Remediation of mercury in contaminated lakes: The Newcastle Reservoir demonstration project

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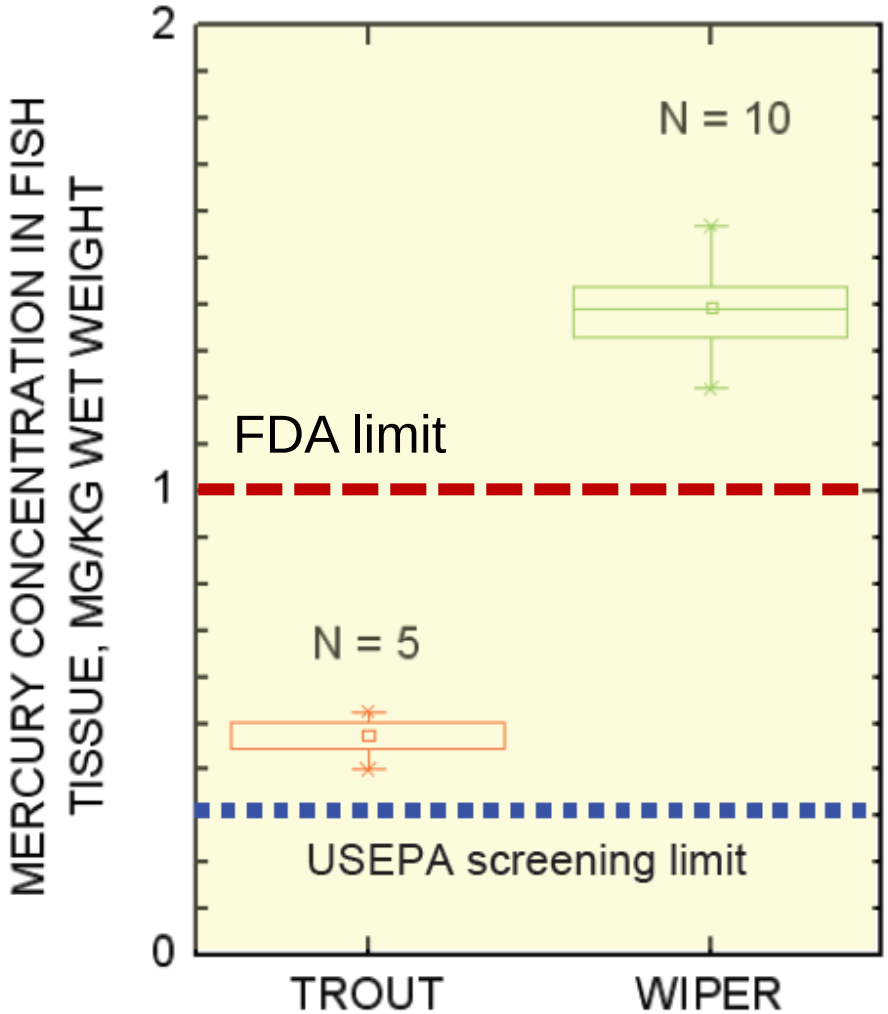
UTAH DIVISION OF Wildlife Resources

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

OUTLINE

- Problem
- Pre-deployment monitoring/modeling
- Pump deployment and operation
- Post deployment results

Hg IN UTAH RESERVOIRS



Data from Utah DWR

Utah News. The Salt Lake Tribune

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High mercury in fish prompts three new Utah warnings

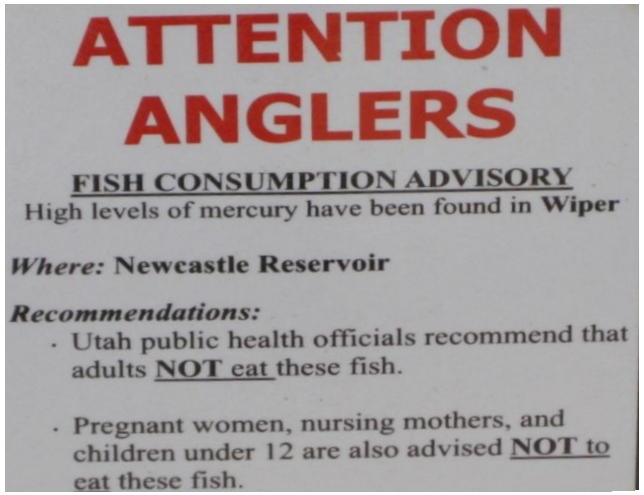
Environment » 19 Utah waterways are now listed as having problems with the metal.

Tweet 25 +1 0

BY JUDY FAHYS
The Salt Lake Tribune

First published Aug 23 2011 11:35AM
Updated Aug 23, 2011 11:49PM

State health and environmental officials added three new locations Tuesday



ATTENTION ANGLERS

FISH CONSUMPTION ADVISORY

High levels of mercury have been found in **Wiper**

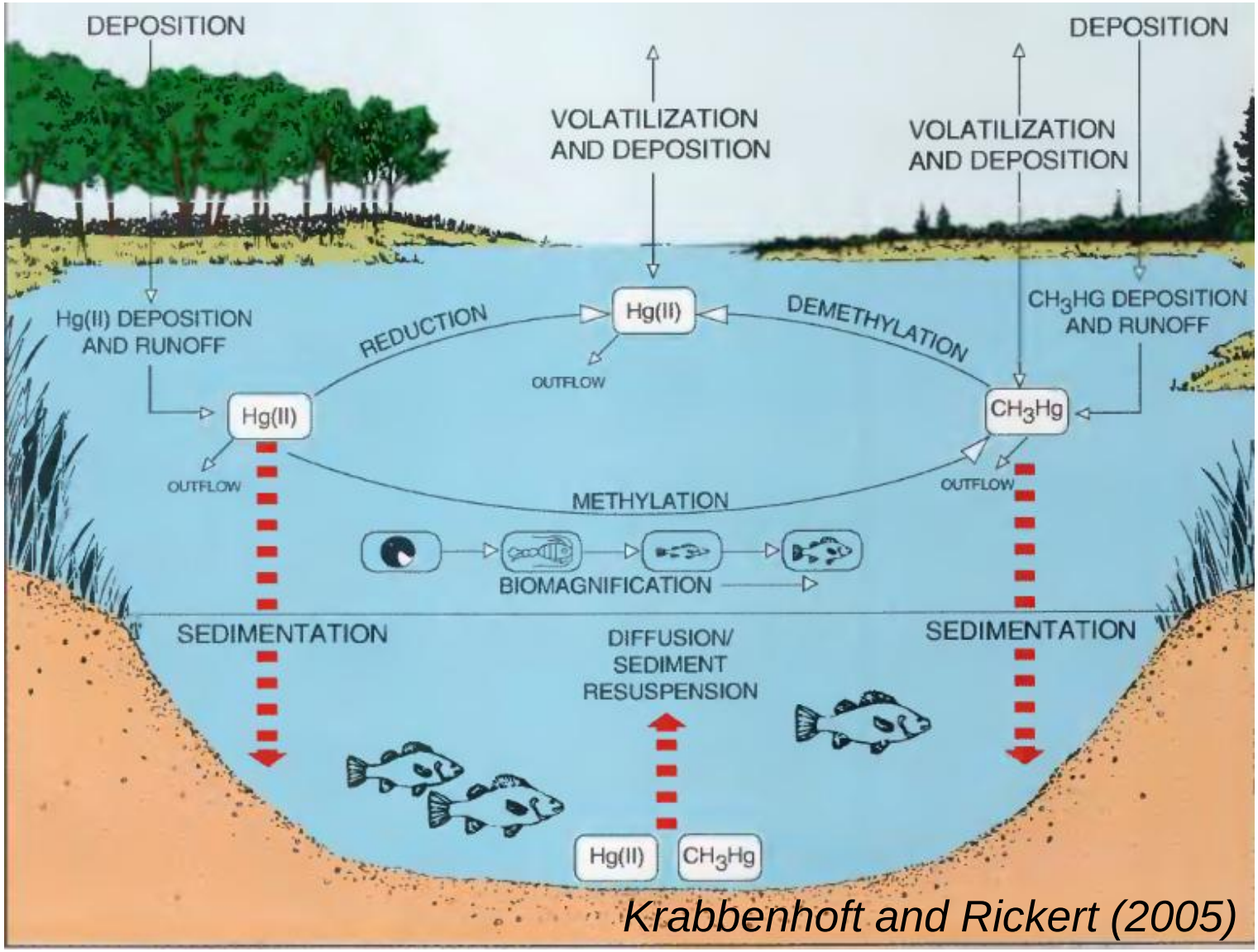
Where: **Newcastle Reservoir**

Recommendations:

- Utah public health officials recommend that adults **NOT eat** these fish.
- Pregnant women, nursing mothers, and children under 12 are also advised **NOT to** eat these fish.

Problem ♦ Pre-pumping ♦ Model results ♦ Remediation

AQUATIC MERCURY CYCLE



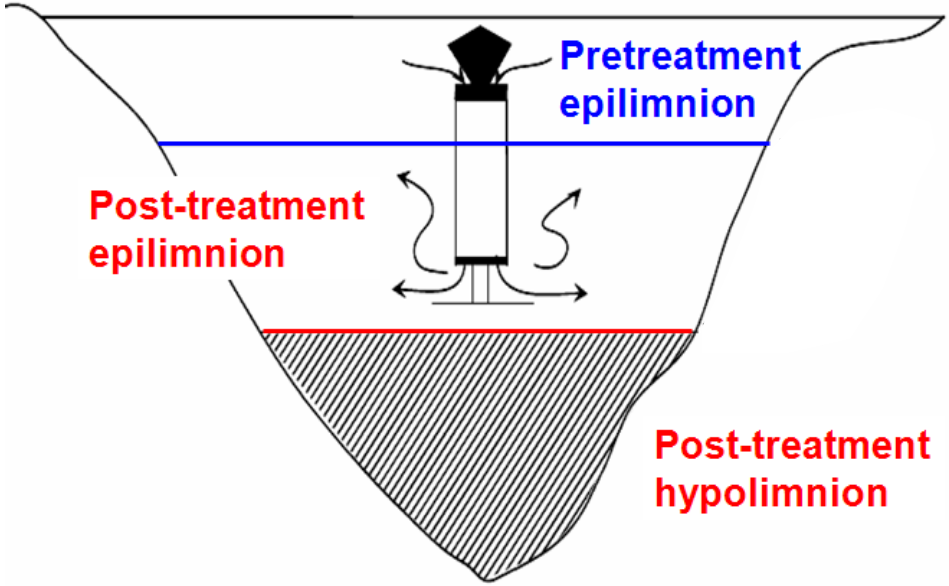
Krabbenhoft and Rickert (2005)

Hg REMEDIATION

Utah regulatory agencies can't do much about controlling atmospheric sources of mercury, but may be able to do something about managing Hg methylation

Rask and others, Biogeochemistry (2010) 101:311–322

Does lake thermocline depth affect methyl mercury concentrations in fish?



