Surfrider Foundation®

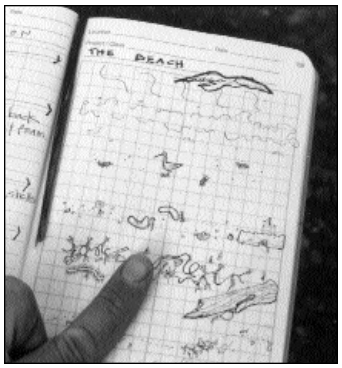
Respect The Beach

BEACHOLOGY: User's Guide

BEACHOLOGY: USER'S GUIDE

Acknowledgements

This Respect the Beach publication features activities developed by the Surfrider Foundation staff in surveying the best available environmental curricula offered by educational, environmental and scientific organizations throughout the nation, and even some abroad. We wish to acknowledge the many individuals who assisted us in this effort, and the many more who waited patiently while we completed a process that we felt would bring us the best result.



Special thanks to Jeff Nelsen, marine science instructor and Director of the Ocean Adventure Camps for providing us with a wealth of materials, for his enthusiastic support, pre-publication review and for "test driving" our activity plans in his classroom.

We also owe special thanks to Craig Strang, Director of the University of California at Berkeley's Lawrence Hall of Science, MARE program, for his early guidance, encouragement (personally guided tour!) and permission to adapt some of MARE's excellent educational materials. Activities in this publication were also adapted from materials contained in the California Coastal Commission's Adopt-A-Beach School Education Guide, the Smithsonian Institution's Ocean Planet Interdisciplinary Marine Science Activities, the Center for Marine Conservation's The Ocean Book, California Aquatic Science Consortium's Fresh Water Guardians and others.

We would like to express our thanks to the many other individuals who generously contributed their time and experience to this effort, including: Laura Seligsohn, environmental educator currently working with the Earth Island Institute; Marty Fujita. Ph.D. and the staff of the Richardson Bay Audubon Center; Doug Hartley, creator and Director of the AfroSurf Shack; Barry Schuyler, Professor Emeritus of the University of California at Santa Barbara's Environmental Studies program; Dr. Richard Marks and Nathan Pierce, of the Surfrider Foundation's Santa Cruz Chapter; Surfrider Foundation Europe; and last but not least, members of the Surfrider Foundation's Program Committee. Also, thanks to Ellen Lougee for the illustrations, Joe Mozdzen for design and photography, Andres Martinez for additional photography, and Mary West, New Leaf Paper.

BEACHOLOGY USER'S GUIDE: Introduction

Introduction to the Guide

The activities in BEACHOLOGY transport students to the sandy shoreline, a favorite destination for young and old alike. The sandy beach is also one of the most fascinating ecosystems to be found on our planet, and a focal point of many of the Surfrider Foundation's activities. At this special ecological transition zone, where the sea meets the land, the results of physical processes such as weathering and sediment transport may be readily observed; and a rich diversity of life forms have adapted to ever-changing and often harsh conditions. This unique environment inspires natural curiosity in students and adults, leading them to discover key scientific and environmental concepts.

Using a variety of learning formats, students may explore and deepen their understanding of many aspects of the sandy shore, from the processes that created and delivered the grains of sand that compose the beach, to the complex ecological interactions that support life in this challenging environment, and the influences of human activities. As students acquire information and build upon their own knowledge, they gain interest in and respect for the environment - fostering an enhanced sense of place, as well as personal and social responsibility.

You don't need to be a marine science expert or a teacher, or even live near the coast to present this guide to students. Background information and resources are woven into each unit. The 'Getting Up to Speed' sections should provide plenty of information to bring you up to a comfortable knowledge level to lead the activities. BEACHOLOGY is intended to provide you with fun opportunities to learn right along with students as they work their way through the activity plans.

This guide is intended to be truly interdisciplinary in nature. There is no need to confine the activities to any given science period or unit. Activities are designed to provide relevant learning experiences in many areas, including language arts, social studies or current events and art. Our research for this Respect the Beach update has indicated that the more various disciplines are intermixed and related to students' own life experiences, the better that students learn to grasp key concepts and apply them to new situations.

Each activity in this guide is designed to help Surfrider volunteers encourage students to talk, write, and draw about their related prior knowledge of a topic, and/or to distill and summarize what they have recently learned. The activity plans are meant to be simple and accessible, and to simultaneously help students build their knowledge of science and environmental issues.

We recommend that you read through this introduction and each unit before you begin to present the activities contained in BEACHOLOGY. This will give you a sense of the activity plans, and help you to foresee how they relate to your chapter's opportunities and special needs.

Unit Summaries

BEACHOLOGY consists of seven main units, each of which contains instructions for presentation as a series of class activities. These activities may be presented 'as is', or condensed to be presented in one or two sessions. In some cases, chapters may wish to present several concurrent sessions, or present only one or two activities, with teachers introducing the preliminary or final portions of the units. The intention is to allow each chapter to adapt or tailor some or all of the activities to suit their own 'flavor' and constraints, as well as school curricular needs. Presenting each unit in its entirety helps build and reinforce many key concepts for students; however implementing this approach will take a considerable commitment of time.

The BEACHOLOGY units are intended to be extremely flexible - so that chapters may implement all, portions of, or variations of the activities presented herein, as may teachers. Some chapters may choose to leave entire units to teachers, and come in only to present one activity ; or some may choose to come in after the students have completed the activities, to do a follow-on beach clean-up, mapping session, or to present information regarding the Surfrider Foundation's mission and community actions. Most of the activities contained in the BEACHOLOGY units have been prepared with elementary school students in mind. However, we feel that the activity plans may readily be adapted to suit younger or older students, or even adults.

The BEACHOLOGY units are summarized briefly below:

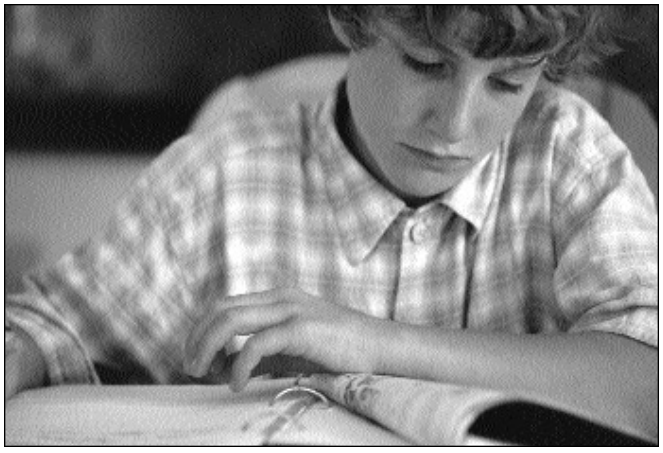
In **Unit 1: Beach Explorers**, students working in small cooperative groups explore a beach environment, or — for those who cannot readily access the shore with students — a simulated sandy beach in a plastic tub that is littered with 'beach drift' and debris. Through a sorting activity, students discover that the objects found on the sandy beach can be grouped into those that show evidence of plant life, evidence of animal life, and evidence of humans. They also learn to distinguish between once-living (biotic) and never-living (abiotic) objects.

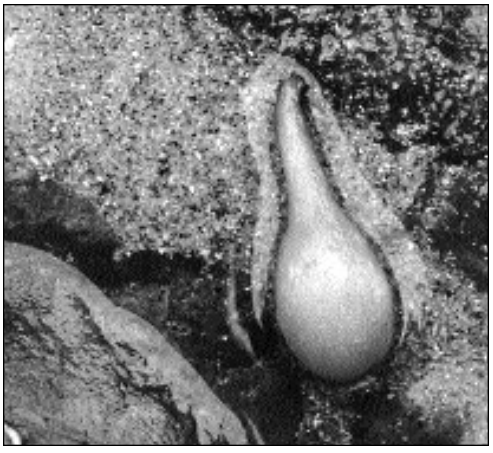
Unit Summaries continued:

In **Unit 2: Studies in Sand**, students with hand lenses work in small groups to compare the color, size and shape of grains from several sand samples. Based upon their observations, students make inferences about the origins of their samples. Students discover that sand grains can be made of animals, plants, rocks, or even of human generated debris, and that these differences can be clues about where the sand came from and how it got to its present location.

In **Unit 3: Sand Travels**, students listen to a story about the journey of a sand grain from high on a mountain to a sand castle on the beach. They work in small groups to write and illustrate a series of 'postcards' that recall points in time along the sand grain's journey. In hearing and re-creating the journey, students discover that sand is created by erosion, and can be transported long distances by wind, rain, rivers, streams, and ocean currents. Through the 'story', students also begin to make connections between the journey of a sand grain and other objects and substances which might be transported to the beach in the same way. They also learn some basic concepts about sand movement along the shore, and how human intervention can affect the sandy beach environment.

Unit 4: Tidal Waves, begins to reveal the interconnections between global geography, the world's oceans and conditions of our local coastlines, as well as the importance of these conditions to living beach organisms and people. Students begin by constructing mobiles to illustrate the relationship between the movements of the earth, moon and sun and the formation of high and low tides. Next, the students act out the movement of the ocean tides. This activity incorporates the use of group cooperation, role playing and physical movement to present the concept of the tidal wave following the moon. In the third activity, students learn to measure and record the daily changes in tidal height and time in relation to a dock. Through group data collection, organization of facts and group discussion, the determining force of the tides in the coastal environment is reinforced, and the stage is set for the next unit, which focuses on shoreline organisms.





In Unit 5: Creature Beach, students discover that most life on a sandy beach is actually hidden in the sand. Descriptions of the creatures living in sandy beach environments focus on the special adaptations that allow them to survive in the conditions present here - ever moving sand, changing tides, crashing waves. Students first color in drawings of sandy beach organisms, and draw a habitat for each organism. Then they build models of beach creatures. The models may be based upon real organisms, or imaginary organisms with their own special adaptations to beach conditions may be created. The model organisms are placed into three displays (also created by the students) that provide views of different parts of the same sandy beach. One of these displays is an 'above the sand' panoramic view of the beach and its surroundings. The second display focuses on the many organisms that live below the sand. The third display is a magnified look at the living and dead organisms that make up the 'beach wrack' washed ashore by the waves.

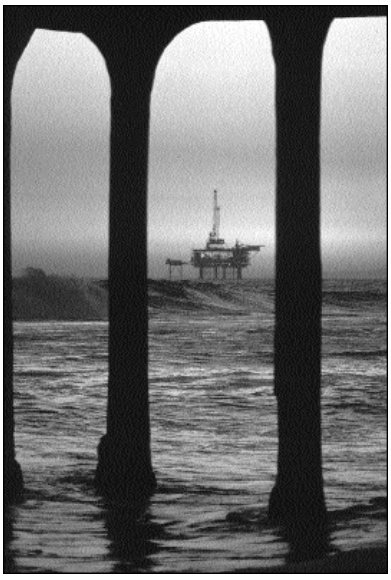
Creature Beach is a good example of an activity that could, in itself, extend over several class sessions. Depending on their time constraints, chapters may wish to modify it to best suit their needs and resources. For example, a chapter could lead a field trip to the beach to explore various regions of the sandy shore environment, find organisms, discuss their adaptations and the varying environmental conditions within each zone. In a sub sequent class session or sessions, the teachers could guide students in preparing the beach environment displays and model organisms. Chapter representatives could come back into the classroom to present the remainder of this activity, once the materials have been prepared - or conversely, chapters could work with students to prepare the models, then leave teachers with follow-up portions of the activity plan.

Unit 6: Animal Zonation and Associations Lab, is designed as a field exercise for older students and adults. The unit is designed to familiarize participants with animals typical of the local sandy beaches, and provoke some thought concerning their relationships to one another and to the physical environment. In the field study, students use a combination of transect and quadrat sampling methods to analyze the distribution and abundance of the four dominant sandy beach species. The entire lab's data is then used to relate the data collected to environmental parameters and determine whether correlations exist. This lab may be used by chapters in implementing the Surfrider Foundation's Surf Site Stewardship program as well as Respect the Beach. It is recommended that chapters working with older students and adult audiences present this exercise prior to and in conjunction with Unit 7. The Oil Spill activity will be enhanced for participants who bring to it a deeper understanding of the beach ecosystem.

Unit Summaries continued:

In Unit 7: Oil Spill!, students learn where oil comes from, how people use oil, ways to conserve it, and why conservation is important. They help make a classroom model sandy beach in a tub, and observe how the beach is affected by oil spilled off shore that washes onto the beach with simulated tides. Students then work in small groups to attempt to clean up the oil spill using a variety of methods. Through experimentation, students discover that oil spills are almost impossible to clean up - rather, people can better help to prevent oil spills and resultant environmental damage through conservation measures, such as reducing the use of oil and oil-based products. These activities build upon what students have learned in the previous units to make a strong connection between their daily life activities and current environmental issues related to the beach environment.

A section highlighting additional resources is also included within each activity guide. We welcome your suggestions for the activity plans, as well as for books and other resources that connect well with the activities in this unit. The Respect the Beach Program is currently under further development, and materials will be revised frequently to incorporate new ideas and feedback.



Getting Ready for the Presentations

Materials lists and steps for preparation for the activities in this guide are included in the instructions for each unit. In order to prepare for presentation of these activities, however, some materials and resources require advance planning and/or ordering. These are highlighted below, so that you should have ample time to prepare for your presentations.

Photos and Pictures of Sandy Shore Habitats

You'll need to gather photographs or pictures of sandy beaches and beach organisms (plants and animals). These pictures are used in Unit 1, when you'll need at least one picture for each student, and several times thereafter, with new pictures added. In Unit 2, for example, many of the pictures used in Unit 1 could be re-used, and you should also have some other pictures that focus on the sand itself. In Unit 5, additional sandy beach images, including slides and videos, are used for a simulated field trip. Pictures of oil-based products, such as plastics, or of oil being used in cars, trucks, pictures depicting refineries, etc. are needed for Unit 7.

