

# Sea Sampler

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**Aquatic Activities  
for the Field and Classroom**

**Secondary**

**Editors:**

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SEA SAMPLER  
AQUATIC ACTIVITIES FOR THE FIELD AND CLASSROOM  
Secondary, Grades 7-12

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## PROJECT BACKGROUND AND PURPOSE

The samplers of aquatic activities are part of an evolutionary process designed to bring marine education into the curriculum of South Carolina schools. Before describing the evolution of the elementary and secondary activity samplers, we would like to define marine education as it is being used in South Carolina.

Marine education is very aptly defined in a publication by Goodwin and Schaadt:

"Marine and aquatic education is that part of the total educational process which enables people to develop a sensitivity to and general understanding of the role of the seas and freshwater in human affairs and the impact of society on the marine and aquatic environments."<sup>1</sup>

Thus, marine education is not a subject but rather a process that can be used in any subject area to increase awareness and understanding of our water resources. It can also be used as a tool to stimulate and increase interest and learning in many study areas.

A concerted and coordinated effort to expand K-12 marine education opportunities in the state was initiated in 1980 when the South Carolina Sea Grant Consortium formed a committee to review K-12 marine education needs. The study committee agreed that all of us need to be more informed about our water world and learned that very little marine education was included in the K-12 curriculum. A plan was proposed to address this need: identify available resource materials, develop new materials, if necessary, and train teachers with these materials.

Elementary marine education materials from across the Nation were gathered and reviewed by Liu and Allen.<sup>2</sup> Secondary marine education materials were also reviewed and trial-tested by teachers who participated in our first marine education course, held summer, 1982. This core group of teachers returned for two reunions, reported on their experiences using the curricular materials, and identified activities which worked well with their students. Two additional summer courses and four workshops were held for elementary and secondary teachers over the next two years.

In summary, a total of 149 teachers gained information on coastal ecosystems and practice using field and classroom activities from a variety of sources. They also identified preferred activities and areas that were not adequately addressed by existing materials. Every participant selected and received curriculum materials to use in the classroom. Clearly, not only have the teachers benefited from the marine education training program, they have also contributed a wealth of information regarding which activities are most appropriate for use in South Carolina.

We have used this valuable information to compile elementary and secondary activities from different sources. Thus, the elementary and secondary versions of Sea Sampler - Aquatic Activities for the Field and Classroom, represent a sampling of activities that have been successfully used in South Carolina classrooms. We hope you too will use these activities to stimulate interest and increase your students' understanding of our watery world.

<sup>1</sup>H. L. Goodwin and J. G. Schaadt, 1978, "A Statement on the Need for Marine and Aquatic Education". Delaware Sea Grant College Program, University of Delaware, 196 South College Avenue, Newark, DE 19716.

<sup>2</sup>J. M. Liu and W. B. Allen, 1982, "The Search and Review of Elementary Marine Education Materials". South Carolina Sea Grant Consortium, 287 Meeting Street, Charleston, SC 29401

## HOW TO USE THIS SAMPLER

The activities in this sampler are designed to be used and infused as you see fit. They do not represent a complete unit of study and thus, should be used as starting points or complements to your regular curriculum. A table listing the activities and their content and skill areas is included at the end of this section to help you place the activities into your curriculum.

The activities are grouped alphabetically according to whether they are for field or classroom use. Guidelines for setting up a salt water aquarium precede the field and classroom activities. A salt water aquarium can be an excellent learning resource for any classroom and this information is included to complement the sampler activities involving aquarium animals.

The title page of each activity contains a box in the upper right hand corner with information on the source of the activity, content and skills covered, and recommended grade levels (see sample below).

GRADE LEVELS: 5-12 CONTENT & SKILLS: science, math SOURCE: Bellefield Nature Center
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The grade levels are guidelines only. Please use your own discretion in determining whether or not an activity is appropriate for your learner group.

Some of the original activities have been slightly adapted so as to be more relevant to South Carolina, while others are simply retyped versions of the originals. We encourage you to obtain copies of the original curriculum units in order to expand your marine education studies. The ordering information for each activity source is included at the end of the packet.

Several of the activities contain student activity sheets. These are color-coded in blue for easy recognition and can be readily copied for your students.

