Lesson 6: “Home Sweet Home” in the Intertidal Zone

Focus Question:
How do animals live in tidal habitats?

Objectives:
• To identify habitats in the tidal area.
• To identify the abiotic/biotic factors plus physical forces that define the tidal zones
• To identify tidal animals and their adaptations for survival in these habitats

S.C. Curriculum Standards:
5-2.2 Summarize the composition of an ecosystem, considering both biotic factors (including populations to the level of microorganisms and communities) and abiotic factors.
7-4.1 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).
8-2.1 Explain how biological adaptations of populations enhance their survival in a particular environment.

Purpose:
Coastal habitats change daily with the tides, so organisms must adapt to changing environmental conditions. Most have special adaptations to endure changes in exposure, tides and wave, while others simply move. In this resource-based activity, students will explore the biotic and abiotic characteristics of the intertidal zone and some of the physical forces found within this habitat.

Time Duration: 2 hours

Vocabulary:
Abiotic Factors- non-living components of an organism's environment, such as temperature, light, moisture, air currents, salinity, etc
Biotic Factors- living components that shape an ecosystem or affect another organism, such a access to food and avoidance of predation.
Desiccation- drying
Habitat – where an organism lives and includes shelter, space, food, air, and water
Intertidal Zone - the area that is exposed to the air at low tide and is underwater at high tide
Mean Low Water- the “0” ft line on a tide graph.
Physical Factors: Waves, currents, tides
Tidal Range - the difference in height between the high and low tides

Materials:
For Class:
• Images of Low & High Tide (Appendix 1 & 2)
• Dock Piling Model (Appendix 3)
• “Sticky Notes” sheets
• Critter Cards Sets for each group (Appendix 4)
• Artifacts, such as oyster shells, barnacles, dry sponges.
• KWL Chart
• “Life in the Salt Marsh” Poster (Appendix 5)
Materials cont’d:
For Each Group (2-4 students per group):
- Intertidal Habitat Models (Appendix 6 & 7)
- Colored pencils (yellow, green, blue, indigo, violet, black)
- Student Worksheet (Appendix 8)
- Scissors

Procedure:
Hooking Students
1. Show students the High Tide pictures (Appendix 1) of the “intertidal” zone, without revealing the Low Tide pictures at this point. Have students predict water depth and provide evidence for this prediction.
2. Reveal the Low Tide picture (Appendix 2). Ask students to revisit their predictions and again estimate the water depth at high tide. What is the tidal range estimate they observe?
3. Ask them to list at least 3 differences they observe between the two pictures.
4. Review vocabulary. Ask students to define Tidal Range, Intertidal Zone, Habitat, Adaptation, Abiotic, Biotic, Physical forces and relate these terms to the pictures.

Student Engagement
A. As a large group, use a KWL Chart to organize the students’ ideas.
1. “K” What do you know? Brainstorm with students to identify the animals commonly found on pilings at marinas, dock, etc. Some may say barnacles, oysters, mussels, crabs, seaweed. Ask if they think all of these animals live in the same space on the piling. What are their experiences on docks and intertidal areas? Write in “K” Column.
2. Pass around shells of oysters, barnacles, etc. Ask students to discuss where these animals live and any information they may know about its habitat. Also add to “K” column. Below are listed possible questions to get students thinking about the habitat of the oyster, barnacles, etc. Their answers should reveal what they know about adaptations.

<table>
<thead>
<tr>
<th>Food</th>
<th>Water</th>
<th>Shelter</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does it eat? How does it eat?</td>
<td>Does it stay submerged? How could it prevent dessication?</td>
<td>How does the animal protect itself from the elements?</td>
<td>How far does it live from other oysters? Does it require much space?</td>
</tr>
</tbody>
</table>

3. “W” What you want to know? Record any questions that students have about intertidal areas.
4. “L” What have you learned? Complete this column at end of lesson.

