

Evaluation of South Puget Sound Ecological Health through Microbiota Species Analysis

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Introduction

Sediment samples were collected at known stations throughout the Puget Sound over the last 10 years by the Department of Ecology for micro-faunal analysis in accordance with the Puget Sound Ambient Monitoring Program (PSAMP). These samples were prepared and analyzed for micro-organism (foraminifera and diatom) assemblages. The two main goals of my project are to first classify foraminifera presence from 3 primary stations in the South Puget Sound and second to help the PSAMP by utilizing the data to determine the health of the Puget Sound based on foraminiferal analysis.

Method

The collected sediment samples were wet-sieved through 63 µm and 124 µm sieves to eliminate all clay, and then dried. The residue sediment was sorted and all foraminifera picked using a dissecting microscope. Stations were determined either viable or nonviable based on the foraminifera to sediment ratio. Viable stations were picked with a goal of at least one hundred foraminifera to ensure statistically relevant species results. Picked foraminifera were then identified. Concordance Correspondence Analysis was utilized to determine the controlling factors of foraminifera at station locations.

Station Overviews

Station 40-Thea Foss Waterway

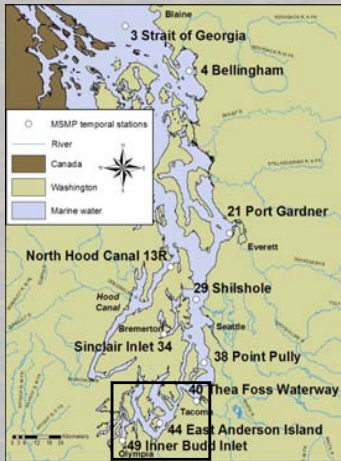
The most northern station in the South Sound, Thea Foss Waterway, was a shallow-water, urban station (~10 meters). Overall, the site supports a high abundance of foraminiferal taxa. Thea Foss Waterway is in close proximity to known contaminated sites. This station had a low presence of foraminifera with a ratio of number of foraminifera picked to sediment volume (grams) that ranges between 1:1 and 6:1.



Elphidium hannai

Station 44-East Anderson Island

This station was centrally located in the South Sound and was relatively shallow (~20 meters). During the Mid-1990s, this station saw an increase in PAH values. This station shared similar foraminiferal density results with Thea Foss Waterway with a ratio of number of foraminifera picked to sediment volume (grams) that also ranges between 1:1 and 6:1.



Station 49-Inner Bud Inlet

This urban station is in a very shallow subtidal zone (~5-6 meters). Generally, the infaunal species abundance was extremely low and varied greatly. The station saw a decrease in contaminants in the 1990s, but heavy cleanup activity in the local area may be responsible for sediment disturbance and the low presence of infaunal microbiota. This station had the highest presence of nickel, mercury, and zinc of the three stations.

What is a foraminifera?

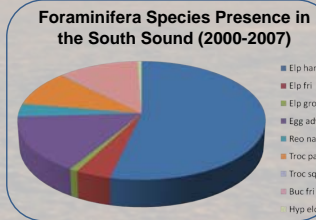
Foraminifera are single-celled protist composed of either calcite or an agglutination of sediment. They can form elaborate, multi-chambered test that display a wide range of morphologies between species. They are extremely prevalent throughout the fossil record and first appeared during the Cambrian Period (520 million years ago). Foraminifera are generally smaller than one millimeter though considerably larger foraminifera have been discovered. Over 275,000 species of foraminifera are known throughout the fossil record with an estimated 10,000 extant species. Benthic and planktonic are the two major types of foraminifera. This study focused exclusively on benthic foraminifera.

Results

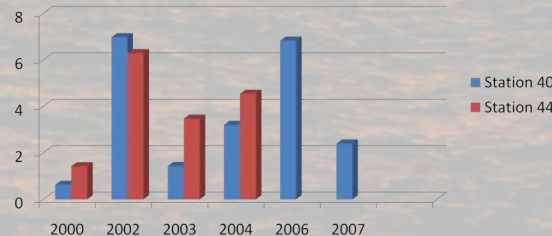
- 714 foraminifera were picked from South Sound stations.
- Foraminiferal density in the South Sound is extremely low.
 - The typical density ratio of picked foraminifera to volume of sediment (grams) was between 1:1 and 7:1.
 - Bellingham Bay had a typical foraminifera to sediment density ratio of 300:1.
- Samples from Thea Foss Waterway and Easter Anderson Island were regularly able to produce viable numbers of foraminifera, but Inner Bud Inlet was not able to.
- In 2002, the dominate species was *Elphidium hannai* for both Thea Foss Waterway and East Anderson Island.
- In 2002, Station 40 and 44 produced low, but viable numbers of foraminifera with the highest recorded densities for each station. In comparison, Bellingham Bay stations were commonly two orders of magnitude higher in species density.
- In 2003 and 2004, *Eggerella advena* became the dominant species at East Anderson Island and the co-dominant species at Thea Foss Waterway.
- According to statistical analysis (CCA), the primary controlling factors were nickel, mercury, zinc, calcium, depth, and sediment type.



Eggerella advena



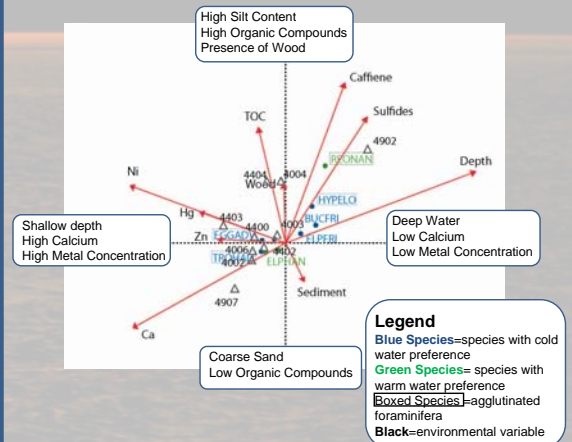
Ratio of Number of Foraminifera to Volume of Sediment (g) for 2000-2007



Conclusion

The South Sound has an extremely low abundance of foraminifera. A high abundance of *Eggerella advena* correlated to a low abundance of *Elphidium* species. In comparison, *Elphidium* is the dominant genus in Bellingham Bay. Inner Bud Inlet samples had few to no foraminifera per sample. The reason for the extremely low abundance of foraminifera in the South Sound has not yet been determined. Salinity has remained virtually the same throughout the Sound. Due to inconsistent chemical analysis in the annual sampling protocol by the DOE, no definitive chemical correlations could be made directly from the South Sound data. Though more complete chemical analysis for Bellingham Bay did allow environmental and chemical controlling factors to be determined and the South Sound's foraminiferal data correlated well with Bellingham Bay's results. *Eggerella advena* and *Elphidium hannai* were determined to be pollutant tolerant species. Because of the large discrepancy of foraminiferal density between stations, it will be difficult to compare sediment quality between sites based on foraminiferal data unless a station correction factor can be taken into account.

Concordance Correspondence Analysis



Further Study

More information is still needed to meet the long term goals of this project. The Central Puget Sound and Hood Canal's sediment samples have still not been analyzed and these areas are vital in determining whether a foraminiferal density gradient exists. Second, with the acquisition of additional data, it will be possible to more accurately determine what are the controlling factors of foraminifera species presence and density. This project is currently in its infancy, but has already made great strides forward in posing fundamental questions on what foraminifera are able to tell us about the health of the Puget Sound.

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