

Intertidal Investigations (Adapted from ELP Marine Team '08)

Time requirement: Minimum 1.5 hours in the field

Summary of Activity: This activity introduces students of all ages to the intertidal habitats of rocky shores while safely exploring tidepools. Using guided inquiry and structured group investigation, students will observe species living in this diverse habitat to make hypothesis about adaptations and interactions that are occurring in the community.

Concepts to Teach: Rocky shores, interactions and change, adaptations and survival, tidal cycles, community interactions, ecosystem balance.

Instructional Strategy: Guided inquiry, field experience

Standards addressed: Scientific inquiry

Goal: Students will better understand the inhabitants of Oregon's Rocky shores, by way of observation and guided exploration.

Specific Objectives:

By the end of this activity, students will be able to:

1. Explore tidepools in a way that is safe for themselves and the habitat.
2. Identify the dominant organisms in the tidepool ecosystem.
3. Explain specific adaptations of species living in the rocky intertidal by making scientific hypothesis based on field observations.

Vocabulary: Habitat, tides, intertidal, high tide zone/supralittoral, mid tide zone/midlittoral, low tide zone/infralittoral, biodiversity, predation, zonation.

Required Materials:

Clipboards & paper or field notebooks

Writing utensil

Proper raingear (it is often rainy and windy on the coast)

Extra warm layers

Proper footwear that protects the toes and can get wet (rubber boots work well as do old sneakers)

Field guides (laminated ones work well)

Digital camera (optional)

Data collection equipment (varies depending on project)

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Background

The coastline is very narrow margin between the land and the sea, but it is an incredibly rich **habitat** full of life. For thousands of years the rocky shores of the Pacific Northwest have been weathered by pounding waves and persistent tides. This action creates hollows and channels that hold seawater, providing a unique habitat for a variety of plants and animals. This lesson focuses on the ecology of

tide pools and factors that affect what organisms live there and where they live within the rocky intertidal.

Over time, the shore has seen changes with the gradual accumulation of sand and the slow degradation of huge boulders. The appearance of the coast changes even with the seasons. Summer brings calmer, smaller waves and more sand, while winter brings high waves that leave the coast respectively slightly barren. The churning of sand and rocks, and the explosion of large air bubbles creates the deep cracks, crevices, and holes that make the intricate rocky shore tidepool habitat.

The tidal patterns in the oceans are caused by the combination of the gravitational pulls from the sun and the moon. **Tides** are rhythmic and predictable changes in the height of the ocean relative to the land. Depending on where the sun and moon are during the month the height of the tides changes causing extreme spring tides every two weeks that alternate with more moderate neap tides. Within a 24-hour period, Oregon's coastline experiences diurnal tides, which means there are two high tides and two low tides in each 24 hour period. The periodic flooding and retreating of water creates tidal zones defined by the amount of water available to different parts of the **intertidal** habitat.

→ There are 5 specific tidal zones found on a rocky shore:

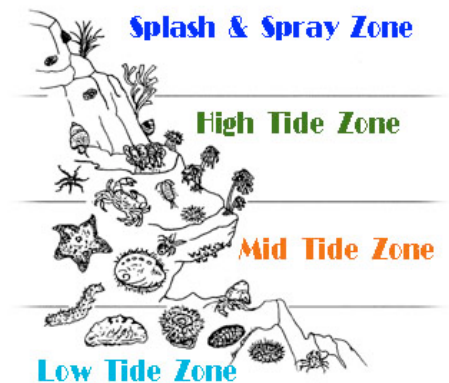
- Spray zone with little water
- High tide zone with water coverage 25% of the time
- Mid tide zone with water coverage 50% of the time
- Low tide zone with water coverage 75% of the time
- Sub tide zone with water coverage 100% of the time

Sometimes these zones are difficult to distinguish from one another as crossovers of species and narrow zoning can blur the lines. In this case it may be easier to look at the intertidal in 3 main zones that have representative plant and animal species.

