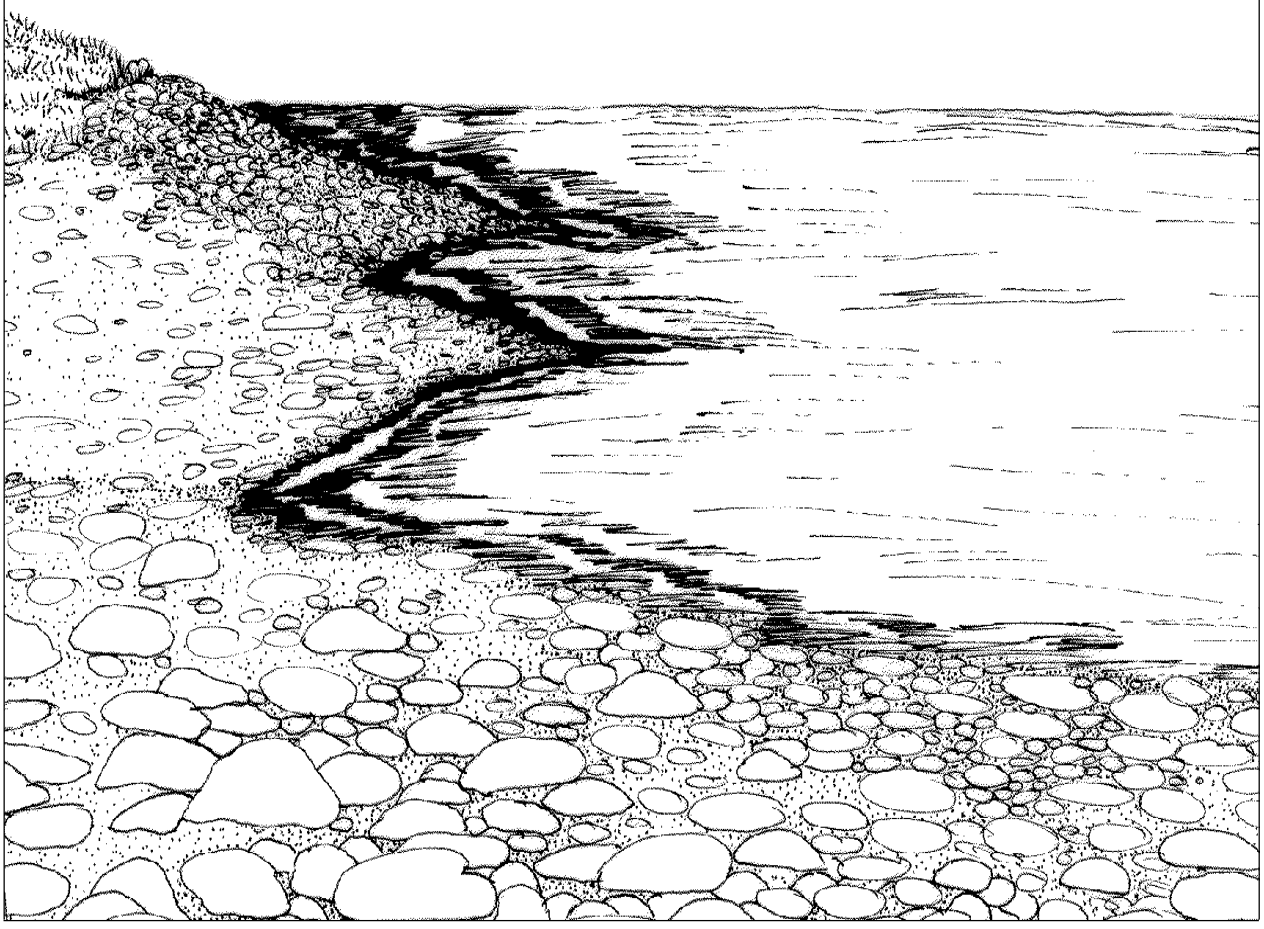
BY THE SEA

A GUIDE TO THE COASTAL ZONE OF ATLANTIC CANADA

MODULE 9: COBBLE BEACHES



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)

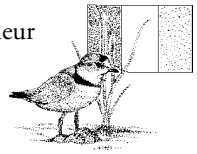
Comments and suggestions from the following people are gratefully acknowledged:

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



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

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

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

COBBLE BEACHES

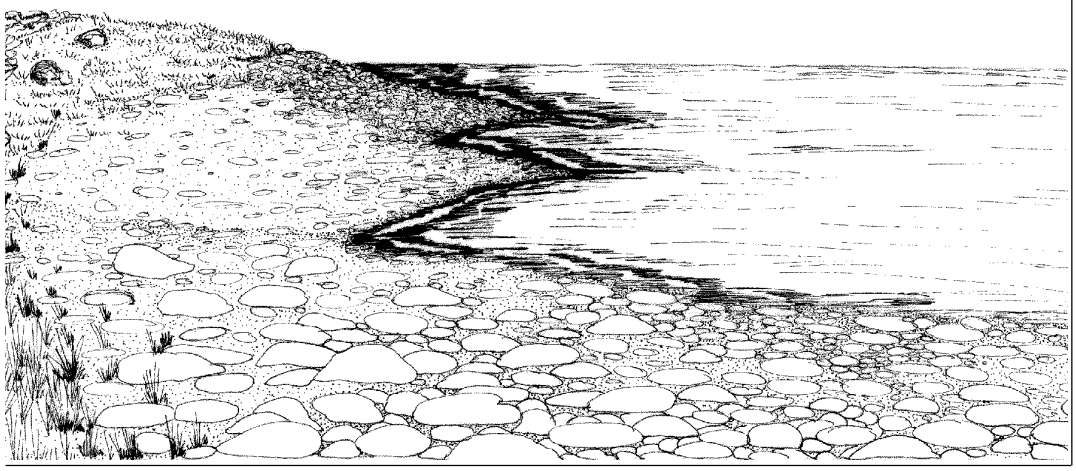
What is a Beach?

A beach is an accumulation of loose sediments at the edge of a body of water. The sediments are shaped and formed in response to wave action. A beach includes the land that is reached by the highest tides and the zone near low tide where the sediments are disturbed by the movement of the waves. Beaches may be composed of sediment of a single grain size, although in certain areas beaches with one size of sediment grain are rare. Usually, cobbles are mixed in with pebbles and sand. Few beaches are free from sand.

see activities 6, 7, 10

Three Common Beach Types

The three common beach types include those composed of sand, those with a shingle or cobble ridge that forms the landward boundary with a broad apron of sand, and those composed only of cobbles. Cobble beaches are much steeper than sand beaches and on those beaches with sand and cobbles, a sharp apron often divides the cobble ridge from the sand apron.



Beach Profile

A profile or a side view of a beach can have the following features, although not all features will be observed on all beaches.

At the land limit of the beach is a low, gentle slope or cliff that is beyond the reach of all but the highest storm waves. This slope is known technically as the coastline. In front of the coastline is a more gentle slope that leads to the beach scarp.

The beach scarp is a low but steep incline that leads to the berm. A berm is a mainly horizontal platform that is reached only by storm waves at high tide.

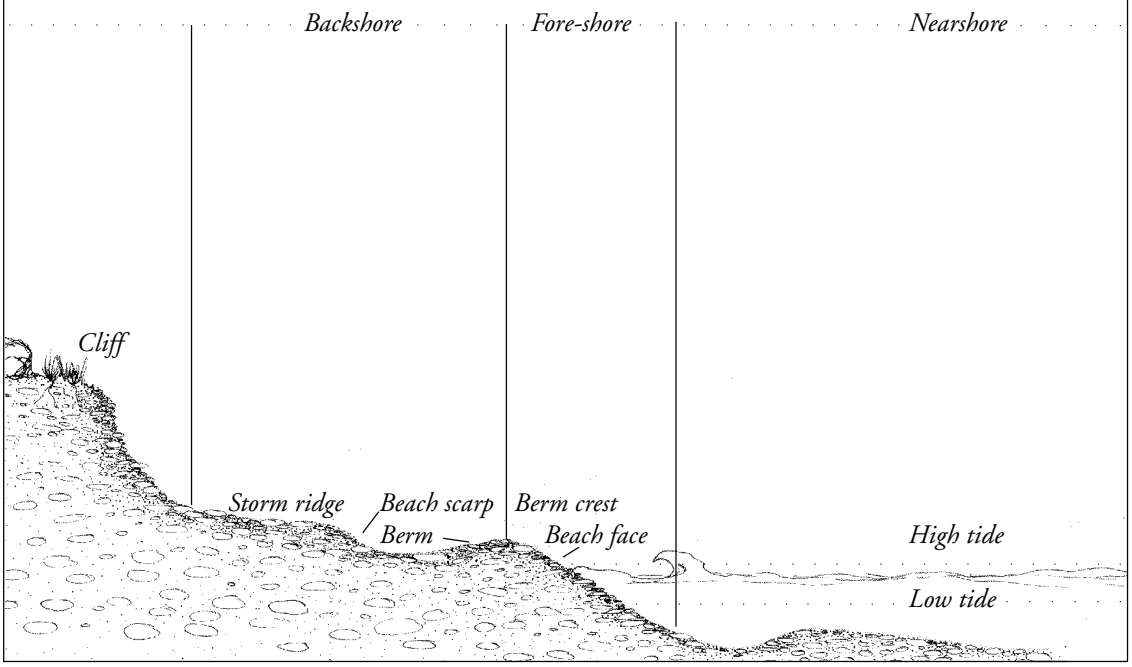
The berm and the slope just behind it form the backshore.