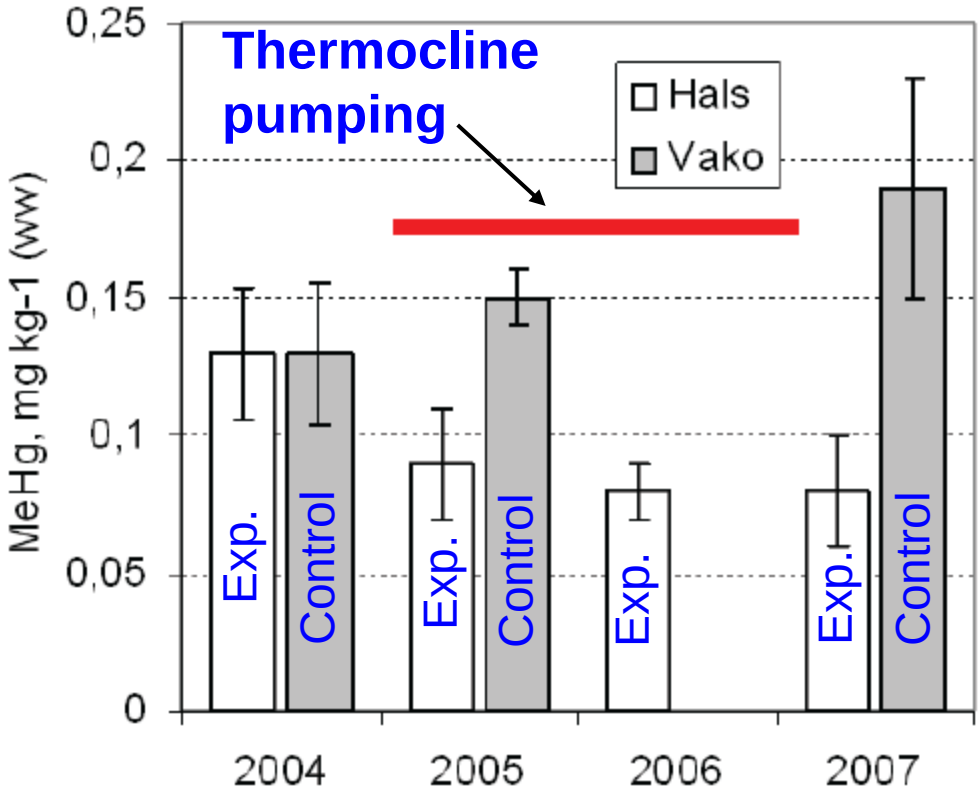
- **Decreased volume of water with high methyl mercury**
- **Decreased surface area of low oxygen sediment**

DECREASE IN METHYL Hg

(Rask and others, 2011)

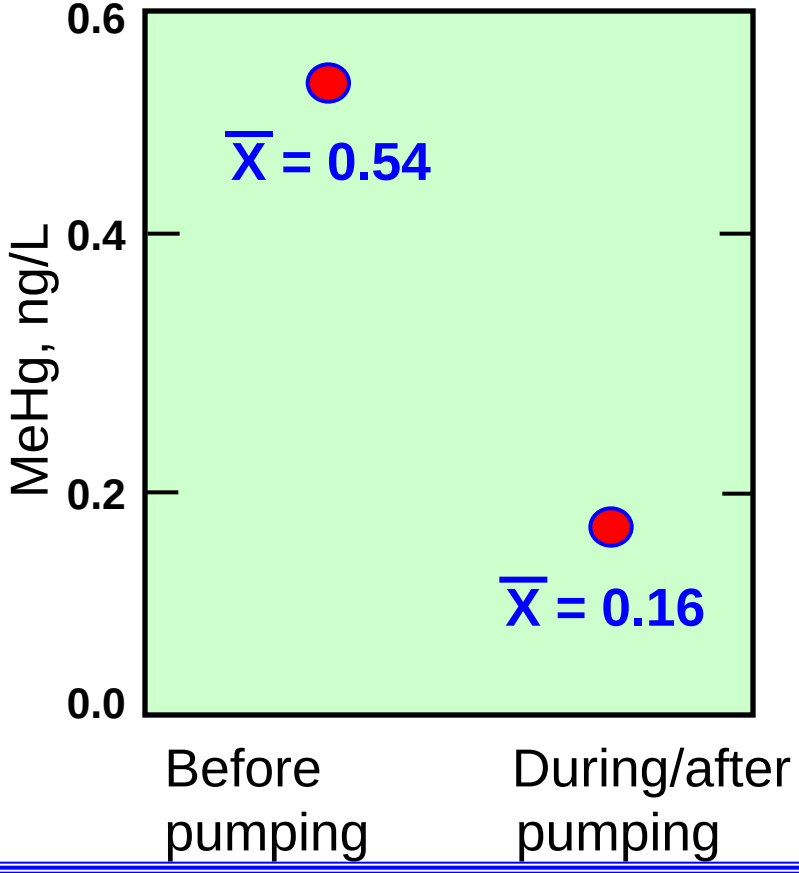
Fish tissue

(small perch, 70-80 mm)

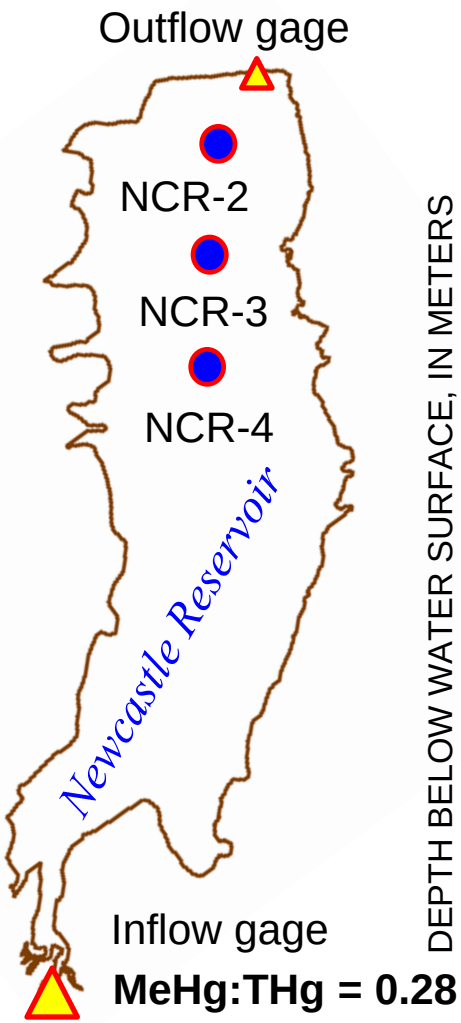


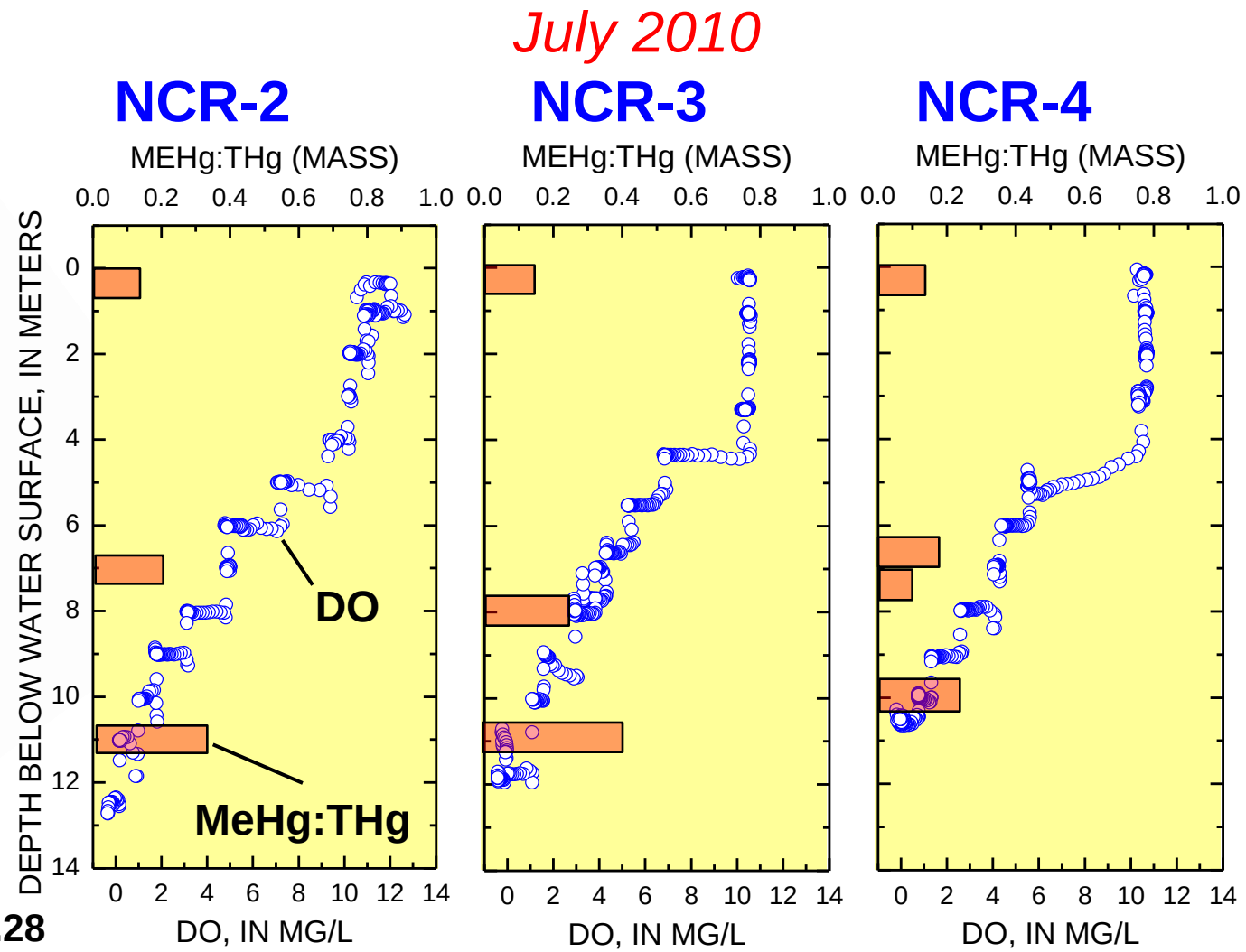
Water

(epilimnion)



