Barrier Beach Ecology

Grades 5-12

Teacher Information including Pre-Post Activities

Wetlands Institute ~ Since 1969

1075 Stone Harbor Blvd, Stone Harbor, NJ 08247

p: 609.368.1211 f: 609.368.3871 | wetlandsinstitute.org

Barrier Beach Ecology

Each summer the Atlantic Coast is the terminating point of a migration of massive proportions. Millions of individuals flock to the sandy beaches that fringe the eastern seaboard. These migrants are not birds come to breed, but sunbathers, surfers, beachcombers and surf fishermen in search of rest, relaxation and fun at the seashore. In the mad dash to the beach, marsh, back-bay, maritime forest and dune become obstacles to be gotten over, around and through. Few of these migrants realize that marsh, dune and beach are components of a complex, restless system constantly interacting with wind and water to create the most dynamic of all natural systems.

This booklet contains information and activities to help prepare you and your class for your trip to the Wetlands Institute. The activities are designed for pre and post-visit sessions; however, feel free to use the activities in a manner best suited to the needs of your class.

PRE-VISIT ACTIVITIES

1. Protecting the New Jersey mainland from Sandy Hook to Cape May is a chain of barrier spits and islands stretching more than 100 miles. **Name That Island!** is designed to introduce your students to New Jersey's barrier beach system.

2. In the days of sail, good charts were essential to safe navigation along the coast. Sailors used sounding lines, lines knotted at regular intervals with a weight at one end, to determine ocean depths. Sonar devices have replaced the sounding line and provide us with detailed maps of the deepest ocean floor. **Charts and Graphs** will introduce your students to nautical charts and the contours of the continental shelf.

POST-VISIT ACTIVITIES

1. Beach Sand. We lay on it, play games on it and even build castles with it. Yet, what do we really know about the stuff? **Quartz and Feldspar and Hornblende, Oh My!** will give your students a close-up look at sand.

2. Barrier islands are no place to build a house. However, development on barrier islands has grown explosively since World War II. In **Down the Shore** your students will take part in a debate concerning the fate of a fictitious coastal community after a severe winter storm.

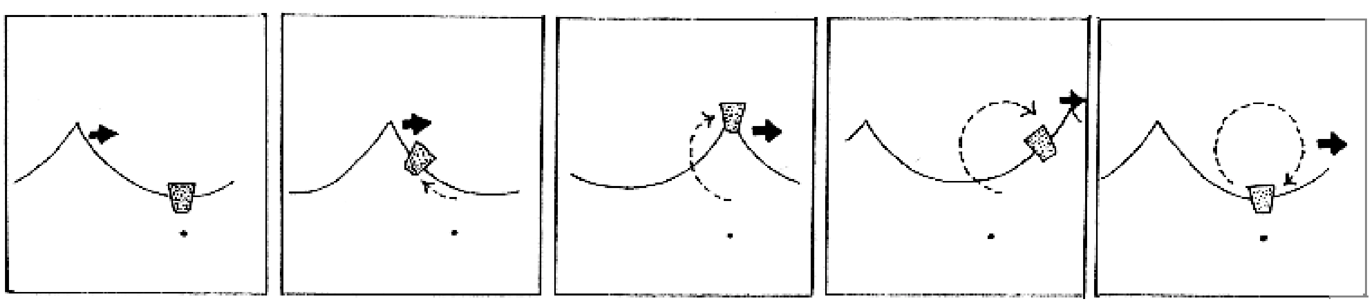
What is a Beach?

In the mid-Atlantic region a beach is usually a long ribbon of sand at the meeting place between land and sea. Not all shorelines have beaches and not all beaches are the same. Along the rocky shores of New England beaches are more often small pocket beaches tucked in between two rocky headlands. The beach material is often pebbles of cobbles instead of sand. In the Florida Keys beaches are also small but made up mostly of bits and pieces of seashells and other marine organisms. Some beaches are composed of coral and lava sand.

Mid-Atlantic beaches are composed primarily of two very hard minerals, quartz and feldspar. Eroded from distant mountains, over millions of years, this material was carried by rivers and streams to the sea. Sand at the edge of the sea never rests in one place for very long. Waves and wind are constantly carrying, dropping, shifting and reshifting the materials of the beach.

Waves

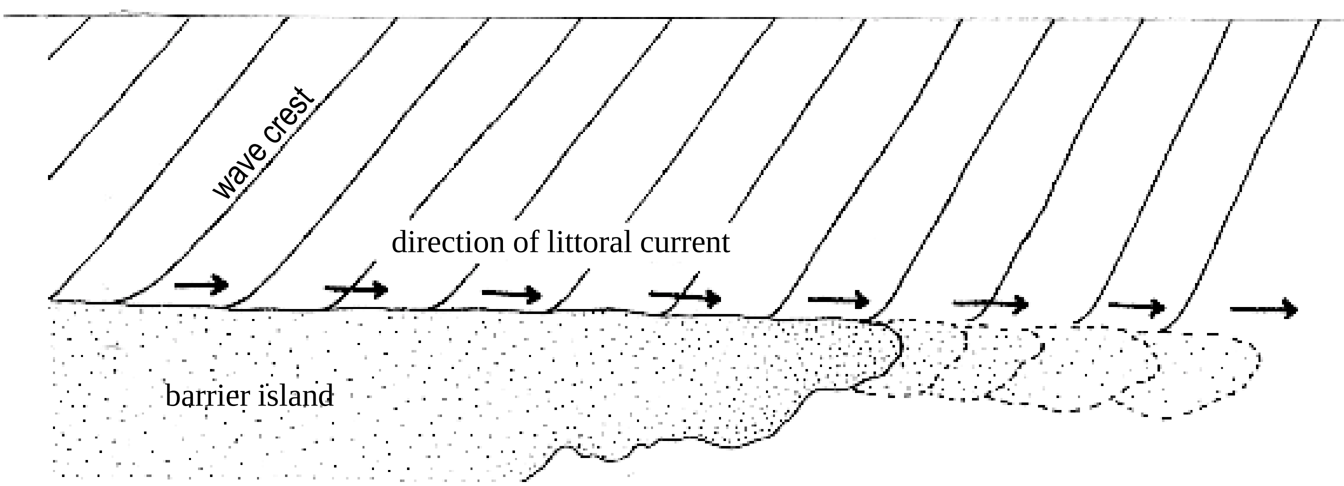
A wave crashing on a New Jersey beach is the culmination of a process that may have begun with a gentle breeze hundreds or even thousands of miles away. When wind blows across water, energy is transferred from the air to the surface of the water. Gentle breezes produce small waves. Strong, sustained winds possess more energy and create large waves. Large or small, waves are the movement of energy through water and not the mass movement of the water molecules themselves. In fact the water molecules along any part of the wave's path move only in a circular orbit. Imagine two people each holding the end of a long rope. Held motionless it could represent the surface of a calm sea. If one person were to raise and lower his or her end of the rope rapidly, energy would be transferred to the rope and it would begin to move up and down. Energy is being passed along the rope as a wave. Each section of the rope moves up and down but does not travel with the wave from one end of the rope to the other.



Waves may travel uninterrupted for thousands of miles. When the depth of the water becomes shallow enough for the bottom of the wave to touch the sea floor, the wave begins to change. In a complex process the wave becomes unstable, collapses in upon itself and becomes a breaker. When a wave breaks, the water itself is cast forward onto the beach. The wave's energy is finally spent and it dies on the beach. The water it carried with it in its death seeps into the sand or flows back to the sea.

Small breaking waves can pick up and move beach sand. Gigantic, powerful waves can move boulders the size of small cars. A high, crashing wave carries sand from the beach out to sea as the backwash spills back down the beach. A low, flat breaker fanning out over the beach and seeping down into the sand adds material to the beach. Even well offshore sand can be pushed toward the beach by the orbiting water molecules of a wave.