B. Class or Group Project: Creating Dock Piling Intertidal Ecosystem
1. Use the image of the dock piling (Appendix 3) as a template for a life size model on butcher paper. Pilings are easy places to show the vertical changes in sea level caused by tides and thus demonstrate intertidal habitats.
2. Use “sticky notes” for students to indicate the top of the mud in which the piling is driven and a low tide and high tide mark about 5-6 feet apart. They can choose a mean low tide mark about a foot above the surface or use the measurements on model. Use a tide chart to get a really accurate tidal range (difference between high and low) for a location of interest.
3. Distribute the Critter Cards (Appendix 4). Ask students to attach the critter card where they think the animals would live on a piling. Using Table 1 for assistance on common adaptations.
4. Brainstorm the biotic/abiotic factors and physical forces facing animals living in these areas. For example:
   - Storms with wind and rain that affect changes in salinity
   - Daily and seasonal temperature changes may freeze or overheat animals.
   - Waves and currents can remove animals from the piling
   - Boats can rub against dock piling. Sediment or chemicals can pollute habitat waters
   - Tides can expose animals to high salinity or exposure animals to sun
   - Predation by land or sea animals can affect the habitat

Table 2: Common Adaptations of Organisms Found in the Intertidal Zone

<table>
<thead>
<tr>
<th>To stay moist:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Seek shelter in wet cracks, crevices burrows and under plant coverings</td>
<td>• Live in large groups</td>
</tr>
<tr>
<td>• Use shells and opercula (snail cavity cover) to protect body from drying at low tide</td>
<td>• Produce mucus to reduce water loss (snail)</td>
</tr>
<tr>
<td>• Burrow into the ground</td>
<td>• Close off gills in a protected cavity so they stay moist.</td>
</tr>
<tr>
<td>• Close the shell to conserve water</td>
<td></td>
</tr>
<tr>
<td>To maintain heat balance:</td>
<td></td>
</tr>
<tr>
<td>• Minimize the body tissue contact with piling or rocks</td>
<td>• Have light colored shells to reflect heat or dark to absorb heat in winter</td>
</tr>
<tr>
<td>To reduce stress of wave action:</td>
<td></td>
</tr>
<tr>
<td>• Streamlined shapes to protect from currents</td>
<td>• Permanently attach to hard structures</td>
</tr>
<tr>
<td>• Permanently attach to hard structures</td>
<td>• Have strong muscles, foot or threads to hold on to hard surface</td>
</tr>
<tr>
<td>To breathe:</td>
<td></td>
</tr>
<tr>
<td>• Become inactive to conserve oxygen</td>
<td></td>
</tr>
<tr>
<td>To salinity changes:</td>
<td></td>
</tr>
<tr>
<td>• Adaptations, such as osmoregulation, closing shells</td>
<td></td>
</tr>
<tr>
<td>To deal with waves:</td>
<td></td>
</tr>
<tr>
<td>• Burrow deep into ground very quickly; attach tightly to a surface</td>
<td></td>
</tr>
</tbody>
</table>
C. Student Group Project: Natural Coastal Shoreline Tidal Model

Thousands of acres of intertidal lands are exposed at low tide in South Carolina. Some say this is about the area of the state of Rhode Island! Each group will create a paper model to illustrate the intertidal zones along a shoreline and identify some animals that inhabit them.

Directions:

1. Cut out the Intertidal Habitat Profile (Appendix 6) and cut slits.
2. Cut out the water level box and insert it into slits. It should pass over the front of the Intertidal Habitat picture.
3. Along the left side of the intertidal zone, find 0 feet in the tidal height scale, and draw a horizontal line from the scale to the land. Label the Subtidal Zone in the box to the left of the scale, beside the 0 feet mark. Appendix 7 shows the different zones so you can check answers.
4. Repeat this process for each of the zones.
5. Using the Intertidal Critter Cards, predict the zones in which each animal lives.
6. Slide the card up and down to model the incoming and outgoing tide.

