Seasonal patterns of methylmercury production, release, and degradation in profundal sediment of a hypereutrophic reservoir

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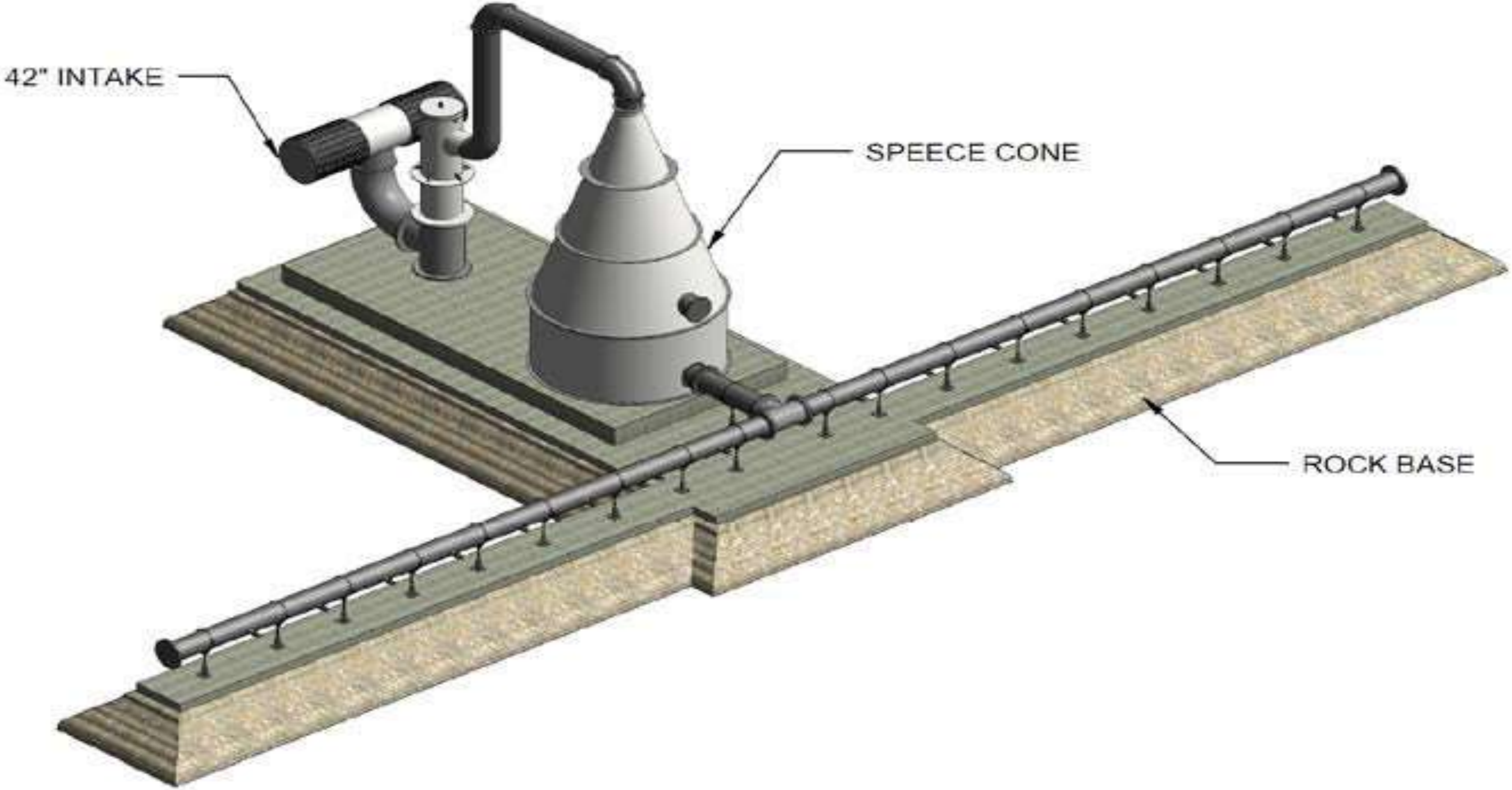
SePRO/EutroPHIX

Hodges Reservoir

- Backup water supply
- 37 million m^3 volume
- ~20 m maximum depth
- 2 monitoring stations:
  - Deep site (A ~ 20m) & shallow site (B ~ 12m)
- Hyper-eutrophic
- 303(d) listed for mercury in fish tissue


42" INTAKE
SPEECE CONE
ROCK BASE

Part 1: What's Going on in the Reservoir?

Spring

Sonoma County, 2019. Spring Lake Regional Park. Available at https://www.sonomacounty.com/outdoor-activities/spring-lake-regional-park