→ These can be defined into 3 more general tidal zones/bands:

- **Spray/high tide zone (supralittoral)** where barnacles and limpets are highly prevalent.
- **Mid tide zone (midlittoral)** is home to many seaweeds, mussels, and hardy sea stars.
- **Low tide zone (infralittoral)** is inhabited by top predators like sea stars and fish.

Many different biological and physical factors influence the **biodiversity** of the intertidal. The main physical factors are wave energy and water loss. One main biological factor is predation. Other factors include salinity, competition, and recruitment. Each species exhibits different characteristics that make it fit for the harsh environment and protect it from predators. The sea urchin, for example,



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slowly scrapes a hole into the rock, which helps it escape the impact of the waves and predators. Sea stars and sea cucumbers have thousands of tiny tube feet that enable them to hold on tight to the rock. Barnacles are permanently attached with concrete it secretes by its glands when it first settles on the rock. Mussels hang on with some ability of movement with byssal threads. To avoid **predation** and to help catch food, the sea anemone's tentacles are loaded with harpoon-like stinging cells. Plants are also adapted. Algae have flexible stalks, can completely dry out and others like rockweed hold moisture throughout its leaves and stalk even when the tide is low.

In addition to biological adaptations, wave action, air exposure, and weather affect what organisms can survive in the harsh environment. Individual organisms have specific adaptations to dealing with these extreme conditions, but it is also important to look at how organisms have adapted to living and competing with each other in the intertidal. The rocky intertidal houses a large surface area of rocks, crevices, hollows and loose cobbles for plants and animals to survive in. With a diversity of habitats in the area there is a high diversity of species all interacting and competing for space to live. Intertidal inhabitants tend to organize themselves by the amount of time they can be out of the water and where competition will be the most minimal. This organization creates **zonation** within the intertidal habitat. Bands or organisms can be seen according to physical and biological factors that organize them.

Prerequisites

None.

Preparation

- Ideally students will visit a site that is nearby or within their local watershed. Preparation for this type of a field experience could last a variable amount of time depending on where the class will visit. Look at the "Field Trip Resources Guide" for more information on choosing a site.
- Students should be oriented to the field site prior to arrival. By showing students where the site is relative to their watershed they will have an idea how both ecosystems are connected. This allows for a richer experience in this diverse ecosystem by way of making comparisons and integrating additional field exercises.
- Read through the questions in the main activity of this lesson. They are designed to be a guide for the facilitator in the tidepools. They are organized in terms of high to low intertidal, but not all rocky shore systems are easy to explore in this format.
- The week prior to visiting a rocky intertidal site, students should be reminded to bring proper field attire. Tidepools are generally wet, slippery and they should be prepared for unfavorable weather as well as wet shoes. Suggest to students

that they bring extra shoes and socks or waterproof boots as well as extra layers for unexpected weather.

- Choose a classroom activity that will help familiarize students with this new habitat. Preparation can include reading stories, having students do research, exploring field guides, creating field guides, or doing a separate activity like “The Rocky Shores Survivors” (see extension activities).

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Lesson Procedure/Activity Description

Introductions and Safety Rules

Step 1: Safety introduction (5 minutes)

1. Before entering the tidepools, gather the group to talk about safety issues. It is a good idea to do this is at the top of a trailhead usually in front of a Rules and Regulations sign away from the beach and water to minimize distraction.
2. Review safety rules and tidepool etiquette slowly and thoroughly
 - a. Watch where you step. If it’s green, it’s slippery. If it’s brown, it’s slippery. If it’s grey or black, it’s slippery.
 - b. Gently giants! It’s okay to touch, but only use **one or two** fingers.
 - c. If you pry, it will die! It’s okay to pick things up, but if you have to pull to get it off a rock, it will die. So if it’s stuck, leave it there and use your eyes and fingers to learn.
 - d. Stay low and slow. The rocks are slippery. Take your time when climbing on the rocks and use your hands.
 - e. Please, turn over rocks, there’s lots of cool stuff underneath, but remember to **turn it back over**. Things that live on the top can survive on the bottom and vice versa.
We’ll use the two hand rule: “If both of your hands do not entirely cover the rock it is too big to turn over”
 - f. If you take something out of a tidepool, make sure you return it to where you found it: how would you feel if someone plucked you off the couch in your living room and put you in some strangers home a mile away? Or worse, didn’t return you at all, which leads to...
 - g. Don’t take anything home. Leave things there so the next people can enjoy them just like you did!