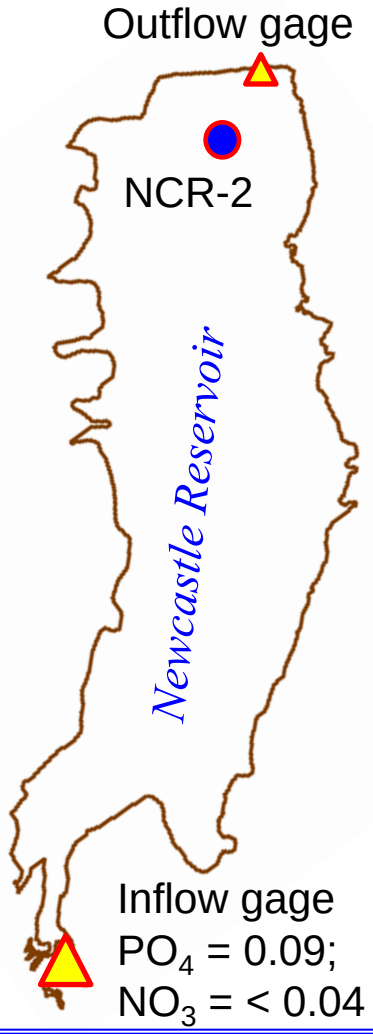
PRE-PUMPING CONDITIONS





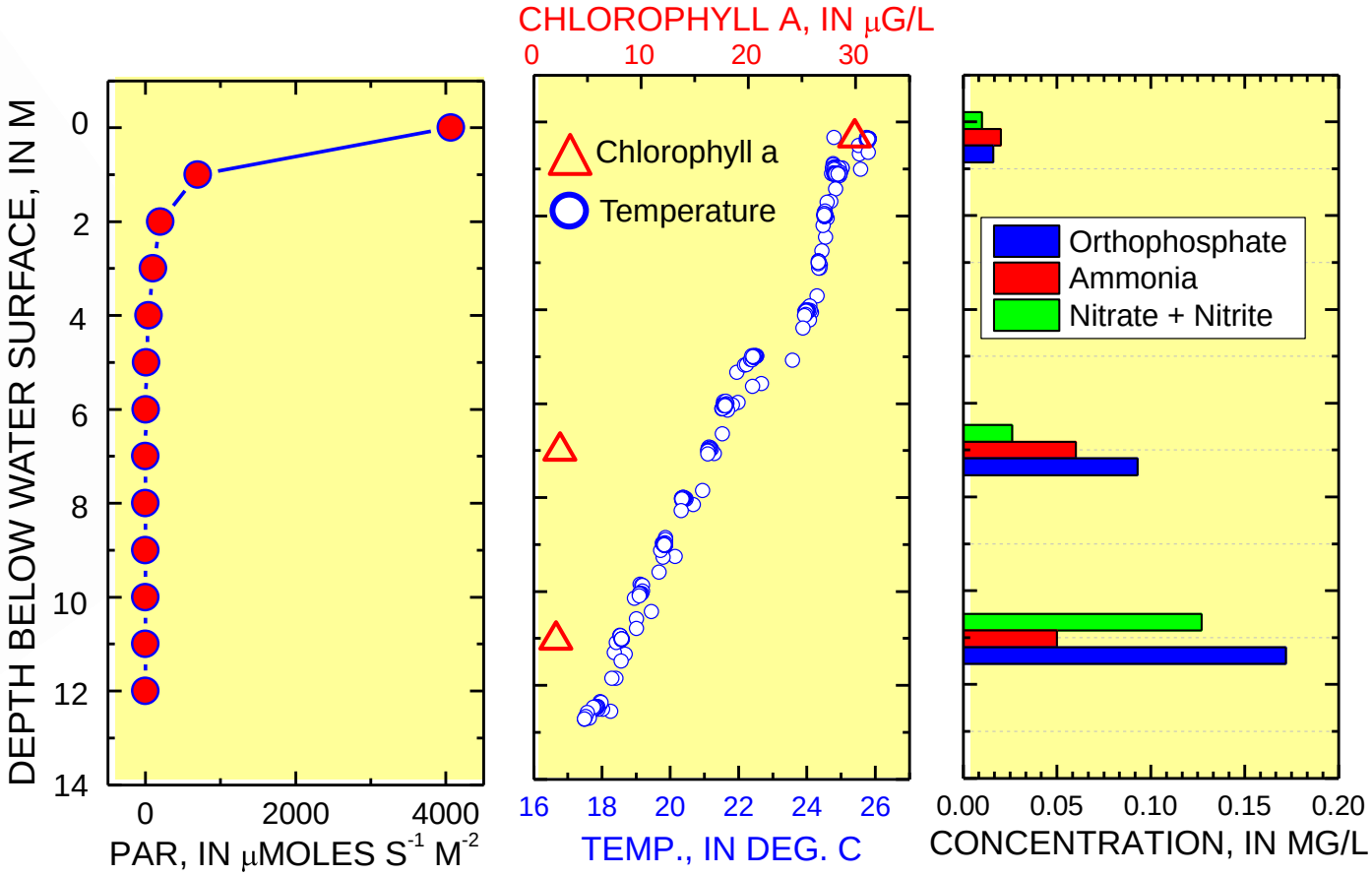
Problem ♦ Pre-pumping ♦ Model results ♦ Remediation

