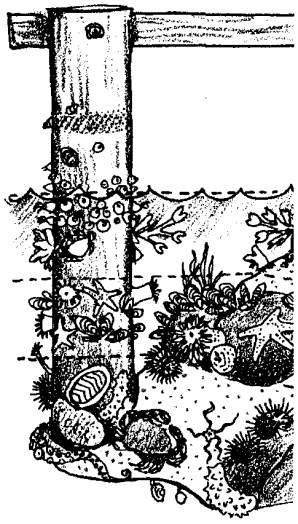
Wharf Rat—Intertidal Zonation

Key Concepts

1. Intertidal animals live in preferred zones determined largely by their tolerance for exposure to the air at low tide.

2. Animals who live in upper tidal zones endure the hazards of exposure at low tide, but also avoid predators who cannot stay in the upper tidal zones.



Background

For hundreds of years, people observed that plants and animals of the intertidal zone tend to occur in relatively distinct bands related to the amount of time an area is exposed to air.

As the tides rise and fall, organisms living on rocky beaches or on pilings are subjected to various environmental hardships. Because the hardships differ from one spot to another, we find that the animals and plants found in those spots differ. Some are better adapted to live high on the beach while others do better low on the beach where they are underwater more of the time.

Habitats high on the beach are exposed to the air for several hours each day. Organisms living there must cope with overheating in the summer, freezing temperatures in the winter, the constant threat of desiccation, and the lack of food and oxygen which the long exposure creates. Animals resting in tidepools may find the salty water in their tidepool quickly diluted by a rainstorm. Conversely, a hot summer day may lead to evaporation which dramatically increases the salinity in the tidepool. Organisms exposed at low tide also are easy targets for land predators such as raccoons and birds.

Barnacles, limpets and mussels are examples of animals well-adapted to this stressful habitat. They are protected from predators by hard shells and can hold small amounts of water inside their shells to avoid desiccation as they wait until the tide returns. These animals tend to be small; the tiniest barnacles, for example, live near the splash zone where they may be uncovered most of the time.

Unlike in the upper beach areas, habitats in the low tide zone are not exposed to the air for very long each day. Animals living in this zone, such as sea anemones and sea urchins, can endure a short amount of time out of the water, often hunkering down in a crevice and covering themselves with pebbles and seaweed. Organisms that would dry out at the higher levels, do well here.

The animals in these habitats do not necessarily need hard armor and are often softer than those in the upper beach areas. With the greater availability of food and oxygen, they also often grow to be larger.

The low tide zone does pose two problems the tiny barnacle escapes higher up the beach. Unlike in the sparsely populated splash zone, living space is at a premium in the low tidal areas. Species must vie with one another for living space. When two clones of sea anemones meet, for example, they sting each other, creating a neutral zone between the two colonies. When the battering action of the winter storms breaks away clumps of seaweed or animals, other organisms quickly colonize the newly vacated rock. If larvae do not find a space to live on the crowded rocks or pilings, they will perish.

The second hazard unique to the low tide zone, is the presence of marine predators. Sea stars, for example, crawl up the beach with the tide, stopping to feed in areas under water long enough for them to complete a meal. Only a few of the barnacles which settle in these low tide areas avoid predation long enough to eat their fill of plankton and grow large enough to foil the hungry predators. While the small barnacles high on the beach may have to wait a long time between tides, they escape the threat of the sea stars.

Materials

For each student team:

- meter stick
- identification books
- clipboard
- rubber boots or appropriate field clothing

Teaching Hints

"Wharf Rat" is a field exercise in which students study intertidal zonation on a rock face or on a wharf piling. You will need to find a suitable location that exhibits zonation and that is accessible to students. Check tide tables before the field trip to make sure the students will have ample time at low tide to complete their observations.

Extensions

Have students do a transect at each of the four sides of a piling, north, south, east, and west. Are there any differences in the distributions of organisms.

Answer Key

Analysis and Interpretation

1. It is unlikely that all the student teams will have the same results. The environmental conditions from one rock face or piling to another may vary. The students will define zones differently and may estimate animal numbers

differently.

2 a. Typically, low or mid tide zones have the most organisms.

b. Low and mid tide zones are exposed for shorter lengths of time so more animals can tolerate life in these areas. Mid tide zones sometimes are more heavily populated because subtidal predators do not venture that high up on the beach or piling.

