Influence of Farmington Bay metal pollution in Great Salt Lake

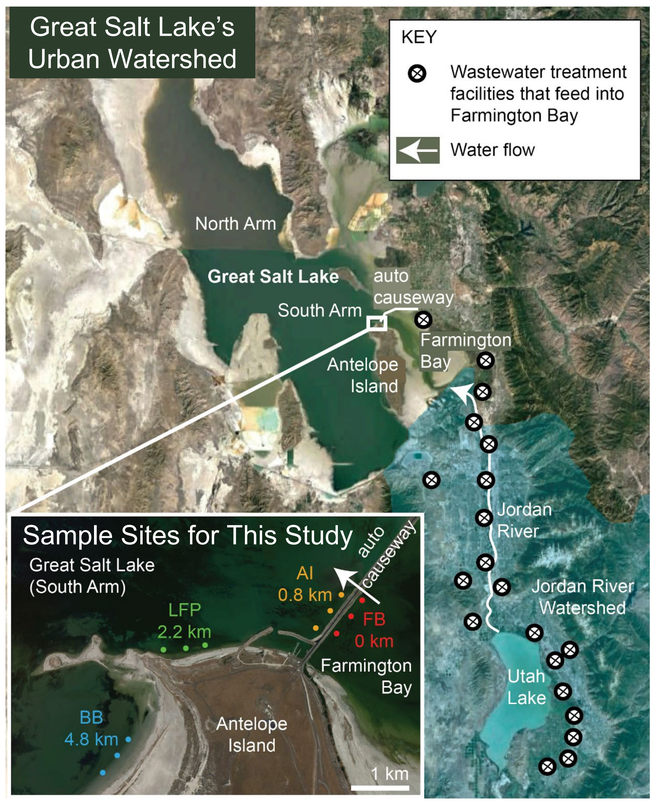
Ian Weech, Kaila Lemons, Megan McNabb, Magan Tea, Carie Frantz

Department of Earth and Environmental Sciences, Weber State University, Ogden, UT

MOTIVATION

Farmington Bay is a potential source of pollution to the Great Salt Lake ecosystem

- High concentrations of Se and Hg have been detected in bird eggs, threatening reproduction rates by thinning the eggs' shells (CH2M Hill, 2008).
- Great Salt Lake (GSL) is bordered by large residential and industrial developments that could be a source of metal pollution.
- Oil refineries, metal fabricators, numerous wastewater treatment facilities, and a copper mine are in the Jordan River watershed, which drains into GSL.
- Jordan River waters enter GSL via Farmington Bay, which is a source of Fe, Pb, Ni, Zn, and Cu to GSL (Abedin, 2016).
- As a terminal lake with no outlet, metal contaminants accumulate in the lake. High concentrations of metals can disrupt the microbial community, and some bioaccumulate in the fauna found at GSL (Adams, 2015).
- In accordance with the National Pollutant Discharge Elimination System, effective pretreatment of waste should prevent excessive concentrations of metals such as cadmium and lead (Office of Wastewater Management, 2004).



METHODS

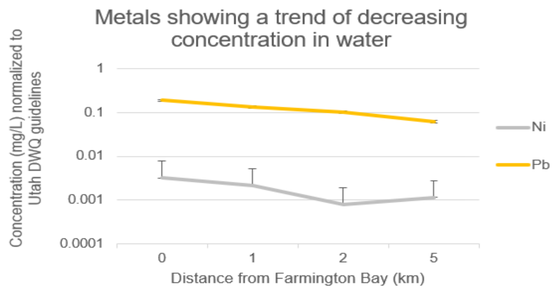
Metal concentrations measured in water & sediment at Farmington Bay and Great Salt Lake sites

- We collected three water and sediment samples from each of four sites of increasing distance from Farmington Bay (figure above) in October 2020.
- Sample metal concentrations were measured via ICP-OES by USUAL.
- The method does not measure mercury or selenium, which were excluded from our analysis but are important toxins in GSL.

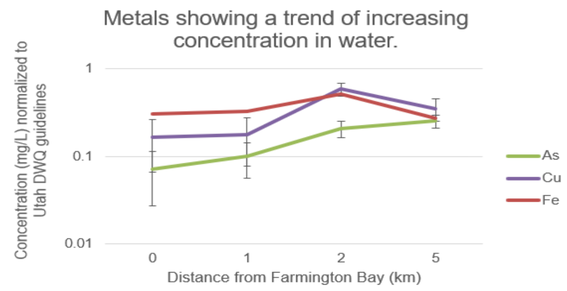
RESULTS

Some metals show trends of decreasing concentration with distance from Farmington Bay, consistent with Farmington Bay as a source