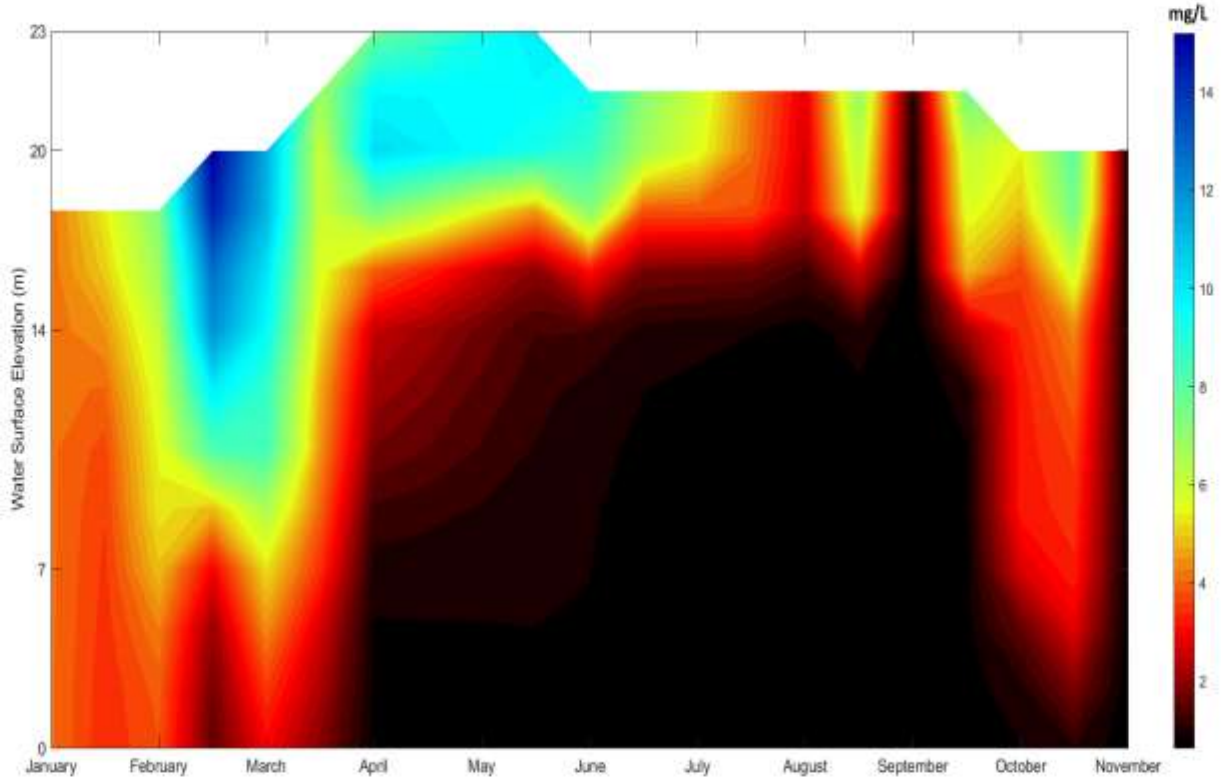
Summer

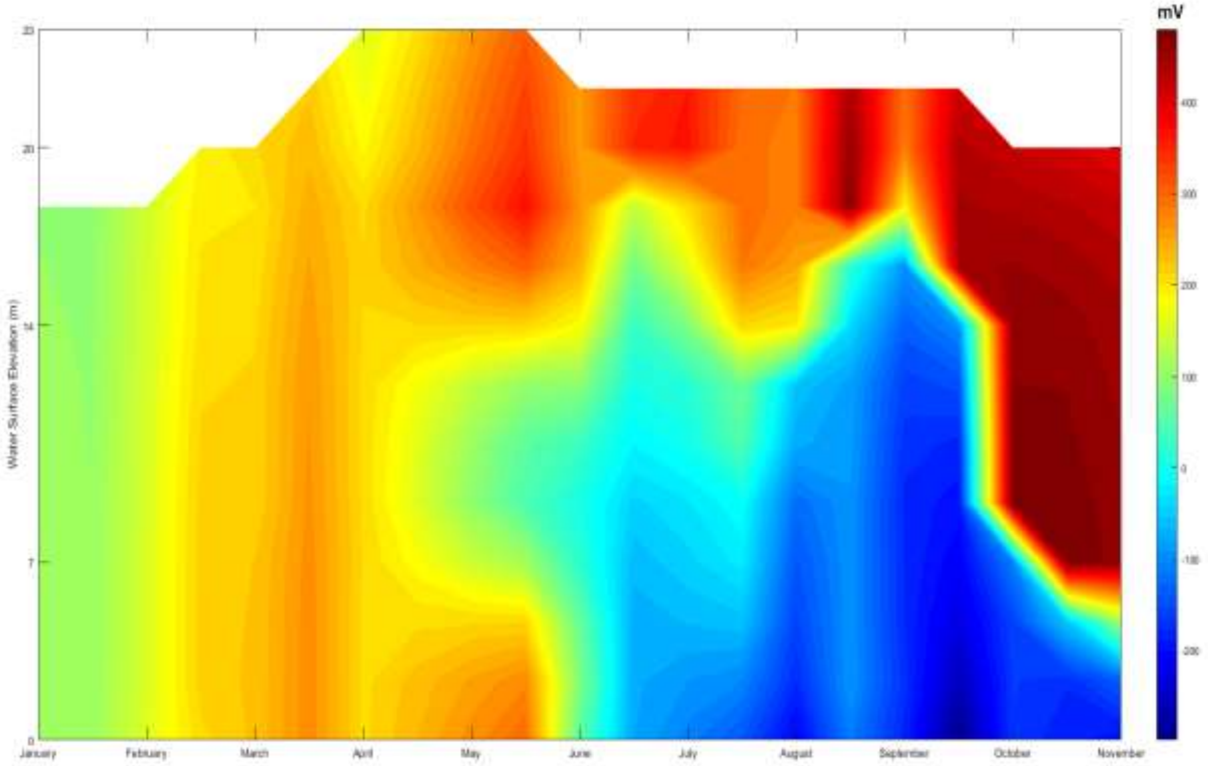
Lake Pictures, n.d. Green Lake. Available at https://freebigpictures.com/lake-pictures/green-lake/

Fall

Beckman, 2018. Mono Lake. Available at http://pages.hmc.edu/beckman/WebPhotos/gallery1/gallery1.html

Hodges Profile