To build up a nice collection of photos and pictures, and to involve students early, contact teachers in advance of your presentation and request that each student bring several images, in addition to those you gather yourself. If you plan to present these activities in a number of schools, you may wish to mount and/or laminate photos for durability. The 'Resources' sections within the unit guides include some suggestions for obtaining posters, slides and videos.

Beach Bucket Items

If you do not plan to conduct the Beach in a Bucket activity in Unit 1 at a beach, you will need to collect items for the beach buckets in advance. Even if you live in a land-locked city, don't worry! There are many ways to obtain beach material without having to visit an ocean, lake or river shoreline. Ask friends to save crab claws, clam shells and fish skeletons from seafood or fish dinners. Seaweed is available from many health food or Asian markets. Sand may be purchased from building supply stores, or ordered from other sources. Beach materials will also come in handy for the displays that classes create in Unit 5, and for the beach model in Unit 7. If you do collect materials from a shoreline, please be aware of regulations and environmental sensitivities of these areas. Take only small amounts of beach drift materials. Nothing may be taken or collected from a reserve, preserve or National Seashore, not even beach drift material or sand. We suggest that you do not purchase shells or other dead animals such as sea stars or sea horses because most are collected live from the wild, and habitats such as reefs may have been destroyed in order to collect them.

Reference Books

For all of the activities, and especially for Activity 5, it will prove helpful to have some nicely illustrated resource books available for your students to consult. The "Resources"sections within each unit contain some suggested reference materials.

Sand Samples/Rock and Mineral Kits

For Unit 2, you will need to obtain rock and mineral kits. You may be able to borrow these from existing kits in schools or universities, find them at a local hobby store, or order them from a scientific supply house (see "Resources" section within the Unit 2 guide).

You will also need to collect a diverse selection of sand samples. As much as several months before conducting this activity, alert teachers, students and friends that the class will be studying sand, and they should be on the lookout wherever they travel for samples of sand. On trips to the coast, to lakes and rivers, even deserts and alpine areas, ask friends and participants to collect small bags of sand. Be sure that each sample is labeled with information about when and where the sand was collected. Alternatively, the "Resources" section in Unit 2 includes information on purchasing sand kits.

With a bit of preparation and advance planning, we believe that you, the students and their teachers will thoroughly enjoy your studies in "Beachology" together. Go to it!

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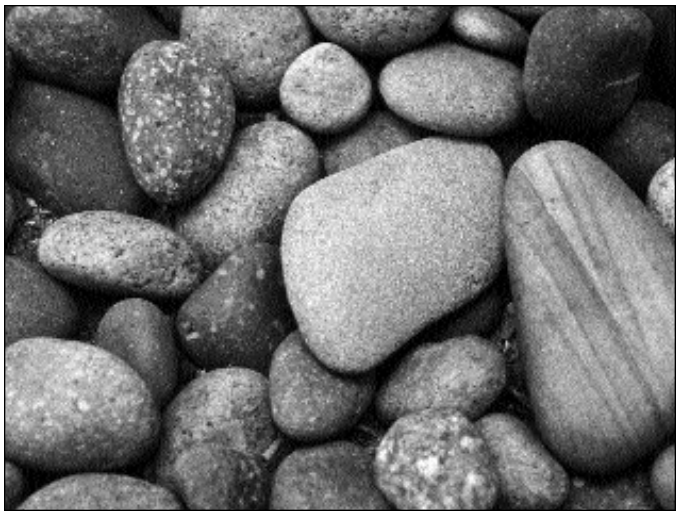

ABOUT THIS PUBLICATION

This workbook was printed with soy based inks on recycled paper. Cover stock: New Leaf paper's Everest cover stock is 100% recycled with 80% post-consumer waste 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.

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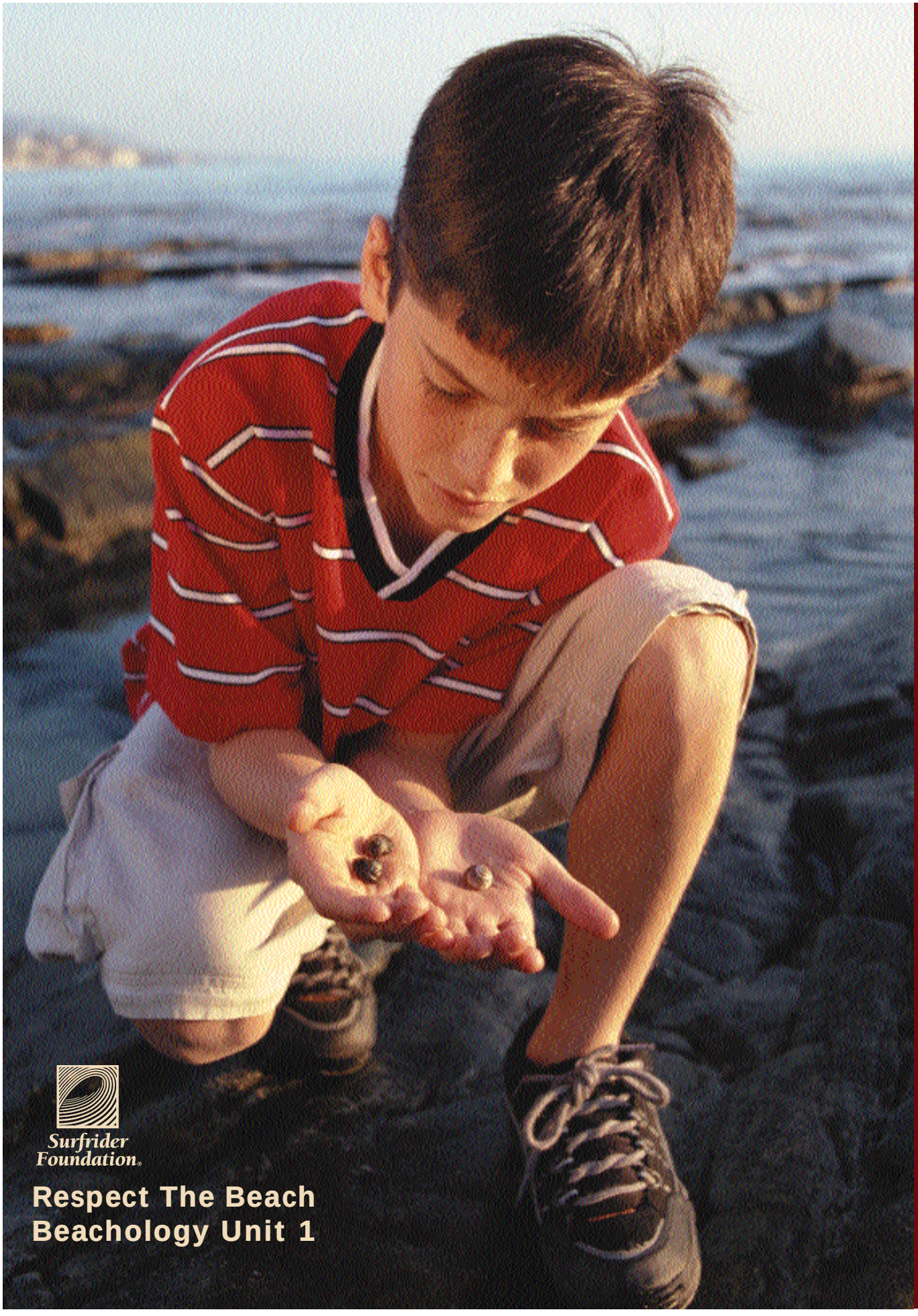


BEACH EXPLORERS

Surfrider Foundation

Respect The Beach
Beachology Unit 1

UNIT 1: BEACH EXPLORERS

Activities for Elementary Level Students

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

- **The world's ocean covers most of our planet. Everywhere the ocean meets the land there is a shoreline or a beach.**
- **Objects found on the sandy beach can be grouped into: evidence of plant life, evidence of animal life, of humans, and of non-living material.**
- **Sand is made up of tiny bits of everything that is found on the beach.**

Two introductory activities, **Blue Planet** and **Beach Blanket Brainstorm**, guide students into the unit by introducing them to global geography and the vastness of our planet's oceans, and by encouraging them to share what they already know, value, and enjoy about the ocean and beaches.

In the main activity of this unit, **Beach in a Bucket**, students work in small cooperative groups to explore a sandy beach (or, for those who cannot or choose not to conduct this activity at the beach, a simulated sandy beach in a plastic tub). Through a sorting activity, they discover that biotic (once-living) objects found on the sandy beach can be grouped into those that represent: evidence of plant life, evidence of animal life, and evidence of humans. They discover the differences between once-living (biotic) and never-living (abiotic) objects. Also introduced in this activity is the concept that sand is made up of tiny bits of virtually everything that can be found on the beach.

In the final activity, students make **Explorers' Field Books** to record what they learned about the beach.

Time Frame: Approximate times for completion of each activity are presented below, but teachers may wish to break each activity into a series of shorter sessions.

Unit 1: Beach Explorers

Activity 1:	Blue Planet	(15 - 30 minutes)
Activity 2:	Beach Blanket Brainstorm	(15 - 30 minutes)
Activity 3:	Beach in a Bucket	(60 minutes)
Activity 4:	Making an Explorer' Field Book	(45 minutes +)

BEACH EXPLORERS: What You Need

What you need

For the class:

- classroom globe, preferably inflatable 'beach ball' type
- 4-6 sheets of chart or butcher paper (approximately 27" x 34)
- markers (4-5 colors, wide tip)
- masking tape
- miscellaneous posters or pictures depicting beach scenes and/or beach organisms (calendar pictures work well because they are large enough to be seen if posted on a classroom wall)

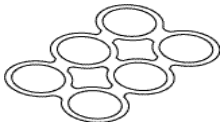
For each group of 4-6 students:

- 1 plastic tub or dishpan, 12" x 9"x 4" (or newspaper to spread out on desks)
- enough beach sand to fill each tub 2" deep
- fine-point markers or crayons
- lengths of cotton string or yarn
- rulers, yardsticks or measuring tape
- 4-6 sheets of 11" x 17" construction paper (and copy of template on pages 15-16, or pre-made version(s) of field book)
- 4-6 photos, pictures of beach organisms or sandy shores with and without marine debris
- pieces of beach drift and marine debris - at least two pieces from each of the following groups:

(If you plan to conduct Activity 2 on the beach, these can be collected by students on the day of the activity. If not, these materials must be collected ahead of time)

evidence of plants:
driftwood, twigs, leaves,
seaweed, kelp or seaweed
holdfasts attached to rocks

evidence of animals:
shells; feathers; bones; dried fish parts;
shark, skate, or ray egg cases
(often called "mermaids' purses");
crab parts; tracks in the sand



evidence of humans:
cans, bottles, candy wrappers,
six-pack rings, straws, bottle caps,
juice boxes, fishing line, balloons,
plastic bags, coins, chicken bones

non-living materials:
rocks, "beach glass"
(broken glass worn smooth),
plastic, metal

Leave Only Footprints

When learning about and enjoying the outdoors we should take care to leave it unspoiled for the present and for those who come later.

Many children do not have the opportunity to visit beaches. As teachers and role models, we can still bring the ocean and an environmental ethic to them. If logistics or resources prevent you from taking students to the beach for this activity, you may collect items for the classroom and present all parts of Unit 1 there. When collecting for classroom presentations, take only a small amount of beach drift - the dead animals and plants washed up on the shore. On the other hand, collect as much human litter and debris as you can carry. It is important that we tell students why we collected our beach drift [many students will have the opportunity to learn by using it], that we only collected drift and debris (no living organisms), and that when we are done with it, we will return the drift to the beach where we found it and properly dispose of the litter [in the trash]. Please note that nothing may be taken or collected from a reserve, preserve, or National Seashore, not even beach drift or sand. We suggest that you do not purchase shells and other dead animals such as sea stars or sea horses because most are collected alive and reefs may have been dynamited to find them.

If you do undertake a field trip to the beach as part of this activity, take similar care in replacing beach drift, beach wrack and organisms in the locations where you found them. Make sure you explain these actions to students, as, in addition to teaching an environmental ethic,this will reinforce concepts introduced during the activities (e.g., be sure to replace the organisms you found in the beach wrack back under the kelp and seaweed where you found them. Organisms move to the underside of the beach wrack to avoid exposure to the sun and to predators such as shorebirds). Disposing of any human-generated litter found during the exercise will also reinforce a stewardship ethic that is in keeping with the Surfrider Foundation mission.

BEACH EXPLORERS: Getting Ready

Getting Ready

1. Several weeks before beginning this unit, plan your strategy for gathering a large number
(at least one for every student in the class you will be presenting to) of photographs, pictures, or drawings of sandy beaches and beach organisms (plants and animals). These pictures are used early on in this first activity and again later in the unit. For the second activity, some of these pictures should focus on the sand itself. You can contact teachers, and ask them to have students bring in photos and illustrations, and gather some yourself.

2. **For those presenting Activity 2 in a classroom:** Collect items for the beach buckets. If you don't live near a beach, don't worry! See the "Getting Ready Tips" in the introductory pages of this RTB notebook for ideas.

3. **For those presenting Activity 2 in a classroom:** Assemble the beach buckets by adding two inches of sand to the bottom of each plastic tub, and randomly placing marine debris and beach drift items on top of or in the sand.

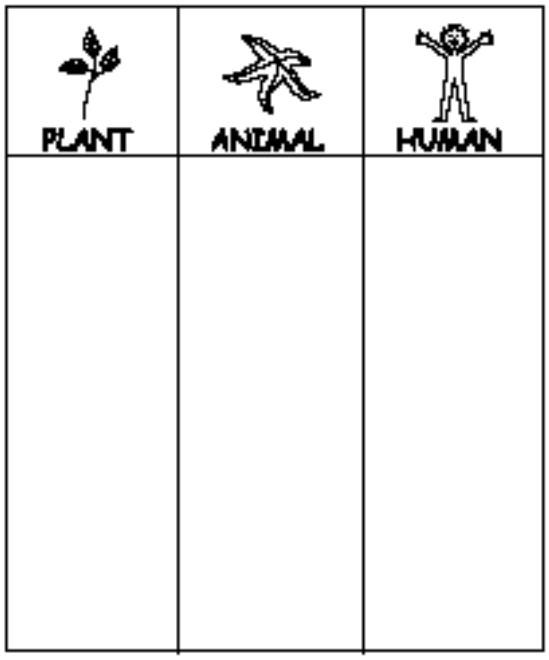
4. Have chart paper, markers, and masking tape at the front of the room. Duplicate the field book template (provided on pages 13-14 of this unit guide) and make up sample field books as needed.

