2024 PSEMP Bellingham Bay Particle Size Analysis and Total Organic Content

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Introduction

This work is part of the continuing research done by undergraduate researchers at the University of Washington Tacoma as part of the Puget Sound Ecosystem Monitoring Program (PSEMP) and its many affiliates. The urban bays component of the program surveys one of six urban bays quinquennially, with Bellingham Bay surveyed for 2024. Our research focused on the particle size analysis (PSA), also referred to as grain size, of sediments and the total organic content (TOC)* contained within the sediments for Bellingham Bay.

*In the context of our research, there is no distinction between organic and inorganic carbon due to the combustion process

Purpose of Study

Analyzing TOC and grain size allows us to better understand any relationships between the two variables within Bellingham Bay. Temporal trends between 2024 and 2017 data can be used to identify changing characteristics within the bay. Additionally, relationships between TOC and PSA allows us to understand current and possible human impacts on the area through nutrient additions and climate change.

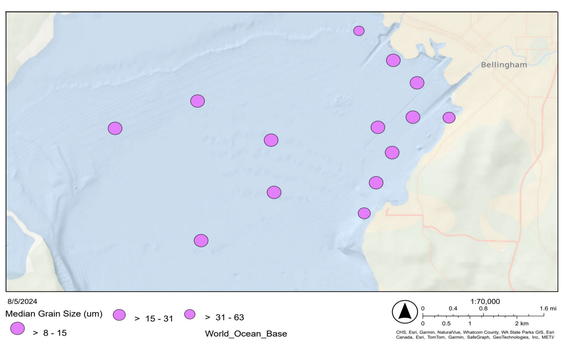


Figure 1. Median grain size (micrometers) of sediments within Bellingham Bay 2024.

References

Methods

Total Organic Content (TOC)

- 5 mL of each sediment sample was deposited and weighed in crucibles to calculate wet mass.
- Samples were oven dried at 105°C for five hours
- After cooling, samples were weighed again to determine dry mass.
- Samples were heated again at 650°C for eight hours to burn organic material, then cooled and weighed to determine mass of carbon
- TOC percentages for dry and wet values per sample were calculated by dividing the mass of carbon by the mass of each parameter and multiplied by 100.

$$\frac{weight\ of\ carbon}{(wet\ or\ dry)\ sample\ weight} \times 100\%$$

Particle Size Analysis (PSA)

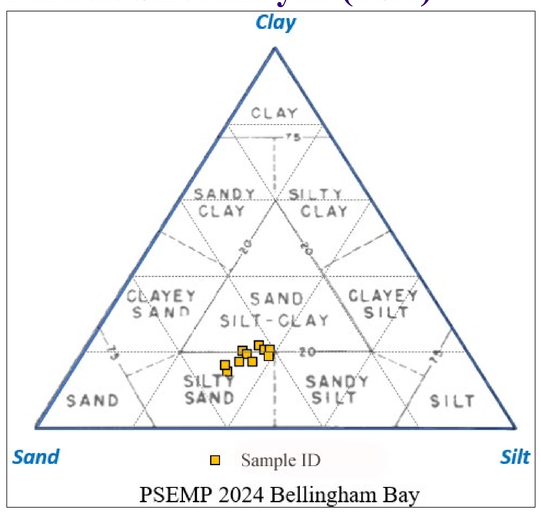


Figure 2. Ternary plot created using 2024 PSEMP data from Bellingham Bay, overlaid on the Shepard classification system (1954).

- Sediment samples were homogenized with grains >2 mm filtered out prior to adding ¼ teaspoon sample to 100mL water
- Mixtures were stirred until evenly suspended
- Sample was slowly dropped in a Beckman-Coulter LS13 320 Particle Size Analyzer until obscuration reached 8-12%
- Procedure repeated twice minimum per sample

