The Benthic Community of Narragansett Bay: A Field and Laboratory study

EVS 616

Introduction

One of the primary attributes that distinguish estuaries from other marine systems is the strong interaction between the sunlit surface waters and the bottom. In terms of physical processes, shallow bottoms in estuarine areas dissipate the kinetic energy of tides, mixing the water column and thus redistributing nutrients and other materials that fuel primary production. Surplus organic matter that settles on estuarine bottoms promotes an active and diverse community of permanent and temporary residents, collectively referred as the benthos. No phylogenetic or functional attributes cause organisms to be classified as benthic. This bottom community exerts a strong feedback on the rest of the estuarine system, recycling materials, providing food and habitat for larval and adult stages of many organisms. In this field and laboratory exercise we will investigate the composition and distribution of a subset of the benthic community of Narragansett Bay, the macrofauna (see below). We will relate those findings to physical and biological characteristics of the sediment matrix and the overlying water column.

Benthic organisms can be classified according to their distribution in the sediments, size, ability to move, and feeding mode. The following definitions should be useful as you begin your background research:

DISTIBUTION:

Benthos – the entire bottom community and its immediate physical environment.
Epibenthos – organisms living on the surface of the sediment.
Infauna – organisms living in the sediment.

SIZE:
Megafauna – organisms greater than several centimeters long that are easily visible with the naked eye.
Macrofauna – organisms that range in size from 0.5 mm to about 2.0 cm.
Meiofauna – organisms that range in size from 30 µm to 500 µm.
Microfauna – organisms less than 100 µm.

MOVEMENT:
Sessile – attached organisms.
Mobile – organisms that are free moving.

FEEDING MODE:
Suspension feeders – organisms that remove food from the water column.
Deposit feeders – organisms that remove food from surface or subsurface sediments.
Carnivores – organisms that prey on other animals.
Scavengers – organisms that feed on dead organic matter.

The purpose of this exercise is to:

1. Familiarize you with standard oceanographic techniques used to sample benthic communities.
2. Characterize the species composition, abundance, and distribution of benthic invertebrates in Narragansett Bay.
3. Examine the variability within one station.
4. Relate these observations to the season and temperature, salinity, nutrients, pollutants, and sediments at the north Jamestown station.
5. Assess potential trophic interactions within the benthic community and between benthic and plankton communities.

Materials and Methods

This laboratory will again use Narragansett Bay as the study site and sample from the R/V Eastern Surveyor. Please come prepared for muddy field sampling; old warm clothes, waterproof boots, gloves, and foul weather gear are recommended.

The field and laboratory procedures used in this study have been adapted from Frithsen and Rudnick (p. 53-59 in Oviatt and Hindle, 1994). If you have any questions about this material, it will be helpful to refer to this
Please study the methods thoroughly before arriving for the field portion of the study.

**Field Sampling Procedures**

On the way to the first station, we will introduce you to the equipment and review the procedures we will be using during field sampling. Please make sure you understand everything before arriving on station, and ask plenty of questions if you don’t. Once we arrive on station, sampling must proceed relatively efficiently to save time.

When the captain announces that you have arrived on station, record the station, date, time, exact latitude and longitude from the ship’s GPS, weather and tide observations, and station depth from the ship’s video echo sounder. Be as detailed in your observations as possible.

**Salinity and Temperature**

You will take salinity and temperature measurements of both surface and bottom water. For that purpose you will use an electronic salinity and temperature probe similar to the one employed during the plankton cruise. The TA will show you the operation of the probe before arriving to the station. Once on station, lower the sensor’s probe into the water making sure that it is completely submerged just below the surface of the water. Let the readings stabilize for a minute or two and record the values for salinity and temperature. If the probe has the capability to measure dissolved oxygen, record that value as well. Once the surface values have been recorded, let the probe reach the bottom by letting cable out, once the cable slackens signaling the probe touched the bottom, recover a meter or two of cable (use this as chance to familiarize yourself with the metric system) so that the probe is just above the sediment but not in contact with it. Record the data for the bottom water, including the depth of the measurement either from the probe readout itself or the echosounder located in the boat’s cabin.

**Collection of Benthic Organisms**

We will use a Van Veen grab to sample the benthos. You should get the dimensions of the grab before the first sample is taken for calculating the surface area sampled. We will demonstrate how to set the trigger bar on the
grab to hold it open. After verifying with the captain that you are still on station, one student wearing a work vest will set the trigger bar and keep tension on the wire until Captain (operating the winch) lowers it over the stern. The Captain will lower the grab to the bottom and when it hits, tension will be released from the wire causing the trigger bar to fall. When the Captain begins to retrieve the grab, tension will again be put on the line causing the grab to close. The grab will then be brought back onto deck. The grab must arrive full and the sediment must fall out undisturbed.

