Intertidal Ecology

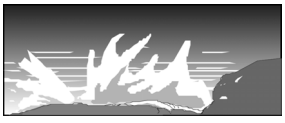
Lesson Objectives: Students will be able to do the following:
- Describe the rocky intertidal zone
- Differentiate between the four intertidal zones
- Explain one way that physical processes affect organism distribution

Key concepts: intertidal zones, nutrient upwelling, desiccation, holdfasts, water vascular systems, larval recruitment

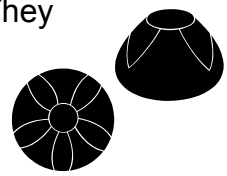
Physical Description of the Rocky Intertidal Zone

Intertidal zones are transitional coastal regions. The cycling of the tides influences these regions. These **littoral** areas are located between the high and low tide marks. They can be found along rocky shores or sandy beaches. We will be taking a closer look at the rocky intertidal region. It is characterized by sturdy boulders, rocks, crevices, and ledges that are home to a variety of organisms.

The rocky intertidal region can be divided into four vertical zones. These zones are based on height and tidal influence. These four zones include from the highest to the lowest: the splash zone, the high intertidal zone, the mid-intertidal zone, and the low intertidal zone. The splash or spray zone is the highest and driest area. This **supralittoral** zone is above the highest high tide mark. It is moistened by saltwater spray from waves and freshwater runoff from rain and streams. This relatively dry area is sparsely populated. Few organisms can withstand the extreme fluctuations in moisture, temperature, and **salinity** found in this zone.



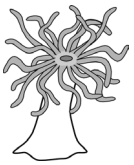
The high intertidal zone is completely covered with water only during high tide. Parts of this region are exposed to the air for long periods as the tides recede. The inhabitants of this area are sturdy individuals. They can remain wet even if they are exposed to the sun and wind. The organisms in this area have also developed attachment devices to help them resist the force of the waves. These devices include muscular feet, suction cups, **byssal threads**, or **holdfasts**.



The mid-intertidal zone is the area between the average high tide and low tide mark. This region is covered by water during most high tides, but it is exposed to the air during most low tides. This environment contains a more diverse group of organisms, than either the splash zone or high intertidal zone. This area is also

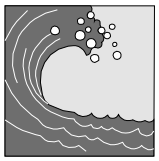
highly populated. Organisms that live here must overcome space and competition problems. To overcome some of these problems, organisms have developed specialized **niches** within the **community**. Some organisms grow more quickly than others, so they can find the required space. Others grow in layers on top of each other to take up less room.

The low intertidal zone is the area between the average low tide level and the lowest low tide level. This area stays moist during most low tides making it an ideal home for many kinds of organisms. The low intertidal zone also has lots of food as nutrients are circulated in nearshore waters. Many **plankton** are found within this **habitat,** and **grazers** enjoy the rich abundance of **algae** available.

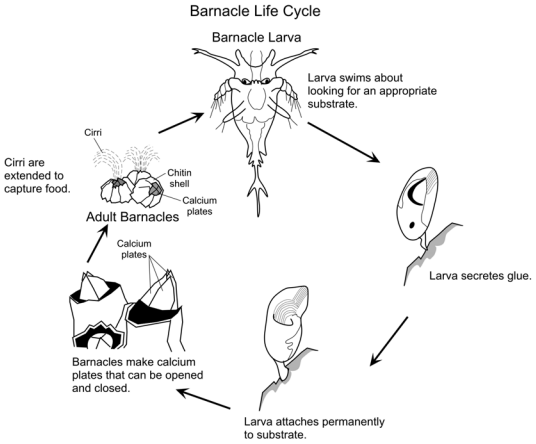


These four zones can be different from place to place. Some of them may contain highly specific **microhabitats** such as tidepools. Tidepools are created as the tides recede leaving rocky depressions filled with water. These areas are interesting and fun to explore, because they are home to some unusual creatures. The organisms within the tidepools have had to adapt to extreme changes in salinity. They are able to survive falling salinity levels as rain freshens the water. They can also withstand rising salinity levels as the sun and wind evaporate the water leaving the salt concentrated.

