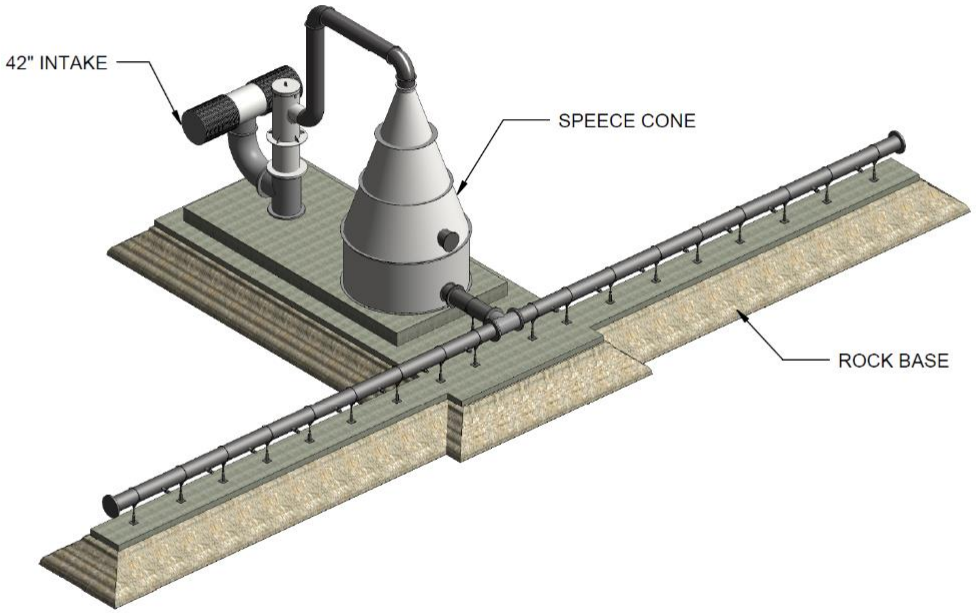
- Backup water supply reservoir
- 37 million m^3 volume
- 35 m maximum depth
- 64,000 hectare watershed
- Urban and agriculture
- Degraded water quality
- Oxygenation in 2019



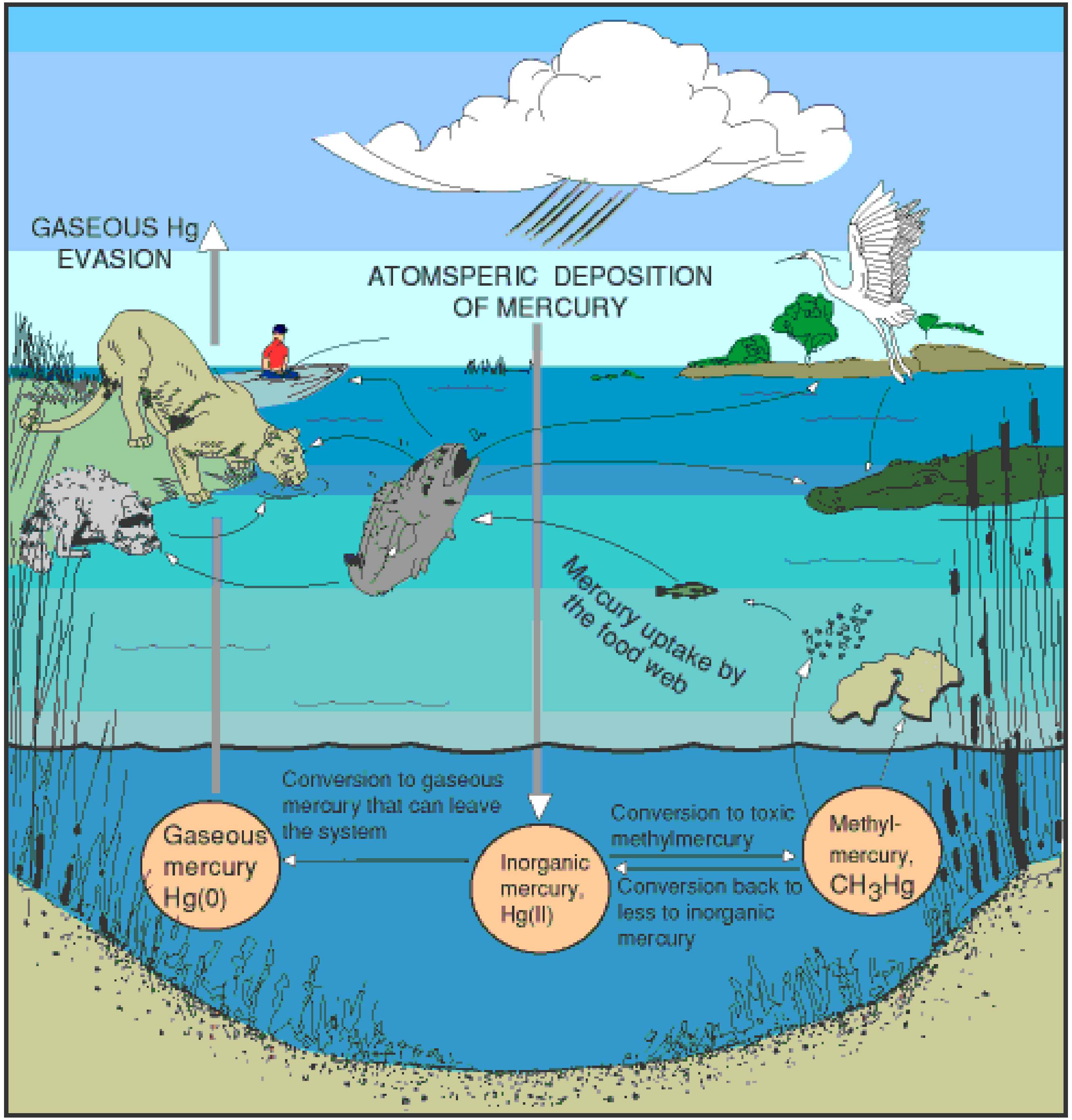
Hodges Reservoir

Hodges Oxygenation

- On-shore LOX storage
- Submerged cone near dam
- 8 tons of oxygen per day
- $4 million construction cost