Conclusion:

Through observations of change, which animals are submerged underwater for the longest period of time and which are exposed to air in this model? Record your observations on your Student Worksheet.

Student Reflection:

What are some of the benefits from living in the intertidal zone and what are some of the difficulties?

Tidal creates are a dynamic habitat, yet animals have many adaptations and behaviors that enable them to survive. Review with students these physical and behavioral adaptations with students and characteristics of the intertidal zone.

All organisms need habitats that provide food, water, air, shelter and space.
Appendix 1: Images from High Tide

High Tide at the Culvert

High Tide at the Pole
Appendix 2: Images from Low Tide

- Low Tide at the Culvert
- Low Tide at the Pole
Appendix 3: Dock Piling Model

Piling

- Spray zone
- High tide zone
- Intertidal zone
- Subtidal zone
- Mean Low Tide
- Mud

Mean Low Tide
Appendix 4: “Critter” Cards
Cut on dashed line & fold along the solid line

**Acorn Barnacle**
*Chthamalus fragilis, Balanus improvisus, B. trigonus, etc.*
**Location:** It attaches to hard surfaces in splash and high tide zones
**Food:** Filter phytoplankton and zooplankton when submerge.
**Behaviors, Adaptations, Characteristics:**
Barnacles, which are crustaceans like crabs, have 10 hairy legs to filter food and can close their valve tight to prevent drying at low tides.

**Atlantic Mud Crab**
*Panopeus herbstii*
**Location:** Crawls in mid intertidal to subtidal areas, hiding in damp places at low tides.
**Food:** Small oysters, worms, and crabs
**Behaviors, Adaptations, Characteristics:**
A crustacean with strong crushing claws, legs to hold on tight.

**Red Beard Sponge**
*Microciona prolifera*
**Location:** Attached to hard surfaces and shells where they are almost always wet.
**Food:** Filter plankton
**Behaviors, Adaptations, Characteristics:**
The sponge has a crusty texture that most animals don’t eat.

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**Ribbed Mussel**
*Geukensia demissa*
- **Location:** mid- to low intertidal zones
- **Food:** Filter Plankton
- **Behaviors, Adaptations, Characteristics:**
  Attach to marsh grass roots or solid objects with tough “byssus” threads, secreted by a gland.

**Eastern Oyster**
*Crassostrea virginica*
- **Location:** mid to low tide zone
- **Food:** Filter Plankton
- **Behaviors, Adaptations, Characteristics:**
  Attach to hard surfaces, often other oysters, forming clusters. They close tightly during low tides.

**Sea Squirt (Sea Grape)**
*Molgula manhattensis*,
- **Location:** low to subtidal
- **Food:** filter phytoplankton, zooplankton, oyster and mussel larvae, and other suspended organic materials through siphons. At low tide, they squeeze out water; this is why they are also called “sea squirts”
- **Behaviors, Adaptations, Characteristics:**
  Attach to hard surfaces in colonies
**Pale Anemone**  
*Aiptasia pallida*  
**Location:** mid intertidal zone  
**Food:** Stinging tentacles capture larval animals and even fish. Some of their cells contain symbiotic dinoflagellates that photosynthesize, providing more food for the anemone.  
**Behaviors, Adaptations, Characteristics:** Form dense colonies that help prevent desiccation at low tides.

**Sea Whip**  
*Leptogorgia virgulata*  
**Location:** low tide to subtidal waters  
**Food:** Capture plankton using tentacles  
**Behaviors, Adaptations, Characteristics:** Attach to hard surfaces and have a hard flexible covering for colonial polyps.

**Naked goby**  
*Gobiosoma bosc*  
**Location:** subtidal, staying along the bottom  
**Food:** shrimps, crabs, worms and amphipods  
**Behaviors, Adaptations, Characteristics:** They hide in crevices in oysters and sea squirts from predators.