The movement of sand onto and off of the beach is only part of the beach's story. When waves approach the shore at an angle part of their energy is reflected, creating a current parallel to the beach called the longshore or **littoral current**. The larger the waves striking the shore the stronger the current. Longshore currents move massive amounts of sand along the beach.



Wind also plays an important part in the shaping of the beach. Winds blowing toward the sea move sand into the water and onto the **shoreface**. Onshore winds carry sand inland. On most beaches debris and plants obstruct the wind and cause it to drop its load of sand. Eventually small mounds form, which in times may grow into dunes. Along the Atlantic coast dunes range in size from small mounds to mountains of sand over 100 feet high.

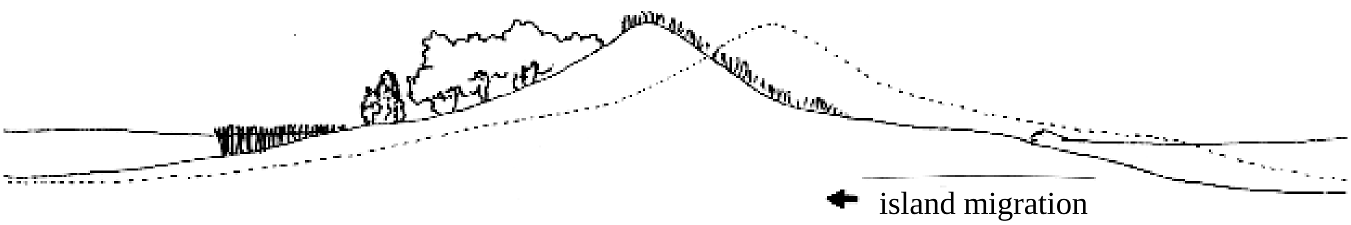
Barrier Islands

Beaches come in many different shapes, sizes and varieties. Barrier beaches protect lagoons, estuaries and salt marshes from the direct action of the sea. There are three kinds of barrier beaches. Bay barriers form between two adjacent headlands. The lagoons that area created by bay barriers may in time become freshwater ponds if the beach is not breached by the sea. This barrier is most common along the rocky coastlines of New England and Canada. Barrier spits form where materials carried from a headland but currents, build a sandy "arm" into a bay or sound. Sandy Hook in New Jersey and Cape Henlopen in Delaware are examples of barrier spits. **Barrier islands** are the third type of barrier beach. They are long, low, usually narrow island with **inlets** to the back bay waters at either end. Barrier islands form a nearly continuous chain from New Jersey to Mexico.

The barrier islands along our coastline have not always been where they are today. Twenty thousand years ago much of Canada and the northern United Sates were covered with a thick layer of ice. Sea level was 400 feet lower than today and the coastline was about 75 miles farther east. Dunes probably lined the shore. When glaciers began to melt sea level started to rise. As sea level rose the sea attacked the dunes, breaching them in some spots and flooding the low areas behind them. As sea level continued to rise the dune ridges migrated landward with the advancing ocean. Barrier islands can also be formed when barrier spits are breached and an inlet is created.

Island Migration

Barrier islands migrate through a complex series of events tied to the dynamic equilibrium of the beach. Basically, the islands roll over themselves. To understand this you have to look at the whole barrier island system, which includes the shoreface, beach, dunes and the marshes in the back bays. As the islands migrate sand is moved by waves, wind and storms from the shoreface and beach, through the dunes, and onto the marshes. The area where a duneline is broken during a storm is called an **overwash** fan. An overwash creates a flat expanse of sand behind the dunes. Eventually new dunes may develop on the overwash closer to the mainland than the breached dune. By this process marsh becomes dune and dune becomes beach. Often, after storms, banks of marsh sod are exposed on the beach. Because marshes can only develop behind the protective barriers, their presence under the beach is evidence of island migration.



Through time, barrier islands change shape and migrate along the coast as well. Actually, the inlets between the islands move. The littoral current upon reaching an inlet drops it load of ands. The island on the “upstream” side of the inlet grows into the inlet. As one island grows the flow of water through the inlet erodes the island on the opposite side and the inlet gradually moves in the direction of the littoral current. The tidal flow in and out of the inlets also moves sand, forming deltas on both the back bay and ocean sides of the inlet. The delta on the ocean side becomes shoals that are a hazard to boats. The larger back bay deltas provide substrate for marsh growth. Lobes of marshland on the back-side of an island mark the site of old inlet deltas. While some inlets are permanent others may repeatedly fill and reopen. By examining old maps and charts you will discover the wandering nature of inlets.

Winter storms and **hurricanes** are important parts of the beach system. Such storms are merely factors in the dynamic equilibrium of the shore. The mid-Atlantic coast experiences at least one major storm each year. Hurricanes hit the region less frequently. After a storm, damage and erosion can appear disastrous. A closer look will reveal how the island has reacted to the storm. Dunes may be severely eroded or overwashed. The overwash has added material to the back of the island or the marsh. New inlets may be cut as flood waters that built up behind the island forced their way through narrow spots in the island. Sand eroded from the beach builds up into offshore ridges and bars which cause large storm waves to break farther off the beach. The beach becomes wide and flattened creating a long gently sloping shoreface. The destructive energy of the surf is thus spread over a broader area, reducing its erosive force.

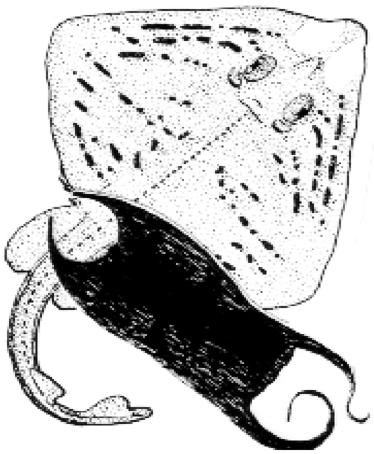
In the spring, when seas are generally calm, the offshore bars will migrate toward the shore. Eventually this sand will be added to the beach. Visit a beach after a storm and take note of where the first line of breakers occurs. Return occasionally throughout the spring and summer to observe the breakers getting closer as the bars migrate toward, and then become part of, the beach.

Life on the Sand

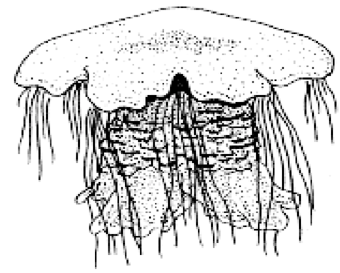
Shifting and blowing sand, wind borne salt spray, overwash during storms and the intense heat of midsummer combine to create an extremely harsh and stressful environment. Few organisms are able to survive on barrier islands. From the open waters over the shoreface to the marsh edge on the island's backside, several ecological zones exist. Each is composed of its own characteristic population of flora and fauna.

Life in the **subtidal** areas of the shoreface is most often revealed by the remains of organisms cast upon the beach by the tides. Large plants are conspicuously absent. The shifting sands do not provide the stable substrate plants require. Occasionally algae will attach to seashells or other hard objects. **Phytoplankton** is the most abundant plant life in this zone.

Many species of fish live in these nearshore waters or visit in search of food. Several species of small fish travel in large schools along the beachfront. Silversides and striped killifish are most abundant. They are often seen darting about the feet of bathers in the surf. These small fish are preyed upon by larger fish and birds. Bluefish are present from late spring through fall. In spring and summer schools of young "snapper blues" feed voraciously on smaller fish. In late summer larger bluefish, weighing up to 15 or 20 pounds, move into shallow water to feed. Schools of migrating striped bass move into shallow waters in the fall to feed on the abundant food fish. Several species of skate, relatives of sharks and rays, also live in this zone. Dead individuals occasionally wash up, but their presence is most often revealed by their egg cases in the wrack line. Called mermaid purses, the cases are black, rectangular capsules with thin, twisting tendrils at each corner. The tendrils are attached to seaweeds or to hard objects on the bottom to keep the cases from washing ashore. Each case contains one egg. The tiny skate emerges from the case in about nine months.