3 a. Student responses will vary.

b. Environmental factors that may cause differences in numbers of organisms from one tide level to another include length of time exposed to air, changes in temperature, food availability and oxygen levels.

4. Animals may not move into the upper tidal zone because of extremes in temperature, long exposure to air, drying, suffocation, battering by waves and insufficient water movement to remove wastes.

5. Animals may not extend their range to lower tidal zones because other animals out-compete them for space in that zone or predators readily decimate their populations. They may stay in upper tidal zones because they prefer those temperatures or other characteristics of the upper tidal areas. It is interesting to note that often species are able to live quite well under the conditions found on other parts of a piling, yet they are not found on the other parts. The explanation lies in the fact that while they are able to survive in these other locations, other animals can survive better, and these other organisms out-compete the species trying to extend its territory. The living environment, then, has a pronounced effect on where an organism can live.

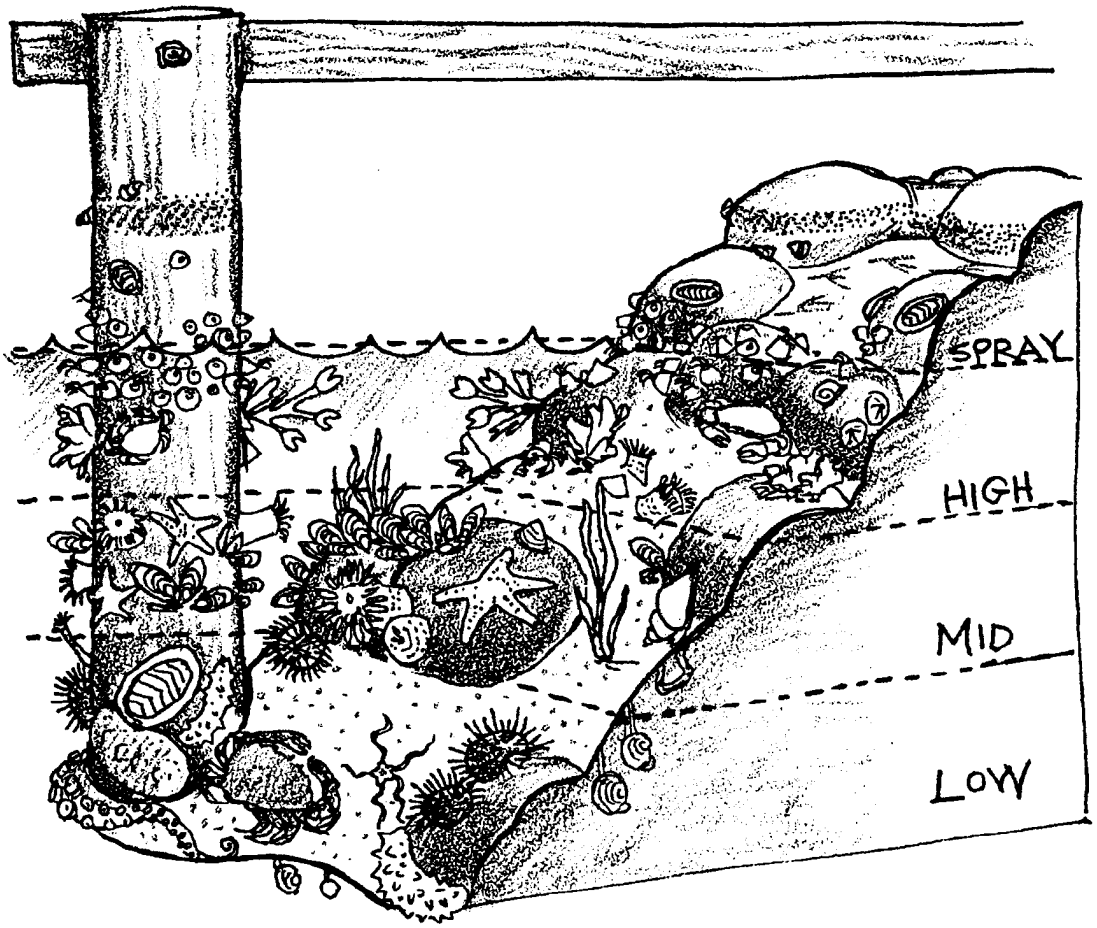
6. The answer depends upon the organisms chosen. While the protective adaptations may be gleaned from the pages of a book, also encourage students to use their observational powers to answer this question.