Mercury Cycle



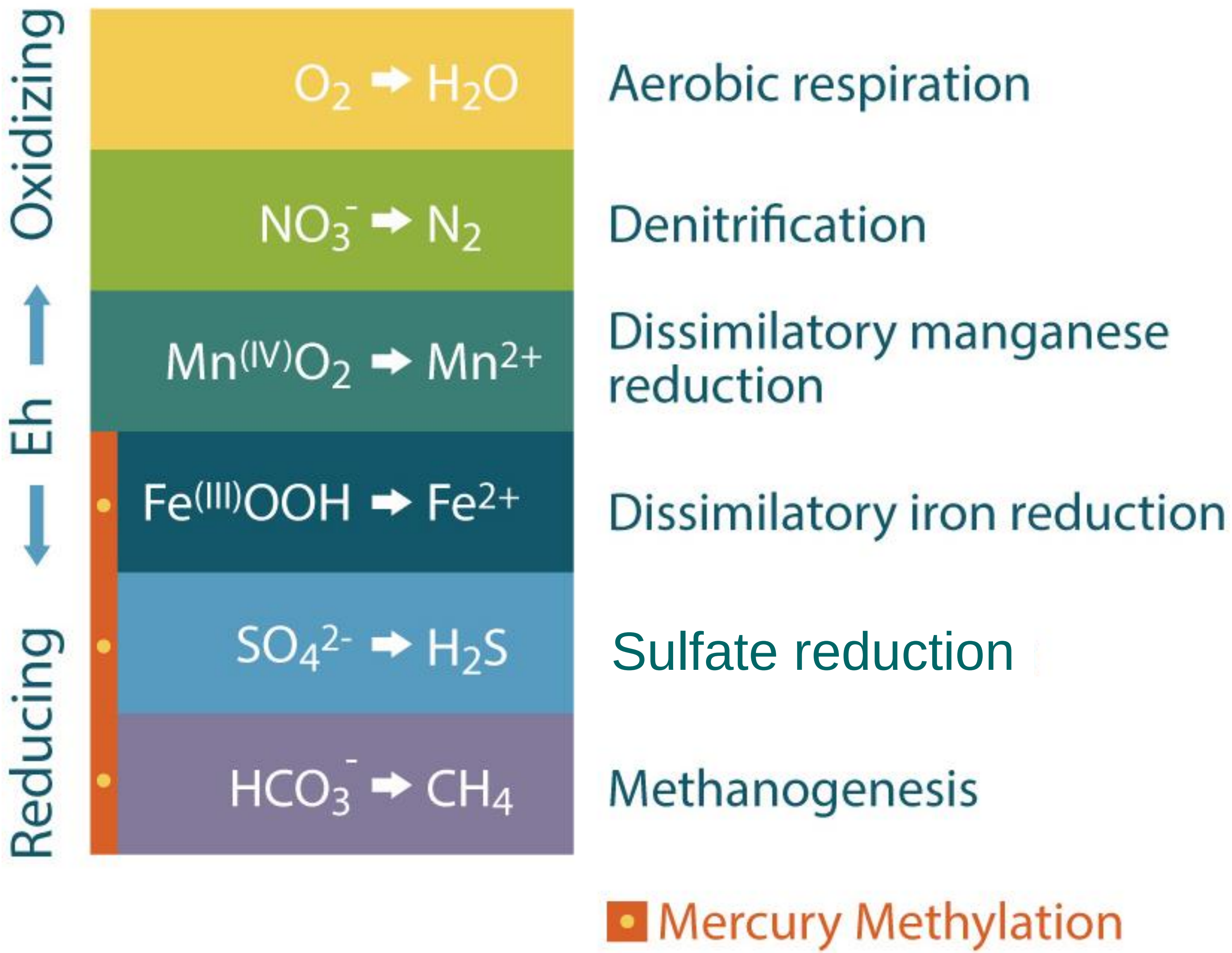
Bioavailable Hg(II)

Active sulfate-reducing bacteria

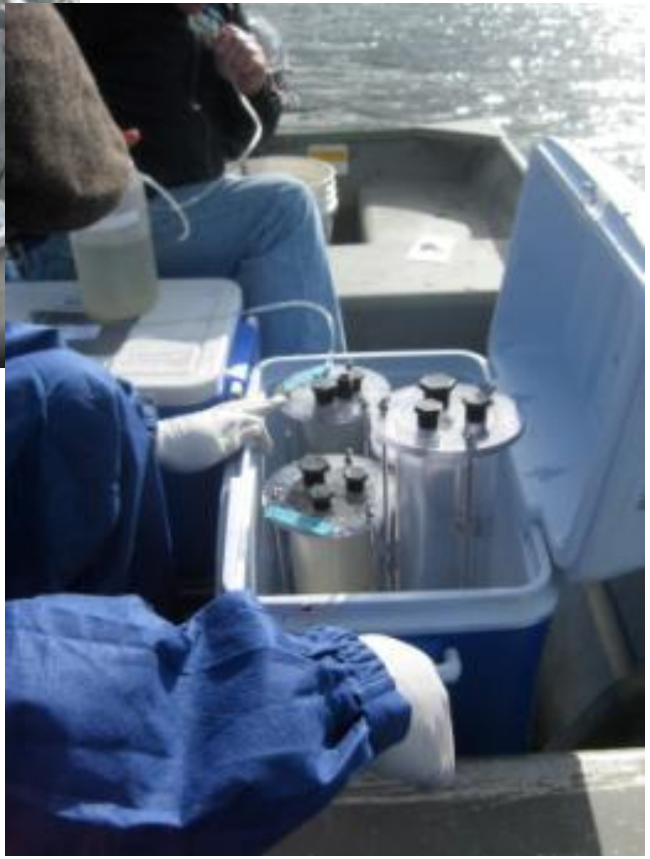
Methylation > demethylation

Mercury Cycle

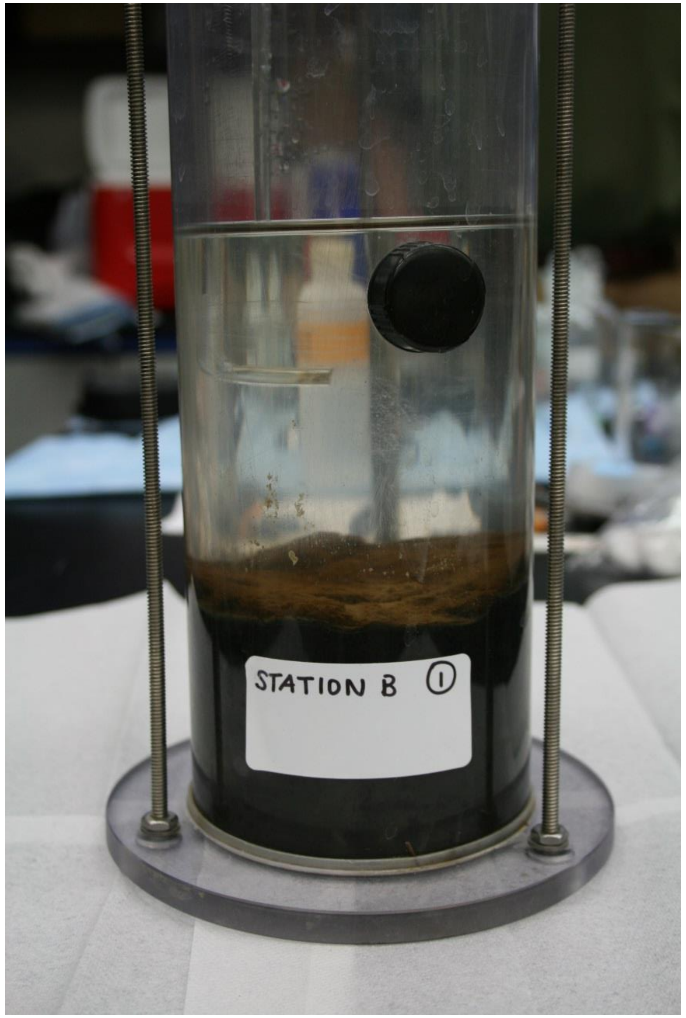
Synergy with internal loading of nutrients, manganese and iron



