



Clam Bioaccumulation Comparison Study

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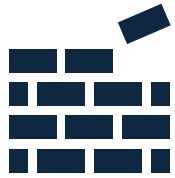
Joy Dunay, Brian Hester, – USACE Seattle District

Alan Kennedy, Gui Lotufo – USACE ERDC

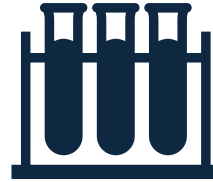
Laura Inouye – Washington Department of Ecology

Presentation to the 2024 Sediment Management Annual Review Meeting (SMARM) May 8, 2024

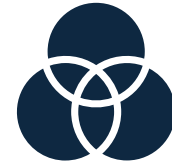
Topic Outline



Background



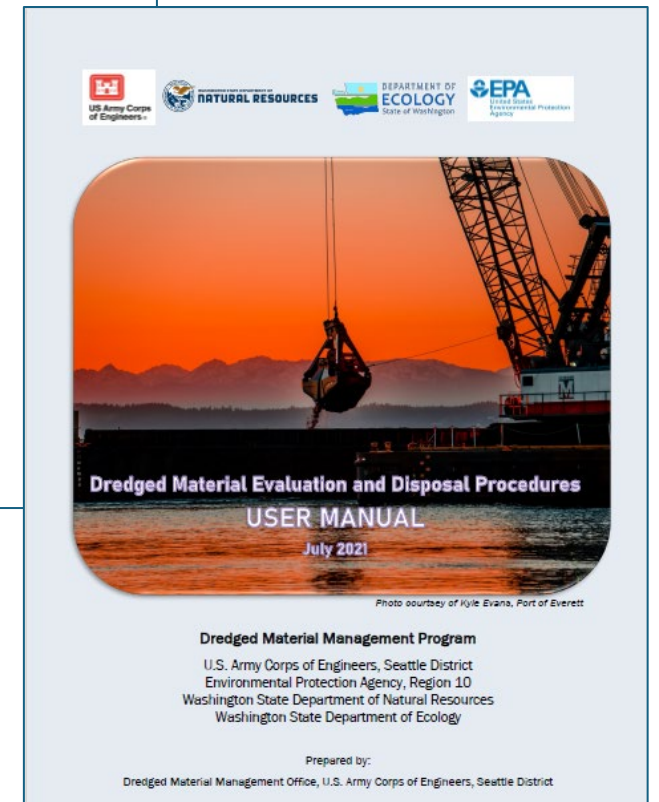
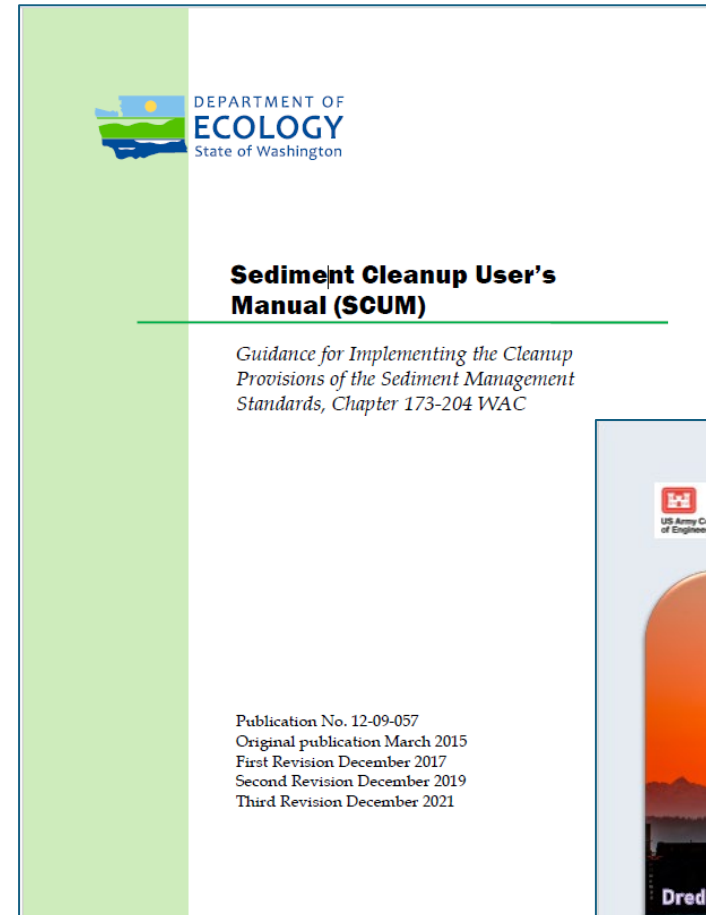
Bioaccumulation Test Results



Chemical Comparisons

Challenge

- Marine Protection, Research and Sanctuaries Act (MPRSA) requires physical, chemical and biological evaluation of perspective dredge materials
 - Regionally - Dredge Material Management Program (DMMP)
 - Requires bioaccumulation testing for samples that result in exceedances of bioaccumulation triggers (BTs).
 - Also - Sediment Management Standards (SMS)
 - May require bioaccumulation testing on a site-specific basis
- Bioaccumulation testing often relies on availability of two test organisms
 - *Alitta virens* (polychaete worm) and *Macoma nasuta* (bivalve)



Challenge

- *Macoma* clams are primarily provided for bioaccumulation testing from one source in and around Discovery Bay, WA
- During the 2021 Heat Dome event
 - Elevated temperatures occurred during low tide events
 - Had a long-term impact on this population of *Macoma*
 - Made obtaining *Macoma* for testing more difficult



Image from CBS news coverage of 2021 weather event

Current Bioaccumulation Species

- Species recognized in USACE User Manual (2021)/SCUM (2021)
 - Polychaetes
 - *Nephtys caecoides* - preferred
 - *Alitta virens* – Alternative
 - *Arenicola marina* - SCUM
 - Bivalves
 - *Macoma nasuta*
- Inland Testing Manual (USACE, 1998) recognizes
 - Polychaetes
 - *Neanthes arenaceodentata*
 - *Alitta virens*
 - *Arenicola marina*
 - Bivalves
 - *Macoma nasuta*
 - ***Yoldia limatula*** – not a feasible alternative
 - Subtidal
 - more expensive
 - low tissue mass per individual

Solution

- Screen alternative clam species for bioaccumulation testing
- Compare these alternative species to chemical uptake by *Macoma*
- Why is *Macoma* so popular
 - Intertidal – “easy” to collect
 - Historically available in large quantities
 - Facultative feeder
 - Filter feeder/surface deposit feeder – Multiple routes of potential exposure
 - Relatively high tissue mass per individual
 - Survive exposure period in lab testing



Potential Alternatives



Varnish Clam (*Nuttallia obscurata*)

Positives

- Facultative feeder – like *Macoma*
- Occupies different part of intertidal zone
- Readily commercially available
- Non-native species
- Current price was half of *Macoma*

Negatives and Questions

- Has not (to our knowledge) been used for bioaccumulation testing
- Will it survive well enough during testing?
- Can it be used in place of *Macoma* for evaluating chemicals that bioaccumulate?

