



**Surfrider
Foundation.**

**Respect The Beach
Beachology Unit 3**

SAND TRAVELS

UNIT 3: SAND TRAVELS

Activities for Elementary Level Students

This unit consists of three activities, designed to bring home the following Key Concepts:

- **Erosion is the gradual wearing away of objects by water, wind, waves, or glaciers.**
- **Sand is created by erosion and can be transported long distances by streams, rivers, and ocean currents.**
- **Waves and currents constantly move sand on and offshore and along the coastline to form beaches which change with the seasons.**
- **Structures like groins can affect sand flow along the shore and cause some beaches to disappear**

In this activity, students learn that sand is created by erosion, and can be transported long distances by streams, rivers, and ocean currents. This activity introduces the concept that erosion is the gradual wearing away of objects by glaciers, water, wind, or waves. Waves and currents constantly move sand on and offshore and along the coastline to form beaches, which change with the seasons. Construction of structures such as groins, which interrupt natural coastal processes such as the movement of sand along shore, can cause beaches to disappear.



In Activity 1, students will listen to a story, "Roxie's Rough Ride to the Beach," and make a Sand Story Chart about the journey of a rock from high on a mountain to a sand grain in the wall of a sand castle. In Activity 2, they work in small groups to write and illustrate a series of "postcards" that re-tell the story of the rock's journey and metamorphosis. In Activity 3, students play a Game Show to respond to questions about the story. Activity 4 gives students a chance to get up and move around, reenacting the motion of summer and winter waves and their effects on sandy beaches. Several "Going Further" activities are suggested for continued study along this theme.

Time Frame: Approximate time frames for completion of each activity are presented below, but teachers/presenters may wish to break up or condense activities to suit their particular time constraints.

Unit 3: Sand Travels

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|---|----------------------|
| Activity 1: Creating a Sand Story Chart | (45 minutes or more) |
| Activity 2: Postcards from the Journey | (45 minutes) |
| Activity 3: Sand Journey Game Show | (45 minutes) |
| Activity 4: Wave Play | (30 minutes or less) |

SAND TRAVELS: What You Need

What You Need

For the class:

- 11 sheets of chart or butcher paper (approximately 27" x 34")
- markers (4-5 colors, wide tips)
- a few real postcards with messages on them
- at least 10 extra 4" x 6" blank index cards

For each group of 8 students:

- 9 4" x 6" blank index cards to make into postcards
- 2-3 sets of crayons, fine-point markers, or colored pencils
- 8 regular ball-point pens or pencils
- clear tape to connect the finished index/postcards

Getting Ready

1. Have students bring in postcards from home.
2. Make the skeleton for the Sand Story Chart. At the top of one sheet of chart paper, write the name of Part 1 of the story "Roxie's Rough Ride to the Beach." On another write the name of Part 2, etc., until each of the following six story parts is on its own sheet of chart paper:

Part 1: High Mountain Winter

Part 2: The Spring River Run

Part 3: Lazy Lagoon in Summer and Fall

Part 4: The Winter Storm – Roxie Meets the Surf

Part 5: Spring on the Kelp Wrack

Part 6: The Summer Beaches

Part 7: The Groin

Part 8: The Sandcastle

3. Write out the Key Concepts for this activity in large, bold letters on separate sheets of chart paper and set aside.

- **Erosion is the gradual wearing away of objects by water, wind, waves, or glaciers.**
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Activity 1: Journey of a Sand Grain: Creating a Sand Story Chart

The Sand Story Chart activity helps students summarize and talk about information they have just learned. It helps them learn how to organize and reconstruct information by putting it into their own language and drawings.

1. Gather the class into a listening circle and tell them they are going to listen to a story about a rock named Roxie. The story is divided into short chapters or parts just like a book. Let them know they will have to listen carefully so they can summarize what happens to Roxie on her journey.

2. Turn to the story "Roxie's Rough Ride to the Beach" on page 11 of this unit guide. Read aloud Part 1: High Mountain Winter. Post the first chart paper of the Sand Story Chart with the title of Part 1 on it. Then ask students what the most important things were that happened in this part of the story. For example, students might recall that Roxie was stuck in a crack; she was smooth on one side and rough on the other; and that the crack was getting wider. Record their ideas on the chart paper just the way they describe them. If some responses are not quite accurate, ask others to help out with the description. Your students will understand and remember the important concepts presented in the story better when the Sand Story Chart they create is in their own words.

3. Repeat this process for each part of the story so that the students have a written outline of the story to refer to later. Move the discussion along by taking only a few minutes to outline the main concepts of each part on the Sand Story Chart. Spending too much time can cause the activity to lose momentum.

4. At the end of the story, ask the students to quickly review the Sand Story Chart. Do they have any questions or clarifications? Is there anything they want to add to any part of the Sand Story Chart?



It will help your students if you create the Sand Story Chart carefully, using the same format for each part of the story. Each part should have its own sheet of chart paper. Use the same color marker for all eight titles of the story's parts. Then alternate at least two other colors to separate and distinguish ideas that students contribute to the chart. Set each contribution apart with a different color bullet. If another student repeats an idea you have already recorded, put a star next to it on the chart to acknowledge the student and to remind her/him to listen carefully to others. It is not necessary to use only complete sentences, but you might want to highlight key words and ideas. Though you may want to record ideas as closely to how students say them as possible, you also may want to paraphrase or re-phrase them verbally to give all of the students another chance to understand the idea.

SAND TRAVELS: Activity 2 - Postcards from the Journey

Activity 2: Postcards from the Journey

1. Ask students if they have ever been on an exciting trip. Sometimes people tell others about a special trip or journey by writing them a postcard. Ask questions, such as: Have you ever written or received a postcard? When do people send them? What types of messages or pictures are on them? Invite students (one at a time) to share the postcards they have brought with them from home.

2. If it doesn't come up in the discussion, describe how postcards usually have a photograph or picture on one side to show the friends or family of the traveler scenes from the journey. On the other side of the card, the traveler writes words relating stories about experiences she/he is having, describing what the weather is like, and telling if she/he is enjoying the trip. It can also include information about where the traveler will visit next.



If you don't have quick access to some real postcards to show the class, write up an example that you or a student can read out loud to the class.

3. Tell the class that they are going to imagine they are Roxie and are writing a postcard home describing one part of her journey to the shore. Divide the class into groups of eight. Give each student a blank 4" x 6" index card.

Explain that each of the cards will be a scene from Roxie's journey. Distribute a ninth card to each group to be a title card. Review the eight parts of the story with the class.

Students can address their postcards to whomever they choose. Some options include: their "mother rock," their former neighbor, the lodgepole pine tree, a friend or relative, or themselves.

4. Pass out crayons, markers, or colored pencils to each group. Assign each of the eight students in each group a part of the story to illustrate. Tell them to imagine that they are Roxie on her journey and writing a postcard home. Have students use crayons or markers to draw where they are in their journey, and be sure they include Roxie in each picture.