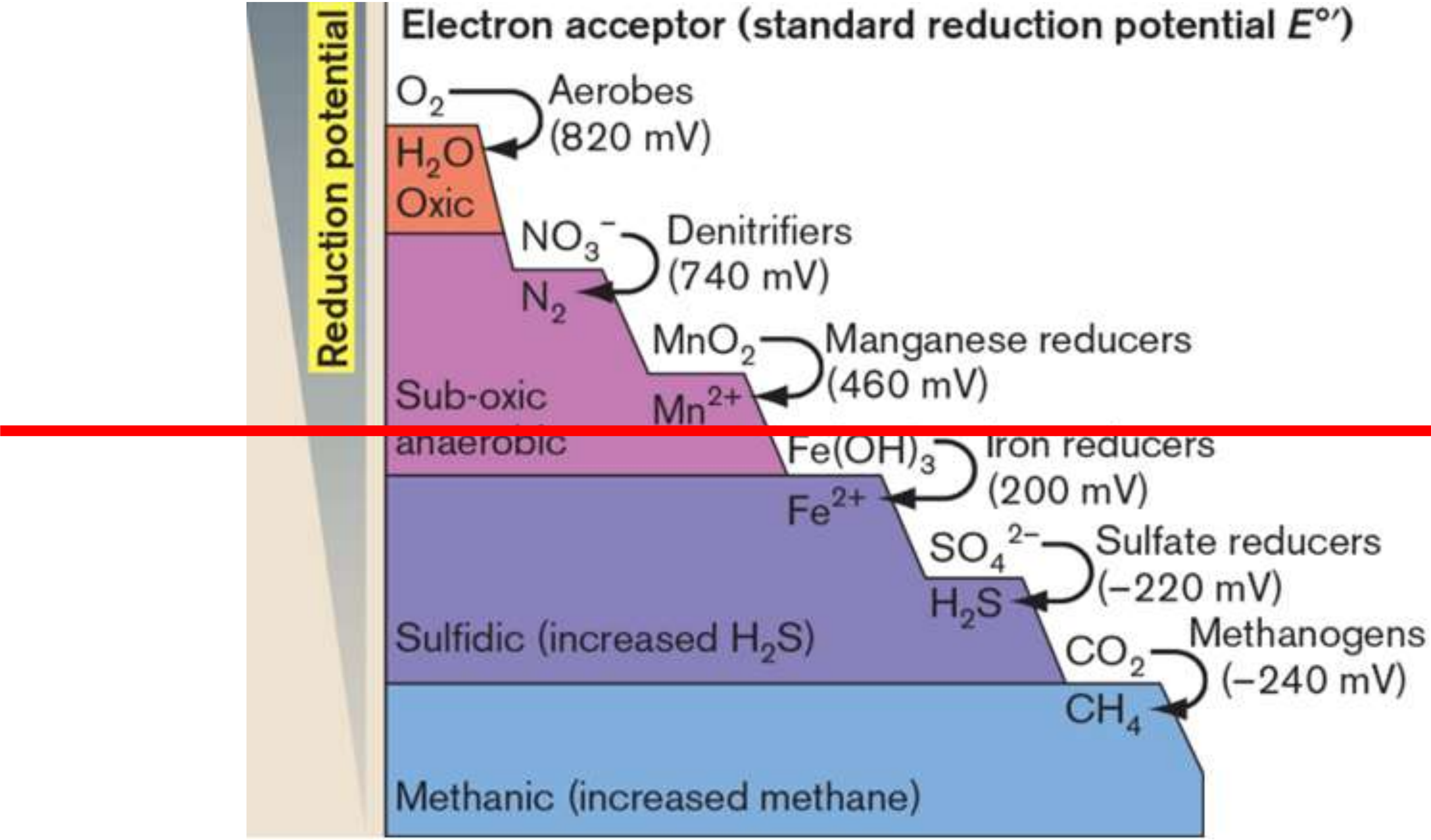




Dissolved Oxygen

Redox

Potential

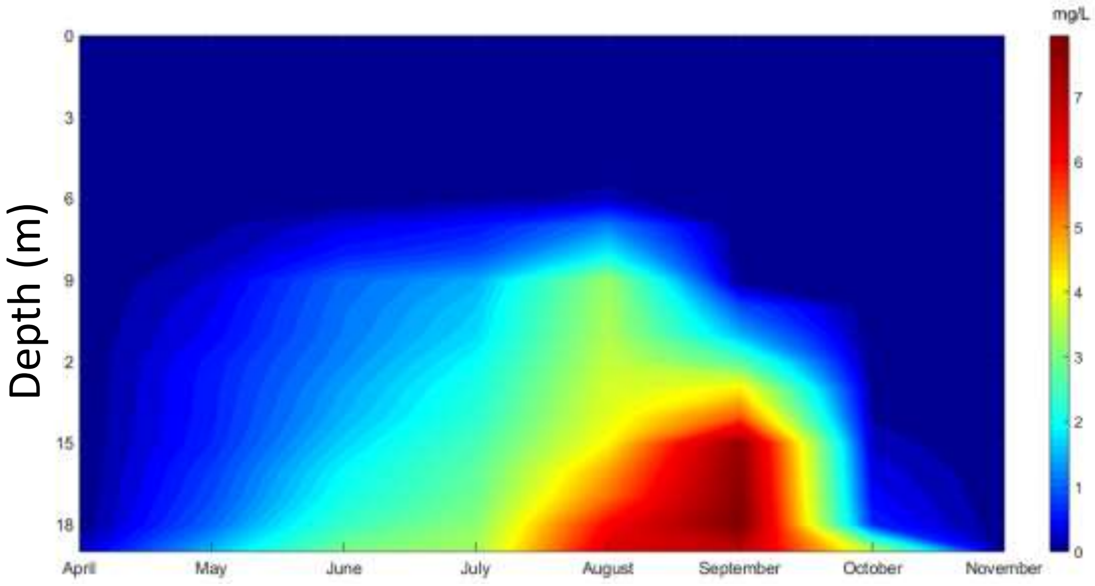


No MeHg production ☺

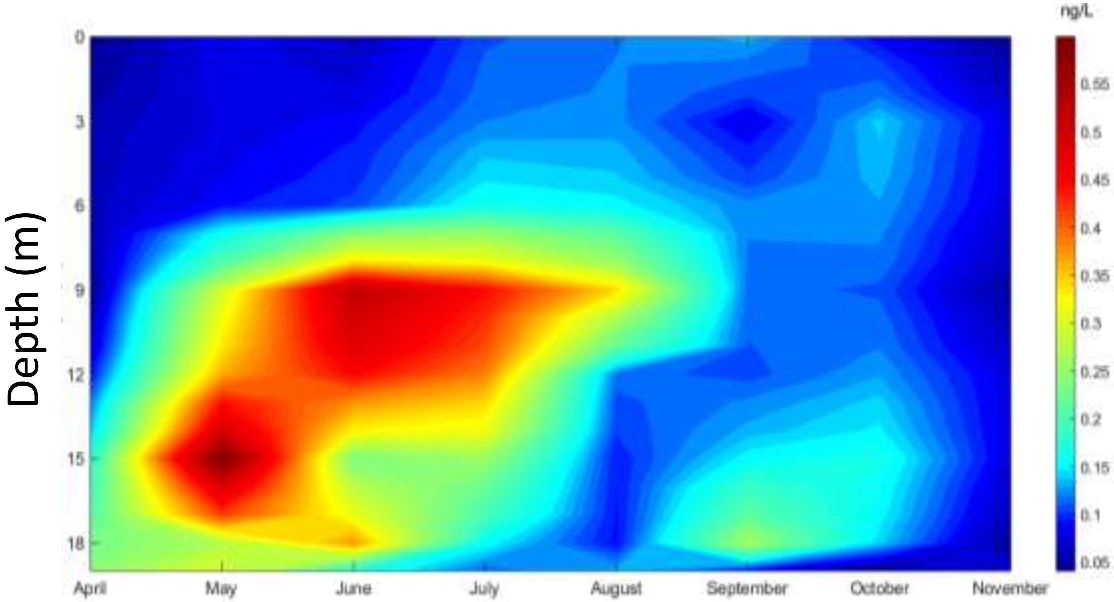
MeHg production ☹

Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, M.W., Stahl, D.A. 2006. Figure 17-35 Brock Biology of Microorganisms.

