TRACE LEVEL SELENIUM ANALYSIS IN HIGH BRINE MATRIX

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Kennecott's Environmental Lab

- A NELAC Certified Laboratory
- A Utah State Certified Laboratory
- American Industrial Hygiene Accredited
- CLEA Licensed
- USGS SRM Audit Series

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Laboratory Instrumentation

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Trace Metal Analysis of Great Salt Lake Waters

- In the early 1970s, Kennecott recognized that clean water analytical methods were not appropriate for GSL brines
- Specialized procedures were required for analysis of GSL samples—especially for trace metals
- Results of analytical work were published in several peer-reviewed articles by Paul Tayler, Lynn Hutchinson, & Melvin Muir

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Analysis of Selenium in GSL Waters

- Kennecott and others recognized the limitations of existing methods for analysis of selenium in high salinity waters
- Kennecott consulted with outside experts including:
  - Dr. Gregory A. Cutter
  - Dr. Eva Prusckowski
  - Frontier Geoscience
  - Battelle NorthWest
- A specialized Hydride Generation method was developed

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The Selenium Hydride Procedure

- Method used in oceanographic studies
- Modified EPA 7742
- Method reviewed and approved by the Utah State Department of Health
- Method accepted by Utah Department of Environmental Quality for Compliance with UPDES Monitoring

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Selenium Concentrations in GSL

- Selenium is less than 1 µg/L in the Great Salt Lake water
- GSL waters were analyzed by Frontier Geosciences
- Data levels confirmed by Battelle & Kennecott

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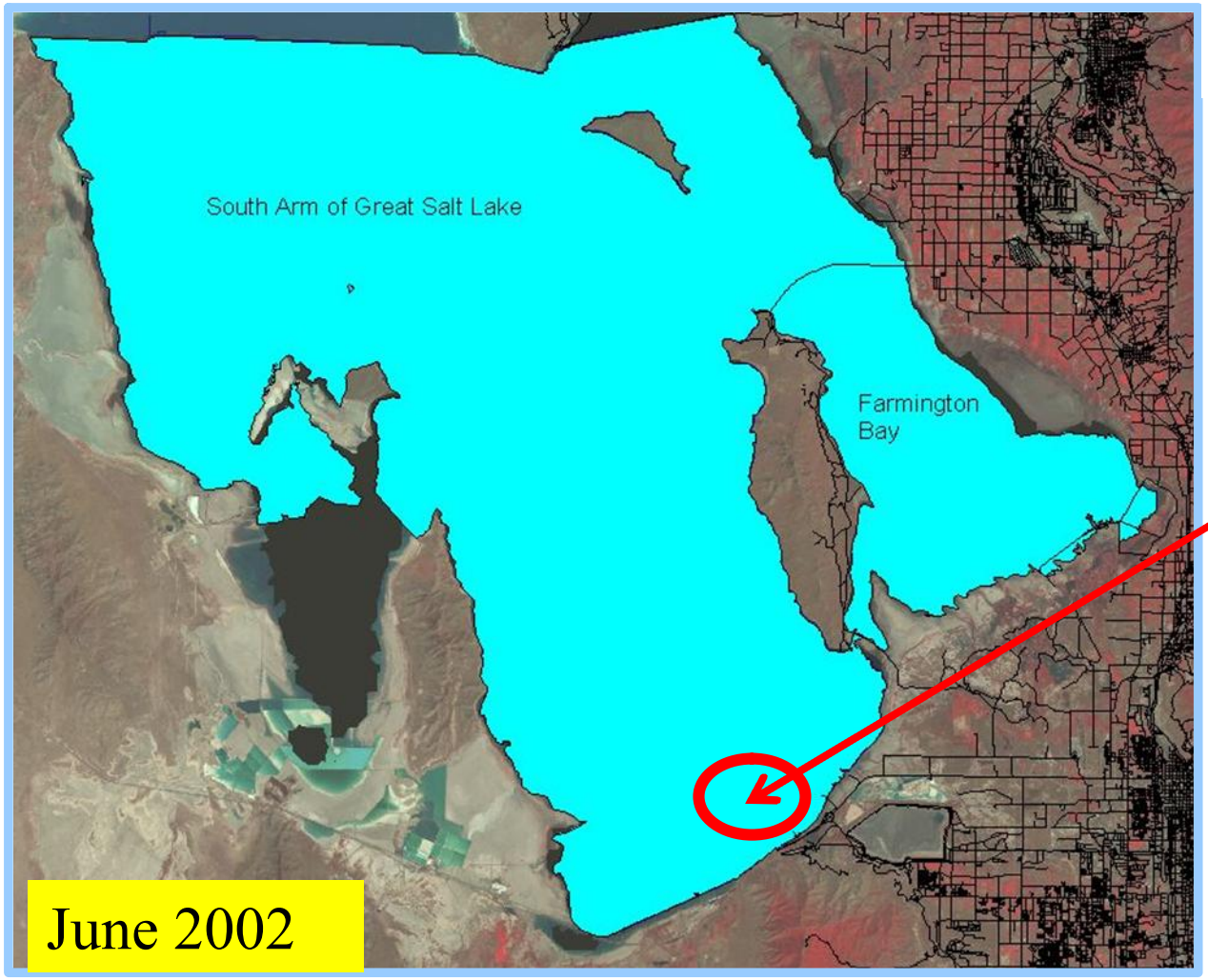
Dissolved Selenium Concentrations in GSL