Chamber Incubations

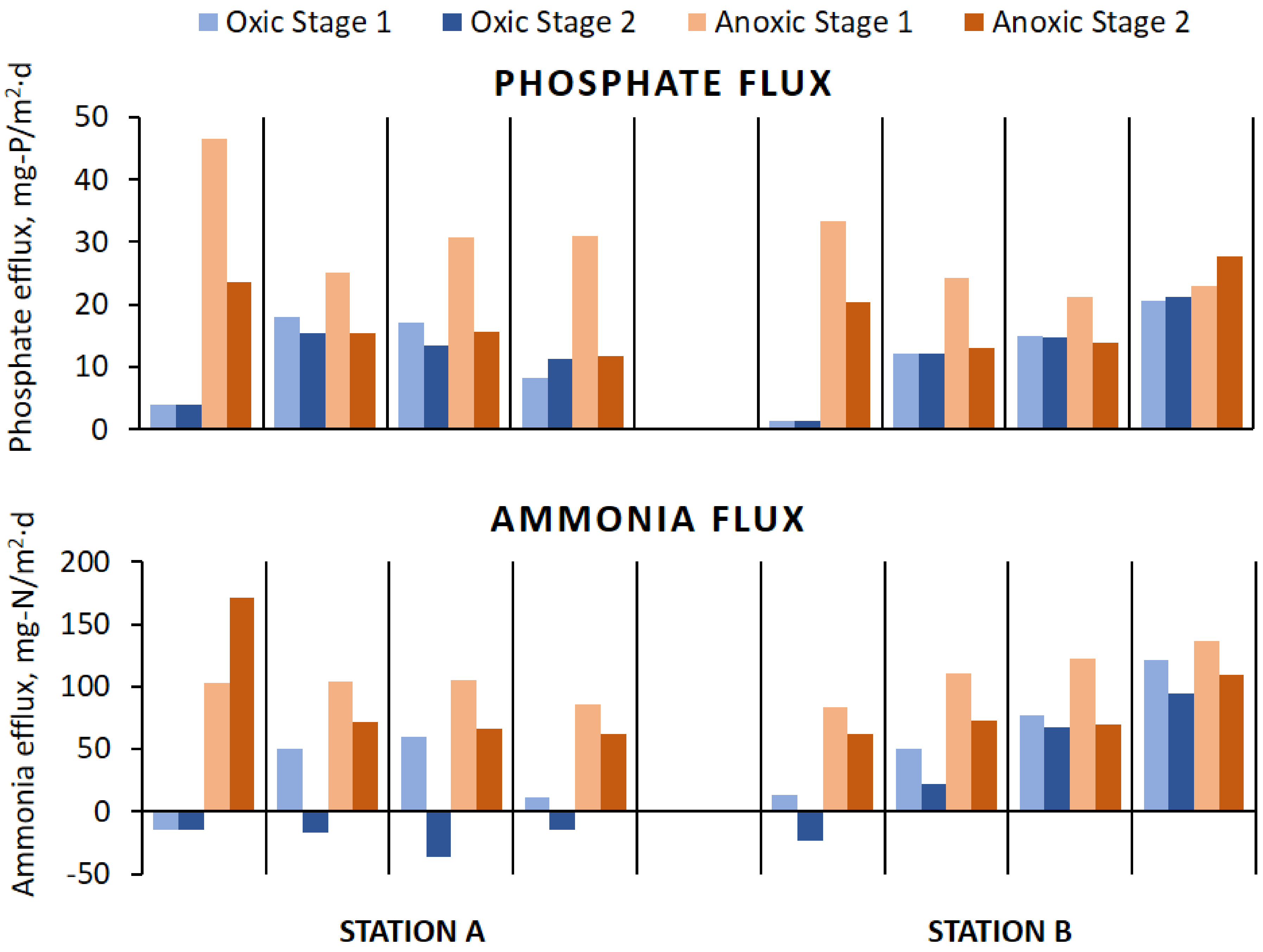


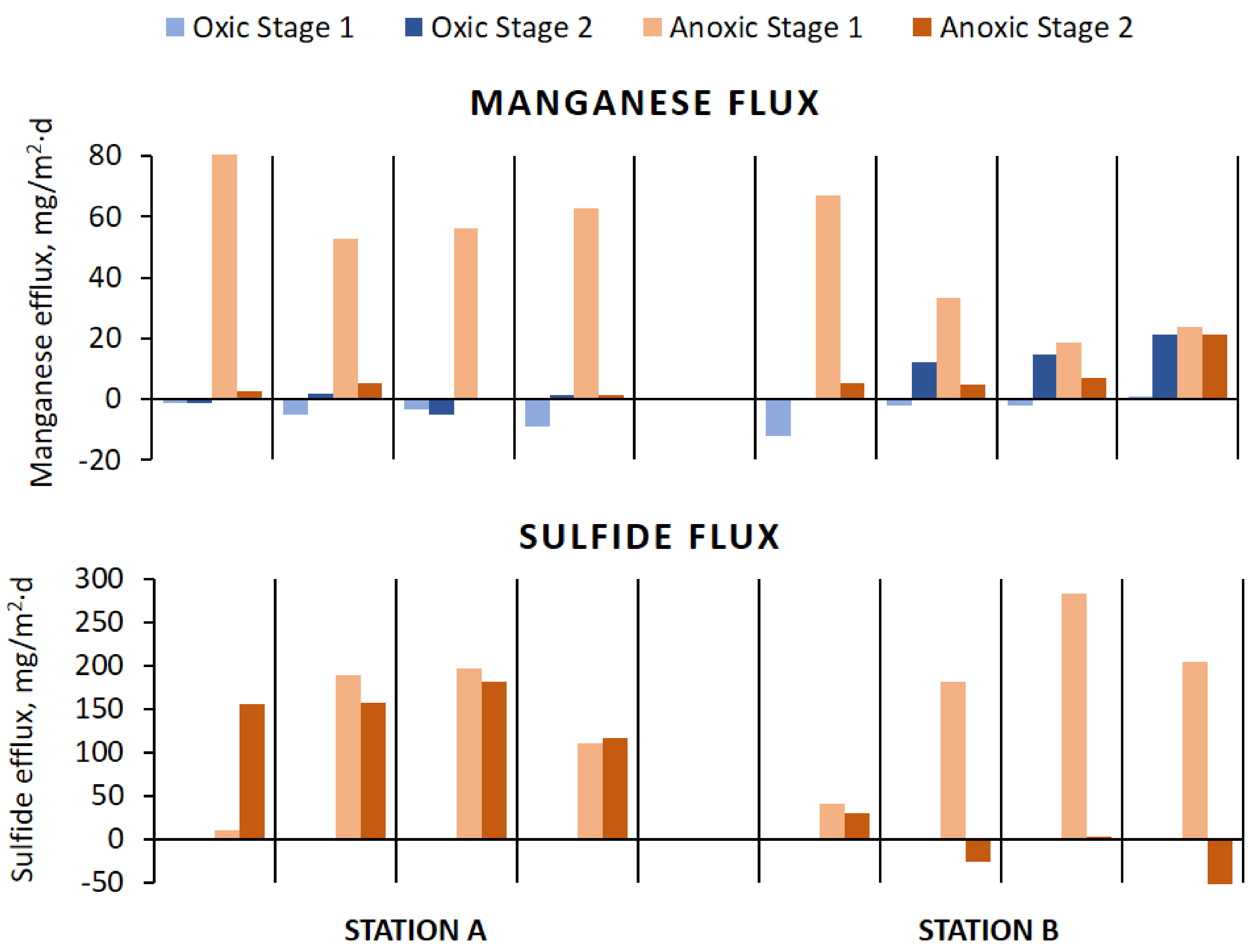
Chamber Incubations



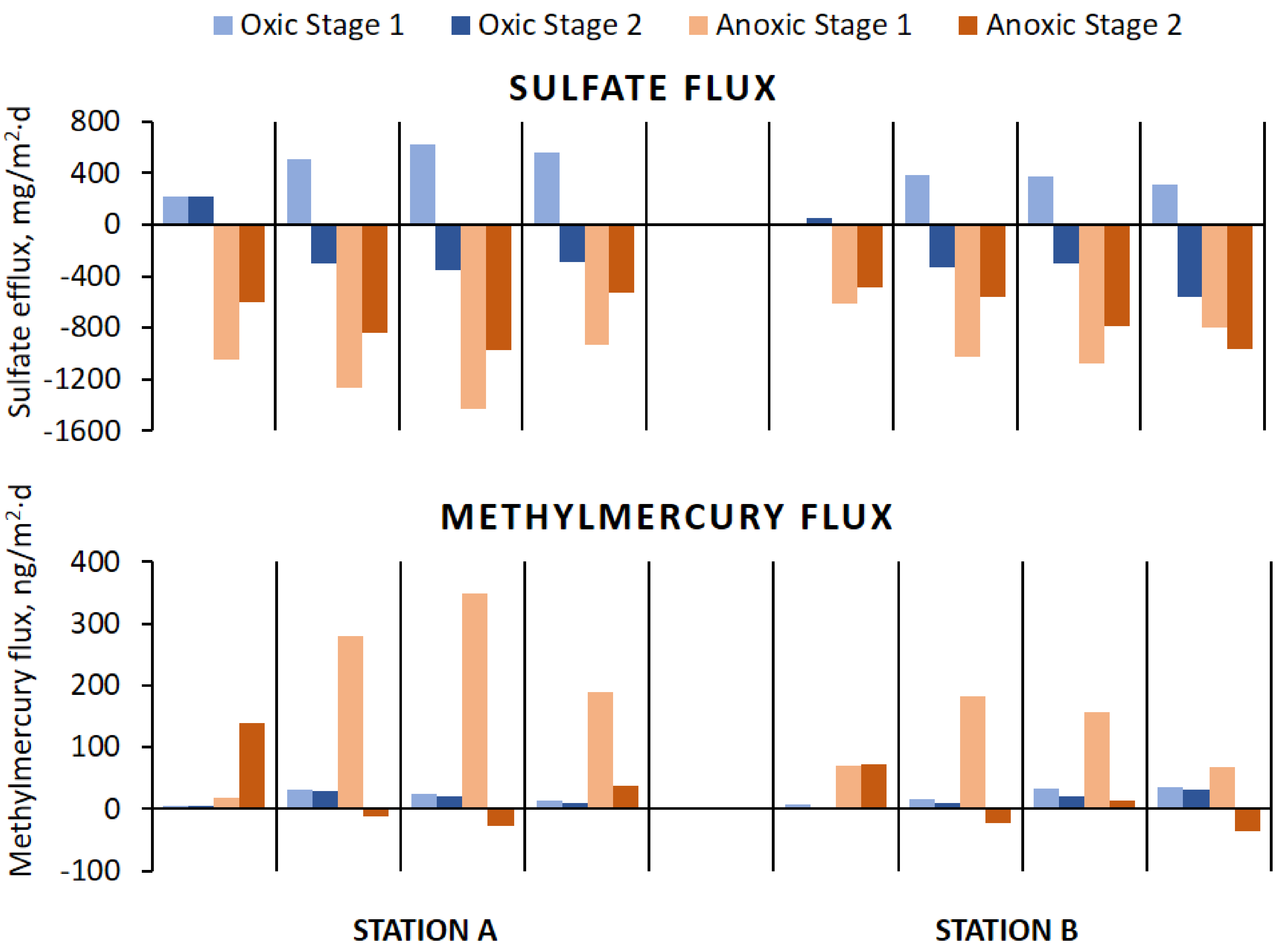
Oxic

Anoxic


Oxic Stage 1
Oxic Stage 2
Anoxic Stage 1
Anoxic Stage 2
PHOSPHATE FLUX
Phosphate efflux, mg-P/m2·d
50
40
30
20
10
0
AMMONIA FLUX
Ammonia efflux, mg-N/m2·d
200
150
100
50
0
-50
STATION A
STATION B