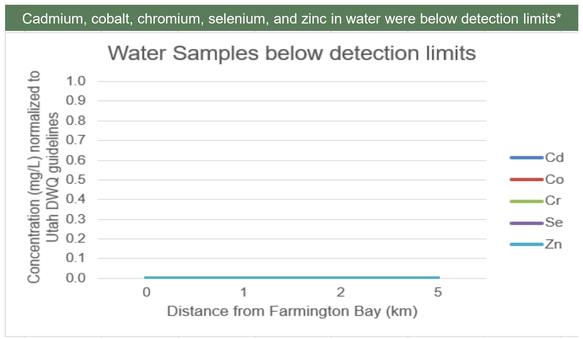
Concentrations of lead and nickel decreased in water with distance from FB



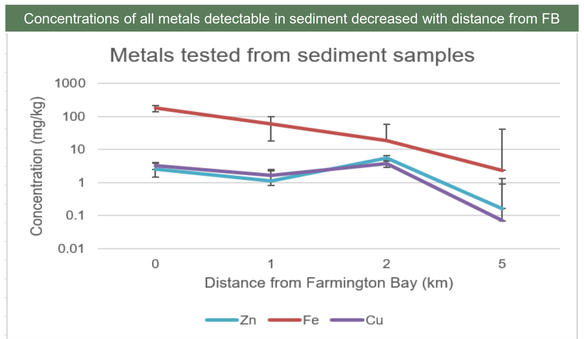
Concentrations of arsenic and copper increased in water with distance from FB



Cadmium, cobalt, chromium, selenium, and zinc in water were below detection limits*



Concentrations of all metals detectable in sediment decreased with distance from FB



* Detection limits for all metals except Se were 1.0 µg/L
Detection limit for Se was 2.5 µg/L

Metal	Trend in water with distance from Farmington Bay	Trend in sediment with distance from Farmington Bay	Suspected contaminant from Farmington Bay?	Potential anthropogenic sources	Other source considerations
As	↑	N/A	No	• copper mining • oil refineries	Microbially-mediated reduction of iron oxides can enhance arsenic mobility
Cu	↑	↓	Yes	• mining • manufacturing • pesticide runoff	Copper is insoluble in high-pH, reducing environments, implying that the copper measured in the lake is in the form of suspended particles
Fe	–	↓	Yes	• coal combustion • mining • manufacturing	
Pb	↓	N/A	Yes	• coal & oil combustion • mining • metal manufacturing • waste	
Ni	↓	N/A	Yes	• fossil fuels • industrial activities • electric utilities • incineration	
Zn	0	↓	Yes	• smelter slag & waste • mine tailings • waste site leaching	Further investigation is needed to identify why the highest concentrations of zinc were observed at the LFP.

CONCLUSIONS & FUTURE DIRECTIONS

- Our results are consistent with Farmington Bay as a source of Fe, Pb, and Ni in water samples and Zn, Cu, Fe, Ni in sediment samples. All of these metals have possible anthropogenic sources in the Jordan River watershed.
- Metal concentrations are also affected by complex geomicrobiological interactions including the oxidation and reduction of selenium, and the reduction of iron-oxides impacting arsenic mobility. This may explain why some metal concentrations in water decreased when they increased in sediments.
- Utah's population is expected to double by 2050 according to the US Census Bureau. Studies of how increased runoff from irrigation, household waste, and treated wastewater contribute to metal contamination will illuminate the future of the lake's water quality.
- Further research is necessary to constrain the sources and impacts of metal pollution on GSL. This study was limited by analysis detection limits, volatilization of Se due to seasonal change, and time.

ACKNOWLEDGEMENTS

This research was done as part of the Fall 2020 Geomicrobiology course with funding provided by the Weber State Department of Earth and Environmental Sciences, Department of Microbiology, and a Nye Undergraduate Research Scholarship.

Antelope Island State Park provided park access. Sampling was done under DNR research permits to Dr. Frantz.

Samples were analyzed by Utah State University Analytical Laboratories USUAL.

REFERENCES

Abedin, S. B. (2016). Nutrient Dynamics in the Jordan River and Great Salt Lake Wetlands. Retrieved from J. Willard Marriott Digital Library The University of Utah

Adams, W.J., DeForest, D.K., Tear, L.M., Payne, K., Brix, K.V. (2015) Long-term monitoring of arsenic, copper, selenium, and other elements in Great Salt Lake (Utah, USA) surface water, brine shrimp, and brine flies. Environ Monitoring and Assessment. Vol. 187, no. 118. DOI: 10.1007/s10661-014-4231-6

Ohlendorf, H.M., DenBleyker, J., Moellmer, W. O., Miller, T. (2008). Development of a Selenium Standard for the Open Waters of Great Salt Lake. *Natural Resources and Environmental Issues*. Vol. 15, no. 1.

Conover, M. R., Vest, J. L. (2009). "Selenium and mercury concentrations in California Gulls breeding on the Great Salt Lake, Utah, USA." *Environmental Toxicology & Chemistry*. Vol. 28, no. 2, p. 324-329. DOI: 10.1897/08-214.1

Office of Legislative Research and General Counsel (2014). "Utah's Population: Growing Fast, Concentrating More, Diversifying Rapidly." *Utah Legislature*.

Office of Wastewater Management. (2004). Primer for Municipal Wastewater Treatment Systems. Washington DC: U.S. Environmental Protection Agency.