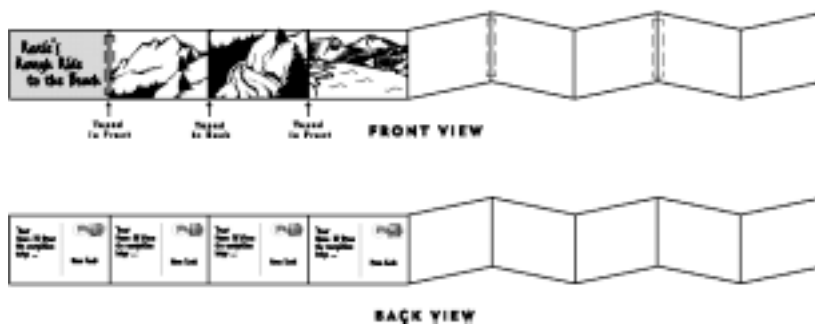
SAND TRAVELS: Activity 2 - Postcards from the Journey

5. Pass out ball-point pens or pencils to each group. On the back of each card, have students write a postcard message from Roxie. They could include something about their experiences, what has happened to them, maybe mention the weather, and whether or not they are enjoying the journey. Tell them to be as creative as they can. They can use humor, happiness, loneliness, or other emotions, but they should try to include accurate information about Roxie's location and activities. Example: "Dear Mom: Hi from the mountains! It is really windy up here and I can feel the rock cracking. I keep getting blown into the wall and banging my head. The snow-capped mountains are really pretty. Bye, Roxie."

6. When the first person in each group finishes designing her/his postcard, ask her/him to complete the set by making a title card that says "Roxie's Rough Ride to the Beach."

7. Have the students make a postcard storybook that tells Roxie's story -- the story of the evolution of a sand grain -- by lining all nine postcards in a row, sequentially, and taping

the short edges together, alternating the tape on the front and back so that it will open and close like an accordion.



Before taping the postcards together, you may wish to re-read the story, asking students to hold up their postcards at the appropriate place in the story.

8. Next, have each student describe their postcard to the rest of their group. They should listen carefully, so that any student in the group will be able to tell about any of the postcards after everyone has shared.

9. Hold up the Key Concepts for this activity one at a time, and have one or more students read them aloud. Post them on the wall next to the Sand Story Chart.

- **Erosion is the gradual wearing away of objects by water, wind, waves, or glaciers.**
- **Sand is created by erosion, and can be transported long distances by streams, rivers, and ocean currents.**
- **Waves and currents constantly move sand on and offshore and along the coastline to form beaches which change with the seasons.**
- **Structures like groins can affect sand flow along the shore and cause some beaches to disappear**

With younger students, you may need to take the time to revisit the concept of erosion, and to explain longshore drift.

SAND TRAVELS: Activity 3 - Sand Journey Game Show

Activity 3: Sand Journey Game Show

The Sand Journey Game Show facilitates small group discussions, review of previously learned information, and informal assessment of students' level of understanding. This activity also helps students to have the confidence to answer questions in front of the entire class.

1. For this activity, have students work in their original Postcard groups of eight. Each group should have its postcard storybook available. Have the groups count off so each student in a group has a different number, from 1 to 8. Points will be awarded in this game. You can keep score on the chalkboard.
2. Tell the students that they are going to play a Sand Journey Game Show. You will ask a question about Roxie's journey and each group will first discuss the question for about a minute and then decide together on an answer. In this way, everyone within the group should know the answer.
3. Explain that you will pick a group, then a number, and the student with that number in that group stands up. You again ask the question and the student answers it. If she/he gives a "complete" answer, her/his group is awarded five points. If she gives a partial answer, call another number from her group and give that person a chance to complete the first person's answer. Each group will get three tries to complete the answer and get five points. Encourage students to use their postcard storybooks to help them answer the questions.
4. If three students from the group fail to give the complete answer, have the students in the group take their best guess about the part of the story where the answer might be found. Read that part of the story aloud and have the students raise their hands if they hear the answer. If they give a complete answer now the group will be awarded three points.
5. Ask if there are any questions about the rules and clarify as needed. Then begin the Sand Journey Game Show by asking Question #1 from the list below. (Or you could make up your own list of questions, based on the interests and backgrounds of your presenters and/or the students). Give 30-60 seconds for all of the groups to discuss their answers. Then select a group and a number and ask the appropriate student to stand up. Repeat the question, ask the student to give the answer, and proceed as described above.

SAND TRAVELS: Activity 3 - Sand Journey Game Show

6. Repeat the process using a new question each time. Make sure that each group gets called on to answer an equal number of questions.

Sample Sand Journey Game Show Questions:

Question 1: Describe how Roxie left her original mountain home. What made her leave?

[The crack widened due to erosion; water, rain and snow carried her away.]

Question 2: Roxie said it seemed like there was always a party going on in the kelp wrack. Who came to the party, and why do you think it seemed like a party to Roxie?

[Flies, crabs, gulls, shore birds came; it was like a party because there were lots of visitors, food, and activity]

Question 3: During the winter storm, Roxie became smaller and smaller until she was just a tiny sand grain. What caused this?

[She was swept into the winter storm waves where she was ground up against other rocks.]

Question 4: Throughout the story Roxie was kept almost constantly on the move. What forces were moving her?

[Many, including winter storms, waves, wind and longshore current, for example]

Question 5: Remember the part of the story when the storm hit the beach at the same time as the high tide? What happened to Sandy when that happened?

[She was washed out into the ocean and broken up into smaller pieces.]

Question 6: Waves in the winter are very different from waves in the summer. How are they different?

[Winter waves are spaced closer together and are bigger and stronger; summer waves are spaced further apart and are smaller and more gentle.]

Question 7: How do waves affect the sand on the beach in the winter? In summer?

[Winter beaches may be just cobblestones, or have a steeper profile because most of the sand has been taken offshore by large waves; summer beaches are wide, deep, and sandy because the smaller waves push sand onto the beach.]

Question 8: What happened to the beaches north and south of the groin after it was built? Can you explain why?

[The beach on the north side of the groin grew wider, and the beach on the south side grew narrower. This happened because the groin became a barrier to the longshore current.]

SAND TRAVELS: Activity 4 - Wave Play

Activity 4: Wave Play

This activity will allow students to get up and move around (always a good thing with youngsters), and reinforce their knowledge about the effect of wave action on sandy beaches by acting it out. No special 'props' are needed for this activity.

1. Tell students they will now act out winter and summer wave activity on a sandy beach.
2. Have most of the class represent sand particles and have five or six students form a wave.
3. Have the students representing sand grains stand in a group on one side of the room (or outdoor area, as the case may be), to form a 'shoreline' and ask the students representing the wave stand side by side in a line on the other, 'ocean' side. Make a pile of jackets in the middle of the room between the 'ocean' and the 'shoreline' to represent kelp.
4. Ask the students to recall the differences between summer wave action and winter wave action. Let them speak out loud, so the whole class can refresh their understanding. You may ask them to recall their responses to the questions 6 and 7 in Activity 3, if you have presented that activity before this one.
5. Tell the students they will act out winter wave action first. Holding hands in a line, have students in the wave come back and forth across the space between themselves quickly to represent fast winter waves, each time taking sand particle students with them to the other side of the room (an off-shore sand bar in the ocean).
6. Ask the students, what might the remaining beach look like following a winter storm?
[Winter beaches may be just cobblestones, or have a steeper profile because most of the sand has been taken offshore by large waves]
7. Have the wave grab a pile of jackets and deposit them on the beach to represent kelp ripped from its holdfasts and washed up onto the shore.