Attached at the back of the sampler is an evaluation form. We are very interested in learning which activities you used and how you rate them. Please take a few minutes to evaluate the sampler after you have used it and return the form to:

SEA SAMPLER  
USC Baruch Marine Lab  
PO Box 1630  
Georgetown, SC 29442

Thank you in advance for your contribution to this project. Now, go get your feet, or at least your hands, wet in these activities.



ACTIVITY / CONTENT AND SKILLS INDEX

	ART	MATH	READING	SCIENCE	SOCIAL STUDIES	WRITING
<b>FIELD ACTIVITIES</b>						
A Beach Study		•		•		
Freshwater Marsh-Marsh Settlers				•	•	•
Freshwater Marsh-Marsh Succession				•		
Salt Marsh Field Study		•		•		•
<b>CLASSROOM ACTIVITIES</b>						
Brine Shrimp Capers		•	•	•		•
Crossword Puzzle			•	•		•
Currents				•		•
Food Chain Connections				•		
Gyotaku	•					
How to Catch Attachers				•		•
Investigating Osmoregulation				•		
Keys to the Kingdom			•	•		•
The Marine Aquarium		•		•		•
Marooned			•		•	
Observing the Living Crab		•		•		•
Open for Business		•				
Pickle Jar Ponds		•		•		•
Sand Study			•	•		

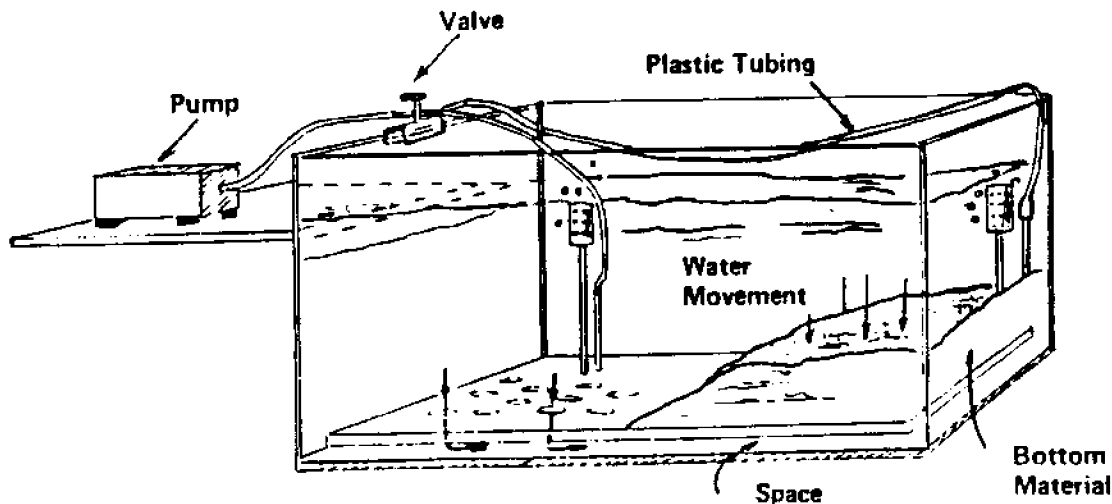
### THE MARINE AQUARIUM

A marine aquarium takes more money, care and patience than a brackish aquarium system. However, you can teach about the sea from a classroom setting by having a marine aquarium. Living marine animals are fascinating to watch and they constantly demonstrate behavior and biological relationships. Then, the water in which sea animals live adjusts to environmental pressures. Many of the changes in sea water can be measured: salinity, pH, nitrate and phosphate, dissolved oxygen and temperature. Monitoring an aquarium is an interesting investigation in itself.

Setting up a marine aquarium requires an initial expense (or donation), care in its placement (not too close to the radiator, door, window) and regular maintenance once established. Students are usually interested in working with aquaria and can provide most of the maintenance and monitoring help. Your aquarium should be at least a 20-gallon tank. Some suggestions to aid and encourage you are given below.

a. Prepare the tank: Obtain an all-glass aquarium without a metal frame. Most marine organisms need a lot of water so be sure the aquarium will be big enough for your purposes. The usual size is between 10 and 30 gallons. Wash the aquarium with tap water and then rinse it with sea water.

b. Install the filter: Place an undergravel filter inside the aquarium and/or attach a pump-circulating filter to the outside of the aquarium. The more water circulation you can provide the better. If you are using a box or outside filter, then you should also install an air stone to provide additional aeration.