The foreshore lies in front of the berm. The beach face, which marks the limit of the usual high tide, is the steep slope in front of the berm.

Just below the beach face is the intertidal zone or foreshore, which is exposed at low tide.

Below the intertidal zone is the shore face, which marks the landward boundary of the offshore zone.

Typical profile of a cobble beach



What is a Cobble Beach?

Cobble beaches are a unique ecosystem. They are the beaches that 'sing and dance' with the waves that hit them. They are the musical beaches of our coastal zone.

Cobbles are stone sediments that generally range in size from 64 to 256 millimetres, from tennis ball to volley ball size. A cobble beach is a special kind of rocky shore in which the sediments move in response to wave action. Other rocky shores composed of bedrock and large boulders do not experience this movement of rock twice daily in response to the tides and waves. Cobble beaches are usually reflective, meaning that they reflect the wave energy that strikes them, and are dominated by plunging breakers. They lack a surf zone and experience strong long-shore bedload transport or sediment movement by water in the swash zone (the zone where water washes up onto the beach following the breaking of a wave).

Types of Cobble Beaches

Cobble beaches are often fronted by gentle dissipative beaches (beaches that cause wave energy to be scattered) composed of sand. Often beaches will have sand at the mean sea-level, pebble at the high water mark, and cobble at the highest water mark. When new sediment is introduced it finds its place with like-sized sediment.

The cobble beach may be only a narrow band of sediment at the high tide mark with a wide intertidal platform of bedrock that may or may not be covered with mud or sand.

Cobbles may form pocket beaches. These are small pockets of cobblestone that have accumulated in indentations along the coastline. With much of the coast of Eastern Canada (except P.E.I., where the bedrock consists of easily eroding sandstone) consisting of rock resistant to erosive processes, there is a scarcity of beach sediment. For many areas, the only place where sediment is deposited are these small, stony pocket beaches found between resistant headlands. These beaches are often associated with deltas and mudflats in sheltered areas or backed by cliffs ranging in height from 10 to 200 m. Cobbles gather at the head of coves.

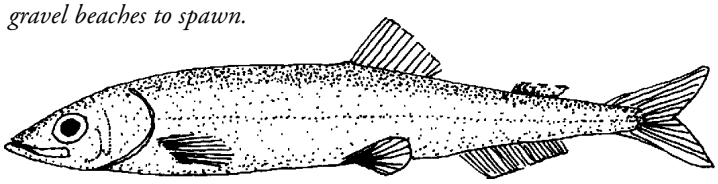
Barrier beaches may be composed of cobbles as well as sand or pebbles. They're formed when rising sea levels erode a beach and deposit the sediments offshore from the original beach, and often many miles from the source of the sediments. These sediments form a barrier to headlands. This barrier beach separates two bodies of water except during the highest tides. In effect it forms a barrier that breaks the force of wind and waves from the ocean. Barrier islands are completely detached from land.

The Cobble Beach Within the Coastal Zone

Beaches have perhaps the most delicately balanced mechanisms of the coastline. They react quickly to changes in wave energy and sediment supply. As they are not isolated systems, a change in one area is transported down the shoreline to successive beaches.

With cobble beaches being primarily the result of the erosion and deposition of glacial till from drumlins near the shore or offshore, the cobble beach can be a source of sediment for other coastal ecosystems. The same erosion processes that deposit the cobble are able to transport sediment of smaller particle size to other areas. Normally, cobbles move around during flood and ebb tides, but they stay within the same general area. In the spring, during ice breakup, shore ice may drag and scour a cobble beach removing some of its sediment and transporting it offshore. This movement by ice will often transport epifauna-animals that normally crawl on the surface of the substrate or are attached to it and to seaweed-to other ecosystems. Storms with high winds and waves will also transport sediments and nutrients to other areas.

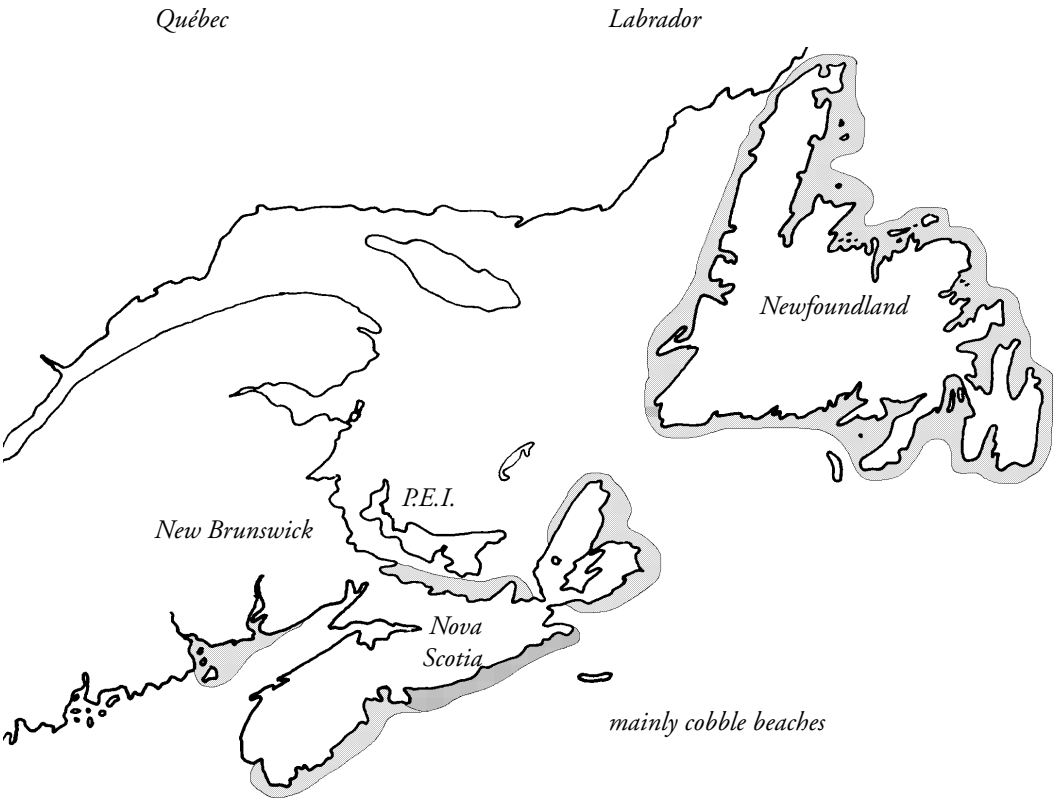
Capelin come to coarse sand and gravel beaches to spawn.



Location

Cobble beaches are found along the whole coastline, but are best developed in areas where there is enough glacial till for source material, such as along the Atlantic coast and the Bay of Fundy. In fact, cobble/pebbles are very important along the Bay of Fundy and the Atlantic coast of Nova Scotia, and occasionally important along the rest of the East Coast of Canada as beach sediment.

Major locations of cobble beaches



THE PHYSICAL ENVIRONMENT

Formation

Where Do Cobbles Come From?

The overall character of cobble beaches is determined by the events of land rather than the sea. Cobbles are formed mainly through the accumulation of glacial till or material that was scraped or ground off bedrock as glaciers moved. Cobble is less often formed through the erosion of bedrock on the coast.

Glaciers and cobble beaches

Cobble beaches are formed largely where there is erosion of glacial deposits on islands or on headlands that were left behind by the retreat of glaciers. This includes periglacial and glaciofluvial deposits. Periglacial deposits were laid down adjacent to the margin of the actual glacier. Glaciofluvial deposits of sediment ranging in size from coarse cobbles down to silt were deposited from rivers of water that flowed from a glacier as it melted. Coastal and offshore drumlins provide sediment for beach deposits of cobble. Drumlins are smooth hills of glacial till that were formed during the last ice age. They are 15 to 30 m high and may be longer than a kilometre. From the air they are egg-shaped with the pointed end indicating the direction of the flow of ice that created them. Drumlins are composed of loose stones and boulders of various sizes. Drumlins, by virtue of their composition, are well drained and easily eroded.

In Newfoundland and Labrador drumlins are not important. Here most sediments are raised glacial/marine deposits.