SAND TRAVELS: Activity 4 - Wave Play

8. Next, ask a few students to act as shorebirds who peck through the kelp wrack looking for snack. Ask the students what types of snacks they are finding -- beach hoppers, kelp flies, etc. Where in the kelp wrack might these be found?

9. Next, to represent summer, have the wave move more slowly, quietly breaking along the shore, pushing the sand particles from the off-shore bar back up onto the beach, spreading them out into a wide, gentle profile.

10. Have some of the sand particle students act out longshore current. As some of the sand grains are washed back and forth by the wave, they will also move laterally (choose a direction) along the shore. Adjust the wave students angle of approach to the 'shoreline' to help them understand how this phenomenon occurs.

Remind the students of Roxie's story and the summer beach where a groin was constructed. Ask them to recall what happened on the north (up drift) and south (down drift) sides of the man-made structure. You may use the postcard story books to help them recall this concept.



11. Have students act out the groin scenario. Now most of the students should act as sand grains in a longshore current moving along a coastline. Then add a line of 5 or 6 students standing perpendicular to the shore to form the groin.

12. Have the students representing sand grains in the longshore current 'flow' down this shoreline again, and become trapped by the groin. (If you have a large number of students, some could also represent grains on the shoreline that are swept into the current, then swept back on shore.) Once the groin is in place, grains will be swept into the current from the down drift beach, but no new grains will be recruited from the longshore current, as the rest of your grains will be trapped against the groin.

13. End with a discussion of what other types of man-made structures might have this effect. What might be some better ways to protect a beach?

Going Further



1. Transform the postcard stories into dramatic presentations. Cluster the students that wrote the postcards from the same part of 'Roxie's Ride' together into "expert groups." Give the groups 15-30 minutes to develop one-to two-minute skits about their parts of the story, and to design simple costumes. Invite the groups to perform their skits in rapid sequence beginning with "Scene 1" until the entire story has been performed. Or, with more time, each group could prepare a dramatic presentation of the entire story. Surfrider Chapters or teachers with access to audio-visual equipment could turn these into slide or even video presentations.

2. Have students create their own, original postcard story. Lead a class brainstorm about all the things that may end up on a sandy beach. List all of their ideas on the chalk board. Encourage the students to choose items from the chalkboard list and tell a story of its travels or life cycle from the first person perspective. Younger students may tell their whole story on one postcard; older students might like to do a series of postcards.

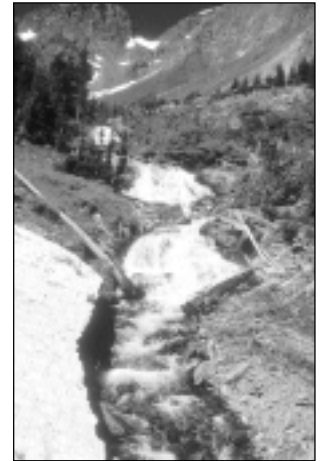
3. Take students to the same beach several times, during different seasons. Compare how the beach looks in winter and late summer/fall. Have students draw pictures showing the differences, including landmarks that stay the same in both pictures. If you don't have access to a sandy ocean beach, observe changes in another water habitat, such as a stream, pond, lake or marsh.

4. Take students to a beach where the littoral current has been interrupted by a breakwater or groin. Let students observe conditions on both sides of the structure. Ask them which direction do they suppose the along-shore current flows? What evidence did they use to draw their conclusions? What do they think is happening to the down drift beach? If a grain of sand were deposited on the up drift beach, do they think it would have a long or a short stay on this beach? What if it were placed on the beach on the down drift side of the structure? What would happen if the structure was removed? (If you don't have access to such a site, this could be turned into a classroom exercise, using slides or pictures ... aerial views are particularly useful to illustrate this concept.)

ROXIE'S ROUGH RIDE TO THE BEACH

Part 1: High Mountain Winter

High in the mountains, the lakes and creeks had begun to freeze over for winter. Golden aspen leaves fluttered down along the banks, leaving the white-barked trees in sharp contrast against the blue sky. Already the craggy granite peaks of the mountains were deep in snow. On a ledge by a gnarled lodge pole pine was a small rock named Roxie. Smooth on one side, rough on the other, the rock was about the size of your thumbnail. She had broken off from her mother -- a big mountain boulder and been wedged in a crack on the ledge below for a very, very long time. Year after year, the small rock watched the seasons go by. Once in a while, usually in the spring when the snow was melting, she would hear a clattering from above, and watch as other rocks, large and small tumbled and slid by her down the slope, but she never moved. She was stuck, she thought, never to see more of the world than the sky, the boulder above and her neighbor on the ledge, the lodge pole pine. But each winter, as rain filled the crack, and then froze with the cold, the ice pushed the crack outward. In the springtime, the roots of the pine tree grew, and the roots were pushing on the crack too. Roxie didn't notice, but very, very slowly, the crack was getting wider. Then one blustery fall day when the wind was blowing very hard, Roxie rattled a tiny bit in her crack! Suddenly she began to feel like she might not stay in her crack on the ledge forever after all.



Part 2: The Spring River Run

One fine morning of the following spring, when the sun was out and shining its warm rays on high mountain snow, a trickle of water crept underneath Roxie. It tickled a little bit and Roxie smiled. The gently moving water was a nice change from the cold, hard ice. As the sun rose in the sky, the little trickle turned to a slow steady stream, and as the day grew warmer, the water began to flow a bit faster, and then even faster through Roxie's crack. Suddenly, Roxie was lifted up out of her crack and swept off over the edge of the granite! Crash, bang! She tumbled down the rocks in the growing stream, and found herself launched into a roaring waterfall. In two seconds Roxie landed at the base of the falls and found herself at the bottom of a deep pool of bubbling, turbulent water. 'Wow!' she thought, 'Cool!' (she was having fun), but she had barely had time to check out her new surroundings before she was whooshed away again, moving fast down a racing river. She jumped and bumped through the raging rapids, catching a glimpse of sky, then the glassy water, then bumping along the smooth stones on the river bottom, then up again. She rolled and rollicked with the river on and on as it flowed out of the high mountains and through the foothills below.



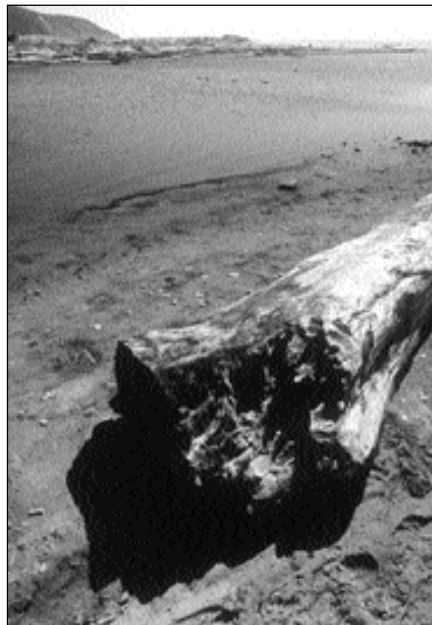
SAND TRAVELS: Roxie's Rough Ride to the Beach

Part 3: Lazy Lagoon in Summer and Fall

After quite some time and many miles, the river's flow slowed and the river widened out to form a glassy lagoon. Roxie had drifted by leopard lilies in spring and dragonflies in summer. During the dry months of summer the river's flow had lessened to a narrow stream, and Roxie lapped up in the calmer waters and settled on a flat sandy bank, near the edge of a wood. After such an exciting journey, she thought she might just stay there a while and rest. With all the wear and tear of going down the river, she was a little worn down—as a matter of fact she was only about half the size she had been when she was first swept out of her crack on the high mountainside! And she was now smooth and shiny. The river had polished her sides to a silky smoothness. Her old crack certainly seemed long ago and far away, for she had been many, many places since she had rested there.

