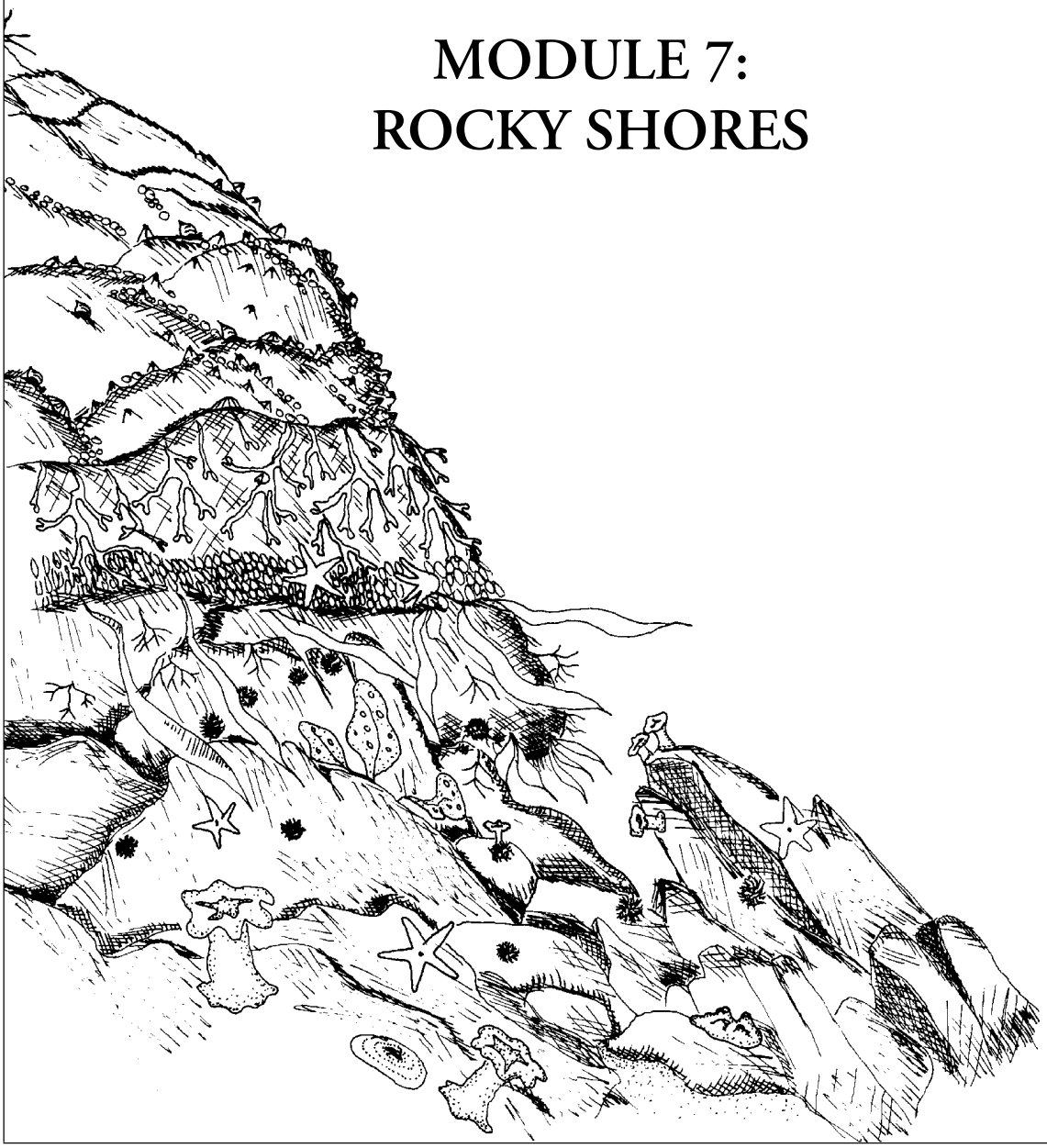
BY THE SEA

A GUIDE TO THE COASTAL ZONE OF ATLANTIC CANADA

MODULE 7: ROCKY SHORES



Canada

ACKNOWLEDGMENTS:

FUNDING: Department of Fisheries and Oceans, Environmental Partners Fund of Environment Canada

COORDINATORS: Roland D. Chiasson, Sabine B. Dietz

COORDINATORS, DFO: John A. Legault, Sophie Bastien-Daigle

MAIN AUTHORS: Mark Butler, Roland D. Chiasson, Richard W. Daury, Susan Dean, Sabine B. Dietz, Nancy MacKinnon, Jamie Steel

CONTRIBUTING WRITERS: Léon Lanteigne, Irene Novaczek EDITING: Anne Champagne (English)

LAYOUT: Sabine Dietz, Roland Chiasson

GRAPHICS: Sabine Dietz, Ursula Koch, Elke Leitner, Jean-Raymond Gallien (used with permission from the N.B. Department of Natural Resources and Energy)

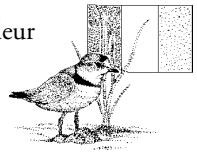
Comments and suggestions from the following people are gratefully acknowledged:

Diane Amirault, T.C. Anderson, Sophie Bastien-Daigle, François Bélanger, Mark Bonan, Yves Bourassa, David Boyce, Alyre Chiasson, Harry Collins, Simon Courtenay, Rosemary Curley, Ted Currie, Jean-Yves Daigle, Adrianne Dorrington, Ernest Ferguson, Phil Ferraro, John Foley, Christopher Hawkins, Denise Henson, Peter Hicklin, Bob Hooper, John A. Legault, Claude Léger, Maurice LeRoy, Allison M. Lowe, Don McAlpine, Mark McLean, Inka Milewski, Randy Milton, Michelle Parsons, Jon Percy, Jim Petrie, Terry Power, Rob Rainer, Lisa Richard, Pierrette Robichaud, Anne Senechal, Tom Sephton, Wendy Skeard, Bruce Smith, Rick Swain, Jacques Thibault, Jackie Waddell, Heather Walters, Judy White.

Également disponible en français.

Fisheries and Oceans / Pêches et Océans

Piper Project/Projet siffleur
4800 Route 11
Tabusintac, N.B.
E9H 1J6



Department of Fisheries and Oceans
Habitat Management Division
343 Archibald Street
Moncton, N.B.
E1C 9B6

ENVIRONMENTAL PARTNERS FUND
Environment Canada / Environnement Canada
PARTENAIRES DE L'ENVIRONNEMENT

Prepared by: Corvus Consultants Inc.,
Tabusintac, N.B., Canada

Cat. no. S-23-289/1996 E ©1996
ISBN 0-660-16410-8

THE MODULES

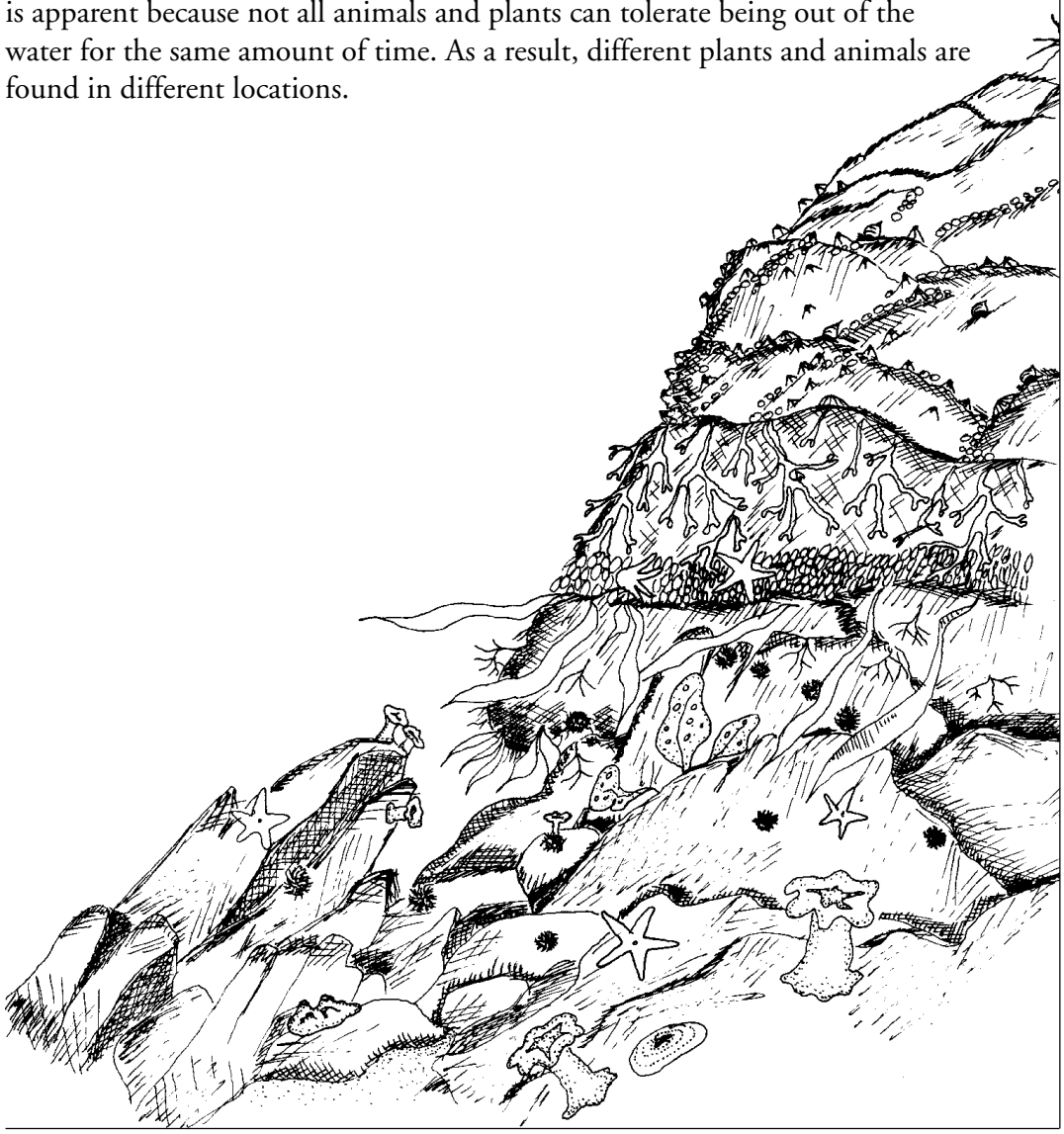
TABLE OF CONTENTS

ROCKY SHORES

What is a Rocky Shore?

Although there are a variety of coastal ecosystems throughout Atlantic Canada, the most common is the rocky shore. The rocky shore is just as its name implies, for the most part bedrock and a combination of large boulders and cobbles. The type of rock, its hardness, slope, and orientation vary from place to place, creating many unique situations. A number of physical characteristics and biological interactions result from these situations.