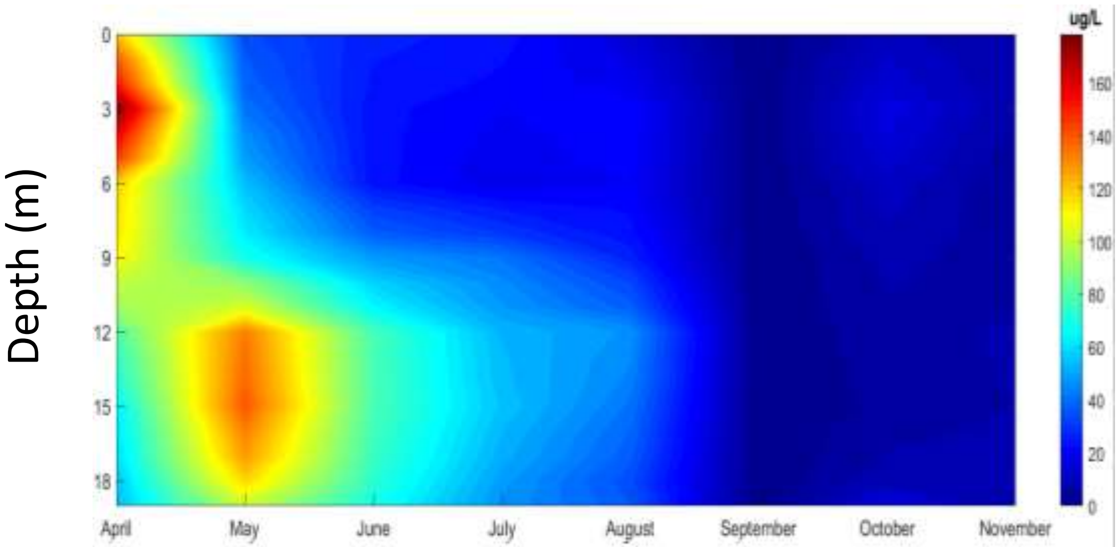
Sulfide



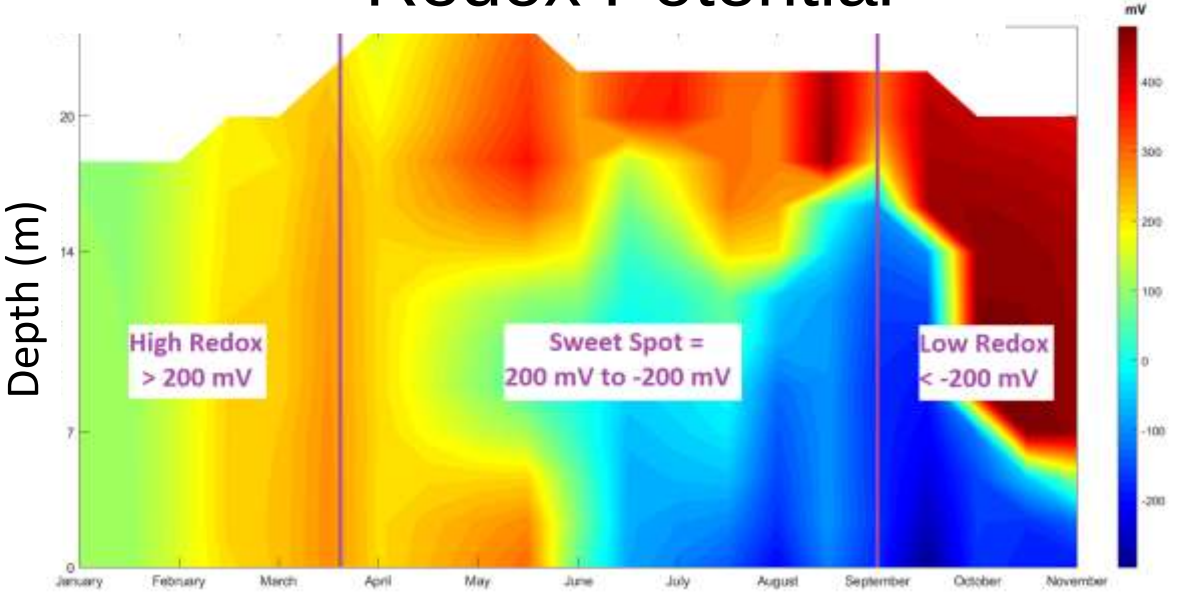
MeHg



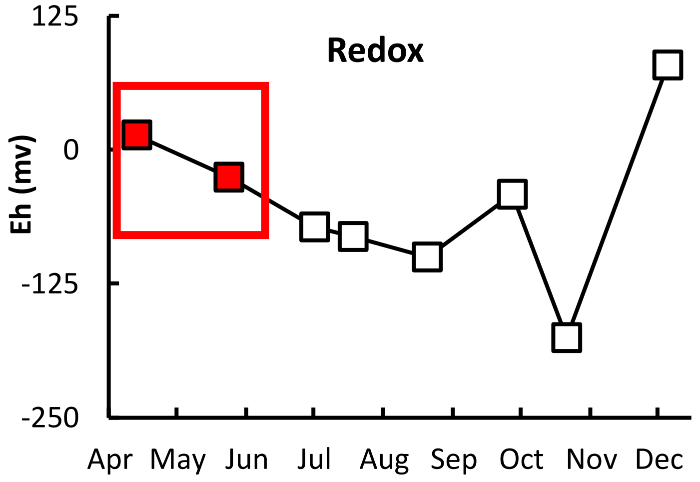
Dissolved Iron

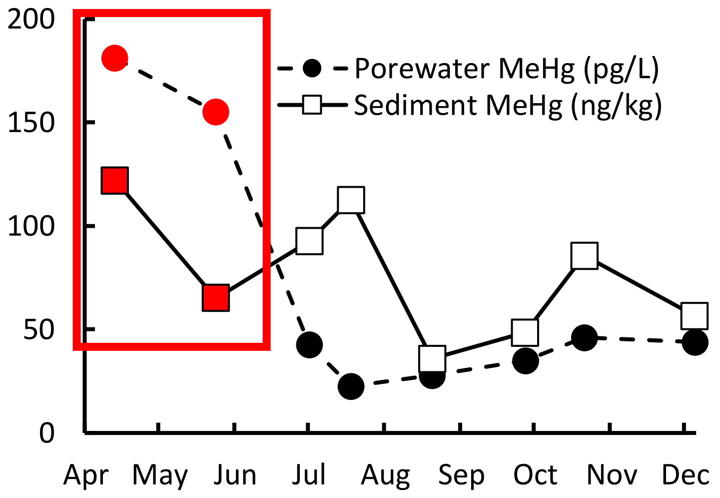


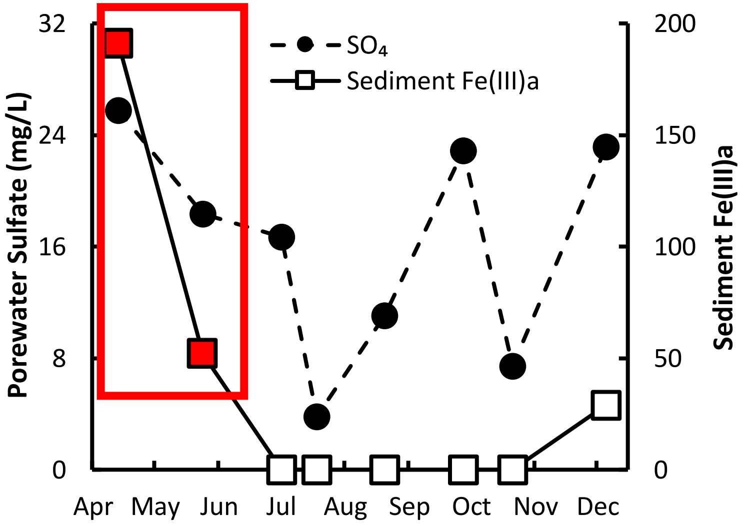
Redox Potential

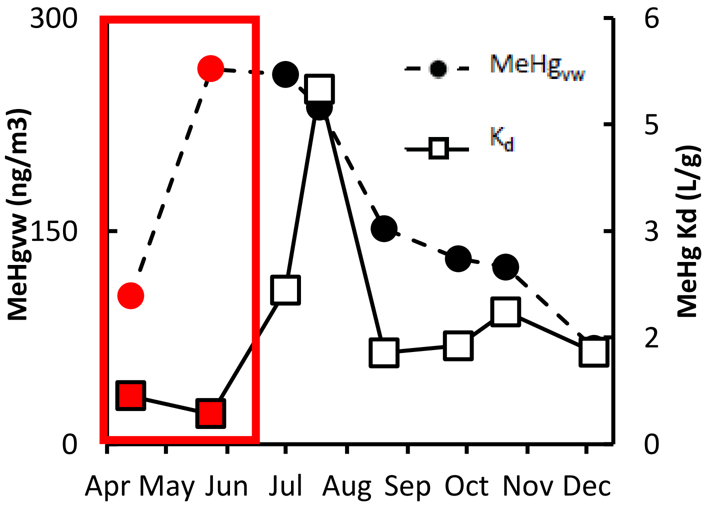


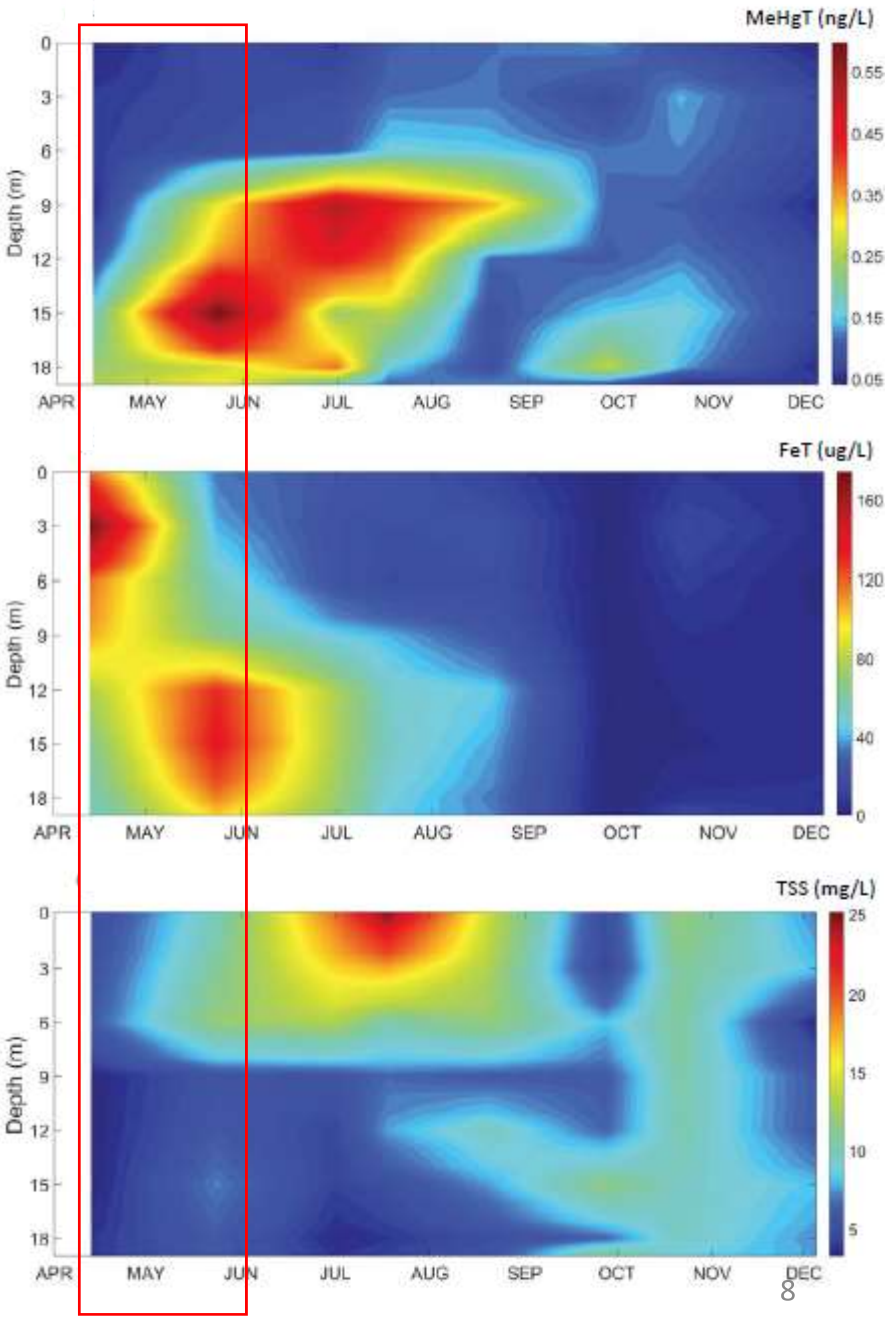
Spring (April – May)



