Predicting Mercury Sequestration as a Function of Vegetation along a Thawing Permafrost Gradient

Michael Layne, (mlayne@csumb.edu)[1]; M. Florencia Meana-Prado[2]; Sam Anderson[2]; Julia G. Bryce[2];
Michael Palace[3]; Ruth K. Varner[2]; Patrick Crill[4]

1.Division of Science & Environmental Policy, California State University, Monterey Bay, Marina, CA, USA 2. Earth Sciences, University of New Hampshire, Durham, NH, USA 3. Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH 03824 4. Dept. Of Geological Sciences, Stockholm University, Stockholm, Sweden

Introduction

❑Recent studies suggest that with increasing climate change mercury (Hg) is likely to be released into the environment from its frozen stores in high latitude peatlands.

❑This liberated Hg may then leave the terrestrial ecosystem by entering the hydrosphere or remain sequestered in Arctic terrestrial ecosystems as it is incorporated into wetland vegetation.

❑ One challenge in forecasting the fate of Hg with climate change lies in predicting the degree to which plants accumulate Hg as a function of species or microenvironment. Existing studies show Hg concentrations in plants can vary significantly in just a short distance in peat lands and even vary among the same species in different ecotones [1].

❑**In order to enhance our understanding of the distribution of Hg in vegetation across the permafrost thaw gradient we carried out mercury analyses of foliage samples in well-characterized ecotones in Stordalen mire.**

Study Site

❑Stordalen mire, in Abisko, Sweden (N 68° E 19°) lies at the edge of the discontinuous permafrost zone and is being severely impacted by climate change.

❑Five distinct site types can be observed with different vegetation composition in each [1]; *Tall Shrub, Hummock, Semiwet, Wet, Tall Graminiod.*

Figure 1(a). Tall Shrub Site Type: *S. lapponum, B.nana*

Figure 1(b). Dry Hummock Site Type: *E. nigrum* and *R. chamaemorus, lichen, Vaccinium*

Figure 1(c). Semiwet Site Type: *Sphagnum*

Figure 1(d). Wet Site Type; *E. Vaginatum*

Figure 1(e). Tall Graminoid: *Carex* and *E. anigustafolium*

Figure 1(a-e): Transition from dry to wet sites types.

Methodology

❑Quadrats (1 m^2), sectioned into 64 subplots, were used to determine percent cover.

❑A Near Infrared Agricultural Camera was used to take ground based remote sensing images. Remote Sensing Images were analyzed for lacunarity, angular second momentum and entropy

❑Dominant plant samples were sampled and extractable Hg was leached in 6M hydrochloric acid then analyzed using Cold Vapor Inductively Coupled Plasma Mass Spectrometry.

Figure 2(a).

Figure 2(b).

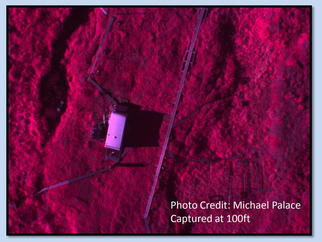

Figure2(a-b): Remote Sensing photos, GoPro© , ADC-Lite.

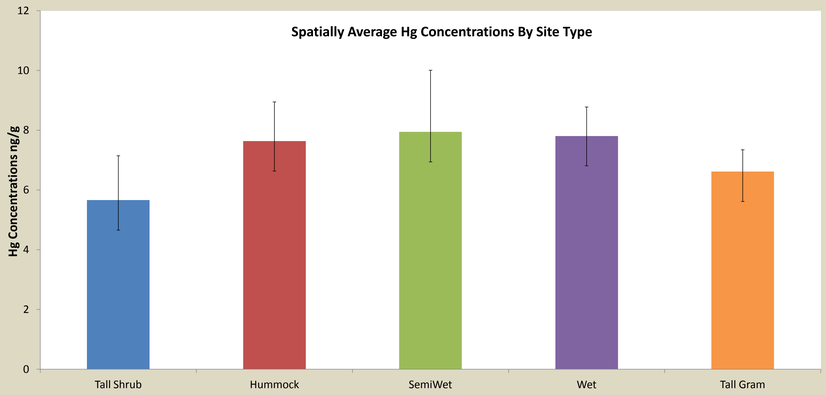

Figure 3: Shows variable trends in Hg concentrations between Site Types.