Common to all rocky shores is 'zonation' or banding. As the tides recede they uncover the shore and leave it 'dry.' It takes approximately six hours for the tide to go out and six hours for it to come in. So the length of time a particular part of the beach is uncovered depends on its location. The top of the beach is dry for the longest time, the bottom of the beach the shortest. Banding or zonation is apparent because not all animals and plants can tolerate being out of the water for the same amount of time. As a result, different plants and animals are found in different locations.

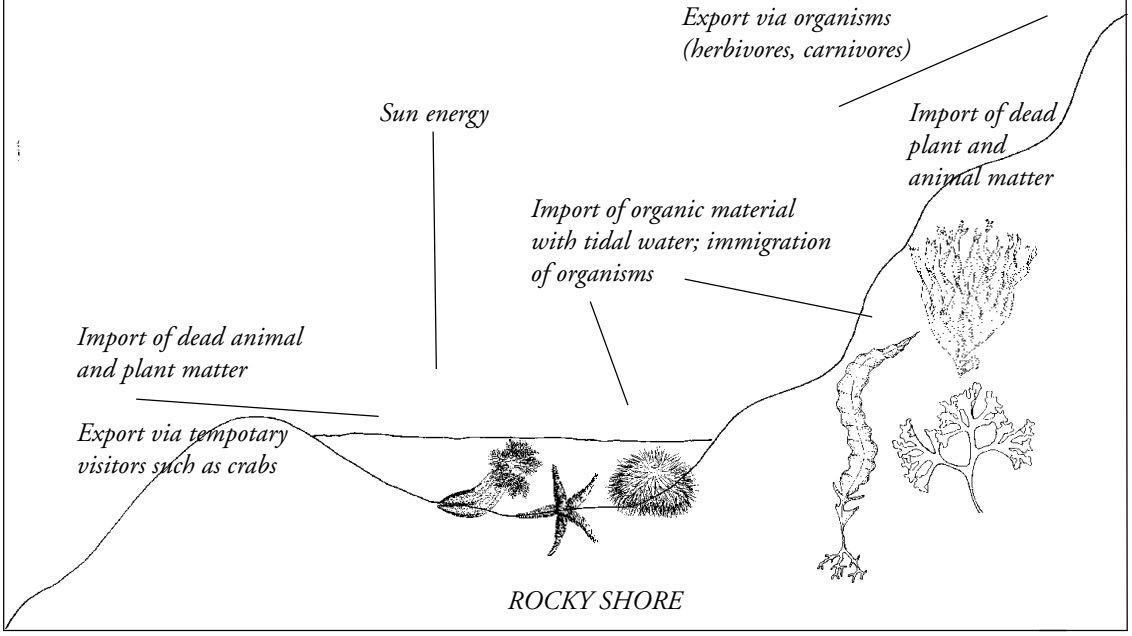


The Rocky Shore within the Coastal Zone

The rocky shore is a source of nutrients and sediments for other coastal ecosystems. Currents move nutrients out of the rocky intertidal area (the area between the high tide and low tide levels) through the transport of plants and animals, both whole and decomposed. Animals also transfer nutrients via food webs. Many animals that frequent the rocky shore do so at high tide. They come looking for food. What is eaten may find its way to other coastal systems through waste products.

The combined work of wind, waves, and currents removes materials from a rocky shore and deposits them elsewhere. Rock may be broken down and transported away by waves, currents, and ice. Sediments may be picked up and carried in similar fashion.

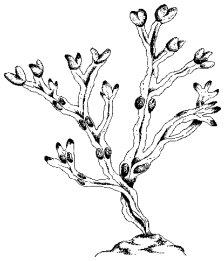
Energy transfer in a rocky intertidal system



Location

By and large, rocky shores are located in high energy coastal environments. They are exposed to wind, waves, storms, tides, and currents without any protection. Rocky shores are commonly found in many parts of the Bay of Fundy, most of the Atlantic side of Nova Scotia and Cape Breton, much of the north shore of the Gulf of St. Lawrence, and almost all of Newfoundland. The daily rhythm of the tides in Atlantic Canada alternately covers and exposes an expanse of rocky shore greater than anywhere else in the world. As a result, our rocky shores provide us with the ability to observe, study, and analyze a great range of biological, ecological, and geological relationships.

Major locations of rocky shores in Atlantic Canada



THE PHYSICAL ENVIRONMENT

Formation

How have rocky shores been formed and how are they changing? The nature of the coast is determined by contemporary physical processes such as waves and currents, and historic geologic processes that have occurred over extended periods of time. These processes give the coast its basic structure. The whole coastal zone of Atlantic Canada displays features that are the result of present-day processes. However rocky shores are more directly linked to historic geologic events.

Physical Characteristics

Rocky shores create unique situations in which the relationship between the nature of the rocky shore itself and a number of abiotic (physical) factors is played out. The effects of wind, ice, temperature, waves, currents, tides, salt, and sediments are all very different on rocky shores than in other coastal ecosystems. All of these have direct and prolonged effects on the physical and biological aspects of the rocky shores.

Currents

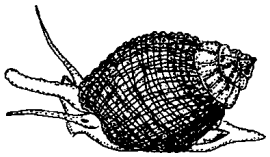
Currents erode the weaker rock and then transport it to lower energy environments, such as beaches and mudflats, where it is deposited. Currents also remove living organisms attached to rocks, which exposes more of the rock's surface area and so in turn allows the rock to be more easily broken down. The moving water associated with currents can also act as a transport mechanism for nutrients, distributing them along the shore or offshore.

Formation

The rocky shores in Atlantic Canada can be classified as primary coasts. Their major structural characteristics have been determined by land-based processes such as erosion, deposition, volcanic, or tectonic processes (changes caused by land movement). Much of the rocky coastline in Atlantic Canada has been created by glacial activity and tectonic forces.

Many organisms living on the rocky shore are dependent on currents. Some rely on coastal currents as a part of their reproductive strategy, moving gametes (reproductive cells) from the harsh intertidal area to more moderate offshore conditions.

Dogwinkle



Ice

Most rocky shores in the Maritimes are not affected by ice to the same extent as the sedimentary shores of beaches and mudflats. The moving water limits the formation of ice. Nevertheless, localized pockets of ice will form on rocky shores. This ice scours exposed rock and expands in the many cracks in the rock, enhancing its breakdown.

Ice can also remove organisms from rocky shores.

Salt

Although it is everywhere and the organisms that live on the shore have evolved specific mechanisms to deal with it, salt can play a role in altering the dynamics of the physical environment. High concentrations of salt can, for example, facilitate the breakdown of rock.

Sediment

On the rocky shore, sediments are created from the breakdown of rock or brought in by currents and waves from adjacent ecosystems such as rivers. Sediments change the physical character of the shore in subtle ways. For example, they act as a scouring agent in association with waves and currents and work to erode rocky surfaces over prolonged periods of time.

Temperature

The constant heating and cooling of rocky shore surfaces is a dynamic process. Extreme temperature fluctuations are thought to be a major contributor to the changing face of the shore; just as freeze-thaw cycles in mountain environments break down mountains, the same cycles work to break down beach rock. High temperatures heat up exposed rocks and change the temperature of incoming water. This creates unique localized conditions and has an effect on the ecology of the shore. Tide pools that are isolated from the ocean at low tide can experience extreme temperature variations.

Tides

The area between high tide and low tide is classified as the rocky intertidal zone.

Tides of varying amplitude will create varying intertidal characteristics. A larger tidal range creates a wider rocky shore and a greater area over which physical factors can act.

Tides create local current patterns. The water of an ebb tide, combined with the hard structure of the shore, leaves pools of water standing at low tide. These tide pools are unique in that they provide a haven for many organisms.

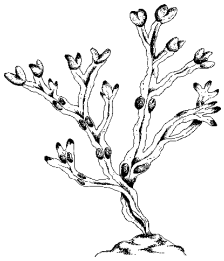
see activities 4, 14

Waves

Waves are the primary force acting on rocky shores. As most rocky shores are in exposed locations, waves constantly sculpt and reshape the coast. Eroded material from the shore is transported away by waves, as are animals and plants that lose their grip. Waves also mix water, enhancing its oxygen content.

Wind

Wind has both direct and indirect effects on the rocky shore. Indirectly, wind creates waves and currents. Directly, wind works to modify the temperature and to dry out surfaces. During the winter, wind lowers air temperatures, aiding in the formation of ice and, as a result, the breakup of rock. In summer, wind evaporates water, drying out shore vegetation. As shore vegetation dries, it is more easily removed from its substrate.



BIOLOGICAL FEATURES

Who Lives Where?

Zonation

One of the most striking features of a rocky shore is its pattern of zonation. Zonation refers to the regular appearance of specific plants and animals at specific places along an intertidal area, the area that lies between the low and the high tide mark.

see activities 6, 13, 15, 17, 18, 19, 20, 21, 21, 24, 25, 26, 27, 28, 29, 34, 41

Zonation may be noticeably different from one location to another. In Newfoundland for example, where there is a regular pack ice cover, this pattern is very different from the Bay of Fundy. Although a pattern of zonation might not be present in Newfoundland to the same extent as in the Bay of Fundy, all rocky shores possess the same general features.

Rocky shores generally display three basic zones characterized by the central plants and/or animals occupying them. On the following page five zones are shown, which represents a further subdivision of the three zones. This type of zonation is observed in the Bay of Fundy.

The pattern of zonation and the daily rhythm of the tides have made rocky shores interesting and relatively easy habitats to observe and study. This is especially true in coastal areas that experience extreme tidal ranges, such as the Bay of Fundy.

Ideas

The idea of universal zonation was first developed by two English marine biologists (J. and A. Stephenson), who travelled the world studying intertidal habitats. They found this pattern repeating itself on all rocky shores. Two of their test sites were here in Atlantic Canada, on the Nova Scotia shores of the Bay of Fundy and on Prince Edward Island. Using this system of zonation as an organizational tool is one way to introduce and become familiar with the animals common on rocky shores of our region.

Spray or Splash Zone

The point where land ends and the sea begins is difficult to pinpoint. From the land we see a transition from land-based vascular (seed-bearing) plants to an assemblage of lichens. It is interesting to note, however, that the land plants are often examples of things not found elsewhere, like the Seaside-Plantain. They, like all of the plants and animals of the coast, have evolved special adaptations to survive in an ecosystem of extreme conditions. This highest band is known as the spray or splash zone.

Black Zone

An extreme high tide mark (one which feels the influence of saltwater only every two weeks) is characterized by a patchy encrustation of black lichens, a few Rough Periwinkles, and a blue-green algae, *Calothrix*. This zone is known as the black zone.