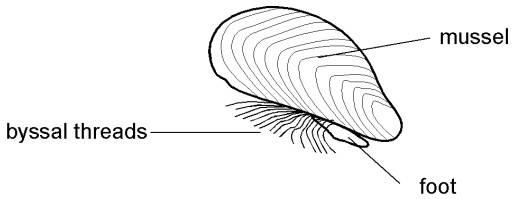
Typical Animals of the Littoral Zones



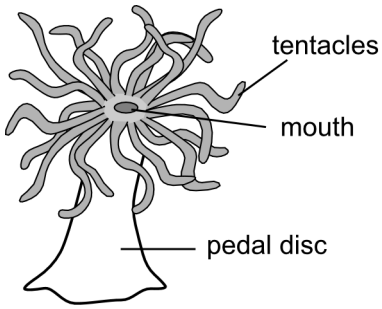
Hardy organisms can be found within the high intertidal zone. They can withstand the pounding waves and extremes in temperature, salinity, and water availability. One such organism is the barnacle. This interesting creature is a **crustacean** or relative of the shrimp. Like other crustaceans, it has a tough, protective covering made of **chitin**. During their juvenile, or **larval** stages, barnacles swim freely about in the water column searching for a place to live. Once they find a place to settle, they produce a glue. This glue oozes from their head. They use this glue to attach themselves to the **substrate**. This keeps them from being tossed about by incoming waves. Once anchored in place, they begin to build a home of calcium carbonate plates. Four plates make a door that can be opened and closed. This door protects them from **predators** or keeps them from drying out. Once their home is complete, they use their feathery legs to filter food from the water. These legs, called **cirri**, have sensory organs that can locate plankton in the water. As the barnacle grows, it must shed its chitin shell and enlarge its home. When it is time to reproduce, the **hermaphroditic** barnacles extend sperm filled tubes to neighboring barnacles. Fertilization takes place and the cycle begins again.



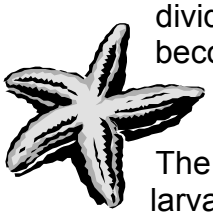
Organisms in the mid-intertidal zone must also adapt to wave action and try to prevent drying out. An animal typically found in this zone is the mussel. Mussels are bivalve mollusks. This means that they have two shells or valves that are hinged on one side. They also have a muscular foot for locomotion. During reproduction sperm and eggs are released into the water. The eggs are then fertilized. Mussel larvae develop and float in the water until they find a place to settle. Once settled, they secrete fibrous threads from a gland in their foot. These byssal threads are used to help the mussel adhere to the rocks. Mussels live close together. They eat by filtering small particles of organic matter from the seawater. They close their shells tightly to keep in moisture while the tide is out or to protect themselves from predators such as the sea star.



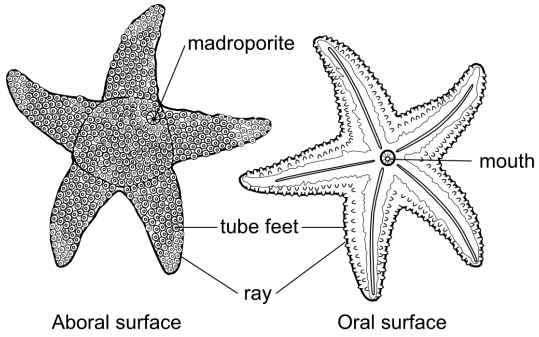
The low intertidal zone is home to organisms that have developed special **adaptations** to live within this region. Two organisms that we will take a closer look at are the sea anemone and the ochre star. Sea anemones have a cylindrical body and a central mouth surrounded by tentacles. These tentacles contain stinging cells called nematocysts that are used to stun **prey** such as small fish. The anemone then swallows and digests the prey. The waste products are released back into the water through its mouth. Sea anemones can reproduce in two ways. In sexual reproduction, fertilized eggs are released in the water column. In asexual reproduction, anemones create **clones**. These clones can form large colonies where intruders are not welcome. Threatened anemones may shrivel up, or they may fight using a specialized tentacle containing many nematocysts for stinging their enemies. To prevent drying out, anemones can turn their tentacles inward and shrink or move to a moist location using a special foot called a pedal.



The ochre sea star (*Pisaster ochraceus*) is an **echinoderm** or spiny skinned animal. Its reproductive cycle begins with the releasing of eggs and sperm into the water. The fertilized eggs continue to



divide. Eventually they become larvae. These larvae develop through two stages. The first free-swimming larval stage eats small plankton. The second larval stage develops arms and a suction cup base. It attaches itself to a rock with a tube foot and grows into a juvenile sea star. As these animals grow, they become very hungry. They must move about to hunt for food. They use their water vascular system to operate their tube feet. In this system, water enters and exists the sea star through an opening on its back. This opening is called the madroporite. As water flows through the sea star, it can create suction that helps the tube feet to stick to surfaces. The sea star also uses its water vascular system to help it open bivalve shells. When the sea star is ready to eat, it grips its prey with its tube feet and wraps its arms around the shell. Using waterpower, it pries open the shell. It then expels its stomach into the opening. Digestive juices dissolve the soft tissues of the bivalve. Sea stars also have interesting ways of protecting themselves. The tough integument or outer covering of some sea stars keeps them from drying out. Some sea stars can stay out of water for 50 hours. They can also regenerate lost arms, so they can continue their predatory life style.