Remove the top cover plate and inspect the fullness of the grab. You may have to collect more than one grab before obtaining a good sample, so keep detailed notes on what takes place. If the grab is sufficiently full, record the distance between the surface of the sediment and the top of the grab. Begin sampling by qualitatively describing the sediment (color, sediment type, hard or soft, presence of tubes or organisms on the surface etc.). You should then very carefully crack open the grab, and allow any water to slowly drain of the surface of the sediment. This is critical to avoid washing away the surface sediments in a rush of escaping water. After the water has drained, open the grab and carefully allow the sediment sample to slide out onto the deck.

Slowly wash the entire grab sample through the 2 mm sieve. Care should be taken to avoid damaging organisms, many of which are fragile and will break apart easily. As each shovel full is washed pick out all organisms larger than the sieve size and transfer to 1 gallon sample containers. Count all organisms and categorize as polychaetes, crustaceans, mollusks, nemerteans, and unknowns. Large organisms such as quahogs should be measured from the hinge to the front of the shell. After they are counted and measured they can be returned to the water. Where possible identify to species. The area of the sample for the 2 mm size fraction is simply the area of the grab. Please calculate the number of individuals per each grouping and total of all organisms per meter squared. Calculate the variability between grabs.

We will also be collecting 15 cores using two SCUBA divers. **We will not process these cores.** We will review the procedure with you. 15 replicate cores will be hand-collected by scuba divers. Cores are made from
transparent acrylic tubing and measured 30 cm in length and 3.4 cm in diameter. Tubes will be inserted into the sediment to a depth in excess of 10 cm, closed at each end, in situ, with rubber stoppers, and returned to the surface. Once topside, the top two centimeters of sediment from each core were removed, along with any trapped overlying water, for analysis separate from the remaining eight centimeters. All samples will be preserved in 10% pH buffered formalin and stained with rose Bengal dye to aid in counting and identification of specimens. Back at the lab, macrofaunal samples will be sieved through stacked 500 and 300 µm mesh sieves prior to sorting, identification, and enumeration.

Results

You will present your results of the large-organism Van Veen samples in the form of a scientific paper. Be sure to include an introduction, methods, results, discussion, and literature cited section. Also include at least one data appendix that summarizes (perhaps through tables) and presents the pooled raw data. You also may want to include another appendix describing in detail any repetitive calculations you make to obtain results or summarize the raw data. Do not include large tables listing all of the observed species in the results section. You should be concise and organized in the body of the paper, presenting only interesting and relevant results that you talk about in the discussion section.

Be detailed and precise in your report, any scientist should be able to read your paper and easily duplicate your work. Present and discuss any interesting observations and trends you find while analyzing the data. Present your data clearly and concisely; the reader should be able to reference your figures and tables and easily see if what you present is supported by your data. You may want to consider the following:

1. How do the physical parameters (including sediment type) vary within the station at the time of sampling? Does this appear to represent a typical pattern for estuaries and/or for Narragansett Bay (cite references)? What might the physical parameters tell you about the environment benthic communities are living in?
2. Does the distribution of benthic organisms (variability between samples) appear to be related to the physical and/or chemical properties of the Bay? What physical parameters seem to have the greatest effect on benthic communities?
3. Does the distribution of benthic organisms appear to be related to biological processes such as predation, competition, etc.? Do certain species appear to influence the distribution of other species?

4. How do your data compare with previous studies of benthic communities in Narragansett Bay? Be aware that mesh size and collection technique can greatly affect the abundance estimates obtained in a particular study.

5. Can you speculate on possible trophic interactions between planktonic and benthic organisms, can you provide evidence from your data?

6. What are the strengths and weaknesses of the sampling methods? How might this affect your data?

Do not limit yourself to these questions; report on things that you find interesting and important! Use your report as a tool to synthesize ideas and communicate interesting findings in your data.

References

The following references are presented to help you get started learning about the benthic communities in Narragansett Bay. You are not required to read them, but you will probably want to search these and others to help with your understanding of the communities, and to help with your report. They will provide background information essential to your understanding of the study.

Three useful studies:


And others:
Common Benthic Species in Narragansett Bay, RI

1. Phylum Annelida
2. Class Polychaeta
3. *Arabella iricolor*
4. Capitella sp.
5. *Chaetopterus* sp.
6. *Chymenella* sp.
7. *Exogone* sp.
8. *Glycera* sp.
9. *Magelona* sp.
10. *Nereis* sp.
11. *Mediomastus ambiseta*
12. *Pectinaria* sp.
13. Phylum Mollusca
14. Class Gastropoda
15. Class Bivalvia
16. *Mercenaria mercenaria*
17. *Mulinia lateralis*
18. *Nucula annulata*
19. *Yoldia limatula*
20. Phylum Arthropoda
21. Class Crustacea
22. Subclass Copepoda
23. Order Calanoida
24. Order Cyclopoida
25. Order Harpacticoida
26. Subclass Malacostraca
27. Order Amphipoda
28. *Ampelisca*
29. *Caprella*
30. *Corophium*
31. Phylum Nemertea
32. *Amphiporus* sp.
33. *Tetrastemma* sp.
34. Phylum Nematoda
35. Phylum Sipunculida