7. The major food source for animals attached to rocks or pilings is water-borne plankton.

8. Oil and gasoline slicks are particularly devastating to rocky shore or piling organisms since the changing water levels allow the slick to coat a large area of the rocks or pilings. The students may think of other types of pollution.

9. The tides alternately wet and dry intertidal animals. Organisms are subjected to changes in temperature and to ultraviolet radiation. The tides also bring and carry away food and oxygen and cool water.

Wharf Rat - Intertidal Zonation



The changing water level caused by the tides produces many different zones on rocky shores. The top section is the high tide zone. This area is found at the extreme upper limit of the tidal wave wash. It is exposed to air most of the time. The second section from the top is the mid tide zone. This zone is found at the level of the higher low tides. This area is not exposed to air by all tides. The lowest section is the low tide zone. This zone is underwater more than it is exposed to air. In fact, it is only exposed to the air during extreme low water tides.

Since animals and plants live where their environmental requirements are fulfilled, we might expect to see different kinds of organisms in the different zones found on one rock face. Barnacles, for example, do well at the high tide zone. They can survive the long periods of time out of water and they are beyond the reach of most sea stars and other predators. Sponges, however, will survive only in the low tide zone. They cannot tolerate much exposure to air. Often these and other organisms are grouped in specific bands which correspond to the different tidal zones.

In this activity you will have a chance to sample, identify, count and analyze some of the species located in zones on a rock face or on a wharf piling. Pilings also provide homes for attached animals. The pilings, just like rock faces, have areas or zones that are subtidal and always underwater. They also have low and mid tide zones that are exposed for some time at low tide and high tide zones that are out of the water for extended periods of time.

Materials

- meter stick
- identification books
- clip board
- rubber boots
- tide table

Procedure:

Part A - Determining Zones

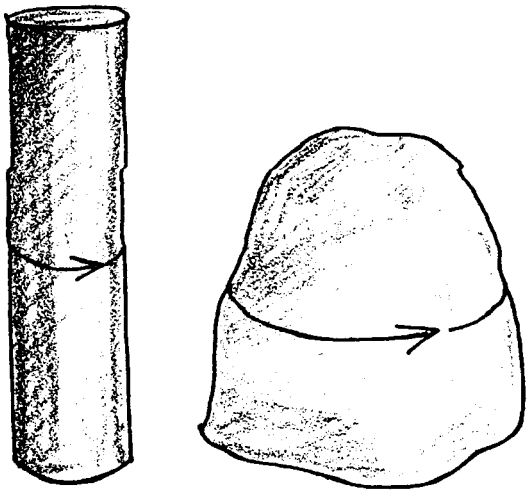
1. Examine your rock face or piling carefully. Divide your rock face or piling into three sections by finding differences in the plant and animal communities. Starting at the bottom, use your meter stick to measure the height of each band in centimeters. Record the height of each band on the drawing of the rock face or wharf piling, whichever you are observing.

2. Use your books to identify the organisms found in each tidal zone. Record their names on your data sheet.

3. Estimate the number of organisms within each zone and record on your data sheet. Do this by counting the number of organisms in an area 5 cm x 5 cm (25 cm^2).

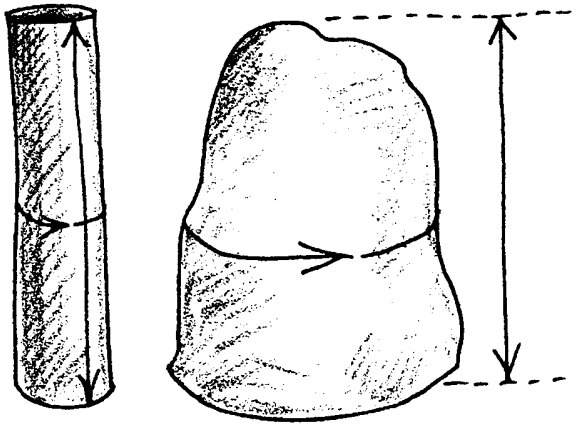
   a. # of organisms in 5 cm x 5 cm area _____

Now measure or estimate the width of the zone you are studying. If you are using a piling, measure the circumference of the piling with string or a tape measure.



b. Width _____cm

Multiply the width times the height of the zone to get the total area of the zone (you measured the height earlier).



c. Width _____cm x Height _____cm = _____ cm^{oc} total area of zone

How many times does your 5 cm x 5 cm (25 cm^2) space fit in your total area?

d. _____total area in cm^2 ÷ 25 cm^2 = _____

e. Now take the number of organisms in your 5 cm x 5 cm space (answer to 4 a.) and multiply it by the number of spaces that fit into the zone (answer to 4 d.).