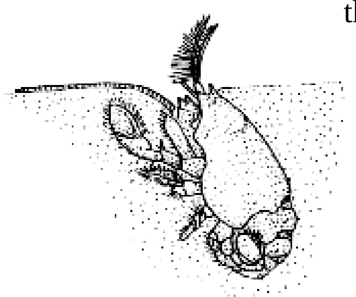
The lady crab is an active crab of sandy shores. Like the blue crab, its last pair of legs bear paddles for swimming. The carapace is attractively patterned with groups of tiny purple spots. Lady crabs bury themselves up to their eyes in the sand in order to ambush prey. When stepped on by bathers it responds with a quick pinch.



Several species of jellyfish also cause problems for bathers. In late summer these creatures may appear in the surf in great numbers. Unable to swim against currents they are at the whim of the sea. The tentacles are armed with thousands of stinging cells. When an object touches the tentacles, the cells discharge a painful, “harpoon”. Lethal to small fish and planktonic organisms, it “merely” causes a painful, stinging rash in humans.

Many species of birds feed on the fish and invertebrates that inhabit zone. In the summer terns dive for silversides and killifish. Brown pelicans also dive for fish. The large throat pouch is used to snare fish weighing up to several pounds. During the winter months the gannet, a northern relative of the pelican, may be seen diving for fish. Loons also migrate from the north to spend the winter in coastal waters. Gulls are found year round. While they do prey on fish they can catch at the surface they often steal food from other birds.

The **intertidal** region of the shoreface is an especially demanding environment. The sand is constantly moved about by, often violent, surf. Like the subtidal shoreface, vegetation is absent. The most abundant organisms are microscopic creatures living in the thin membrane of water between sand grains. Two burrowing organisms may be found, often in abundance in this zone. Both migrate up and down this zone with the tide to take advantage of organic material stirred up by the waves.



The mole crab is a sand colored, egg-shaped relative of the hermit crab. Females may reach a length of one inch. Males are less than 1/2 inch long. These crabs bury themselves just below the surface with large feathery antennae exposed. The antennae sweep food particles from the water and transfer them to the mouth. Like other crabs, females carry their eggs under their telson until they hatch. The egg mass resembles a small orange sponge.

The coquina is a small clam about the size of a fingernail. In the north they are pale yellow marked with purple rays. South of Virginia they are more brightly colored with white, red-yellow and purple. They travel by rising to the surface and riding the swash and back-wash up or down the beach, depending on the tide. The foot is used to quickly burrow back into the sand.

Mole crabs and coquinas provide food for many bird species. During the summer months laughing gulls, fish crows, boat-tailed grackles and willets are commonly found foraging here. During spring and fall migration and throughout the winter months flocks of sanderlings, dunlin and black-bellied plovers, three species of shorebirds, invade the beaches to feast on crab and clam alike. These birds, with their relatively small bills, probably feed only on male mole crabs. The sanderling is known for its habit of chasing outgoing waves and quickly retreating up the beach just ahead of the next incoming wave swash.

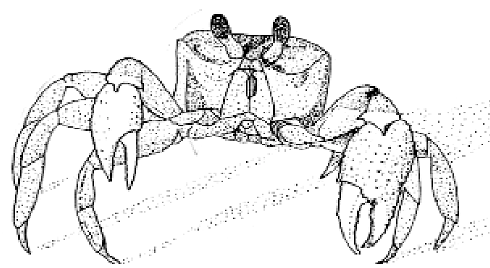
On the Beach

Above the reach of the waves is the upper beach. This zone extends from the upper edge of the intertidal to the toe of the first dune. It is a particularly harsh environment exposed directly to hot summer sun, wind borne salt spray and occasional inundation by storm waves and tides. Several species of hardy plants may be found growing on the beach. Three of these, sea rocket, American beach grass, and cocklebur are common along the mid-Atlantic coast.

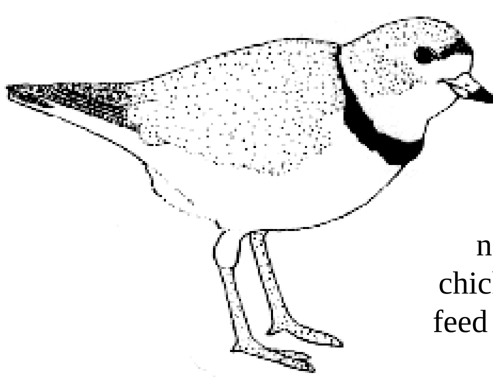
Sea rocket is the most common plant on the lower beach. It grows from the toe of the dune to the high tide line. It gets its name from the seed pods which vaguely resemble a rocket. Each pod contains one seed that only germinates when buried. Its pale lavender blossoms bloom from July to September. Often found growing closely with sea rocket is cocklebur. Its inconspicuous female flowers develop into 1/4" - 1/2" burs armed with many hooked bristles.

American beach grass is found on the beach in scattered clumps. It does not grow as far out on to the beach as sea rocket and cocklebur. It is found from New England to North Carolina and can be identified by its compact, cylindrical seed head, borne on a stalk two to four feet high.

Few animals are permanent residents of the beach. The one animal that does live here is active mostly at night. The ghost crab gets its name because of its pale sand colored shell. It leads a strictly terrestrial life, only entering the water to wet its gills and to release its planktonic larvae. It spends the hottest part of the day in its burrow, which may reach depths up to four feet. Ghost crabs are both scavengers and predators. They prey primarily on amphipods that are found in the wrack and occasionally on the young of beach nesting birds. Ghost crabs are swift runners, which, combined with their cryptic coloration and wariness, makes them difficult animals to observe. They also are capable of delivering a painful pinch.



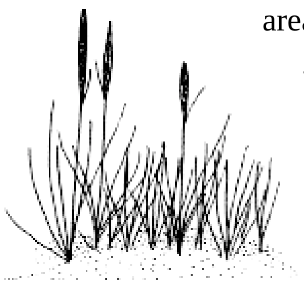
The upper beach provides nesting habitat for several bird species. The piping plover is a small shorebird with pale, sand colored back and wings, white underparts and a dark, often incomplete ring around the throat. It lays four eggs in a shallow scrape in the sand. The young are precocial, covered with down and within an hour or two after hatching follow their parents to the water's edge to feed on insects and small crustaceans. Piping plovers often nest with colonies of least terns. Least terns are small relatives of gulls which nest in groups of up to a hundred pairs or more. The terns, like the plovers, lay their speckled, sand colored eggs in a scrape in the sand. Terns are very protective of their nest sites and will defend them vigorously. When trespassers enter a colony the birds hover above the intruder, calling loudly. If the warning is ignored the terns will fly at and often strike the intruder with their bills. Plovers nest within the tern colonies to take advantage of their neighbor's aggressive defense of the colony. Least terns feed on the small fish that live along the water's edge. They capture prey with their slender bills by diving headfirst into water. Unlike plover chicks, young terns are fed by their parents. Black skimmers and common terns are two other colonial beach nesting birds. Due primarily to habitat loss, populations of beach nesting birds have declined along our coasts.



Many other animals visit the beach in search of food. Foxes, raccoons, skunks, crows and several gull species, to name a few, scavenge in the wrack line and prey on the eggs and chicks of beach nesting birds. Rabbits may come onto the beach to feed on plant material in the wrack.

