# THE INTERTIDAL ZONE

Bullfrog Films
Oley, PA 19547

"One foot in sea, and one on shore:
To one thing constant never."

Shakespeare

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# THE INTERTIDAL ZONE

## Study Guide
## by
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Introduction and Post Viewing Questions (1-4)
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**PURPOSES OF THE FILM.**

- To illustrate the geodynamic forces that create the intertidal zone environment.
- To introduce the biology and ecology of the intertidal zone.
- To examine organisms' special adaptations needed for existence on a rocky shoreline.
- To investigate life cycles and food chains where land and sea merge.
- To recognize that people are part of the tidal food chain and realize the responsibilities of human interactions with the intertidal zone.

## INTRODUCTION

The surf comes thumping in to the west coast of Vancouver Island, British Columbia, with all the muscle of 3,000 miles of North Pacific behind it. It rolls in over the outer reefs, curls elegantly, and crashes onto the beach. It flows back, hissing and bubbling through the million little channels between the rocks and the seaweed. Then the next wave comes rolling in behind it, and the next, and they both smash down on the intertidal zone.

The zone is the vertical stretch of beach that is covered by the sea between high tide and low tide. It is a very rich place for the plants and animals that try to live there. Look down into a rock-pool and you will see a waving jungle of seaweed, and rocks covered with improbable animals: mussels, limpets, and barnacles; starfish, sea-urchins, and anemones' tentacles. They hang on to the rocks for dear life, with their spines and suckers and cemented fibers and everthing they have, as the surf surges around them and tries to suck them back to sea.

The advantage of living between the tides is that the sea automatically brings in a surge of food twice a day: the detritus of rotting seaweed, and tiny, swimming zooplankton shrimps. This is the rich soup that feeds everything in the intertidal zone. The detritus fertilizes the phytoplankton - the tiny, drifting plants of the open ocean. These gradually take hold on the rocks, and the limpets mow their way slowly through lawns of green diatoms. Higher up the food chain, barnacles reach out with a fisherman's net of feathery tentacles, sweep up every particle of zooplankton in range, and drag it back into their shells. Higher still, the shoals of Pacific herring move inshore on the flood tide, gulping and swallowing, and filter the zooplankton through their gills. The sealions that follow the herring are faster and less discriminating. They race through surf above the intertidal zone, snapping at everything that moves.

When the sea withdraws on the ebb-tide, the surf is still crashing in from the Pacific, and the spray still flies over the intertidal zone. But the rock pools are beginning to dry out, and the endless rain along the outer coast of British Columbia dilutes the pools with too much fresh water. The anemones, barnacles and sea-urchins simply close up, and wait helplessly for the sea to come back again. They are very vulnerable. A new set of predators from the land - gulls, raccoons and shorebirds - forages for them among the stranded seaweed, and tries to pry them off the rocks. But, after 12½ hours, the tide begins to flood in again. Then the barnacles and the anemones expand in the first flush of salt water like flowers in the spring rain.

The intertidal zone is battered by the surf, driven by the tides, and perpetually dragged between the land and the sea - all day and EVERY day. It ought, in theory, to be a temporary refuge for living things, nothing more. Oddly enough, as you can see, it's remarkably stable and well-adapted ecosystem.

## SUGGESTED TEACHING ACTIVITIES

Pre-Viewing Activities

1. Discuss the ocean tides and the forces that create them. Identify the intertidal zone. Does the range of tides vary along different coastlines? At other times of the year?
2. Discuss the making and breaking of a wave. Compare the angle of wave attack on a rocky coastline to that on a sandy beach. Study wave action in a wave machine or a bucket.
3. Study the taxonomy and structure of marine organisms.
4. Discuss structural and functional adaptations of animals.
5. Study the basic principles of food chains or webs. Sketch or diagram a simple, familiar land or freshwater

food web. Identify each organisms' role as producer, grazer, predator, scavenger, or decomposer. After viewing the film, make a list of organisms, identify their function and draw a web of the intertidal marine organisms. Compare both webs.

Questions for your intertidal zone food web: Where are the primary producers in the web? What happens if you remove one? Where are the primary consumers in the web? What happens if you remove one? Several?