Roxie spent her days basking in the warming rays of the sun, and watching all of the creatures of the surrounding woods come to drink at the water's edge. One day a striped snake even rested himself against her, as he curled up for an afternoon sun bath. In the evenings, Roxie was lulled to sleep, by the music of the gently flowing water. It was a very pleasant time indeed.

As the season turned to winter, Roxie felt chilly in the cold night air. But she didn't mind, for the sky was brilliant with beautiful stars of many colors. One especially quiet night she gazed for hours at the silver dazzling full moon. Then, one early morning, in the quiet of dawn she heard a new sound ... it was so far away, she could barely hear it, but it was there, a rhythmic sort of roaring sound, unfamiliar, but oddly soothing. Roxie was hearing the ocean's waves breaking on the shore.



PHOTOGRAPHY: JOE MOZDZEN

SAND TRAVELS: Roxie's Rough Ride to the Beach

Part 4: The Winter Storm – Roxie Meets the Surf (and gets a little broken up about it!)

Boom, crack! It was the first big storm of the winter. In the dark of night, Roxie listened to the crash of rolling thunder as rain fell all around her. By the flashes of lightening, she watched the water of the lagoon rise with the rain and tide until it once again reached her on her spot on the sandy bank. The flowing water lapped against her and then with a swish she was once again swept into the current. The water was muddy and brown, and Roxie was not alone in the flow. Branches, leaves, other rocks and even discarded cans and bottles swirled all around her. Just a few hours later, in the light of dawn Roxie was amazed to find that the ocean was at her feet! It was high tide and winter storm waves were rolling in fast and hard, one right after the other. The ocean looked wild, with white caps as far as she could see. The water was brown and gray where the river flowed into it – not clear and blue green the way she had imagined it would be. Before she knew it, Roxie was washed out to sea in a great churning of stones and sand. She barely caught one last look at the river mouth, where now only big rocks remained on the banks – it seemed that all of the fine sand and small stones had been washed away in the churning water.

Sloshing and grinding, rocks, shells and all manner of objects crashed into each other as they were surged forward with each wave, then swept back to meet the next one. Bit by bit, pieces broke off from Roxie until only a small sand grain was left. Roxie didn't mind this at all, because the smaller she got, the higher she could ride in the waves! She thrilled at the power of the waves and their natural rhythmic motion! Riding the waves was a lot more fun than sitting in that crack on the mountain! For days and days, Roxie tumbled around in the huge ocean, surfing the waves, kissing the shore, sweeping back to ride the next, then sinking down into the silky darkness of the deeper water off shore.



PHOTOGRAPHY: JEFF DIVINE

SAND TRAVELS: Roxie's Rough Ride to the Beach

Part 5: Spring on the Kelp Wrack

After a month of gray skies and rain the storms cleared. Roxie washed up on the beach with many other sand grains. She herself was stuck to a big stalk of brown kelp that was tangled and intertwined with a clump of other seaweeds. The air bladder of the kelp had allowed them to ride high on the waves, and they were washed up above the tide line next to a driftwood log. After seeing so many branches and logs in the river during the storm, she wondered if this log might be her old friend the lodgepole pine.



As the sun grew hot, the kelp began to grow slimy and start to rot. Roxie was quite stuck in place, but at least she was never lonely. The kelp wrack was a hub of activity. Snails and limpets who were also attached to the kelp made their way to the underside of it, so that they could stay out of the sun and keep away from predators who might eat them. Flies and beach hoppers nibbled at the kelp, while gulls and shorebirds wandered by, poking into the sand with their beaks. As darkness fell, the crabs sidled their way across the sand to pick and nibble at the kelp and other organisms that had washed in with it. It seemed there was always a party going on at the kelp wrack. Out in the ocean, other sand grains waited underwater on sand bars for their time to join the party.

Part 6: The Summer Beaches

As the days grew long and spring changed to summer, the waves were more gentle, and spaced further apart. Many of the sand grains who had spent the winter and spring resting off shore on a sand bar, were now washed onto the shore, and the beach grew wide and deep. The kelp dried up and Roxie finally fell off onto the beach. She felt free again, as the wind helped her skip over the beach and mingle with other sand grains. People and dogs came by and scuffed the sand. Roxie hitched a ride on someone's toe and found herself at the edge of the ocean again. At high tide she was scooped up in the quiet rocking motion of the wave wash and carried into the longshore current. Here Roxie drifted, pushed along by the ocean, heading slowly south with out much to do except go with the flow.



One afternoon she washed up again onto a shoreline. As she washed in, she got stuck on a dead sand crab, and just as she thought the waves had pushed her in as far as she would go that day, a gull swooped down and grabbed the sand crab. She could hardly believe it as she was lifted high into the air. She could see from the air that this was a narrower beach than the last one she had visited, and there were houses built all along the shore. So this was what was meant by a 'bird's eye view'! But after a moment, her attention was drawn back to the situation at hand. She was about to become part of this gull's afternoon snack! But just then, another gull spotted his buddy with the crab, and flew over to get in on the snack. The gulls swerved and squabbled in the air, and as they maneuvered and argued, Roxie was shaken free. Down, down she fell, and landed quite far up the beach, above the high tide line. "Well," she thought, "this is much better. Perhaps I will stay here and take in the sun for a while. After all of this travelling, I could use a rest." And that she did

Part 7: The Groin

Roxie was enjoying the summer, mixing with many other sand grains. She had met green and blue grains that had come from glass bottles, grains made from shells, from bone, from just about anything she could think of. Roxie had learned a lot since her days in the crack on the mountain ledge. But she hadn't moved far in a while, and she was beginning to get bored with this high and dry life. Every morning a big machine came along and raked through the sand grains, picking up all the kelp and other items that had washed onto the shore. There were no lively beach wrack parties here, as it was all picked up and taken away. As usual, however, just as she was beginning to think life was getting dull, Roxie was met with a new surprise. Big machines came onto the beach one morning, bringing truckloads of big rocks. These rocks were not as big as her mother had been, but they were very large indeed. The machines dug a trench and placed the rocks in a line, beginning on the beach very near Roxie, just north of her, and continuing out into the water, where the waves were breaking. Then they filled the gaps between the rocks with concrete. She heard one of the builders tell a person that the structure they were building was called a 'groin' and that it would protect the beach. Roxie felt lucky that she wasn't among the sand grains that had gotten cemented into the groin. Then she'd really be stuck!

