Distribution and Availability of Trace Metal(loid)s Within the Plant-Soil-Water Nexus at the St. Jones Salt Marsh

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Abstract

The presence of toxic metals and metalloids such as copper, chromium, and arsenic in soils may pose toxicological risks to biota even at trace concentrations. In preliminary analyses, the Seyfferth Research Group has observed elevated levels of arsenic in pore waters (0.4 – 27 ug L^{-1}) and sediments (up to 47mg/kg) at the St. Jones Reserve that may impact its ecosystem service as a nutrient buffer between the terrestrial and oceanic environments. We hypothesize that the elevated concentrations are due to the use of pressure treated lumber for boardwalk materials. Trace metal(loid) concentrations and partitioning among the soil, pore water, and vegetation pools were monitored to assess the potential chronic toxicity to salt marsh biota as well as the source and fate of arsenic. Expanding water inundation from projected sea level rise will influence the redox chemistry and therefore the mobility of trace metal(loid) contaminants. This study aims to determine whether the influence of redox potential or salinity is the dominant control over the availability of trace metal(loid)s in the St. Jones salt marsh.

Introduction

CCA-Treated Wood

- Wood treated with chromated copper arsenate (CCA) leaches metal(loid)s into nearby soil and interstitial water
- Leaching rate decreases during the first year after installation, but surface rejuvenation causes leaching to continue years later
- Older piers with low water flow interaction have highest metal(loid) enrichment within 1 meter radius
- St. Jones boardwalk installed cir. 1996, with several renovations

Arsenic Availability and Toxicity

- EPA Heavy Metal Standards for Chronic Exposure in Salt Water: 0.48 uM As, 0.96 uM Cr (VI), and 0.049 uM Cu
- Low redox potential reduces iron (oxyhydr)oxides, releasing As
- Salinity has unclear influence on As availability

Research Question 1: What is the source of elevated arsenic in the soils at St. Jones Reserve?

Research Question 2: What factors are controlling the cycling and bioavailability of arsenic and how does it change with shifting biogeochemical regimes?

Methods of Analysis

- Monthly to bimonthly collection of soil, plant, and pore water samples
- Processed and digested soil and plant samples (EPA Method 3050b)
- Measured redox potential, pH, and conductivity of pore water with standard electrodes; acidified pore water with 2% nitric acid
- Pore water and plant digests analyzed by ICP-MS at UD Advanced Materials Characterization Lab; Soil digests analyzed by ICP-OES at UD Soil Testing Lab