Barnacle Zone

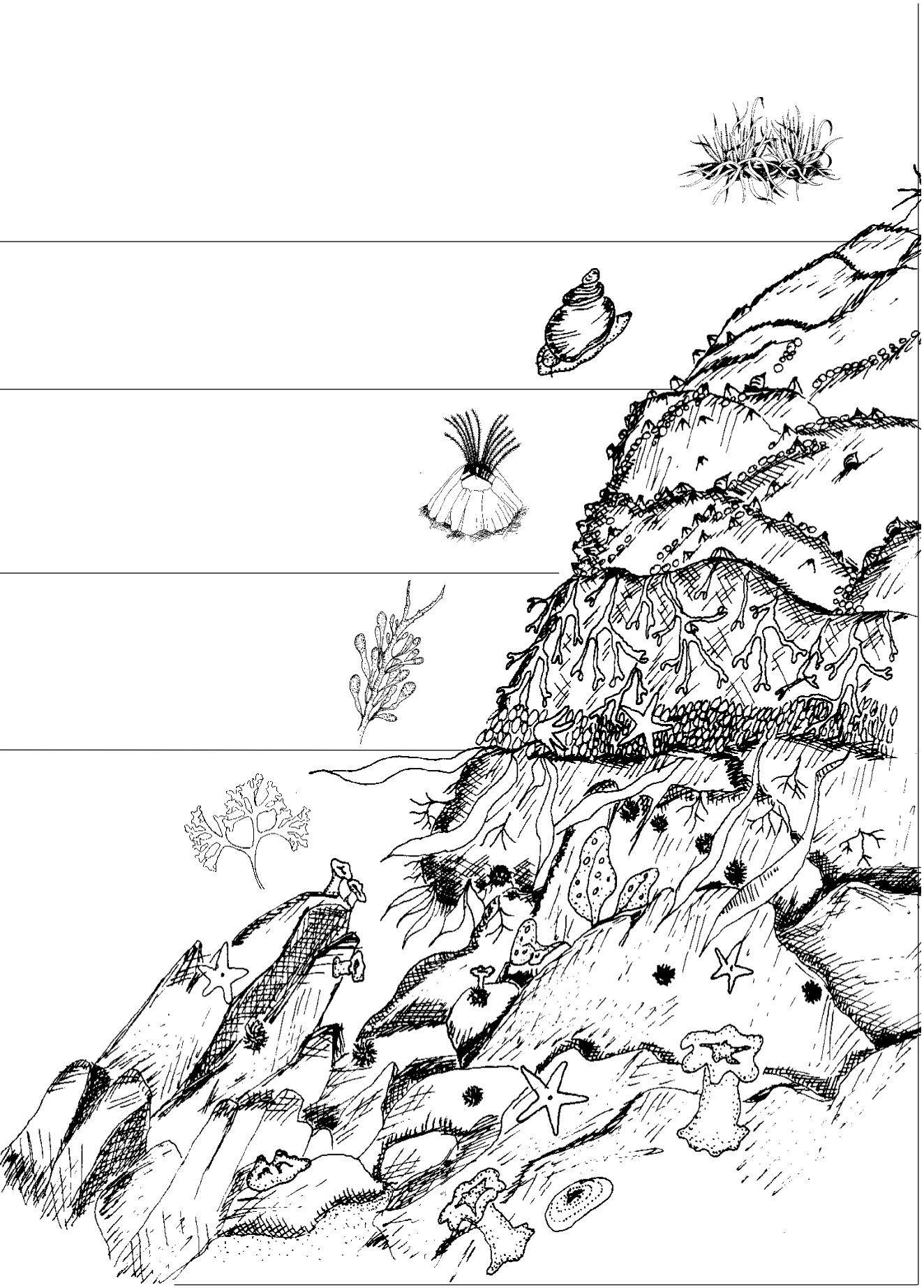
Farther down the beach, the diversity and abundance of life begin to change. Incoming tides generally flood this high intertidal area every day, providing necessary food for a number of animals. The most common are the Common Periwinkle (*Littorina littorea*) and the barnacles (primarily *Balanus balinoides*) from which this zone gets its name...barnacle zone.

Brown Algae Zone

Midway down the shore, below the barnacle zone, the brown algae zone extends to the level of mean low water. Here a marked increase in the fucoid seaweed, especially Knotted Wrack (*Ascophyllum nodosum*), can be detected. Also found in extreme abundance are the Edible or Blue Mussel, the Smooth Periwinkle, and barnacles.

Irish Moss Zone

From the end of the brown algae zone and extending below the low water mark is the Irish Moss zone. This lowest section of the rocky intertidal area displays the greatest diversity and abundance of living things, and the animals and plants of greatest size. This is primarily because they are uncovered for the least amount of time.



The rocky shore is home to a great diversity of plants and animals. Most of its inhabitants are well-adapted to living on the hard surface.

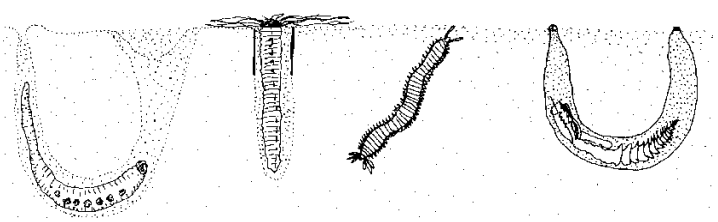
The plants that are most common on the rocky shore are the macroscopic (visible with the eye) algae or seaweed. These are classified according to their colour-brown, green, or red-and the specific locations in which they are found. Vascular plants such as Seaside-Plantain are found at the sea/land interface but are not really part of the rocky shore. One such plant, Eelgrass, may be found intertidally in tide pools if the pools have accumulated enough sediments for the plants to take root. Other plants of the rocky shore are the attached micro-algae.

The most common animals include snails like the periwinkles, whelks, nudibranchs (naked molluscs), limpets, and chitons; Blue Mussels and Horse Mussels; crustaceans such as crabs, shrimp, barnacles, amphipods and isopods; sea stars, sea urchins and sea cucumbers. A variety of worms can also be found intertidally, especially where large rocks and boulders provide a calm place for sediments to settle. These areas supply a source of food, as well as the building materials for the sand and mud tubes many worms build to live in. Other worms include flat worms and nematodes. Some rocky shores provide a home for simple animals, such as sponges and sea anemones.

A rocky shore also supports a range of visitors. During periods of high water, fish swim inshore to take advantage of the many delicacies an intertidal area supplies. At low tide a variety of birds uses the riches of the rocky shore. They pick up unprotected urchins and fish for shrimp and small fish caught in tide pools. Land-based animals may also venture onto the shore in search of food. Raccoons, for example, love a meal of mussels every now and again.

Sedimentation on rocky shores

In tide pools and on the leeward (sheltered) side of rocks and boulders, the energy of waves and currents will be absorbed. When this occurs, sediments that may be in suspension (floating in the water) will settle. The resulting pockets of sand and mud provide a micro-habitat (very small habitat) for some animals that may not otherwise be able to live on a 'rocky' shore. The animals may include burrowers such as worms or clams.

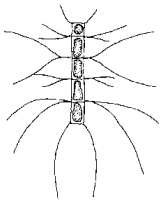


Plankton

On the rocky shore, phytoplankton are found in great numbers floating freely in tide pools.

Diatom

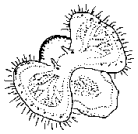
Diatom-Chaetoceros sp.



Zooplankton are also found in tide pools and stranded on seaweed. Many zooplankton provide food for the intertidal critters that are filter feeders, such as mussels, clams, and barnacles. When the tide is in, free-floating plankton are trapped by the feathery legs of barnacles or sucked out of the water by the pump action of clams and mussels.

Crab larva

Fish larva



Mollusc larva

Plankton are also connected to rocky shores for another reason. Many zooplankton are the larval stages of the animals that live here. When most marine animals reproduce they have a number of developmental stages. The early stages of these animals are typically 'planktonic.' They are known as meroplankton which means they spend a part of their lives as plankton. In other words, the larvae of crabs, barnacles, and mussels drift at the water's surface, settling down onto the substrate after a period of several days to several months.

Light from plankton

Many of the phytoplankton that are stranded on seaweed are 'bioluminescent.' This means they produce their own light through a chemical reaction. If you have the opportunity to visit a rocky shore at low tide at night, rub your hand over the seaweed draped over the rocks and look for little sparkles of light.

Plants

Much of the plant life associated with the rocky shore is seaweed. On rocky ledges some specially adapted land plants can be found, such as Seaside-Plantain.

Seaside-Plantain

Seaweed

When you see a rocky shore at low tide, you will probably notice the prominence of seaweed draped over the rocks. The most abundant are the rockweeds, brown macroscopic algae that collectively make up close to 90% of the vegetation found in rocky intertidal areas. The most common are the brown/green-coloured wrack or rockweed (four species of *Fucus*) and Knotted Wrack (*Ascophyllum nodosum*). A walk along the shore will reveal seaweed of vibrant green and a dark maroon/red in addition to a host of other brown/green varieties.

see activities 28, 29

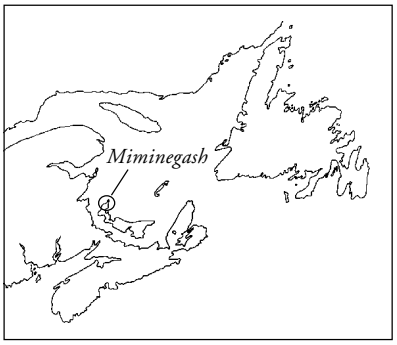
Seaweed

The green algae common on rocky shores are Sea Lettuce (double-sheet: *Ulva*, single-sheet: *Monostroma*) and hollow green weed (*Enteromorpha sp.*). Other filamentous or stringy green algae may also be found, such as *Spongomorpha*, a dense, tufted bush of filaments that looks like the oversized head of a shaving brush, and green thread algae (*Chaetomorpha sp.*), a stringy, entangled mass of green threads.

Among the brown seaweed are Smooth Cord Weed (*Chorda filum*), and at the low tide mark, Sugar Kelp (*Laminaria saccharina*), and Edible Kelp (*Alaria esculenta*). These brown algae are important sources of food for the intertidal grazers and periodic visitors to the shore at high tide.

Common red seaweed begins to appear at the mid-tide mark and includes Irish Moss (*Chondrus crispus*), Dulse (*Palmaria palmata*), and laver or nori (*Porphyra sp.*). The Irish Moss is characterized by its bushy and branched structure, while both the Dulse and laver are characterized by broader-lobed blades. Another red seaweed found attached to the rockweeds is the Red Tubed Weed (*Polysiphonia lanosa*). It is known as an epiphyte because it grows on another plant.