(0.5 – 20 feet sample depths)



Frontier Geosciences Lab
Hydride method

0.612 µg/L
0.607 µg/L
0.653 µg/L
0.564 µg/L
0.628 µg/L
0.638 µg/L
0.586 µg/L
0.102 µg/L

Avg = 0.549

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Concentration Factors

- Input of selenium from the Jordan River is ~4 µg/L into the GSL
- Selenium concentration in the Lake is 0.6 µg/L
- Selenium does not show concentration like other elements i.e. chloride
- Natural processes are reducing selenium concentration in the Lake

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USGS National Lab, Denver, CO

ANALYTICAL METHODS FOR TRACE ELEMENTS

Arsenic

As separated saline matrix before quantitation using IC
Cl interference with ICPMS is eliminated using IC separation
Detection limits enhanced using arsine generation

Transition

Metals
Metals

If USGS recognized the need to address matrix and to use Hydride Generation for arsenic, why did they not recognize the need to do likewise for selenium?

Selenium

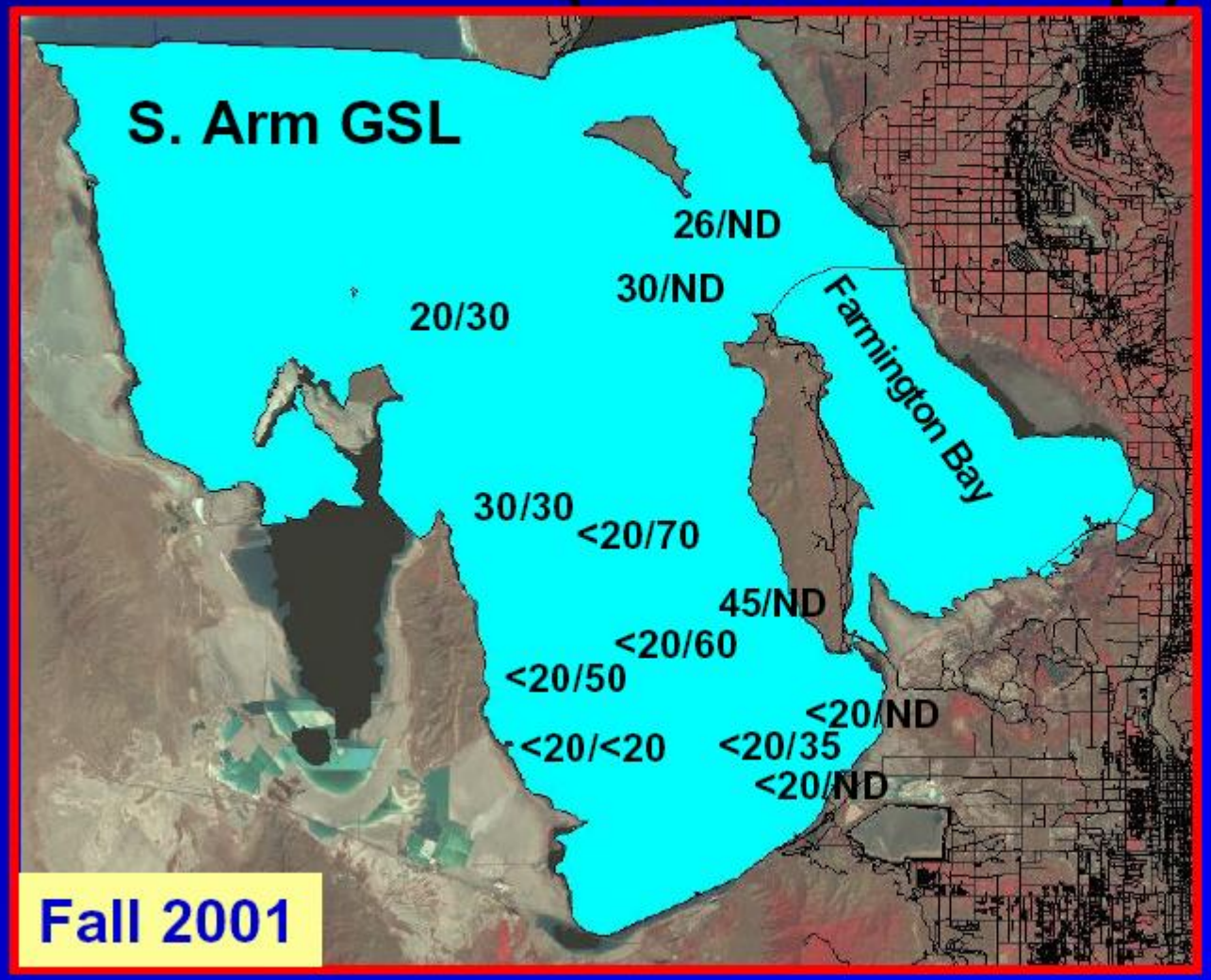
Determined by GFAAS

Jones, S.R., and Garbarino, J.R., 1999, USGS OFR 98-639, 39 p.

Great Salt Lake Study Team

from Waddell, B., et al. *Preliminary investigation of selenium in water, bottom sediment, and biota, Great Salt Lake, Utah*

Dissolved Se, in µg/L (shallow/deep)