St. Jones Boardwalk

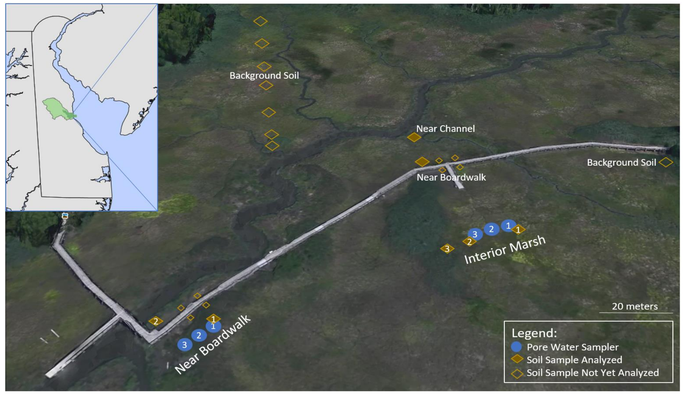

Figure 1: Aerial View of St. Jones Salt Marsh and Sampling Points

Preliminary Soil Results

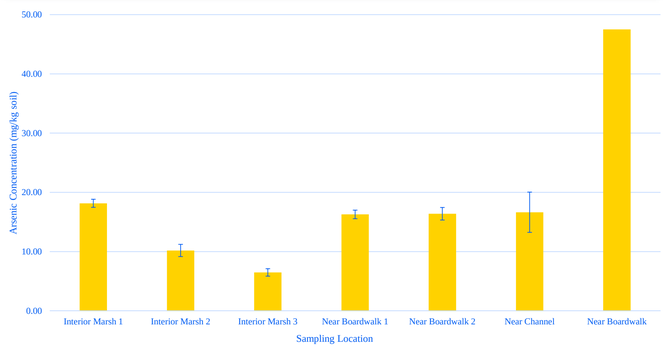

Figure 2: Total soil arsenic concentration for sampling sites at St. Jones

Preliminary Pore Water Results

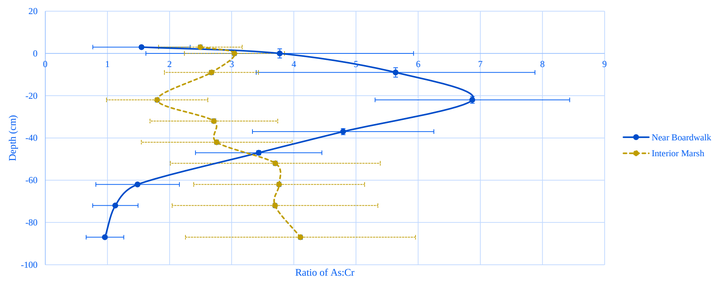

Figure 3: Ratio of As:Cr in different pore water sampling locations at St. Jones

Preliminary Pore Water Results

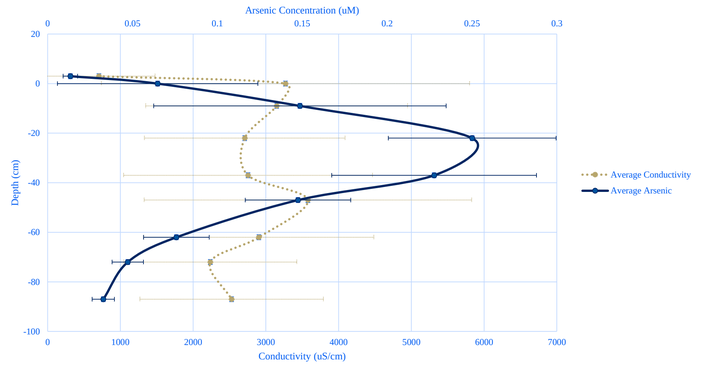

Figure 4: Pore water arsenic and conductivity for near boardwalk peepers

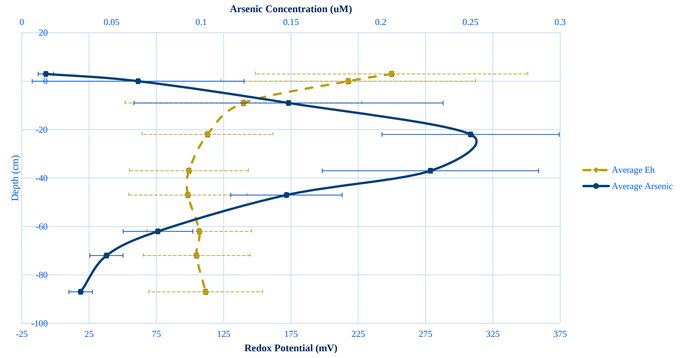

Figure 5: Pore water arsenic and redox potential for near boardwalk peepers

Preliminary Conclusions/Future Directions

- Chromium and arsenic in pore water samples were on average lower than EPA heavy metal standards. Pore water copper was below detection
- Future soil incubation will test arsenic release over salinity gradient and controlled redox potential
- Sequential Extraction Procedure (Wenzel et al. 2001)
- Adding more pore water sampling sites: near boardwalk, away from channel

Acknowledgements

- Seyfferth Research Group, University of Delaware
- Caroline Golt, Advanced Materials Characterization Laboratory, University of Delaware
- Karen Gartley, Soil Testing Laboratory, University of Delaware
- Kari St. Laurent, Department of Natural Resources and Environmental Control & Delaware National Estuarine Research Reserve