Does a disturbance at certain levels of the web result in a greater change than disturbances at other levels? Explain this. How does the complexity of a web affect its susceptibility to change? How do you explain this?

6. Make a list of at least ten seafood items. Which ones are your favorites? Complete your food web by adding the human consumer.

7. Explain the impact of mankind on the environment and on marine ecosystems.

## POST-VIEWING QUESTIONS

1. Do you remember how plants and animals stick to the rocks when the surf comes pounding in? How does the sea-palm do it? Choose three animals in the intertidal zone. How do THEY cling to the rocks?

2. Name two predators that come into the intertidal zone at high tide, and two at low tide. What do they eat?

3. How do limpets, sea-cucumbers, sea-stars and hairy-gilled worms feed? What do they eat? And how do they eat it?

4. How many gallons or litres of water does a mussel have to filter every day to get its ration of food? Why does this system sometimes go wrong - and why do mussels sometimes become poisonous?

5. In addition to light, matter is required for photosynthesis. List what factors account for the abundance

of life along the intertidal zone. In what ways can the productivity of the intertidal zone be limited?

6. The existing tidal cycle and pattern directly influence many physical factors that in turn affect an intertidal animal's ability to successfully adapt and survive. Discuss as many of these physical factors as you can in relation to their influence or effect upon the animal.

7. Identify possible disruptive forces (e.g. red tide, pollution) and discuss their effects on the intertidal zone. What organisms in the food web do they effect?

8. Do an "Organism Interview." Have each student choose an organism from the film and complete the following interview:

   - How would you describe yourself? Are you a plant or an animal? How would you classify yourself: Phylum, Class, Order, Family, Genus, Species.
   - Describe your life. Where do you live? How do you get around? What do you eat and how do you obtain it? How do you reproduce? When are you most active and when do you rest? Is there anything "special" about you?
   - How do you deal with your problems of wave action, tidal action, salinity changes, temperature changes and enemies?
   - How do you get along with your neighbors? Ask the person next to you what he is and discuss your relationship to him. How do you get along with humans?
   - Speculate what the future of your species might be. What are some possible changes that would affect your species?

## FOR THE LABORATORY

1. Compare different rates of water loss by evaporation. Take four identical glasses and put the same amount of water in each one, marking the water level in each. Put

the first in a cold place. Put the second in a warm place. Leave the third at room temperature, but cover the top with a piece of cardboard. Leave the fourth at room temperature, but pour a thin layer of cooking oil on top of the water. Leave all the glasses for a week, then measure the depth of water loss below the initial mark. Which glass lost the most water? Which one lost virtually no water? What does this experiment tell you about life on the seashore?

2. Observe diatoms through a microscope. They can be found in diatomaceous earth or collected from the sides of aquaria where they form a brownish growth. Where are diatoms located in the food web? Are there any commercial uses of diatoms?

3. Watch a filter feeder eat. Obtain a mussel or other bivalve and watch how it anchors itself in the aquarium. Using an eye dropper, put some drops of food coloring near it and observe what happens.

4. Obtain a starfish from a petshop. Place it in an aquarium with sandy or loose soil and watch how it moves. Now place it in an aquarium with rocky or hard surfaces and watch how it moves. Observe how it eats by placing a piece of shellfish, small clam or mussel near it.

## FOR THE FIELD

1. Identify the intertidal zone. Look for a sharp upper line of seaweeds, barnacles or mussels fouling sea walls, pier supports or other man-made structures. Find out the time of high water and of low water by looking in local tide tables. Time how long the upper zone is covered by the sea and how long it is exposed to the air. Study the distribution of barnacles or limpets in relation to tidal levels.

2. Make a check list of the different groups of animals which live under boulders. Down the left-hand side of your page, list tube worms, sea-mats, sea squirts, crabs, cowries, sea slugs, sea spiders, chitons and topshells.

Turn over a few boulders very carefully and quickly examine the different kinds of life present under each boulder. Use the check list to record your finds. What adaptations have these animals made to their life under boulders? You can do a similar investigation of animals associated with seaweeds.