Glacier carving a valley

How Do Cobbles Accumulate on a Beach?

Cobble beaches often form a distinctive profile. The profile of a cobble beach is usually described as 'stepped' because it has a number of distinctive areas as you go from extreme low tide to extreme high tide. Distinctive sorting of shapes is often apparent in a profile. Packing of different sized sediment together often occurs.

Cobble beaches with a step-berm profile experience waves that break prematurely and re-form as spilling breakers. Storm beaches or berms of cobbles are formed in areas of high energy at or above the high tide mark. Cobbles are thrown up by waves and tidal action. Not all beaches have berms associated with them. They're only found when wave run-up fails to be confined to the beach face, and water and sediment pass over the crest to settle on the landward side.

On some beaches, storms have thrown up gravel and cobbles behind the berm to form structures called beach ridges. These are different from dune ridges, which are made of finer material and form behind the beach. A beach ridge may persist for years until the waves of a huge storm break it up.

Beach cusps form on the upper part of the beach face and the outer portion of the berm. They're anywhere from a few metres to 60 m across. They're composed of any grain size including cobbles and boulders. The largest sediment forms a projection between cusps called the cusp horn. There are many theories, but the exact reason for their formation is not resolved.

What is Shore Erosion?

Shore erosion is a seaward cutting into land by waves and currents striking, bulldozing, and heaving the land in its path. With the help of weathering and gravity, waves and currents are continuously transporting and depositing erosional debris. Where the erosion of drumlins is occurring, the smaller particles are carried away by winds, tides, and currents. The larger particles such as cobbles and boulders move less. The edges of land are in a constant retreat to the sea unless land mass is added to the coast by deposits of glacial debris.

Physical Characteristics

Beaches are usually smoothly curved with their concave side facing seaward. The character of a beach varies according to such factors as the type of sediment and the size of incoming waves. They are dynamic landforms that are able to adjust to variations in waves, tides, and other influences. When considering a beach and the physical forces that act upon it, it's necessary to consider offshore characteristics as well. For example, shallow offshore areas absorb some of the wave energy before a wave ever hits the shore, thus directly influencing the final beach profile.

Slope

The slope of a beach determines the type of sediment that will be found there. The slope is a result of the rapid percolation of the swash into the beach, and the corresponding weakness of the backwash. With the backwash reduced as a result of the percolation of water into the beach, more sediment moves landward than seaward, causing the beach to become steeper. In fact, beach slope increases with the grain size of the sediment, resulting in steep cobble beaches and flat sand beaches. The steepest beaches face the highest waves and the strongest winds. In contrast, flatter beaches are the most protected from waves and wind. Steep beaches become steeper during calm seas and less steep during storms.

Sediment

Size

Beaches pass quickly through the cycle that other landscape forms undergo from their formation until they're entirely eroded away, with the young stage being followed by the stages of maturity and old age. Young beaches tend to have larger calibre sediment as sediment falls from the coastline cliffs faster than it can be ground up. Fine sediment moves seaward leaving the larger sized sediment such as cobbles on the beach.

Beaches loaded with coarse sediment are levelled to the horizontal more slowly than those with finer sediment because the swash drains through the sediment readily and there is little backwash.

Material eroded from one area on the coast is deposited elsewhere. This deposition and erosion may form an equilibrium over time or one process may work faster than the other. All materials within reach of the waves on a shore tend to migrate along the shore in a process called beach drift. Sediment is carried up the beach at an oblique angle by the swash and then swept down perpendicularly by the backwash. Beach drift is generally in the direction of the dominant winds. The resultant effect over time is for sediment to migrate downwind and accumulate against other shores far away. This is less evident on cobble beaches where there is a small backwash resulting from the drainage provided by cobble stones.

Tides

see activities 4, 14

Tides exert a strong influence on wave processes and thus on beach sedimentation and erosion. Where there are high tidal ranges wave energy is less concentrated and water level changes faster and by greater amounts.

Movement of sediment

Movement of beach sediment has been studied fairly extensively and is still poorly understood. The most mobile sediment has been found to be not the smallest stones, but those of intermediate size. This shows that the long-shore movement of sediment is more than just a winnowing action (whereby fine sediment is separated from coarse), but instead involves much more complex relationships. It's hard to experiment with sediment because introduced sediment is often not accepted by resident sediment. Its movement cannot be concluded as typical for the resident sediment.

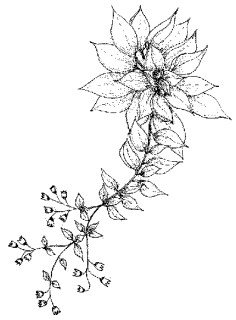
see activity 23

Waves

The uprush or swash of water carries a highly corrosive load of sand, gravel, and cobbles. During moderate weather, the waves disturb only the upper layer of the debris that covers the beach, but in storms the entire mass may be moved back and forth, grinding the beach lower.

Large breaking waves throw cobbles up above the limits of the swash, building ridges at the back of the beach that are considerably higher than the high tide level. Storm ridges often develop across the mouths of small streams, diverting the flow of water to the sea.

For more information on waves and their effects on coastal ecosystems please refer to module 1: Introductory module.



BIOLOGICAL FEATURES

Zonation

A cobble beach offers a precarious, unstable anchor for inhabitants. The size of the rocks and their close contact give some protection to some of the inhabitants by providing crevices and shaded caves. The upper surfaces of the cobbles can provide a substrate for intertidal rockweeds. The rockweeds in turn provide protection for the inhabitants of the caves and crevices between the cobbles and thus protect them from desiccation and temperature fluctuation. In fact, in sheltered spots, every available cobble surface abounds with organisms. Even the cracks in the cobbles and the mud and sand under the cobbles will contain crabs, snails, sideswimmers, worm tubes, egg cases, and a great variety of other life.

Beach life is distributed in zones parallel to the shoreline because of the varying ability of different plants and animals to withstand the conditions that occur when they're exposed at low tide. The most adaptable organisms live at the top of the beach.

They're exposed to the air for the greatest length of time. The width of each zone is determined by the slope of the beach-the steeper the slope, the more narrow the band. Larger cobbles may be covered in seaweed and barnacles, whereas smaller cobbles may be pretty well barren, depending on the amount of wave exposure. The movement of lighter rocks dislodges or kills any plant or animal that tries to attach to them. This movement is often seasonal. Many cobble beaches have productive ephemeral (short-lived) animal and plant communities that are adapted to take advantage of seasons with calm weather.

Low Water Mark

Organisms that are least able to withstand desiccation, temperature fluctuation, and exposure to air are found near the low water mark.

Once uncovered, these inhabitants must wait only briefly for the return of the tide, nevertheless it's an uncomfortable period for them as they are marine life and need the sea. Some of these organisms only see the direct sun and feel the drying effects of the air twice a month during the exceptionally low tides. These low tides are a good time to view plants and animals that are seldom seen, such as stranded fish, sponges, the larger predatory snails, and sea stars.

Intertidal Zone

The intertidal zone is a rough place to live, but there is a rich supply of food and a good variety of potential homes. Intertidal inhabitants are adapted to harsh conditions such as the drying wind and sun; fresh water in the form of rain; frigid winter air or hot summer air; attack by fish and beachcombing humans; ice cakes and winter storms that can carry the inhabitants to a new shore location or out to sea.

Here creatures such as sea stars, periwinkles, crabs, and various types of seaweed can be found. They can be exposed for some time without dying.

Upper Beach and Wrack Line

The wrack is found where the highest tides reach. It consists of seaweed, shells, driftwood. Scavengers that feed on the plant and animal matter in the wrack such as beach fleas, mites, spiders, bacteria, and flies live in the wrack. They help to break it down while it's stranded on shore. When the next spring tide comes in to take it back to the sea, the decomposed material is returned to the sea and recycled through the ecosystem. When it's redeposited it contains newly detached seaweed and other material. In such turbulent environments wrack plays an important role in the recycling of nutrients.

There are unique species that live here and nowhere else. They have adapted to the special conditions of this area.

The wrack rests on the upper shore on cobbles. Beyond the wrack line some lichens and flowering plants such as Beach-Pea and Sea-Lungwort are found.

Inhabitants

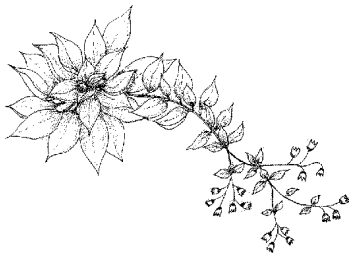
The abundance of life on a cobble beach depends on the size of the cobbles and where the cobbles are located on the beach. Larger cobbles packed together can be as stationary as boulders, thus allowing organisms to colonize their tops and sides, whereas small cobbles are constantly overturned.

Some cobble beaches are not made purely of cobbles, rather there is a grading of material from sand at the low tide mark to cobbles near the high tide mark. At this cobble/sand interface, if it isn't located too high up on a beach, is a perfect spot for some of the burrowing creatures and those that live under rocks.