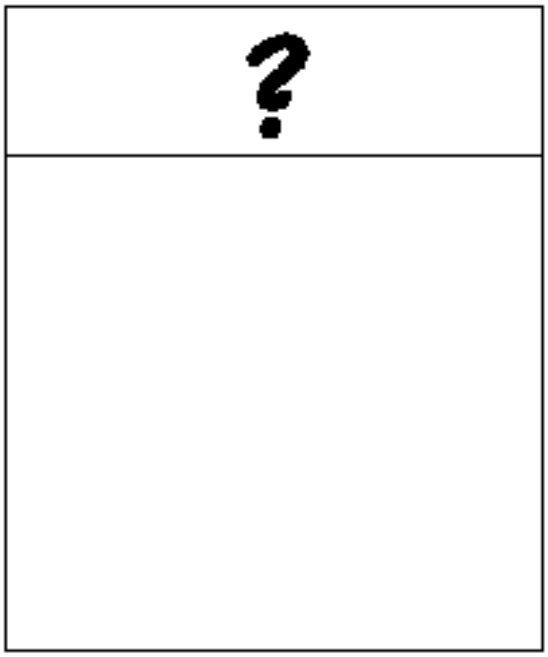
5. Divide one piece of chart paper into three columns, each one headed by simple drawings of a plant, an animal, and a human. On another piece of chart paper, draw a large question mark as a heading

6. Hang the posters and/or pictures of beach scenes and beach animals in the classroom. Teachers and/or students could also hang these ahead of time to build interest and anticipation for your presentation.

7. Write out each of the Key Concepts for this activity (below) in large, bold letters on separate sheets of chart paper and set aside.

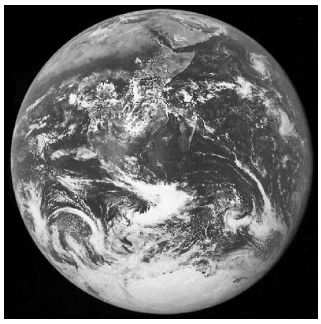
- **The world's ocean covers most of our planet. Everywhere the ocean meets the land there is a shoreline or a beach.**
- **Objects found on the sandy beach can be grouped into: evidence of plant life, evidence of animal life, of humans, and of non-living material.**
- **Sand is made up of tiny bits of everything that is found on the beach.**





The things one can find at the beach can be separated into many categories. One can find evidence of things that were once alive (or biotic materials), such as shells, bones, feathers, corals, egg casings, driftwood, and seaweeds. Biotic material can be further subdivided into evidence of plants or evidence of animals. One can also find evidence of things that were never alive (or abiotic materials). A few common types of abiotic materials are rocks, minerals, glass, and plastics. Evidence of people is another category, but these materials can be biotic (paper, pieces of lumber, chicken bones), or abiotic (plastic, glass, metal).

Activity 1: Blue Planet



The ocean has such immense influences over our global environment and our daily lives that it is difficult to study or understand. Even the simple fact of its vast aerial extent over the earth's surface is a difficult concept to comprehend. However, many students do have some prior knowledge of,and experience with, the ocean or the beach. Beginning with these familiar experiences will help students to create a context within which they can place new ideas and concepts about the ocean.

1. Ask students to brainstorm about all the ways that people use and depend on water. Then ask them to think of the largest body of water in the world - most certainly some or all will come up with the correct answer: the ocean. Use a globe to show a "traditional" map view of the world - that is, with the continents in full view and the Americas in the center. Now turn the globe to show the "Pacific Ocean view" - half of the world with almost no land showing. What does this view tell us about the world?

[Most of the earth is covered by oceans.]

2. Ask the students, based on what you have just shown them, what percentage of the earth's surface is covered by water. (A brief and simple explanation of percentages may be necessary). Let them make some of their own estimates. Then tell them that you are all going to play a little game together to make a better estimate of the portion of the earth that is covered by the ocean. If you have an inflatable globe this game can be played by tossing the "earth" from student to student — like playing with a beach ball. As each child catches the globe,she or he will tell whether ocean or land is under her or his right thumb. Make a tally of the student' answers on the chalk board or a piece of chart paper and compute the percentage [# land 'hits'/# ocean 'hits' X 100]. If you only have a traditional globe, the globe should be passed around with the same reporting done by each child — or you could spin the globe and have students stop it with a finger and again report: land or ocean. This is rather a random process, but if you toss or spin the globe enough times, the final score will show that the world ocean covers approximately 70% of the earth's surface.

Blue Planet continued

3. Introduce and discuss the following ideas:

- Most of our planet is covered by ocean.
- People get food and water from the ocean.
- Over half of our oxygen comes from plants in the ocean.
- The ocean plays a major role in moderating our climate. Without an ocean, the surface of our planet would burn up or melt during the day and freeze at night.

4. Tell students that in the next few activity sessions they will be learning more about the ocean and, in particular, about the place where the water meets the land. Ask if anyone knows what this place is called. [beach, shore, shoreline]

5. If the students have learned about measuring, you can have them trace the coast lines of some of the continents using lengths of yarn, then measure the yarn to learn how many miles of coast we have in the U.S. or the Americas, Australia, Europe, etc. (this could be done using the globe, or using maps handed out to students working in small groups).

6. Hold up the Key Concept for this activity, and have one or more students read it aloud. Briefly discuss how this statement sums up the important ideas from this activity. Post the concept on the wall for students to revisit during the rest of the unit.

- **The world's ocean covers most of our planet. Everywhere the ocean meets the land there is a shoreline or a beach.**

Activity 2: Beach Blanket Brainstorm

This activity is meant to encourage students to talk about their prior knowledge of beaches and oceans. This discussion activity should also give you and/or their teacher a better understanding of their level of knowledge on the topic of oceans and beaches.

1. Introduce the topic of a beach to your class by asking, "Has anyone been to a beach?" "Where was the beach you visited?" "What kinds of things have you seen at a beach?" Remind students that a beach can be located along a river, creek or lake as well as the ocean.

2. According to the size of the class, the number of volunteers you have to help students and the amount of time allotted for this activity, group students into pairs or small groups. Pass out a picture or pictures of a beach, beach object or beach organism to each student or group of students. The pictures will help the students to think about beaches and respond to a few questions with their group. Pass out a large piece of chart paper or butcher paper to each group.

3. Ask a question from the list below (or make up some of your own questions), and give the groups or pairs a chance to discuss a response.

- Close your eyes and imagine that you are sitting on a beach. Now look down at the beach, and describe what the beach looks like.
- Where are some of the beaches you have visited?
- What are some of the things you like best about beaches?

Ask the students to write down an agreed upon response on the chart paper. Tell them that they don't have to choose just one person's answer, rather their group answer might take the form, for example, of a list that includes everyone's response to the question posed. If you are working with primary level students, you may need a helper to assist each group by writing out their responses. If you are short on volunteers, you and the students' teacher should circulate among the groups to help them formulate their responses and write them down.

4. Repeat this exercise with two or three more questions. Then go over with the entire class, each group's responses to the questions, one question at a time.

5. Once the preliminary questions have been addressed, spend some time with the entire class discussing the following question:

- If you walked along a sandy beach looking very carefully, what types of things do you think you might find?

Write down class responses on chart paper or the chalkboard, using words and simple drawings.

Activity 3: Beach in a Bucket

1. Tell students that now they will have the chance to explore a "beach" (either as a field trip or right in their own classroom.)

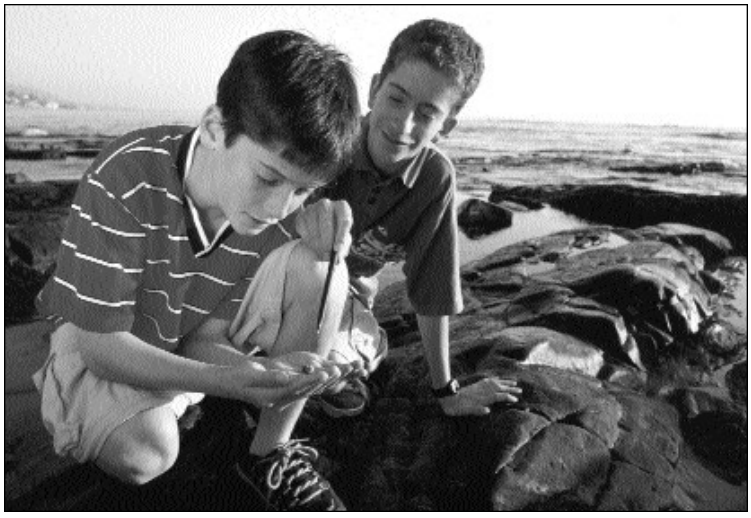
2. Divide the class into groups of four to six students.

   If this is to be a classroom exercise: Show students the pre-prepared beach buckets, distribute one to each group and ask the students to handle the items carefully. Tell them that they can feel the sand and pick up pieces of drift and debris to look at them more closely. They should keep all the sand in their buckets so the classroom will stay clean!

   If this activity will be conducted as a field trip: Distribute the empty tubs to the student groups. Have them spread out across an area of beach. Ask the students to collect items as prescribed in the "Getting Ready" section of this activity. Be sure to caution them not to over collect, and remind them that they will be asked to replace all items of drift where they found them. Remember .... "Leave only footprints." Encourage students to feel the sand and pick up pieces of drift and debris in order to observe them closely.

3. Circulate among the groups. Ask focusing questions, such as:

   - What colors do you see?
   - What do the things on the beach feel like? [fuzzy, rough, prickly, soft, etc.]
   - What are some of the shapes of objects on the beach
   - Where do you think the items came from?
   - What evidence is there of living things?



Sorting and Grouping

1. After they've made some observations, encourage students to sort or group the items into categories, based on any observable characteristic of their choice.

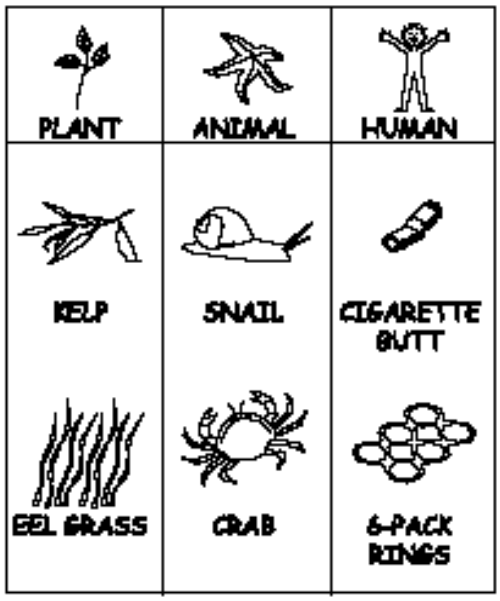
2. Give groups time to share and describe the categories they devised.

3. Explain that often when we go to a sandy shore, we may not see many living plants and animals at first, but if we look closely, we will always find plenty of evidence of living things.

4. Next, have students re-sort the items into the following four groups: evidence of plant life, evidence of animal life, evidence of humans, unknown items (or items about which they can't agree).

5. Display the piece of chart paper with three columns headed by simple drawings (Plant, Animal, Human). Display the second piece of chart paper headed by a large question mark to record unknown items.

6. Have the groups share again. On the chart paper, record with simple labeled drawings, the items groups share. Explain that everything in the first two categories is evidence of life (or biotic material). Evidence of humans could be biotic (chicken bones or paper) or abiotic (plastic, aluminum). Can anyone identify the unknown items?



Recording student ideas on chart paper provides a permanent "group memory" for which the whole class is responsible. If misconceptions arise, they should also be recorded. If they are challenged by another student, add a question mark in another color next to the idea. Make sure that sometime during the unit,all misconceptions are "discovered"and corrected, preferably by students. Go back to your group memory and physically replace the misconceptions with the new information. No individuals need be 'wrong.' The group's collective knowledge simply changes as it grows.

Sorting and Grouping continued

7. **If you are conducting your activity in the classroom:** Point out pictures or posters you have put up or passed around that show examples of the whole, live animals and plants from which the biotic material came.

If you are at the beach: Gather the class around a mass of beach wrack and have them look through it carefully to find some of the living organisms of the beach. Others could dig and sift through the sand to find hidden animals such as beach hoppers and sand crabs. Remember to handle these creatures with care and return them to the locations on the beach where they were found, once the students have had an opportunity to observe them and note some of their characteristics. Ask the students to observe other animals that may be present, such as shorebirds.

8. Ask students if there are things left in their beach buckets that were never alive. These things, such as rocks and most of the sand, are called non-living or abiotic materials. Ask if there are items that could go in more than one category. In general, things found at the beach are called "beach drift." More specifically, the things found in beach drift that have been left by humans are referred to as "marine debris."

