DISHPAN BEACH

FOR THE TEACHER

Discipline
Physical Science

Theme
Water Movement

Synopsis
Students create a flannel board story and conduct several experiments to differentiate between waves and changing tide levels on a sandy beach.

Key Concept
The rise and fall of the tides and the pounding waves keep the sandy beach habitat in constant motion.

Science Process Skills
observation, communication, comparing, organizing, relating

Vocabulary
debris, flotsam/jetsam, moon phases, ebb, full/new moons, tidal cycle, flow, gravitational attraction, tidal range/extremes

MATERIALS
For Flannel Board Story
• flannel board with cut-outs of moon phases, sun, seashore animals, birds, driftwood and logs, kelp, people, waves, sea cliff, rock jetty and dock with wood pilings; (alternative to flannel board: draw on large sheets of butcher paper or flip charts)
• blue cellophane to use with flannel board, or blue felt to cover board at high tide
• clock to show the passage of time as the tide changes
• labels for each story element
For Everyone Has a Story to Tell activity
For each cooperative group of students
• flannel in various colors, scissors, glue, paper for labels, and colored pens (alternative to flannel board: large sheets of butcher paper or flip charts)
For The Tidal Cycle on Dishpan Beach activity
• two plastic dishpans, pierced near the bottom with a nail about the size of a pencil

• 1 yard length of rubber tubing joining the two pans through the nail holes in the dishpans
• bathtub toys, e.g. rubber duck or boat
• various flotsam and jetsam, e.g. pieces of plastic, balloons, plastic sandwich bags, wood chips, popsicle sticks or small pieces of driftwood;
• rocks of various sizes for each dishpan;
• small rubber or plastic animals to represent beach organisms; real or plastic aquarium plants and shells glued onto larger rocks;
• water to fill one dishpan
• sand to form sloping beach and cliff in each dishpan

INTRODUCTION

The striking features of the ever-changing face of the shoreline are created by changing tide levels and the constant battering of the waves. Ocean waves which ultimately reach the beach are generated by the force of the wind blowing across the surface of the ocean. The size of waves reaching the shore is determined by how fast the wind blows, over how long a time and distance it blows and from what direction it crosses the shore. It has been estimated that waves strike the shore an average of 8,000 times every day. It is no wonder that waves are considered to be the primary physical feature shaping the beach.

The other great force on the sandy beach is the rise and fall of the tides. The effect of the changing tides is to carry the zone of crashing waves higher and higher up the shore over a period of six hours. Six hours later it will again be low tide and the waves will be breaking far down on the shore. The beach will again be a wide expanse of sand instead of the frothy wave-swept area seen during the high tide.

One of the main forces creating the movement of the tides is the gravitational attraction between the moon, the sun and the earth. Twice a month when the new or full moon is directly overhead in the sky, tides will be at their most extreme and the highest high tides and the lowest low tides will occur. At this time, the earth, moon and sun form a straight line and the gravitational forces of the moon and sun on the earth work in concert and their effects are combined. At the time of the new moon, the moon is between the earth and the sun; at the time of the full moon, the earth is between the moon and sun. During the moon's other phases (half, quarter and etc.), the gravitational forces of the moon and sun are working against each other and the difference in water level between the high and low tides is much reduced.

Tides can be compared to a huge wave following the moon around the earth. High tide occurs as the highest point of the wave passes a particular location, lagging just a little behind the time when the moon is directly overhead. Low

tide occurs as the low point of the wave passes by that same location six hours later or as the moon sets on the horizon.

The highest reach of the tides forms the wrack line where debris from the ocean comes to rest. The amount and type of debris varies seasonally and increases when storms rip kelp from offshore forests and currents transport the rafts of kelp to the beach where waves toss them ashore and tides carry them high up the beach. Storms may become devastating to seaside communities if the storm front hits the shore at the same time that the tide is at its highest point.