In discussing inhabitants of a cobble beach, it must be noted that not all of them will be found on any one beach. In sheltered areas, a few of the following inhabitants may be found in varying densities depending on the suitability of conditions.

Plants

Algae or seaweed make up most of the plant life found on a cobble beach. Few land species have the necessary adaptations to permit their growth in this type of environment. Notable exceptions include the Beach-Pea and Sea-Lungwort. Seaweed is the primary producer in the intertidal zone. In addition to food, it provides protection by sheltering plants and animals that live on and under it when the tide is low.

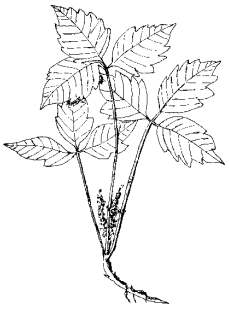


Sea-Lungwort, Oysterleaf

Oysterleaf has blueish green leaves with pink to blue flowers. Oysterleaf refers to the salty-fishy flavour of the leaves.

Beach-Pea

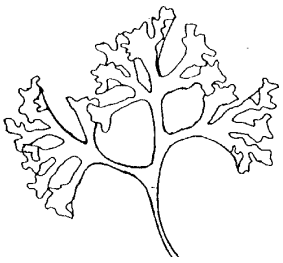
The Beach-Pea is tolerant of salt spray and low soil moisture. It produces small amounts of edible peas similar to the garden pea.



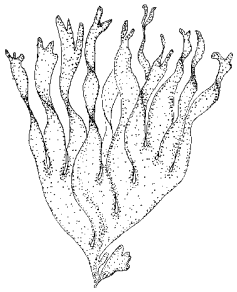
Poison Ivy

Poison Ivy is rare on the New Brunswick coast and common in the dunes of Nova Scotia. Allergic reactions increase after each contact.

Irish Moss



Irish Moss is a member of the red algae, variable in colour and form, but usually deep purplish red and bushy. Repeatedly forked blades come from a short stalk.

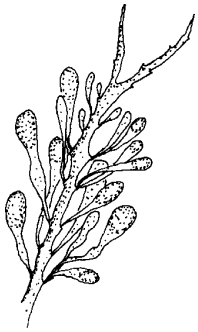


Dulse

see activities 28, 29

Dulse grows up to 30 cm in length. This tough, leathery red algae with purple-red to yellowish coloration is found in the lower intertidal zone on cobbles and other algae. The blades on this perennial seaweed are broad, lack ribs and have a small stalk.

Knotted Wrack

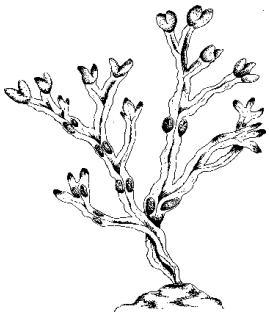


Knotted Wrack is an olive-coloured rockweed with air bladders at regular intervals. It can get up to 60 cm in length. Found on rocks in the intertidal zone, this brown algae is below the upper band of rockweeds. Very slippery.

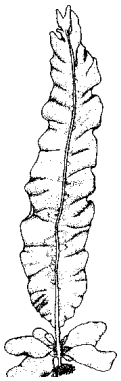
Sea Lettuce

Sea Lettuce is bright green with ruffed edges and a short stalk attached to rocks or free-floating. Up to 90 cm with an annual blade and a perennial holdfast.

rockweed, wrack



Rockweeds are brown algae with broad, flat blades with a distinct midrib and a tough discoid holdfast. *Fucus spiralis* is found at extreme high tide zone. *Fucus vesiculosus* is found in the mid-lower intertidal zone bearing paired, pea-shaped air bladders that are found at intervals along the blade. *Fucus serratus* is found in the lower intertidal with toothed edges and lacking air bladders. It is not a native, but was introduced from Europe.

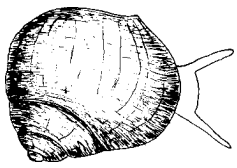


Sugar Kelp

Sugar Kelp has a dark brown, long, leathery blade, lacks a midrib, and has a strong round stipe or stalk. It can be found attached to rocks at low tide with a branched holdfast.

Molluscs

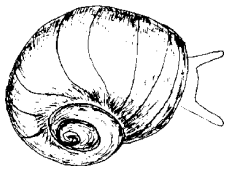
see activities 33, 35, 36



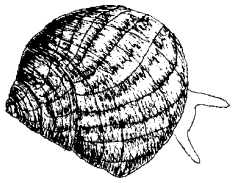
Common Periwinkle

This periwinkle is found intertidally on rocks where it feeds on algae. It's able to withstand periods of drying and food shortage. It's edible, after boiling. 3.1 cm.

Smooth Periwinkle



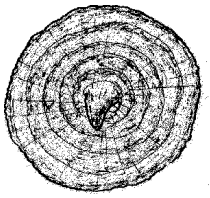
This small, roundish periwinkle ranges in colour from yellow to orange, brown, green, or black. It's found intertidally among rockweeds. 1.2 cm.



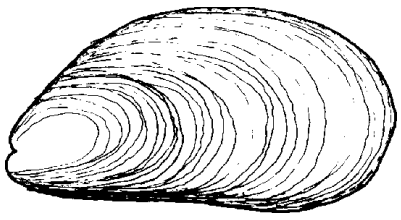
Rough Periwinkle

The Rough Periwinkle lives higher on the shore than does the Common Periwinkle. It produces live young instead of aquatic eggs and larvae. 1.2 cm.

Cup-and-Saucer Limpet

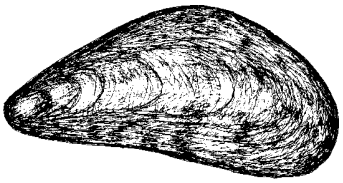


Cup-and-Saucer Limpets are circular with a conical, twisted apex. They are found intertidally in Nova Scotia on rocks. 2.5 cm.



Horse Mussel

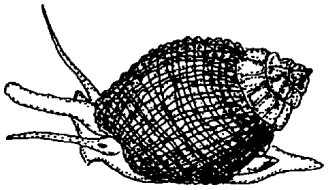
Horse Mussels are larger than Blue Mussels. Externally they're shaggy, brownish or bluish black with a whitish shell sometimes tinged mauve. They're found attached to rocks intertidally extending to the subtidal zone. 15 cm.



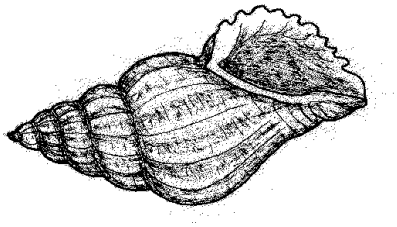
Blue Mussel

Blue Mussels are found intertidally on rocks. They fasten themselves with tough threads. The external part of the valves is shiny bluish or bluish black and the inside is violet. They're edible and may take anywhere from 1-5 years to become full-grown. 10 cm.

Dogwinkle



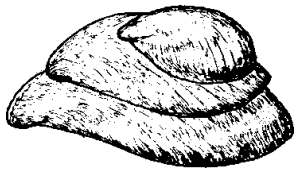
Dogwinkles are found intertidally, where they prey on other molluscs such as barnacles and mussels. Their colour depends on what they've consumed. They're white if they live on barnacles and brown or purplish if they eat mussels. 3.8 cm.



Oyster Drill

Oyster Drills are found in the intertidal zone to subtidally where they attack oysters by drilling a hole in the oyster's shell and then sucking the soft parts out. 2.5 cm.

Common Slipper Shell



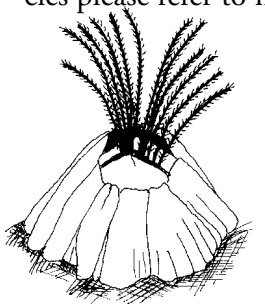
The Common Slipper Shell is common in the intertidal zone, attached to rocks. The shells are slipper-shaped with one end covered halfway with a platform. 3.8 cm.

Insects

Insects are a common inhabitant of the strandline and the uppermost tidal level. They may make their presence known by inflicting bites or flying around your head or you may never see them at all. They include mosquitoes, black-flies, house flies, horse flies, ants, kelp flies, spiders, and mites.

Crustaceans

A variety of crustaceans can be observed on the cobble beach, including crabs, scuds, beach fleas, Gribbles and barnacles. For extensive information on barnacles please refer to module 7: Rocky Shores.