Positives

- Occupies different part of intertidal zone
- Readily commercially available
- Has been used in laboratory testing
- Current price was $\frac{3}{4}$ of *Macoma*

Negatives and Questions

- Filter feeder? Is this a real negative
- Can it be used in place of *Macoma* for evaluating chemicals that bioaccumulate?



Littleneck (*Leukoma staminea*)

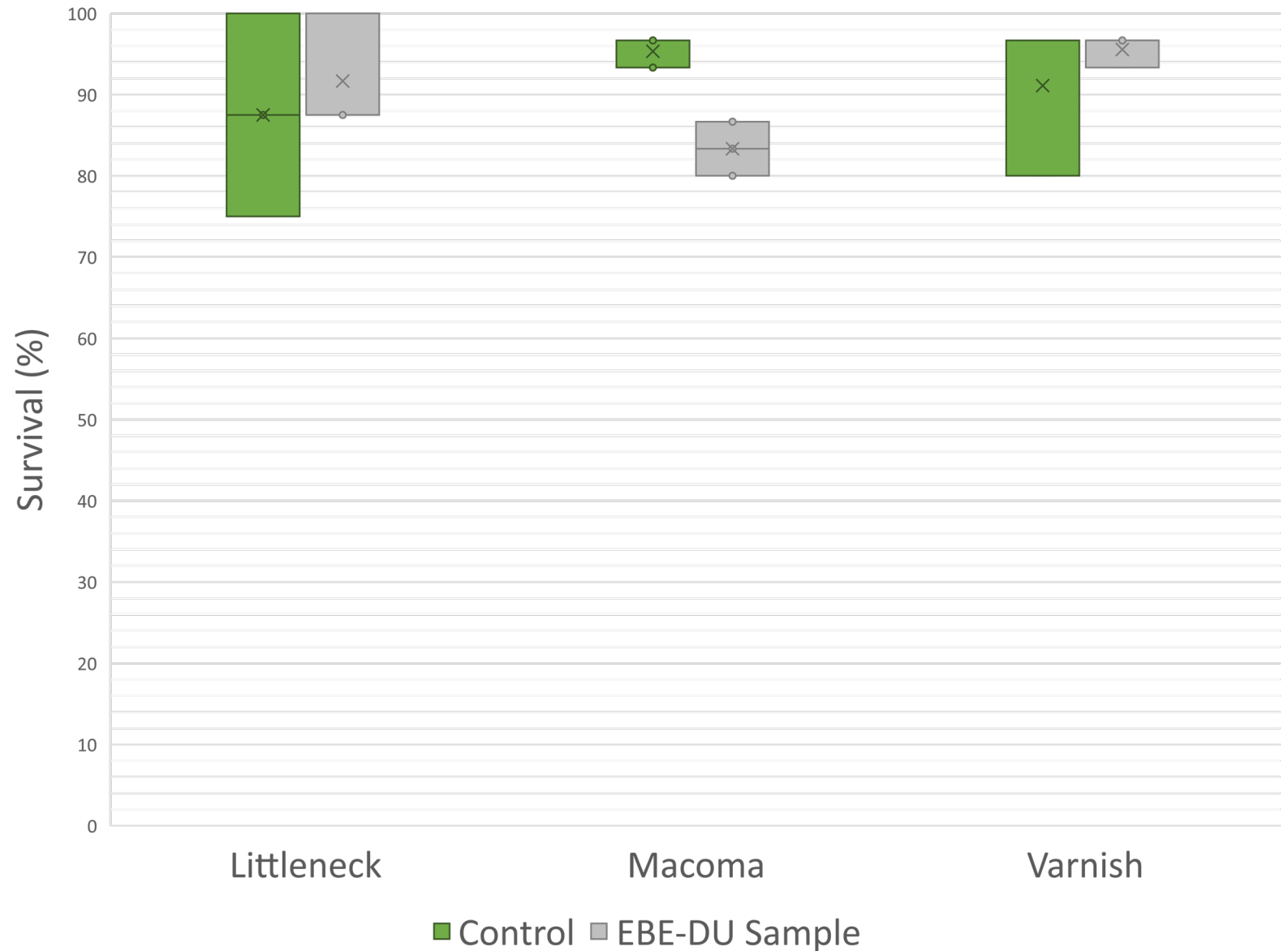
Comparison Test Design

- Opportunity - Elliott Bay dredged material disposal site monitoring
- Elliott Bay Environ samples have shown chemicals known to bioaccumulate during previous monitoring programs
- Already measuring the DMMP List 1 bioaccumulative chemicals of concern in *Macoma*