Hills of Sand

Behind the beach, wind blown sand, through the action of beach plants becomes dunes. The dune zone may be composed of a single primary dune only a few yards wide or a series of dunes and **swales** stretching hundreds of yards to meet back bay marshes. A swale is the low area or valley between dunes. American beach grass is the most important dune grass from New England to North Carolina. In southern dunes, graceful 3 to 6 foot tall sea oats replace American beach grass.



American beach grass and sea oats are able to survive and even thrive when buried by sand. When buried they send out a vertical stem that sprouts new leaves at the surface. The plant also spreads horizontally by **rhizomes**. This unique adaptation results in the formation of dunes. Winds blowing across the beach are slowed by the grass causing wind borne sand to fall to the base of the plant. As sand accumulates the plants push upward and outward. In time huge dunes may result. The dune is stabilized by the rhizomes and roots of the grass. On tall dunes grass roots may extend down 40 feet to the water table beneath the dune.

Beach grass, sea rocket and cocklebur are often the only plants found on the front side of the primary dune. These and other plants are also found on the backside of the primary dune, which is somewhat protected from salt spray. Seaside goldenrod which may reach six feet in height produces a profusion of bright yellow blooms in late summer and fall. Sandspur is a low growing grass that produces seeds armed with sharp spines. It is most often discovered inadvertently by people walking barefoot to the beach.

In the swale between the primary and secondary dune a few shrubs grow among the other beach plants. The shrubs are usually low growing and stunted. This condition is caused by wind borne salt spray. Bayberry is a common deciduous shrub of coastal habitats in the northeast. In the fall it produces large quantities of small, waxy, blue-gray berries. From New Jersey south, wax myrtle, a closely related evergreen species, is also found. It produces smaller darker berries. From Maine to New Jersey beach plum may form dense thickets in the dune swale. The purple-black, edible fruit is produced in late summer and fall. Other shrubs found here include red cedar, wild black cherry, groundsel, winged sumac and poison ivy.

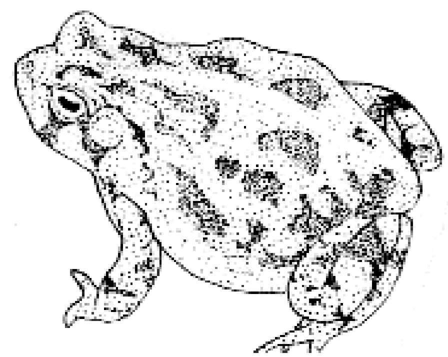
Secondary dunes are populated with many of the same plants as the primary dune and swale. The plants on the ocean facing side of the secondary dune must contend with salt spray. Behind the secondary dune the influence of salt spray is diminished and dense thickets of shrubs or a maritime forest may be present. Many of the shrub species already mentioned, are found in the maritime forest. The individuals here are usually taller and more robust than their counterparts in the less protected areas of the dunes. Other less salt tolerant species of trees will also be present. Trees here, however, do not reach the size that they might in a forest on the mainland.

Sassafras, whose bark and roots were once used to make root beer, is a common maritime forest tree. It is easily identified by its leaves. They may be three lobed, mitten-shaped, or unlobed. Pitch pine and loblolly pine are also found here. Pitch pine is found from New Jersey northward. Loblolly replaces it in forests south of New Jersey. Several species of oak and holly are also found in maritime forests.

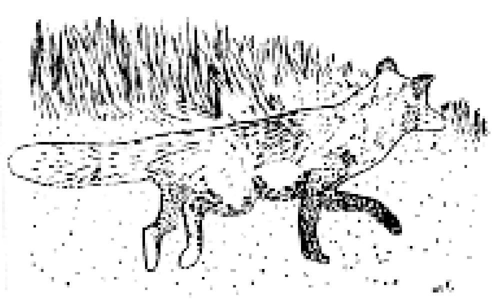
The understory of the forest is dominated by woody vines. Virginia creeper has compound leaves resembling those of poison ivy, with five leaflets instead of three. In the fall its leaves turn deep scarlet and it produces many small, dark, blue berries. Greenbrier is easily recognized by its thorns on the stem. Greenbrier can make travel through a maritime forest an unpleasant, painful experience. Several species of grape area also present. In low areas behind the secondary dune ground water may form freshwater marshes or shrub swamps.

The number and variety of animal species that live in the dunes far exceeds those on the beach. Insects, spiders, amphibians, reptiles, birds and mammals are all represented. Ants are perhaps the most abundant insect in the dunes. Their underground systems of tunnels protect them from the harsh summer heat. The surface of the sand may reach 120 degrees or more. The burrowing wolf spider also depends on its burrow, which may reach 3 feet in depth, to escape the heat of day. It emerges at night to prey on insects. Other insects found in the dunes include wasps, grasshoppers, dragonflies and butterflies.

Freshwater marshes and shrub swamps in dune swales provide habitat for the larvae of mosquitoes, dragonflies and other insects. They also provide breeding areas for the Fowler's toad, a common dune inhabitant. Fowler's toads have three or more small orange warts in each of the large dark spots on the skin. They spend the day buried in the sand or seek shade in the vegetation. These toads are easily observed in the evening when they emerge in search of their insect prey. The dunes are also inhabited by the eastern hognose snake that feeds on Fowler's toads, frog and tadpoles. The hognose snake has an interesting means of defense. When approached it opens its mouth wide and may strike several times. Most often it misses its target. When this fails to frighten an intruder away the snake turns over on its back and plays dead. If turned right side up it will immediately turn back over and continue to feign death. Other reptiles also live here. The fence lizard's brown coloration serves as excellent camouflage. It often climbs trees in search of its insect prey. The box turtle is also common in the dunes. It feeds on fungi, insects and fruits. Like the toad, the box turtle can burrow to escape the heat of day. In the fall it burrows into the sand and hibernates through the winter months.



Birds can also be found in the dunes. Several species of birds, including the robin, mockingbird, thrasher and towhee nest in the shrub thickets and maritime forest. Migrating birds stop in the dunes in the fall to take advantage of the berries produced by bayberry, red cedar, poison ivy, greenbrier and Virginia creeper. In late summer and early fall tree swallows by the thousands flock to the dunes to feed on bayberries. Migrant hawks patrol the dune thickets in search of unwary songbirds. The yellow-rumped warbler remains throughout the winter feeding on bayberry and cedar berries. Horned larks, snow bunting and longspurs are occasional visitors to the dunes in winter.



Mammals live in the dunes as well. Most, however, are nocturnal and their presence is only revealed by tracks and droppings. Cottontail rabbits spend the day hiding in thickets and venture into the dunes to feed on vegetation. Rodents, raccoons and skunks are all dune inhabitants. The red fox roams the dunes feeding on fruits and acorns, snakes, rodents, rabbits and ground nesting birds. On larger barrier islands whitewall deer seek the shelter of maritime forests. Like the cottontail they venture into the dunes in search of food.

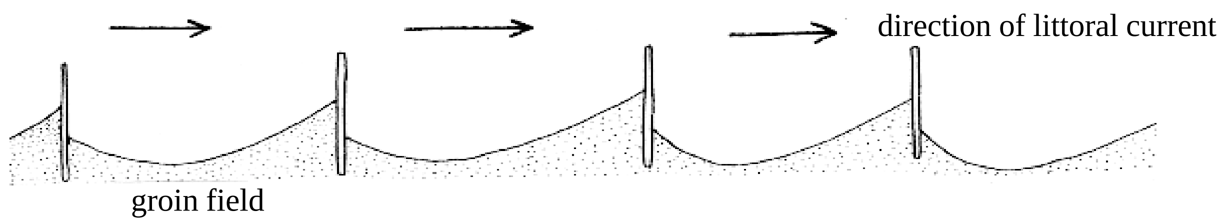
Barrier Islands and Man

Few barrier islands exist in their natural state today. Altered by human activities, only those islands or parts of islands set aside as parks or reserves, retain the natural habitats historically found on barrier islands. Humans were living along the Atlantic coast before today's barrier islands were formed. **Paleoindians** were hunting large Pleistocene mammals on the exposed continental were before the glaciers began. Native Americans living along the coast shunned the islands as sites for permanent settlements. They visited the islands during the summer and fall to take advantage of available resources, but always returned to their more protected mainland villages.