INTO THE ACTIVITIES

A Day in the Life of a Beach Flannel Board Story

Use the flannel board and cut-outs to show how the beach changes during a tidal cycle. Include the following information in a story about a day in the life of a beach and be sure to label each feature as it is introduced in the story.

Low Tide
Set the scene at low tide showing a wide, dry beach sloping up to the sea cliff. Include a dock with most of the pilings and the animals living there out of water and a rock jetty with its associated animals mainly above the water line. Show breaking waves and shorebirds feeding low on the shore and include people playing or sunbathing on the beach.

Low Tide Progressing to High Tide
Tides are a gradual process, progressing from low to high to low and again to high in one day, giving us two high tides and two low tides each day. The entire cycle takes 24 hours, so to change from low to high tide takes 6 hours.

As low tide progresses into high tide, the dock pilings and rock jetty with their associated animals are gradually submerged under water. Shorebirds and sunbathers are forced to retreat up the beach toward the cliff as the waves break higher and higher on the shore. Over a period of six hours, the beach appears to be shrinking in size as the water gets closer and closer to the base of the cliffs.

High Tide
Most of the plants and animals on the rock jetty and dock pilings are completely underwater and the waves are striking the face of the cliff.

High Tide Receding to Low Tide
As the tide again starts to recede, more and more of the beach and the animals living on the jetty and pilings start to reappear. Driftwood and kelp can be seen high up on the shore where it was left at the highest reach of the tide.

Low Tide
Finally, when the tide again nears its lowest point, shorebirds begin to feed and the waves are again breaking low on the shore.

The entire tidal cycle took 24 hours so only half of the cycle depicted above was actually occurring in daylight hours. Progress through the tidal cycle story again, this time include the clock and the sun and moon cut-outs to show the passage of time.

The highest of the high tides and the lowest of the low tides occur twice a month when the earth, moon and sun are in a line. Put various phases of the moon on the flannel board and discuss with students what the level of the tide would be. Phases of the moon other than new and full would not create as extreme tides and the water would not be as low on the beach or as high up the cliffs.

THROUGH THE ACTIVITIES

Everyone Has a Story to Tell

Place the students in cooperative groups to create their own flannel board animals, waves and etc. They can add their creations to subsequent readings of the story or make up their own story about their real or imagined visit to the beach and then present it to the class.

The students should be sure to include animals -- birds, people, invertebrates; physical features -- waves, tides, cliff, rocks, sand; and people-made structures -- docks, jetties. They should also include the sun and phases of the moon. Have them make labels for each of the features of their story, including the organisms, tidal heights and moon phases and then present their story to the class.

Encourage LEP students to present their story to the class in their native language or someone in their group can relate it in English. Pair more proficient English writers with those less proficient to work on the labels for their story.

Roles may include storyteller, writer, physical feature designer, animal designer, people-made structure designer, and mover of the story pieces or illustrator.

The Tidal Cycle on Dishpan Beach
Create a beach scene in each of the two dishpans using the materials listed. Have the students help you with the design and placement of each of the features and animals. You might want to include some plants and animals glued to the rock and some animals, flotsam and etc. that are "free" to move around.

Once each of the pans is completed to everyone's satisfaction, place the pans at different heights and connect the hose between the two of them. Put a nail, pencil or cork in the hole of the upper pan. Add water to the upper pan to a height that you would consider to be the highest high tide.

Now remove the plug and watch the tide as it slowly recedes down the cliff, uncovering more of the "sandy beach" and animals stuck on the rocks of the upper pan. Have the students observe that at the same time in the lower pan, the "sandy beach", cliff and animals are slowly being covered by the water. Use the plug to stop the receding tides at various intervals to note changes in both pans. Also manipulate the clock to show the passage of time -- lowest tide in the upper pan (which would be the highest tide in the lower pan) should be reached at the six hour mark. In addition to the clock, use cut-outs of the moon and sun to show a 24 hour cycle.