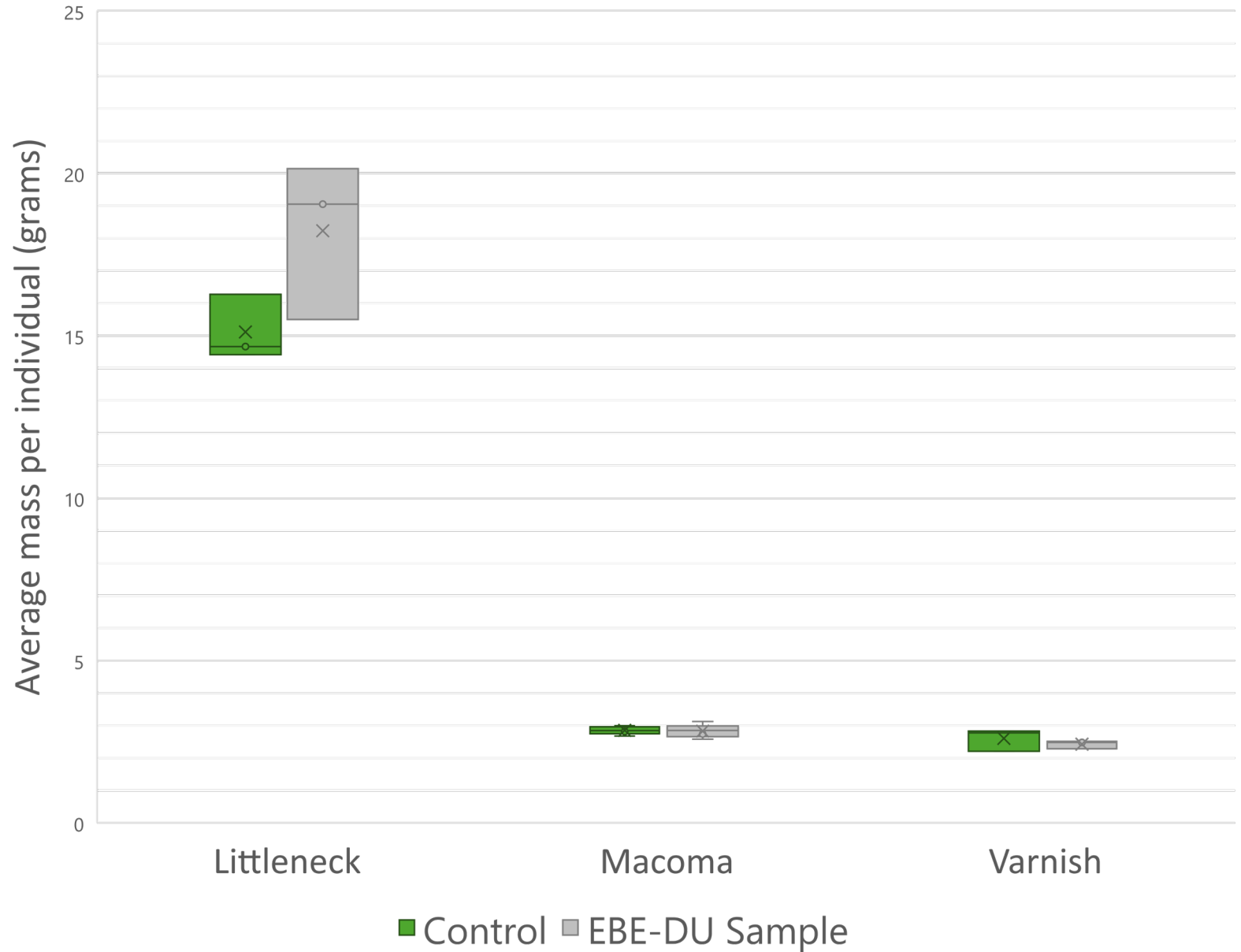
Average Percent Survival

- **Average Percent Survival**
- Average Individual Tissue Mass
- Percent Lipid
- All boxplots for *Macoma* EBE-DU sample include reps 1 – 3.



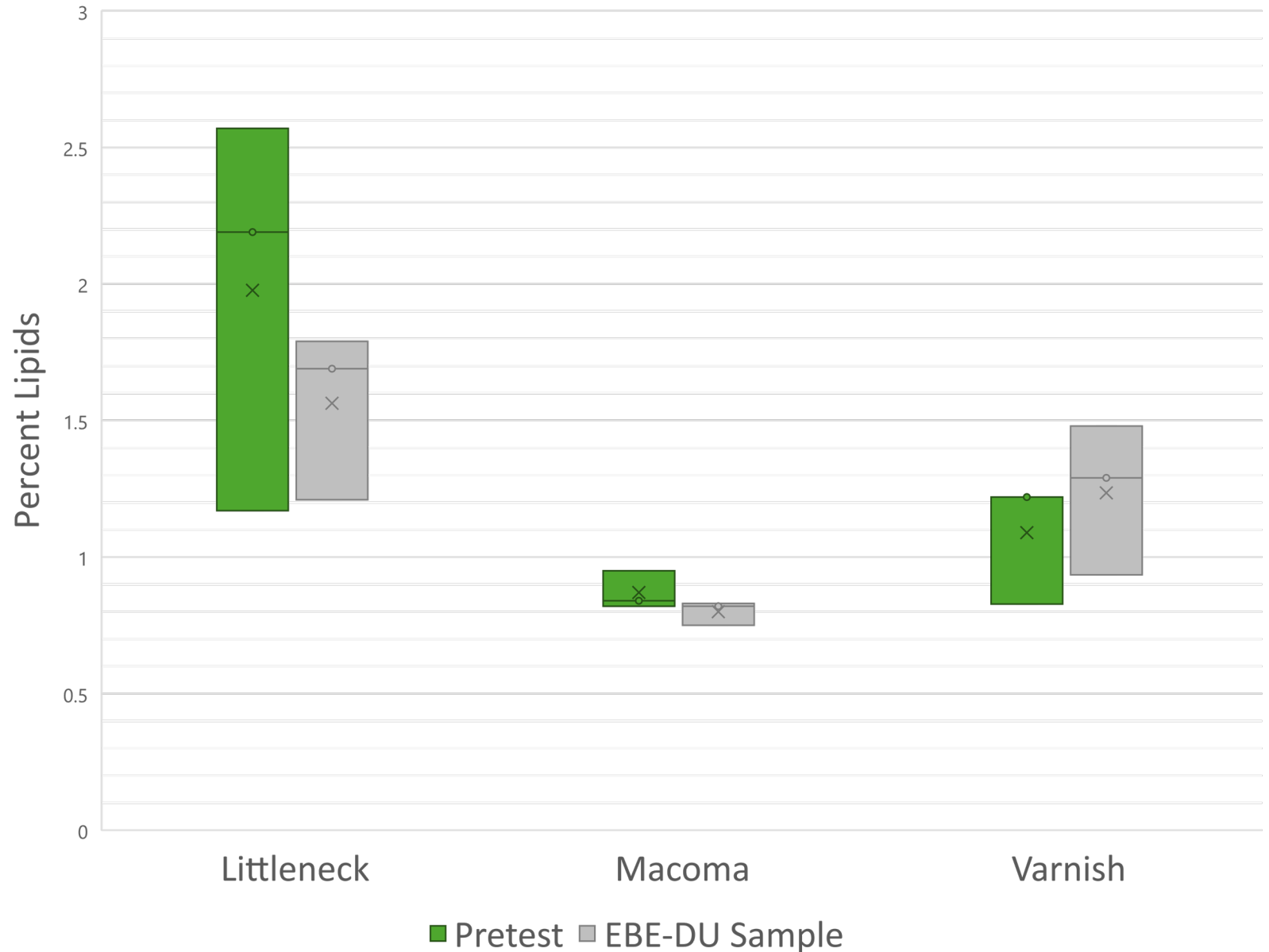
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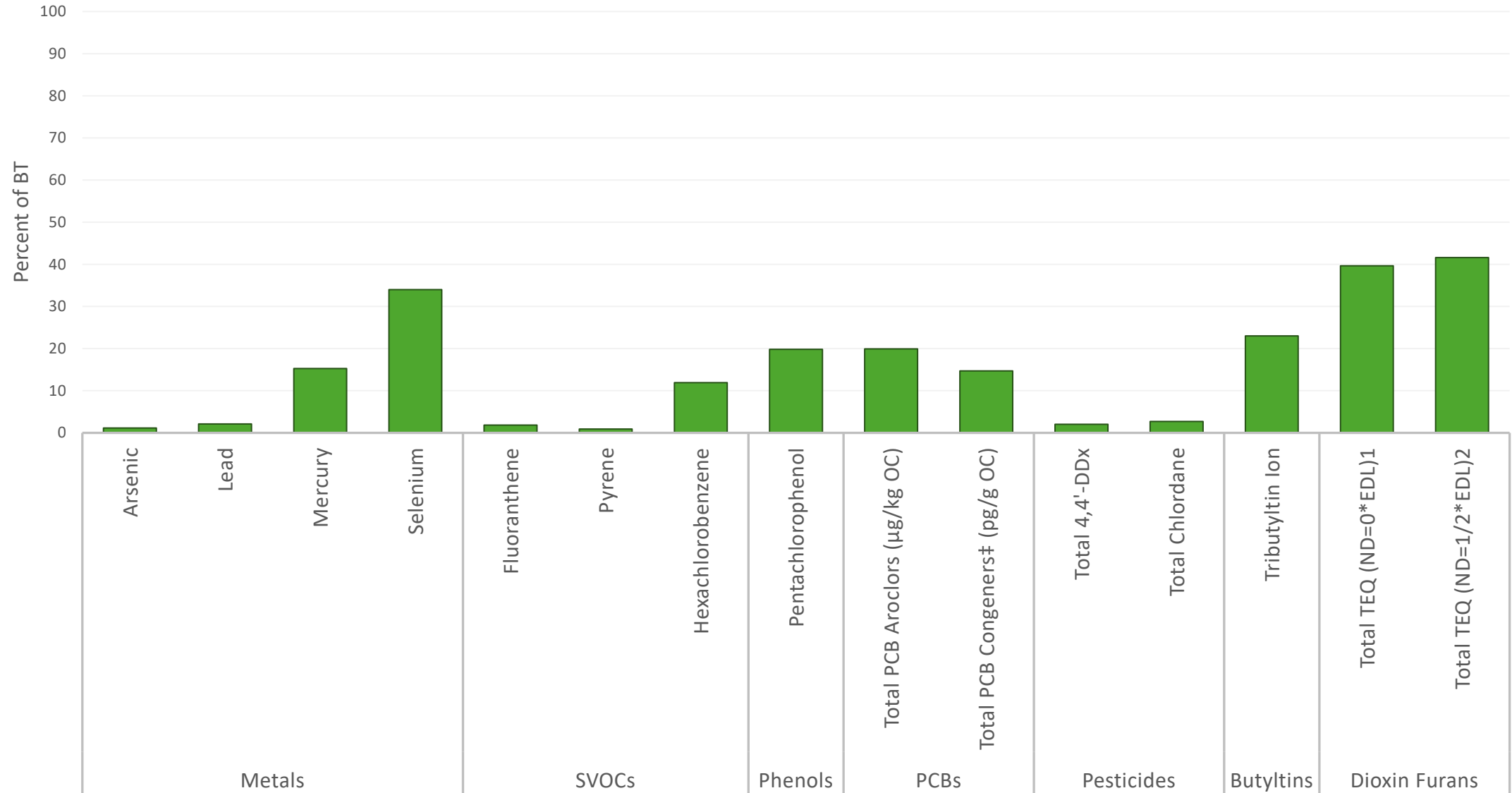