c. Add gravel substrate: Obtain a quantity of calcareous gravel about 5 mm ( $\frac{1}{2}$ " in diameter to buffer the pH of sea water and filter water). Crushed oyster shell can be bought from a feed/hardware store. If you are using an undergravel filter, the gravel will be placed on top of the filter and must not be small enough to fall through the openings in the filter. Enough gravel is needed to make a layer 5-7 cm (2" - 3") deep on the bottom of the aquarium. Rinse the gravel before using to remove any debris. Do not put any object into the tank that is made of metal.

d. Fill the tank with water: Obtain a supply of artificial sea water, e.g., "Instant Ocean." Very clean, settled sea water can be collected offshore or during a flood tide at an inlet, then held in the dark for 3 weeks. Place a pan or piece of paper on top of the sand in the aquarium to prevent the sand from being disturbed when the water is poured in. Fill the aquarium until the water level is about 2-3 cm (one inch) from the top of the tank. With magic marker, wax crayon or tape, mark the outside of the tank at the water level in order to check evaporation.

e. Install a glass cover and an aquarium light (optional): A glass cover will reduce water loss from evaporation and light will help you to see into the tank. The glass cover also prevents accidental trash (coins, gum, etc.) from being dropped into the tank.

f. To culture the filter, several methods are available; however, one of the surest is to obtain about a cup of gravel from a healthy marine aquarium that has been running for several months. Spread this "dirty" gravel over the gravel in your aquarium to inoculate it with beneficial bacteria. The bacteria are essential to the success of the aquarium. They utilize the waste products given off by the aquarium animals that if not removed would poison the animals. Add a few hardy animals such as crabs, lobster, groupers or sea bass to the aquarium so that as they are fed they will provide the filter with waste material to get it going. Do not feed them any more than what they will eat and remove any uneaten food. After about three weeks you should be able to begin replacing the hardy animals with more delicate species, but do not overcrowd the tank.

g. Avoid sharp changes in temperature, food or water. Remove about  $\frac{1}{3}$  of the water every six weeks, and add new sea water. Replace any water lost by evaporation (indicated by the water level sinking below the line you placed on tank in step (d)) with fresh water.

h. Choose animals which are hardy and have good survival records in a classroom situation. These can be ordered from several biological supply companies or brought back from a beach trip (in aerated, cool jars).

1. Marsh minnows - mummichog, killifish and sheepshead minnow.
2. Small flounder, eels, rock bass or toadfish.
3. Starfish, sea anemones and sea cucumbers are usually very hardy.

4. Very small crabs (hermit, blue, mud) are useful to clean up scraps. Too large or too many crabs will destroy all the other life.
5. Most small snails do well. (Remember the "marsh periwinkle" - *Littorina* - breathes air.) Bivalves like clams, mussels, or oysters live reasonably well for short periods. Barnacles are an added bonus if you find some on oyster shells.
6. Avoid seaweeds, algae, and sponges in the tank as they don't survive and easily foul a tank.

1. Maintenance:

Daily

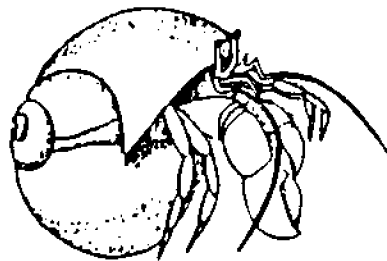
1. Check airlifts to ensure maximum water flow.
2. Make sure any accessories are operating correctly (heater, outside filter, light, etc.).
3. Check for any sick or dead fish.
4. When feeding, watch to see that most of the food is eaten.

Weekly

1. Check salinity and add fresh water to maintain initial water level.
2. Remove any salt accumulations on aquaria or accessories.

Monthly

Lightly stir gravel to stir up excess detritus, and siphon out  $\frac{1}{4}$  of the sea water. Replace with aged natural or freshly mixed artificial sea water of the same salinity and temperature as the water removed.



*Hermit Crab  
(Pagurus)*

GRADE LEVELS: 5-12  
CONTENT & SKILLS: science, math  
SOURCE: Bellefield Nature Center

## A BEACH STUDY - TEACHER'S GUIDE

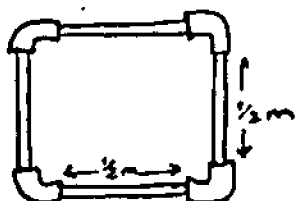
### Introduction

This packet contains information for two separate activities that will help you plan a successful beach study. Also enclosed are student activity sheets, color-coded in blue, which can be copied for your students.