NUTRIENT POOL AT DEPTH

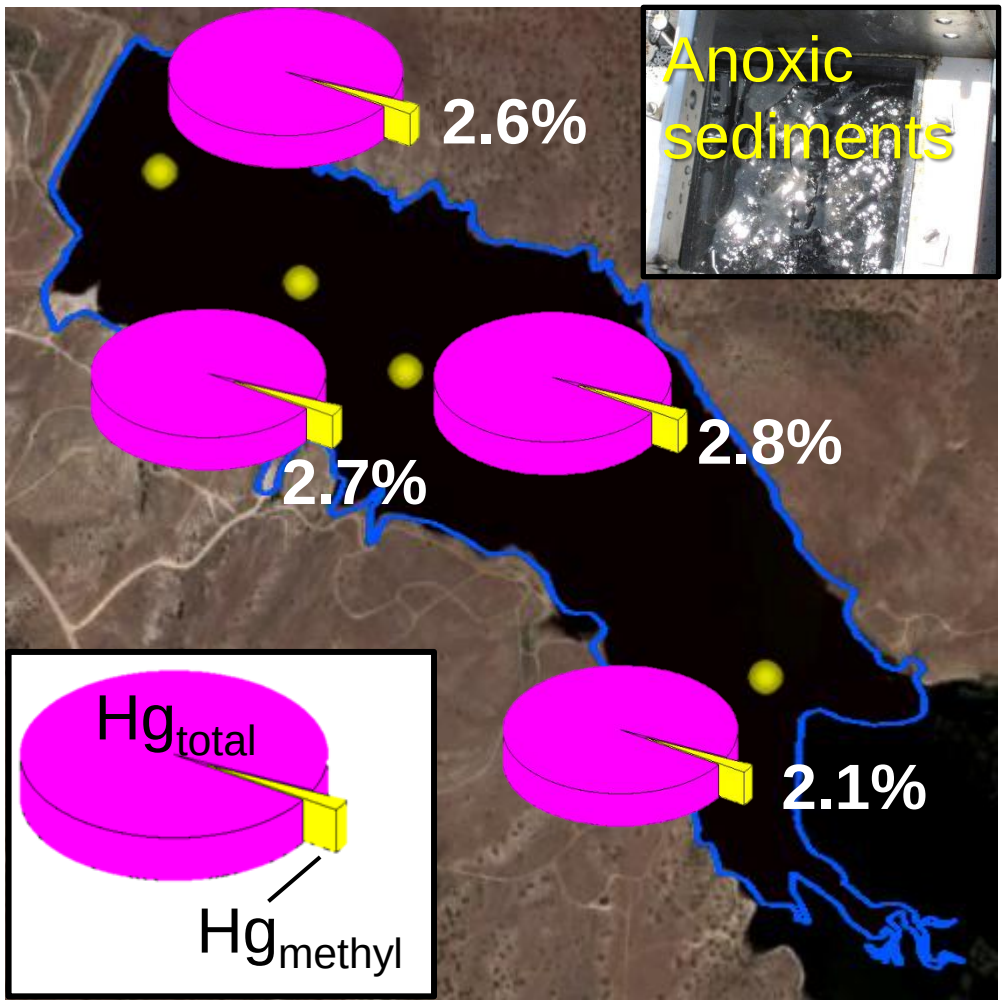


July 2010

Site NCR-2

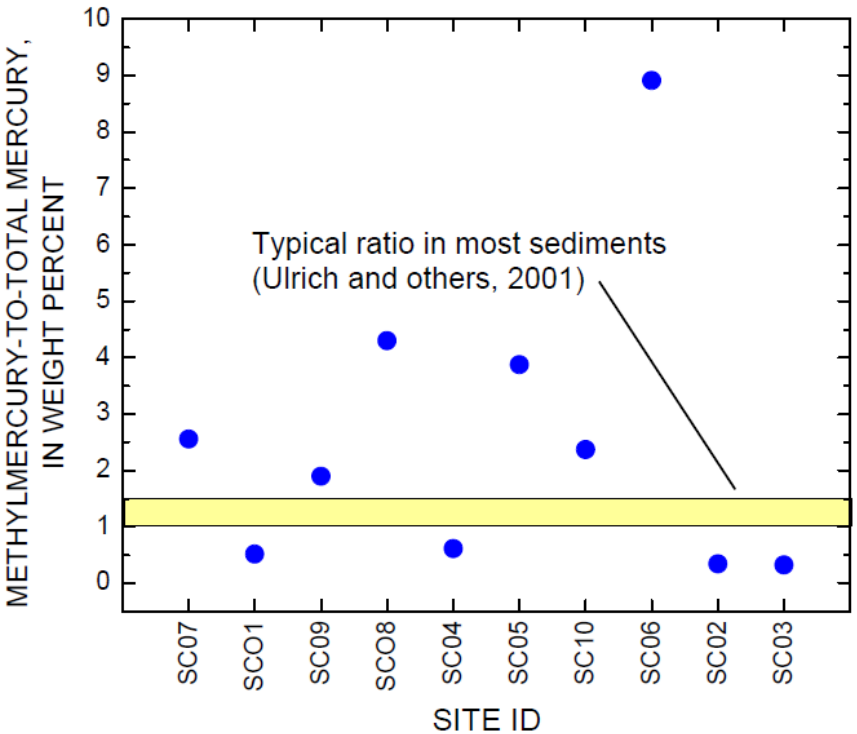


Hg SPECIES IN SEDIMENTS

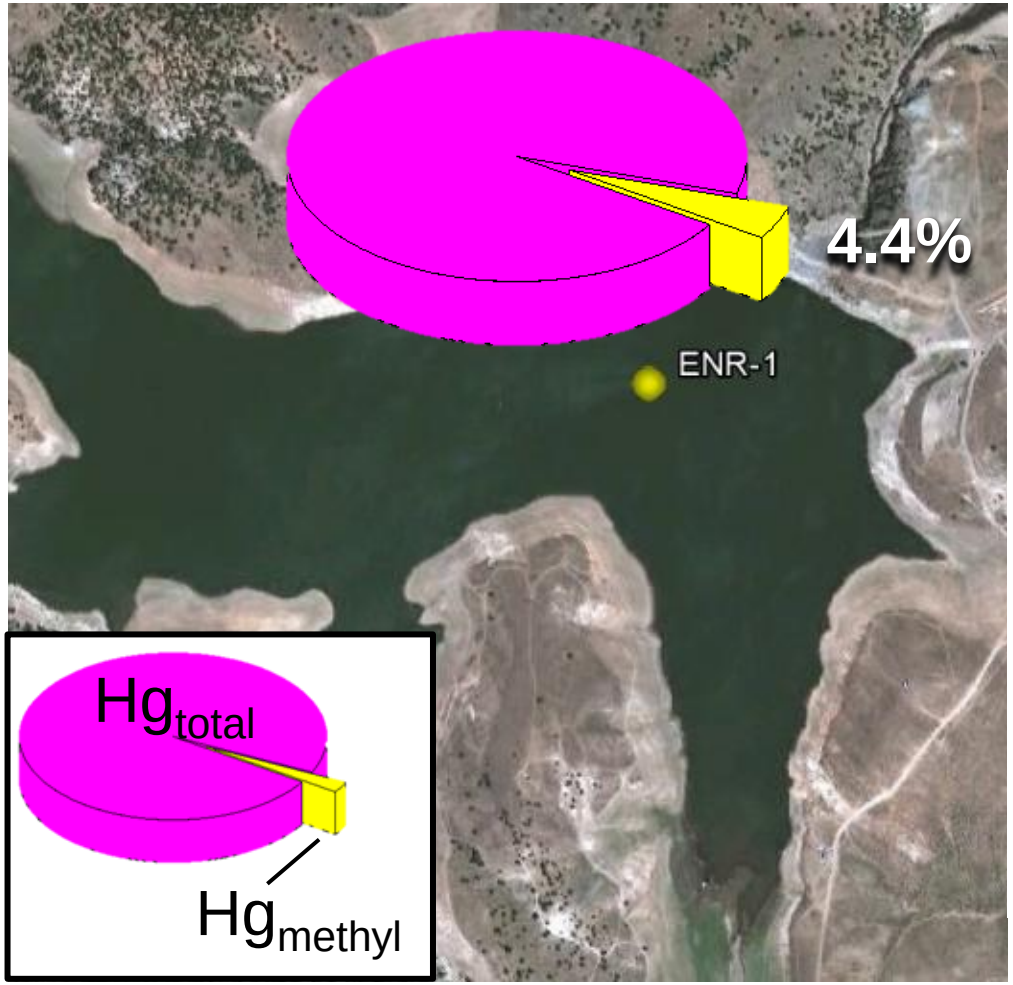


Great Salt Lake wetlands

Naftz and others, in review



Hg SPECIES IN SEDIMENTS



Great Salt Lake wetlands

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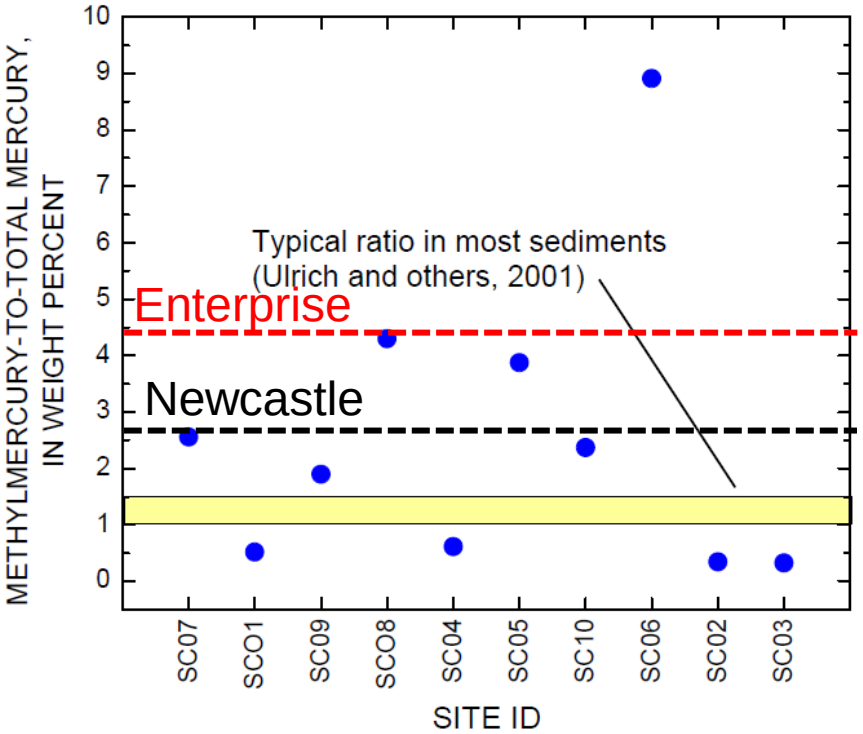
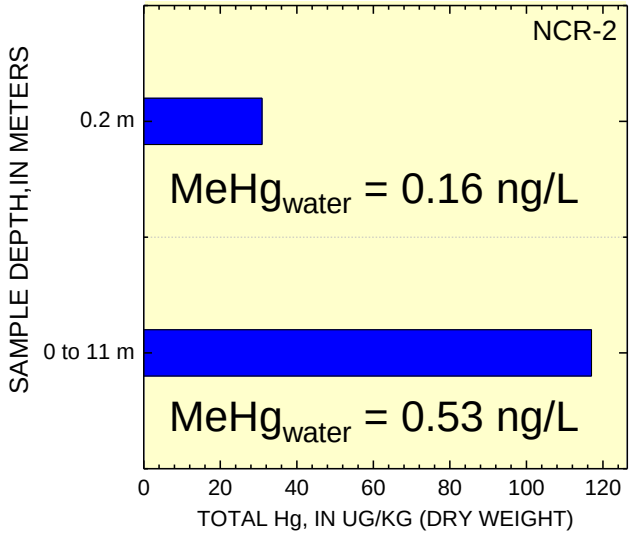
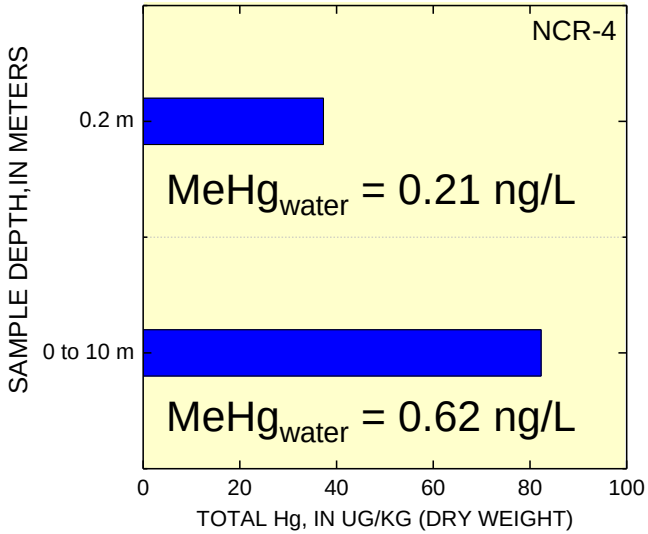
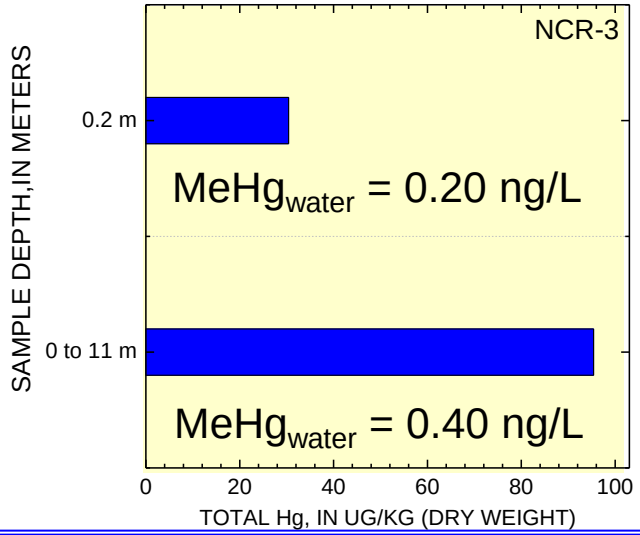


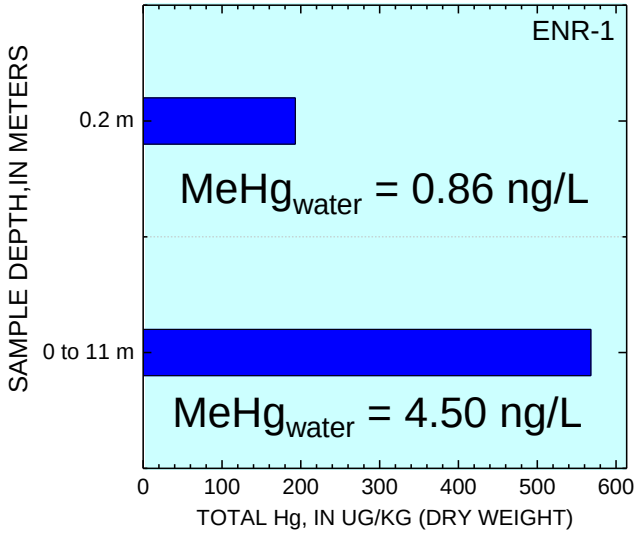
SESTON PROFILES (Hg_{total})