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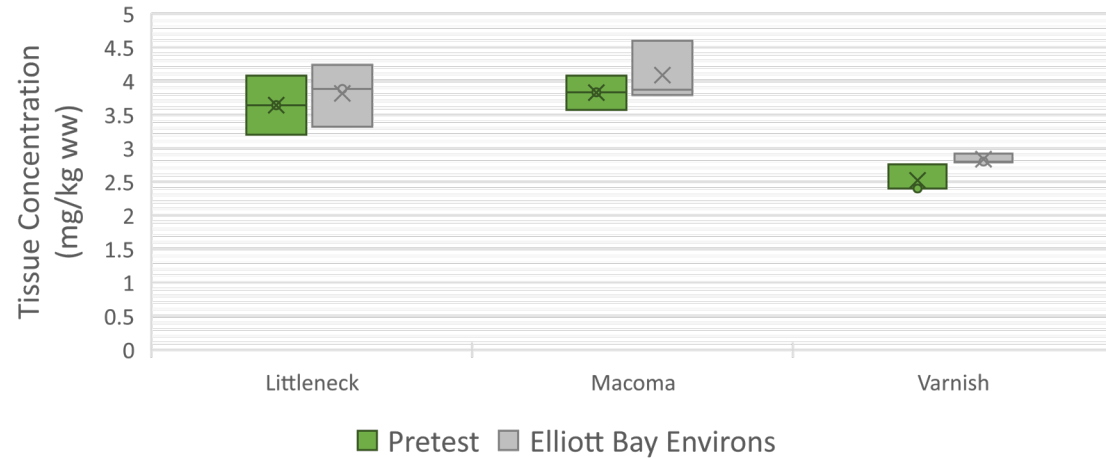