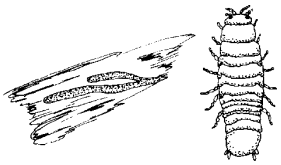


Northern Rock Barnacle

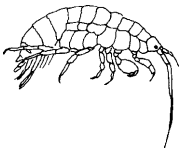
Barnacles are found with blue mussels and rockweeds on rocks and pilings in intertidal areas. They're white or stained. In crowded colonies, individuals may grow up rather than out. Barnacles secrete a shell of calcareous plates. When covered in water, acorn barnacles, including the Northern Rock Barnacle, extend feathery cirri that trap plankton and detritus floating in the water. 2.5 cm.

see activity 34

Gribble



Gribbles are small, wood-boring isopods that are found intertidally on woodwork, feeding on a fungus in the wood. By burrowing into the wood, they reduce it to a spongy consistency, making the wood fall apart easily. 0.5 cm.

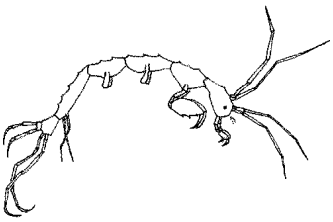


beach flea

Beach fleas are dark olive to reddish brown. They are often found under seaweed and debris that has been washed up on shore. Their name is derived from their means of locomotion-they jump like a flea. 1.9 cm.

scud/side swimmer

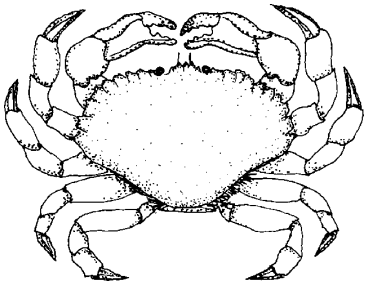
Scuds live lower on the beach than do the beach fleas. They swim on their sides and are found under rockweeds or intertidal rocks. 0.31 cm.



Skeleton Shrimp

Skeleton Shrimp are delicately transparent to brown or reddish. They're found among other organisms on rocks and wood structures. 1.2 to 1.9

cm.

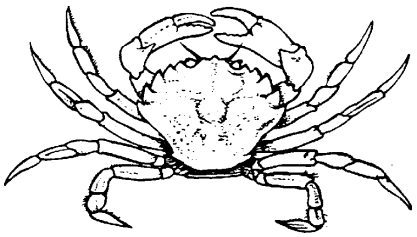


Rock Crab

The Rock Crab is yellowish, freckled with reddish or purplish brown. It's found intertidally on all bottom surfaces, under rocks and in crevices. This crab is a scavenger that occupies deep water in winter and migrates to shallow water when it warms up. 13.1 cm.

Green Crab

Male Green Crabs are greenish on the back to yellowish underneath while females are red dish orange underneath. They're found intertidally under stones, in pools, and in crevices. To 7.5 cm.

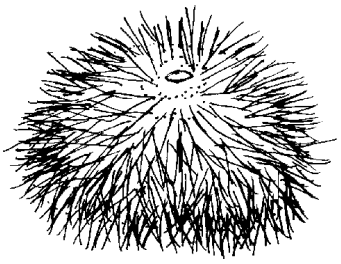


Echinoderms

Echinoderms or 'spiny skins' in the intertidal zone of the cobble beach include sea stars, sea cucumbers, and sea urchins.

Green Sea Urchin

Green Sea Urchins are greenish with spines. They're found intertidally in tide pools. They provide food for foxes, seabirds, sea stars, people, cod, and other fishes. 7.5 cm.

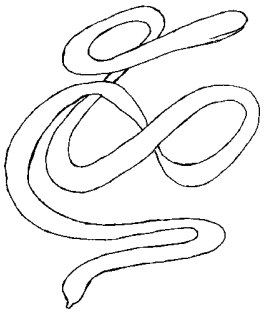


Worms

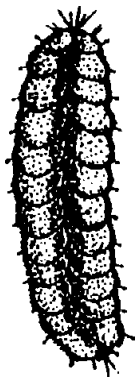
Nemertean worms are soft, leech-like, unsegmented and lack appendages. They have a retractable proboscis that exits through a tiny pore and is used to impale prey. They break if handled. Individual colours are important in identification.

Most polychaete worms are externally segmented. They have bristles or setae that vary in form and detail and are the basis for differences between species.

Milky Ribbon Worm



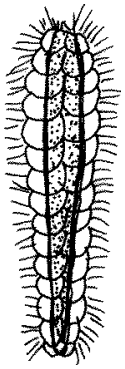
The Milky Ribbon Worm is a thick ribbon-like worm that is white or tinted pink. Found intertidally under rocks. 0.9-1.2 m long by 1.2-1.6 cm wide.



twelve-scaled worm

Twelve-scaled worms are worms with 12 or 13 pairs of scales that are roughened. They range in colour from brown to brown mixed with yellow, red, or green. They're found intertidally on all bottom surfaces except mud among seaweed, animals, and in crevices. They roll up like a pill bug when disturbed. 5 x 1.6 cm.

fifteen-scaled worm



The fifteen-scaled worms have 15 scales. They're found with twelve-scaled worms in a wide variety of habitats and associations including commensally with hermit crabs. 6.2 x 1.9 cm.

Other Invertebrates

Sponges

Sponges are the most simply organized of multicellular animals. Lacking organs, their cells are specialized for different functions. Identification relies on spicule form and arrangement as well as body colour and form.

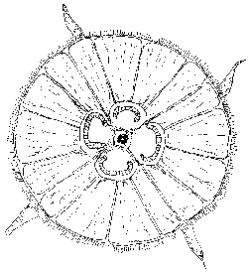
Crumb of Bread Sponge

The Crumb of Bread Sponge is a common green sponge that can be found in colonies encrusting rock surfaces. The common name of this sponge refers to its texture.

Hydroids

Hydroids have a polyp or medusa form or they alternate generations of each phase. They have nematocysts that serve to protect the hydroid and help to capture food. Nematocysts are microscopic, egg-shaped capsules found in special cells with a trigger-like bristle projecting from the surface. When this bristle is disturbed, the tube suddenly flies out and becomes embedded in whatever disturbed it, injecting poison.

Jellyfish



Jellyfish are found on the beach when left high and dry by the retreating tide. The common jellyfish in this area is the Moon Jelly. Jellyfish capture tiny zooplankton with their tentacles.

Sea Anemones

Frilled Anemone

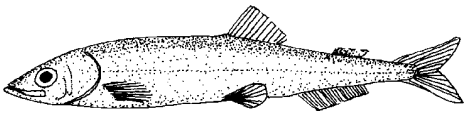
The Frilled Anemone is smooth orange to yellowish brown. It is found intertidally to subtidally in rock crevices and pools. 10 cm tall and 7.5 cm wide.

Bryozoans

Bryozoans are sessile, colonial animals. Colonies grow along a stolon-like, creeping vine, or form crusts that may be rubbery or gelatinous.

Fish

Very few fish come on shore. These fish take advantage of the intertidal zone when the tide is high. Some fish may be caught in intertidal pools when the tide retreats.

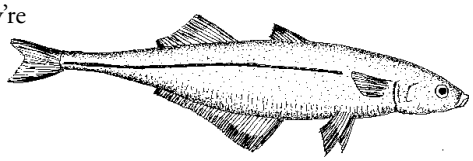


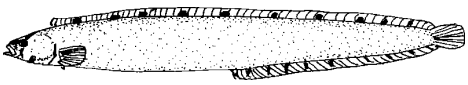
Capelin

Capelin are normally fish of the high seas. They come to coarse sand or gravel beaches to spawn. They spawn where the waves are breaking onto the beach and some are left stranded in the process. Cod are the capelin's main predator, but they're also eaten by salmon, dog fish, seagulls, and terns. To 20 cm.

Atlantic Silverside

Atlanic Silversides are small, silvery and slender. They're found in shallow waters and may become trapped in tide pools. They're protected from predators by their shallow water habitat. To 13.7 cm.



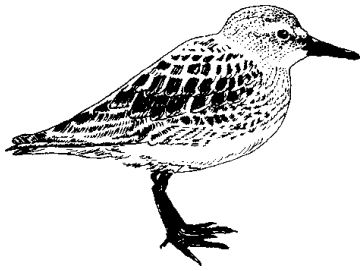


Rock Gunnel

Rock Gunnels are found in tide pools hiding under stones and seaweed. Rock Gunnels, as their name suggests, avoid muddy bottoms. Around 15 cm.

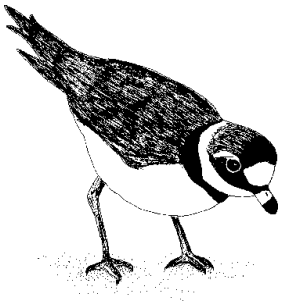
Birds

Shorebirds forage different areas of a beach depending on the substrate type and available prey. These birds are able to find invertebrates in the wrack on cobble beaches. Cobble beaches provide important breeding sites for certain birds such as terns.