July 2010







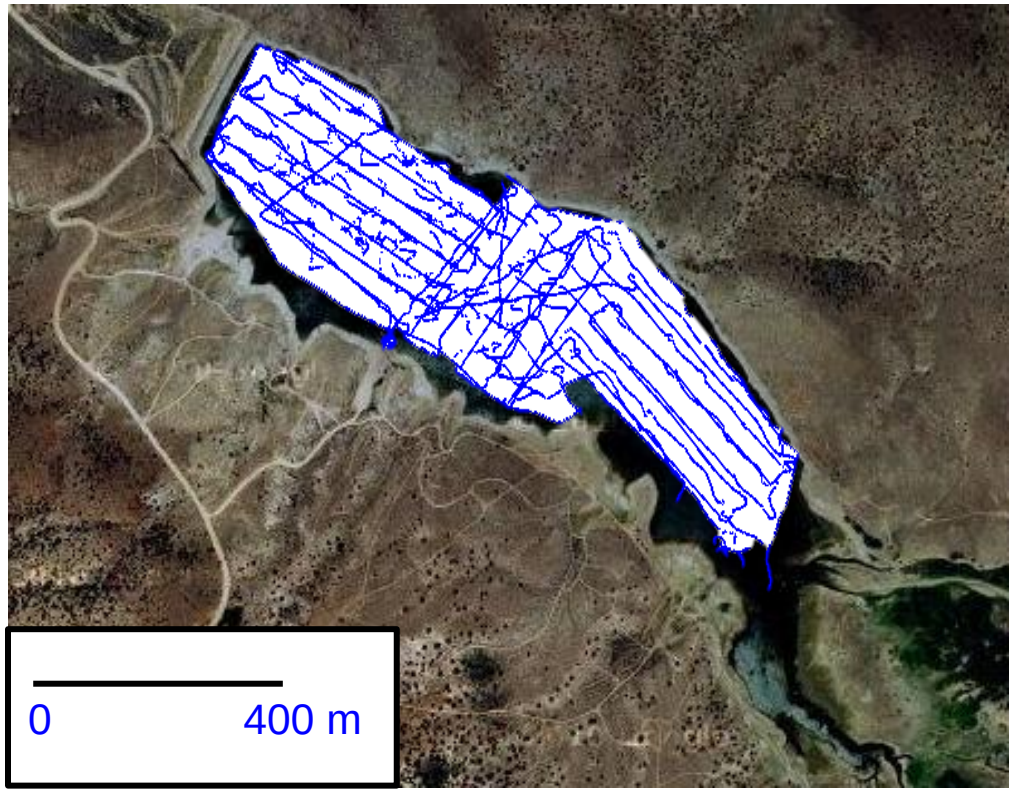


HYDRODYNAMIC MODEL

Generalized Environmental Modeling System for Surfacewaters

Model Objectives

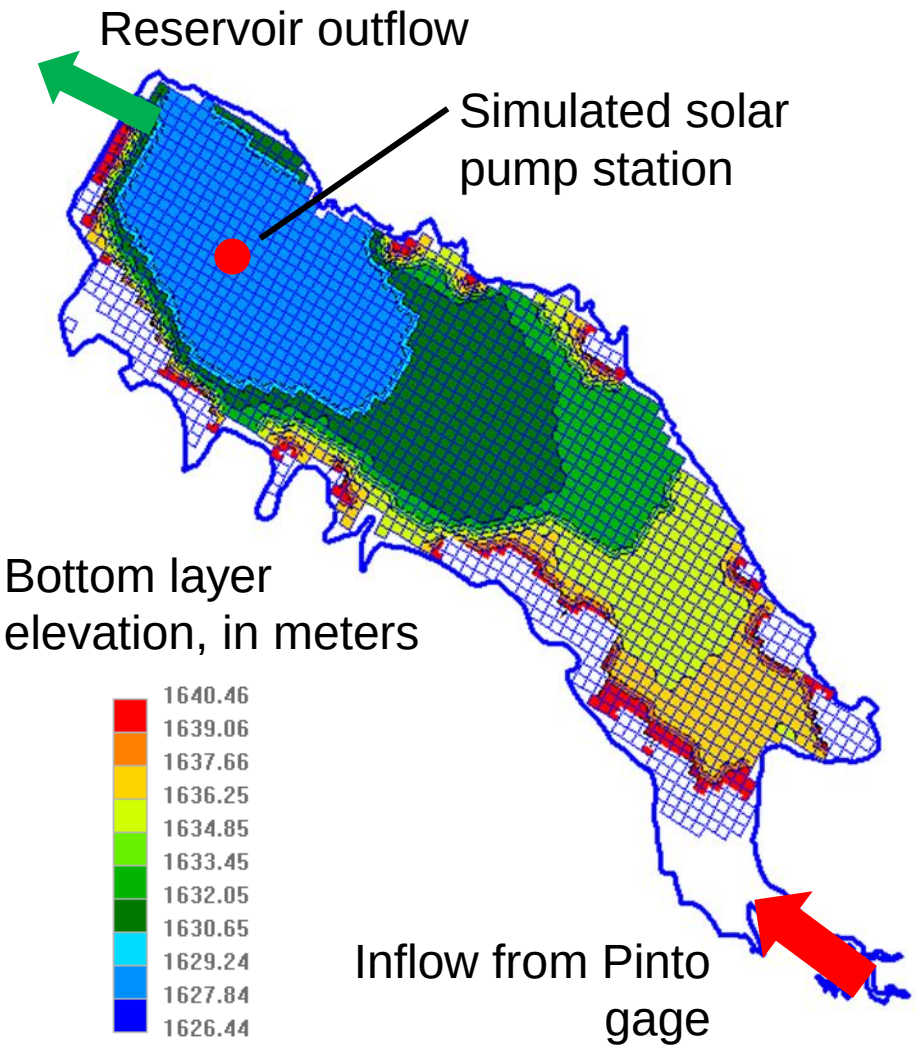
- **Simulate pumping of near bottom water to surface**
- **Simulate area of influence under different (1) pump rates; (2) pump positions; and (3) reservoir outflows**



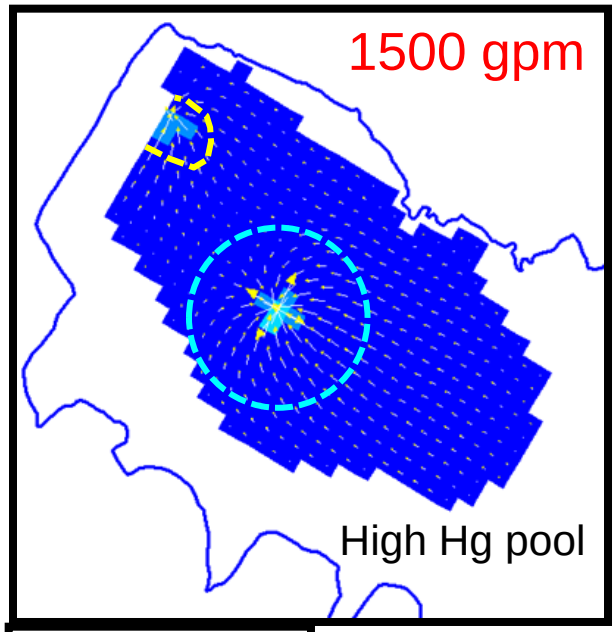
Bathymetric survey lines from AUV (1 day)

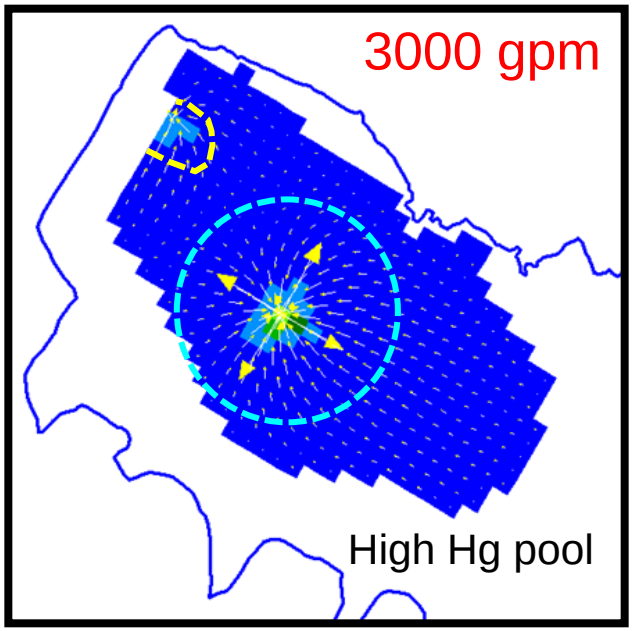
BOUNDARY CONDITIONS

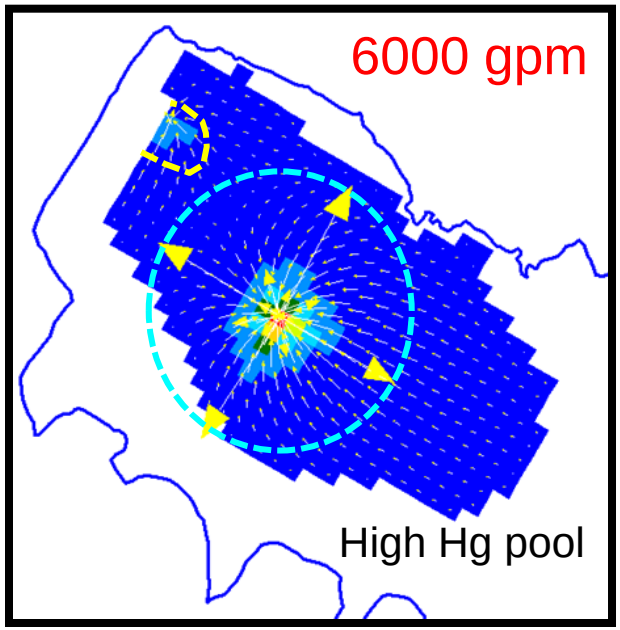
- 15-minute weather station data (Enterprise, Utah)
- Daily water-level data (regression model)
- Inflow from Pinto Creek gage (15-minute data)
- Hourly reservoir outflow data
- Pump locations and rates inserted at various model grid points