Sediment Chemistry Results

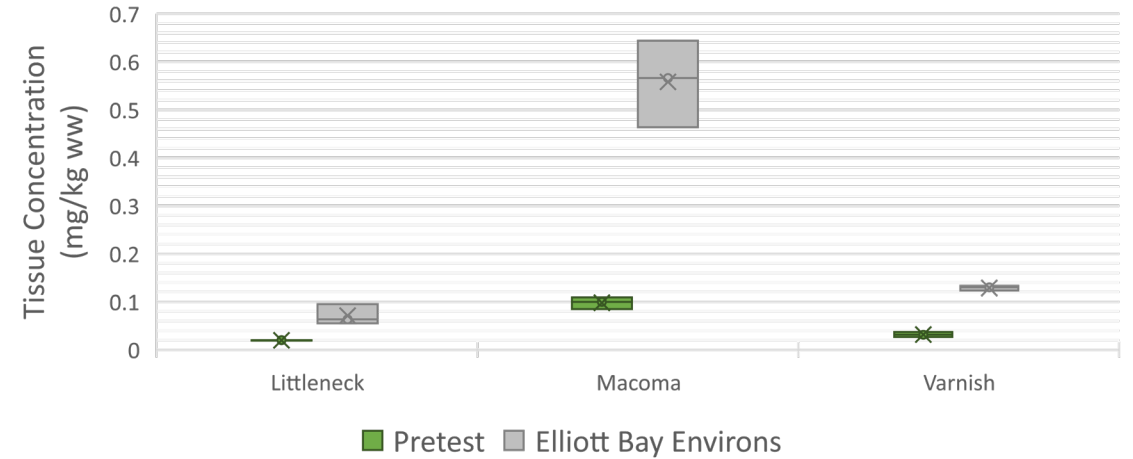


Chemical Comparison - Metals

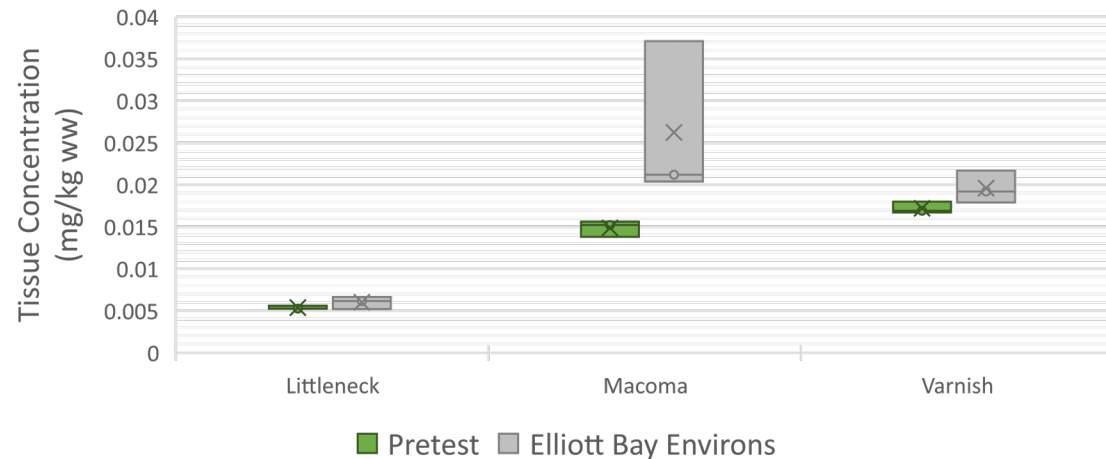
Arsenic



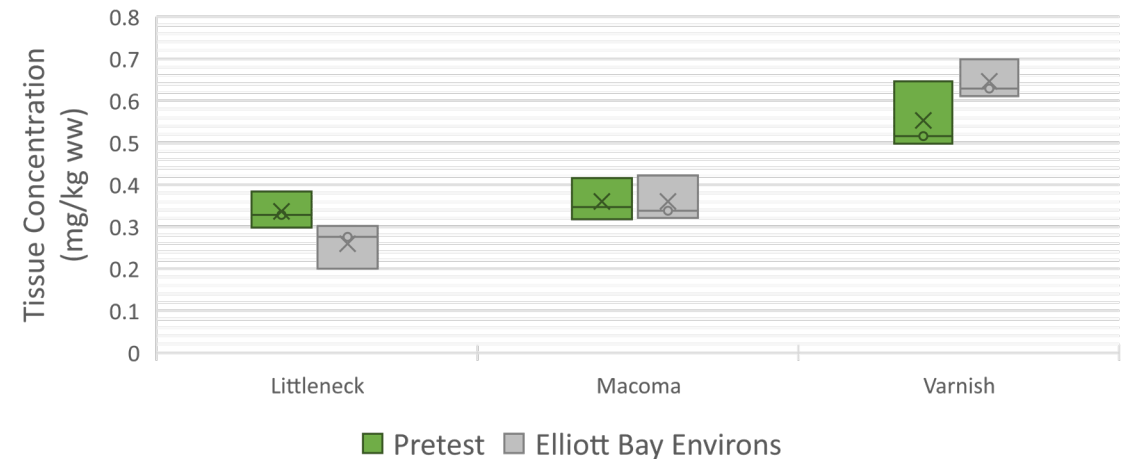
Lead