These algae are the primary producers of the rocky intertidal zone, as trees are on land. Not only do they provide a direct source of food for a wide range of animals, they also provide shelter. In addition, they are an indirect source of food for all things living along the coast and offshore.

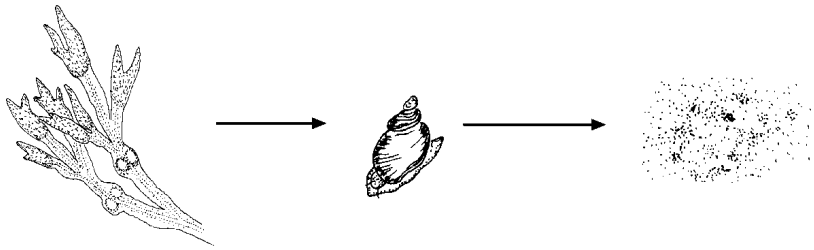


Although not harvested from rocky shores to any great extent, Irish Moss is harvested in great quantities on Prince Edward Island's north shore. The compound carrageenin is extracted and utilized, making this seaweed a well-known resource in the food processing industry.

A drying plant for Irish Moss is located at Miminegash.

Composting on the beach

Periodically, seaweed breaks from the rocks and ends up in a line across the top of the shore. This decomposes over time and in the process essential nutrients are released and dispersed by spring tides.



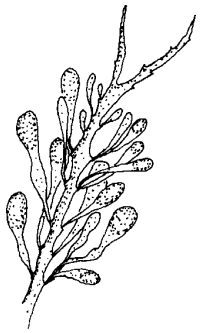
Seaweed is broken down by the grazers, such as periwinkles. Many of the first animals to appear on the rocky shore are those that use the stranded seaweed. Lift up a pile of composting rockweed and a host of arthropods will spring upwards. Here, small springtails and beach fleas, all amphipod crustaceans, will thrive, working to decompose this mass of vegetation.

In addition to these little beasties, an assortment of fly larvae time their initial life stages to that of the moon. Washed high on the shore as a result of spring tides, the creatures that find their home here are safe for 28 days, a complete lunar cycle. At the next spring tide the seaweed and its liquid, nutrient-rich leftovers will be washed offshore.

A myriad of organisms such as microbes, insects, fungi, and nematodes have adapted specifically to live at the top of the rocky shore and are only found there.

Bladder Wrack

Bladder Wrack is olive-green in colour. It has flat blades with paired air bladders along their length, and large swollen reproductive receptacles at the end of blades. It is common in the intertidal zone.



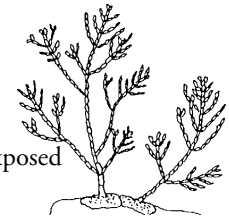
Knotted Wrack

Knotted Wrack is olive-green to dark green in colour with long narrow blades (up to 2¸3 m) and single large gas bladders along their lengths. It is common intertidally and found draped over rocks.

Smooth Cord Weed

Smooth Cord Weed is olive-green to brown. It has long, smooth, leathery strings and is found in tide pools.

Encrusting Coralline Algae

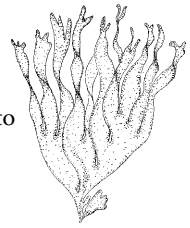


This encrusting pink (red) algae is found on lower intertidal rocks in tide pools. It will bleach white if exposed to air for even short periods of time.

Irish Moss

Irish Moss is purple/brown and is usually found on the lower shore. It is highly branched and bushy.

Dulse



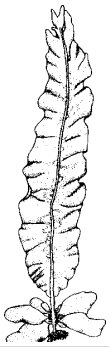
Dulse is purple/brown and usually found in the lower intertidal zone. It is quite leathery. Its blade is divided into lobes at the end.

Sea Lettuce

Sea Lettuce is vibrant green and sheet- or lettuce-like.

hollow green weed

Hollow green weed is vibrant green and intestine-like. It is often found in association with freshwater input or high nutrient levels.



kelp

Kelp is a large, brown seaweed with a wide leathery blade. It is usually found at low water. It attaches to the rocks with a branched holdfast.

Molluscs

Probably the most conspicuous of the intertidal animals are the molluscs. On the rocky shore periwinkles, whelks, Dogwinkles, mussels, clams, chitons, limpets, and nudibranchs or sea slugs can be observed.

The periwinkle is one of the most common inhabitants of the rocky shore. Three species are most common in Atlantic Canada: the Rough, Smooth, and Common. These snails are found in different locations on the shore.

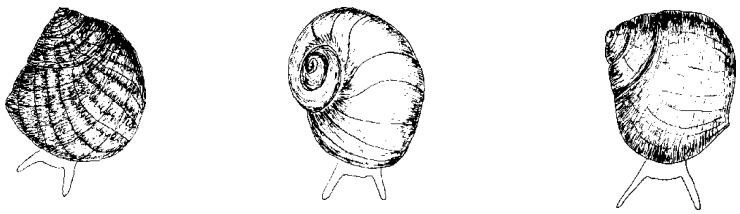
In addition to the periwinkle, a number of other gastropods also inhabit the shore. The Dogwinkle, a periwinkle-sized snail, is not a grazer like its cousin but a predator of barnacles and mussels. It is one of the major predators in the rocky intertidal area.

Hat-like limpets and the armour-plated chitons are two additional grazing gastropods found intertidally. Both prefer to be submerged most of the time. They use a radula, a unique serrated tongue to scrape microscopic algae off the rocks. In Atlantic Canada there is one common species of chiton and limpet each found on the rocky shore.

Three periwinkles

The Rough Periwinkle is usually limited to the upper intertidal zone, where it has adapted to long periods of time out of water; the Smooth Periwinkle is a resident at the other end of the beach and lives in association with rockweed and wrack, closer to the low water mark; the Common Periwinkle is found throughout a wide area of the shore. These gastropods are herbivores and use a rough, serrated tongue to scrape the microscopic algae from the rocks and seaweed. They can also be found munching on many of the thinner algae growing on the shore such as Sea Lettuce, hollow green weed, and nori.

Rough Periwinkle *Smooth Periwinkle* *Common Periwinkle*



Periwinkles have become a delicacy. They are popular in Britain but commercially they have only recently been discovered in Atlantic Canada. Boiled and then picked out of their shells with a toothpick, they can be eaten with garlic butter or as a garnish for pizza or pasta.

Mussels are common rocky shore inhabitants, attaching themselves to rockweeds, rocks, and each other with hair-like byssal threads. Without a mechanism to hold on, mussels would be washed away, perhaps offshore or above the high tide mark away from a supply of food. Mussels, like other bivalves such as clams and scallops, are filter feeders, relying on plankton-laden water for nourishment. Among the mussels found on the rocky shore are the Blue Mussel and the Horse Mussel. Horse Mussels may be found close to low water. They are larger than the Blue Mussel and have a thicker shell.

Sea slugs or nudibranchs are molluscs without a shell and can sometimes be observed on the rocky shore, but only immersed in water. Many are quite beautiful.

Limpets: home base

The Tortoiseshell Limpet (*Acmaea testudinalis*), unlike other grazers, will forage for food and then return to a 'home base' at low tide or when resting. If the rock on which it lives is soft, a depression exactly the size of the shell is eroded away, creating a tight fit.

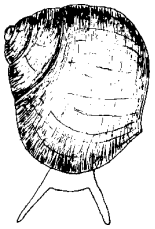
Mussels

They are teardrop-shaped, the narrow end abutting the substrate they have attached to and the wide end oriented into the open water where they have the best access to food. This shape enhances their ability to feed effectively and resist the force of onshore waves.

Mussels are economically important. The intertidal zone is relatively easy to access, so mussels are picked both commercially and recreationally. However, today many areas in Atlantic Canada where mussels live are restricted or closed because of contamination. Commercial quantities of mussels are now available from mussel aquaculture sites.

Dogwinkles and whelks

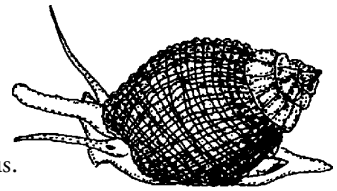
Dogwinkles use a drill-like serrated tongue called a radula to eat periwinkles as well as barnacles and mussels. They attach themselves to their prey and rasp away at the shell, eventually drilling a perfectly round hole. After completing this task they are then able to secrete a digestive enzyme into their prey and suck rather than chew their food. Other whelks found intertidally include the Waved Whelk and occasionally the Ten-ridged Whelk. Both of these are predatory as well but are not as common as the Dogwinkle. They usually prefer deeper water.



periwinkles

Periwinkles have globular shells, usually grey to brown in colour. Their opening is almost round. They are found throughout the rocky shore in large numbers on seaweed and on or under rocks. 3 cm.

Dogwinkle

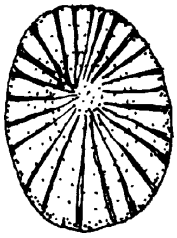


The shell of the Dogwinkle is rougher, more elongated and pointed than the periwinkle. The opening is oval with a small, often purple, canal at its lip. Dogwinkles are found in association with periwinkles but they are not as numerous. They occur at mid-water to low water. 2 cm.

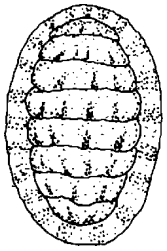
nudibranch/sea slug

Sea slugs eat hydroids and sea anemones. Without a shell they are not protected from drying out and are usually found immersed in water at all times. 7.5 cm.

limpet



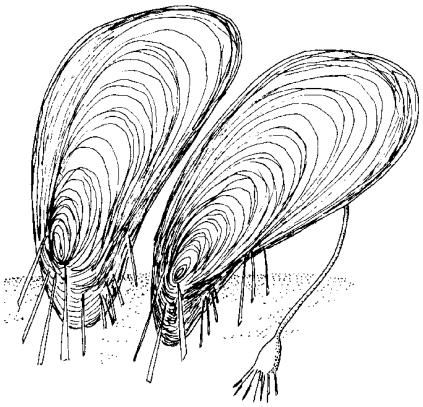
The limpet is shaped like a Chinese hat. It is found firmly attached to rocks from the mid-tide mark to low water. 2.5 cm.



chiton

Chitons are more frequently found in tide pools or close to the low water mark. They are oval creatures with a row of 8 broad but short valves across the back. 2.5 cm.

Blue Mussel



Blue Mussels are common in the intertidal zone. They are attached by hair-like byssal threads to rocks, rockweed, or each other. They are teardrop-shaped with the wide end usually pointing into water. Blue Mussels are black/blue in colour. 10 cm.