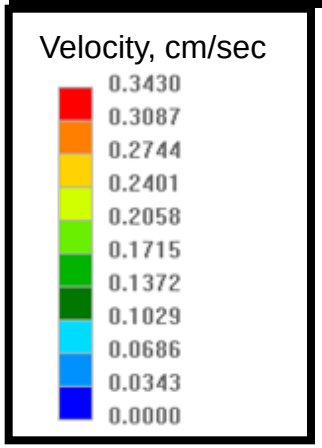


PUMPING INFLUENCE



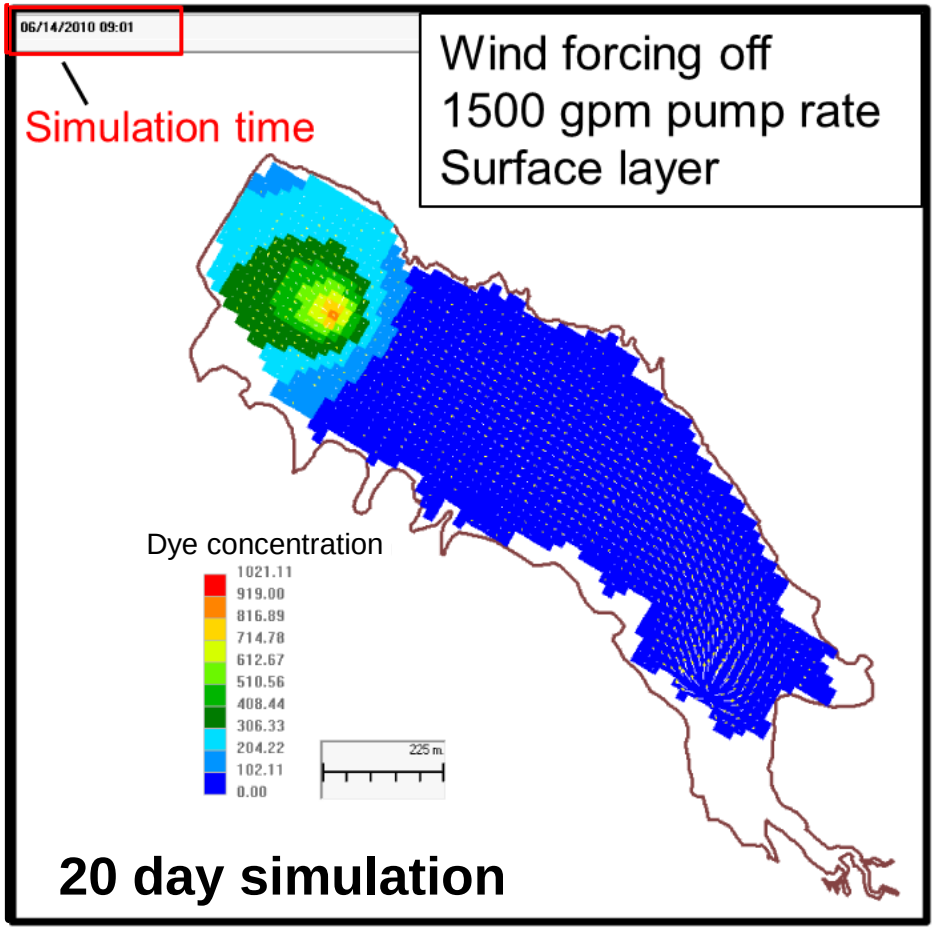


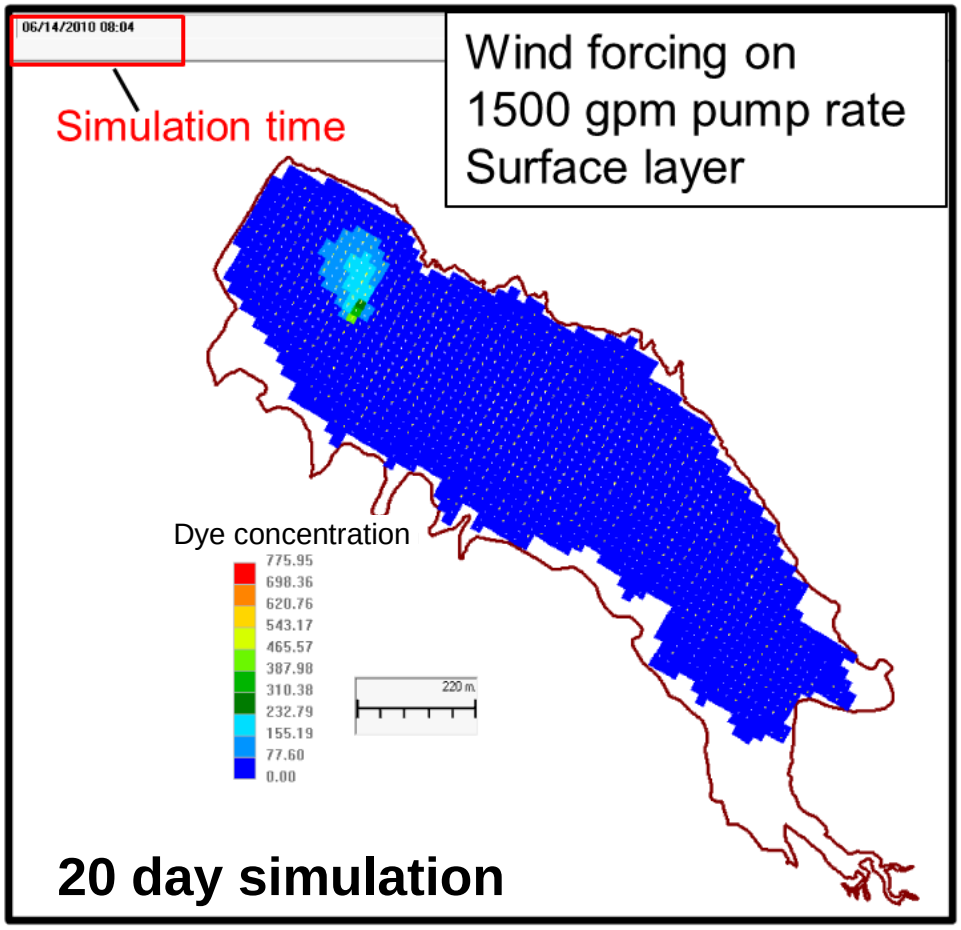




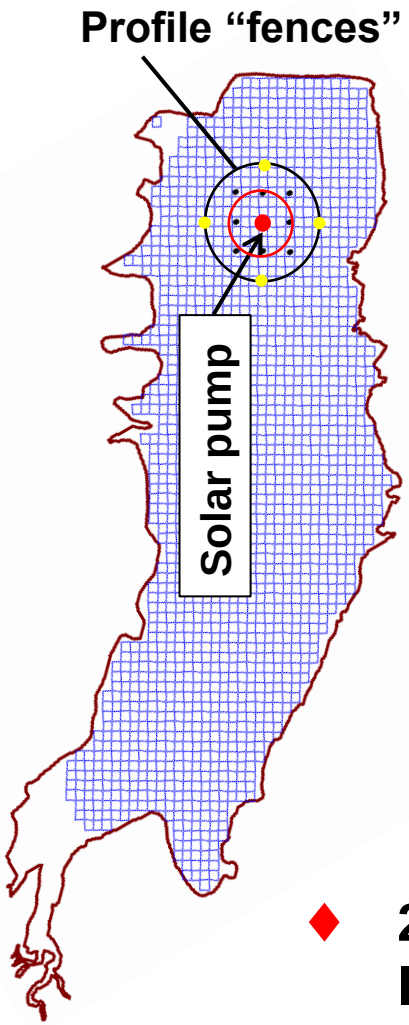
- **No wind, pump inlet in bottom layer, reservoir outlet at bottom, vertical pipe inflow and outflow**
- **Position pump to the NE and migrate up reservoir (take advantage of bottom water removal from reservoir outflow)?**
- **Position closer to reservoir outflow for Hg removal?**