Use the phases of the moon cut-outs from Part 1 to show how the height of the highest and lowest tide is dependent on the phase of the moon. Proceed through a tidal cycle for a day that the moon is only in a quarter phase. In this case, don't let so much water out of the upper pan before replacing the cork and switching the pan to the lower position. The range between the tidal extremes is not so great as at the time of new and full moons.

Introduce waves into the dishpan beaches by blowing over the surface of the water with a straw or hairdryer. Alternatively, use a small shingle or piece of cardboard and force it through the water at the edge of the pan. Discuss the difference between waves and the tides and the effect of waves hitting the shore at high tide vs. their effect at low tide. Include how storms may increase the damaging effects of the waves if the storm front reaches the beach at the time of the highest tides.

Reverse the positions of the pans so what was the lower pan is now the upper one and vice versa. Repeat the demonstration for the next group or for the class as a whole. Have the students discuss what changes are occurring at the beach as the tide ebbs and flows.

Demonstrate for small groups of students as the rest of the class is working on their "Day in the Life of the Beach" stories. Alternatively, the cooperative

groups of students from Part 2 can do Part 3 themselves after a brief demo by the teacher.

DISCUSSION

1. What is the difference between waves and tides?

2. What does the beach look like at high tide? In what ways does it look differently at low tide?

3. How many high tides and how many low tides occur in one day --24 hours? (two highs and two lows). How many hours between high tide and the next low tide? (six hours).

4. The very highest line of beach wrack was deposited there during which phase of the moon? (new or full moon because the highest high tides occur then). How long would the wrack stay at that level before again being touched by the high tide? (two weeks -- the length of time between the new moon and the next full moon).

5. When do shorebirds feed on the beach, at low or high tide? (they feed at low tide or as the tide is receding). Why do the shorebirds only feed during the low tides? (they can wade in the shallow water where they can locate and reach their prey). Where do you think they go during the high tides? (they travel to their roosting areas to rest) When do you like to visit the beach? What might be the effect of dogs and people on the beach at low tide when the shorebirds are feeding? (the birds are disturbed or frightened away from their feeding areas).

6. What sort of problems do the animals living on the sandy beach face at low tide? (they become susceptible to terrestrial predators, or may become too dry or hot). What about at high tide? (susceptible to ocean predators)

7. What sort of adaptations do sandy beach animals have to protect themselves from waves, predators and exposure at low tide? (thick shells, ability to quickly burrow in the sand or hide in burrows where they are protected from some predators, crashing waves and the drying effect of the sun).

8. Why aren't there as many kinds of animals living on the sandy beach as you would find on a rocky seashore, dock piling or rock jetty? (the sand is in constant motion and it is difficult to keep from being swept out to sea. Large algae cannot grow on this shifting habitat so grazing animals are dependent on the transitory presence of drift kelp on the beach).

9. What are the animals living on the dock pilings and rock jetties doing at high tide when they are covered with water? (most are moving around looking for food or opening their shells and filtering the water for plankton.)

BEYOND
THE ACTIVITIES

Have the students write their stories in addition to relating them orally to the class.

In Part 1, instead of just covering the animals with water at high tide, actually replace them with cut-outs of how the animals look at high tide. You might also want to show zonation of the plants and animals on the dock pilings and jetties.

Make flip chart books showing the rise and fall of the tides on the sandy beach. Be sure to include some landmarks so changes in the tidal height can be followed.

Use a large wall calendar and add the phases of the moon. Have the students hypothesize when the lowest and highest tides of the month should occur. Check this with a tide table or log.

Take a field trip to the beach and place a stake in the sand to mark the height of the tide when you arrive and then compare it to the tidal height when you leave. Have the class help you determine when the best time to visit the beach would be to see shorebirds feeding by consulting their wall calendar, tide tables in the newspaper or a tide log.

Use a solar system model to show the positions of the sun, moon and earth relative to each other during different phases of the moon.