Semipalmated Sandpiper

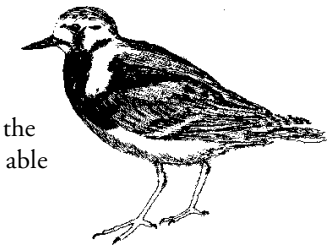
The Semipalmated Sandpiper feeds at the wrack/water interface when waves turn over sections of the wrack exposing the invertebrates. It has a short bill so it is not able to penetrate the lower layers of the wrack to obtain invertebrate larvae and pupae. 16 cm.



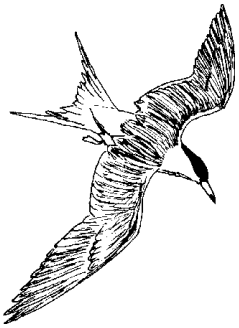
Semipalmated Plover

Semipalmated Plovers are visual feeders with short bills. They glean insects from the top of the wrack. Some nest on cobble beaches in Nova Scotia and Prince Edward Island. Their back is dark to match their surroundings. 26-34 cm.

Ruddy Turnstone



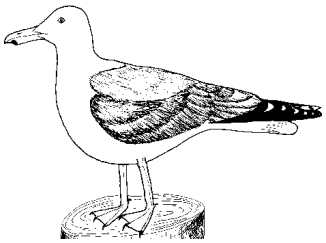
Ruddy Turnstones are able to turn over stones and other items to obtain prey. They're able to flip over the top wrack layers to get underneath. These birds are able to open barnacles and excavate holes in search of invertebrates. 20-25 cm.



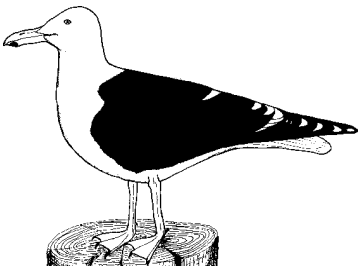
Common Tern

Common Terns like to nest on sandy, gravely, rocky beaches so the cobble beach is an ideal spot for them. They're found nesting as single pairs or in colonies. The coastal waters provide them with an ample food supply. 37 cm.

Herring Gull



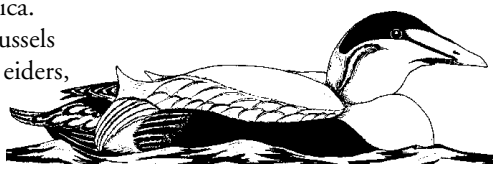
The Herring Gull is a common sight along the coast throughout the year. These birds have a grey back and wings that are tipped in black. When you think of a seagull this is the gull most people picture. They're often seen feeding at dumps, canneries, and following ships. 64 cm.



Great Black-backed Gull

This gull is much larger than the Herring Gull, and has a black back and wings with white under-parts. The bill is heavier than the Herring Gull's bill. 76 cm.

Common Eider



Common Eiders are the largest ducks in North America. They characteristically fly low over the water. Blue mussels are the single most important food item taken by the eiders, comprising 50 to 80% of their diet. 58-68 cm.

Mammals

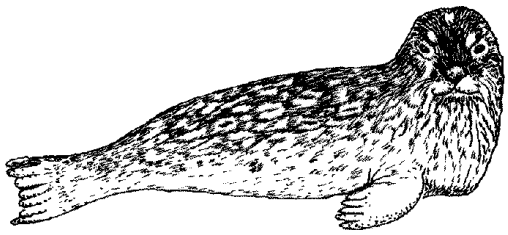
Along the coast foxes may frequent beaches in search of carrion, sea urchins, or eggs.

White-tailed Deer frequent the beach area to escape the summertime swarms of flies and to eat seaweed and salt. They are edge animals often seen at the interface of a clearing and an older stand of forest, but do not occur in P.E.I.

Masked Shrews will venture to the beach in search of insects. The inhabitants of the decomposing wrack beds are an excellent source of food for the shrew. Once in the open, the shrew becomes a prey for hawks.

Raccoons include in their diet small fish and molluscs from the beach.

Caribou, mink, and otter are the main mammals that can be observed on cobble beaches in Newfoundland.



Harbour Seal

The Harbour Seal feeds on fish such as Gaspereau, Atlantic Mackerel, cod, and Capelin and invertebrates such as crabs. Predators include Orcas, sharks, humans, and Polar Bears. It's the only seal that can live in fresh water. It comes to rocky beaches. Around 150 cm.

ECOLOGY

Life on a beach, as in any other ecosystem, is delicately balanced. A great deal of the energy that an intertidal organism expends goes into maintaining its position within the mobile sediment. When the abundance of one organism is changed many other seemingly unrelated organisms experience changes in their abundance and in their relationship to other organisms around them.

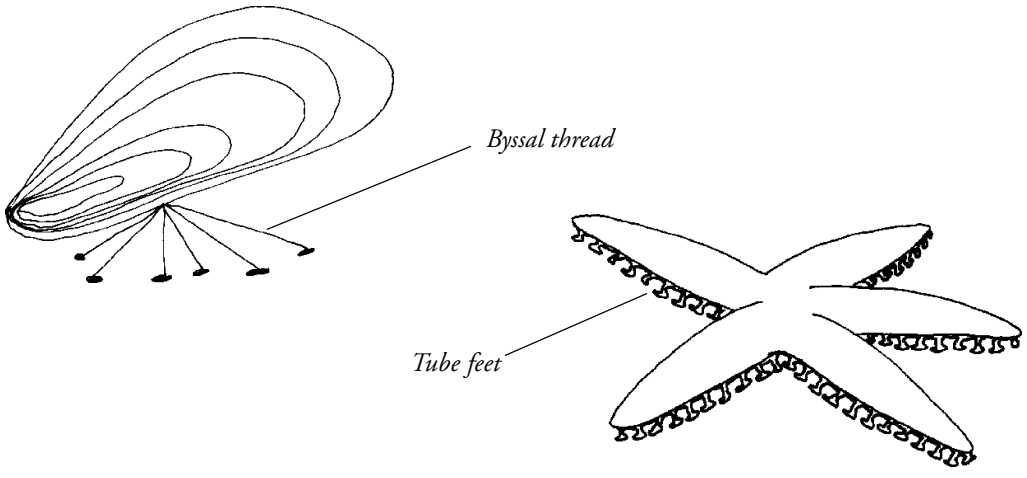
Seaweed and sessile animals live in the intertidal zone because many of their predators can't live there. Turbulent water that ebbs and flows over the intertidal rocks is rich in oxygen, carbon dioxide, dissolved nutrients, and organic debris, providing abundantly for their needs.

Stress and Survival

Holding On or Losing Out

Organisms living on a rocky substrate are not able to penetrate it. Some are fastened to it in one place permanently while others are mobile, being able to creep around on it with adhesive feet. On a rocky substrate organisms are exposed to the rigours of the physical environment. They must be able to withstand freezing in winter, baking in summer, dilution by rainwater, desiccation by drying air, and lack of obtainable oxygen.

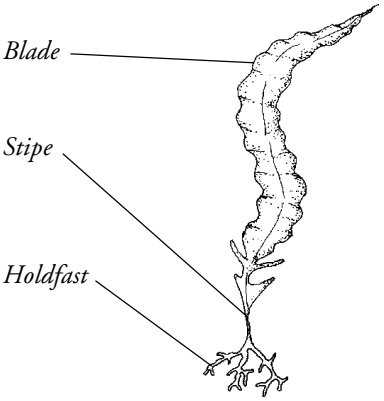
Adaptive features are necessary for an organism to maintain its position in the face of strongly moving water. Algae have holdfasts, barnacles cement themselves firmly to rocks, mussels attach by byssal threads, urchins and sea stars use tube feet. The adhesive foot of gastropods and the modified sucker-fins of many pool fish are strong attachment devices that help these organisms maintain their position in the intertidal zone.



Some organisms, such as algae, sponges, polychaete worms, and boring clams, are able to bore into rock by releasing chemicals that help to break down the rock. Others are able to change their orientation to minimize stress from the flow of water. Many use crevices between rocks to escape the full force of waves. Some organisms live in dense colonies which reduce the surface area that is exposed.

Algal stipes have increased flexibility to allow them to bend with the waves. They may also have irregular surface contours, such as the ridged or crinkly fronds of many kelp, to reduce turbulence and minimize drag.

For more information on seaweed please refer to module 2: To the Horizon - The Nearshore, and module 7: Rocky Shores.



Algae

Only where brown algae grow thickly on rocks can animals and smaller algae find protection from the daily changes in temperature, salinity, desiccation, and crashing waves.

Once a plant attached to a cobble reaches a certain size it may provide enough buoyancy to allow it and the rock to which it's attached to be transported to deeper or shallower areas by wave action. When this happens the algae may die as it may no longer be able to receive light in the wavelengths it needs to perform photosynthesis.