SAND TRAVELS: Roxie's Rough Ride to the Beach

Part 7: The Groin (*continued*)

As the days grew shorter and the shadows grew long, Roxie knew that it would soon be winter. The waves would get bigger and sweep sand from the beach. But it seemed to her that her beach was changing faster than it should. The waves were still gentle, but the beach was getting narrower and narrower. The sand grains near the water's edge were still being swept out into the longshore current, just as she had been, and moving south, but no new sand grains were arriving from the north. All of the sand grains travelling in the longshore current were getting stuck at the groin. As the beach on the south side of the groin became narrower and narrower, the waves reached farther and farther up the beach toward Roxie, and she knew she would be traveling again soon. By the time the waves reached Roxie, the southern beach was almost gone.

Part 8: The Sand Castle

By the end of the summer, Roxie had traveled quiet a few miles from the kelp wrack beach and the beach south of the new groin. Now she was near a small coastal town by a large point of land. The nearshore current caught her up and pushed her on shore right next to a child building a sandcastle. Scoop! The shovel picked her up and she landed at the bottom of the child's bucket. Splat! The bucket turned upside down and she found herself on top of the castle. She felt the child's warm hands patting her into a beautiful shape. "Oh, how lovely!" she thought. She could see the child smiling, and she was glad to be there -- at least for a while.



PHOTOGRAPHY: EVE KLISZEWSKI

GETTING UP TO SPEED

Beaches are one of the most unstable marine environments, better thought of as rivers of sand than static features of the landscape.

Sandy beaches are products of erosion, sediment transport and deposition. Every grain of sand has a history and is a tiny world in itself. It started its evolution as something other than a grain of sand, somewhere other than the beach where you see it today. To begin to trace it's history we can look at the grain of sand under a microscope. White sand beaches might be made up of crushed coral or coralline algae. Black sand beaches are made up of crushed volcanic rock. There might be many different multi-colored minerals on the beach if the sand originally came from mineral-rich granite. Pieces of bone, shell, and feathers are also mixed in with the sand on many beaches.

Erosion can start long before a rock reaches the ocean. Wind, ice, and rain are powerful tools of erosion that break up rock formations high in the mountains. Wind can push boulders and stones loose, but it also gradually wears down rock surfaces by blowing particles such as sand, silt, and gravel into cliff faces. In essence these particles sandblast the rock, loosening from it fine sediment. Rain often combines with wind to wash out wind-loosened sediment. Rainwater also can chemically dissolve many types of rocks. Some other erosion processes are seasonal. During the fall, water collects in rock fissures, and then freezes (and expands) during the winter, pressing outward within the crack and slowly causing the fissure to get larger. This seasonal cycle of precipitation, freezing, snowmelt and runoff causes slowly works on fissures and cracks and causes sections of rock to loosen and break. Gravity and runoff carry these pieces, large and small, into the the lower valleys and drainages of the mountain ranges, where streams and rivers wash them downstream toward the ocean, often tumbling and breaking them up into smoother, smaller pieces along the way.

Once the pieces of rock reach the ocean, the strong, continuous force of ocean waves sorts the particles by size and further grinds them into smaller and smaller pieces. Waves are an important influence on life in the ocean. They can easily be observed from a sandy beach where they roll toward the shore in rhythmic swells throughout the year. Storm waves are especially powerful when they hit the shore-line and can cause extensive erosion.

Waves in summer and winter are different in size and strength. Winter storms cause large, steep waves that crash onto the shore in close succession, pulling sand offshore with the power of their weight and force. Winter beaches are often eroded to become narrow and steep, sometimes reduced to cobble beaches with no sand at all. The sand is moved just offshore onto sandbars or out to sea. In summer, waves are less steep, shorter, and farther apart. As they roll in more gently, the sand is deposited back on shore, to form a wider beach with a gentler profile.

SAND TRAVELS: Getting Up to Speed

The rhythmic waves also push a variety of objects other than sand onto the beach: kelp and other seaweeds, shells, human trash, and sometimes other organisms, to the top of the high tide line. Often this line of kelp and other debris—called "beach wrack"—forms a visible line the length of the beach at the highest extent of the most recent high tide. Along with the kelp, a myriad of organisms living on the kelp stipes and fronds and in its holdfasts are carried into the beach wrack. Among these organisms might be snails, crabs, or limpets. A new community forms in the beach wrack as the kelp begins to decay. This association of 'detritivores' (detritus eating organisms) includes beach hoppers, worms, and flies. Birds, who in turn feed on these creatures, are also attracted to the nutrient-filled mass. The beach wrack becomes a temporary but important ecological association of the sandy beach ecosystem.

The sand on the beach is in constant motion, due to the intense impact of regular wave action as well as the force of winter storms. Sand grains may be hit by as many as 8,000 ocean waves a day! A single sand grain may move up and down the beach many times in a day in the wash of waves. Because most waves hit the shore at an angle, the sand is also moved along the beach. When the waves break at an angle to the shoreline, a portion of the incoming wave energy is directed along the shore, creating a lateral current. Surfers call this current 'the drift'. This longshore current or 'littoral drift' can move sand considerable distances. Due to predominant winds, on the West and East Coasts long shore currents generally move in a southerly direction.

The natural process of beach building and erosion has been altered by extensive development of much of the US coast. Prior to development, natural loss of sand from beaches, largely to dunes and submarine canyons, and natural sand supply, mostly from rivers and streams, were in rough balance. The damming of rivers alone has drastically reduced the natural sand supply to beaches. The natural balance of beach sand supply and loss has also been altered by the construction of offshore breakwaters, and shoreline structures such as bulkheads, groins, jetties, and seawalls, which may divert sand from one location to another and change beach slope. These man-made structures often provide short-term protection to property and infrastructure but frequently have an adverse effect on the beach.

Groins are piles of rock and other materials that are constructed perpendicular to the shoreline. The idea is to create or widen beaches by capturing sand moving along the shoreline in littoral drift. As the longshore current is interrupted, sand particles drop out of suspension, and sand builds up on the 'up drift' side of the structure, as desired. But wave action and resumed long shore current on the down drift side of the structure erodes sand from the 'down drift' beach, with no incoming sand source to replenish it (the structure has effectively blocked the source of incoming sand). One needs only look at an aerial view of the southern California shoreline to understand the domino effect and degradation of beaches that has ensued from this short sighted management approach.

UNIT 3 RESOURCES

Books

For Children:

Exploring the Seashore, William H. Amos, National Geographic Society, Washington, DC, 1984.

A Field Guide to Seashores Coloring Book, John C. Kricher, Houghton Mifflin, New York, 1989.

Kelp Forests, Judith Conner and Charles Baxter, Monterey Bay Aquarium Foundation, Monterey, California, 1989.

Monster Seaweeds: The Story of the Giant Kelp, Mary Daegling, Dillon Press, Minneapolis, 1986.

One Small Square: Seashore, Donald M. Silver, W. H. Freeman, New York, 1993.

Rocks and Minerals, R. F. Symes, Knopf, New York, 1988.

Sand and Man, Willma Willis, Children's Press, Chicago, 1973.

Sand Dunes, Jan Gumprecht Bannan, Carolrhoda Books, Minneapolis, 1989.

Seashore, David Burnie, Dorling Kindersley, New York, 1994.

The Seashore, Elisabeth Cohat, Scholastic, New York, 1995.

Seashore, Steve Parker, Knopf, New York, 1989.

Seashore Surprises, Rose Wyler, Julian Messner, Englewood Cliffs, N.J., 1991.