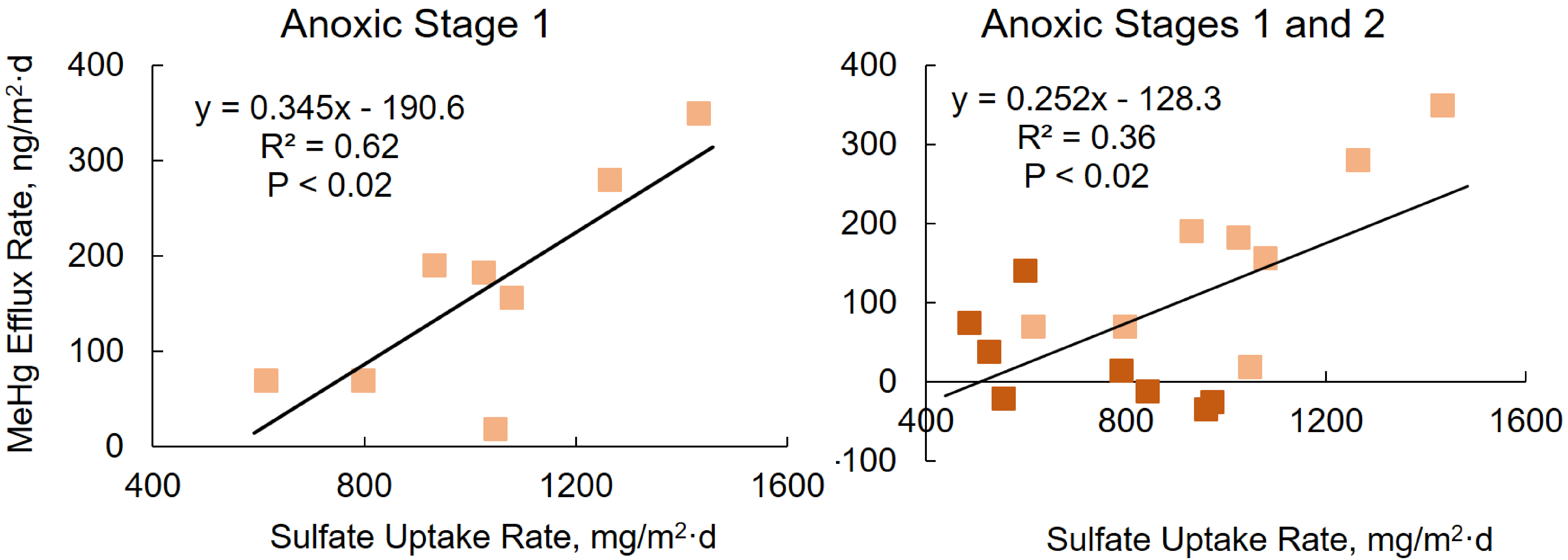


Oxic Stage 1
Oxic Stage 2
Anoxic Stage 1
Anoxic Stage 2
MANGANESE FLUX
Manganese efflux, mg/m2·d
80
60
40
20
0
-20
SULFIDE FLUX
Sulfide efflux, mg/m2·d
300
250
200
150
100
50
0
-50
STATION A
STATION B



Oxic Stage 1
Oxic Stage 2
Anoxic Stage 1
Anoxic Stage 2
SULFATE FLUX
Sulfate efflux, mg/m2·d
800
400
0
-400
-800
-1200
-1600
METHYLMERCURY FLUX
Methylmercury flux, ng/m2·d
400
300
200
100
0
-100
STATION A
STATION B