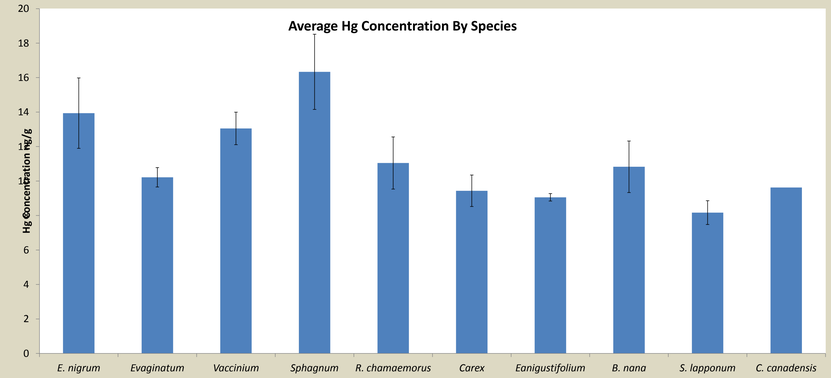

Figure 4: Shows variable Hg concentrations between species.

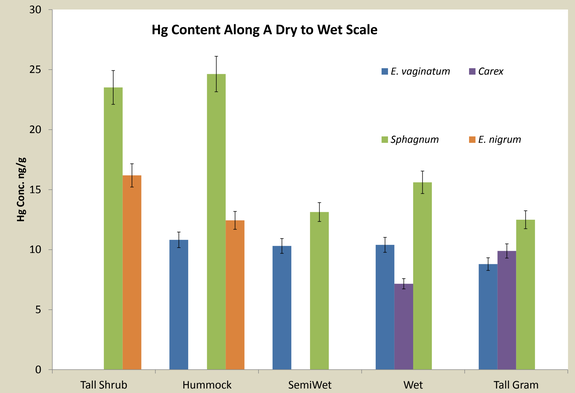

Figure 5. Hg concentrations tend to drop as site types become wetter.

Results

❑Mercury abundances varied between 7.0 and 28.8 ng/g (for *S. lapponum* and *Sphagnum*, respectively).

❑*Sphagnum* had the largest mercury content variation (7.6-28.8 ng/g).

❑Results of a Kruskal Wallis test find there is a significant difference in sequestration of Hg based on plant species alone (df=9, χ^2=18.04, p=0.03) (Figure 4).

❑Differences in mercury concentration can be seen between site type but there was no significant difference with existing data (~80% of plant cover) (Figure 3).

Conclusions

❑Plant species sequester Hg differently .

❑Variable trends in *Sphagnum* may be attributed to water abundances (Figure 5).

❑Large variations of Hg in the *Tall Shrub* site type can be attributed to differences in species composition among this site type (Standard Error =1.5 ng/g) (Figure 1(a)).

❑Complete analysis of the plant species could lead to significant differences between Site Types.

❑The integration of plant Hg abundances across sites well-characterized for spectral properties may ultimately enable the scaling up to an ecosystem model for Hg distributions within the landscape.

Acknowledgements

This research was supported through the Northern Ecosystems Research for Undergraduates (NSF REU site EAR#1063037). We would also like to thank everyone in the NERU program and everyone else behind the scene who contributed to this project.

References

[1] Rydberg et al. (2010), *Geochimica et Cosochimica Acta* (74), 7116-7126.

[2] Malmer et al. (2005), *Global Change Biology* (11), 1895-1909.