Seashores, Joyce Pope, Troll, Mahwah, New Jersey, 1990.

Shell, Alex Arthur, Knopf, N.Y., 1989.

Shells, S. Peter Dance, Dorling Kindersley, New York, 1992.

Shoreline, Barbara Taylor, Dorling Kindersley, New York, 1993.

Where the Waves Break: Life at the Edge of the Sea, Anita Malnig, Carolrhoda Books, Minneapolis, 1985.

50 Simple Things Kids Can Do to Save the Earth, John Javna, The Earth Works Group, Andrews and McMeel publishers, Kansas City, 1990.

For Adults:

The Book of Waves, Drew Campion, Roberts Rinehart Publishers, Boulder Colorado, 1997

The Oregon Ocean Book, Tish Parmenter and Robert Bailey, State of Oregon Department of Land Conservation and Development, Salem, 1985.

Pacific Coast, The Audubon Society Nature Guides, Bayard H. McConaughy and Evelyn McConaughy, Alfred A. Knopf, New York, 1985.

Sand, Raymond Siever, Scientific American Library, New York, 1988.

Seashore Identifier, Bob Lollo, Mallard Press, New York, 1992.

The Seaside Naturalist: A Guide to Nature Study at the Seashore, Deborah Coulombe, Prentice Hall, New York, 1984.

Waves and Beaches, Willard Bascom, Anchor Books, Garden City, N.Y., 1964.

Wild Ocean, America's Parks Under the Sea, Sylvia A. Earle and Walcott Henry, National Geographic, Washington DC, 1999

Magazine Articles

"Beaches," *Scientific American*, Aug., 1960

"Collecting and Examining Beach Sand: Getting Started," *Microscopy Today*, 96(5): 18- 20, June 1996.

"Sand," *Scientific American*, April 1960.

"Sands of the World," *Scientific American*, 275(2): 62-67, July 1996.

Music

Slugs at Sea

by Banana Slug String Band
Music for Little People Redway, CA. 1991

This cassette contains many fun and entertaining songs all about the ocean. The most appropriate song for Beachology is "Life on the Shore" where the lyrics say if you live on the shore "you've got to move with the tide...run real fast or burrow and hide."

Videos

At Ocean's Edge: Coastal Change in Southwest Washington (Adults)
Washington State Dept. of Ecology
(360) 407-6568
www.wa.gov/ecology/sea/swce/index.html
20 minutes

Historically, the southwest coast of Washington expanded as sand supplied by the Columbia River nourished coastal landforms. Today, however, that growth trend is changing and many areas along Washington's ocean coast are experiencing erosion at unprecedented rates, placing at risk community infrastructure, economic livelihood and recreational opportunities. This video presents coastal erosion hotspots in southwest Washington and the work being done through the Southwest Washington Coastal Erosion Study, a Federal-State-Local partnership. Field research is being performed in a wide array of disciplines, including coastal processes and coastal geology. Results of this effort will serve as a base of knowledge for use by coastal communities in land-use planning and decision-making.

Keepers of the Coast
The Surfrider Foundation
P.O. Box 6010
San Clemente, CA 92674-6010
(949) 492-8170
31 minutes

Spectacular surfing footage dramatizes the message of this important video. Every year, thousands of beaches are closed due to pollution. This video teaches students about the water cycle, the causes of coastal pollution and the interaction of the ocean, shore, winds and tides that creates waves. The video describes the grassroots efforts of the Surfrider Foundation in battling coastal water pollution.

SAND TRAVELS: Unit 3 Resources

Videos (continued)

Living On the Edge: California's Coastal Erosion Dilemma

NonProfit Distributions:

Eden Productions
1503 Beach Street
San Luis Obispo, CA 93401
(805) 544-2843
vidman2@msn.com
29 minutes

Public & Educational Institutions:

University of California
Center for Media & Independent Learning
2000 Center Street, 4th Floor
Berkeley, CA 94704
(510)642-0460
www.cmil.unex.berkeley.edu/media/

Living on the Edge explores California's coastal erosion issues from a variety of perspectives. The video includes interviews with coastal scientists, public activists and coastal property owners. Issues examined include El Nino and the inter-decadal oscillation, historical shoreline development trends, coastal engineering and associated impacts, State policies concerning coastal hazards and a case study: The Cliffs Resort revetment dispute in Shell Beach, California.

Oceans In Motion

National Geographic Adventures
1145 17th Street N.W.
Washington, D.C. 20036
24 minutes

Professional surfer Robert "Wingnut" Weaver serves as a guide through this video, which illustrates, with helpful animation, how the familiar phenomena of waves and tides are created. The impacts of ocean currents on climates around the world is explained, citing examples from the Gulf Stream in the Atlantic and El Nino in the Pacific. The video also explores how oceans came to be: how all that water got therein the first place and how it became salty. Viewers travel back to the time when the earth was first formed.

Dramatic footage from the ocean floor reveals that the formation of the earth's crust is still taking place. Seismic activity on the ocean floor and formation of tsunamis, as well as ocean floor topography and life forms are revealed. The video is accompanied by a teacher's guide which includes key concepts and suggested follow-up activities.

New England Aquarium Videos (various titles)
New England Aquarium Teacher Resource Center
Central Wharf Boston, MA 02110-3399
(617) 973-6590
various lengths

The Teacher Resource Center maintains a large collection of circulating videos, slide shows, software, filmstrips, posters, and small kits available to teachers nationwide. Included are 10 video titles on a wide variety of topics. Call or write for a list of titles.

Oceans Alive!
Environmental Media & Marine Grafics
P.O. Box 1016
Chapel Hill, NC 27514
(800)368-3382
50 minutes (10 five-minute programs)
available in English or Spanish,

Oceans Alive! illustrates the relationships among marine life and supports the teaching of life science. Filmed entirely in the wild in many locations, this series encourages students to ask questions and share experiences. The series is divided into four main parts, each with 10 programs ranging over a wide and diverse spectrum of organisms, habitats, and environmental issues. It is recommended for ages 10 to adult.

Sand Through a Microscope, 2nd edition
Warren A. Hatch Productions
1330 SW Third Avenue, #703
Portland, OR 97201-6636
52 minutes

Shows a wide variety of sands from around the world. The video ends with a question period when the viewer is asked to guess the types of sand shown.

Sea World Videos (various titles)
Sea World Education Department
1720 South Shores Road
San Diego, CA 92109-7995
(619) 226-3834
40 minutes—except Meet the Challenge: Marine Conservation (28 minutes)

Sea World's education department has a wide array of educational materials available to teachers including videos, teacher's guides, posters, information booklets, and even a live TV program. Video topics include marine conservation issues, baby animals, sharks, polar animals, dolphin research, and coral reefs. Call or write for details.

Seashores
Hollywood Select Video Inc.
10010 Canoga Avenue, B5
Chatsworth, CA 91311
(818) 773-0299
25 minutes

This video explores the inhabitants of the Atlantic and Pacific coasts. A detailed view of both is presented in this colorful video.