When Europeans arrived in North America, they too chose mainland sites for their settlements. The islands were used to graze livestock, but were deemed useless for human habitation. It wasn't until the early nineteenth century that barrier islands became valuable real estate. In 1801 a Philadelphia entrepreneur opened a boarding house in Cape May. By 1801 Cape May had become a famous seaside resort. Atlantic City and other well-known shore resort communities followed. By the early twentieth century boardwalks, hotels, summer homes and amusement piers could be found on barrier islands from Long Island to Miami Beach.

As resort communities grew sea level continued to rise and barrier islands retreated. In most instances the retreat of beaches was accelerated by coastal development. On many islands dunes were leveled to provide fill and construction material, or just to provide an unimpeded view of the ocean. The removal of dunes robbed the beaches of important reserves of sand. Eventually storms damaged or destroyed beachfront property.

To protect valuable real estate, communities, often with state and federal assistance, erected beach protection devices. To slow beach erosion **groins** were built to capture the sand being transported by the littoral current. These wood or stone structures extend into the ocean perpendicular to the beach. They slow the littoral current causing it to drop its load of sand. The opposite side of the groin is deprived of sand. Eventually waves erode the beach on the down current side of the groin. Usually a whole series of groins, called a groin field, is erected. When groin fields can't keep sand on the beach expensive beach renourishment projects are undertaken. Sand is dredged up from inlets, back bay areas or from the shoreface and pumped onto the beach. On many beaches renourishment must be repeated periodically to provide adequate protection for valuable beach front real estate.



Bulkheads and sea walls are structures built behind the beach, usually where dunes once stood. These structures are often constructed after a major storm has already caused considerable damage. In front of these devices many communities attempt to build dunes. One method is to erect snow or sand fencing. The fencing acts like beach grass by slowing the wind and causing it to drop its load of sand. Once the fence is buried beach grass is planted to hold the sand in place. Avalon, New Jersey has been quite successful in building several rows of dunes along some sections of its beach using sand fences. Another often used method is to build a dune with a bulldozer and then plant it with beach grass.

Dunes, whether natural or man made, must be protected from human trespassers. Beach grass is very sensitive to trampling and will die if walked on just a few times. When the grass dies, bare patches are created which can quickly be eroded by the wind. Such blow out areas are vulnerable to overwash during storms. Most shore communities provide public beach access paths or boardwalks to protect the dunes. Trespassing in the dunes can result in stiff fines.

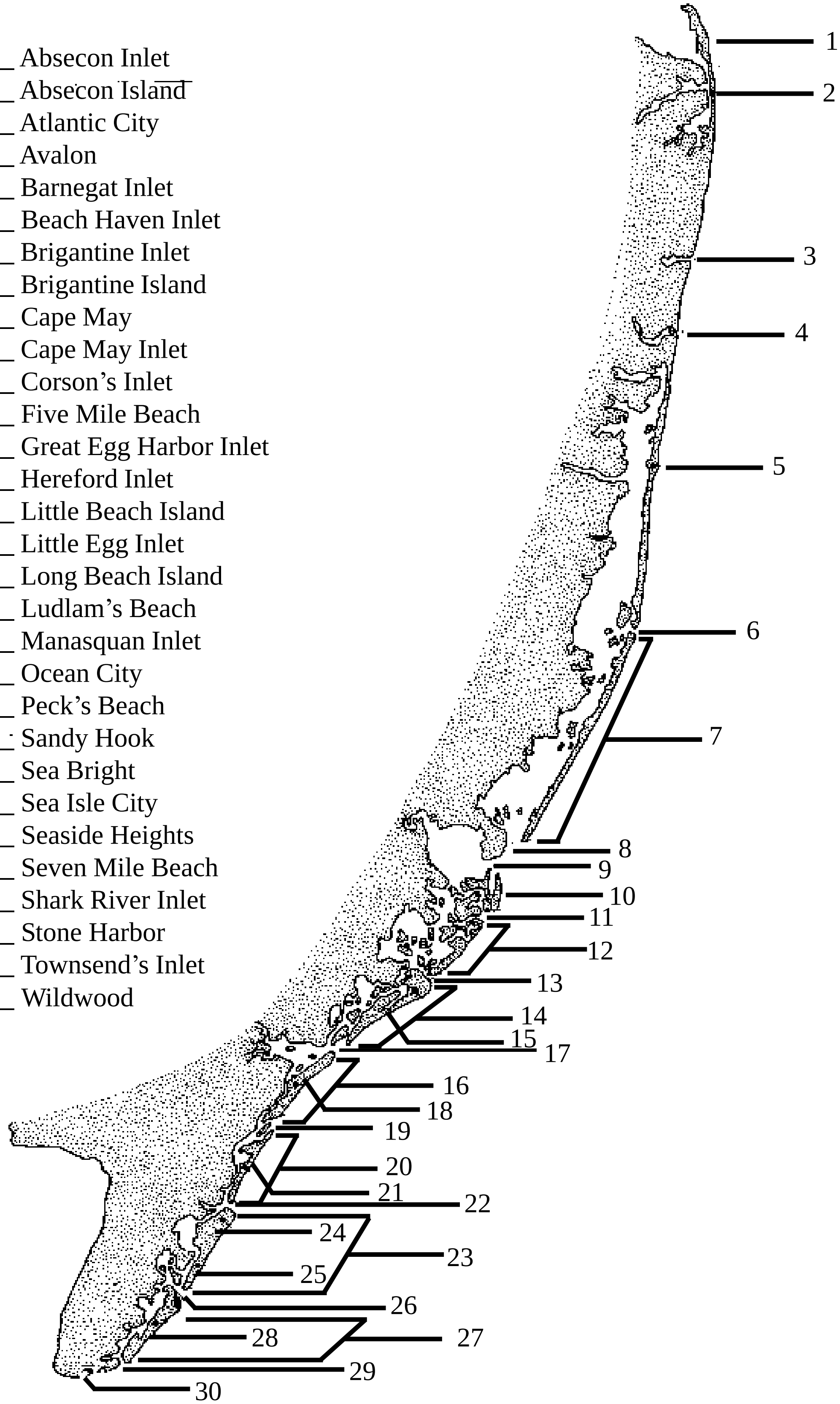
Inlets, in addition to playing an important role in barrier island dynamics, also provide access from back bay to ocean. Commercial as well as recreational boat traffic passes through inlets to and from docks, marinas and commercial fishing centers. Inlet migration and the natural cycle of closing and opening is inconvenient to such traffic. Jetties have been built on the most important inlets to keep them open and in one place. A **jetty** is a large version of a groin built out into the ocean, on one or both sides of an inlet, to keep the inlet from filling with sand. Jetties, like groins, can create problems as well as provide benefits. Jetties constructed to protect the inlet in Cape May have caused Wildwood's' beaches to grow considerably. At the same time, south of the inlet beaches in Cape May are eroding rapidly. Even inlets with jetties need periodic dredging.

In their natural state, free to move and react to the "whims" of the sea, barrier islands provide invaluable protection to the mainland. In the calm waters behind harrier islands, salt marshes, the most productive of all ecosystems, are able to develop and thrive. Barrier islands provide important habitat for many species of plants and animals. Left to the forces of nature, barrier islands are one of the most beautiful of all landscapes. Built upon, developed and "improved" they merely become the next "natural" disaster waiting to happen.