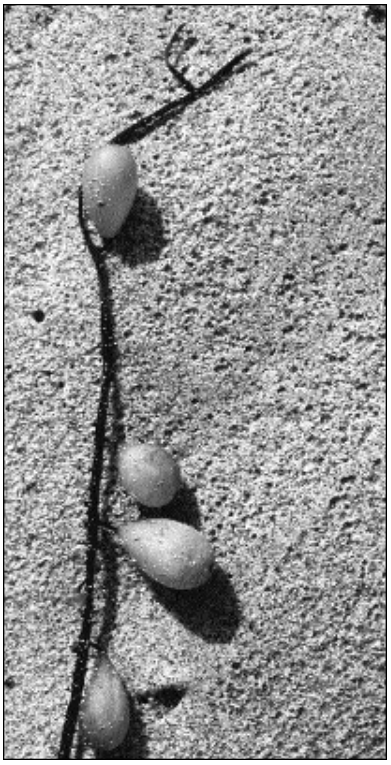
Sorting and Grouping continued

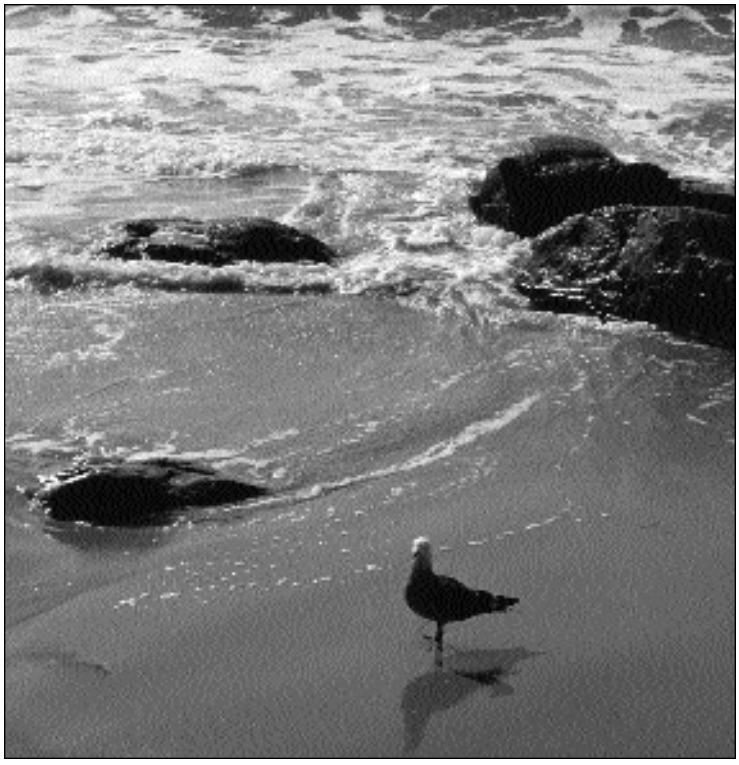
9. Ask students what might eventually happen to all of this beach drift and marine debris if it were left on the beach? If it doesn't come up in the discussion, explain that many of the items found at the beach will be pounded by wind, waves, tides, and each other, and eventually will be ground into sand. Sand can be either biotic or abiotic,and is usually a combination of both.

10. In closing the activity, hold up the Key Concepts for this activity one at a time, and have one or more students read them aloud. Briefly discuss how these statements review the important ideas from today's activities. Post the concepts in the classroom near your chart-paper record of evidence of plants, animals, and humans for students to revisit during the rest of the unit.

- **Objects found on the sandy beach can be grouped into: evidence of plant life, evidence of animal life, evidence of humans, and non-living material.**

- **Sand is made up of tiny bits of everything that is found on the beach.**

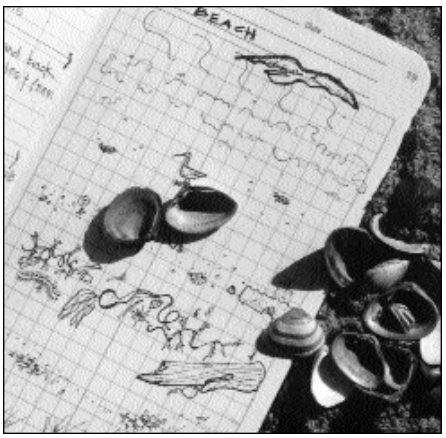




Activity 4: Making an Explorer's Field Book

The field book activity is designed to help students organize and reconstruct new information in preparation for future studies in science. This activity also provides opportunities for students to use their creativity and to improve their writing and drawing skills.

1. Explain to students that scientists and explorers often use written notes accompanied by maps and drawings that they make to record their observations at study sites. They make these notes and drawings in pocket-sized books, called 'field books', so that they can later refer to their notes, and retain information in far greater detail than simple recollection would allow. The use of field books is a very old practice, first used by scientists and explorers who lived in times before photography was invented. It is a time honored practice, and still very much used to this day.



2. Tell students that in this activity, they will be making their own field books about their (classroom or actual) trip to the beach. First they will need to make the blank book. Pass out fine-point markers and crayons and 11" x 17" paper. Lead them through the directions on the field book instruction sheet . *(Please see pages 15-16)*

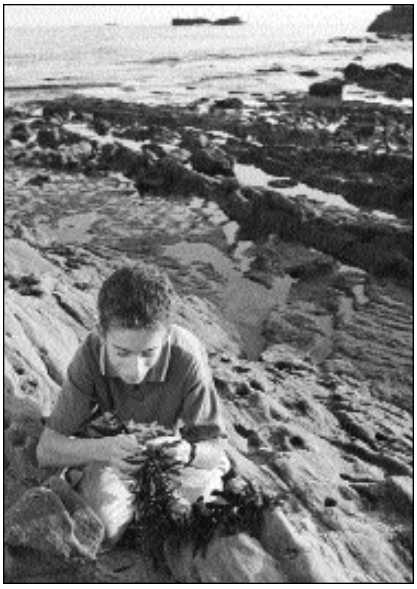
3. Encourage students to write in their field books about what they learned by creating text and illustrations on alternate pages. They can title their books, "My Field Book," "My Beach Book," or make up their own titles. Suggest headings for each two-page spread such as: Heading 1: Plants and Animals; Heading 2: People at the Beach; Heading 3: The Best Thing About the Beach.

4. Provide students with time to write and draw pictures that are appropriate for each heading. Circulate among the students to answer questions and check their progress.

5. When completed, give the students time to share their field books informally. Students could display the books on their desks, and circulate around the room to view each other's books.

6. After they've completed the field book exercise, ask students to think about two or three of the following questions and then hold a class discussion:

- How did you decide what to put in your field book?
- Was there anything special you did to help you remember what you learned in this activity?
- Are you proud of your book? Could you improve it?
- Do you think this book will help you to remember what you learned?
- Does your book reflect the most important things you learned?



Going Further

1. Take a field trip to the beach (at a local seashore, stream, river, pond, or lake) and conduct a beach clean-up project. Have students explore the beach and sort what they find into the same categories used in this activity. Bring enough plastic garbage bags so that every pair of students can have one. Divide the pairs into three collection groups: 1) unbroken glass and cans; 2) plastic; 3) paper and other miscellaneous trash. Students should wear gloves and be warned of picking up sharp or toxic items. If you're on an ocean beach, you could have all pairs line up from the water's edge to the dune or cliff area and sweep a half-mile section of beach. Remind students that they should collect only evidence of humans. Take all the debris they have collected and organize it into categories. Weigh or measure the volume of each. Discuss the differences between biodegradable and non-biodegradable, and recyclable and non-recyclable objects. Point out any collected items that are natural, rather than human-made, and ask students to return them so that your impact on the ecosystem is minimized.

2. Introduce students to Surfrider's Beachscape program by conducting a mapping exercise at a local beach. Have students explore the beach and locate beach features, such as areas of wide and narrow beach, creek or river mouths (or lagoon outflows), structures, outfall pipes and others. Discuss which of these features are natural, which are man-made, and which might fall into both categories.

3. As appropriate, research nearby beach and shoreline conservation projects, and seek out ways your chapter can assist classes in getting involved.

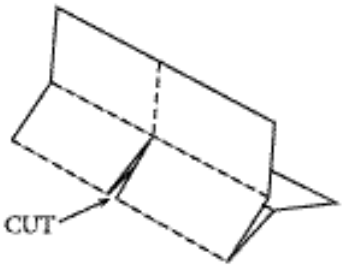
BEACH EXPLORERS: Instruction Sheet for Making Field Books

1. Fold the sheet in half crosswise.

2. Fold up ends separately to form a "W" shape.

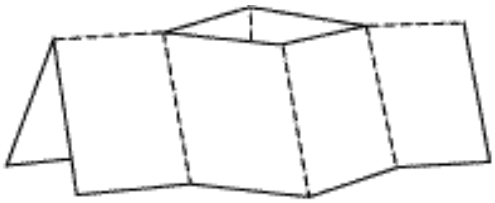
3. Fold the paper in half again to form a small rectangle. Then unfold this last fold, and fold it again back the opposite way, making good, hard creases on each side.

4. Unfold back to Step #1, where the sheet is only folded in half.

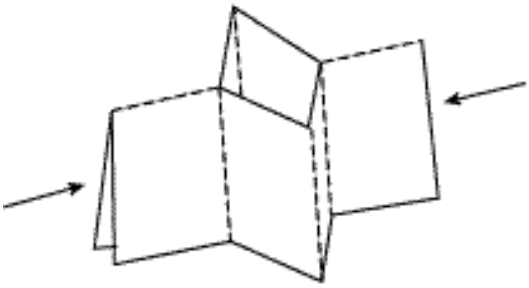


5. Face the folded edge closest to you and cut along the middle fold through both sides to the center as in diagram.

6. Unfold the sheet entirely

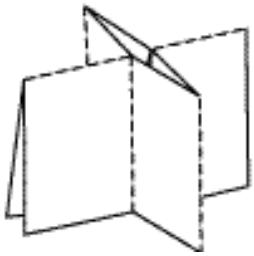


7. Refold the sheet in half, this time lengthwise.

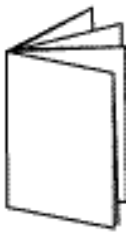


8. Grab the two outside panels and push inward. The part you cut with the scissors should open up and form a diamond.

9. Keep pushing until the "diamond" closes flat.

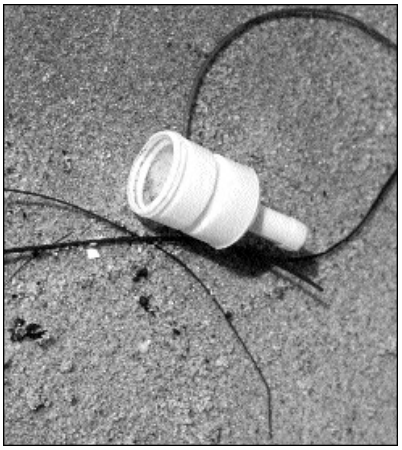


10. Finally, fold all the pages together to form a s mall b ook. make good,hard creases on all sides.



GETTING UP TO SPEED

Unit 1: Beach Explorers



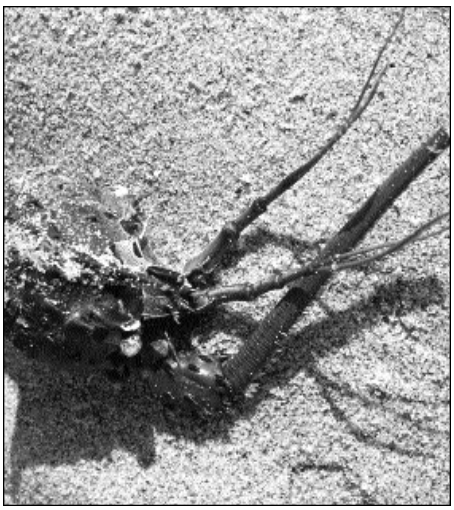
This section is not meant to be read out loud to or distributed directly to students (although this is at your discretion). It is primarily intended to provide the necessary, concise background for you - the Surfrider chapter representative (or teacher) - in presenting Unit 1 activities and responding to students' questions. Please see the "Unit 1 Resources" section for books and other materials that will help you, teachers and students to delve more deeply into the subject matter addressed in this unit.

Overview

In this unit, students are introduced to the vastness of our planet's oceans and to the characteristics of one type of shoreline we call a sandy beach. Two introductory activities, Blue Planet and Beach Blanket Brainstorm, guide students into the unit by introducing them to global geography and encouraging them to share what they already know, value, and enjoy about the ocean and beaches.

In the main Beach in a Bucket activity, students work in small cooperative groups to explore a sandy beach (or, for those who cannot or choose not to conduct this activity at the beach, a simulated sandy beach in a plastic tub). Through a sorting exercise, they discover that biotic (once-living) objects found on the sandy beach can be grouped into those that represent: evidence of plant life, evidence of animal life, and evidence of humans. They discover the differences between once-living (biotic) and never-living (abiotic) objects. Also introduced in this activity is the concept that sand is made up of tiny bits of everything that can be found on the beach. In the final activity of this unit, students make Explorers' Field Books to record what they learned about the beach.

BEACH EXPLORERS: Getting Up To Speed



Background

Our sandy beaches are a special part of our landscape. Our beaches are places we go to relax and play, to contemplate our lives, or just to watch the natural beauty of the sun on the water, the waves and the amazing diversity of life forms that can be seen there.

A sandy beach is also a natural classroom. On closer observation, a beach reveals evidence of natural processes, as well as of man's activities on the adjacent land and ocean (or lake, or river). Distant mountain ranges are weathered by sun, wind, rain, snow and ice, releasing rock and sediments from the mountains' geologic parent material. These eroded sediments are carried by runoff into streams and rivers, which, in turn, transport them to the oceans and the shore. Ocean currents, waves and wind push sediments and "beach drift" from the ocean onto beaches around the world. Marine debris (human-generated refuse that ends up in the ocean or on the shore) is carried from land by the millions of visitors to the world's beaches and dumped from the world's fleet of boats and ships. As waves crash against the shoreline, all of these objects are ground into smaller and smaller bits - rough-edged particles are progressively smoothed and rounded into tiny grains, until they all become part of what most people consider the defining characteristic of a beach: sand.

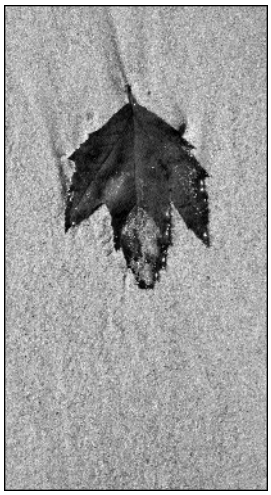
Look closely at sand and you might see pieces of rocks and minerals that have broken free from the rocky seashore, cliffs, ocean floor and even from the distant mountains. There might be shells or shell fragments from animals that once lived on nearby reefs, bones from animals living in the ocean and on land, algae, coral fragments, glass, driftwood, plastics, feathers, and much more. For more information about the formation of sand, see the "Unit 1 Resources," section as well as Units 2 and 3.