Disturbance

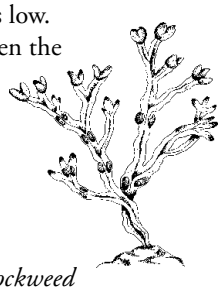
When rates of disturbance are high, species that are slow to grow or recruit new individuals may be prevented from establishing themselves. Species that are able to resist disturbance, such as crustose algae, are able to dominate habitats in a disturbed environment. The largest cobbles, which are infrequently moved, are able to support life similar to boulders. Life is found generally on the top and sides of these rocks. Cobbles that are smaller may be turned slightly as is indicated by attached life growing underneath them. Their disturbance is not great enough to completely eradicate all life associated with them.

Hot and Cold

Algae need to be very flexible to withstand the movement of the ocean water. This flexibility allows brown algae to lie flat on their substrate when the tide is low and float in a luxurious jungle when the tide is high. When the algae are flat they serve to protect seaweed and other algae underneath them from desiccation, high temperatures, and killing frosts.

Temperature Adaptations

Algae have thick cell walls that protect them against desiccation. When they overlay other organisms, the algae prevent the substrate underneath from drying out, thus allowing creatures that would otherwise not survive to live quite comfortably when the tide is low. Normally, algae are frost hardy as they are able to release water quickly when the temperature lowers to prevent damage to their cells when ice crystals form. During killing frosts, when the tide is low, the upper layers of algae may be killed, but those underneath remain viable. Alginates (polysaccharides) in cell walls help the brown algae cope with temp erature and desiccation stress.

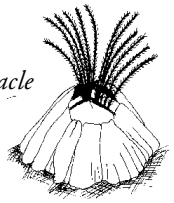


rockweed

Barnacles can withstand temperature fluctuations ranging from 44 to -15° C. A barnacle can retain sea-water when exposed by low tide, which helps to keep its temperature more or less constant in the cold. It can also rapidly get rid of water from within cells to prevent ice crystals from forming and rupturing the cells. In this manner, the ice crystals form between the cells of the barnacle so that the individual cells may be distorted, but not rupture.

Barnacles use water evaporation or transpiration to survive during extreme heat. Evaporation of bodily water allows the barnacle to be 5½C below the temperature of the surrounding air, thus it can survive heat that kills most other animals. The upper limit of barnacle distribution is limited by how much heat they can stand in the summer. Cobbles are small in mass and large in surface area so they heat very quickly during low tides on a sunny summer day. This can lead to a huge mortality on cobble surfaces. Barnacles found in these areas are on the larger cobbles or in dense colonies that buffer against temperature extremes.

barnacle



Barnacles have a special blood pigment that allows them to use a very small amount of oxygen that they have stored and to survive while completely closed.

Mussels are prevented from living high up on the beach because of the high temperature associated with cobbles on a sunny day.

Interactions between Species

As organisms grow they have different requirements. Many organisms pass from a free-swimming larval stage to a sessile adult stage. Thick mats of encrusting algae on intertidal rocks keep densities of barnacles low by not allowing free-swimming larvae to settle. Herbivores grazing on these mats provide space for barnacles to attach. This in turn reduces the density of herbivores by reducing foraging space. Interactions of this type are common in intertidal communities.

Small juvenile sea urchins take shelter from predators by hiding under cobbles. As the sea urchins grow, they graduate to boulders and the larger interstitial spaces where they aggregate on the underside for protection.

A beach is populated with detritus and predatory feeders such as echinoderms, birds, molluscs, and crustaceans. Many of these are able to move up and down the beach with the tide. Some feed on the wrack or the strand line. Significant predation occurs between high and low tides. Sea birds can consume between 30 and 50 bivalves an hour. Over a year this can constitute up to 40% of the standing population.

Productivity

Cobble beaches are important to other coastal ecosystems through the transfer of nutrients, sediment, and food. On a cobble beach, primary production occurs in the form of seaweed growth. The growth of seaweed may be severely limited or non-existent in exposed conditions. Plankton captures energy that can be used in the ecosystem. Energy is also provided by nutrients and plants transported in from adjacent areas. Herbivores and detritus feeders are present in varying quantities. In intermediate and low energy areas numbers are fairly high but in high energy areas, with the resultant unstable substrate, their numbers are low.

Food Web

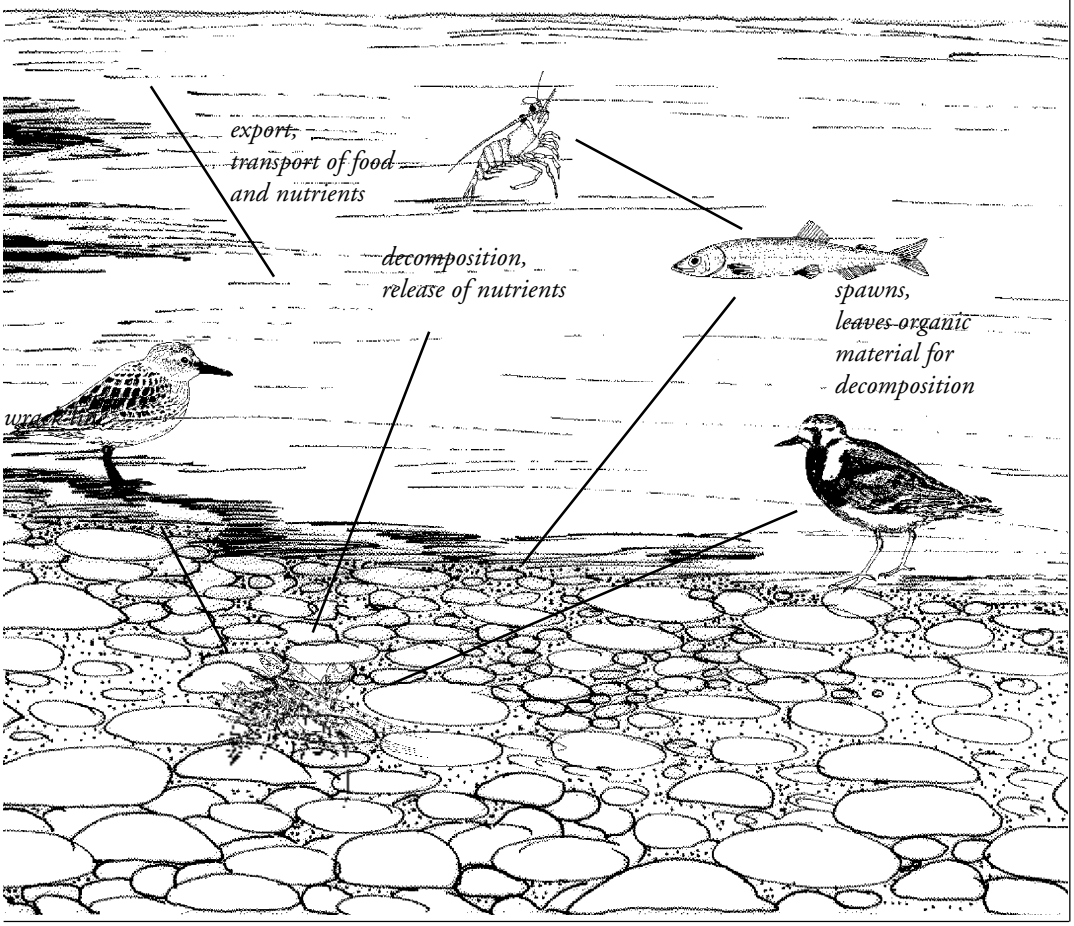
The wrack bed is a major site of decomposition. It's where organisms are decomposed into their constituent inorganic parts. These inorganic components can be recycled and used in the formation of new organic matter. When a spring tide comes and the water mixes with the wrack the inorganic nutrients are circulated about the nearshore water and the water farther out to sea or along the coast, thus nutrients are transported out of the system.

see activity 40

Food in the form of seaweed or young free-swimming animals can also be carried along the coast to other ecosystems. The same process that carries the food and nutrients along shore is responsible for transporting sediment.

Simple food relationships on the cobble beach

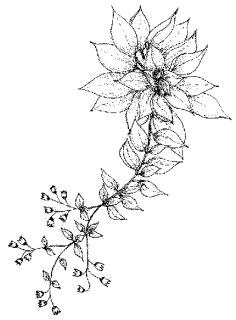
see activity 40



Wrack or strand line

The wrack or strand line is composed of plant and animal life and remains gathered from intertidal, subtidal, and far offshore areas and deposited at the upper limits of the highest tides. It can provide a glimpse of the subtidal life that is not usually seen. It can contain rockweeds, kelp, salt marsh grasses, Sea Lettuce, coralline algae, Eelgrass, Irish Moss, mermaid's purses, jellyfish, sea urchins, dead sponges, crab, snail and mussel shells. Many shells, egg cases, and moults become broken in their journey to the beach, but others are in perfect condition. The wrack bed along the high water line, in various stages of decomposition, teems with life and is a major foraging location for shorebirds that stop during their southward migration. The wrack provides a place for shorebirds to feed when the tide is high. Common Eiders, Great Black-backed Gulls, Herring Gulls, and Masked Shrews also feed on invertebrates that reproduce in the wrack. It's a highly profitable habitat for shorebirds as they have to expend very little energy to gain a great deal of energy in the form of prey.