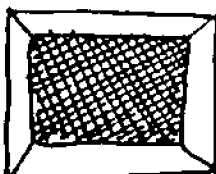
### Teacher Preparation

Beach studies can be scheduled for any season, although there is less activity and diversity in the winter. A successful study does not require a low tide; however, some narrow beaches will not be exposed enough during high tide.

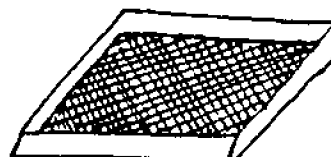
This packet contains information and student activity sheets for two activities, "Making a Beach Profile" and "Beach Community Study". These are two separate but easily combined activities. Each activity lasts approximately 2-3 hours. The Student Activity Sheets list the objectives and needed equipment for each study. Most equipment is readily available. You may have to make some quadrats ( $\frac{1}{2}m^2$ ) and sieve boxes for the Community Study. Quadrats can be easily made from flat pieces of wood or PVC pipes. Each side should be  $\frac{1}{2}$  meter in length. Sieve boxes are merely screens stapled to a wooden frame or box. The frame box can be of any size.



Quadrat



Sieve Frame



Sieve Box

### Student Preparation

Before your visit, prepare the students for the study by letting them know:

1. Where they are going - It is recommended that you visit and select an appropriate area for your study. Some considerations are access, length of beach, presence of dunes, and whether the site represents a "typical" beach.
2. What they will be doing - Describe the kinds of activities they will be doing at the site. You may want to review the student activity sheets and objectives.

3. What they should wear and bring - Insects and sun may be a problem. If you sample at the water's edge, feet will get wet. It is important that the students and adult leaders be properly dressed and equipped so that they can participate in the field experience. Recommended clothes and supplies are:
  - old clothes
  - change of shoes if feet will be getting wet
  - rain gear, if rain is likely
  - insect repellent
  - sun screen and hats if sun-sensitive
  - worksheets and pencils

### References

1. Calder, Dale R. and Margaret Callison Pridgen. Guide to Common Jellyfishes of South Carolina. Charleston, SC: South Carolina Sea Grant Consortium, 1977.
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## A BEACH STUDY

### At the Study Site for "Making a Beach Profile"

1. Divide the class into work groups of 4-5 students and distribute equipment.
2. Review the data sheet and field any questions. You may want to demonstrate the technique to the group. Remind the students that there will be no collection or destruction of any live plants or animals. Tell them to use care when walking around the dune plants.
3. Once everyone is clear about what they are to do, assign each group to a transect site. (If also doing the activity, "Beach Community Study", combine the study sites, and mark quadrat placement on the profile data sheet.) Have each group put a visible benchmark at the transect's end to keep the study straight. The starting point should be near the high tide line. Some student reminders:
  - \* Fill out only the first two columns of the datasheet. Cumulative values can be determined after the field study.
  - \* Carefully collect and record all data.
  - \* Pay special attention to + and - signs for elevation changes.
4. The recommended horizontal interval between meter sticks is 10 meters. Lengthen this for long, unchanging beaches, or shorten it to include special features. Have the groups measure this horizontal interval with the transect line on the ground.

Explain to the students that this measurement is not necessarily the value they record in Col. 2 - "Horizontal Distance". The value to be recorded is read from the transect line when the line is stretched tight between the meter sticks. For steep areas, this distance may be significantly different than the initial distance measured along the ground. See example #3 on the Student Activity Sheet.

### After the Field Study for "Making a Beach Profile"

Follow-up activities maximize the field experience. Below are some suggestions.

1. Plot the beach profile. First, fill out cumulative calculations on the data sheet. These are horizontal and elevation measurements from the starting point. See example below.

Elev. Difference Col. 1	Horizontal Distance Col. 2	Cumulative	
		Elevation Col. 3	Distance Col. 4
+40 cm	9 m	+40 cm	9 m
+12 cm	10 m	+52 cm	19 m
-2.5 cm	8.5 m	+49.5cm	27.5 m

On graph paper, plot the elevation versus horizontal measurements to get a profile of the beach. Make sure any special observations are placed on the profile where they occurred. Indicate the water line.