Crustaceans

Intertidally, many different kinds of crustaceans are found from the top of the shore to the low water mark.

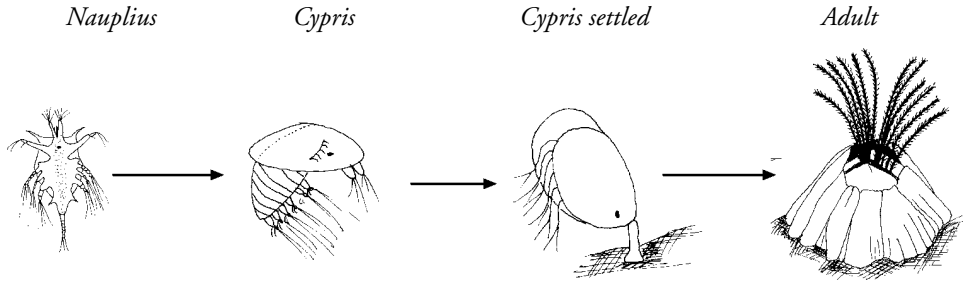
The first arthropods that appear on the rocky shore are those found in the line of stranded seaweed at the head of the beach. The residents of this community include the Sand Shrimp or Beach Hopper, an amphipod crustacean that requires a semi-terrestrial but humid habitat.

Crabs may be found hiding amongst the cracks and crevices, behind and under seaweed. Green Crabs are the most common rocky shore crabs in the Maritime provinces, whereas toad crabs are more common in Newfoundland.

Barnacles

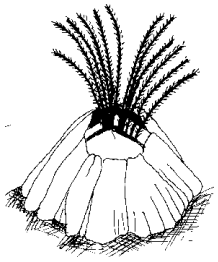
Described by Louis Agassiz as 'an animal living in a little limestone house waving its feet in the air and kicking food into its mouth,' the barnacle is a filter feeder that depends on the rising tide to immerse it with phytoplankton-laden water.

Life cycle of a barnacle



Male and female crabs

Females and males may be distinguished by looking at their abdomens. Carefully picking up a crab and turning it over will reveal a triangular or dome-shaped abdominal flap. The male possesses the triangle, the female the dome. In the spring females may also be distinguished if they are brooding eggs. These appear as a large mass of orange being clasped by the abdominal flap.



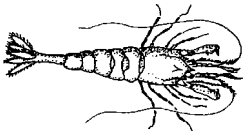
barnacles

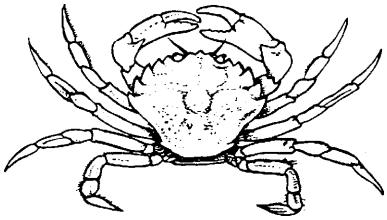
Barnacles are found on rocks throughout the intertidal zone. They have a white exterior 'shell' with a retractable top. They are usually no more than a few millimetres high. Because of their size and food requirements these arthropods seem to be one of the most tolerant animals of the shore.

see activity 34

Sand Shrimp

Sand Shrimp are crustaceans that often live in tide pools. These are not the commercial variety. Almost 10 mm.



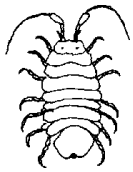


Green Crab

Green Crabs have eight legs, two claws, and on the margin of the 'head' on each side of the eyes a five-pointed, serrated edge can be identified. They are found under seaweed and rocks, in cracks and tide pools. They feed on mussels and amphipods as well as detritus (dead animals and plants). To 7.5 cm.

isopod

Isopods are silver to clear and are found in tide pools and under rocks along much of the shore. They have many legs, a segmented and elongated body, and are generally flattened from top to bottom. Around 3 mm.



side swimmer/scud

Scuds are abundant shrimp-like animals found under rocks and seaweed. They are olive-green to almost black in colour, and flattened from side to side. Around 31 mm.

More about amphipods and isopods

Amphipods and isopods are common on the rocky shore. The intertidal amphipods are little shrimp-like creatures that swim on their sides, hence the common name side swimmer or scud. Among the most common of all intertidal inhabitants, they are found under rocks and seaweed. Their colouring gives them appropriate camouflage for the area they live in.

Amphipods are often seen in the intertidal zone hanging onto one another. These are mating pairs, the larger male hanging onto the smaller female until she lays her eggs.

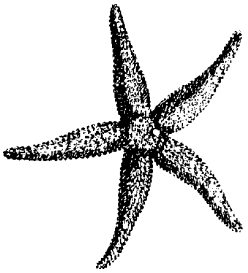
The isopods have the same characteristics as many of the sow bugs or pill bugs we find on land in gardens or rotting logs. They are flattened from top to bottom, unlike their amphipod cousins, which are fattened from side to side. Isopods are grazers and feed predominately on the microscopic algae living on rocks and on the shells of other animals.

Echinoderms

Echinoderms are among the largest of the rocky shore inhabitants. In Atlantic Canada they include the sea stars, the Green Sea Urchin, and sea cucumbers.

Sea urchins have their mouth on the underside, where five teeth can be easily seen. Their unique teeth and mouth structure allows them to tear and rip large quantities of seaweed from the rocks. They feed primarily on the seaweed found in the lower intertidal area. The presence of a wide variety of seaweed keeps urchins in this lower part of the shore, as does its need for water to move.

On occasion, during extremely low tides, sea cucumbers may be found. They are cucumber-shaped, especially *Cucumaria frondosa*, the most common intertidal species. Unlike their relatives, they are neither carnivores nor herbivores. They are suspension feeders and as a result rely on a set of mucous-coated, branched feeding tentacles and their ability to catch plankton and suspended food.

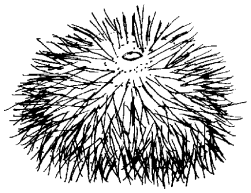


Boreal Asterias

This sea star is an efficient carnivore with a passion for Blue Mussels, but it is only found in the lower intertidal zone. 20 cm.

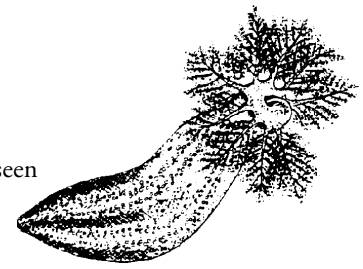
Hanging on

Echinoderms are highly developed animals that have a unique 'water vascular' system. The system, which employs tube feet and changing water pressures, allows these animals to hang onto rocks and grasp onto prey. For example, the suction-cup-like 'feet' of a sea star drape themselves over a mussel, the sea star's favourite meal. The tube feet wrap around the mussel while the stomach is extended. The mussel tries to stay sealed but eventually gets tired. The sea star opens the two valves and expels its stomach into the mussel, digesting its meal outside of its body. Because of the need for water to operate their tube feet, sea stars and sea urchins must live close to water all of the time. If they are caught at low tide they will wedge themselves into cracks and crevices or find refuge under rocks where a bit of moisture might still be found.



Green Sea Urchin

These urchins look like green spike-covered globes. They are found close to low water or in tide pools. 7.5 cm.



Orange-footed Cucumber

The Orange-footed Cucumber can only be seen at extreme low tide. To 25 cm.

Worms

A variety of worms are also found intertidally on the rocky shore, in tide pools or at the base of rocks, where there is a supply of finer sediments. Worms such as the Trumpet Worm and terebellid worm will build a protective cover in the sand and mud. Clam worms are also found here.

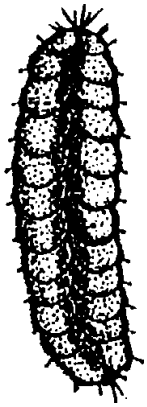
Worms are detritus and suspension feeders. The Trumpet Worm uses a set of rigid bristles to scoop organic matter out of the mud and the terebellid worm uses a set of mucous-covered tentacles to pick up food floating in the water or lying on the sand or mud bottom.

Rockweeds may also support a small tube worm known as Spirobis. The tube of this tiny segmented worm is a coiled, shell-like structure that makes the worm look more like a snail.

On the underside of rocks near low water or in tide pools, two common species of scale worms may be found. These 'armour-plated' worms are clingers and if disturbed, will roll themselves into a loop for protection.

scale worm

Scale worms are found under rocks in the lower intertidal zone. They have two rows of overlapping brown plates covering their back, and bristles around the perimeter. Underneath they are noticeably segmented. 5 cm.



Other Invertebrates

A number of other invertebrates may also be found on the rocky shore.

Hydroids

Hydroids grow on the seaweed and in tide pools. They are small plant-like animals that are seasonal predators, unable to withstand the extreme temperatures of winter. They are better suited to subtidal situations.

hydroid

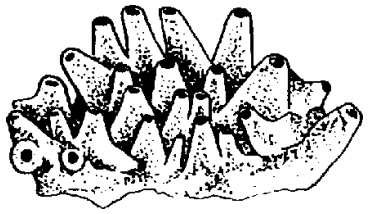
Hydroids are small animals usually found growing on the rockweeds, especially the Knotted Wrack. They are made up of clusters of pink, club-shaped polyps.

Bryozoans

Bryozoans, like hydroids, are small plant-like colonial animals. They have a calcareous skeleton with a series of compartments from which a myriad of tentacles reach out to filter water and obtain food.

Sponges

Encrusting sponges are filter feeders found on the rocks at the low tide mark or in tide pools. They are among the simplest of all animals and can only withstand short periods of exposure.



encrusting sponge

These sponges form soft encrusting growth on rocks in the lower intertidal zone. They are yellow/brown in colour and have large holes dotting their surface that are used in exchanging water.

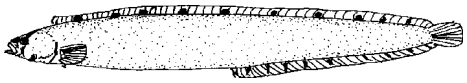
Sea anemones

Sea anemones (Cnidarians) are another common invertebrate of rocky intertidal systems. They are attached to the rocks and rely on a set of feeding tentacles to capture passing zooplankton or falling detritus for nourishment. They are soft-bodied creatures and can only be out of water for short periods of time.

Fish

The Rock Gunnel is one species of fish that inhabits the rocky intertidal area. It can be found in tide pools or under rocks from mid- to low water. Catching a Rock Gunnel is difficult, which gives it another common name, the Butterfish. Other fish found occasionally on the rocky shore include the Lumpfish and the Sea Snail, both known for the sucking disks they have to help them cling to rocks.

Only at high tide will a greater variety of fish use the rocky shore. When water floods the shore, the seaweed stand upright, changing the face of this ecosystem. Floating seaweed provides protection for a number of fish, especially juvenile Pollock, herring, and Mackerel.



Rock Gunnel

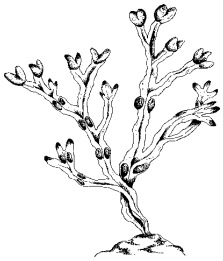
A Rock Gunnel is a small eel-like fish found under rocks, often in little water. It is mottled brown in colour. Around 15 cm.