The wrack line changes composition with the varying tides and winds found along the coast. There is a new wrack bed immediately following the full moon and the new moon. The kelp fly is credited with the majority of the decomposition of the wrack. Growth from egg to adult takes two weeks, which fits neatly within the time period that the wrack sits on the beach undisturbed by the water.



COBBLE BEACHES AND US

Importance to Humans

On cobble beaches we find diversity of life, rare species, fragility in that the beach life can be easily damaged, and aesthetic appeal. They are nice places to get away from the hustle and bustle of daily life and to take part in recreational activities such as bird watching and rock climbing. Perhaps this is why so many people flock to the shore during the summer months. The beach, where land and water meets, is the point from which the moderating effects of the ocean on air temperature and climate can be felt.

Problems in the Ecosystem

Beaches are thought to be great sources of sediment. It's true that most beaches are eroding, but removal of sediment for the construction industry upsets the equilibrium of the beach. The source of sediment is so low that new sediment deposition occurs at a very low rate and recovery is very slow. When minerals are taken intertidally or subtidally this activity can cause problems for coastal protection. Material taken from a single source can impact areas far removed.

When channels are dredged for harbours and shorelines are reclaimed for residential and industrial development, habitat is destroyed for those creatures living in the areas affected.

To prevent erosion from a certain part of the coast, huge boulders are sometimes dumped at the coastline. This prevents erosion at the site of the rocks, but farther down the coast erosion will proceed at a greater rate.

Garbage can be found on all our beaches in the coastal zone, posing a threat to humans and wildlife alike.

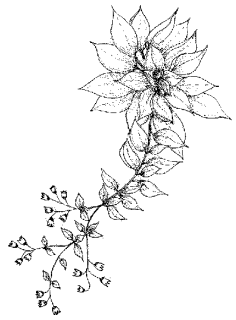
Dredged materials that are dumped near the shore area can be carried onto beaches by wave, current, and tide action where they may interfere with the recreational use of beaches. Some dredged materials may contain oil, grease, or other toxic materials, which can affect filter-feeding animals such as shellfish by poisoning them. Oil spills can leave a beach extensively damaged. On cobble beaches dispersed oil can be removed rapidly by water as this material forms an extremely porous substrate. During an oil clean-up bulldozers are the only type of heavy equipment that can operate on a cobble beach. Sediment removal from a cobble beach that has been contaminated with oil is not a viable option because of the slow replacement of sediment from natural sources, so contaminated cobbles must be cleaned in place, or left alone.

Protection of the Ecosystem

Protection of a beach includes the physical beach and the organisms that live there. If the material that the organisms live on is removed then they no longer have a home. Animals most in need of protection in a marine environment are those living in shallow water, between the tide marks or in the beach area.

Beaches provide a nesting ground for certain species of birds. If their breeding grounds are disturbed the birds will not nest or will do so unsuccessfully.

Cobble beaches are unique ecosystems. They need our protection. They provide a home for many animals and plants.



SPECIES LIST

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 cobble beach. There are also great regional and local variations, and we realize the difficulty in accommodating all of these.

Plants

Wavy Hair Grass	*Deschampsia flexuosa*
Sea Lyme-Grass	*Elymus mollis*
Squirrel-tail Grass	*Hordeum jubatum*
Creeping Juniper	*Juniperus horizontalis*
Bluebell/Harebell	*Campanula rotundifolia*
Seaside-Plantain	*Plantago maritima*
Seaside Goldenrod	*Solidago sempervirens*
Three-toothed Cinquefoil	*Potentilla tridentata*
Red Fescue	*Festuca rubra*
Scotch Lovage	*Ligusticum scothicum*
Pearlwort/Birdseye	*Sagina procumbens*
Knotted Pearlwort	*Sagina nodosa*
Alkali-Grass	*Pucinellia langeana*
Sea Rocket	*Cakile edentula*
Saltwort	*Salsola kali*
Beach Wormwood/Dusty Miller	*Artemisia stelleriana*
Beach Sedge	*Carex silicea*
Poison Ivy	*Toxicodendron rydbergii*
Bayberry/Candleberry	*Myrica pensylvanica*
Seabeach Groundsel	*Senecio pseudoarnica*
Beach-Pea	*Lathyrus japonicus*
Sea-Lungwort/Oysterleaf	*Mertensia maritima*

Seaweed

hollow green weed	*Enteromorpha sp.*
Sea Lettuce	*Ulva lactuca*
spongomorpha	*Spongomorpha sp.*
Bootlace/ Smooth Cord Weed	*Chorda filum*
	Chorda tomentosa
Sugar Kelp	*Laminaria saccharina*
Knotted Wrack	*Ascophyllum nodosum*
rockweed	*Fucus spiralis*

	Fucus vesiculosus
	Fucus serratus
Spiny Sour Weed	*Desmarestia aculeata*
Irish Moss	*Chondrus crispus*
Coral Weed/	
Encrusting Coralline Algae	*Corallina officinalis*
Dulse	*Rhodymenia palmata/*
	Palmaria palmata
laver/nori	*Porphyra sp.*

Molluscs

Common Periwinkle	*Littorina littorea*
Smooth Periwinkle	*Littorina obtusata*
Rough Periwinkle	*Littorina saxatilus*
Cup-and-Saucer Limpet	*Crucibulum striatum*
Common Slipper Shell	*Crepidula fornicata*
Oyster Drill	*Urosalpinx cinerea*
Dogwinkle	*Nucella lapillus*
Bushy-backed Nudibranch	*Dendronolus frondosus*
red-gilled nudibranch	*Coryphella sp.*
Blue Mussel	*Mytilus edulis*
Horse Mussel	*Modiolus modiolus*

Insects

kelp fly	*Coelopa frigida*
mites	Order *Acarina*
spiders	Order *Araneida*
horse and deer flies	Family *Tabanidae*
mosquitoes	Family *Culicidae*
black flies	Family *Simuliidae*
ants	Family *Formicidae*

Crustaceans

barnacle	*Balanus sp.*
greedy isopod	*Cirolana sp.*
Gribble	*Limnoria lignorum*
beach flea	*Orchestia sp.*
scud	*Gammarus sp.*
skeleton shrimp	*Caprella sp.*
Spider Crab	*Libinia emarginata*

Rock Crab	*Cancer irroratus*
Green Crab	*Carcinus maenas*

Echinoderms

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

Worms

polychaete worms:	
hard tube worm	*Spirorbis borealis*
	Spirorbus spirillum
twelve-scaled worm	*Lepidonotus squamatus*
fifteen-scaled worm	*Harmothoe imbricata*
nemertean worms:	
Leidy's Micruran	*Micrura leidyi*
Milky Ribbon Worm	*Cerebratulus lacteus*
many-eyed nemertean	*Zygonemertes virescens*

Sponges

organ-pipe sponge	*Leucosolenia sp.*
Crumb of Bread Sponge	*Halichondria panicea*
Bowerbank's Halichondria	*Halichondria bowerbanki*

Bryozoans

lacy crust	*Electra pilosa*
	Membranipora sp.

Cnidarians

Silver-spotted Anemone	*Bunodactis stella*
Frilled Anemone	*Metridium senile*
stalked jellyfish	*Haliclystus sp.*

Hydroids

Club Hydroid	*Clava leptostyla*
hydromedusae	*Obelia sp.*

Fish

Capelin	*Mallotus villosus*
Ninespine Stickleback	*Pungitius pungitius*
Atlantic Silverside	*Menidia menidia*
Rock Gunnel	*Pholis gunnellus*
Atlantic Snailfish	*Liparis atlanticus*
Grubby	*Myoxocephalus aenaeus*

Birds

Ruddy Turnstone	*Arenaria interpres*
Semipalmated Sandpiper	*Calidris pusilla*
Least Sandpiper	*Calidris minutilla*
Short-billed Dowitcher	*Limnodromus griseus*
Semipalmated Plover	*Charadrius semipalmatus*
Common Eider	*Somateria mollisima*
Great Black-backed Gull	*Larus marinus*
Herring Gull	*Larus argentatus*
Common Tern	*Sterna hirundo*
Spotted Sandpiper	*Actitis macularia*

Mammals

Masked Shrew	*Sorex cinereus*
Red Fox	*Vulpes vulpes*
White-tailed Deer	*Odocoileus virginianus*
Raccoon	*Procyon lotor*
Harbour Seal	*Phoca vitulina*
Caribou	*Rangifer tarandus*
Mink	*Mustela vison*
River Otter	*Lontra canadensis*
Ringed Seal	*Phoca hispida*
Harp Seal	*Pagophilus groenlandicus*