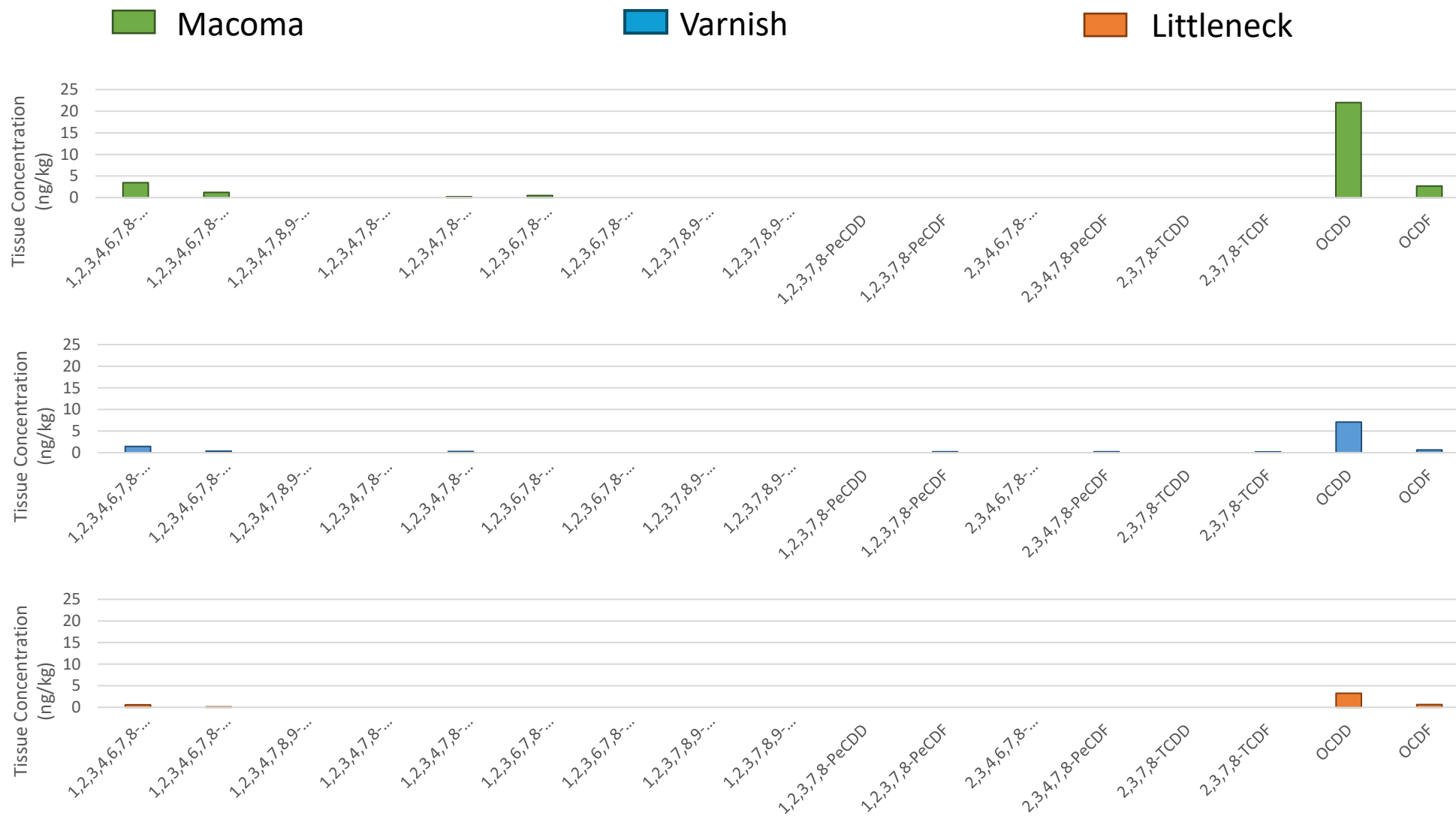
Mercury



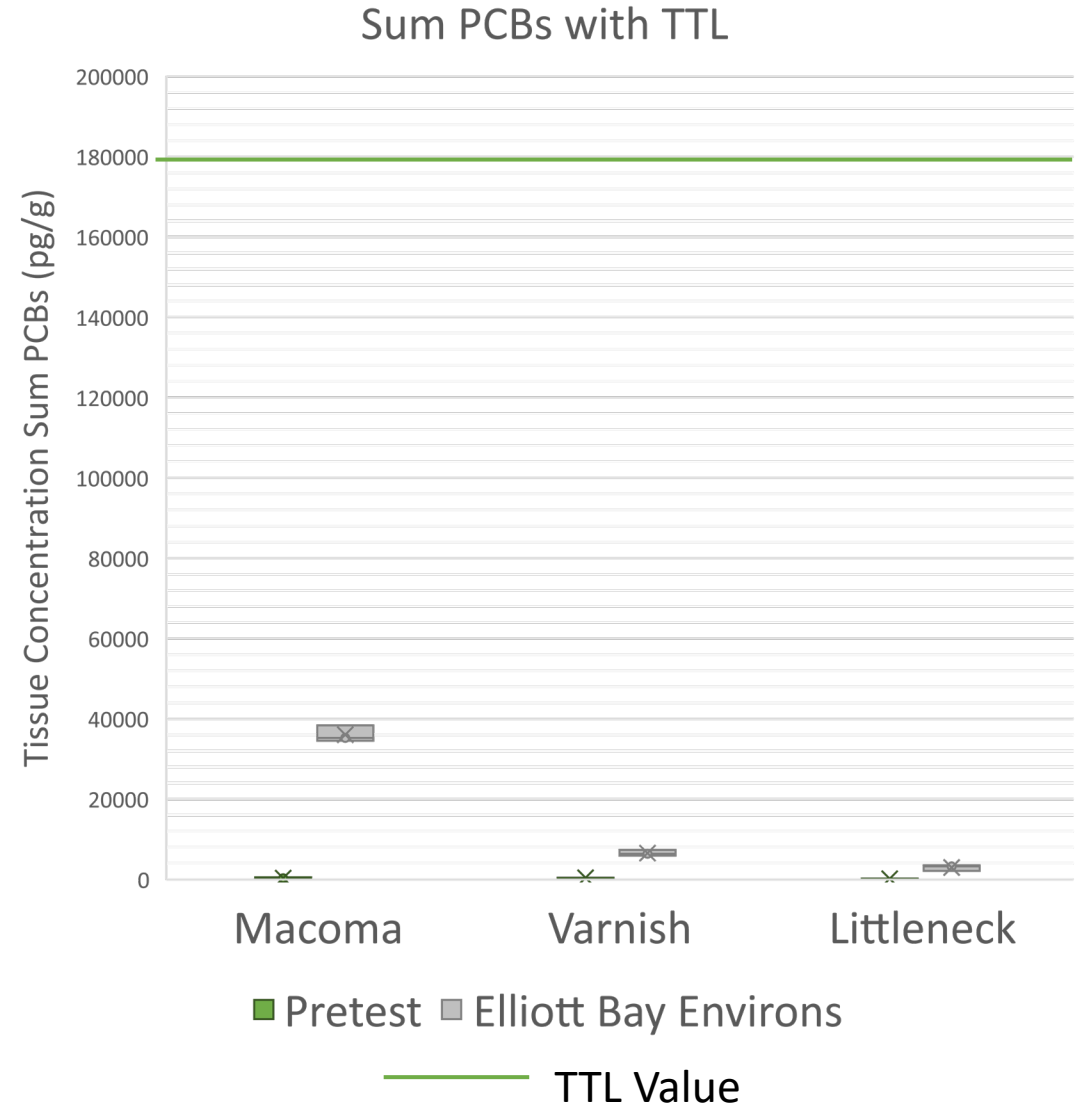
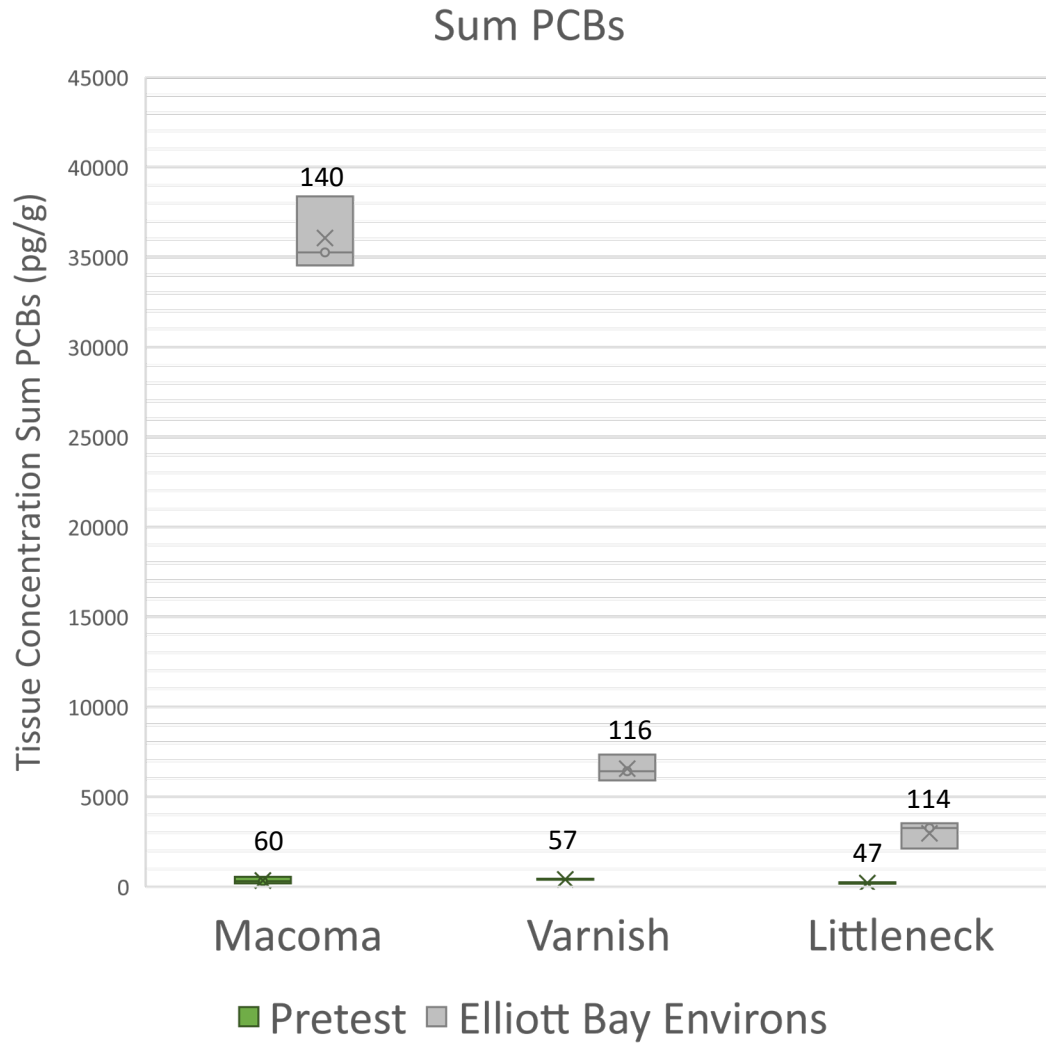
Selenium



Chemical Comparison – Average Dioxin (Tissue Concentration)



