A Retrospective Analysis of Mussel Monitoring in the Puget Sound

Catherine Wangen[1,2,*] Mark D. Scheuerell[3,*]

[1] Quantitative Ecology and Resource Management, University of Washington, Seattle, WA
[2] School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA
[3] U.S. Geological Survey Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA

[*] Correspondence: Catherine Wangen <cwangen@uw.edu>, Mark D. Scheuerell <scheuerl@uw.edu>

Introduction

The purpose of this report is to provide a retrospective analysis of data generated by previous mussel monitoring surveys coordinated under Washington Department of Fish and Wildlife's (WDFW) Toxics Biological Obsevation System (TBiOS). We determine how existing historical California mussel (*Mytilus californianus*) contaminant data can be used for in a Toxics in the Nearshore Vital Sign indicator. In addition, we assess the predictive ability of existing sampling rate to predict expected contaminant trends.

Toxics data was obtained by transplanting relatively uncontaminated mussels from a local aquaculture source to locations along the Puget Sound shoreline, covering a broad range of upland land-use types from rural to highly urban. Mussels were then recovered, and concentrations of several major contaminant classes were measured. Four mussels surveys were performed, with mussels being retrieved in 2013, 2016, 2018, and 2020. Our analysis focuses on polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls(PCBs) due to their significance in both ecosystem and human health.

All materials used to prepare this report can be found in the following GitHub repository: https://github.com/cwangen/mussel_toxics/.

Methods

Data

The data used in this analysis originated in the form of an Microsoft Excel file, titled "2013-20MusselCagesPOPsPAHs_Cnty_WRIA_LIO_Coverages.xlsx." The data included more fields than used in our analysis, and can be found in its entirety in "~mussel_toxics/data/raw/." The data was cleaned in order to correct minor inconsistencies, resulting in "~mussel_toxics/data/clean/totals_all.cvs."

-describe maps, raincloud plots?

Modeling

We modeled the dry weight of the analytes found in mussels using a linear mixed model (LMM). These models consist of fixed effects, which remain constant, and random effects that follow a normal distribution and can correspondingly vary by individual. Our goals were to evaluate 1) The effect of year on dry weight of the relevant toxic analyte 2) If any other factors significantly affected dry weight, and 3) the effect of WRIA by year.

Exploratory analysis of the data allowed us to remove extraneous factors, while including those we wished to investigate. The model takes the form,

$$D_i = \beta_{1,year} + \beta_{2,year \times wria} + \beta_3 \text{surface}_i + \beta_4 \text{time}_i + \mu_i + \epsilon_i$$

Where D_i is the natural logarithm of the dry weight of the analyze from a sample site, β_1 is the categorical effect of year, β_2 is the interaction effect of year and WRIA, β_3 is the coefficient for mean percent AU of the nearest watershed region (**figure out how to actually describe this from Mariko**), β_4 is the coefficient for the time the mussels remained in the water (which varied by sampling year), μ is the random effect of longitude, and ϵ is the normally distributed error.

Results

Data Analysis

-maps? -cloud plots?

Model

-model parameters (this might require a table) -partial R2 for year -estimated effect of WIRA by year (significance?), also would need a table

Discussion

-note deficiencies in data -what we can and can't say

Toxics in the Nearshore Recommendation

While the predictive capability of the current data is short due to the size of the sampling years, certain areas

Acknowledgments

References