Birds

Birds are limited in rocky intertidal area. The most apparent ones are the ever-present gulls and a number of species of ducks that use the rocky shore at high tide. The Common Eider, Spotted Sandpiper, and Ruddy Turnstone are some of the species that roost and feed here.

Mammals

Few mammals use the rocky shore at low tide. Those that do come to forage the occasional meal. For example, Raccoons and Otters may spend some time here but are not considered residents. Neither are Harbour or Grey Seals, which may use an isolated section of the rocky shore as a resting site. Mink often feed on fish along the shore. Moose and caribou augment their diet on the rocky shore in parts of Newfoundland and Labrador.



ECOLOGY

Rocky intertidal shores are one of the best ecosystems in which to study a variety of ecological relationships. Since rocky shores are transition zones between land and sea and are influenced by the daily rise and fall of the tides, the animals and plants that live there are well-adapted to a number of situations. These adaptations help them deal with specific physical processes or biological factors that may limit their distribution, growth, and survival. All adaptations have some purpose in enhancing the ability of an organism to survive.

Stress and Survival

Drying Out (Desiccation)

The processes that affect the physical characteristics of the rocky shore also affect life in the intertidal zone. To be successful, animals and plants must have evolved special adaptations to deal with these stresses. For example, as the tide rises and falls, organisms may dry out. This can occur not only as a result of sun, but also wind. Some organisms have developed an ability to tolerate high water loss. Others have developed mechanisms to retain water.

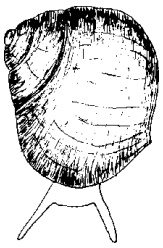
Dry seaweed

Many of the rockweeds become almost brittle in the hot summer sun. They can however tolerate a water loss of close to 80% without the cellular structure of the plant being damaged. Thinner, more delicate algae such as Sea Lettuce or hollow green weed cannot tolerate the same extent of drying so their ability to grow in such abundance is reduced.

Shells

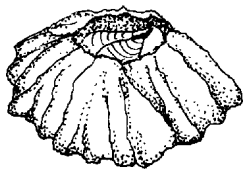
Animals have varying abilities to tolerate desiccation. Many of the most abundant intertidal critters are shelled molluscs such as periwinkles and whelks. Their hard shells not only protect them from predators but also enable them to retain water. The animals can withdraw themselves entirely into their shells, close a trap door (the operculum) with a glue-like mucous plug, and remain comfortable for hours and hours.

periwinkle



Heating Up

Changing temperatures have demonstrable effects on many animals. On rocky shores, air temperatures may range seasonally from -30½C to +30½C. Even in summer, air temperatures reaching +30½C are contrasted against water temperatures that may only be 5½C. Again, the shelled animals deal with this limiting factor much in the same way they deal with drying out. The barnacle also has this wonderful ability to close up tightly, retain water, and stay moist and cool during low tide in the summer and relatively warm and moist in the winter.



Changing Salinity

see activities 37, 41

Intertidal organisms also deal with the potential of being drenched by fresh water during torrential downpours, or being in tide pools where salinity concentrations can be reduced over longer periods of time by rain. Salinity also changes with increasing evaporation potential. As temperature and / or wind increase, tide pools can become more saline.

Light and Dark

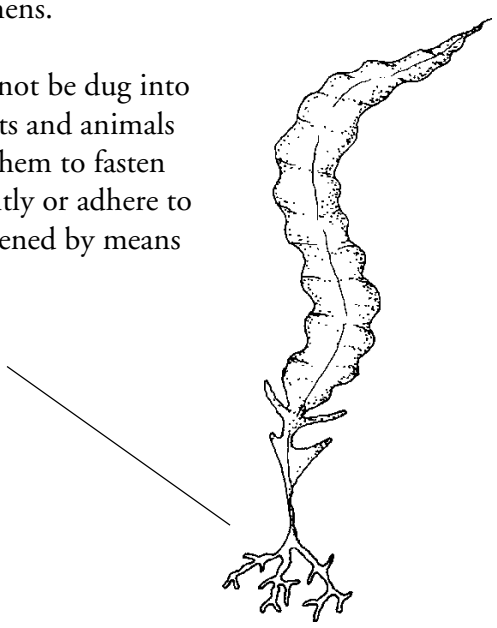
Light is another physical factor that limits the distribution and success of animals living intertidally. Light is essential for photosynthesis and therefore for plant growth.

Light is also a stimulus that many animals respond to. Because light is essential for plant growth and some animals are plant feeders, there may be a positive response by herbivores to light. As a result, they may be attracted to it. Others may respond negatively to light, searching for shaded areas to hide. Shade represents protection from predators and from extremes in environmental conditions.

Holding On or Losing Out

Waves and currents have helped to evolve a range of unique adaptations for organisms living on rocky shores. Waves broaden the intertidal area, creating a zone above the high tide mark. Wave spray, splash, and swash (upcoming waves washing onto the shore) create varying degrees of stress for plants and animals that may try to colonize land above the high tide mark.
Here life is limited to a few species of lichens.

Further down the shore the substrate cannot be dug into as can sand or mud. As a result both plants and animals have a variety of mechanisms that allow them to fasten themselves to the hard surfaces permanently or adhere to the textured surface. The seaweed are fastened by means of structures known as holdfasts.

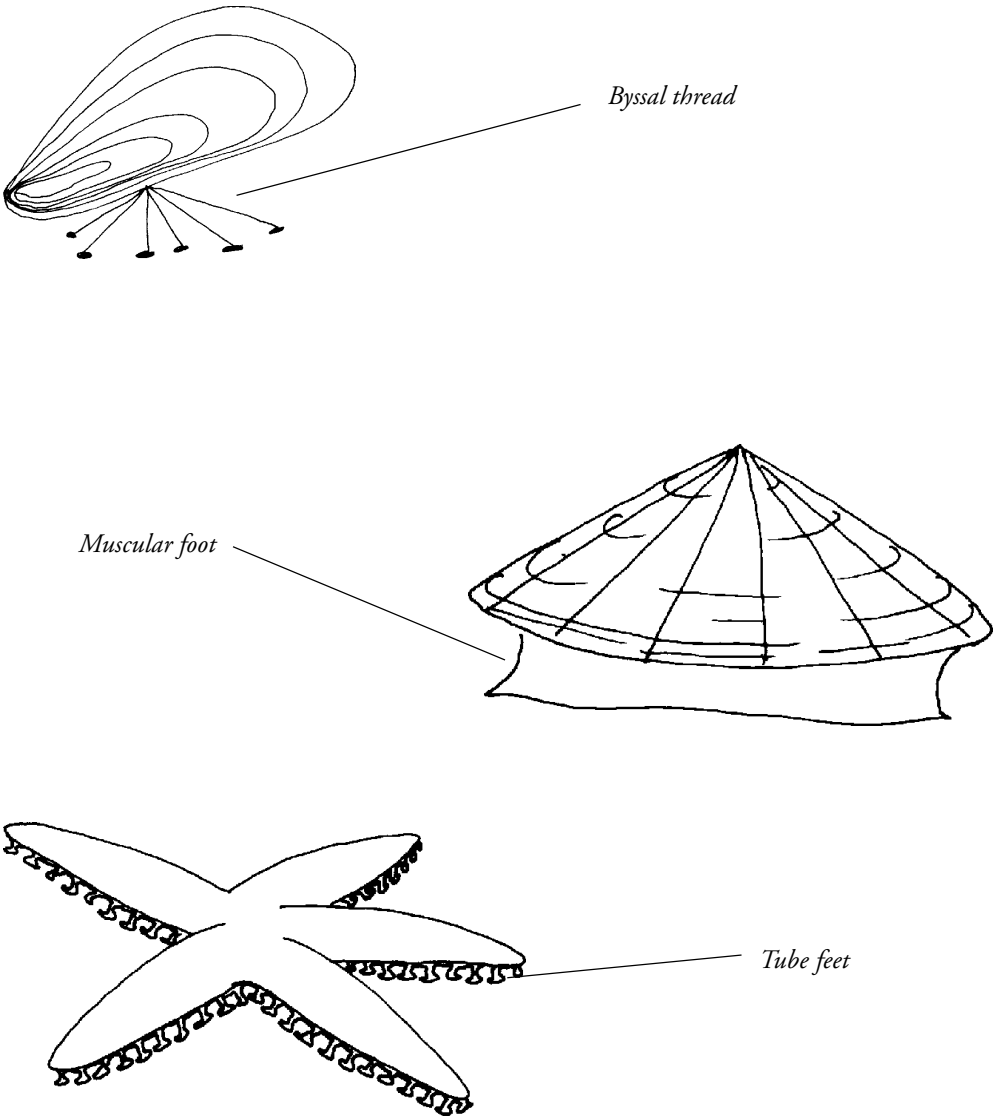


Holding onto the rock

Seaweed does not have roots, because roots require getting into a substrate. Even in sandy and muddy areas, seaweed is not rooted because the movement of water by waves and currents constantly shifts sediments and would not allow rooted plants to grow. Seaweed has holdfasts, which vary from a single modified cell to various kinds of entangling branches like small roots or sticky discs. They are quite effective at keeping these large algae in place.

The adaptations that animals have to hang on include tube feet in the sea urchins and sea stars, and a large muscular foot in the gastropod molluscs (the snails). Sessile animals such as mussels and barnacles have specific mechanisms to hold them in one place. Barnacles cling to rocks using a bonding compound they secrete through a cement gland located on their underside. Mussels secrete a liquid protein along their trough-like foot. The compound is a glue-like substance that hardens on contact with sea-water. Several of these byssal threads are created and used as anchors to hold single or groups of mussels in place.

Comparison of the types of adaptations used by animals to hang on.



In addition to the physical or abiotic factors affecting life on the shore, ecologists have identified a number of biological or biotic factors to which many organisms also have to adapt. These include both inter- and intra-relationships such as competition, predation, herbivory, availability of food, reproductive strategies, and excretion.