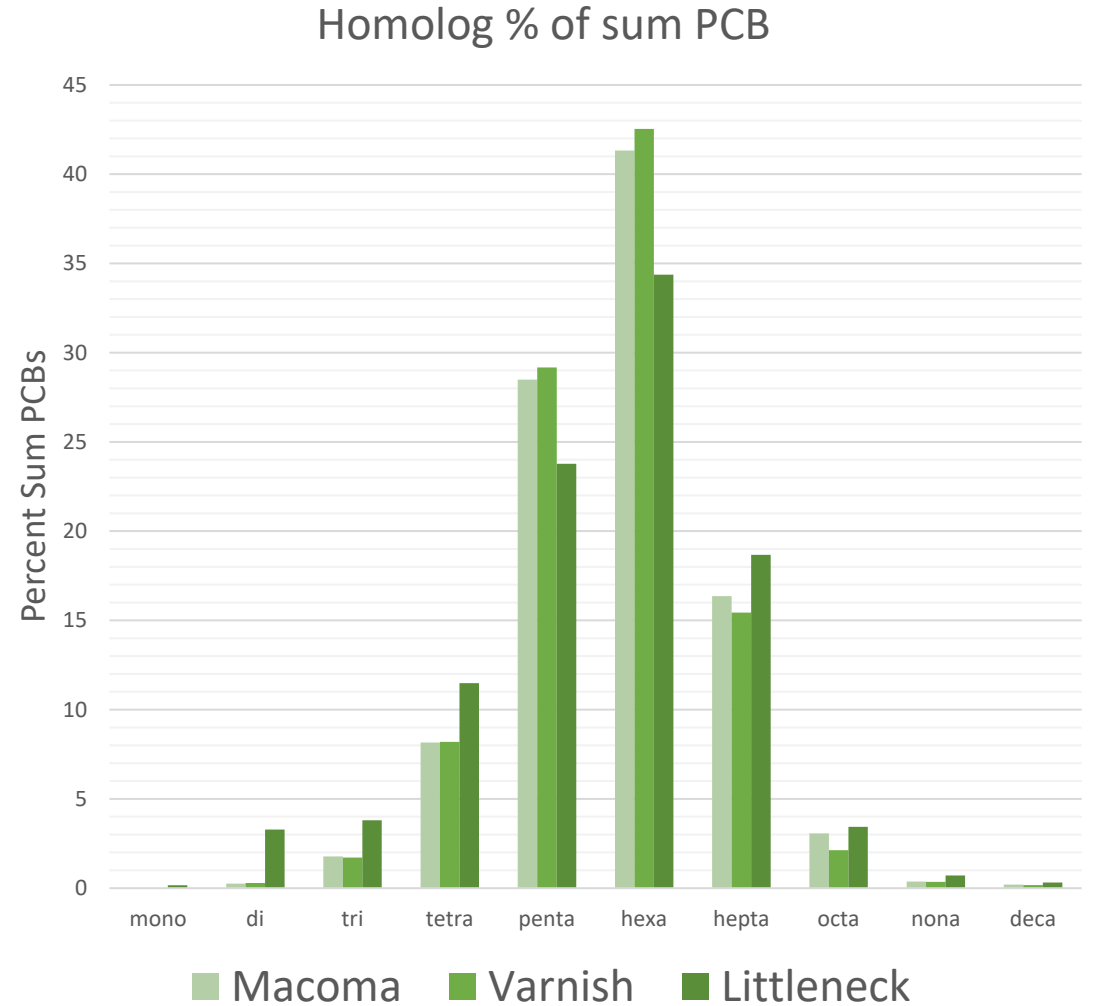
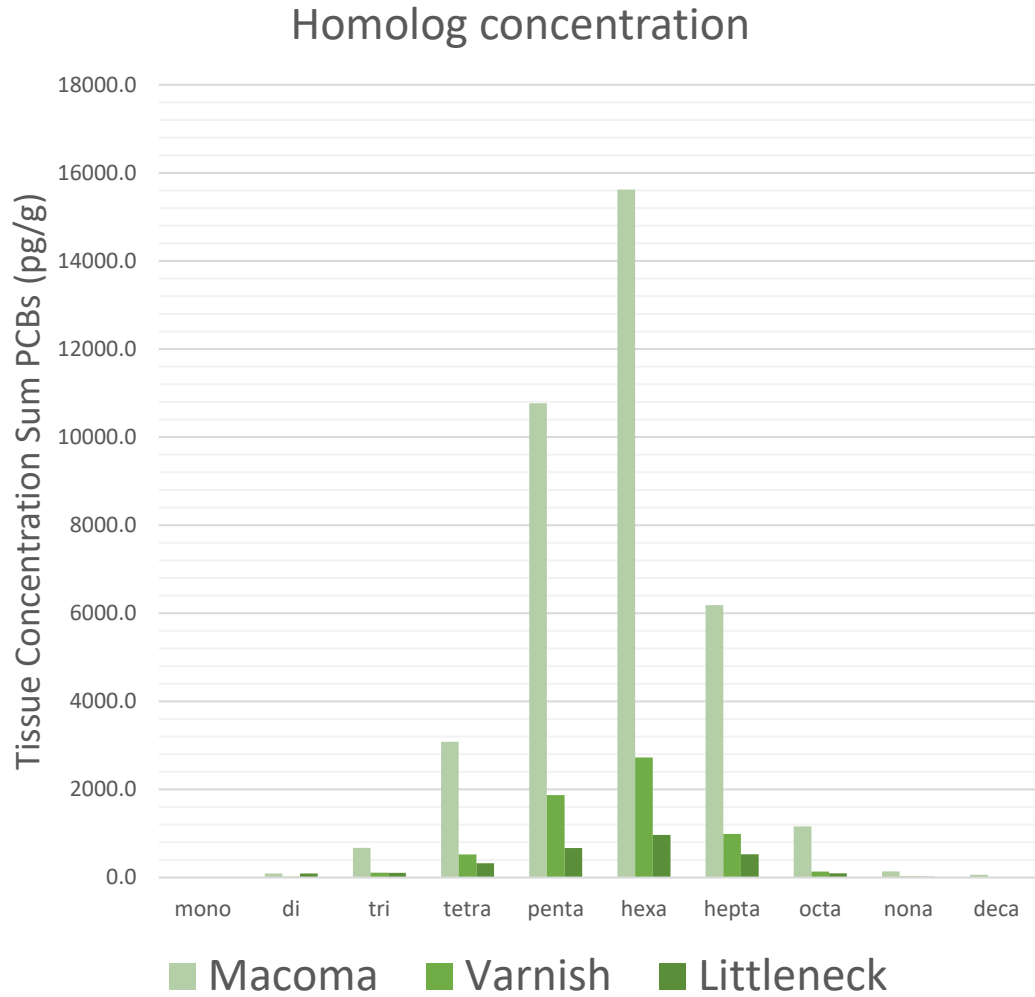
Chemical Comparison – Sum PCBs