PISCO: Intertidal Research

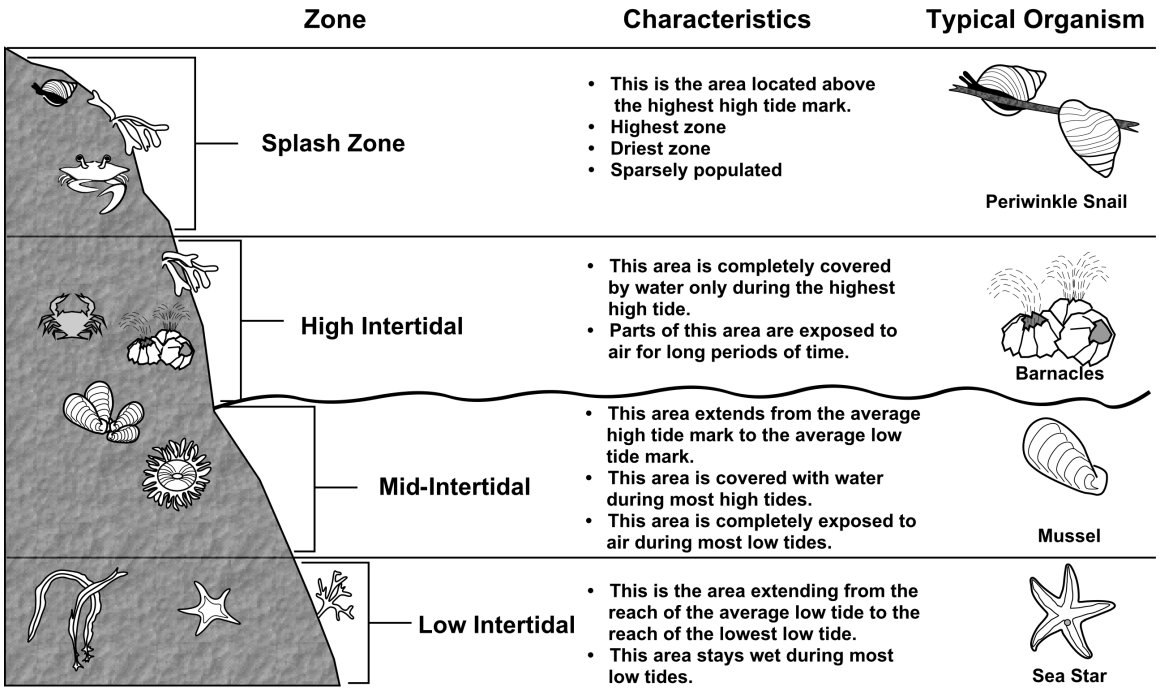
Scientists are interested in studying the rocky intertidal zone, because it is a highly structured **biodiverse** region. In the past, research was limited to small sample areas. Scientists would study either physical factors or biological factors. This information was valuable, but it didn't help scientists understand the overall picture. They wanted to learn more about what was happening in these areas and how this affected surrounding environments.

Scientists at four universities have come together to form a collaborative research program. This program is known as the Partnership for Interdisciplinary Studies on Coastal Oceans (PISCO). PISCO is conducting an extensive study of the intertidal region that will bring together physical and biological information. These data will be collected from over 1200 miles of the nearshore Pacific coast reaching from Oregon to California. Using this broad approach, PISCO researchers will collect information about larval organisms. They are especially interested in larval recruitment.

Larvae or immature forms of many intertidal organisms recruit or settle to hard surfaces where they stay anchored for life. These larvae dispersed in water and moved about by currents have only a short time to find a suitable home. Scientists studying these immature forms are placing artificial substrates in the study areas. They are using clay tiles and kitchen scrubbers (tuffies) as recruitment platforms. They are trying to see how many organisms of different kinds attach themselves to these platforms. Information from these studies can be used to understand some of the complicated life processes that take place in the intertidal zone. This research should help scientists gather information that will improve conservation efforts in our ocean systems.

Rocky Intertidal Zone

This area is divided into horizontal bands based on height and tidal influence.