The Center for Marine Conservation reports that the twelve types of trash (the "dirty dozen") most often found in the United States during the 1998 National Coastal Clean Up were (in order of frequency): cigarette butts, plastic pieces, foamed plastic pieces, plastic food bags/wrappers, paper pieces, plastic caps and lids, glass pieces, straws, glass beverage bottles, metal beverage cans, plastic beverage bottles and metal bottle caps.

Nike Shoe Spill in the ocean, 1990

The Nike shoe spill of May 27, 1990 just southeast of Alaska, was one of the largest releases of human-made drift objects ever with an estimated 60,000 shoes spilling into the ocean. Several months later, Nike sneakers were washing up on the U.S. West Coast. By 1993, the shoes were washing up onto the beaches of Hawaii, many thousands of miles away. Trash, which many nations dump regularly into the oceans, can drift just like Nike sneakers. This is just another indication of the GLOBAL nature of ocean pollution. (Source: The Wealth of Oceans, Michael Weber and Judith Gradwohl, WW Norton and Co., 1995, p. 59)

Background continued



The things one can find at the beach can be separated into many categories. One can find evidence of things that were once alive (or biotic materials), such as shells, bones, feathers, corals, egg casings, driftwood, and seaweeds. Biotic material can be further subdivided into evidence of plants or evidence of animals. One can also find evidence of things that were never alive (or abiotic materials). A few common types of abiotic materials are rocks, minerals, glass, and plastics. Evidence of people is another category, but these materials can be biotic (paper, pieces of lumber, chicken bones), or abiotic (plastic, glass, metal).

Beaches throughout the world are strewn with drift and debris, both natural and human-made. "Beach drift" is anything that washes up on the beach, whether it came from living or non-living materials. In later units, students will learn about "beach wrack" in greater detail. You may want to clarify the distinction between beach drift and beach wrack for them. "Beach drift" generally refers to items that wash up on the shore. "Beach wrack" is made up of kelp, other seaweeds, or sea grasses that washes up and often forms a line across an entire beach at high tide. It includes other organisms, shells, beach drift and debris. Many organisms - such as snails,crabs, and limpets - that live on the kelp stipes and fronds are carried into the beach wrack along with the kelp. Worms, flies, and birds feed on the beach wrack as the kelp begins to decay. Most of the animals of the beach wrack are hidden underneath the seaweed to avoid bird predators and the hot sun. The beach wrack forms its own temporary ecosystem on the sandy beach.

The human-made debris, mostly in the form of plastics, is often deadly to ocean and sandy beach inhabitants. It is important to recognize the different types of drift and debris, and to be able to distinguish between those that should be removed for the safety of people and animals from those that should not. For instance, drift and debris such as kelp and broken shells should not be removed from the beach because they form part of an important ecological association within the sandy beach habitat.

Armed with a better understanding of sandy beach habitats, we can protect our beaches and keep them healthy through beach clean-up projects and prevention of behaviors that lead to their degradation.

UNIT 1 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.

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, Wilma 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, New Jersey, 1991.

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

Shell, Alex Arthur, Knopf, New York, 1989.

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

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

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:

A Citizen's Guide to Plastics in the Ocean: More Than a Litter Problem, Kathryn J. O'Hara, Suzanne Iudicello, and Rose Bierce, Center for Marine Conservation, Washington, DC, 1988.

Beachcomber's Guide to California Marine Life, Thomas Niesen, Gulf Publishing Co., Houston, Texas, 1994.

Beachcomber 's Guide to the Gulf Coast Marine Life, Thomas Niesen, Gulf Publishing Co., Houston, Texas, 1989.

Beachcomber's Guide to the Gulf Coast Marine Life: Florida, Alabama, Mississippi, Louisiana, and Texas, Nick Fotheringham and Susan Brunenmeister, Gulf Publishing Co., Houston, Texas, 1989.

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

Pacific Seashores, A Guide to Intertidal Ecology, Thomas Carefoot, University of Washington Press, Seattle and London, 1977.

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

Seashells of the World, R. Tucker Abbott, Golden Press, New York, 1985.

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

Seashores: A Guide to Animals and Plants Along the Beaches, Herbert S. Zim and Lester Ingle, Golden Press, New York, 1989.

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

Shells of the World, A. P H. Oliver, Henry Holt, New York, 1975.

Shore Ecology of the Gulf of Mexico, Joseph C. Britton and Brian Morton, University of Texas Press, Austin, Texas, 1989.

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

Magazine Articles

"Beaches," *Scientific American*, August 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

Daughters of Water, Sons of the Sea
by Jesse Boggs
Schneider Educational Products, Inc.
San Francisco. 1991

This cassette is full of delightful songs about the ocean and some of the creatures in it.

Slugs at Sea
by Banana Slug String Band
Music for Little People
Redway, California. 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

Keepers of the Coast
The Surfrider Foundation
122 So. El Camino Real, PMB#67
San Clemente, CA 92672
(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.

Oceans In Motion
National Geographic Edventures
1145 17th Street N.W.
Washington, D.C. 20036
(202)775-6563
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 there in 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 teacherís 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

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

Videos continued

Oceans Alive!
Environmental Media & Marine Grafics
P.O. Box 1016
Chapel Hill, NC 27514
(800)368-3382
50 minutes (each part has 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, second 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.

Trashing the Oceans
NOAA Marine Debris Information Office
c/o Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104 (415) 391-6204
7 minutes +

Trashing the Oceans describes the threats of marine debris using graphic video footage.

Posters

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

If You Take It Out, Matey. Bring It Back
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204

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

Many marine sanctuaries and estuarine reserves provide educational posters for teachers. Contact any of the following for more information. These estuaries and marine sanctuaries can also be a great source for local information.

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
web site: 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
website: www.orst.edu/dept/tbaynep/nephome.html

San Francisco Estuary, CA
San Francisco Estuary Project
(510) 662-2465
web site: 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
no web site

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
web site: pelican.gmpo.gov/gulfofmex/estuarypartner/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
web site: www.epa.gov/OWOW/oceans/lagoon

South Atlantic continued:

Indian River Lagoon, FL
Indian River Lagoon National Estuary Program
(407) 984-4950
web site: 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
no web site

Albemarie-Pamilco Sounds, NC
Albemarie-Pamlico Estuarine Study
NC Depariment of Environment, Health and Natural Resources
(919) 733-5083 ext. 585 (general info)
(252) 946-6481 (education)
web site: 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
web site: www.co.suffolk.ny.us/health/pep

Long Island Sound, NY and CT
Long Island Sound Office
(203) 977-1541
web site: 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
web site: www.epa.gov/region10/eco/massbay

New Hampshire Estuaries, NH
New Hampshire Estuaries Program
(603) 433-7187
no web site

Casco Bay, ME
Casco Bay Estuary Project
(207) 828-1043
no web site

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
web site:
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
web site: www.flowergarden.nos.noaa.gov/

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
website:
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
web site:
www.ocrm.nos.noaa.gov/nmsp/nmsolympicoast.html

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

National Marine Sanctuaries *continued*

Monitor National Marine Sanctuary
The Mariners Museum
100 Museum Drive
Newport News, VA 23606
(804) 599-3122
web site: 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

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/coastalcom/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
Konocti 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

Critters: K-6 Life Science Activities
Education Foundation
PO. Box 8120 Fresno, CA 93747
(209) 255-4094

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

MARE Curriculum Guides and Teachersí 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 and Curriculum
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204
web site: 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

Curriculum Resources *continued*

Zoobooks Exploring Ocean Ecosystems
Wildlife Education
9820 Willow Creek Road, Suite 300
San Diego, CA 92131
(800) 477-5034

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.

Cool Web Sites

American Oceans Campaign home page
www.americanoceans.org/

The Bridge
Online resources for marine science education
www.vims.edu/bridge/

Center for Marine Conservation home page
cmc-oceans.org/

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

Smithsonian Institutionís 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.

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% recycled with 80% post-consumer waste 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.

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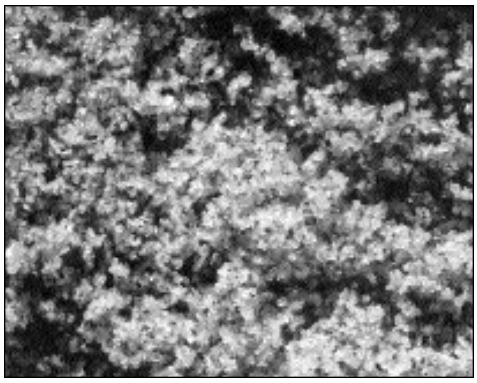
STUDIES IN SAND

Surfrider Foundation®

Respect The Beach
Beachology Unit 2

UNIT 2: STUDIES IN SAND



Activities for Elementary Level Students

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

- **Sand grains can be made of animals, plants, rocks, or minerals.**
- **Sand grains come in many different shapes, sizes, and colors.**
- **Differences between sand grains can be clues about where the sand came from and how it got to the beach.**

In this activity, small groups of students use hand lenses (or low-powered microscopes, if available) to compare the color, size, and shape of several sand samples, and to make educated guesses about their origins. Students discover that sand grains can be made of animals, plants, rocks, or minerals - even of debris. Sand grains come in many different shapes, sizes, and colors. These differences can be clues about where the sand came from and how it got to the beach.

In Activity 1, **Sand-sation**, students work in small groups to discuss and write about sand. They record their knowledge and any questions they may have on their own charts, then contribute their ideas for a class "Q&A Chart." In Activities 2, 3, and 4, students compare different types of sand, observe sand with hand lenses or microscopes, and record their findings on a Sand Studies Sheet. Then they gather into focus groups to complete the Focus Group Study Sheet and draw pictures of the beach where the sand they examined might have been found.

Time Frame: Approximate times for completion of each activity are presented below, but teachers may wish to break each activity into a series of shorter sessions.

Unit 2: Studies in Sand

Activity 1:	Sand-sation	(30 minutes)
Activity 2:	Sand Sources	(60 minutes)
Activity 3:	Scoping It Out	(45 minutes)
Activity 4:	Hocus Focus	(45 minutes +)

STUDIES IN SAND

Surfrider Foundation®

Respect The Beach
Beachology Unit 2

STUDIES IN SAND: What You Need

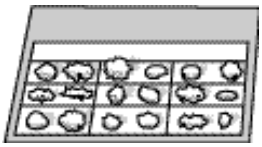
What You Need

For the class:

- pictures of sandy beaches and beach organisms from various parts of the world
- 4-6 sheets of chart paper (approximately 27” x 34”)
- markers (4-5 colors, wide tip)
- small flat tray, box lid, or shoe box (for demonstration of Blowing in the Wind)
- (optional) 1 large piece of construction paper or 1 paper plate for Sand Display
- (optional) white glue
- (optional) masking tape
- (optional - but highly recommended) 1-6 student-friendly microscopes (See the “Resources” section for information about where to obtain.)

For each group of 6 students:

- cup of sand, any kind (for Blowing in the Wind)
- 1 small flat tray, box lid, or shoe box
- 1/4 cup each of 6 different sand samples, each from a different location (See the “Getting Ready”and “Resources” sections for information about where to obtain.)
- 1 large ziplock freezer bag
- 6 small but sturdy ziplock freezer bags
- 3-6 hand lenses
- 2 magnets, each in a separate thin plastic sandwich bag



- 10 3” x 5” index cards (5 white, 5 a dark color)
- white glue
- 3 sheets of paper for Q&A Chart
- 1 or more small rock or mineral kits (See the “Getting Ready” and “Resources” sections for information about where to obtain.)
- 2-3 sets of crayons or colored markers and pencils
- 2 glass or clear plastic jars with tightly fitting lids
- 6 each of both student sheets: Sand Studies and Focus Group study sheets (masters on pages 17,18 and 19,20)

Getting Ready

1. Obtain rock and mineral kits. Track down existing kits in your school or order from a scientific supply house (see the "Unit 2 Resources" section).

2. Acquire Sand. If you have enough lead time, alert students, parents, and friends that the class will be studying sand. Ask them to be on the lookout wherever they travel for samples of sand. On trips to the coast, lakes, rivers, deserts, or even playgrounds, have them collect small bags of sand. Does anyone have a friend in another state or country that can send an exotic sample? Be sure to label each sample as it arrives with: where and when it was collected, and who collected it. Alternatively, sand kits can be purchased from a number of sources (see the "Unit 2 Resources" section).

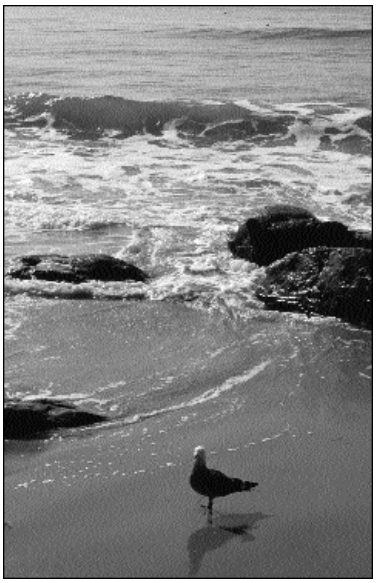
3. Organize sand samples. For each group of six students,fill six ziplock bags with a 1" layer (about 1/4 cup) of sand. If possible, each small bag should have a different sand sample and should be labeled with the location from which the sand was collected. Tightly seal each bag. Place the six samples into a large ziplock bag and seal. Each group should have the same six samples.

4. Place 1/2 cup of sand on tray, box lid, or shoe box for each group.

5. (Optional) Make a Sand Display by gluing a small amount of sand from each sample to a paper plate or construction paper. Label each sample with its source location.

6. Obtain hand lenses and/or 1-6 low magnification microscopes. Using microscopes will make this activity much more dramatic and fun. Grains of sand become huge boulder-sized rocks or easily discernible chunks of shells or glass. Beautiful colors and the details of shapes that would otherwise be lost, are made easy to see. See "Unit 2 Resources" for ideas on about how to obtain microscopes. If microscopes are not available, hand lenses are adequate - just make sure they are not too scratched up.