Posters

California Kelp Forest
Center for Marine Conservation
1725 DeSales Street N.W., Suite 600
Washington, DC 20036
(202) 429-5609

Don't Teach Your Trash to Swim
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204

I Help Make the Beach See Worthy/Annual Beach Clean-up
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219
(415) 904-5206

Oceans in Peril
National Audubon Society
National Education Office
Route 1, Box 171, Sharon, CT 06069
(203) 364-0048

SAND TRAVELS: Unit 3 Resources

National Estuary Program Contacts

For general information on the National Estuary Program and profiles of all 28 estuaries, visit the EPA's NEP Home page: www.epa.gov/OWOW/estuaries/nep.htm

West Coast:

Puget Sound, WA
Puget Sound Water Quality Authority
(206) 407-7300
www.wa.gov/puget_sound/index.html

Lower Columbia River Estuary, OR
Lower Columbia River Estuary Program
(503) 229-5247
web site: www.lcrep.org

Tillamook Bay, OR
Tillamook Bay
National Estuary Program
(503) 322-2222
www.orst.edu/dept/tbaynep/nephome.html

San Francisco Estuary, CA
San Francisco Estuary Project
(510) 662-2465
www.abag.ca.gov/bayarea/sfep.html

Morro Bay, CA
Morro Bay National Estuary Program
(805) 528-8126
web site: www.mbnep.org

Santa Monica Bay, CA
Santa Monica Bay Restoration Project
(213) 266-7515
web site: www.smbay.org

Gulf of Mexico:

Corpus Christi Bay, TX
Corpus Christi Bay
National Estuary Program
(512) 985-6767
web site: www.sci.tamucc.edu/ccbnep

Galveston Bay, TX
Galveston Bay National Estuary Program
(713) 332-9937
web site: gbep.tamug.tamu.edu

Barataria-Terrebonne
Estuarine Complex, LA
Barataria-Terrebonne
National Estuary Program
(504) 447-0868 or (800) 259-0869
web site: www.btnep.org

Mobile Bay, AL
Mobile Bay National Estuary Program
(334) 990-3565

Tampa Bay, FLA
Tampa Bay Estuary Program
(727) 893-2765
web site: www.tbep.org

Sarasota Bay, FL
Sarasota Bay National Estuary Program
(941) 359-5841
pelican.gmpo.gov/gulfofmex/estuary-partner/sarasota/sarasotabay.html

Charlotte Harbor, FL
Charlotte Harbor
National Estuary Program
(941) 995-1777
web site: www.charlotteharbornep.com

South Atlantic:

Indian River Lagoon, FL
Indian River Lagoon National Estuary
Program
(407) 984-4950
www.epa.gov/OWOW/oceans/lagoon

San Juan Bay, PR
PR Environmental Quality Board
(809) 751-5548
Puerto Rico Department of Natural
Resources and Environment
(809) 724-5516

Albemarle-Pamlico Sounds, NC
Albemarle-Pamlico Estuarine Study
NC Department of Environment, Health
and Natural Resources
(919) 733-5083 ext. 585 (general info)
(252) 946-6481 (education)
h2o.enr.state.nc.us/nep/default.htm

Maryland Coastal Bays, MD
Maryland Coastal Bays Program
(410) 213-2297
web site: www.dnr.state.md.us/mcbp

Delaware Inland Bays, DE
Delaware Inland Bays Estuary Program
Delaware Department of Natural
Resources and Environmental Control
(302) 645-7325
web site: www.udel.edu/CIB

Delaware Estuary, DE, PA, and NJ
Delaware Estuary Program
U.S. EPA, Philadelphia PA
(215) 597-9977
web site: www.delep.org

Northeast:

Barnegat Bay, NJ
Barnegat Bay Estuary Program
(732) 506-5313
web site: www.bbep.org

New York-New Jersey Harbor
Estuary Program, NY and NJ
US EPA Region 11
(212) 264-5170
Hudson River Foundation
(212) 924-8290
web site: www.hudsonriver.org/nep

Peconic Bay, NY
Peconic Estuary Program
Suffolk County Department of Health
Services, Office of Ecology
(516) 852-2077
www.co.suffolk.ny.us/health/pep

Long Island Sound, NY and CT
Long Island Sound Office
(203) 977-1541
www.epa.gov/region01/eco/lis

Narragansett Bay, RI
Narragansett Bay Project
Rhode Island Department of
Environmental Management
(401) 277-3165
web site: home.earthlink.net/narrabay

Buzzards Bay, MA
Buzzards Bay Project
(508) 748-3600
web site: www.buzzardsbay.org

Massachusetts Bays, MA
Massachusetts Bays Program
(800) 447-BAYS
www.epa.gov/region10/eco/massbay

New Hampshire Estuaries, NH
New Hampshire Estuaries Program
(603) 433-7187

Casco Bay, ME
Casco Bay Estuary Project
(207) 828-1043

SAND TRAVELS: Unit 3 Resources

National Marine Sanctuaries

For general information on the National Marine Sanctuary Program and profiles of the sanctuaries, visit the NOAA's NMS Home page: www.sanctuaries.noaa.gov

Channel Islands
National Marine Sanctuary
113 Harbor Way
Santa Barbara, CA 93109
(805) 966-7107 fax(805) 568-1582
web site: www.rain.org/~cinms/

Cordell Bank National Marine Sanctuary
Fort Mason, Building 201
San Francisco, CA 94123
(415) 561-6622 fax(415) 561-6616
www.ocrm.nos.noaa.gov/nmsp/nmscordellbank.html

Fagatele Bay National Marine Sanctuary
P.O. Box 4318
Pago Page, American Samoa 96799
(684) 633-5155 fax(684) 633-7355
web site: www.fbms.nos.noaa.gov/

Florida Keys National Marine Sanctuary
9499 Overseas Highway
Marathon, FL 33050
800-942-5397
(305) 872-2215 fax(305) 872-3786
web site: www.keyswreckdive.com/

*Key Largo National Marine Sanctuary
P.O. Box 1083
Key Largo, FL 33037
(305) 451-1644 fax(305) 451-3193

*Looe Key National Marine Sanctuary
Rt. 1, Box 782
Big Pine Key, FL 33043
(305) 872-4039 fax(305) 872-3860

*Part of Florida Keys National Marine Sanctuary

Flower Garden Banks National Marine Sanctuary
216 West 26th Street, Suite 104
Bryant, TX 77803
(409) 779-2705 fax (409) 779-2334
www.flowergarden.nos.noaa.gov/



PHOTOGRAPHY: JEFF DIVINE

Gray's Reef National Marine Sanctuary
10 Ocean Science Circle
Savannah, GA 31411
(912) 598-2345 fax (912) 598-2367
web site: www.graysreef.nos.noaa.gov/

Gulf of the Farallones National Marine Sanctuary
Fort Mason, Building 201
San Francisco, CA 94123
(415) 556-3509 fax (415) 556-1419
web site: www.gfnms.nos.noaa.gov/

Hawaiian Islands Humpback Whale National Marine Sanctuary
726 South Kihei Road
Kihei, HI 96753
(808) 879-2818 fax (808) 874-3815
www.ocrm.nos.noaa.gov/nmsp/nmshawaiiislands.html

Monterey Bay National Marine Sanctuary
299 Foam Street, Suite D
Monterey, CA 93940
(408) 647-4201 fax(408) 647-4250
web site: www.mbnms.nos.noaa.gov/

Olympic Coast National Marine Sanctuary
138 West First Street
Port Angeles, WA 98362
(360) 457-6622 fax (360) 457-8496
www.ocrm.nos.noaa.gov/nmsp/nmsolympiccoast.html