Results

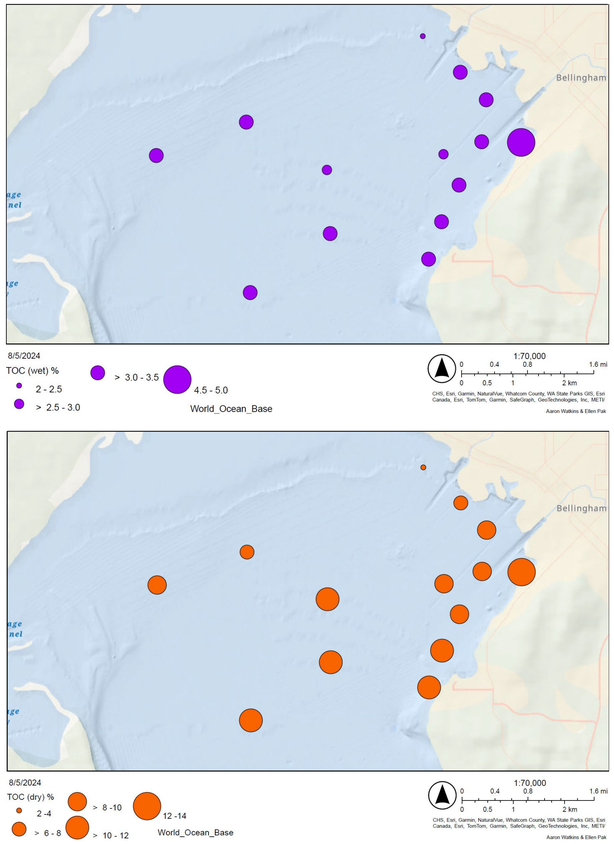
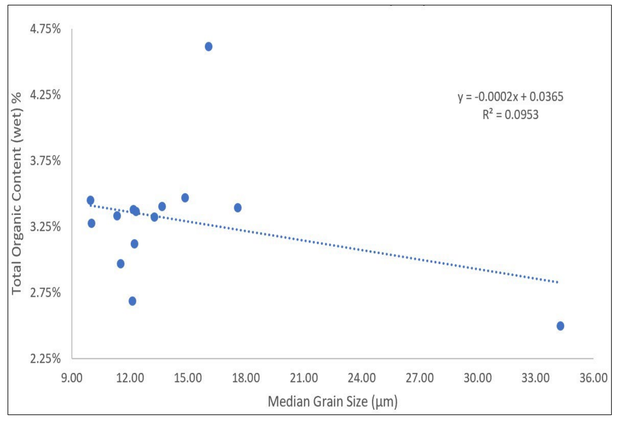


Figure 3. (top, purple) TOC wet, with values ranging between 2.0% – 5.0%; (bottom, orange) TOC dry, with values ranging between 2.0% – 14.0%.

Results

- Sediments ranged between 9 - 35 µm, with 13 of 14 samples between 9 - 17 µm
- Sediments classified as silty sand & sand silt clay (Shepard 1954)
- TOC (wet) % ranged from 2.49 – 4.61%
- TOC (dry) % ranged from 3.98 – 12.06%
- Median grain size vs TOC (wet) analysis: $R^2 = 0.0953$, no correlation
- Median grain size vs TOC (dry) analysis: $R^2 = 0.2927$, poor correlation



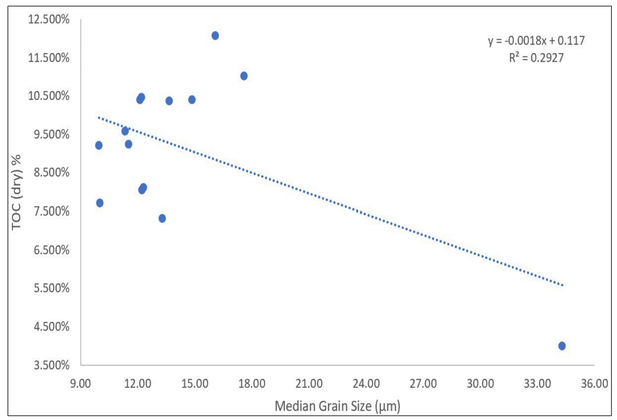


Figure 4. Median grain size (µm) versus TOC_{wet} % (top), and median grain size versus TOC_{dry} (bottom).

Research Significance

- Bellingham Bay is an area of importance due to frequent agriculture and petroleum runoff.
- Researchers found that smaller particle sizes had the highest total organic carbon percentages (Arunachalam et al. 2022).
- Algae concentrations were found to have a positive correlation with TOC and a negative correlation with particle size (Raju et al. 2022).
- Low energy levels of smaller particle sizes allows for organic content to persist in aquatic systems, increasing nutrient levels and as a result, algae levels.
- Further research is needed to determine the true significance between the variables.