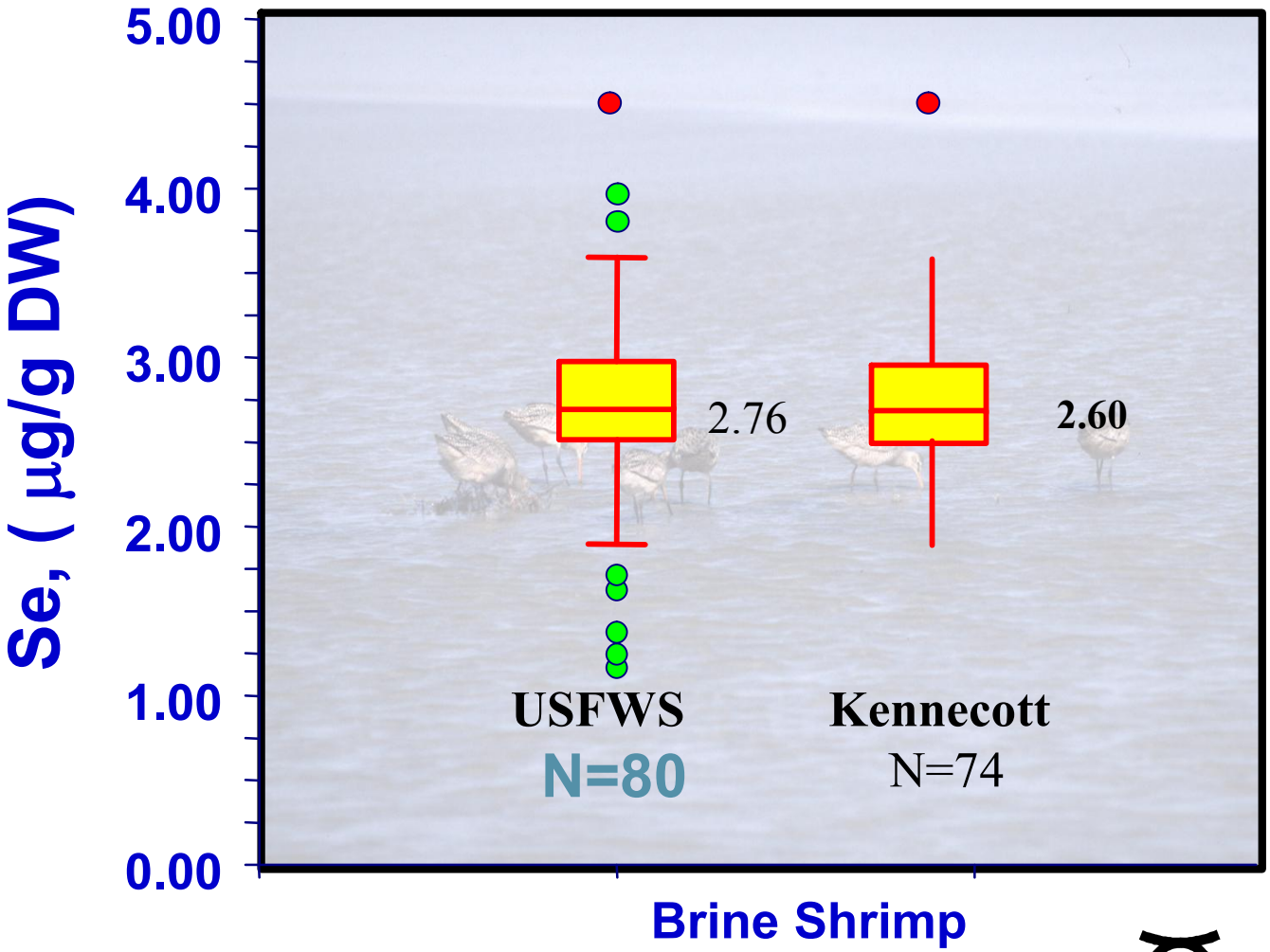


5 µg/L Se is Water Quality Criteria in freshwater

Great Salt Lake Study Team

from Waddell, B., et al. *Preliminary investigation of selenium in water, bottom sediment, and biota, Great Salt Lake, Utah*

Observed Effect of Selenium on the Biota



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Toxicological Perspective

- If selenium concentrations were in the range of 20-70 µg/L, selenium would be detected at much higher levels in biota of the GSL, i.e., brine shrimp, brine flies, and bird eggs
- Observed selenium biota levels are consistent with reports for other areas in the Western US where selenium is present at similarly low concentrations

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Conclusions

- High saline GSL waters require specialized and rigorous analytical methods (GFAAS is not appropriate)
- Measured south arm GSL selenium concentrations are less than 1 µg/L (ppb)
- Selenium concentrations in the GSL are lower than source streams due to natural reducing conditions. Selenium is not returned to a soluble state by lake turn-over and does not become bio-available
- Observed low selenium in GSL waters is consistent with measured biota levels

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Conclusions (cont.)

- USGS needs to update selenium analytical procedures to reflect saline interferences as addressed for arsenic and other transition metals
- USFWS should revisit their conclusions in light of appropriate analytical procedures for selenium in high brine matrix

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