STUDIES IN SAND: Getting Ready



7. If you plan to collect sand for your classroom samples, remember that only a very small amount is needed. A sandwich bag filled with sand is more than enough for years of use in your classroom. Also keep in mind that it is not permissible to collect or take anything, not even sand, from reserves, preserves and most National Seashores.

8. Make duplicates of the Sand Studies and Focus Group Study Sheets for each student (masters on pages 17,18 and 19,20).

9. If you are presenting these activities to younger students and/or like to have free exploration stations set up in the classroom, you may want to consider setting up a sand exploration station (as described in #1 in the "Going Further"section on page 16) before you present the activities.

10. Start the class Q&A Chart. Draw a line down the middle of the chart paper to divide it in half lengthwise. At the top of one column write "What we already know about sand." At the top of the other column, write "What we want to find out about sand."

11. Fill jars with water and close the lids.

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

- **Sand grains can be made of animals, plants, rocks, or minerals.**
- **Sand grains come in many different shapes, sizes, and colors.**
- **Differences between sand grains can be clues about where the sand came from and how it got to the beach.**

Activity 1: Sand - sation

This activity helps students to talk and write about their related prior knowledge, and focus their thoughts on the subject of sand.

1. Group students into pairs or small groups. Pass out a picture of sand or a beach to each student. Remind the students to look at the pictures closely. The pictures will help them to think about sand and to have a better discussion with their partner or group. Pass out a large piece of chart or butcher paper or butcher paper to each group.

2. Tell the students that you will be asking a series of questions or giving them an ideas to talk about with their partners. After you have done asked each question, they will have about a minute to discuss it. If they can't think of anything to say, they can talk about their pictures.

3. Pose the first question from the following list for the students to discuss (or make your own list along these lines):

- When was the last time you visited a sandy beach? Where was it?
- What do you think of when you hear the word "sand?"
- Describe all of the different places you might find sand.
- What color is sand?
- Where do you think sand comes from? What is it made of?
- How do you think sand gets to the beach?

4. Ask the students to write down an agreed upon response on the chart paper. Tell them that they don't have to choose just one person's answer, rather their group answer might take the form, for example, of a list that includes a number of responses to the question posed. If you have enough volunteers to put one helper with each group, the helper could assist the children with this. Otherwise you and the students' teacher should circulate among the groups to help them formulate their responses and write them down.

5. Repeat steps 3 and 4 until you have asked all of the questions.

Q&A Chart

1. Have students continue to work with their partners or groups from the first part of this activity. Show them the beginnings of the class Q&A Chart that you made in advance. Distribute more paper to each pair or group of students and have them create their own charts.

2. If you have them, you may want to pass out a few more pictures of different beaches to each pair or group to give the students new ideas. Ask students to discuss the two questions about sand (what we know/what we want to find out) in their groups and write notes on their charts. If there is time,each pair or group can share their responses with another group and discuss again.

3. When the groups are ready, call them back together to share some of their best ideas and questions with the whole class. Record the groups' ideas on the class Q&A Chart. If the same idea comes up more than once, put a star next to it each time it is mentioned.

4. Display the class Q&A chart and refer back to it throughout the remainder of Unit 2. As questions (on the "what we want to find out" side of the chart) are answered, draw lines through them and record the answers on the 'what we know' side. Collect the pictures of sand, beaches, and beach organisms.

WHAT WE ALREADY KNOW ABOUT SAND	WHAT WE WANT TO FIND OUT ABOUT SAND

Activity 2: Sand Sources

Observing Samples

1. Divide students into groups of six. Tell the groups that they will now have the opportunity to observe different types of sand from many different places.

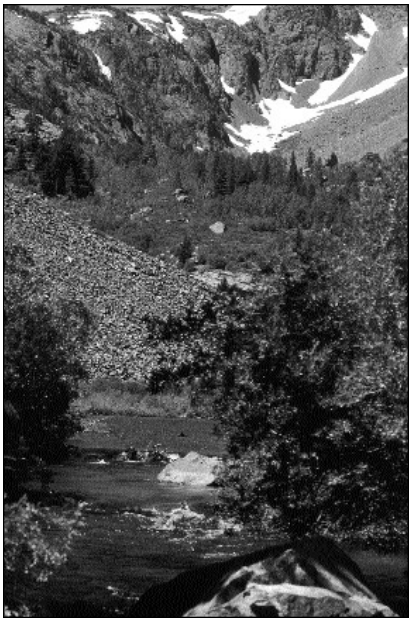
2. Give each group the one large bag containing six small bags of sand. Have each of the six students in each group take out one small bag of sand. Tell them that for now they should not open the bags; they should make their observations by looking or feeling through the bags. Ask them to do this gently, being careful not to puncture the bags! Ask,"How big are the sand grains?" "Can you tell what they're made of?" "What colors do you see?" "What do the sand grains look like?"

3. Next, have each group compare their six samples. How are they similar? How are they different?

4. Bring the whole class back together for a short discussion. What did they discover about their sand? How were the samples the same? How were they different?

5. Ask students to imagine a clam living burrowed in the sand on a beach. How might its shell end up as sand?

[The clam dies and the pounding waves break it's shell up into little pieces. These pieces wash back and forth with other shells and rocks and are jumbled and pounded in the waves over and over again, until the now many small pieces of the clam shell become tiny grains of sand.]



Use the responses to the Sand-sation and the Q&A Chart to assess the students' prior knowledge. If students seem generally familiar with the topics of what sand is made of, how it is formed, and how it travels to sandy shores, you can move rather quickly through the following activities and allow students to draw further conclusions and inferences. If they do not seem to have much prior knowledge of' those topics, you may have to proceed more slowly and provide more directed information.

As students respond to the notion of how a rock on a mountain might become sand, you may want to introduce the word and concept of erosion. Or you could simply describe the process without introducing the word itself. Erosion is defined, and featured as a Key Concept in Unit 3: Sand Travels.

How might a rock that is part of a mountain become sand on a beach?

[Due to baking sun and wind and winter ice, a crack forms in the mountain rock. One day a piece of rock breaks off from the mountain along this crack. Rain carries the rock down the mountainside to a stream , which flows down the valley, tumbling the rock along its bottom as it goes. The stream joins a river, with faster flowing water that carries the rock faster and over long distances until it meets the ocean. By the time it joins the ocean, the rock has been broken into smaller pieces, and the pounding waves at the shore, break these pieces down until they are small grains of sand]

How might coral on a coral reef become sand on a beach?

[Parrot fish eat it and crunch it into small bits and ocean currents eventually bring the pieces of coral to the shore. Once near the shore waves gradually wear the pieces into smaller and smaller bits, until they are sand grains.]

Why might there be so many different colors of sand?

[Different colors indicate that the sands are made of different things such as different types of rocks, shells, bones and coral.]

6. (Optional) Show students your Sand Display, and ask them to look at how different some types of sand can look from others. Ask students to look for sand wherever they go to add to the display.

Making Sand Slides

Tell students that they will now get to make 'sand slides' from their samples. Explain that scientists use slides - usually a small amount of the material they are studying preserved on a flat piece of glass - to keep portions of these materials to refer to throughout their work. Scientists make slides of minerals, plant tissues and even human and animal cells or tissues. They use these slides to compare samples and record similarities, differences and sometimes changes over time.

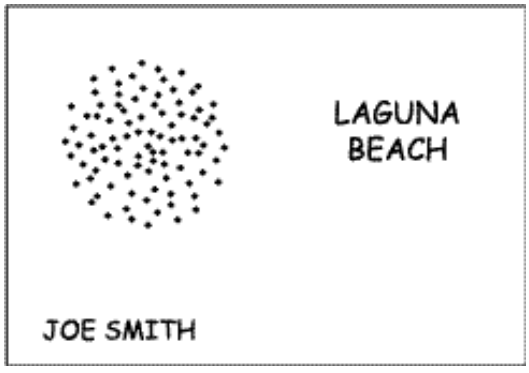
1. Pass out index cards and glue to each group. Tell students that if their sand sample is light colored, they should use a dark index card, so that the sand will be clearly visible; if their sand sample is dark, they should use a light colored card.

2. Have students label their cards with the location that their sand came from and also with their own name.

3. Demonstrate how to make a sand slide:

- Place a very small dab of white glue near an edge of the card and smear it in a small circle to make a sticky spot about the size of a nickel. Wipe off the finger you used to smear the glue.
- Reach into the sand sample (with clean fingers!) and take out a pinch of sand.
- Sprinkle the sand over the sticky spot of glue, wait a few seconds to let the sand set and then tap any loose sand back into the bag.

4. Have students make their own sand slides. Collect the slides or have students keep them for the next activity session where they will make detailed observations of their sand grains. Collect the sample bags of sand.



Sample sand slide

Activity 3: Scoping It Out

Observing and Recording

1. Regroup the students into the same groups gathered for Activity 2. Give each student a Sand Studies Sheet and the sand slide she or he made in the last session. Distribute to each group one of the large bags containing six small bags of sand. Ask each student to choose the same small bag of sand she/he used to make her/his sand slide. Have available pencils,crayons or markers,magnets in bags,hand lenses (and/or microscopes), and rock/mineral kits for each group.

2. Guide the class through the observation and recording activity (directions and questions from the student sheet are in italics):

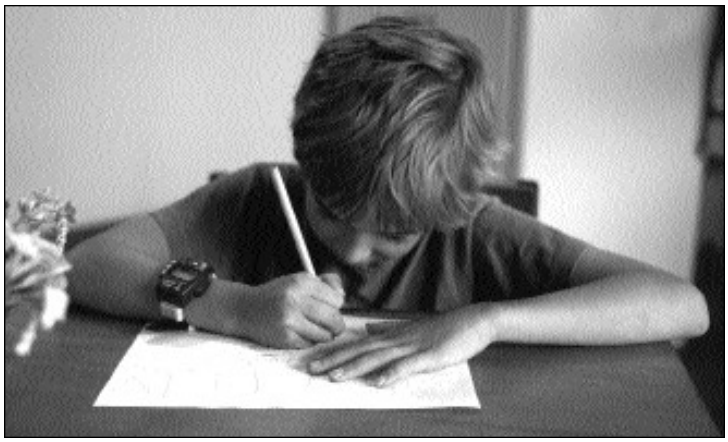
#1 - Look closely at your sand with a magnifier. List or use crayons to show all the different colors you see. Students who are not proficient at writing should be encouraged to find crayon colors that match the sand colors.

#2 - Draw a picture of some of your sand grains. Draw them BIG!
Encourage students to draw the sand grains about the size of a quarter. They could use the grains drawn in #3 as models.

#3 - Circle the pictures that have shapes like your sand.
This task takes some extra concentration, so tell students to help their fellow teammates. Have students look again at their slide through a hand lens (or a microscope). This time, look specifically at the shape of individual grains. Does the sand have rounded edges or angular edges? Why are some grains smooth while others have sharp (angular) edges?

[Very round grains have been worn smooth for hundreds or thousands of years, while angular grains may have broken off a rock or shell more recently.]

Older students will be able to go through the activities in their cooperative groups at their own speed after you provide simple directions. With younger students, you may need to go through the student sheet task by task with the whole class, guiding each observation.



#4 - Gently rub a magnet on the outside of your bag of sand. Are any of the grains in your sand attracted to the magnet? If so, what color are the magnetic sand grains?
Distribute the magnets in bags. Have each student drag a magnet gently across the outside of her/his bag of sand. If any grains are attracted, this is evidence that the sand contains some magnetic minerals, such as iron or magnetite. These magnetic minerals are usually black in color.

#5 - Which of the following things can you find in your sand?
Students especially enjoy guessing/inferring what their sand grains are made of.

#6 - Look at the rock kit. Does your sand have pieces of rock that match some in the kit? List the kinds of rocks that may be in your sand.
Give each group a rock and/or mineral kit and have students compare their sand grains to rocks in the kit.

#7 - Which sand in your group is the lightest in color? Which is the darkest? Arrange them in order from lightest to darkest.
Have students pass their sand slides around the circle of their group, looking at each, until they have their own slide back. They should especially notice the colors of the different sands. Ask, "What can you learn by observing the color of your sand?"

> [Colors give you clues about what your sand is made of - dark sands are often volcanic in origin; light sands can be made of animals like shells or corals, or of quartz from granite mountains.]

Now, have each group arrange all of their samples in a line from lightest to darkest and record their answers.

#8 - Compare your sand slide to the size chart below. Imagine that the black dots are grains of sands. Color the group of dots that are about the size of your sand grains. If your sand is not like any of these,use the empty circle to draw how yours looks. Are your grains all about the same size or many different sizes?
This may be confusing for some students. The different groups of dots in the illustration represent different sized grains of sand. They are clustered in a circle similar to the students' cluster of sand on their sand slide.

#9 - Which sand in your group has the biggest grains? Which has the smallest grains? Arrange them in order from smallest to biggest.
Have students pass their slides around the group again, this time observing grain size. Next, have each group sequence their sand cards, this time from the smallest grains to the largest grains and record their answers.

Ask the class to imagine they are a very tiny sand grain, about the size of the smallest grain in their group's samples. What might happen to them if they were hit by a wave or caught in a current? Do they think they would be able to stay in one place?

[Small grains are kept moving by even very slowly moving water.]

What about if they were one of the larger grains?

[Because they are heavier they might stay put until a bigger wave or faster moving current came along.]

#10 - Choose two samples of sand from your group: the sample with the smallest grains, and that with the largest grains. Take a pinch or two of sand from the bag of sand with the smallest grains, and drop the sand into one of the jars of water. Once the sand has been added, close the jar lid tightly. Follow the same procedure with the largest grained sand sample. Once both jars have sand and are tightly closed, shake the jars vigorously, then put them down on the desk at the same time. In which jar does the all of the sand settle to the bottom first?

[The larger sized sand grains should settle out of suspension first.]

Pick up both jars again. This time move them around slowly. Swirl them in a circle. Does all of the sand move in both jars?

[The larger sized sand grains may not be suspended in slower moving water.]

Which type of sand would move in slow-moving water?