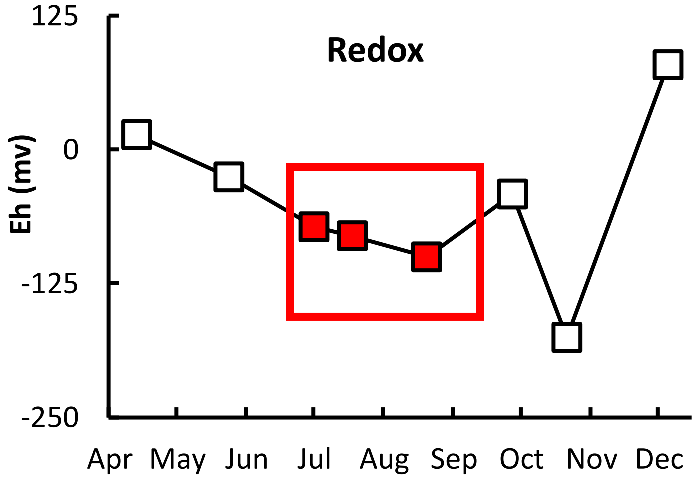


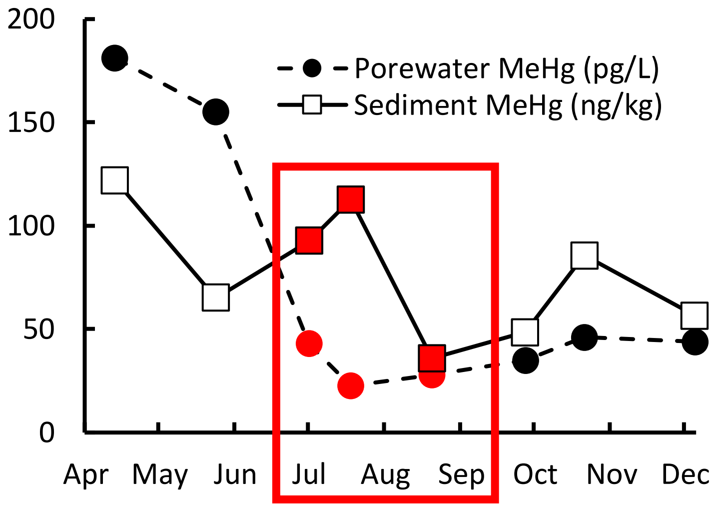


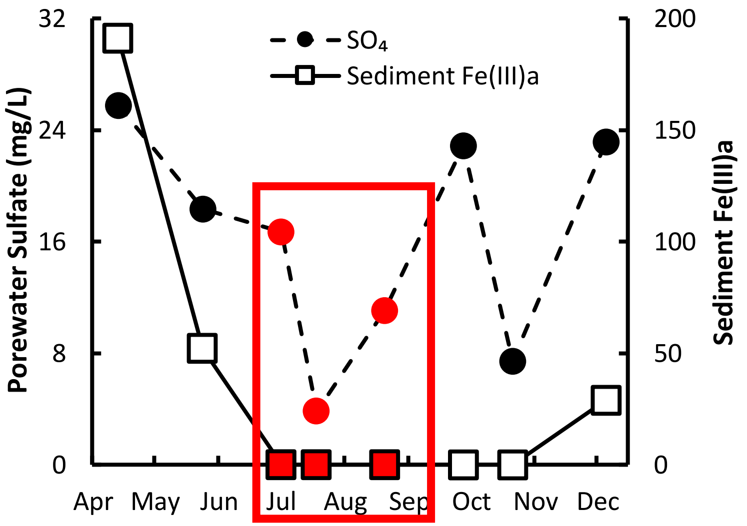


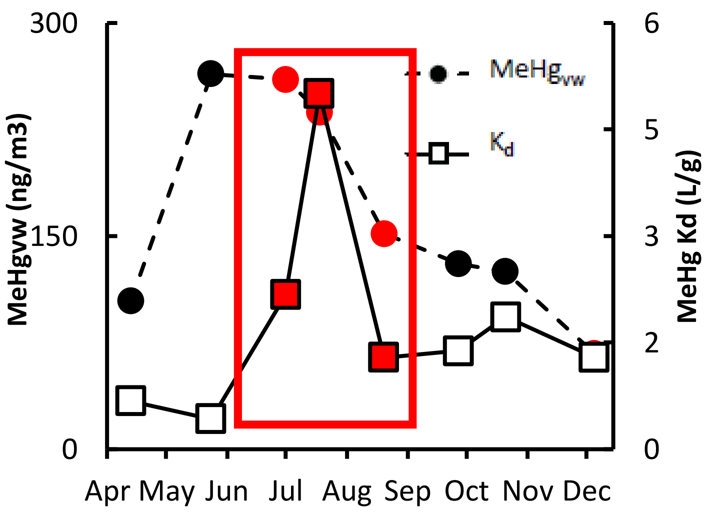


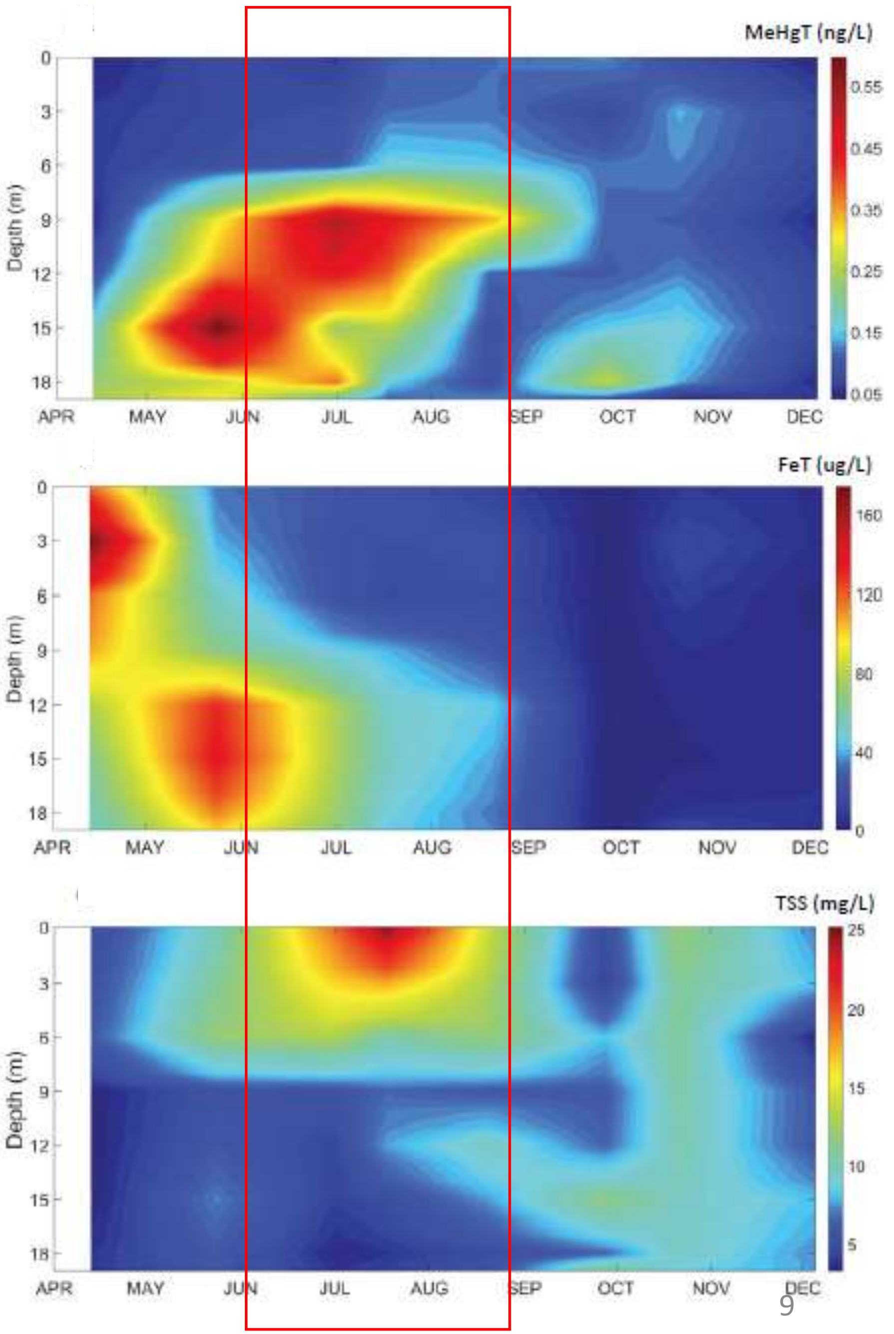
Summer (June – Aug)