Name That Island!

Can you match the islands, inlets and shore communities with the corresponding number on the map?

_____ Absecon Inlet
_____ Absecon Island
_____ Atlantic City
_____ Avalon
_____ Barnegat Inlet
_____ Beach Haven Inlet
_____ Brigantine Inlet
_____ Brigantine Island
_____ Cape May
_____ Cape May Inlet
_____ Corson's Inlet
_____ Five Mile Beach
_____ Great Egg Harbor Inlet
_____ Hereford Inlet
_____ Little Beach Island
_____ Little Egg Inlet
_____ Long Beach Island
_____ Ludlam's Beach
_____ Manasquan Inlet
_____ Ocean City
_____ Peck's Beach
_____ Sandy Hook
_____ Sea Bright
_____ Sea Isle City
_____ Seaside Heights
_____ Seven Mile Beach
_____ Shark River Inlet
_____ Stone Harbor
_____ Townsend's Inlet
_____ Wildwood



Charts and Graphs

For ages the depths of the sea were a place of mystery. When mariners began sailing the ocean's surface they had to map the sea floor along the coast to avoid running aground and wrecking. Charts recording ocean depths were made by measuring depth with a sounding line. In uncharted waters a sailor was stationed in the bow to record the water's depth. By their nature barrier island have always caused problems for sailors. While rocky headlands and the sea floor around them will remain virtually unchanged for generations, barrier islands may shift location in a matter of days during a large storm. A captain with an old chart would find himself in a lot of trouble. In fact the mid-Atlantic cost has long been called the graveyard of the Atlantic.

In this activity your students will produce a map of a section of sea floor along the southern New Jersey coast from a nautical chart. This type of may is called bathymetric chart. After completing the map they will graph the slope of the sea floor along a transect.

Procedure

1. Give each student a copy of the nautical chart. Ask the students if they have ever seen or used a nautical chart. Discuss the features on the chart.

2. After discussing the chart have the students draw contour lines on the chart at intervals of 20 feet.

3. When the students have completed drawing their contour lines ask them which is easier to interpret, a chart or bathymetric map? Do the maps reveal any hazards to navigation?

4. Now have each student choose a point along the coast. It will be more interesting if each student chooses a different point. From that point they will draw a horizontal transect across their map.

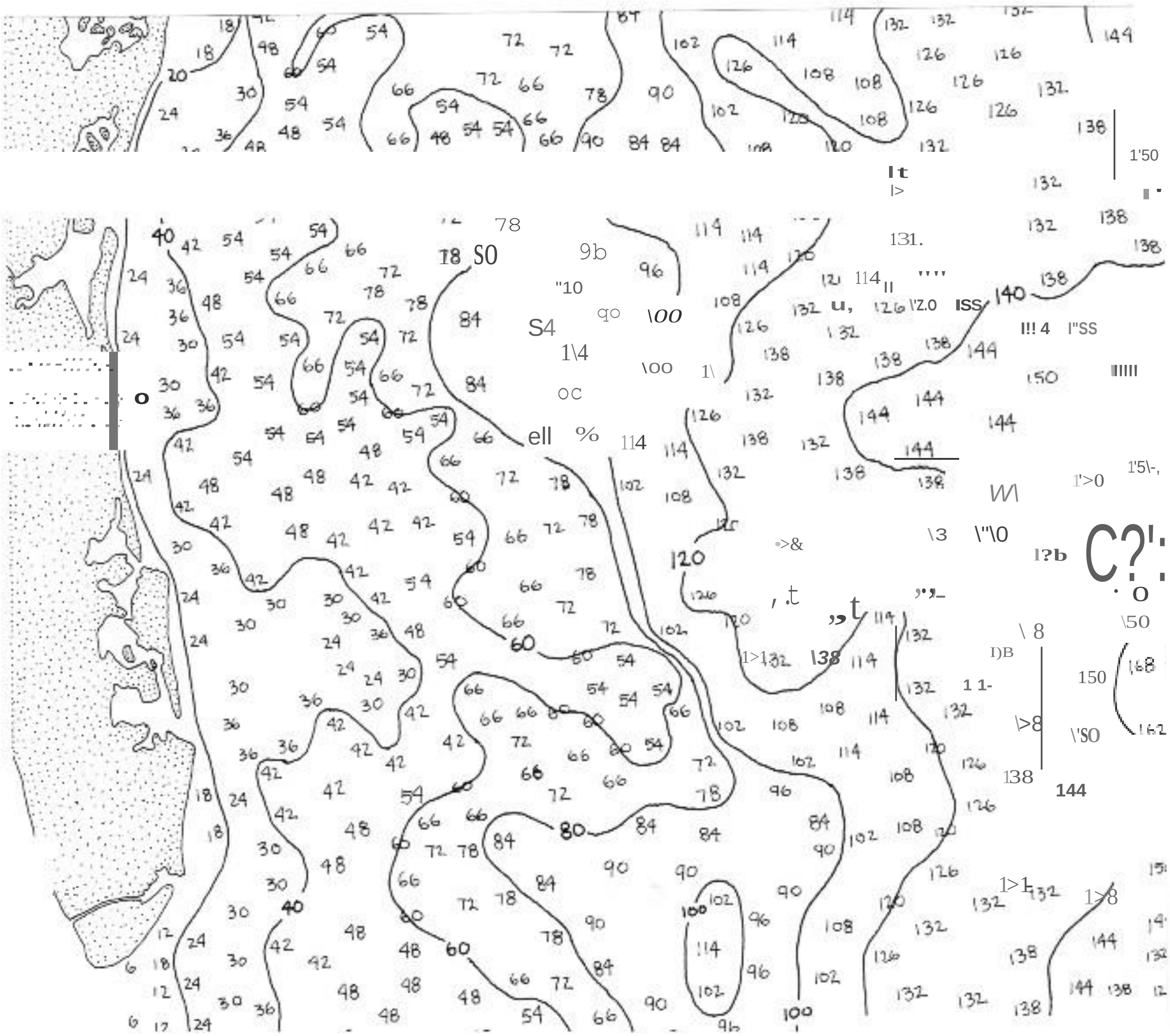
5. Have the students graph the slop of the sea floor along their transect on a piece of graph paper. Is the slope along this section of the coast very large? How do the students' graphs compare to one another?