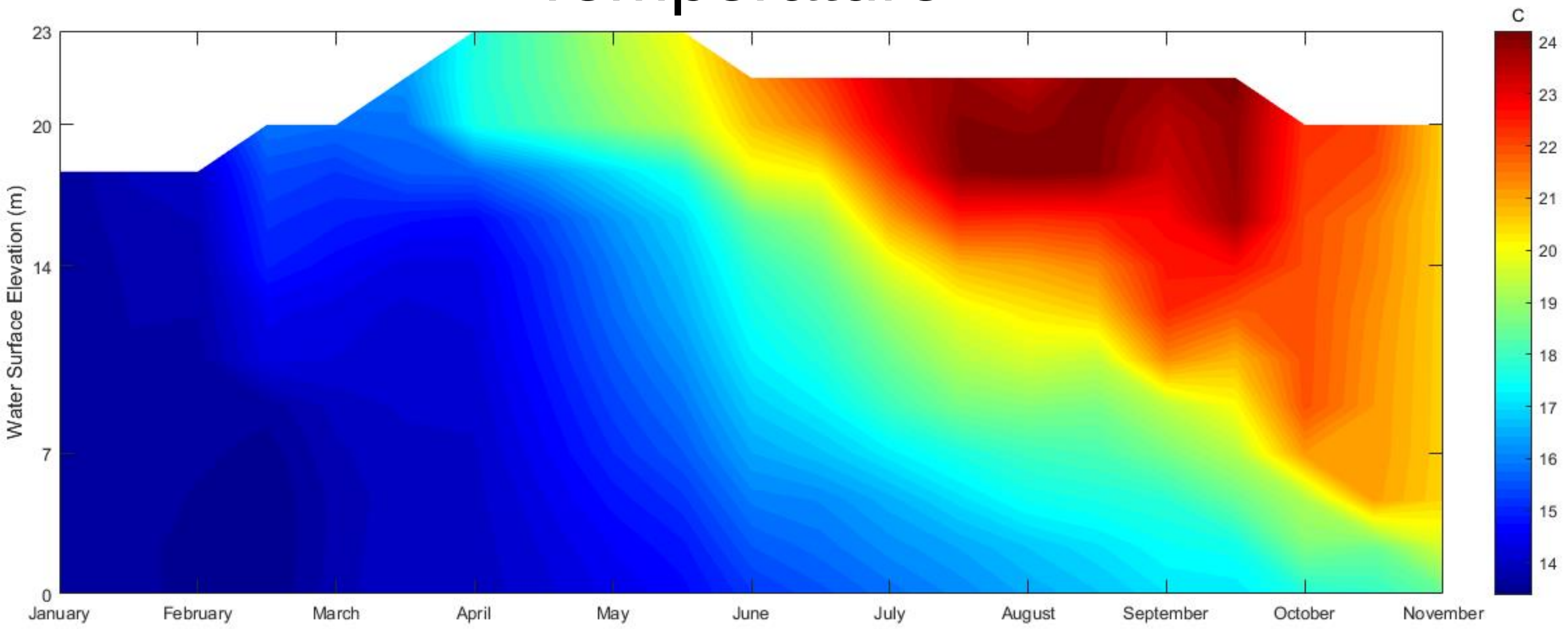
Sulfate – Methylmercury Linkage



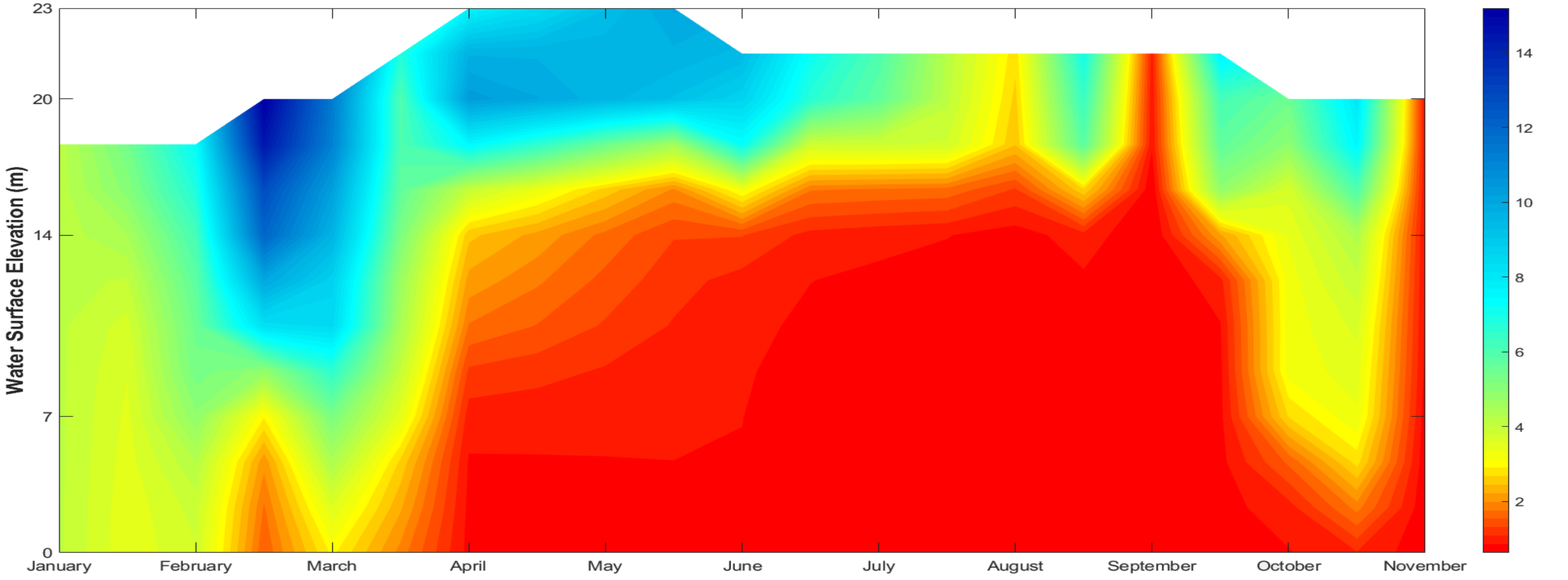
Net methylation declines as anoxia progresses