There is Only So Much Room (Competition)

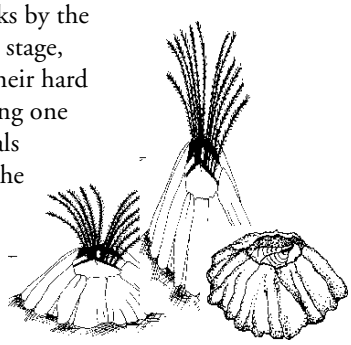
Competition is the common use of space, food, or light by a number of animals and/or plants of the same or different species. On the rocky shore both animals and plants need space. Some species tend to crowd out or restrict others.

see activity 34

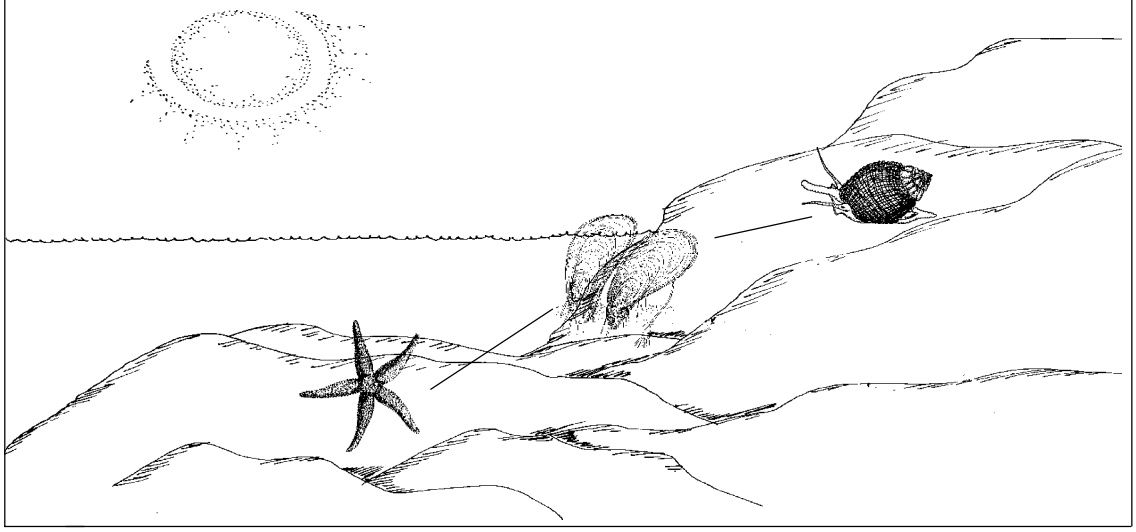
Competition

For example, rockweeds and barnacles attach themselves to the same rock. Both may coexist for some time but as the seaweed grows it may begin to interfere with the barnacles' feeding.

Barnacles can also control their numbers. Settling on rocks by the thousands in the spring after a six-week planktonic larval stage, barnacles begin to feed and grow rapidly. As they grow, their hard exterior 'shell' gets larger. Soon shell bases may be touching one another. On some occasions when this happens individuals begin to grow upwards instead of outwards. In doing so the taller barnacles get the most food.



Some species that feed on the same food avoid bothering each other by living in different places. For example, sea stars, whelks, and Dogwinkle eat mussels, which are found from the mid-intertidal to the low water mark and beyond. Sea stars are limited to the lower intertidal. Dogwinkles can be found from the mid-intertidal to the low intertidal but restrict themselves to areas where they have a greater ability to find food, in the part of the rocky shore where there are no sea stars.



Eating and Being Eaten (Predator/Prey)

The rocky shore is filled with examples of predator/prey relationships or predation. Predation is the act of one animal eating another and on the rocky shore these food chains and webs can be readily seen in action. Predatory animals can alter the composition of species within an ecosystem. In fact it is possible for a predator to eliminate a species, making the area more inviting for other species. Like carnivorous predators, grazing herbivores (plant eaters) can alter species composition within an area.

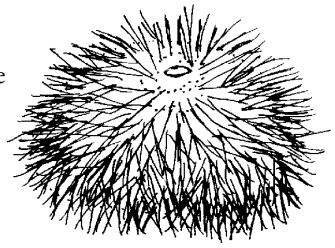
Availability of Food

All animals and plants are limited in their growth and survival by the availability of food. In a marine environment many animals have adaptations that allow them to take small food particles out of the water through filtration. These filter feeders therefore are dependent on the amount of time they spend in the water. Their size and distribution on a rocky shore is determined by this immersion time.

see activities 41, 44

Predator/prey

Sea urchins are primarily herbivores, preferring to feed on the green, brown and red macroscopic algae in the lower intertidal zone. As they graze, they remove algae from rocks. Algae-free rocks create available space for sessile animals such as barnacles to settle down. For a time, barnacles may replace algae on the rocks. With no algae present to feed on, the urchins move to other areas of the lower intertidal zone, retreat to subtidal areas, or starve. Without the sea urchins, algae may begin to grow between the barnacles or in some cases on the barnacles. As the algae grow, they use the same space as the barnacles and hinder their ability to feed. Barnacles die off, algae continue to spread, and the grazing sea urchins return to feed once again.



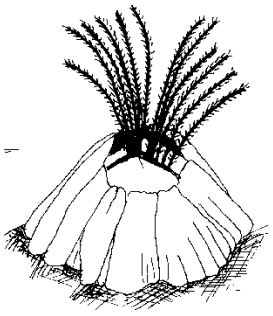
A similar situation exists between Dogwinkles, mussels, and barnacles. Mussels and barnacles use the same space. Dogwinkles will eat both. As a result, where predator and prey are abundant, the Dogwinkle keeps both in check and sometimes decimates both populations to the extent that space becomes available for algae and the herbivores that eat them.

Predators can help keep population numbers down.

Producing Offspring (Reproductive Strategies)

Distribution and survival are also determined by specific reproductive strategies. For many marine animals, reproductive cycles are triggered by temperature and the availability of food.

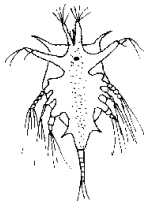
Availability of food



Walk down any rocky intertidal area starting at the high tide mark and what you'll see is both a noticeable increase in the number of barnacles and in their size. The closer you get to the low tide mark, the longer that part of the shore is under water during a tidal cycle. This translates into a longer feeding time for barnacles. Just like most of us, the more we eat, the bigger we get!

Producing offspring

Phytoplankton is the food for the larval stages of intertidal organisms, and it blooms in the spring. These blooms coincide with an increase in water temperatures. As the water temperatures begin to warm up (if 6 to 8½C is warm!!), many marine animals begin to release their gametes (sperm and eggs) into the water. The larvae of barnacles, sea stars, and urchins float around in the water column offshore until they have reached a certain stage in their development. They then find their way to shore and settle down on rocks and seaweed. This floating larval stage is an adaptation for survival, too. If gametes were released on the shore, the probability of them meeting and forming a new animal would be low.



barnacle larva

Those animals that do have their young on the shore have special ways to help fasten their offspring to the shore. Periwinkles, for example, cover their fertilized eggs in a gelatinous bag that clings to seaweed or the underside of rocks. Dogwinkles create a unique 'growth chamber.' Rice Krispie-like vases can be found under seaweed attached to rocks. These contain young Dogwinkles, as many as 25 to 30. Inside these egg cases, these carnivores get an early start cannibalizing their siblings until only one remains to emerge onto the rocky shore.

Productivity

Many rocky intertidal areas are very productive, characterized by high primary productivity. Plant growth is plentiful. Rocky shores provide many of the nutrients for other ecosystems in the coastal zone.

Rocky shores are capable of supporting a diverse array of animals because of this high primary productivity. In fact, in rocky intertidal areas it is possible to identify examples of animals from more groups and in higher numbers than in many other coastal ecosystems.

Food Web

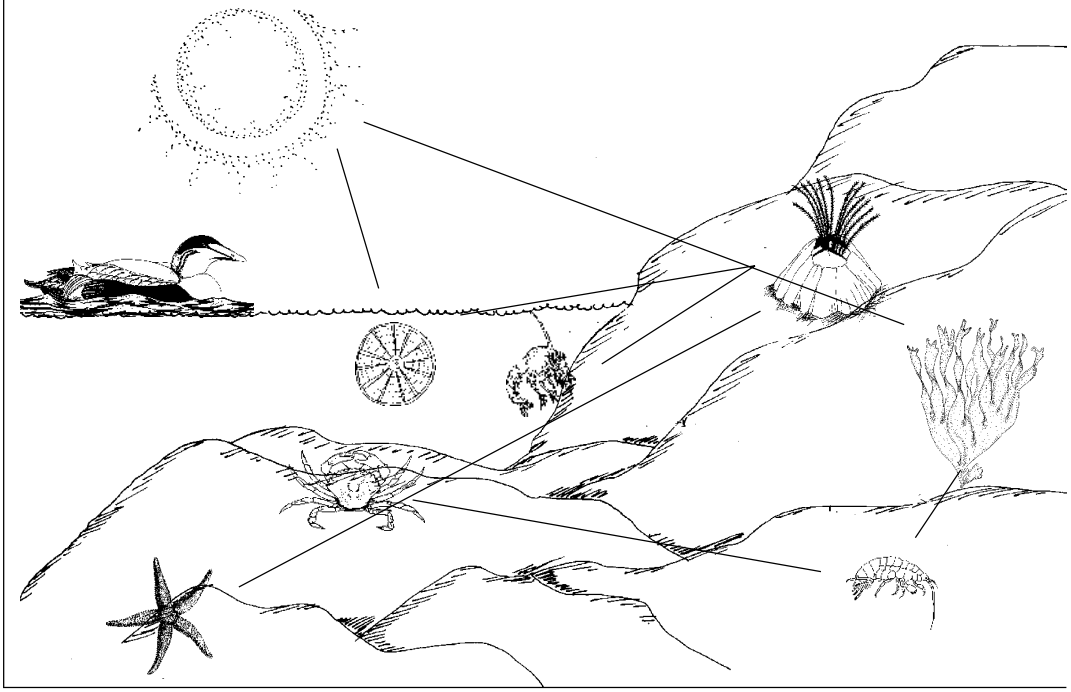
Nutrients are released from the decomposition of seaweed and distributed widely by tides and currents. These nutrients are used by phytoplankton, which in turn are eaten by both zooplankton and filter feeders such as barnacles and mussels. Fish and filter feeders eat zooplankton. Sea stars eat filter feeders and fish. Birds or mammals eat smaller fish.

see activity 40

The rocky shore is also a nursery area for inshore species of fish. They do, in many cases, take the place of salt marshes where salt marshes do not exist.

Food web

Arrow: indicates direction of food/energy



Links with other coastal ecosystems

Other food links involve the use of intertidal areas by organisms from other ecosystems during high tide. Foraging fish and birds visit the rocky shore for food at this time. This is, in effect, a classic example of a food web.

In addition, during reproductive cycles the larval stages of many intertidal animals are spent offshore, the larvae floating at or near the surface where they will be food for the inhabitants of these waters.