(i.e. total # organisms (4 a.) x # of spaces (4d) = organisms living in that zone

(4 a.) x (4 d.) =)

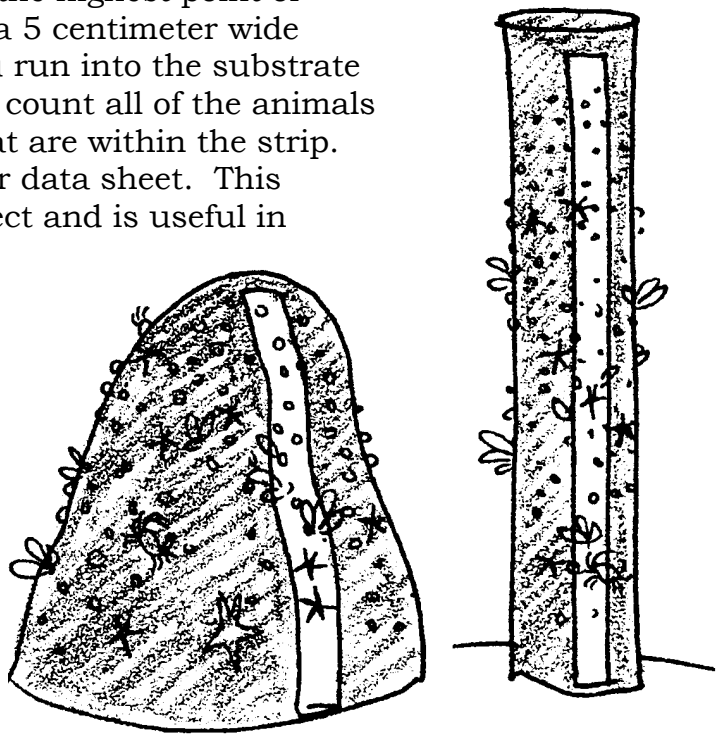
_____ _____ _____

How many organisms are living in that zone? _____ Record this number on your data sheet.

f. Repeat for the other two tidal zones. Record the number of organisms on your data sheet.

Part B - Strip Transect

1. Choose **two animal** species found on your rock face or wharf piling. Beginning at the highest point of your high tide zone, measure a 5 centimeter wide strip down the piling until you run into the substrate (bottom). For each tidal zone, count all of the animals (of the two species chosen) that are within the strip. Record these numbers on your data sheet. This method is called a strip transect and is useful in estimating animal numbers.



2. Show the abundance of each animal graphically. Use the graph paper on your data sheet to construct a single graph showing the number of animals in each tidal zone. Use two different colored lines to show the changes in the number of each animal with changes in zone. Be sure to give your graph a title and indicate which line represents which animal.

Analysis and Interpretation

1. Compare your results with those of others in your class. Were all of the rock faces or pilings divided at the same depth? If not, what are two possible sources of the differences observed?

2 a. Which zone had the most organisms?

b. What are two possible reasons that might explain why this zone had more organisms than the others?

3 a. Were the two animals you chose found in the same number at each level? If not, at which level was each most numerous?

b. What is one environmental factor that might cause a difference in the number of organisms from level to level?