3. Find a small stone to which live barnacles are attached. Transfer the stone to a transparent box filled with sea water, or a shallow pool, and observe the way a barnacle combs the water with its limbs. Take the temperature of the water and time the feeding rate. Transfer the stone to a warmer or colder pool. Note what happens to the feeding rate.

4. Visit a sheltered shore on a warm, sunny day with a thermometer and a book of pH papers. Take the temperature and the pH of the water in the pools at different shore levels. Sketch the shore so that the pools can be found at a later date. Return to same area on a cold, overcast day. Take the temperature and the pH of the same pools. Compare the pairs of readings for each pool by plotting them on graph paper. Explain any differences between the pairs of readings.

5. Carry out a "five senses pollution search" affecting the intertidal zone. Ask the students to go on a "pollution search" attempting to identify the various kinds of pollution representing each of the major human senses, sight, touch, hearing, taste, smell (with a sixth group for other "senses" or perceptions). For example, litter (sight), jet plane (hearing), engine exhaust (smell). This can be done over a period of time spent both in and out of school in "searching." As the list is constructed some discussion topics might include: How some things represent pollution to one person or group of people and not to others; How types of pollution are both similar and different to each of the others. With each type of pollution consider health of humans, wildlife, and plant life; the national economy; and international relations.

## GLOSSARY

**Abalones** - marine snails characterized by their flat dish-like shells, which are iridescent on the inside.

**Adaptation** - the mutual fitting of structure, function and environment.

**Algae** - the predominant plant forms in the ocean and the producer organisms in the marine ecosystem. Included in this group are red, green and brown algae and also phytoplankton life forms.

**Bacteria** - group of unicellular, microscopic organisms combining both animal and plant characteristics. They are mostly decomposers releasing trapped nutrients back into the food chain.

**Barnacles** - small crustaceans that attach themselves to rocks, pilings, ships, etc.

**Comb Jelly** - a tiny free swimming animal with eight longitudinal rows of ciliary combs.

**Detritus** - particles of debris from decaying plants and animals.

**Diatoms** - microscopic, singled-celled algae with cell walls of silica.

**Filter Feeder** - marine animal which feeds by straining off small organisms from water.

**Food chain** - chain or organisms which feed successively on each other, e.g. plant (primary producer) → herbivore → carnivore.

**Giant Sunflower Star** - the largest, most active sea star on the Pacific Coast, reaching a width of 52".

**Grazer** - the herbivores or plant eating animals.

**Hairy-gilled Worm** - a detritus feeder with bristles along its body which aid in feeding.

**Intertidal Zone** - area between extreme high and low tide marks.

**Limpet** - a grazing mollusk which is found in tidal regions of rocky shores.

**Mussel** - a bivalve mollusk that fastens itself by means of tough byssal threads secreted by a gland in its foot.

**Plankton** - small floating or drifting plants (phytoplankton) and animals (zooplankton) of the sea.

**Predators** - specialist feeders which obtain food by killing and consuming animals.

**Producer** - any organism which can manufacture its own food.

**Purple Sea Urchin** - these echinoderms of rocky shores when found above the low tide line often live in rounded depressions in the rock, which they slowly erode with their teeth and spines.

**Sea Cucumber** - an echinoderm which resembles a hollow tube with an opening on each end, a mouth and a vent.

**Sea Lion** - large mammals and predators of the marine environment.

**Sea Palm** - a Pacific marine plant found on exposed portions of the outer coasts. Its distinctive appearance resembles a small palm tree with a thick flexible stalk and anchored by cemented holdfasts.

**Sea Star** - various species of marine echinoderms also known as starfish and brittle stars.

**Sea Urchin** - a marine echinoderm with a surface that is typically covered with bristling spines.

**Scavenger** - animal feeding on carrion.

**Snail** - a grazing mollusk of the tidal zone.

**Tides** - the rhythmic, worldwide rising and lowering of sea level, along most coastal areas, occuring twice daily in response to the gravitational attraction of the moon and sun.

## REFERENCES AND FURTHER READING


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Brown, Vinson, **Investigating Nature Through Outdoor Projects,** Stackpole Books, Harrisburg, 1983. Contains activities with seashore animals and instructions for setting up a sea aquarium.

Carson, Rachel, **The Edge of the Sea,** Houghton Mifflin, Boston, MA, 1955.