[The finer grained sand is more easily moved by slow moving water.]

Ask, "What might the size of the sand grains tell you about the kind of place your sand sample is from?"

[If their grains are very small, they were probably from an area with slow moving water such as a protected bay beach or a pool in a slowly moving stream. Tiny particles can stay put only where the water is moving slowly and gently. Large waves (or fast water) pick up small grains and carry them away down the river or off the beach and out to the ocean. If their sand grains are mainly large, they were probably from a wave-tossed beach where the rough water carried all the smaller grains away. Only the larger grains remained because they were not picked up by the waves.]

3. Have each group take a few minutes to compare their answers on the Sand Studies sheets. Why might some people have gotten different answers? What do the differences tell you about the different types of sand?

Blowing in the Wind

1. Explain that sand is almost always in constant motion, and that the sand grains on a beach on a given day might be entirely replaced by others in a few weeks. One way that sand moves is by being blown with the wind.

2. Hand out the trays of sand to each group and give each student a chance to gently blow on it for five seconds or so. What happens? At a real beach, the wind blows almost all the time. What effect does this have on beach and dune sand?

[The "wind" separates or sorts the grains by size - the smaller ones are blown the farthest.]

3. Have students look at their own sand slide now. If all the grains are roughly the same size, they may have come from a windy beach. If the sample is "mixed" in size, it may have been from a beach with little wind. Can they make a guess about whether or not their sand came from a windy place?

4. When they are finished, groups should clean up the materials at their tables. Tell them they will need their Sand Studies sheets, sand slides, and small bag of sand for the next session.

Session Activity 4: Hocus Focus

1. Ask students from each group with the same type of sand to meet together in 'focus groups.' Have them compare their answers on their Sand Studies Sheets and discuss any discrepancies.

2. Ask them to think about where their sand may have come from before it showed up on the beach. A coral reef? A mountain? A lava flow? Clam or mussel shells? Is the sand very old or very young? What evidence do they have for each inference? (Note: Younger students may benefit more from an informal discussion such as this, rather than completing the Focus Group Study Sheet.)

3. Have each student complete a Focus Group Study Sheet, working with the other students in her/his group. As the students consider the questions, especially #3 and #4, you may need to focus their thinking by having them recall their responses to the Sand Studies Sheets, as well as previous discussions about how rocks, shells, etc., become grains of sand.

Inferring roughness and calmness of the water from the sand grain size is a difficult "leap" to make, even for adults! To help students,ask them to think about what size grains could calm, gentle waves push onto a beach? What about big, strong waves?

4. Next, ask them to imagine the beach where their sand may have come from. What does it look like? Is it a sunny, warm place with tropical animals or a cold place? Have each student draw a picture of what she/he thinks this beach may look like.

For younger students who may have difficulty making guesses or inferences from the evidence they've collected, drawing and discussing an imaginary beach is fine. Notice whether they include descriptions of color, the types of material that became their sand, and the age of the sand as identified by being sharp or smooth. These characteristics are the most visible and therefore the most concrete, and this helps students in deriving simple cause-and-effect statements about them. For example, a student might describe the beach this way: "My beach has white and pink sand from clam shells. The sand is young sand because the sand grains are sharp and pointy. My beach has a lot of people swimming because the waves are small."

For older students, provide some clues to help them draw their beaches such as: if you think you have coral sand, the water at your beach will probably be clear and blue, and the animals Living around the coral reef will be brightly colored. If you think there is lava in your sand, there must be,or have been at one time, a volcano nearby. If the grains are very large,the waves at your beach are probably big, and maybe it would be a good beach for surfing. If the grains are small, the water is probably calm, and it may be a good beach for swimming and snorkeling. Students could also be encouraged to label the drawings to point out features that they think contributed to the type of sand they have.

5. Students can present their drawings and evidence to the class individually. Or you can post the student art around the room next to the sand sample it illustrates.

6. Discuss with students why sand is important to people.
[It creates fun and beautiful places for us to walk and play. It is an important home to many, many plants and animals. Many things that we use are made from sand.]

Ask "What are some of the ways sand comes to the beaches?"
[Rocks, minerals and sediment are carried to the shore by rivers and creeks. Shells and bones of creatures that live on shore and at sea are brought to the shore by ocean currents. Sea cliffs and marine outcrops and terraces erode.]

"What would happen if all of the rivers were dammed?"
[Remind students about how rivers move swiftly, but behind a dam, flow is virtually stopped and a large body of still water, called a reservoir, is formed. In still water, rocks, cobble, gravel and even fine sand settle to the bottom of the reservoir, just as it did in the glass jar. If all the rock and sand settles in the reservoir, it can no longer be carried to the beach. With no sand coming to the beaches from the rivers, the beaches could eventually disappear!]

7. Hold up the Key Concepts for this activity one at a time, and have one or more students read them aloud. Post them near your sand table or Sand Display for students to refer to later.

- **Sand grains can be made of animals, plants, rocks, or minerals.**
- **Sand grains come in many different shapes, sizes, and colors.**
- **Differences between sand grains can be clues about where the sand came from and how it got to the beach.**

Going Further

1. Encourage younger students to "get a feel for sand." Set up a sand table or tub for free exploration, and encourage students to explore it individually or in small groups when they have free time. You might put out water, funnels, sieves, spoons, or cups. Have them look at the sand closely, run it through their fingers,make sand sculptures, or look for evidence of life. Put out drawing paper and pens for students to write descriptions or illustrate sand-related images. Every day or so, add a new item: a shell, feather, rock, or piece of litter. This would make a nice pre-presentation exploration station before presenting the activities in this guide.

2. Students could compare their individual sand samples to the sand in the Beach Buckets from Unit 1.

3. Bring in old stuff to make sand, such as rocks, shells, bones, plastic, and pencils. Wrap them in old pillowcases or towels and have a few students take turns breaking them up outside with hammers. (Or put them into a tumbler, if you have one at your disposal). Make sure you keep a secret list of all your "ingredients," and see if students can discover what they are by examining the new "sand". Make exhibits in class to display the new sand samples next to a list or picture of the ingredients.

4. Have students explore some geography related to their sand samples. Use wall maps, globes, atlases, and encyclopedias to locate the places from which the sand came. Measure with string and latitude lines to determine how far each place is from where you live. Is there anything special that anyone knows or can find out about each location? Are there mountains or volcanoes nearby? Is the ocean there cold or warm? Any famous surf breaks or diving spots nearby?

5. Have students continue to collect sand samples. Find a class in another region of the state, country, or world to be pen pals with, and send each other sand samples. Create a sand exhibit or museum, with descriptions of each sample.

6. Take a field trip to a sandy shore. Students can act as detectives to determine if the sand has a source that is close by or far away. Sometimes sand is brought in by people from other places to "make" or "nourish" a sandy beach. Why would people undertake such a project? What evidence can they find about its origin and evolution? What clues are observable [rocks, cliffs, shells, streams, etc.] Is the beach "cleaned"? By who or what? [people, machines, birds, currents, high tides]

Name: _____

SAND STUDIES SHEET

1. Look closely at your sand with a magnifier. List or use crayons to show all of the different colors that you see.

2. Draw a picture of some of your sand grains. Draw them BIG!

3. Circle the pictures that have shapes like your sand.

not rounded | a little rounded | very rounded

4. Gently rub a magnet on the outside of your bag of sand. Are any of the grains in your sand attracted to the magnet?

If so, what color are the magnetic sand grains?

5. Which of the following things can you find in your sand?

- ☐ small rocks
- ☐ pieces of shells
- ☐ pieces of glass
- ☐ pieces of wood
- ☐ pieces of plants
- ☐ pieces of plastic

☐ other things. They are:

STUDIES IN SAND: Sand Studies Sheet

6. Look at the rock kit. Does your sand have pieces of rock that match some in the kit? List the kinds of rocks that may be in your sand.

7. Which sand in your group is the lightest in color?

   Which is the darkest?

   Arrange them in order from lightest to darkest.

8. Compare your sand slide to the size chart below. Imagine that the black dots are grains of sand. Color the group of dots that are about the size of your sand grains. If your sand is not like any of these use the empty circle to draw how yours looks.

   Are your grains all about the same size or many different sizes?

   Which sand In your cooperative group has the biggest grains?

   Which has the smallest grains?

   Arrange them in order from smallest to biggest.

9. Choose two samples of sand from your group: the sample with the smallest grains, and that with the largest grains. Take a pinch or two of sand from the bag of sand with the smallest grains, and drop it into one of the jars of water. Once the sand has been added, close the jar lid tightly. Follow the same procedure with the largest grained sand sample. Once both jars have sand and are tightly closed, shake the jars vigorously, then put them down on the desk <u>at the same time</u>. In which jar does the all of the sand settle to the bottom first?

   Pick up both jars again. This time move them around slowly. Swirl them in a circle. Does all of the sand move in both jars?

   Which type of sand would move in slow-moving water?

Name: _____

FOCUS GROUP STUDY SHEET

1. Where do you think your sand was collected from?

2. What do you think your sand is made of?

3. How do you think your sand got to the beach?

4. On the back of this sheet, draw a series of pictures to show the story of how your sand became sand. Be sure to include crashing waves, freezing mountain tops, rushing rivers, or exploding volcanoes, or anything else you think helped to form your sand.

STUDIES IN SAND: Focus Group Study Sheet

Part 1: Draw a picture of where your sand came from (a clam, a mountain, a coral reef, or ?...) before it arrived on the beach.

Part 2: Here's what happened next.

Part 3: Look what happened next!

Part 4: My grain of sand now looks like this.

GETTING UP TO SPEED

Unit 2: Studies in Sand

This section is not meant to be read out loud to or distributed directly to students (although this is at your discretion). It is primarily intended to provide the necessary, concise background for you - the Surfrider chapter representative (or teacher) - in presenting Unit 2 activities and responding to students' questions. Please see the "Unit 2 Resources" section for books and other materials that will help you, teachers and students to delve more deeply into the subject matter addressed in this unit.

Overview

In this activity, small groups of students use hand lenses (or low-powered microscopes, if available) to compare the color, size, and shape of several sand samples and to make educated guesses about their origins. Students discover that sand grains can be made of animals, plants, rocks, or minerals - even of debris. Sand grains come in many different shapes, sizes, and colors. These differences can be clues about where the sand came from and how it got to the beach.

In Activity 1, Sand-sation, students work in small groups to discuss and write about sand. They record their knowledge and any questions they may have on their own charts, then contribute their ideas for a class "Q&A Chart." In Activities 2, 3, and 4, students compare different types of sand, observe sand with hand lenses or microscopes, and record their findings on a study sheet. Then they work in focus groups to concentrate on one type of sand, complete the Focus Group Study Sheet and draw a picture of the beach where the sand they examined might have been found.

Background

Nearly every imaginable type of solid material in the world, both living and non-living, is eventually eroded into sand. Mountains, rocks, minerals, shells, corals, bones, metals and glass are all worn down over time by wind,waves, rivers, earthquakes,and other forces into smaller and smaller particles. For this reason, sand is sometimes said to represent the Earth in miniature. The story of a grain of sand can be the story of the evolution of the crust of the earth. Thousands or millions of years may pass as a rocky outcropping on a mountain top is transformed into a grain of sand on a sandy beach - this sand grain may be blown by winds and swept by currents, and eventually fall into a submarine canyon, where it again might be compressed into rock and once again be uplifted as part of a mountain. Sand, whether found in Native American paintings, on a beach or in a child's sandbox is often associated with soothing feelings such as drifting, flowing, and timelessness.

Background continued

Beaches can form wherever water deposits sediments onto a shore. Rivers, lakes, ponds, and oceans can all have beaches. These beaches can be made of sand, gravel, or cobbles - these terms refer only to the size, rather than composition, of individual grains on a beach.

The sand on every beach has its own unique history. Detailed observations combined with some good detective work, however, can often allow us to make some reasonable hypotheses about where the sand originated, how old it is, and perhaps even from what part of the beach it was collected. Sand from the remains of plants or animals is referred to as biogenic, while sand from non- living sources is called abiogenic. A closer look at sand, through a hand lens or microscope also reveals the striking beauty of individual grains.

Some sand is produced right at the shore where waves crash on rocks,headlands,and reefs. For example, black or red sand beaches on the Hawaiian and the Galapagos islands are found directly next to or on top of lava flows of the same color. White sand beaches in Florida and in the Caribbean are primarily made of eroded coral reefs. Parrot fish, which eat coral polyps, grind up the corals with their sharp teeth, and can excrete up to 100 pounds of coral sand per year. Pink sand might be full of coralline algae fragments. Other sand comes from far inland. Mountains are weathered by freezing, wind, rain, and running water, and their fragments are carried down streams and rivers to the seashore. Quartz, a glass-like mineral, is the most common mineral on earth, and is nearly insoluble in water. It is often the most common component of these transported sediments. In fact, most light colored sand beaches contain large amounts of quartz.

Sediments are classified by particle size, from silt to cobble. Particles are generally called sand when they are between 0.06-2.0 mm in diameter. Where particles are deposited depends on the velocity of the water carrying them. In fast moving river or ocean water, only the largest, heaviest sand grains settle out. On wave impacted outer coast beaches, only large sand grains or even cobble will be found. The smaller the particle, the slower the water must be moving for it to settle out. Silt-sized particles are only found inside protected marshes or bays, or far offshore on the deep ocean bottom where the water is barely moving. The finest grains of sand can become airborne in the wind, and are often deposited high on the beach in the dunes. Dune sand is usually noticeably finer and lighter than beach sand.

On a typical coastal beach, no individual sand grain stays in the same place for long. Each wave picks up thousands of grains and deposits them somewhere else. If a prevailing wind causes waves to consistently strike the coast from the same angle, sand can be slowly transported great distances along the coast.

Sandy beaches surround the edges of nearly every coastline, but each is unique, and tells a different story about the history of the continents. Beaches are a shared resource, and are firmly embedded in the psyche of people from many cultures.