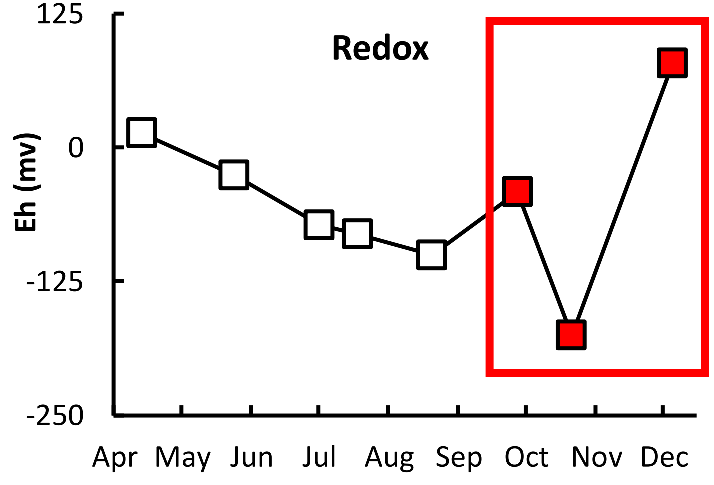


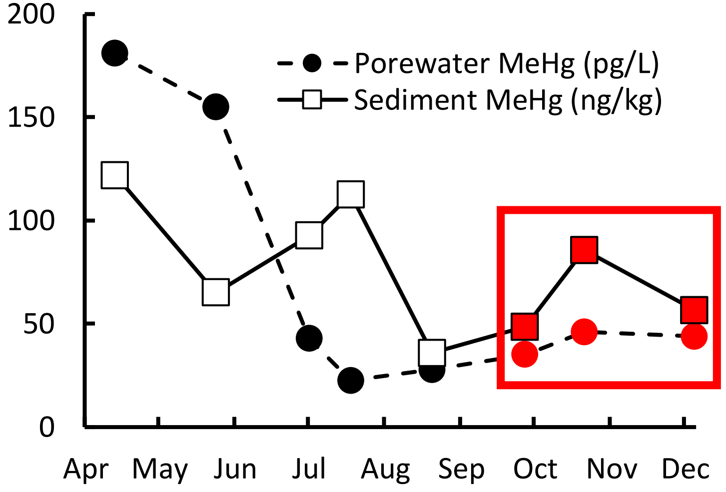


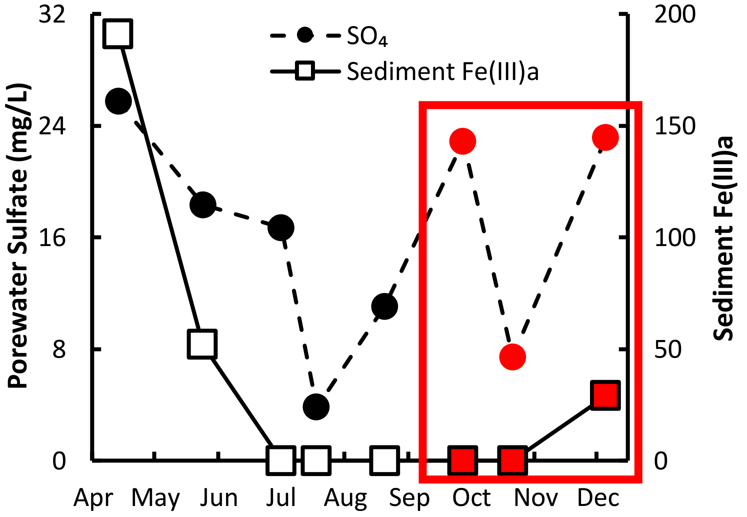


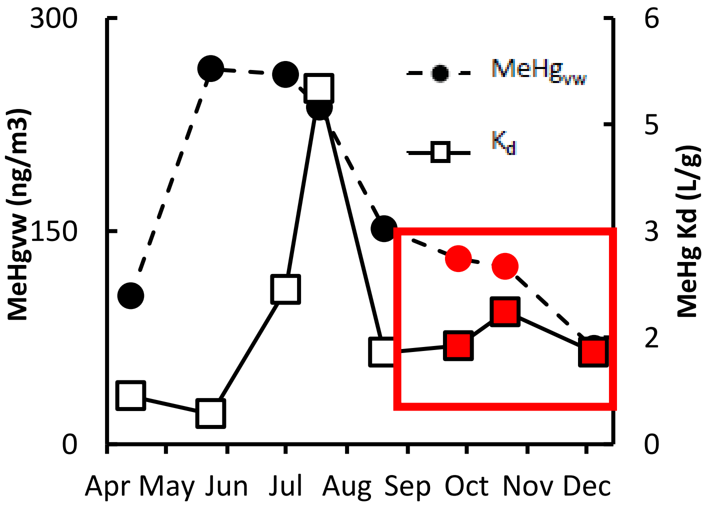


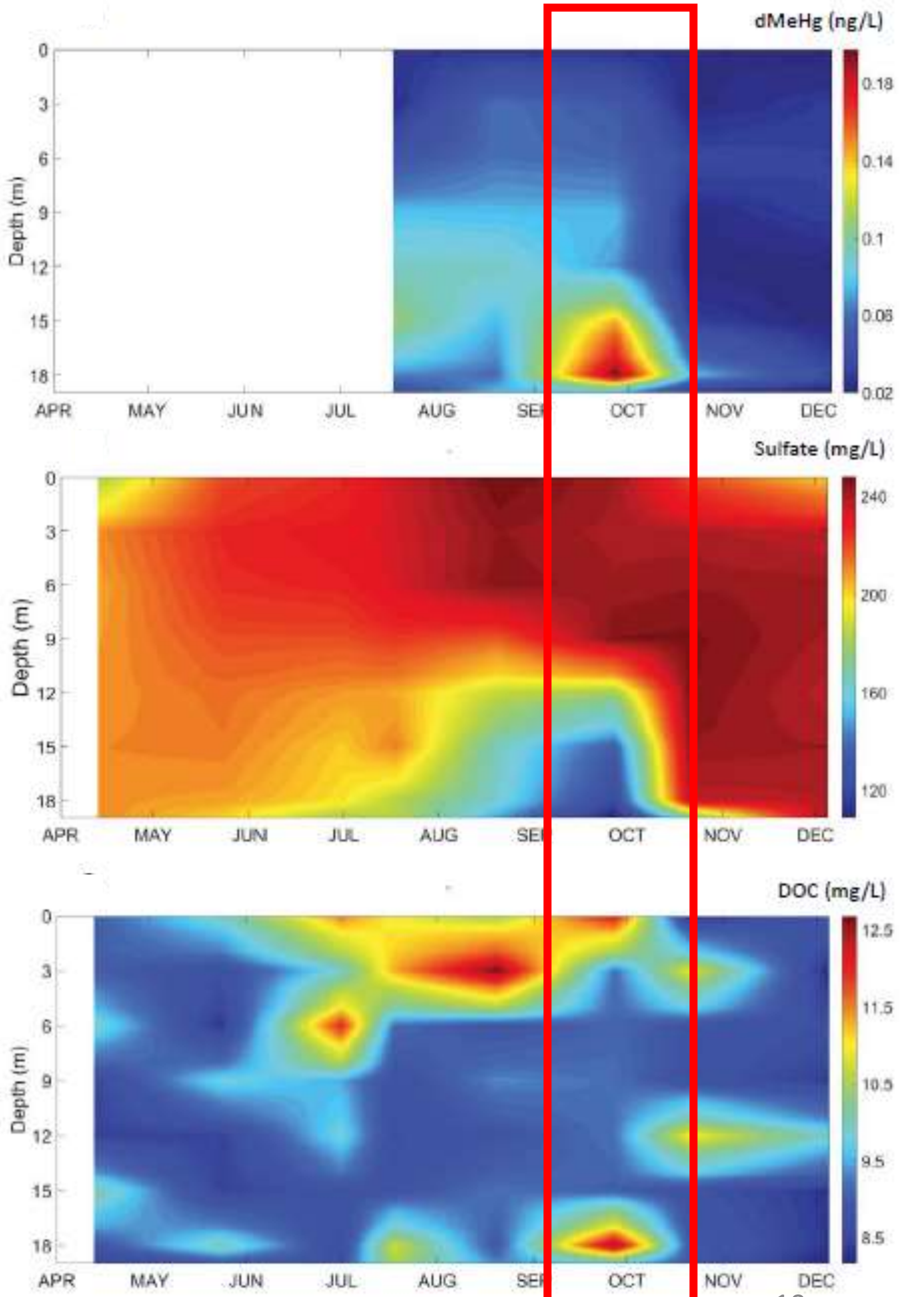
Fall (Sept – Nov)











Reservoir Mercury Cycling Takeaways

<u>Spring</u>

- Sediment MeHg is highest in early Spring (during medium redox)
- Sediment MeHg is released in mid-Spring (during iron-reduction)

<u>Summer</u>

- Sulfate Reduction leads to more Sediment MeHg
- Sulfide leads to high binding and low entry into water column
- No sulfate => methanogenesis and demethylation

<u>Fall</u>

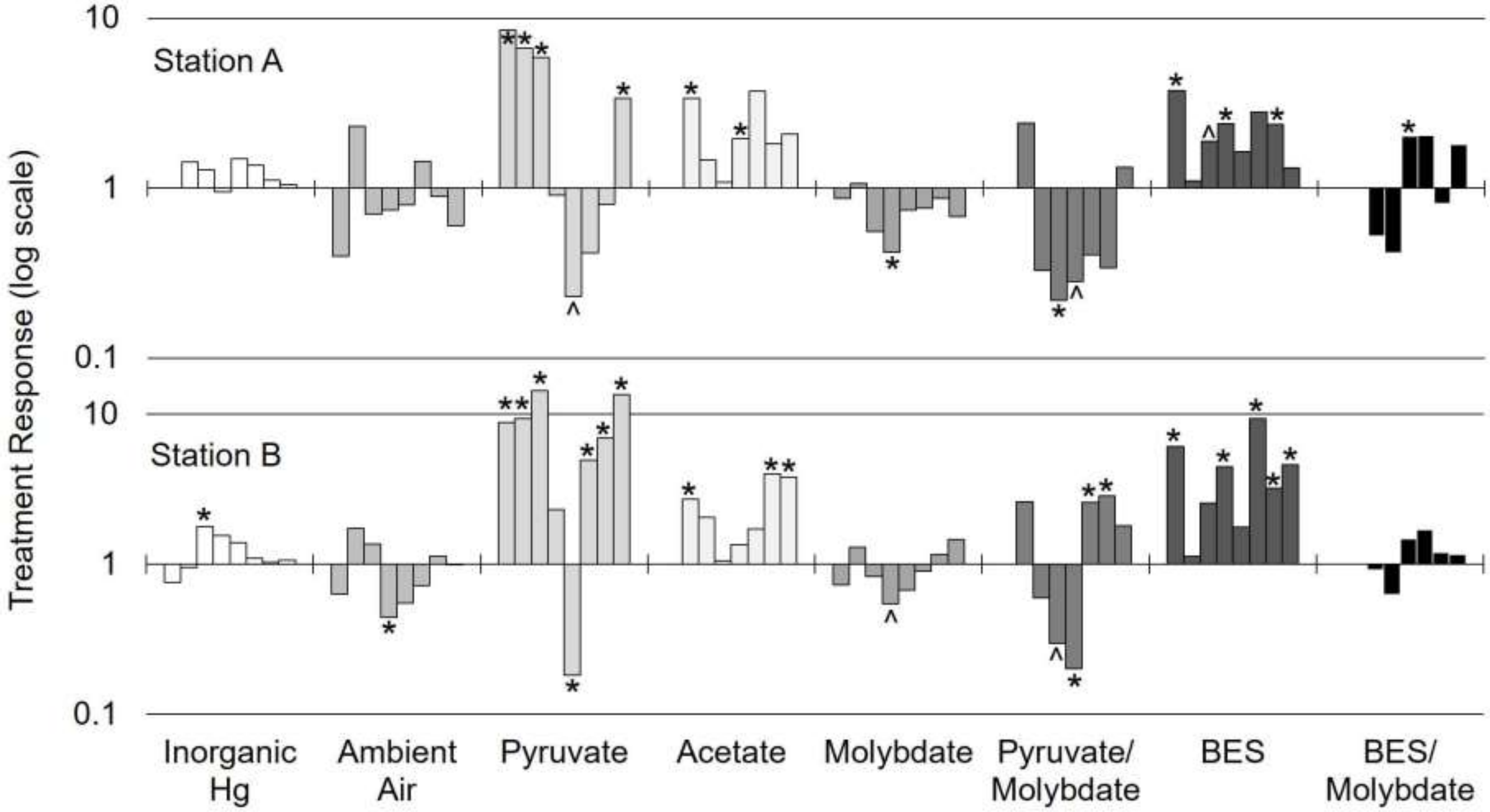
- Water column sulfate reduction
- Likely water column methylation by sulfate reducing bacteria

Part 2: Sediment-Water Incubations

- ~ Monthly
- 2 Stations: Deep (A) & Shallow (B)
- 30 mL of anaerobic lake water
  + 1 gram of sediment
- 8 treatments (triplicate)
- Using 40 mL sealed glass vial
- Orbital shaker @ 100 rpm
- 15 ^{o}C in the dark for 2 days
- Analyze for MeHg at end

Treatment Results

* = statistically significant ($p < 0.05$)
^ = almost statistically significant ($p < 0.10$)