Activity: Roving People Count

The idea for this activity is adapted from activities being developed by the CINMS.

Some scientists are interested in learning about the relationships within certain types of communities. These relationships can be studied using some type of monitoring technique. Monitoring studies are designed to detect changes over time. With these techniques, scientists can look at changes in the physical environment or changes in the abundance of organisms. They can even use this information to help them understand the connection between the living and nonliving components of a particular habitat.

Objectives: Students will be able to do the following:
1. Identify situations in which roving counts would be useful.
2. Explain two reasons why abundance of a particular species may change.
3. Calculate percentage.

Materials:
- Writing instrument
- Something sturdy to write on (clip boards, notebook, etc.)
- Data sheets-one per student
- Markers to identify area-(cones, tape, or visual locations)
- Timing device (stopwatch or watch)

Prior to Class:
- Make copies of data sheets (one for each student)
- Choose a study area. This area should be accessible to a variety of people throughout the day. Some choices include a designated part of a hallway, playing field, playground, library, or cafeteria.
- Decide on the appropriate format for the count. (The count can be done using the entire class for each survey or sending small groups or pairs to do individual surveys and then comparing the results.)
- Decide on the species categories. The categories can include just two “species” such as boys or girls, or many species such as clothing color. (Some ideas include hair color, hair length, shirt or shoe color.)
- Decide on the time span of the survey. Will students survey an area for 5 minutes or 20 minutes?

Procedure:

1. Explain that roving counts involve counting different kinds of organisms that move in and out of a designated area. These counts are also done more than once over several time periods.
2. Brainstorm some of the following:
   - Why would scientists use roving counts?
   - What types of information could you get from roving counts?
   - How could this information be used?
   - How would you decide what to measure and how often?
3. Explain that today the students will be conducting a roving "people" count in the designated area. They will be recording the species and number of each species that they see in the time allowed.
4. Hand out data sheets and explain the following:
   - Students should be sure to fill in all the information at the top of the data sheet.
   - In the first column students will list all of the "species" they see in the designated area.
   - In the second column students will tabulate the number of each species they see. (Remind students that as new "species" enter the area they are counted, but as species leave they are not subtracted.)
   - In the third column students will record the total number from the tabulated data.
5. After all the surveys are completed, have the students categorize species abundance using the following terms. Have students record this information on the data sheet. (The following is an example for areas that would have no more than 20 members. The numbers can be adjusted for other amounts.)
   - **One**-only one member
   - **Sparse**-two to six
   - **Common**-seven to fifteen
   - **Abundant**-fifteen to twenty
6. Have students calculate and record the percent of sighting for each species. Use the following formula:

   $$\text{\% sighting of species} = \frac{\text{number of surveys in which species was present} \times 100}{\text{total number of surveys taken}}$$

7. Use the answers to numbers 5 and 6 to discuss trends, etc. that could be determined from the information.

Roving People Count Data Sheet

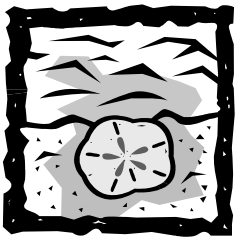
Observer's Name: _____ Survey Number: _____

Date of Survey: _____ Survey Location: _____

Time Survey Began: _____ Time Survey Ended: _____

Experimental Data			Trend Analysis	
Species Name	Species Tabulation	Total Species Number	Abundance Category	Percent Sighting

Student Information: Intertidal Exploration



Intertidal habitats are found at the water's edge. Here tides bring water to cover and uncover the shore. These areas can be sandy beaches or rocky shorelines. These regions are divided into zones. The zones are identified by height and the amount of water coverage. The splash zone is the highest zone. It gets moisture from breaking waves and sea spray. Few organisms live in this dry environment. The three lower zones are covered with water as the tides rise. As the tides fall, parts of these areas are exposed to air. These zones have many different kinds of plants and animals. Each zone has a dominant or most common organism. This animal is specially adapted to the conditions found in this particular zone.

Exploring intertidal zones can be fun. Using a few rules, we can learn about the animals and plants while still protecting them from destruction. Walk carefully. Try not to disturb the inhabitants. Before picking anything up, be sure it is safe to do so. Wet your hands before picking up organisms that need to stay moist. Try not to do anything that would scare the animals. Be gentle when touching them. When you are finished, return the animals to the place that you found them. If an animal is difficult to pick up, leave it where it is. If you turn over a log, rock, or other **microhabitat** turn it back when you are through. Enjoy your experience and share it with your friends and family.