Durrell, Gerald, **The Amateur Naturalist,** Alfred A. Knopf, New York, 1982. Contains explorations with rocky shores, smooth shores, cliffs, dunes and coastal wetlands.

Gross, Phyllis, **Teaching Science in an Outdoor Environment,** University of California Press, Berkeley and Los Angeles, CA 1972. Contains activities exploring a coastal area, food chain game, and food chain and food web studies.

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Sumich, James L., **An Introduction to the Biology of Marine Life,** William C. Brown, Dubuque, Iowa, 1976.

## FURTHER READING

Most Highly Recommended

Gross, M. Grant, **Oceanography: A View of the Earth,** Prentice-Hall, Englewood Cliffs, NJ, 1987.

Other textbooks for high school and first-year college students:

Anikouchine, William A., and Sternberg, Richard W., **The World Ocean: An Introduction to Oceanography, (Second Edition),** Prentice-Hall: Englewood Cliffs, NJ, 1985.

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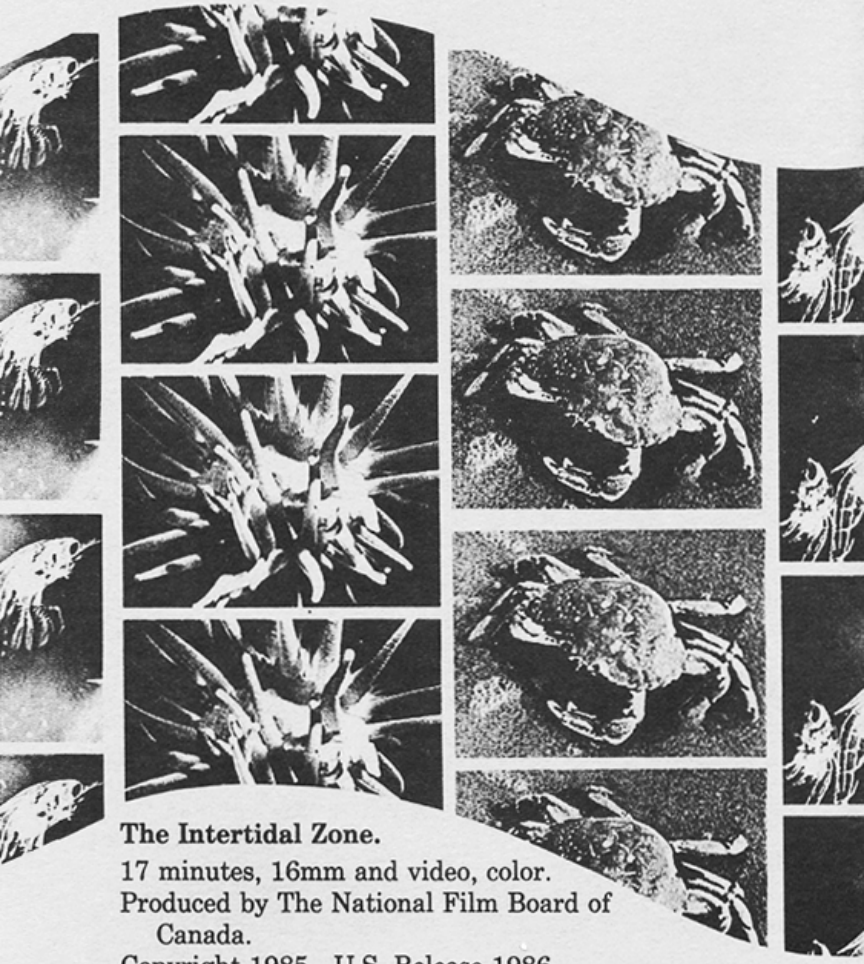

**The Intertidal Zone.**
17 minutes, 16mm and video, color.
Produced by The National Film Board of Canada.
Copyright 1985. U.S. Release 1986

This highly informative film is a basic analysis of the ecology of the intertidal zone, that area covered by the highest tides and exposed during the lowest.

The many special adaptations to this difficult environment are detailed with some stunning visual materials.

We see life cycles and food chains from land and sea merge where these two environments overlap, in the intertidal zone.