Unit 2 Resources

Sources for Materials

Rock/mineral, and sand kits can be ordered inexpensively from:
The Math/Science Nucleus
3710 Yale Way
Fremont, CA 94538
(510) 490-MATH

Also from most large science and earth science supply houses, such as:

Ward's Natural Science Establishment, Inc.
5100 W. Henrietta Road
PO. Box 92912
Rochester, NY 14692-9012
(800) 962-2660

Frey Scientific
905 Hickory Lane
P.O. Box 8101
Mansfield, OH 44901-8101
(800) 225- FREY

Sand samples can also be obtained from members of the International Sand Collectors Society. For more information contact :

William Diefenbach, President
International Sand Collectors Society
43 Highview Ave.
Old Greenwich, CT 06870-1703.

Another method of obtaining sand from around the world is through an Internet bulletin board service. Scroll to a heading called "K12.Science.Ed" and place your ad there.

"Magiscopes" from Brock Optical are one highly recommended model because of their quality, durability and reasonable price. Young students can use them easily and they do not require electricity or mirrors. Product and ordering information can be obtained by calling (800) 780-9111.

Books

For Children:

Dune Fox, Marilynne K. Roach, Little, Brown, Boston, 1977.

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.

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, Wilma Willis, Children's Press, Chicago, 1973.

Sand and Man, Wilma 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, New Jersey, 1991.

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

Shell, Alex Arthur, Knopf, New York, 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.

STUDIES IN SAND: Unit 2 Resources

For Adults:

Between Pacific Tides, Edward E. Ricketts, Jack Calvin, and Joel W. Hedgpeth, Stanford University Press, Stanford, California, 1939.

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

A Field Guide to Atlantic Seashores, Kenneth Gosner, Houghton Mifflin, Boston, 1978.

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. McConnaughey and Evelyn McConnaughey, Alfred A, Knopf, New York, 1985.

Pacific Seashores, A Guide to Intertidal Ecology, Thomas Carefoot, University of Washington Press, Seattle and London, 1977.

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

Seashells of the World, R. Tucker Abbott, Golden Press, New York, 1985.

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.

Shells of the World, A. P H. Oliver, Henry Holt, New York, 1975.

Shore Ecology of the Gulf of Mexico, Joseph C. Britton and Brian Morton, University of Texas Press, Austin, Texas, 1989.

Waves and Beaches, Willard Bascom, Anchor Books, Garden City, New York, 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*, August 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

Daughters of Water, Sons of the Sea
by Jesse Boggs
Schneider Educational Products, Inc.
San Francisco. 1991

This cassette is full of delightful songs about the ocean and some of the creatures in it.

Penguin Parade
by Banana Slug String Band
Music for Little People
Redway, California. 1996

In the style of the Banana Slug String Band, this cassette is full of fun and entertaining nature songs.

Slugs at Sea
by Banana Slug String Band
Music for Little People
Redway, California. 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 Department 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
122 So. El Camino Real, PMB#67
San Clemente, CA 92672
(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.

Living On the Edge:
California's Coastal Erosion Dilemma
NonProfit Distributions: Eden Productions
1503 Beach Street, San Luis Obispo, CA 93401
(805) 544-2843
robin.chilton@delphos.net

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/
29 minutes

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
(202) 775-6563
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 there in 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 teacherís 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 al large collection of circulating videos, slide shows, software, filmstrips, posters,and small kits available to teachers nationwide. Included are about 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 (each part has 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, second 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 peroiod 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, teachers' 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

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

If You Take It Out, Matey. Bring It Back
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204

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

Olympic Coast National
Marine Sanctuary Dedication
Olympic Coast National Marine Sanctuary
138 W. First Street
Ft. Angeles, WA 98362
(206) 457-6622

Save Our Seas Curriculum Poster
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219
(415)904-5206

The U.S. Government Printing Office has several posters showing oceans and ocean life. For a complete list of titles and ordering information, write to:

U.S. Government Printing Office
Superintendent of Documents
Washington, DC 20402

Many marine sanctuaries and estuarine reserves provide educational posters for teachers. These estuaries and marine sanctuaries can also be a great source for local information. Contacts are listed in the Unit 1 Resources section.

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: mwww.ceres.ca.gov/coastalcom/publicized/aab/educate.htm

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
Konocti 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

Critters: K-6 Life Science Activities
Education Foundation
PO. Box 8120 Fresno, CA 93747
(209) 255-4094 Earth Island Institute

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

MARE Curriculum Guides and 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 and Curriculum
Center for Marine Conservation
580 Market Street, Suite 550
San Francisco, CA 94104
(415) 391-6204
web site: 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

Cool Web Sites:

American Oceans Campaign home page
www.americanoceans.org/

Cool Web Sites: *continued*

The Bridge
Online resources for marine science education
www.vims.edu/bridge/

Center for Marine Conservation home page
cmc-oceans.org/

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

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.

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% recycled with 80% post-consumer waste 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

Surfrider Foundation®

CONSERVATION • ACTIVISM • RESEARCH • EDUCATION

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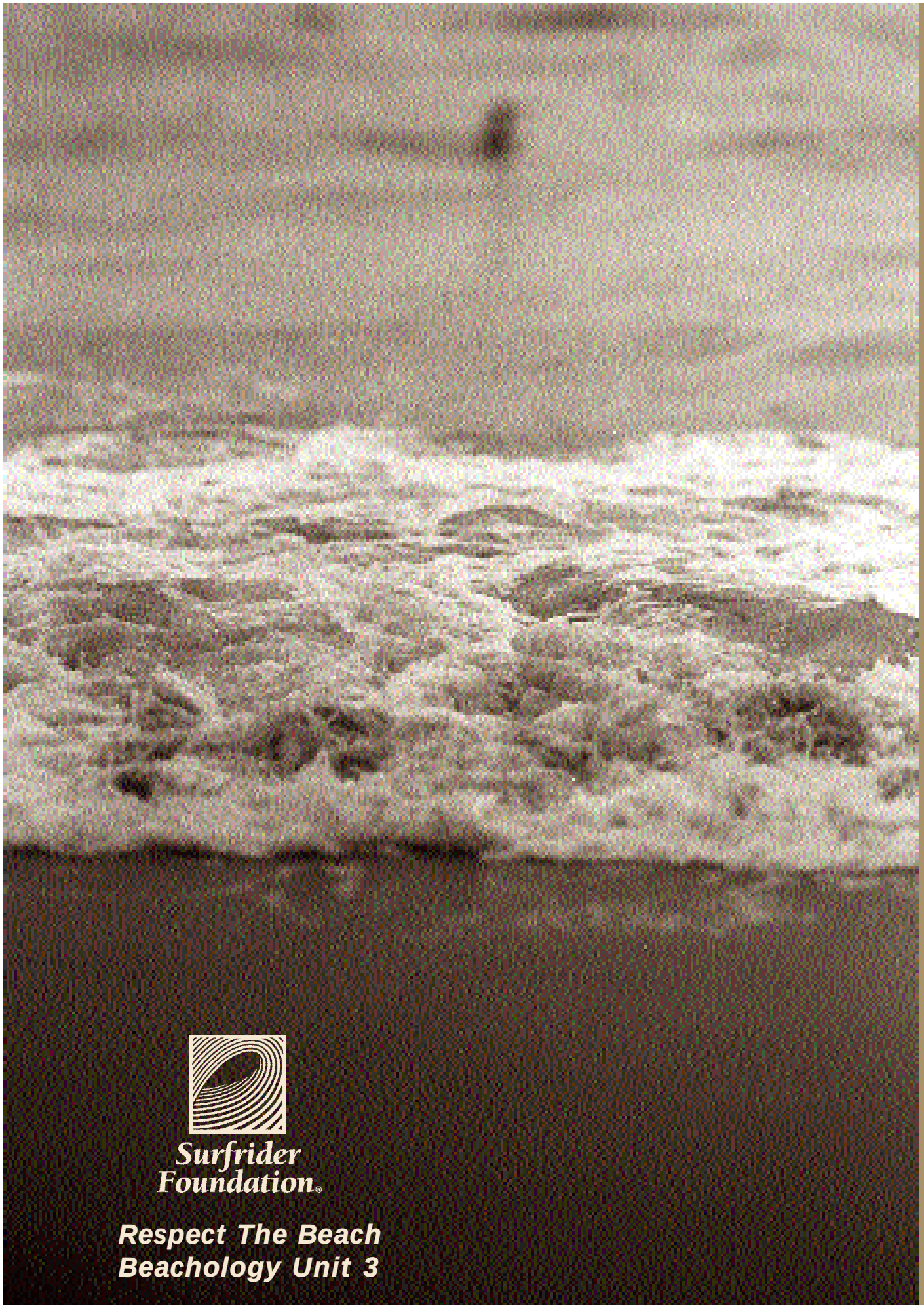


SAND TRAVELS

Surfrider Foundation®

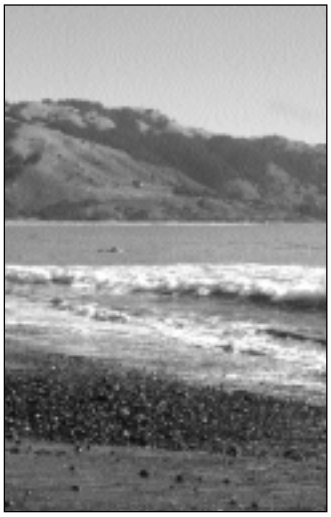
Respect The Beach
Beachology Unit 3

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***



PHOTOGRAPHY: ANDRES MARTINEZ

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

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.***
- ***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***

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?

ILLUSTRATION: PATTI ROBERTS

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.

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.

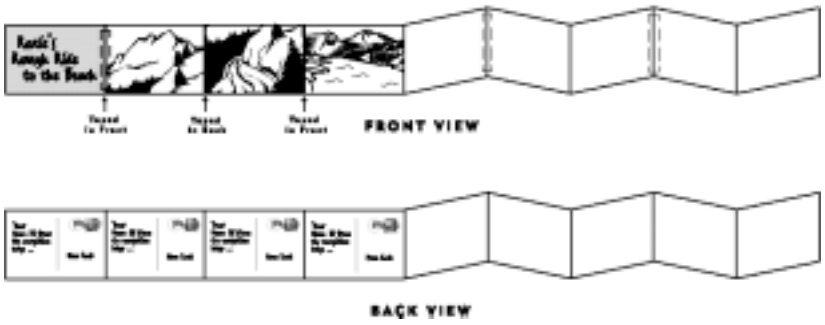
4. Pass out crayons, markers, or colored pencils to each group. Assign each of the eight students in each group a part of the story to illustrate. Tell them to imagine that they are Roxie on her journey and writing a postcard home. Have students use crayons or markers to draw where they are in their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

ILLUSTRATION: PATTI ROBERTS

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.

ILLUSTRATION: PATTI ROBERTS

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.

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.]

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.

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.

PHOTOGRAPHY: GUY MOTIL

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.)

PHOTOGRAPHY: JOE MOZDZEN

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.

PHOTOGRAPHY: JOE MOZDZEN

Part 2: The Spring River Run

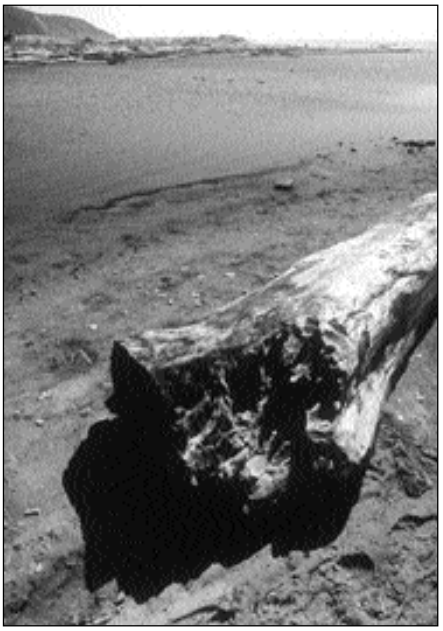
One fine morning of the following spring, when the sun was out and shining its warm rays on high mountain snow, a trickle of water crept underneath Roxie. It tickled a little bit and Roxie smiled. The gently moving water was a nice change from the cold, hard ice. As the sun rose in the sky, the little 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.

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

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

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 scuffled 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.

PHOTOGRAPHY: JOE MOZDZEN

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!

Part 7: The Groin *(continued)*

As the days grew shorter and the shadows grew long, Roxie new 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 shoreline 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.

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. McConnaughey and Evelyn McConnaughey, 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 opportunites. 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 caostal 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.

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 Edventures
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 peroid 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

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

Albemarie-Pamilco Sounds, NC
Albemarie-Pamlico Estuarine Study
NC Dapariment 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

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

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
Konocti 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.americanoceans.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 exerpts 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

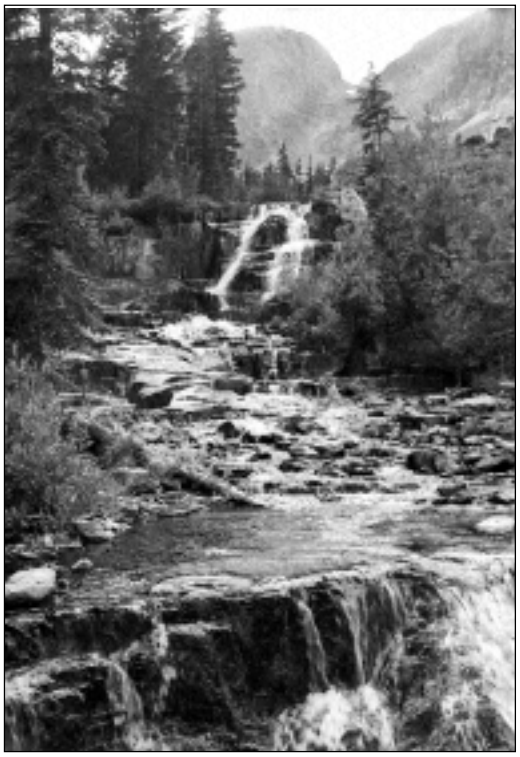
NOAA Central Library
Photo collection, historical maps and charts, online journals, and links to other NOAA sites
www.lib.noaa.gov

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.

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