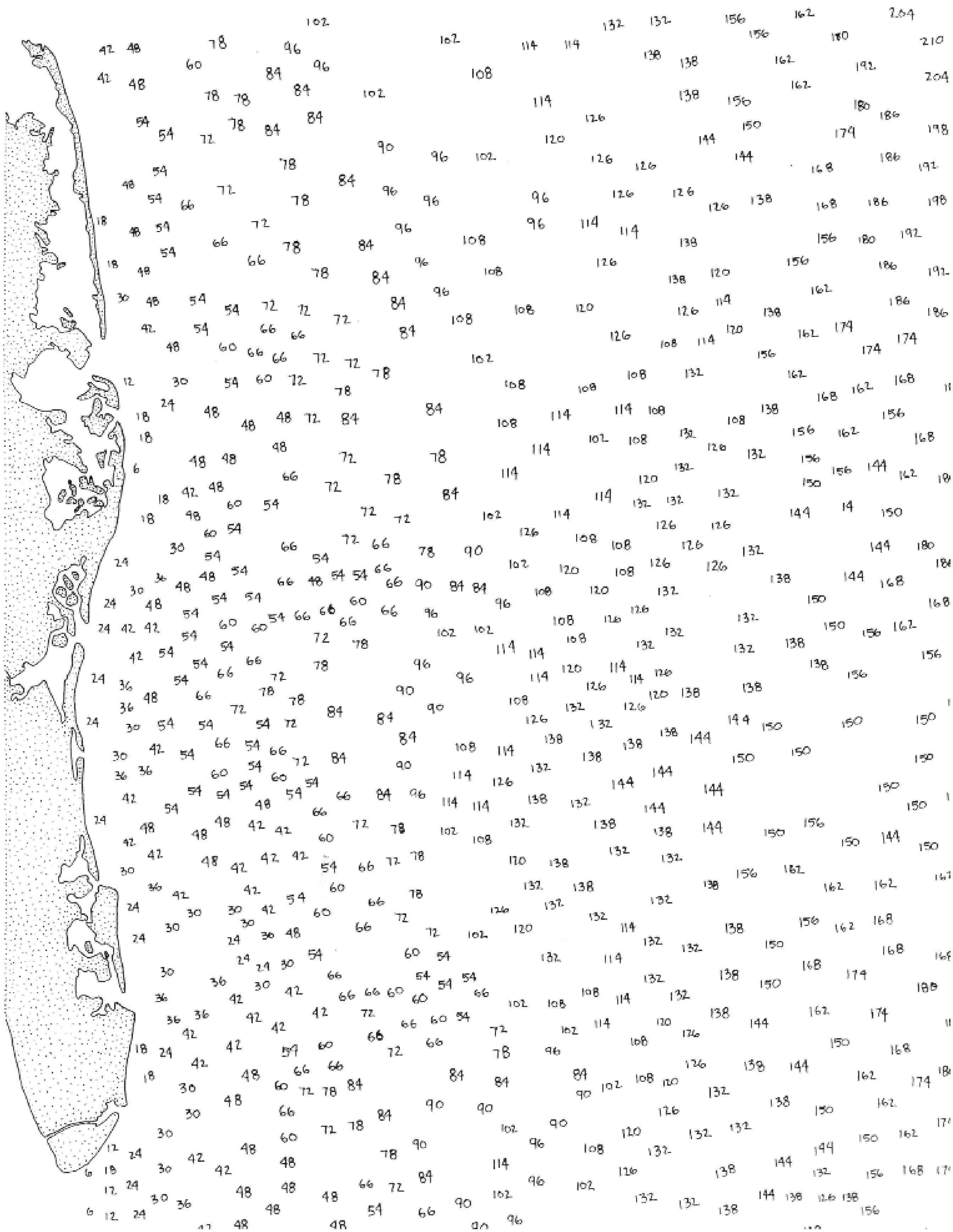
Extensions

1. Do the same activities with charts from different areas. New England or the Pacific coast will provide bathymetric charts that contrast greatly with New Jersey.

2. Create a three-dimensional map of the New Jersey sea floor using corrugated cardboard or sheets of Styrofoam. They need not be to scale. In fact an exaggerated scale will make the maps more interesting. To make the 3-D maps get an 8 1/2 x 11" piece of cardboard for each contour interval. One uncut piece will serve as a base and represent the deepest depth on your map. One by one cut the deepest contours off the map (copy the map onto tracing paper first so you don't destroy the original) and trace the outline on to a piece of cardboard. When all the lines have been traced cut the cardboard and construct the 3-D map.

3. Find charts from different time periods of the same section of coastline. Compare the charts to determine any changes that have taken place through time. Find charts of a barrier island coast and for a rocky coast like lv.faine. Which coastline has changed the most through time?





Quartz and Feldspar and Hornblende, Oh My!

Materials

6 containers with airtight lids
trowel
scale which can measure in 10th of a gram
petri dishes
hydrogen peroxide
eyedropper
test tubes
coffee filters

Procedure

At the Beach

1. Have your students collect samples of sand from the six locations described below.

1) at the tide line on the beach in front of the bulkhead
2) half the distance from the tide line to the base of the bulkhead
3) at the base of the bulkhead
4) along the road behind the dunes
5) on the sand bar behind the bulkhead and jetty
6) in the center of the mud flats between the sandbars

Place the samples in the containers, numbered to correspond with the collection site. Containers must have airtight lids to prevent the samples from drying out.

In the Classroom

2. Have the students examine the six sand samples. Are there any differences in the appearance of the samples? Have them record their observations. In step 3 equal amounts of each sample will be weighed. Ask your students which sample they think will weigh the least? the most?

3. Place one teaspoon of sand from sample #1 on a coffee filter. Mark the filter with the sample number. Weigh the sample and filter and record the weight. Repeat for samples 2 - 6.

4. Set the filters and sand aside and allow them to dry for at least 24 hours. They will be used again in steps 6- 9.

5. In the next procedure the students will test the sample for the presence of organic matter. Hydrogen peroxide react with organic matter producing carbon dioxide. The carbon dioxide forms bubbles and foam the test. Which samples would you expect to contain organic matter? Place a small amount of each sample in a test tube. With an eye dropper and 15 to 20 drops of hydrogen peroxide to each test tube. Is there a reaction in any of the samples? Which samples contain organic matter? From where might this material have come?

6. After your samples from step 4 have dried weigh them again. Record your results. Are the dry weights different from the wet weights? Why? What percentage of the weight of each sample was water? Which sample contained the most water?

7. Number six petri dished 1 through 6. With a ruler draw a straight line 5 cm long on a piece of paper. Mark off the line in one millimeter increment. Tape the piece of paper face down on the bottom of the petri dish. Turn the dish upside down, and with a scalpel or Exacto knife trace your line and mm marks in the dish. To highlight the lines rub them with a black crayon. Wipe off any excess crayon.

8. Place each of the dried samples onto a petri dish. Examine the sand under a microscope. Are the grains all the same? Are they all the same color? Beach sand is composed of a number of different minerals. Clear, glassy grains with uneven fractures are probably quartz. This mineral comes in several shades from clear to gray and black. Milky red, pink or white grains are probably feldspar. Glassy black or clear flakes are probably mica. Most of the dark grains are probably varieties of hornblende. What is the most common mineral in this beach sand? Estimate the percentages of each mineral you identify?

9. Are the sand grains all the same size? Using the mm scale on your dish estimate the size range of the grains in each sample. Which size grain seems to be the most abundant? Does mineral type seem to determine grain size?

Extensions

1. Collect samples of sand from other beaches and conduct the same experiments. How do samples from different beaches compare? Examine sand collected near your school. How does it compare to beach sand?

2. Put together a collection of sand from beaches around the country. If you or your students know of anyone going on vacation to a coastal area have them collect some sand for your class. Nature centers in coastal areas may also send you a sample of sand. The Natural Science for Youth Foundation's *Directory of Natural Science Centers* listed in the bibliography provides addresses for hundreds of nature centers in the U.S. and Canada.

Down The Shore

America's coastal barriers were the first land forms to greet the Europeans that settled on this continent. They recognized the dangers of living on these restless ribbons of sand and built their permanent settlements on the mainland. Barrier islands today bear little resemblance to the untamed coast of the past. Bulkheads and seawalls have replaced dunes. Homes, condominiums and hotels have replaced maritime forest. In the last half of this century coastal development has grown explosively. Along the New Jersey cost there is only one undeveloped barrier island along 125 miles of shoreline.

Development has brought prosperity not only to the shore but contributes immensely to the economies of coastal states. Tourism is New Jersey's second most important industry. However, development also has its costs. Each year millions of dollars are spent on projects to protect shoreline development from the sea. When storms hit the cost millions more are spent repairing and rebuilding damaged and destroyed real estate and beach protection devices.

If affected homeowners and coastal communities were paying the bills this seemingly endless drama might seem unimportant to the rest of the population. However, state and federal funds often pour into coastal communities to help the unfortunate victims repair the damages and get on with their lives. Everyone pays the bills for life down the shore.

Where's the Beach? A Coastal Scenario

Folly's Beach is a barrier island somewhere along the Atlantic coast. Like many other barrier islands it has been heavily developed. The year round population of the Island is just over one thousand. However, most of the development is summer homes. During the summer months the population of Folly's Beach explodes to more than 30,000.