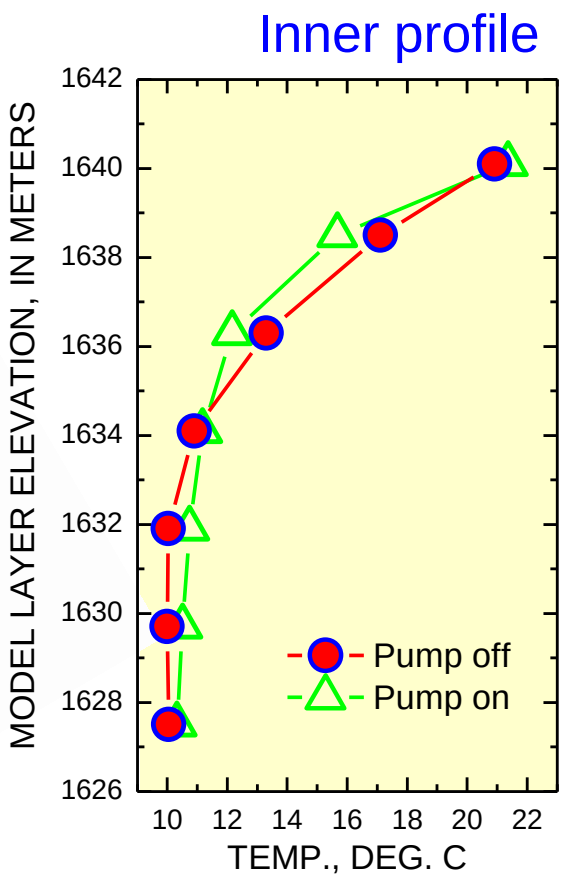
NUTRIENT DISPERSION

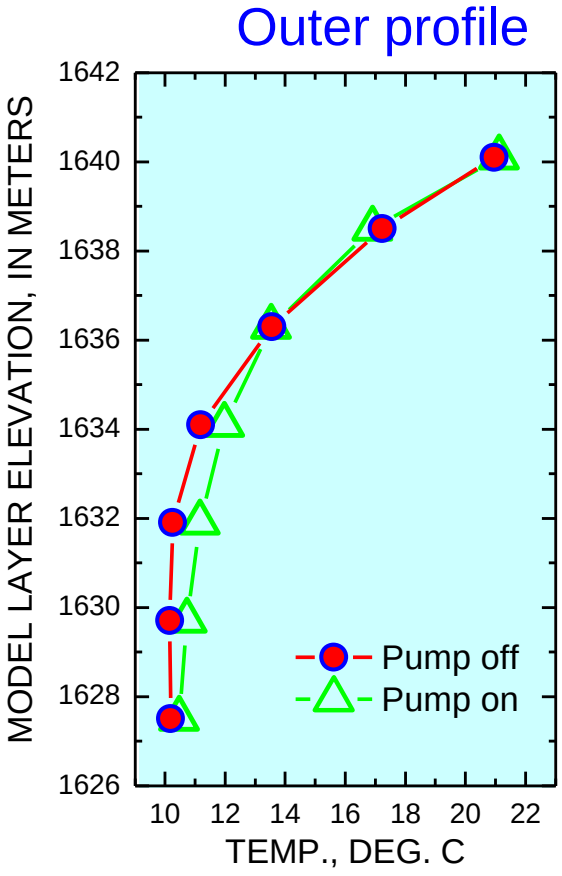




THERMOCLINE IMPACTS

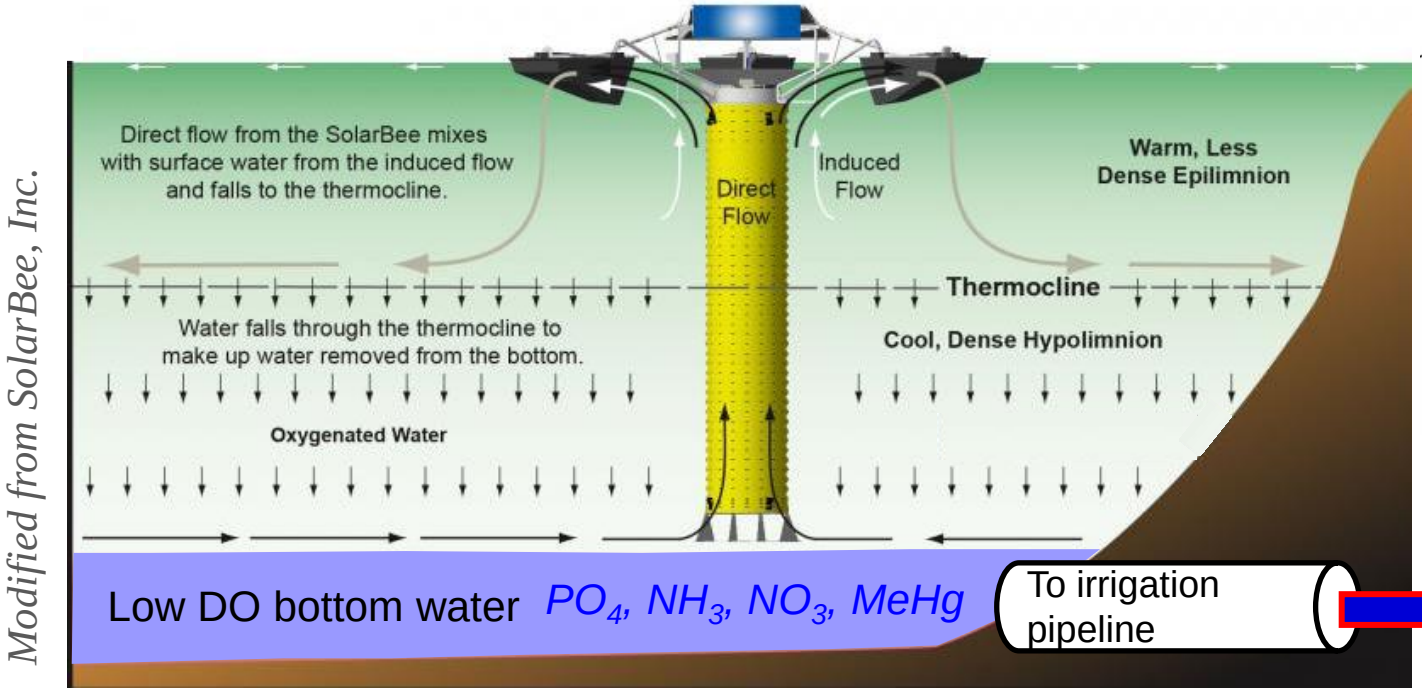




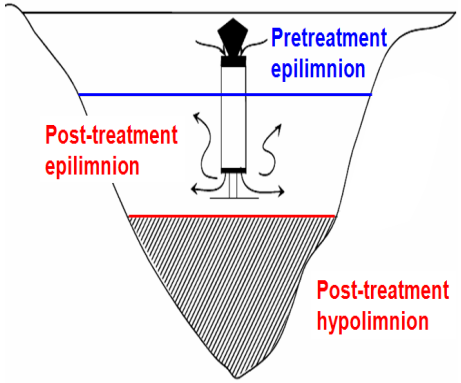


- **20-day pumping cools upper water column and warms lower water column relative to "pump off" simulation**

Hg REMOVAL PROJECT



Modified from SolarBee, Inc.



Irrigated fields

- **Solar-powered pump (SolarBee, Inc.) 1,500 gpm**
- **Reverse water flow (bottom → up)**
- **Oxygenate bottom water, photodegrade MeHg, export nutrients, and ??**

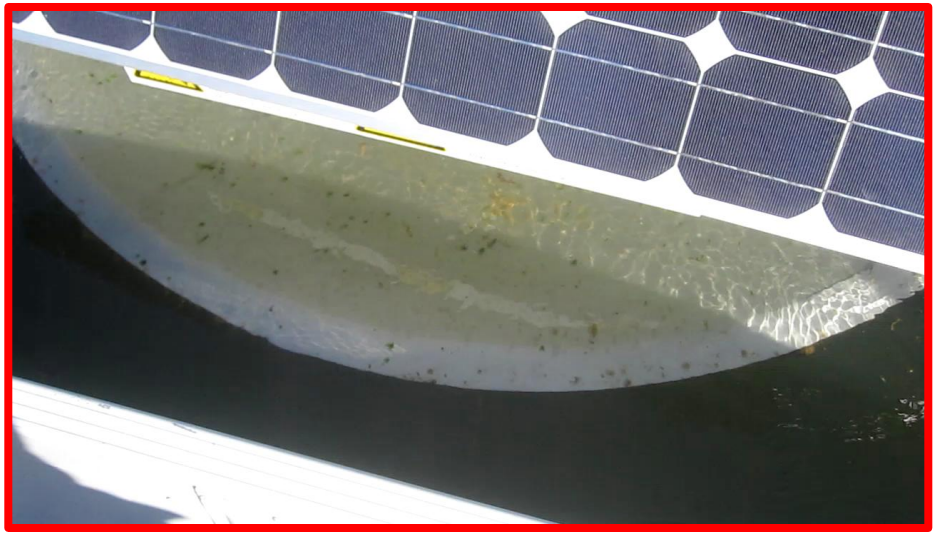
SOLAR PUMP INSTALLED

July 2011

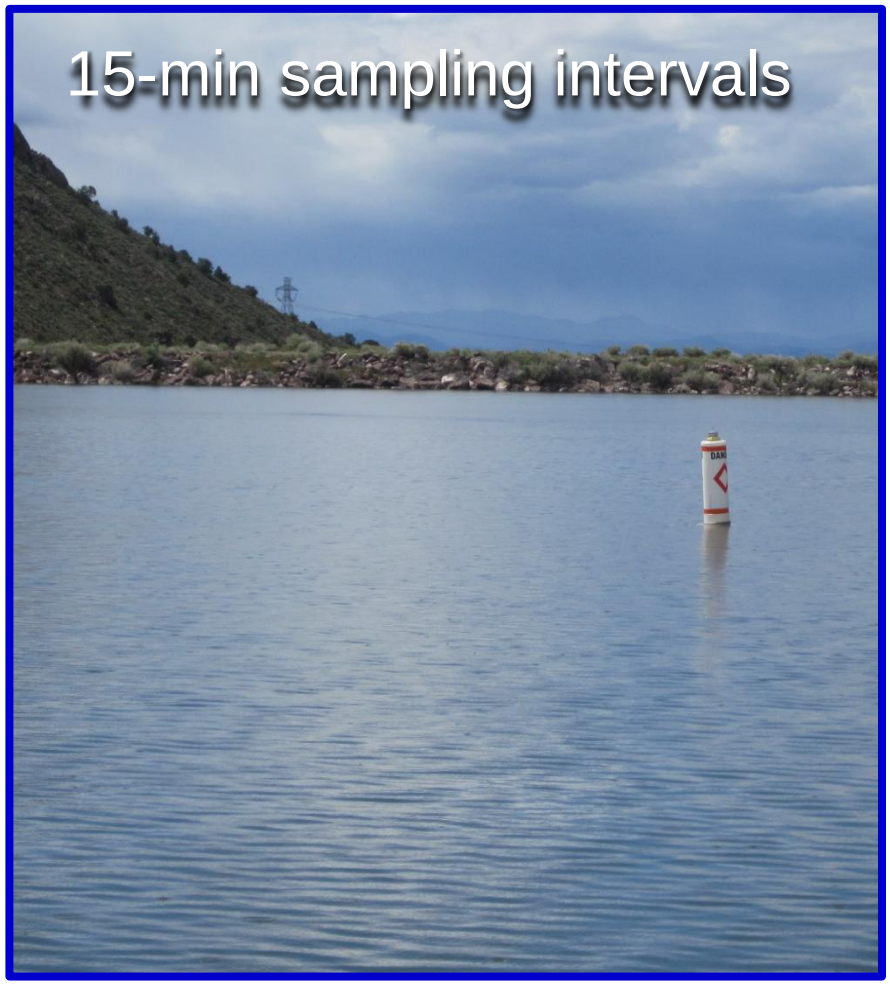
SOLAR PUMP OPERATION

- Small surface footprint
- Low-noise operation
- Hazard light and perimeter chain
- Sulfide odor

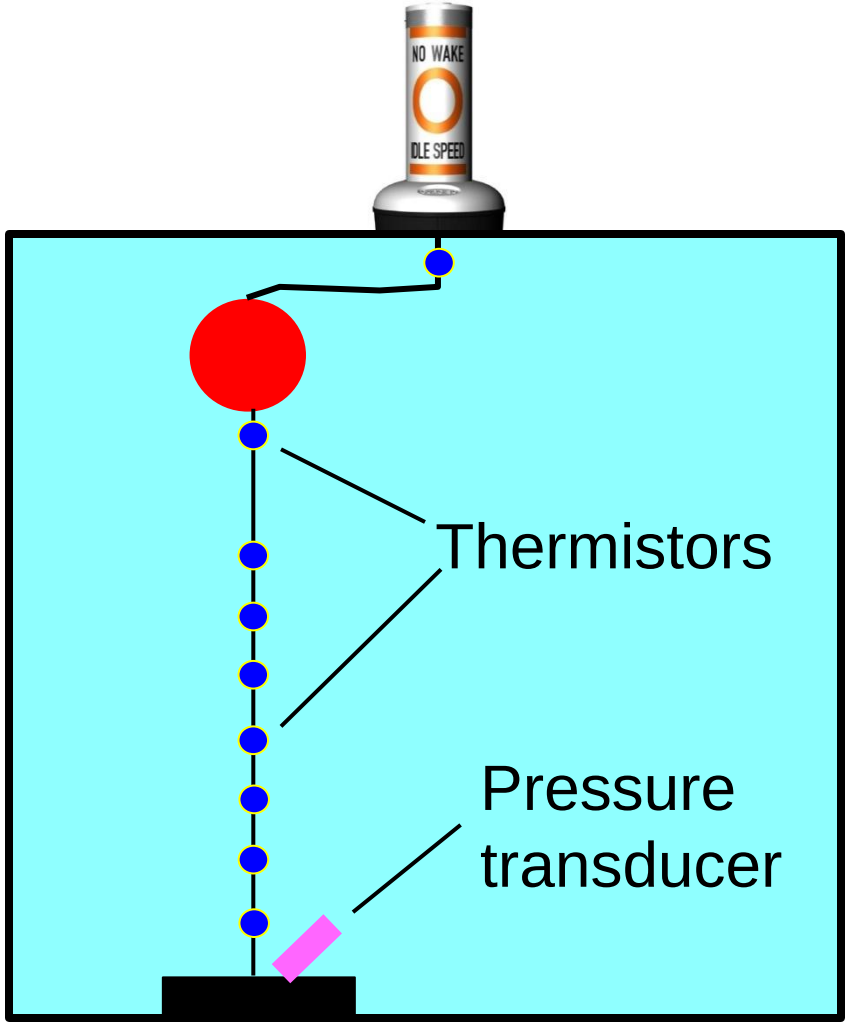
- 1,500 gpm total flow
- Operates 24-7, 365 days/year
- Remove algae from outflow