Step 2. Introduction to the tide pool habitat (10 minutes)

1. After walking to the edge of the intertidal area (a sandy beach or high intertidal area works well), gather the group so that everyone can see you without the sun in their eyes and so everyone can hear you over the wind

- and waves.
2. Ask students to look around from where they are standing. Ask them to describe what they see:
Q: what types of habitats do they see?
Q: Is the tidepool area relatively big or small compared to the sandy beaches or sand dunes along the coast?
Q: Is the water at high tide or low tide?
 3. Ask students to close their eyes to listen to the environment for a minute or so. Continue to have the students listening while telling a story of the tides and waves describing the impact they have and the cyclical nature of the phenomenon.
“Close your eyes and pretend your sitting on your living room couch enjoying a bag of popcorn and your favorite movie, when water starts leaking through under your front door. You tell your mom, and she tries to stop the water with towels, but it just keeps coming in. It’s starting to cover the entire floor of your house, so you put your feet up on the couch. But it doesn’t stop there! As the water begins soaking through the cushions on the couch, you stand up on the couch, trying to get away from all the water. Meanwhile your mom is standing in the doorway screaming in shock. It rises and rises until your holding onto the ceiling with your nose up in the last bit of air, gasping for each breath. The worst has happened! Your face is completely covered in water, and just as you think you’re a goner, the water level begins to subside, out and out in goes, until finally your living room is just a soggy mess.”
Now have students open their eyes
Q: Can you imagine how stressful that would be?
-Now imagine that happening two times a day for your entire life!! That’s pretty much what happens to the animals in the tidepools that you are about to see.
 4. Describe to students just how small of an area this type of habitat encompasses. It is one of the most intense small habitats they can visit because of the high diversity of animals and plants living in the small space. At low tide it is important to remember that these animals are “sleeping”; they are hunkered down and trying to survive the exposed conditions. This is why it is especially important that students are “gentle giants” in the tide pools.
 5. Have them repeat rules for proper etiquette in tidepools.

Main Activity - Guided Inquiry (about 30 minutes)

1. Remind students that they will be working together to explore and investigate the three main tidal zones and plants and animals living within them.

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2. Students should be encouraged to take notes and make observations while participating in the tidepool inquiry. Hand out clipboards and handouts (if applicable) so they can make observations to take back to the classroom. You can hand out respective laminated field guides to help students identify tidepool inhabitants as well. Remind students not to turn their materials into tidepool pollution.
3. Remind students of safety rules and etiquette to keep their eye on the ocean and watch for rising water levels and sneaker waves.
4. For the first 20 to 30 minutes student will be exploring the intertidal with the instructor and chaperones who are facilitating the guided inquiry. Leave time for free exploration. Give students a designated signal, like a whistle, to listen for when it is time to head back to the beach. Give boundaries so that students can always see you and you can see them. Remind students not to climb up on rocks or cliffs.

→ Begin by examining the splash/high tide zone. Ask students what they see living there.

Q: What types of animals do you see?

A: Responses could include acorn or gooseneck barnacles, limpets, periwinkles, black turban snails. Depending on the area ochre sea stars and California mussels could also be present.

→ Refer to the resources section for more information and stories on specific animals and plants in the different tidal zones.

Q: What plants do you see? Describe them.

A: Many plants inhabit the upper zones of the tidepools because there is much less competition for space. You may see lots of sea lettuce that is thin, bright green (and very slippery). It can survive in the high tide zones because it able to dry out and re-hydrate when the tide comes back in. Also common in the upper zones of the intertidal is rockweed. It is small brown algae with little balloon floats on the ends.