Hodges 2017

Temperature

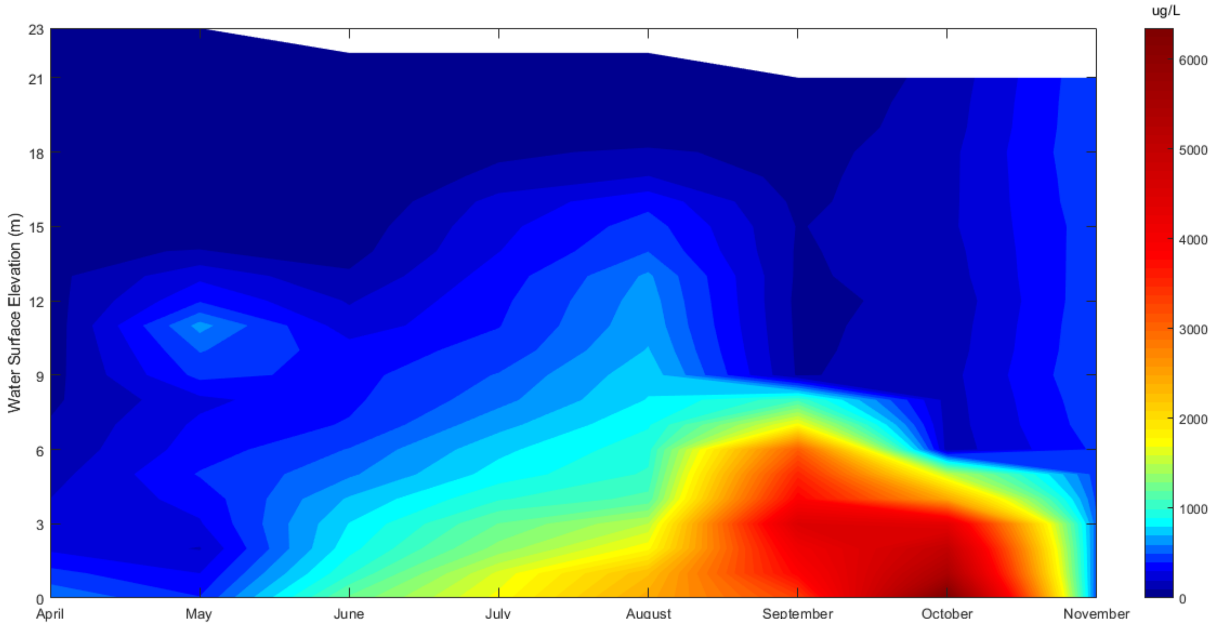


Dissolved Oxygen

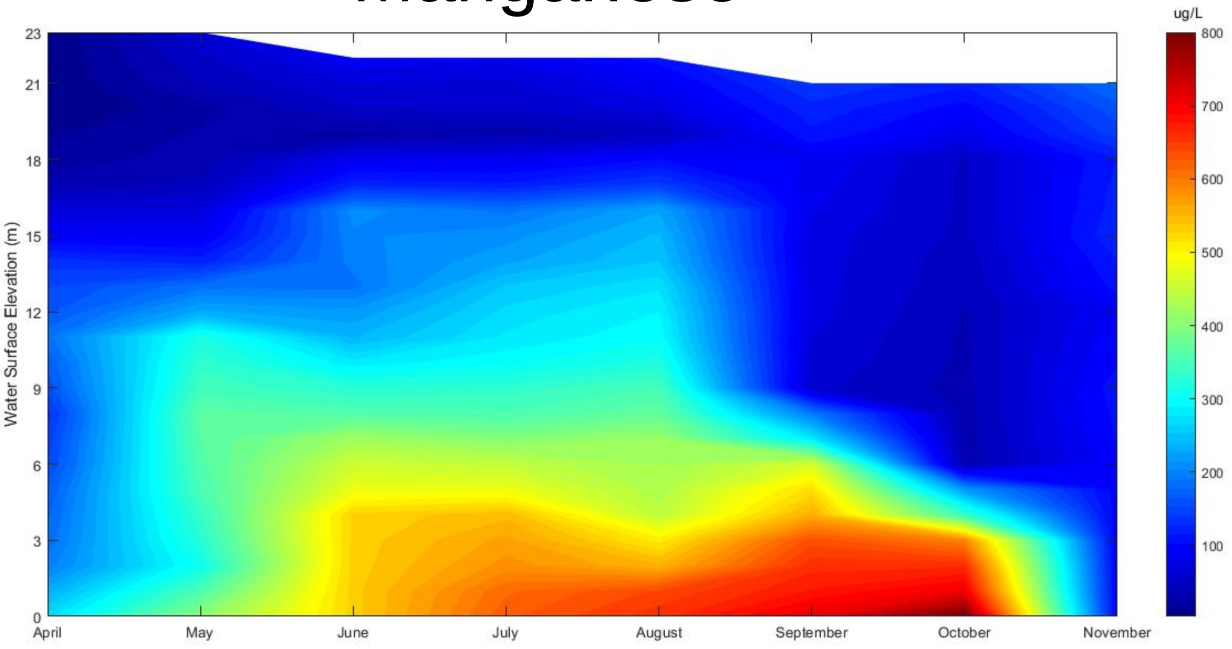


Hodges 2017

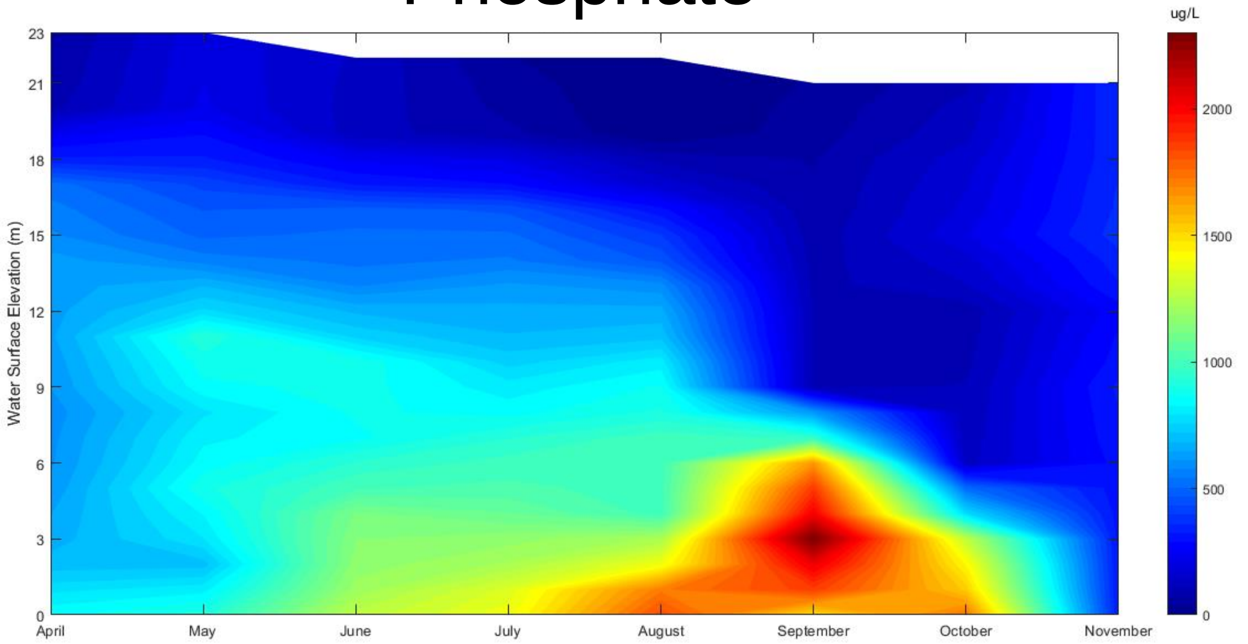
Ammonia



Manganese

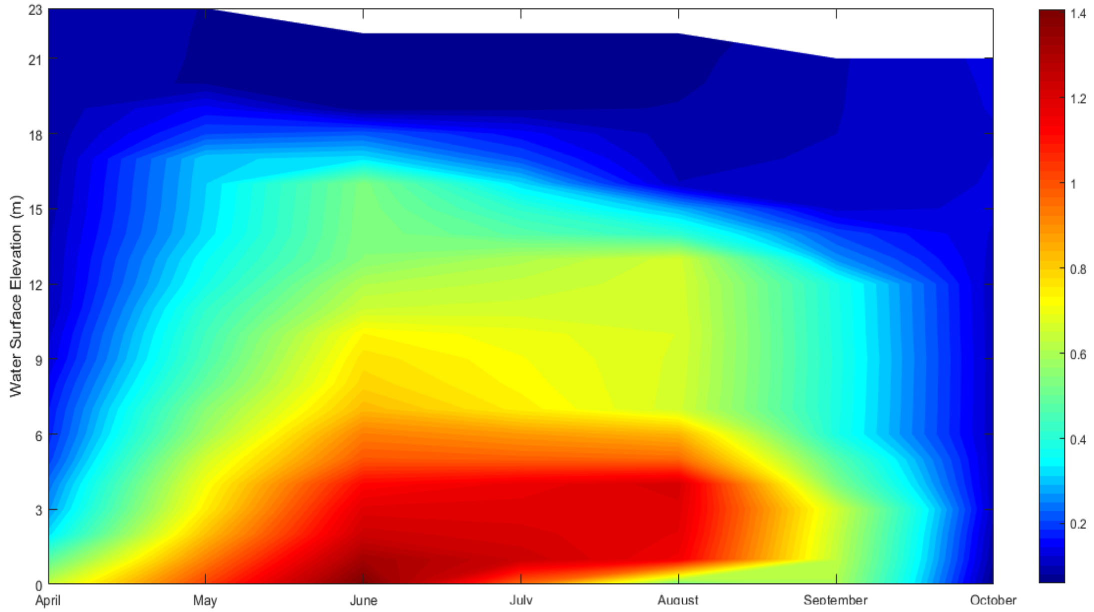


Phosphate

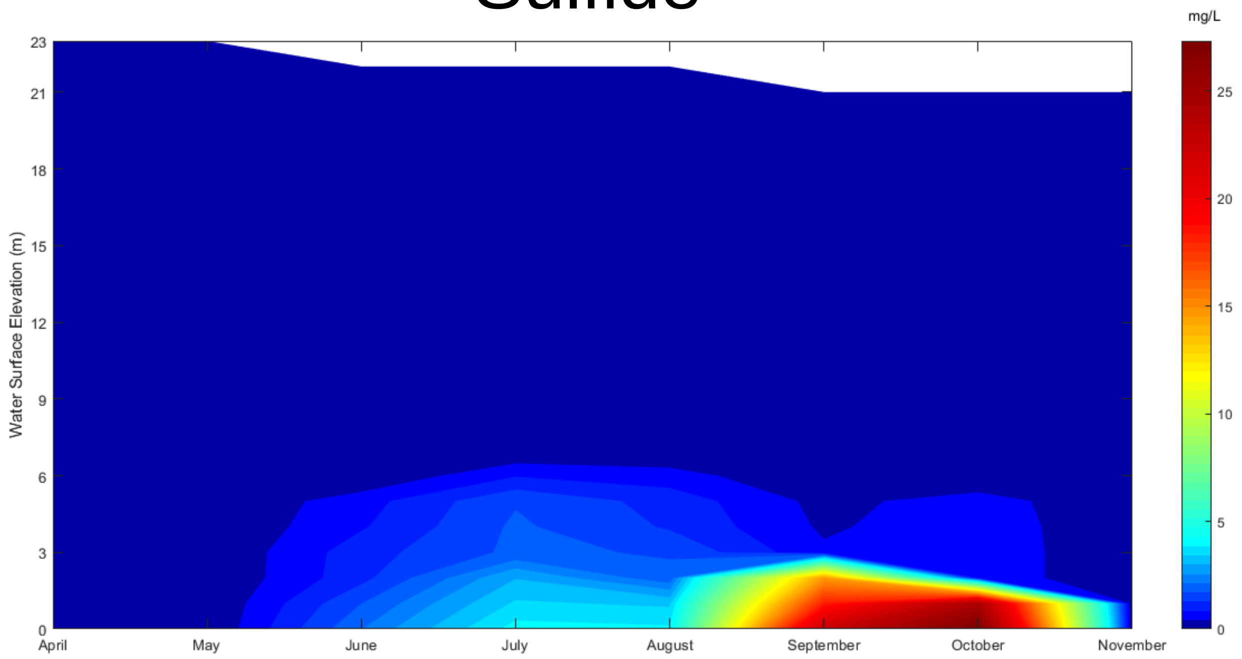


Hodges 2017

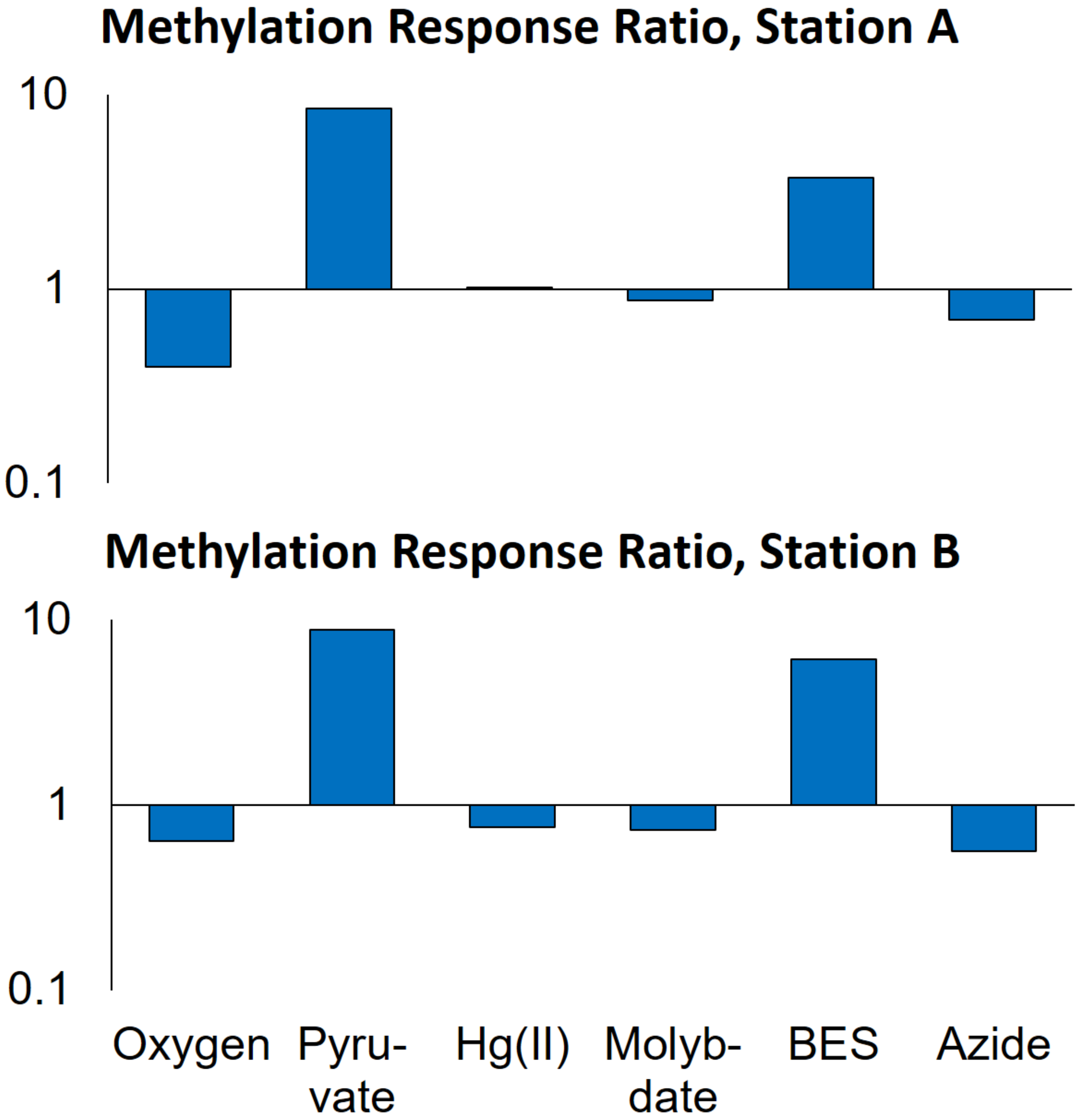
Methylmercury



Sulfide



Hodges 2018



Net methylation in sediment is stimulated by carbon and suppression of methanogens that demethylate MeHg

Conclusions

- Experimental chambers show that maintenance of oxygenated conditions near the sediment-water interface represses methylmercury release
- Both experimental chambers and field monitoring indicate that methylmercury production is associated with mildly reduced conditions
- Results suggest that carbon availability, Hg(II) bioavailability and/or demethylation may play a role in repressing methylmercury production under highly reduced conditions
- Oxygenation could yield synergistic repression of sediment release of nutrients, manganese, iron and methylmercury
- Reservoir managers must avoid accidently enhancing methylmercury production due to incomplete oxygenation of the profundal zone!

Thanks for your attention!