2. Discuss or research these questions:
  - \* What physical and biological factors shape the beach features?
  - \* How do humans impact the beach?
  - \* What is the source of beach sand?
  - \* How might the beach change seasonally?
  - \* What is the importance of beaches?
3. Compare beach profiles of different sites or of the same site over time. How are these profiles different? What could have caused these changes?



## A BEACH STUDY

### At the Study Site for "Beach Community Study"

1. Divide the class into work groups of 4-5 students and distribute equipment.
2. Review the data sheet and field any questions.
3. Once everyone is clear about what they are to do, assign each group to a site to begin their study. Quadrat 1 should be near the high tide mark. (If also doing the activity, "Making a Beach Profile", combine the study sites, and mark quadrat placement on the profile data sheet.)
4. Remind the students that data should be carefully recorded and that zero is an important number. Stress that no live plants or animals will be collected or destroyed in the dunes. Have them be very careful to walk around the dune vegetation.
5. After each group has completely analyzed Quadrat 1, have them pace off or measure a distance (on the marked transect line) in a straight line towards the dunes. The next stop is Quadrat 2 on the data sheet.
6. Continue these procedures until everyone has analyzed the last sample site. You will want to visit each group to make sure they are following the procedures correctly and to help identify the plants and animals.
7. You may want to return to the water's edge and end with intertidal and subtidal sampling. This is Optional Stop 0 on the data sheet. (This sampling is not recommended as a beginning to the Community Study.)
8. Once everyone is finished, regroup to collect equipment. You may want to discuss some follow-up questions in the field or later in the classroom.

### After the Field Study for "Beach Community Study"

Follow-up activities maximize the field experience. Below are some suggestions.

1. Use community study information to reconstruct a map of the beach site. (If a beach profile was graphed, place community data directly onto profile.)

Discuss:

- \* How did community structure change with distance from the water?  
What factors may have caused this?
  - \* What role does vegetation play in the beach system?
  - \* What could change the community structure?
  - \* What stresses and adaptations are important to the success of beach inhabitants?
2. Compare this community structure with a different beach site, or the same beach over time.
  3. If a beach seine was used, set up a salt water aquarium with collected organisms.

Making a Beach Profile  
Student Activity Sheet

Introduction

In this activity you will follow a transect line (trans=across, sect=to cut) from the water's edge to the back dune area. You will work in groups of 4-5 students to make regular elevation and horizontal distance measurements along the transect. This information will later be graphed to provide a profile of the study beach.

Objectives

1. Measure elevation and horizontal distance changes along a beach transect.
2. Plot a beach profile using these measurements.
3. Infer shaping/controlling factors for the beach features.

Equipment (for each group)

visible benchmark (large stick or flagging material)  
2 meter sticks  
transect line - at least 10 meters long, marked off in 1 meter intervals  
clipboard and pencil  
data sheet - "Beach Profile Data Sheet"  
line level

Procedures

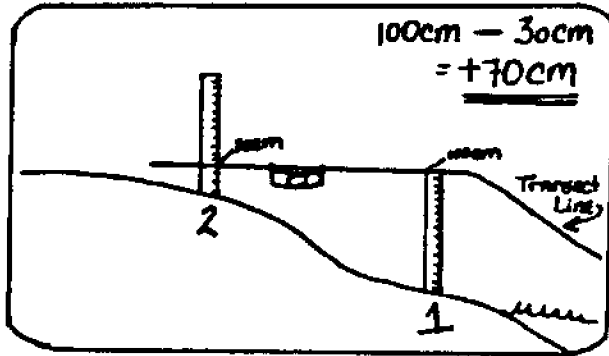
Your group will begin its study at a designated spot along the water's edge. Place a visible benchmark at the transect's end as a reference point to keep the transect in a straight line.

1. Start transect measurements as close as possible to the water's edge. Place meter stick #1 at the starting point, and meter stick #2 10 meters away. Keep the transect line on the ground to measure this 10 meters.
2. Stretch the transect line between the two meter sticks, and attach the line level. Raise the line until it is horizontal (when the level's bubble is centered). The actual height does not matter, as long as the line is level.

