Zonation Patterns on a Sand-Influenced, Rocky Intertidal Shore

Introduction

One of the most salient patterns of marine organisms on rocky shores is **vertical zonation**: the distribution of species in **horizontal bands** or **zones** that are (1) parallel to the waterline and (2) perpendicular to the physical gradient caused by the rise and fall of the tides. In today's field activity, we will be investigating several aspects of vertical zonation.

Species high on the shore spend a large proportion of the time out of water, exposed to:

- aerial desiccation stress (during hot days),
- low salinity stress (during rainstorms), and
- terrestrial consumers (birds, mammals, shore crabs, etc.).

These species also are constrained by:

- limited feeding opportunities during emersion (for animals) and
- limited gas exchange for photosynthesis during emersion (for seaweeds and seagrasses).

These factors, alone or in combination, may determine how far up the shore a given species can occur. We call this the **upper limit** of that species.

Species also have **lower limits**, namely how far down the shore they extend. Today you will observe a discrete lower limit to the mussel beds at Short Sands Beach. In some cases, lower limits are set by physical factors such as light levels (for seaweeds and seagrasses) and sediment disturbance; in other cases, species interactions (predation, herbivory, competition for space) control lower limits.

Objectives

1. Determine the number of horizontal zones exposed during low tide,
2. Document major taxa of each zone or band,
3. Quantify the number of taxa inhabiting each of 2 zones, and
4. Determine how taxonomic richness varies with relative tidal level.

Methods

1. Each group will decide how many horizontal bands or zones are present and what the major **habitat formers** are. For example, mussels form beds in which a diversity of species resides: the mussels are providing a habitat and ameliorating physiological stress of other species. Note whether the upper and lower limit of each zone is discrete.
2. You will qualitatively survey each zone for major organisms. For example, in the barnacle zone, you will probably see periwinkles and limpets (herbivores), acorn barnacles, whelks (carnivorous snails), flies, perhaps tiny red mites, etc. Record the taxa in 3 general functional categories:
    a. **Primary producers** (seaweeds, seagrasses, and microalgae) that capture light energy and photosynthesize.

   b. **Sessile invertebrates** that are firmly attached to the rocky surfaces (*e.g.*, the barnacles, attached polychaete worms, sponges, mussels, etc.). These are animals that feed on suspended organic matter.
   c. **Mobile consumers** that either feed on other animals (carnivores or predators) or on plants (herbivores or grazers).

3. We will stretch a transect line through the middle of two different zones. Each group will have a square quadrat frame (0.25 m^2). You will be assigned 2-3 randomly determined locations along the line to place your quadrat. After you place your quadrat in the specified location, one group member will record the data while the other two will systematically identify taxa to the best of their ability. Remember: you do not need to know what a taxon is called to know that is different from another taxon. For example, you could call unidentified red algae as "red blade sp. 1", "wiry red alga sp. 2", etc.
4. Each group will calculate the average number of taxa per quadrat at each tidal level as well as the overall number of species. In general, the number of taxa increases as you move down the shore (more benign physical conditions, more opportunities to feed or photosynthesize, etc.). Determine whether your data support this general prediction.

Results

Compile the data from the field collection sheets of your group. After you synthesize your data, we will discuss your results as a group.

Questions

- Would you expect sessile and mobile animals to be influenced differently by tidal emersion? If so, how? If not, why not? What do the data indicate?
- What general attributes do high and upper-mid shore seaweeds have to avoid desiccation stress? Do most species have similar strategies or are there several biological solutions to problems of desiccation?
- Would you expect sessile and mobile animals to be influenced differently by sand disturbance (abrasion or burial)?
- Were the ecologically important ochre sea star (*Pisaster*) and the dog whelk (*Nucella*) abundant? For perspective, we will give data for other sites. If these major consumers were not abundant, the competitively dominant mussels theoretically should dominate much of the shore. Do they? If not, what other factor might be important in limiting mussel abundance?
- How could you set up an experiment in the field to determine the relative contributions of tidal level and species interactions on species diversity? An experiment should include an experimental treatment where something is manipulated and one or more control treatments. What would you manipulate? What would you have as your control(s)?
- Compare taxonomic diversity between the two intertidal levels. What conclusion might you draw concerning the effect of intertidal height on diversity? How can a difference in diversity be explained in terms of intertidal height?

Zone_____

Types of Taxa	**Quadrat #1** (list taxa & then count them)	**Quadrat #2** (list taxa & then count them)	**Quadrat #3** (list taxa & then count them)	**Mean # of Taxa**	**Overall # of Taxa**
Primary Producers					
Sessile Invertebrates					
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