Stellwagen Bank National Marine Sanctuary
14 Union Street
Plymouth, MA 02360
(617) 982-8942

Monitor National Marine Sanctuary
The Mariners Museum
100 Museum Drive
Newport News, VA 23606
(804) 599-3122
monitor.nos.noaa.gov/welcome.html

Proposed Sanctuaries:
Sanctuaries and Reserves Division
National Oceanic and Atmospheric Administration
1305 East-West Highway
SSMC4, 12th Floor
Silver Springs, MD 20910
(301) 713-3125

SAND TRAVELS: Unit 3 Resources

Curriculum Resources

Adopt-A-Beach School Education Program Curriculum
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219
(415) 904-5206
web site: www.ceres.ca.gov/coastal-com/publicized/aab/educate.html

Año Nuevo Education Packet
Año Nuevo Interpretive Association
95 Kelly Avenue
Half Moon Bay, CA 94019
(415) 879-2025

A Child's Place in the Environment
Konociti Unified School District
Lake County Office of Education
1152 South Main Street
Lakeport, CA 95453
(707) 263-7249

Bayshore Studies Program (Locally-based curriculum and programs)
Richardson Bay Audubon and Sanctuary
376 Greenwood Beach Road
Tiburon, CA 94920
(415) 388-2524

Earth Island Institute
Earth Island Institute
300 Broadway, Suite 28
San Francisco, CA 94133-3312
(415) 788-3666

MARE Curriculum Guides & Teachers' Guide to Marine Science Field Trips
Marine Activities, Resources & Education (MARE)
Lawrence Hall of Science
University of California
Berkeley, CA 94720-5200
(510) 642-5008

Marine Science Project: FOR SEA
Grade Two
Marine Science Center
17771 Fjord Drive N.E.
Poulsbo, WA 98370
(206) 779-5549

Marine Debris Teachers and Educators Packet
Marine Debris and Entanglement Slide Show
Trashing the Ocean Video & Curriculum
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204
cmc-ocean.org/mdio/teacher.php3

Plastic Eliminators:
Protecting California Shorelines
CASEC University of California
Santa Barbara, CA 93106
(805) 893-2739

Project MER, Elementary Curriculum Learning Resource Services
-Publication Sales
Office of the Alameda County Superintendent of Schools
313 W Winton Avenue
Hayward, CA 94544
(510) 887-0152

Other

Wavelets

These are handouts on different ocean topics. Each one contains background information on the topic, and a game, puzzle, or activity. Single copies are free. For a list of these and other marine education publications, write to:

Sea Grant Communications
Virginia Institute of Marine Science
Gloucester Point, VA 23062
(804) 642-7000
web site: www.vims.edu/adv/ed/

The Monterey Bay Aquarium has printed educational materials, slide sets, and a video. For more information, write to:
Monterey Bay Aquarium
Education Department
886 Cannery Row
Monterey, CA 93940
(408) 648-4941
web site: www.mbayaq.org/

Aquatic Project WILD has materials covering topics which cover both fresh and salt water environments in broad categories such as diversity and ecological principles. These can be obtained only through your state fish and wildlife or fish and game agency.

The Rocky Shore and The Salt Marsh are guides to conducting successful field trips. For more information, write to:
Seacoast Science Center
P.O. Box 674
Rye, NH 03870
(603) 436-8043



ILLUSTRATION: JENNIFER L. RIGG

SAND TRAVELS: Unit 3 Resources

Cool Web Sites:

American Oceans Campaign home page
www.americoceans.org/

Beach.com

A website about beaches: www.beach.com

The Bridge

Online resources for marine science education

www.vims.edu/bridge/

California's Beaches

Informative excerpts from the California Coastal Commission's California Coastal Resource Guide.

<http://ceres.ca.gov/ceres/calweb/coastal/beaches.html>

Center for Marine Conservation

home page

cmc-oceans.org/

Dr. Beach

Dr. Stephen P. Leatherman, Professor and Director of the International Hurricane Center at the Florida International University has an informative website about beaches.

<http://www.topbeaches.com/>

Education Index

A guide to education-related sites on the web

www.educationindex.com/

EPA's BeachWatch homepage

Contains links to EPA beach reports and references, Beach Program overview, meetings and events, and links to other beach related sites

www.epa.gov/ost/beaches/

La Jolla Surfing

Ocean and beach news, photos, Weather, reviews, etc.

facs.scripps.edu/surf/surfing.shtml

National Ocean Service

Inventory of NOS educational materials Including cd roms, lesson plans, literature, Posters, videos and more

www.nos.noaa.gov/education/education_products.html

NOAA Central Library

Photo collection, historical maps and charts, online journals, and links to other NOAA sites

www.lib.noaa.gov

NOAA Sustain Healthy Coasts pages

<http://www.noaa.gov/str-plan/m-coasts.html>

Scripps Institution of Oceanography Coastal Studies Center

The Center engages in world-wide scholarly studies of the coastal environment, and advising on coastal protection and sediment management. Among the areas studied are waves, currents, and tides in nearshore and estuarine waters; sediment transport by waves, winds, and rivers; fluid-sediment interactions; and marine archaeology.

<http://www-ccs.ucsd.edu/>

Smithsonian Institution's Ocean Planet

A travelling exhibition

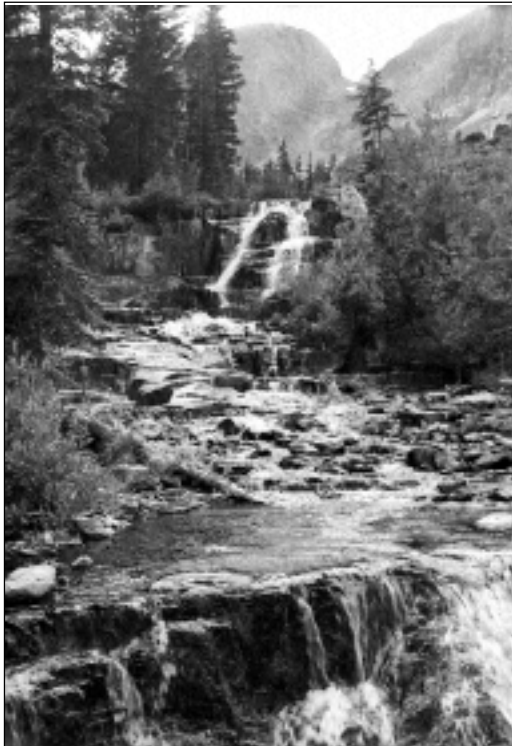
Seawifs.gsfc.nasa.gov/ocean_planet.html

Surfrider's Education web page


Info on beach and ocean topics,

Plus 'Top 40' links

www.surfrider.org/educational/html.



PHOTOGRAPHY: JOE MOZDZEN



ABOUT THIS PUBLICATION

This workbook was printed with soy based inks on recycled paper. Cover stock: New Leaf paper's Everest cover stock is 100% post-consumer waste recycled paper and is process chlorine free. Interior stock: Simpson's Quest is 100% post-consumer content paper that is non-deinked. The small flecks you see are bits of toner and ink from its past life.

Design by MOZDZEN, Laguna Beach, California

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