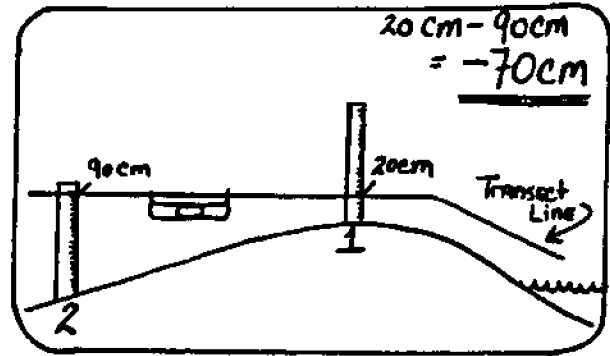
Keep the sticks vertical with the zero end touching the ground. If you need to push the sticks into the ground, make sure an equal portion of both is showing.

3. On each meter stick, read the height of the string. Subtract the reading of the meter stick furthest from the starting point

(stick #2) from the meter stick closest to the starting point (stick #1). This results in positive numbers for inclines and negative numbers for declines. See examples below. Record the difference in elevation in cm. in Col. 1 - "Elevation Changes". Don't forget the + or - sign!



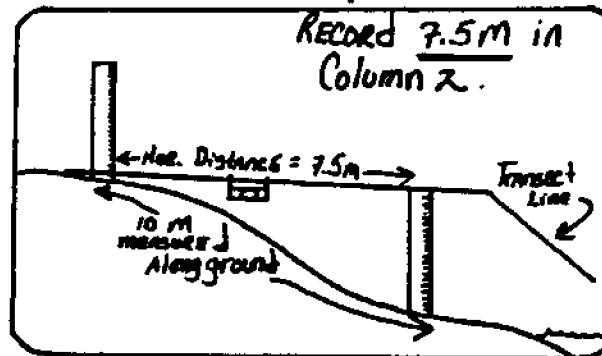
EX.1 Incline



EX.2 Decline

4. With the transect line still stretched between the two meter sticks, estimate in meters the horizontal distance. This may be different than 10 meters, especially if the ground is steep. See example #3. Record this distance in Col. 2 - "Horizontal Distance".

Don't worry about cumulative calculations yet. These can be filled out after the field study.



EX.3 Horizontal Distance

5. Record in Col. 5, "Comments", any special observations - strand line, start of plant life, wet sand, animal tracks, etc.
6. Move the starting point meter stick (stick #1) up to the position of the next meter stick (stick #2). Lower the transect line to the ground and move this second meter stick 10 meters along the line. Ten meters is only a recommended interval. Increase the distance for a long, unchanging beach. Shorten it to include any special features. Your teacher may help you decide on these intervals.
7. Repeat procedures for measuring elevation and horizontal distance changes until you reach the benchmark end-point.

After the field study, transect information will be used to calculate cumulative measurements and to graph a profile of the beach.

BEACH PROFILE DATA SHEET  
Student Activity Sheet

Measured from mark to mark		Cumulative from starting point to mark		Comments
Elevation Change (cm)	Horizontal Distance (meters)	Elevation Change - cm	Horizontal Distance -m	
1	2	3	4	
0	0	0	0	<sup>5</sup> STARTING POINT

Beach Community Study  
Student Activity Guide

Introduction

In this activity you will work in groups of 4-5 students to describe plant and animal community changes moving along an environmental gradient from the backdune area to the water's edge.

Objectives

1. Identify common plants and animals.
2. Describe assemblages or "communities" of plants and animals.
3. Infer what factors may have caused the observed changes in community structures.

Equipment (for each group)


quadrat ( $\frac{1}{4}m^2$ )  
data sheet - "Beach Community Description"  
clipboard and pencil  
transect line marked off in meters (optional)  
seine  
bucket  
sieve box  
shovels

Procedure

Your group will begin its study at a designated spot near the high tide mark. This is sample site or quadrat 1 on your data sheet. Once at this site you should:

1. Lay the quadrat down randomly.
2. Identify and count individuals of each animal species found.
3. Describe any animal signs.
4. Estimate total % coverage of all plant species.
5. Identify and count individuals of each plant species found.
6. Describe the sediment. Include in your description the moisture, texture, and color.
7. Include any other observations.
8. When you have completely described quadrat #1, your instructor will direct you to the next site moving towards the dunes. Repeat the procedures listed above for each site.
9. As an optional stop (Study Site 0), return to the water's edge to describe the intertidal and subtidal community. To best sample here, dig and screen for organisms. Use a seine if available.

