

# Analyzing Species Distribution of Foraminifera in Bellingham Bay as a Supplement to Pollution Research

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## Abstract

Foraminiferal assemblages can be instrumental in determining habitat conditions. This study, located in Bellingham Bay, is part of a larger study to establish the effect of pollution on foraminifera of the Puget Sound, WA. Significant distribution changes of foraminifera have occurred through the 13 year's sampling. These changes are represented by a decrease of species abundance and a decrease in species diversity. A substantial decline in the number of calcareous foraminifera was observed. *Eggerella advena*, an opportunistic agglutinate species with the ability to survive in less tolerable conditions than numerous forams, was highly abundant.

## Introduction

Foraminifera are microscopic eukaryotes which can be used to interpret habitat conditions through species diversity and other parameters. Marine environmental conditions can be inferred by using a combination of foraminiferal species preferences such as tolerance of hypoxia (low oxygen), substrate grain size, temperature, and salinity. They are useful for study because they are inexpensive to collect and are rarely damaged in the collection process due to their minute size (Haynes 1981). Foraminifera are abundant in most marine sediments, with an ample diversity of species, and they are frequently studied for geological purposes (Phleger 1960).

This study examines the distribution of benthic foraminifera at two sites in Bellingham Bay, WA within the greater Puget Sound Basin. Foraminifera are classified as agglutinate or calcareous. Agglutinates collect materials from the sea floor and sometimes particles in suspension to build their tests (shells). Many agglutinates can live below the calcite compensation depth (CCD) with lower oxygen levels (Haynes 1981). Calcareous foraminifera build their tests by secreting calcium carbonate.

In 1997 and 1998 sediment samples were collected in the Puget Sound by NOAA under the Puget Sound Ambient Monitoring Program, establishing a baseline of water conditions and toxin levels. The Department of Ecology continued sampling the substrate in the following years with the Urban Waters Initiative using the Sediment Quality Triad (SQT) approach (Biedenbach 2011). Samples were provided to the Burke Museum for evaluation of the foraminifera. In this team research project, my position is to extract foraminifera and identify the species retrieved.

## Methods

Substrate samples were collected by the Department of Ecology with a van Veen grab from several stations throughout the Puget Sound, and placed in clean high density polyethylene containers or Zip-Lock® bags (Biedenbach 2011). The water was removed and samples were tested by the US Geological Survey for salinity, total organic carbon, grain size, and miscellaneous additional parameters. Samples were refrigerated and then supplied to the Burke Museum where they were washed through several sieves, the smallest was 63µm. I examined the washed sediment under a microscope to separate foraminifera onto a slide, and then identified the foraminifera according to genus and when possible, species. Some stations had samples collected annually while others were less frequent. Comparisons are being made to determine species abundance and diversity at each station for all years collected.

## Results

- Station 4 covered a four year period. Samples were collected in 2002, 2004, and 2006.
- Station 21 covered a thirteen year period, first sampled in 1997 and then again in 2010.
- The stations both demonstrate a considerable decline in abundance of species collected.
- Eggerella advena* has the highest frequency of individuals, in the most recent samples, at both stations.
- Calcareous forams are poorly represented at Station 21 in 2010
- It is unclear at this time why the species diversity is so much greater at station 21

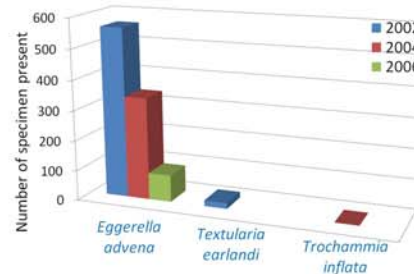


Figure 1: Station 4 contained only agglutinates. The quantity of individuals picked descended considerably over the four year period. All samples were 0.1g.

Testing sediment by the US Geological Survey (USGS) results:

- Salinity was 30‰ in 2004 and 2006 and 28‰ in 2002 sample at station 4; salinity data is not available for station 21.
- The grain size varied significantly at station 4. In 2002, samples were 24.9% sand and 73.67% fine grains. In 2004, there was 7% sand, and 91.5% fine grains. This may explain the decline of agglutinates that rely on particles to build their tests, and the further decline in 2006.

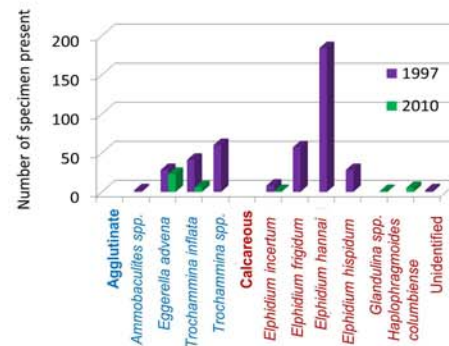


Figure 2: Species diversity change at station 21 from 1997 to 2010

## Results

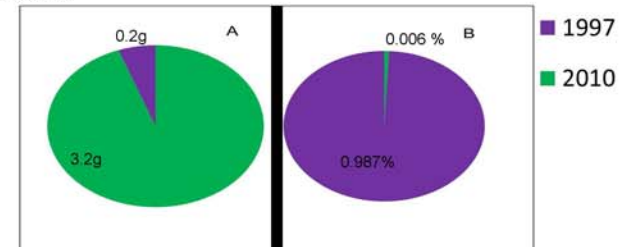


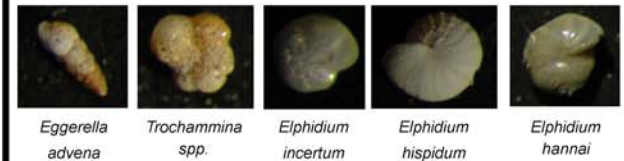
Figure 3: Graph A compares the weight of samples picked and Graph B shows the percentage of individuals picked

## Conclusion

While toxins are likely to be a factor in the foraminifera assemblage shift, there are other conditions which could equally effect the distribution. Substrate was collected at depths within two meters of each other across the years; yet some foraminifera are so sensitive to habitat conditions that they may appear in one location and be completely absent 20 centimeters away. Depth may have been a factor in the overall decline. Similarly, temperature, salinity, and grain size can affect the presence of certain species. Due to many factors that might affect the distribution of foraminifera, the data collected from this study should be combined with other parameters tested, as well as further foraminiferal assemblage studies for a more accurate assessment of the marine environmental conditions of the greater Puget Sound basin.

*Eggerella advena* is an opportunistic species; because they are the most prevalent, more stations should be examined to determine the cause. Several factors could affect their abundance, and it is too early to draw conclusions with certainty.

The team I am working with will continue to sort substrate samples for foraminifera that can later be compared for species diversity and richness. At this point, I have only been able to evaluate two stations, which is too small for a real understanding of the entirety of Bellingham Bay.



## References

- Phleger, F.B. 1960. Ecology and Distribution of Recent Foraminifera. The Johns Hopkins Press, Baltimore. 297p
- Haynes, J.R. (1981). Foraminifera. Halsted Press. 433p
- Biedenbach, J.M. 2011. Sediment toxicity test results for the Urban Waters Study 2010, Bellingham Bay, Washington: U.S. Geological Survey Data Series 591, 65 p. plus 9 appendices.