Like most barrier islands most of Folly's Beach is only a few feet above sea level. During storms many areas are flooded causing minor damage. One section of the island, called Cetacean Sands is very low and exceptionally narrow. In a major storm many years ago most of the homes in this area of the island were completely destroyed. This did not deter other from rebuilding on the same spot.

A major winter storm has again hit Folly's Beach and caused great damage. Most of the homes on Cetacean Sands were severely damaged or destroyed. As wind, waves and flood waters subsided a new storm began to brew. It has been suggested that the property owners on Cetacean Sands not be allowed to rebuild in such a vulnerable location. What do you think?

Procedure

1. Read the above scenario to the class. Then divide the class into two teams. Assign one team to debate in defense of maintaining the development on the barrier island. Assign the other team to defend the idea of prohibiting rebuilding structures destroyed by storms.

2. Allow the students a period of time to research the topic of barrier island development and coastal zone management.

3. After the students have had time to accumulate information for the debate have each team choose four or five points they wish to make during the debate. Divide each team into small groups to prepare a defense for each point. Have the teams announce or exchange the points so the opposition can prepare questions.

4. Each team should prepare an opening statement for the debate. The statement should include their stand on the issue and the four or five points they have prepared. One person should be chosen from each team to give the opening statement. One student from each group within the team should be chosen to state the points they will raise and to answer questions regarding that point from the other team.

5. On the day of the debate have the students follow the rules of parliamentary procedure. The teacher should act as moderator, maintaining order and recognizing speakers. Flip a coin to decide which team will speak first.

6. After each team has made their opening statement the spokesperson for each group on one team will state their point and any facts or information to defend their stand. When all of the groups on one team have spoken repeat the procedure for the second team.

7. After all groups have made their presentations open the floor to questions. All students can ask questions based on the main statement or the points raised by the groups. Questions should be answered by the group spokesperson. Alternate questions between teams.

8. When all questions have been answered the team spokesperson should be allowed to make a closing statement.

9. When closing statements have been given ask the students which side of the debate they favor.

Extensions

1. Is your school in a coastal area? How is coastal development regulated in your community? During coastal storms does your community suffer damage of any kind? Contact your local Office of Emergency Management and find out how your town prepares for coastal storms.

2. New Jersey has the highest population density in the United States and a highly developed coastline. How does New Jersey handle coastal development? Do some research to find out. Does New Jersey have a Coastal Zone Management Plan? Contact the State Department of Environmental Protection and Energy for information about the plan.

3. What is the Federal Government's role at the shore? The U.S. Army Corps of Engineers and the Federal Emergency Management Agency are two federal agencies involved with coastal issues. What are the roles of these two groups concerning coastal development?

Vocabulary

Barrier island a narrow, usually long, sandy island that forms along gently sloping shorelines and acts as a barrier between the mainland and the sea.

Bulkhead the limiting wall of stone, wood or concrete along the shoreline.

Groin a kind of jetty, usually constructed of wood or stone, built perpendicular to the beach projecting into the ocean to obstruct the littoral drift of sand.

Hurricane a large cyclonic storm which develops over warm tropical oceans characterized by very strong winds in excess of 75 mph, very low barometric pressure, strong thunderstorms and a calm central eye, occurring in the western Atlantic between August and October.

Inlet a narrow channel of water between two islands.

Intertidal the zone of the shore between the highest and lowest tides.

Jetty a structure of wood or stone built on one or both sides of an inlet projecting into the ocean top intercept the littoral drift of sand and prevent it from filling the inlet.

Littoral (longshore) current the flow of water created, parallel to the shore, by the waves approaching the shore at an angle.

Overwash fan a flat area of sand created when a dune line is broken by waves and sand is deposited on the opposite side.

Paleoindians first native American inhabitants of North America.

Phytoplankton aquatic free floating, mostly microscopic, photosynthetic organisms.

Rhizome a horizontal underground stem.

Shoreface the subtidal area extending seaward to the depth where waves touch bottom and move sediments.

Subtidal the zone of the shore below the level of the lowest tide.

Swale a low area between dunes.

Bibliography

Abbot, R.T. 1968. *Seashells of North America*. Golden Press. New York.

Bascom, W. 1964. *Waves and Beaches* Anchor Books. Garden City, New York.

Beston, H. 1928. *The Outermost House*. Ballentine Books, New York.

Carson, R. 1955. *The Edge of the Sea*. Houghton Mifflin Co. Boston.

Crowder, W. 1931 *Seashore Life Between the Tides*. Dover Publications, Inc. New York.

Engel, L. 1961. *The Sea*. Time, Inc. New York.

Gosner, K.L. 1978. *A Field Guide to the Atlantic Seashore*. Houghton Mifflin Co. Boston.

Jackson, T.C. and D. Reisch, eds. 1981. *Coast Alert*. Friends of the Earth. San Francisco.

Kaufman, W. O.H. Pilkey, Jr. 1983. *The Beaches Are Moving: The Drowning of America'sShoreline*. Duke University Press. Durham, North Carolina.

Kopper, P. 1979. *The Wild Edge: Life and Lore of the Great Atlantic Beaches*. Penguin Books. New York.

Leatherman, S.P. 1979. *Barrier Island Handbook*. National Park Service. Amherst, Massachusetts.

..... 1979. *Barrier Islands: From the Gulf of St. Lawrence to the Gulf of Mexico*. Academic Press. New York.

Martin, W.E. 1970. *An Unspoiled Bit of Atlantic Coast*. New Jersey State Museum, Trenton, New Jersey.

Milleman, B. 1986. *And Two If By Sea: Fighting the Attack on America's Coasts*. Coast Alliance Inc. Washington, D.C.

Morris, P.A. 1973. *A Field Guide to Shells*. Houghton Mifflin Co. Boston.

Morrison, H.R. and C.E. Lee. 1981. *America's Atlantic Isles*. National Geographic. Washington, D.C.

Nordstrom, K.F. et al. 1986. *Living with the New Jersey Shore*. Duke University Press. Durham, North Carolina.

Petry, L.C. and M.G. Norman. 1963. *A Beachcomber's Botany*. The Chatham Press. Old Greenwich, Connecticut.

Reiger, G. 1983. *Wanderer on My Native Shore*. Simon and Schuster. New York.

Ricciuti, E.R. 1982. *The Beachwalker's Guide*. Doubleday and Co., Inc. Garden City, New York.

Rudloe, J. 1971. *The Erotic Ocean.* World Publishing Co. New York.

Rutgers University. 1983. *New Jersey's Barrier Islands: An Ever-Changing Public Resource*. Center for Coastal and Environmental Studies. New Brunswick, New Jersey.

Silberhorn, G.M. 1982. *Common Plants of the Mid-Atlantic Coast: A Field Guide*. Johns Hopkins University Press. Baltimore.

Simon, A.W. 1978. *The Thin Edge*. Harper and Rowe Publishers. New York.

Sutton, A. and M. Sutton. 1977. *The Wild Shores of North America*. Alfred A. Knopf, Inc. New York.

Touvell, D. O.D. Winters, eds. 1990. *Directory: Natural Science Centers*. Natural Science for Youth Foundation. Roswell, Georgia.

Waldron, R. *Maritime New Jersey: An Economic History of the Coast*. New Jersey State Museum. Trenton, New Jersey.

Wells, J.T. and C.H. Peterson, *Restless Ribbons of Sand: Atlantic and Gulf Coastal Barriers*. Louisiana Sea Grant College Program.

Yasso, W.E. and E.M. Hartman, Jr. 1975. *Beach Forms and Coastal Processes*. New York Sea Grant Institute. Albany, New York.