**Sheepshead**  
*Archosargus probatocephalus*  
**Location:** subtidal, often found near oyster reefs and the pilings of piers, docks, and bridges  
**Food:** barnacles, oysters, mussels, small crabs, and shrimp  
**Behaviors, Adaptations, Characteristics:** Has several rows of stumpy teeth, which help to crush its prey.

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Appendix 5: SC DNR Life in the Saltmarsh Poster

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Figure 7. Water Line insert  Cut a Rectangle that include the Waterline
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Appendix 8 : Student Worksheet (Teacher’s Copy)

1. In the table below list the animals that which may be live in each zone:

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<th>High Tide Zone</th>
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<th>Subtidal Zone</th>
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<tbody>
<tr>
<td>Barnacle</td>
<td>Barnacle</td>
<td>Mud Crab</td>
<td>Mud Crab</td>
</tr>
<tr>
<td>Raccoon move in</td>
<td>Pale Anemone</td>
<td>Ribbed Mussel</td>
<td>Red Beard Sponge</td>
</tr>
<tr>
<td>and out</td>
<td>Raccoons and</td>
<td>Eastern Oyster</td>
<td>Sea Grape</td>
</tr>
<tr>
<td></td>
<td>birds</td>
<td>Mud Crab</td>
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<td></td>
<td>Eastern Oyster</td>
<td>Sheephead</td>
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<td></td>
<td>birds</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Sheephead</td>
<td></td>
</tr>
</tbody>
</table>

2. Why is the intertidal zone such a difficult place to live?
   The conditions in the intertidal zone are dynamic and constantly changing.

3. Select three abiotic or physical factors of the splash, intertidal or subtidal zones and describe special adaptations that allow animals to survive. Answers will vary.
   - **Air Exposure at low tide:** Marine barnacles have protective valves that close tightly to preserve moisture loss or desiccation until the tide submerges them again.
   - **Waves:** Oysters attach to hard surface. Other animals like crabs hide in crevices to avoid being moved by wave action.
   - **Temperature Changes:** many marine animals, like sheephead fish, avoid warm temperatures by moving to deeper water.

3. Identify your favorite tidal organism. Name: _________________________
   a. Draw its picture
      *Answers will vary*
   b. Where is this organism’s habitat?
      *Answers will vary*
   c. What adaptations does it have?
      *Answers will vary*
Focus Question: How do animals live in tidal habitats?

Student Worksheet

1. In the table below list the animals that may be live in each zone:

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3. Select three abiotic or physical factors of the splash, intertidal or subtidal zones and describe special adaptations that allow animals to survive. Answers will vary.

3. Identify your favorite tidal organism. Name: _______________________
   a. Draw its picture
   b. Where is this organism's habitat?
c. What adaptations does it have?

**Focus Question:** How do animals live in tidal habitats?

**Appendix 9: Background Information:**

*Text taken from “Of Sand and Sea: Teachings from the Southeast Shoreline” by P. Keener-Chavis and L. Sautter*

**Tidal Zones**

Marine zones near the shorelines are influenced by the tides—the periodic rise and fall of water. The major zones are the splash zone, the intertidal zone, and the subtidal zone. The splash zone is rarely submerged with water and typically receives only salt spray from the waves. Periodic submergence of the splash zone occurs during storms and occasional extreme high tides accompanied with high winds. The intertidal zone experiences the full effect of a tidal range, or the difference in the height the water between high tide and low tide, as it is completely submerged at high tide and completely exposed at low tide. Saltwater marshes, beaches, tidal rivers, creeks, sounds, and bays that are submerged during high tides and exposed during low tides are some examples of intertidal environments.

The subtidal zone remains submerged all of the time, with possible exceptions occurring during times of extremely low tides. Portions of saltwater marshes, beaches, saltwater rivers, sounds, bays, and tidal creeks that are submerged at low tide are located in the subtidal zone.