THERMISTOR STRING

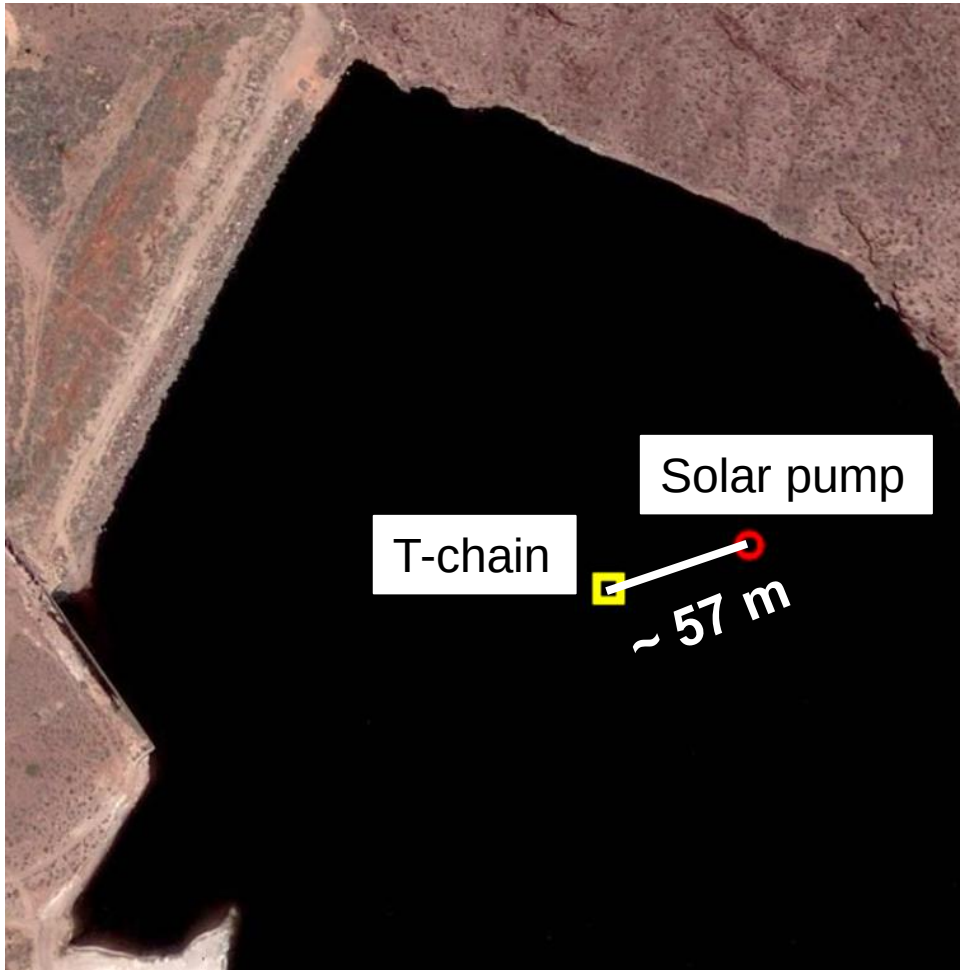


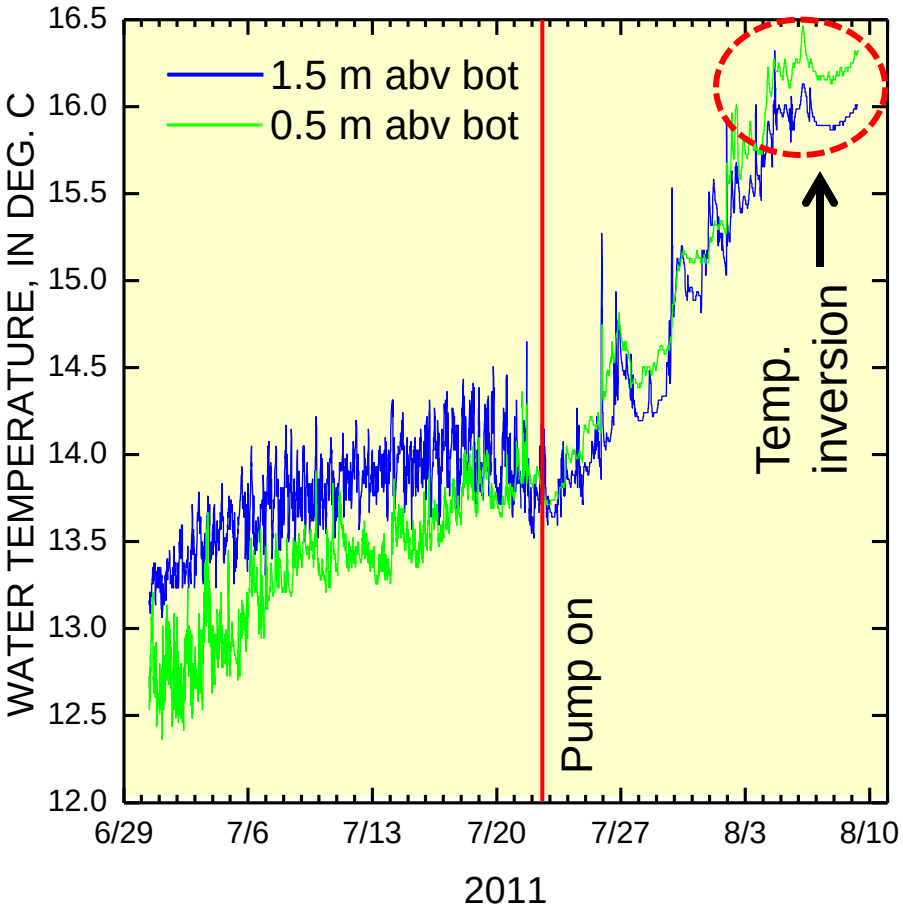
Thermistor string, Newcastle Reservoir



POST-INSTALL TEMPERATURE

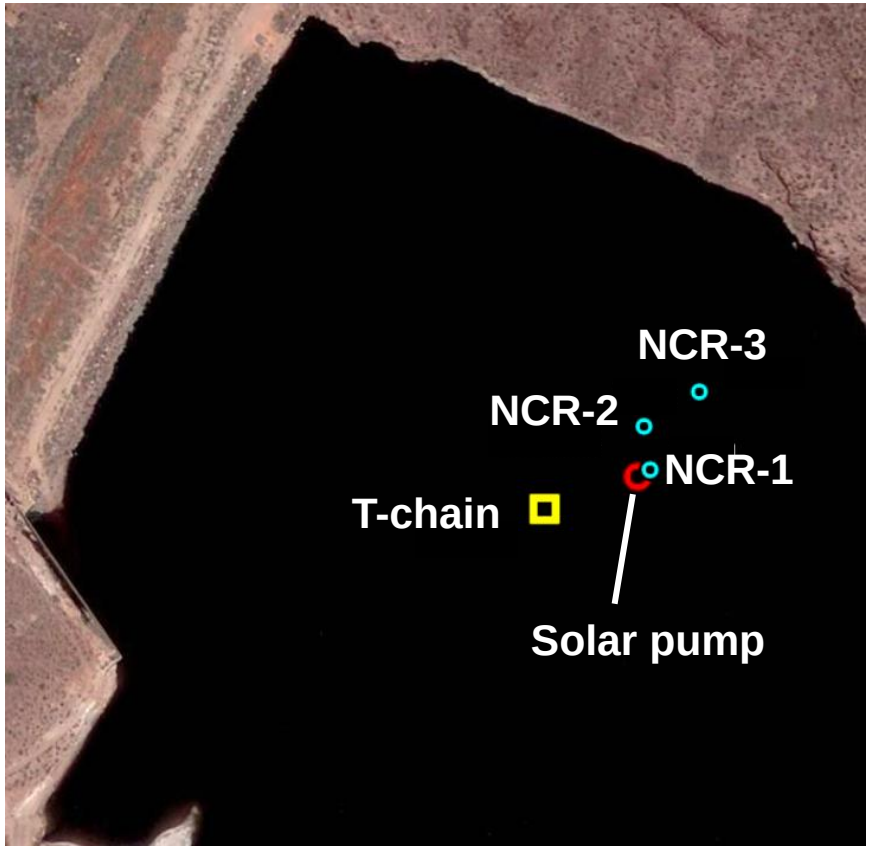
Temperature increase near bottom

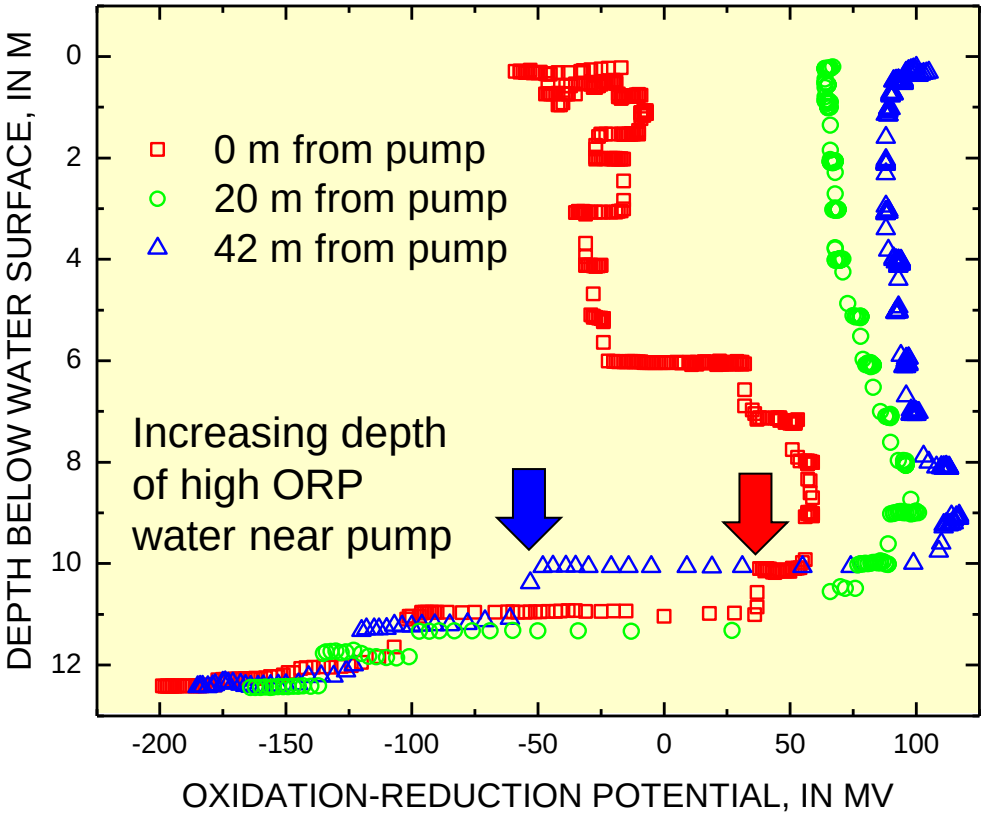




Pump impacts thermal gradient

POST-INSTALL PROFILE





- *Low redox water moving to surface*
- *Penetration of higher ORP water near pump*

SUMMARY


ATTENTION ANGLERS
FISH CONSUMPTION ADVISORY
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Where: Newcastle Reservoir
Recommendations:
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UTAH DIVISION OF
Wildlife Resources
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ENVIRONMENTAL QUALITY