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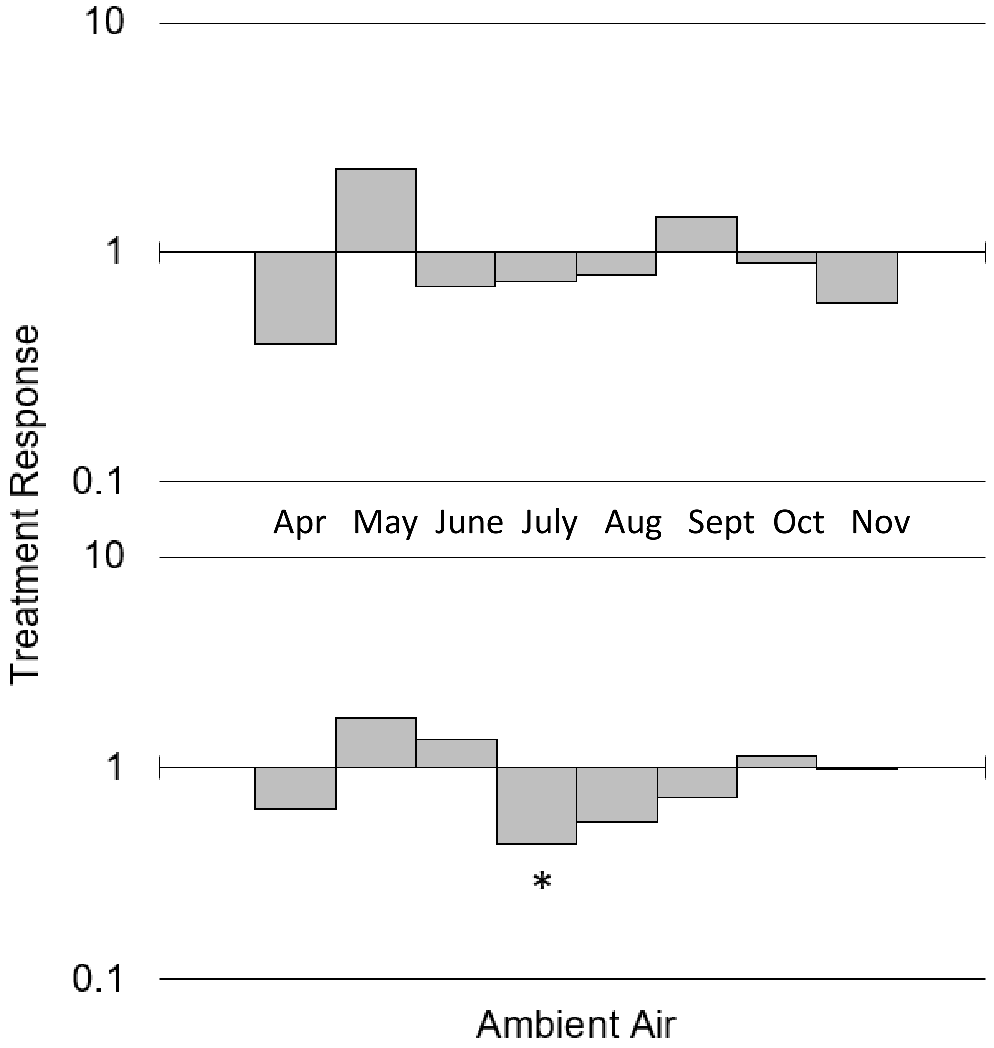

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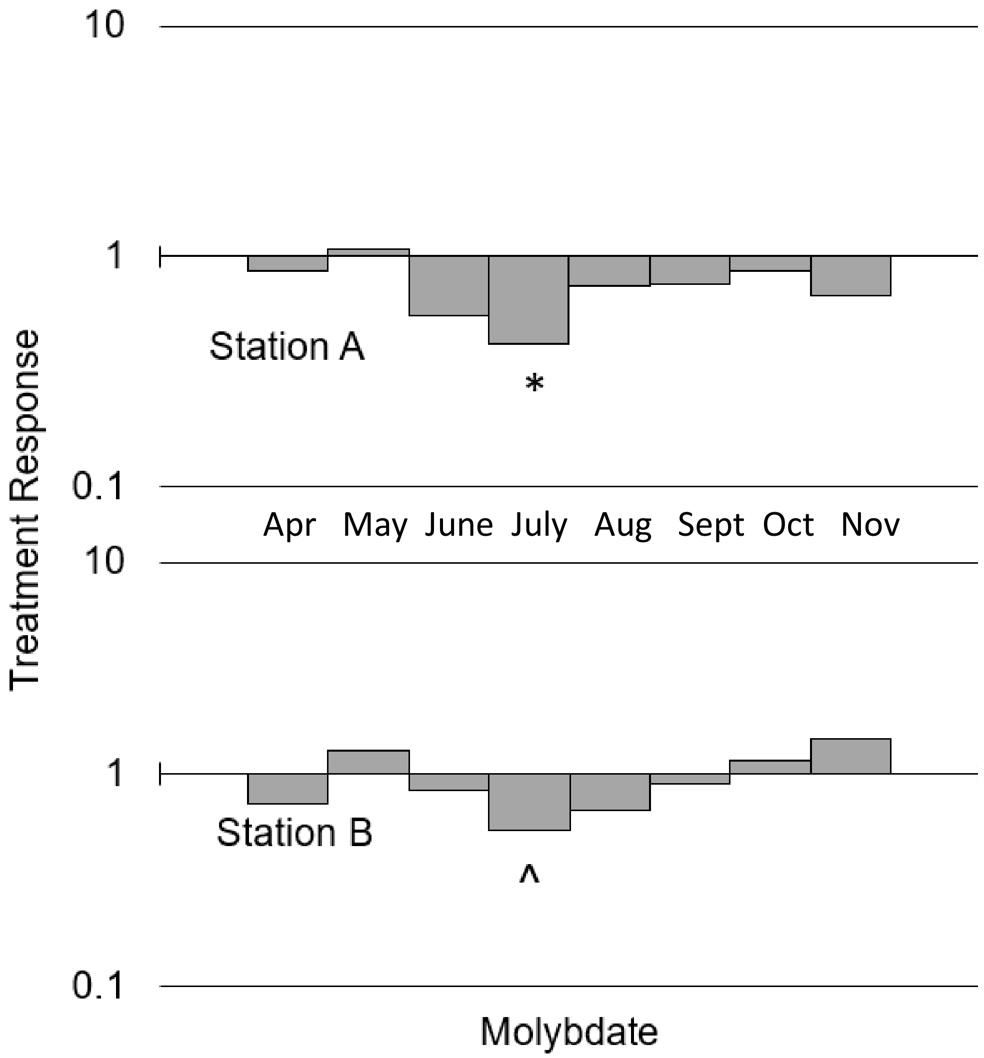

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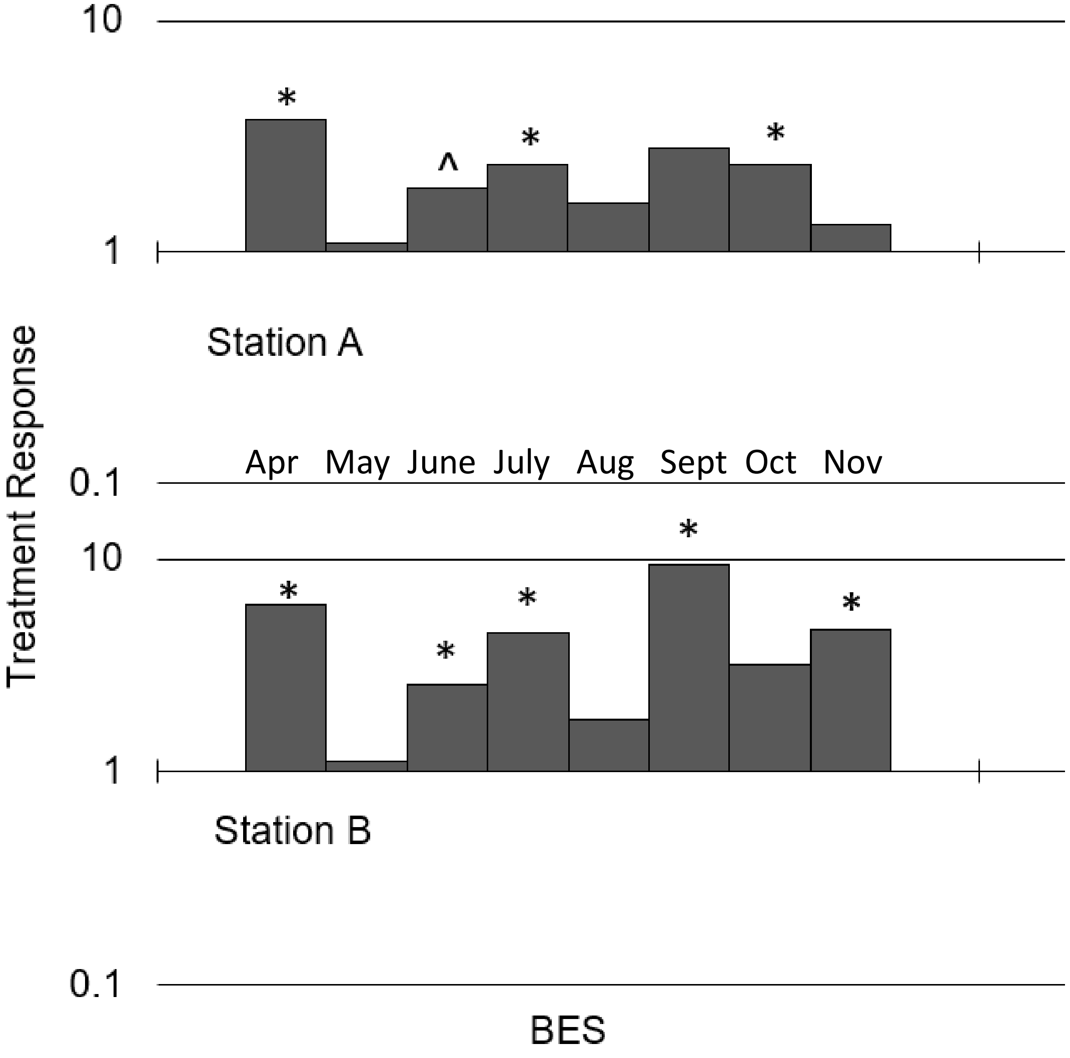