-Describe to students the relative amount of water the inhabitants in this zone are exposed to in a 24-hour period.

Q: What challenges could this present to the animals and plants here?

Answers could include difficulty staying wet, not getting too hot from the sun, predation from birds (black oyster catcher or gulls) or other land animals. It is important to understand that these animals are some of the few that can survive the extreme conditions but that they may not be able to survive the predation or competition for space at a lower zone.

Q: What would maybe happen if these same creatures lived in the low or subtidal areas? Can they? What types of challenges would they be presented with?

A: Remember that most of the intertidal plants and animals can live under water 100% of the time. The zones are created mostly based on competition and predation from other inhabitants. Some plants, like sea lettuce, however could not live very low in the subtidal as they need adequate sunlight.

Q: How might you find this out?

A: This is a great opportunity to have students come up with ideas for inquiry projects. Have them record their ideas and observations for later use or the instructor or chaperone may choose to record them.

→Next move to a mid-tidal zone occupied by many seaweeds and animals.

-Have students describe what they see.

Q: What is different between this zone and the high tide zone?

A: This area has much more water available to it during the day as it is always covered up at high tide. Students may notice the increase in biodiversity and that rocks are more covered by plants and animals. Space competition increases due to this zone having more water. Predation from other tidepool inhabitants becomes more apparent as well.

Q: What do you notice about the plants?

A: The plants here are bigger and more plentiful. Here students can begin to see eel/surf grass, which is the only truly flowering plant in the intertidal. It is most related to land grasses like wheat that makes our bread and cereal. Also bigger kelps may begin to appear like sea palms that are attached to the rocks by strong holdfasts to deal with strong wave action.

Q: What animals do you see here?

A: Here students will begin to see many sea anemones. There are three types that may be seen: giant green anemones, aggregating/cloning anemones, and brooding anemones. The presence of California mussels will mainly be at the top end of this zone and also ochre sea stars will be more numerous as they feed on the mussels. Here you can begin to see chitons of all varieties with the gumboots being the largest (and easier to pick up) and smaller species include lined chitons and mossy chitons, which are often found on the underside of rocks or in shaded areas.

Q: Why is there an increase in diversity?

A: There is more water available to the inhabitants. The more animals and plants that can live there, there is more food available to eat! (more competition, predation etc).

Q: Do you see the same animals here as there were in the high tide zone?

Now is a good time to ask students if they can see the zonation bands

A: Sometimes yes you can, depending on the space available. Barnacles can

live lower in the tidal zones, but don't most of the time due to competition for space. In the mid tide zones barnacles grow to be much bigger and are often found within patches of mussels. They move in after mussels get eaten or waves break them off.

-This is an excellent opportunity to flip over a smaller rock to see what is living on the protected underside. Have students turn over a couple of rocks and point out different species they see. Remind students to flip rocks back over and leave them exactly as they found them.

-Seaweeds provide excellent protection for animals as well. It is appropriate to lift up large kelp blades or move eelgrass to see what is hiding amongst the vegetation.

-Find some shells out of the water. Students can pick them up as well.

Q: Are these still snails or something else?

A: Depending on what the opening looks like it could be either the original snail or a hermit crab. Talk about how hermit crabs get their shells.

Q: Do hermit crabs fight to get their shells or do they scavenge for them? How could you test for this?

Q: Why would animals living in eelgrass?

A: The plants make a good shelter for animals in this zone, protecting themselves from the sun and using it for camouflage from predators.

Q: What other animals do you see protecting themselves?

A: One good example is anemones that hold onto bits of shell, rocks and vegetation to keep the sun off.

Q: Why might these animals do this?

A: Answers could include protection from the sun or camouflage.

→ Low tide zones can be found near the edge of the tidepool habitat or in large tidepools. Here organisms that prefer to be dry part of the time won't be found as much, while others who like to be wet more often begin to dominate the tidal zone. Top predators like fishes and sea stars can be commonly seen here along with plant eaters like urchins and sea anemones. This is the richest zone for biodiversity because these areas are only exposed at the lowest low tides

-Ask students to describe what they see.