4. What are two environmental factors that might limit a species, keeping it from extending into the upper tide zone?

5. What are two environmental factors that might limit a species extension into the low tide zone?

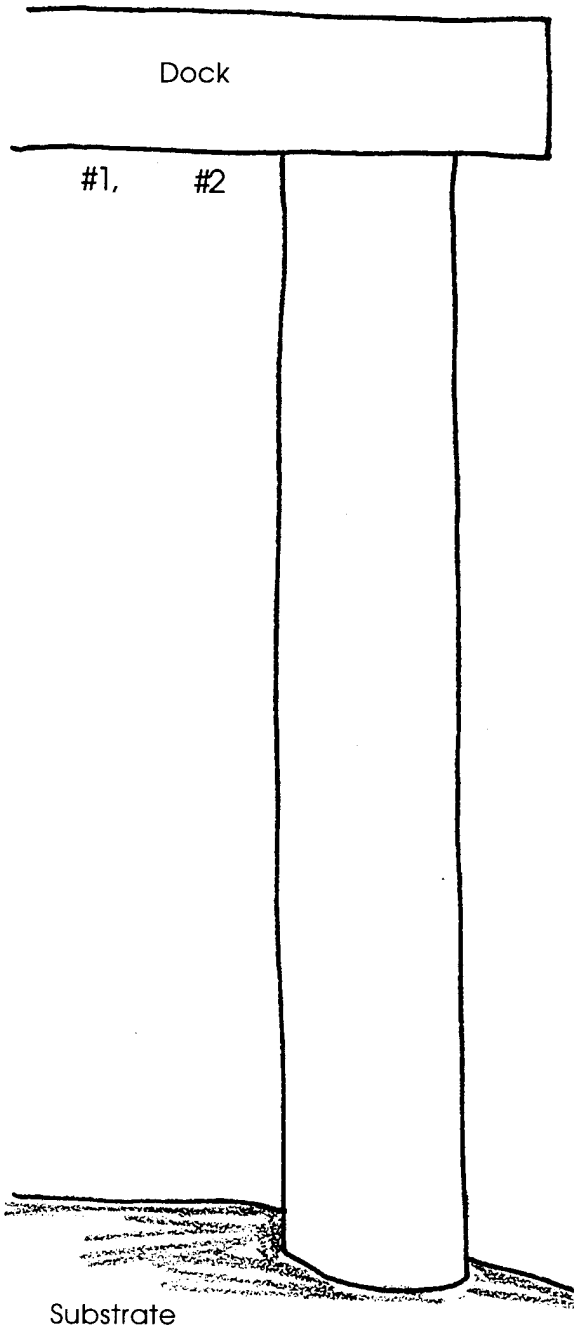
6. Pick one organism from the each zone and describe how it protects itself from drying out in the sun at low tide on summer days or freezing at low tide in the winter.

7. The majority of the animals on your rock or piling probably are attached. Many do not travel to find food. What, then, is the major food source for these sessile animals?

8. What types of environmental pollution do you think would be particularly devastating to rocky shore or piling organisms?

9. The tide is perhaps the most important environmental factor affecting rocky shore and piling organisms. How does the tide affect these organisms?

Wharf Rat Data Sheet—Piling



#3

High Tide Zone

Animal Name	# of Organisms in Zone

Mid Tide Zone

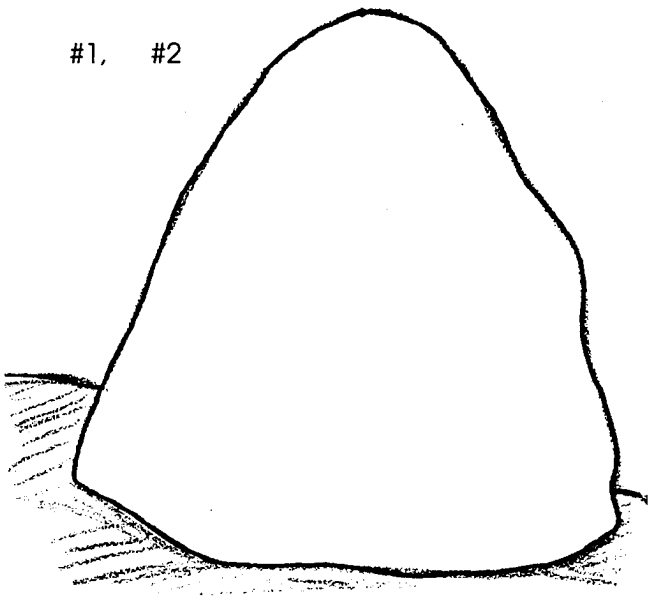
Animal Name	# of Organisms in Zone

Low Tide Zone

Animal Name	# of Organisms in Zone

Wharf Rat Data Sheet—Rock

#1, #2



Substrate

#3

High Tide Zone

Animal Name	# of Organisms in Zone

Mid Tide Zone

Animal Name	# of Organisms in Zone

Low Tide Zone

Animal Name	# of Organisms in Zone

Wharf Rat Data Sheet—Part B

1. Strip transect

Number of _____ (animal 1) Number of _____ (animal 2)

High Tide Zone _____ _____

Mid Tide Zone _____ _____

Low Tide Zone _____ _____