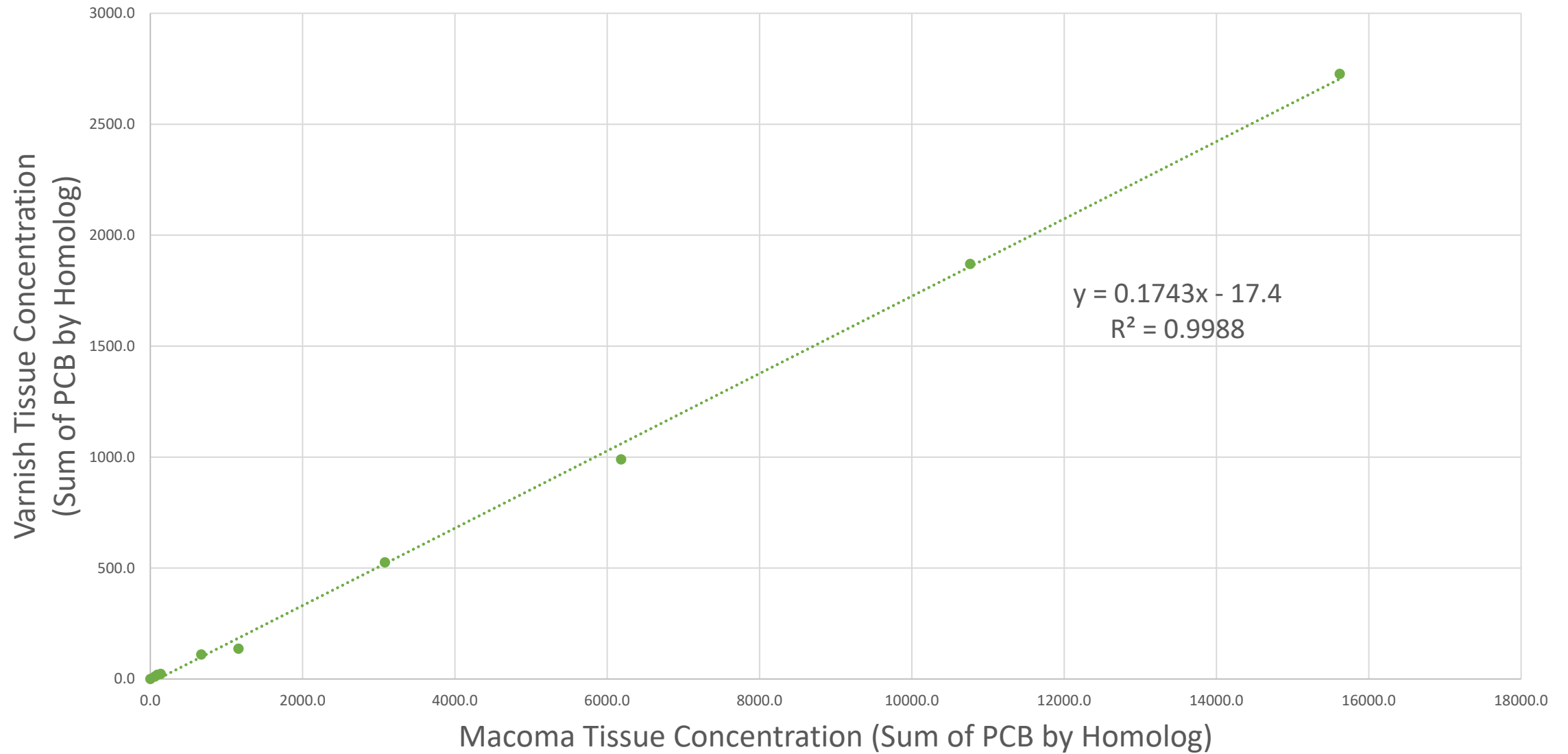
ND=0

= number of detected congeners

Chemical Comparison – PCBs (Homolog)

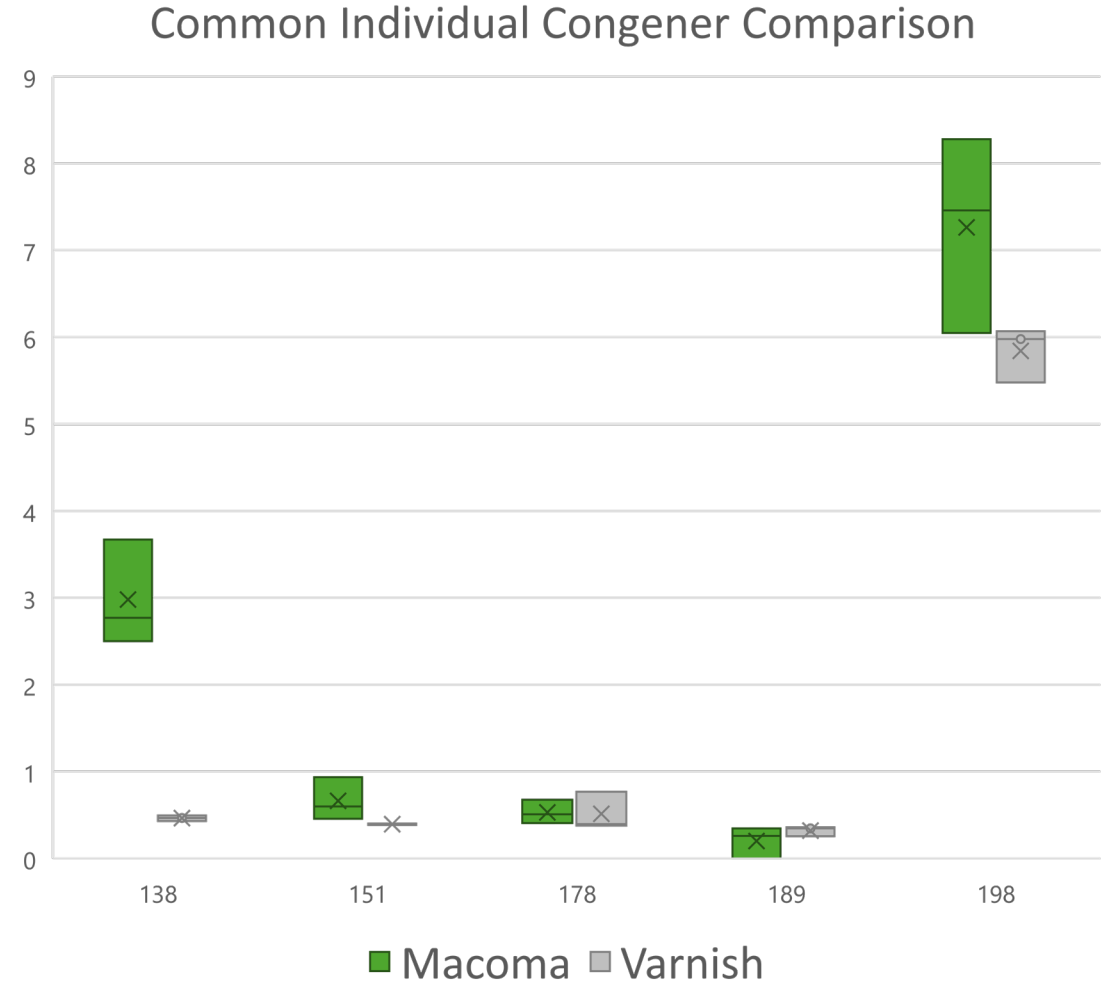


Chemical Comparison – PCBs (Tissue Relationship)



Chemical Comparison – PCBs (Individual Congener)

PCB Congener	Ratio (M/V WW)	Ratio (M/V lipid norm)
138	6.4	5.6
151	1.7	1.1
178	1.0	1.3
189	0.9	0.7
198	1.2	1.4



Conclusions

- All three clam species survived testing well.
- Individual tissue mass for *Macoma* and Varnish were similar. Tissue mass for Littlenecks was higher.
- Percent lipid was similar between *Macoma* and Varnish and did not appear to decrease during the testing. Percent lipid was higher for Littleneck.
- The environs sample from Elliott bay would not have triggered bioaccumulation testing based on the BTs.
- *Macoma* may have accumulated some metals at a greater rate, however we are not certain what these accumulations would look like when tested on sediments with greater concentrations.
- Dioxin accumulation was minor across the board
- *Macoma* appear to accumulate PCBs at a greater rate than the other two species.

Next Steps

- Identifying a sample that has sediment chemistry results that exceed the BTs.
- Likely can remove Littleneck testing from further evaluations.





Thank you and Questions