Q: What is unique about this habitat?

A: Answers could include that it has some animals from the upper and middle tide zones along with some new ones, or that there is a lot of water that forms deep tidepools.

Q: What types of conditions do low intertidal zone inhabitants have to deal with?

A: Answers could include heavy wave action and more space competition. Ask students to look around and observe the inhabitants they see. Look for examples of feeding, competition for space, possible predation.

Q: What animals do you see in the pools that you saw in the other zones out of water?

A: Sea anemones are great in this example as they are very different looking when their tentacles are out in the water ready to catch some dinner. Answers could also include more sea stars (but maybe different species like the sunflower star with up to 24 legs), also students can probably find hermit crabs in the pools as well as in mid tide zones. Hermits are scavengers so they can find food in either area.

Q: What other animals do you see in this low tide zone? Have students watch very calmly to see if anything else starts to move and it will help them to see more animals.

A: Students may be able to see sculpins, ribbon worms, animals hiding in or under kelp plants, chitons or nudibranchs feeding on sponges. You could ask students to take a closer look at the sponges and coralline algae living in the water, ask whether they are plants or animals and introduce stories to them about them.

Q: Could these same animals survive at higher levels? How could we test for this?

A: Some animals like anemones can survive at higher levels, but probably would have a harder time finding food and would grow much smaller. Ochre sea stars can also be found at higher levels.

Q: Look at the higher zones, are there any of ____ living there? Why?

Q: What do you see down here that you didn't up there?

A: The organisms may need more water than is available in the upper zones. Tidepool sculpins certainly won't be found at high tide, but anemones and some sea stars can survive at higher levels.

Depending on availability of time for the field experience students should have time to explore the area freely while still following the guidelines given earlier. Give a set time limit or signal, like a whistle, to round students up.

Conclusion:

At the end of the free exploration time period allow about 10 minutes for students to gather at the designated area, either in the high intertidal or on a sandy beach to minimize distraction. Have students form a circle and respond to the following question: **What was the most interesting thing you found in or around the tidepools?**

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Use the interests of the students to review what happened on the field experience. These reflections are often interesting and lead to questions and further investigation of relationships and adaptations found in the rocky intertidal.

Adaptations & Extensions

Before going on the fieldtrip, have students use the internet and books to find out about the main inhabitants of Oregon's rocky intertidal. Students can be challenged to create field guides for the trip based on research or activities done in class.

Depending on the age and skill level of the group have students be responsible for teaching their peers in the class or in the field. Students can choose specific organisms to investigate and share what they have learned.

You may choose to use visual media to learn more about the animals and plants found in Oregon's rocky intertidal zones. By learning in the classroom how to identify such creatures, time can be spent in the field doing inquiry projects in small groups or collect data as a full class to later be analyzed. Projects utilizing quadrats and transect lines to collect data within and between intertidal zones can provide some outstanding data leading to many levels of inquiry.

Have students build a food web made up of animals and plants they observed or learned about while on their field experience. This idea can be expanded from the rocky intertidal community to the watershed depending on skill level of the group.

Additional Resources:

Vocabulary

Habitat – the specific environment in which an organism normally occurs that provides food, water and shelter.

Tides – The twice daily rise and fall of the sea level caused by gravitation forces of the earth, moon and sun combined.

Intertidal – the part of the shore between the high tide mark and low tide mark.

High tide zone/supralittoral – The area exposed to for 75% of the tidal cycle dominated by limpets, barnacles and mussels.

Mid tide zone/midlittoral – The area exposed to air for half of the tidal cycle, dominated by crabs, sea stars and smaller alga.

Low tide zone/infralittoral – The area exposed only 25% of the time to air, dominated by large brown algae.

Biodiversity – the diversity of plant and animal life in a habitat

Predation – the act of preying by a predator who kills and eats the prey

Zonation – An arrangement or distribution of things into zones