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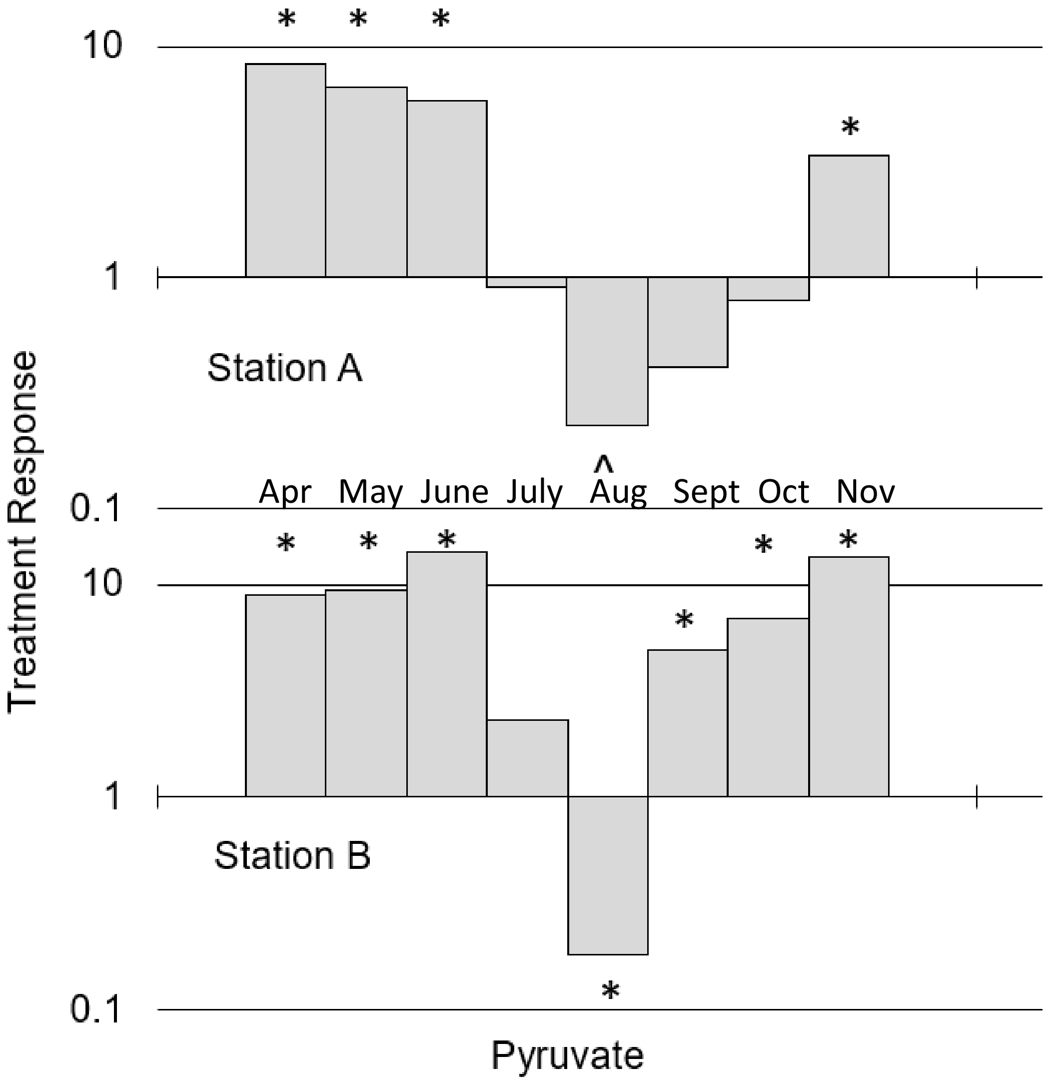
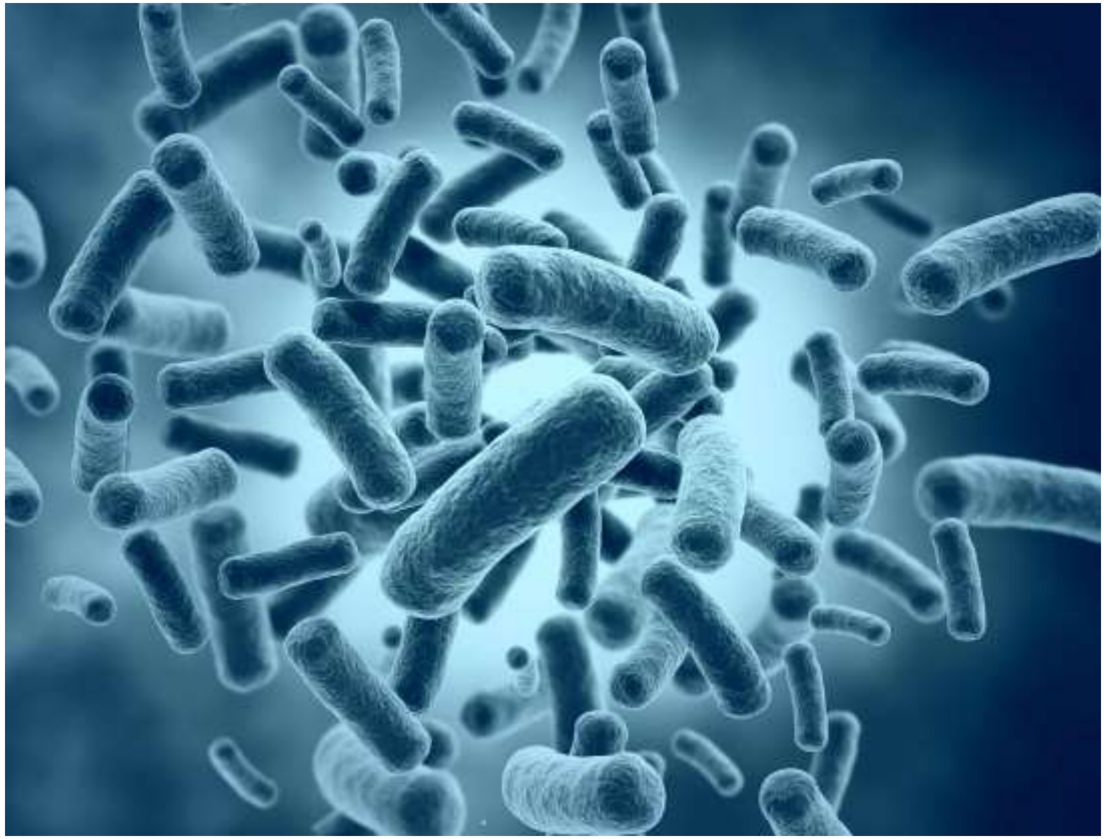


Incubation Conclusions

- High Redox (Aeration) = ↓ MeHg
- Sulfate reducers make MeHg
- Methanogens degrade MeHg
- Carbon can have a different impact
  - Mild redox = ↑↑ MeHg
  - Moderate redox = Ø MeHg
  - Low Redox = ↓↓ MeHg



Antell, A., 2019. Couple Alleges Fournier's Gangrene Linked to Jardiance Side Effects. Top Class Actions. Available at: https://topclassactions.com/lawsuit-settlements/prescription/diabetes/884557-couple-alleges-fourniers-gangrene-linked-to-jardiance-side-effects/

Conclusions: Mercury at Hodges Reservoir

<u>Prior to Spring</u>

- Transition to anoxia seems to be hotspot for MeHg production in the sediment

<u>Springtime = mild redox</u>

- Iron reducers mediate release of MeHg
    - But they don't seem to very good at making it

<u>Summertime = moderate redox</u>

- Sulfate reducers are good at making MeHg
    - But they seem to reduce MeHg solubility

<u>Fall = low redox</u>

- Methanogens are very good at degrading MeHg


Thank you for your attention!
Questions?

Publications for More Details

Cycling of methylmercury and other redox-sensitive compounds in the profundal zone of a hypereutrophic water supply reservoir:

Beutel et al., 2020. Hydrobiologia.

Seasonal patterns of methylmercury production, release, and degradation in profundal sediment of a hypereutrophic reservoir:

Fuhrmann et al., 2021. Lake and Reservoir Management.

Effects of mercury, organic carbon, and microbial inhibition on methylmercury cycling at the profundal sediment-water interface of a sulfate-rich hypereutrophic reservoir:

Fuhrmann et al., 2020. Environmental Pollution.