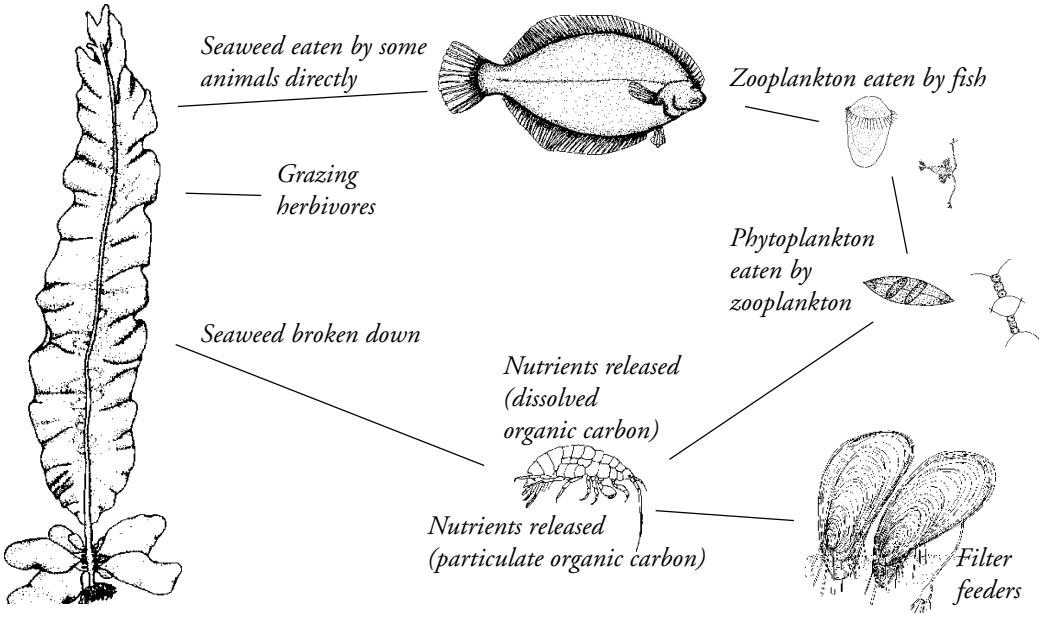
Rocky shores may play an important role in the maintenance of sedimentary shores. The constant bombardment of this intertidal system by waves and currents creates some broken rock and finer sediments that may be carried to adjacent ecosystems.

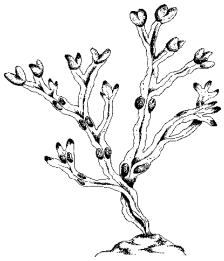
Seaweed

One of the things most noticeable on a rocky shore is seaweed. It is used by animals for protection and food. The nutrients, bound up in the algae itself, are accessed, too.

Not only do we notice seaweed on the rocks, it often piles up at the top of the beach, having washed ashore after a storm or with the tide. If you have the opportunity, look closer at this 'wrack line.' Instead of stepping over it as many of us often do, bend down and pick through it. What you will see are tiny beach fleas and sand hoppers, as well as nematodes and insect larvae. All of these small creatures and the work of sun, air, and moisture have created a compost pile. At the base of this stranded seaweed there will likely be a liquid, somewhat smelly mass of decomposed algae; in other words, carbon, phosphorus, sulphur, and other beneficial elements are used by the vegetation onshore or are taken away with the next high spring tide. These nutrients, dissolved in sea-water, will be used by phytoplankton offshore, by mussels and clams intertidally, and by scallops subtidally. Phytoplankton are the source of food for many zooplankton and zooplankton feed many invertebrates and fish species. Many of these fish are important commercial species on which livelihoods depend.

The importance of seaweed in the food web





ROCKY SHORES AND US

Rocky shores are important to people in many ways. They play a role in the images we have about the world around us. To many, rocky shores would conjure up images of waves pounding the coast or memories of beachcombing. These are satisfying images.

If you like seafood, rocky shores can enhance your culinary practices. For many years people have relied on rocky shores as an important source of food. They are also important for many commercial species of fish, such as herring, Pollock and flounder. Mussels, periwinkles, and seaweed are also collected from this ecosystem.

Problems in the Ecosystem

Rocky intertidal areas are fortunate in many ways because they are not as accessible and as usable as many other coastal systems. The physical characteristics of the rocky shore prohibit the use of ATVs, trucks, or cars, and they are not the sort of location that is used for typical coastal recreational pursuits.

However, rocky shores are facing many problems. The resources are not always harvested in a sustainable manner. For example, the harvesting of seaweed such as rockweed can create tremendous repercussions not only for the rocky shore itself but for adjacent ecosystems and offshore areas. Rockweed is an integral part of the system. It provides protection for many animals and essential nutrients that are used by both plants and animals including phytoplankton, zooplankton, filter feeders, and fish. Many of these fish are commercial species.

Harvesting rockweed

Another stress on the rocky shore ecosystem is the harvesting of previously unused species. In southwestern New Brunswick and Nova Scotia, sea urchins are now being caught and sold on the Japanese market. The resource is plentiful but some people have concerns about the method of harvest, principally dragging. This technology has its negative effects on rocky intertidal areas. Not only does it catch sea urchins by dragging, but also other plants and animals.

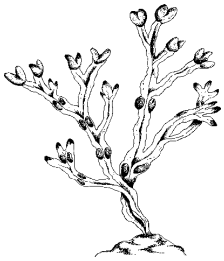
Protection of the Ecosystems

Rocky shores are important for many fascinating animals and plants. They also contribute to the health of the entire coastal zone of Atlantic Canada. Their high productivity provides a necessary source of nutrients for other ecosystems.

For people, rocky shores not only supply food but also a wonderful educational resource. They provide a place to study, and to better understand, the relationships between a variety of plants and animals, as well as the role we play in their health and survival.

Protection of rocky shores begins with discovery. Listen to the pounding of the surf on the rocks. Unravel the mysteries of life in the intertidal area. Look for colourful seaweed and creatures that live there. Watch for sea stars, Green Crabs, and barnacles in tide pools. Discover the amazing adaptations these intertidal creatures have to survive on the rocky shore.

You can begin your journey of discovery today. All you need is a good pair of boots and a curiosity about the world around you.



SPECIES LISTS

The following lists are by no means a complete account of the organisms living in this ecosystem. They were chosen as representative species, ones that would most likely be observed when visiting the rocky shore. There are also great regional and local variations, and we realize the difficulty in accommodating all of these.

Plants

Common Juniper	*Juniperus communis*
Creeping Juniper	*Juniperus horizontalis*
Bluebell/Harebell	*Campanula rotundifolia*
Seaside-Plantain	*Plantago maritima*
Seaside Goldenrod	*Solidago sempervirens*
Silverweed	*Potentilla anserina*
Three-toothed Cinquefoil	*Potentilla tridentata*
Red Fescue	*Festuca rubra*
Scotch Lovage	*Ligusticum scothicum*
Knotted Pearlwort	*Sagina nodosa*
Alkali-Grass	*Puccinellia langeana*
Sand-Spurrey	*Spergularia canadensis*
Sand-Spurrey	*Spergularia marina*

Seaweed

'Brown'	*(Phaeophyta)*
	Petalonia fascia
	Chorda tomentosa
Smooth Chord Weed	*Chorda filum*
Sugar Kelp	*Laminaria saccharina*
Sea Collander	*Agarum cribrosum*
Edible Kelp	*Alaria esculenta*
Knotted Wrack	*Ascophyllum nodosum*
rockweed	*Fucus vesiculosis*
	Fucus spiralis
	Fucus endentatus
	Fucus evanescens
'Green'	*(Chlorophyta)*
	Monostroma grevillei
hollow green weed	*Enteromorpha sp.*
Sea Lettuce (double sheet)	*Ulva lactuca*
	Spongomorpha arcta
Green Thread Algae	*Chaetomorpha melagonium*
	Cladophora sericea

'Red'	*(Rhodophyta)*
Irish Moss	*Chondrus crispus*
Encrusting Coralline Algae/Coral Weed	*Corallina officinalis*
Dumont's Red Weed	*Dumontia incrassata*
Dulse	*Rhodymenia palmata/Palmaria*
palmata	
	Ptilota elegans
Red Tubed Weed	*Polysiphonia lanosa*
laver/nori	*Porphyra sp.*

Molluscs

Tortoiseshell Limpet	*Acmaea testudinalis*
Periwinkle (Common, Rough	
and Smooth)	*Littorina sp.*
Common Slipper Shell	*Crepidula fornicata*
Waved Whelk	*Buccinum undatum*
Ten-ridged Whelk	*Neptunea decemcostata*
Blue Mussel	*Mytilus edulis*
Horse Mussel	*Modiolus modiolus*
Bushy-backed Nudibranch	*Dendronotus frondosa*
red-gilled nudibranch	*Coryphella sp.*
Chiton	*Ischnochiton ruber*
Dogwinkle	*Nucella lapillus*

Crustaceans

barnacles	*Balanus sp.*
Sand Shrimp	*Crangon septemspinosa*
Green Crab	*Carcinus maenas*
side swimmer/scud	*Gammarus sp.*
Little Shore Isopod	*Jaera marina*
toad crab	*Hyas sp.*

Echinoderms

Forbes' Asterias	*Asterias forbesi*
Boreal Asterias	*Asterias vulgaris*
Green Sea Urchin	Strongylocentrotus droebachiensis
Orange-footed Cucumber	Cucumaria frondosa

Worms

twelve-scaled worm	*Lepidonotus squamatus*
fifteen-scaled worm	*Harmothoe imbricata*
Trumpet Worm	*Pectinaria gouldii*
terebellid worm	*Amphitrite johnstoni*
hard tube worm	*Spirobis sp.*
clam worm	*Nereis sp.*

Sponges

encrusting sponge	*Halichondria sp.*

Bryozoans

lacy crust	*Electra pilosa*

Cnidarians

Frilled Anemone	*Metridium senile*

Hydroids

Club Hydroid	*Clava leptostyla*
hydromedusae	*Obelia sp.*
tubularian hydroid	*Tubularia sp.*

Fish

Rock Gunnel	*Pholis gunnellus*
Lumpfish	*Cyclopterus lumpus*
Sea Snail	*Liparis liparis*

Birds

Black Guillemot	*Cepphus grylle*
Spotted Sandpiper	*Actitis macularia*
Semipalmated Sandpiper	*Calidris pusilla*
Ruddy Turnstone	*Arenaria interpres*
Northern Gannet	*Sula bassanus*
Common Eider	*Somateria mollissima*
Double-crested Cormorant	*Phalacrocorax penicillatus*
Osprey	*Pandion haliaetus*

Bald Eagle	*Haliaeetus leucocephalus*
Herring Gull	*Larus argentatus*
Great Black-backed Gull	*Larus marinus*
Common Tern	*Sterna hirundo*

Mammals

Harbour Seal	*Phoca vitulina*
Grey Seal	*Halichoerus grypus*