BEACH COMMUNITY DESCRIPTION  
Student Activity Guide



Quadrat#	1	2	3	4	5	6	OPTIONAL STOP 0
Location (m from water's edge)							
ANIMALS:							
mole crabs							
coquina clams							
polychaetes							
amphipods							
ghost crabs							
ant lions							
ants							
other							
er							
other							
other							
Animal Signs							
PLANTS:							
Total % Cover							
sea oats							
sea rocket							
pennywort							
beach bean							
beach elder							
sandspur							
aster							
other							
other							
other							
er							
SEDIMENT:							

GRADE LEVELS: 5-12  
CONTENT & SKILLS: science, writing,  
social studies  
SOURCE: USFWS, Freshwater Marsh  
Habitat Pac

## FRESHWATER MARSH - MARSH SETTLERS

### Purpose

In this activity students will take a field trip to investigate a freshwater marsh from the point of view of pioneers settling the area. Students will learn about food webs and their place in them. They will evaluate the marsh as a source of food and shelter.

### Learning Outcomes

After completing this activity, the students will be able to:

- A. Identify the values of the marsh to humans.
- B. List two reasons why settlers might not want to live near a marsh.
- C. Draw a food web containing at least five elements of which the student is one.
- D. Name two marsh plants that pioneers might have used for food.

### Organization

Who: Groups of 5 to 6

Where: freshwater marsh

When: Spring, summer, or fall

Time: 1 to 2 hours

- Safety:
- A. This activity takes place near open water. Where the water is deep, identify the nonswimmers; organize the class in a buddy system for water safety. There should be at least one adult for every 10 students.
  - B. Wild food plants: Students must not eat any plants they find as potential wild food sources.

### Materials: For the Group

- Guides to edible wild plants
- Freshwater marsh field guides
- Insect repellent

### Materials: For Each Student

- Student Data Sheets and pencil
- Clipboard (Masonite or stiff cardboard with a paper clip or binder clip)



## Directions

1. Introduce the concept of the food web. Discuss different animals and what they eat. Stress the role of plants as the primary producers.

Give examples of marsh plants as food (Consult a food guide, see references). Name some common ones that the students are very likely to see in the marsh.

### Examples:

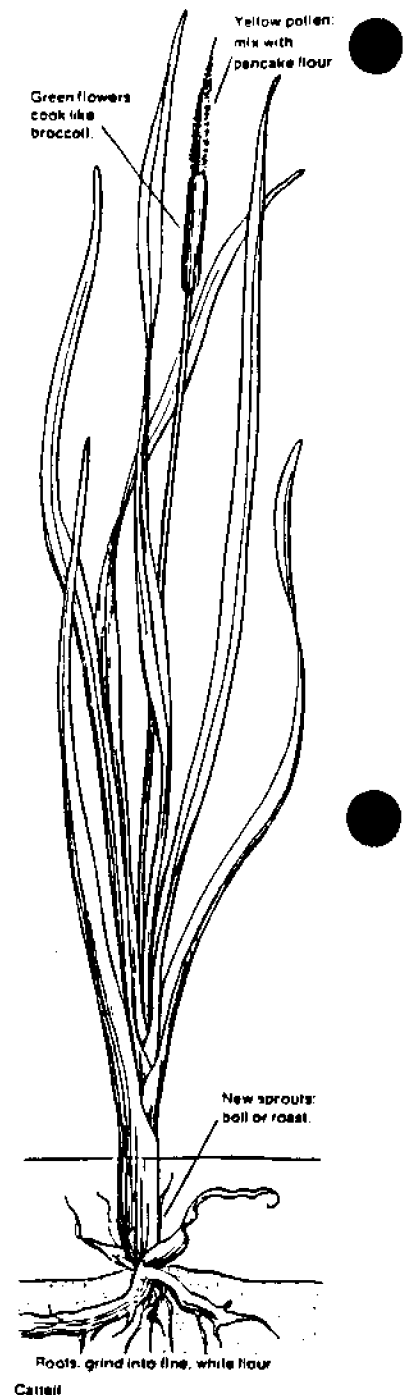
**Cattails** - muskrats eat leaves, stems, and roots and use them for building their lodges; humans eat the stems and flowers.

**Arrowheads** - ducks and humans eat the tubers.

**Bulrushes** - ducks eat the seeds; humans and muskrats eat the roots.

2. Distribute student materials and caution the students to be careful around the marsh, especially near open water. (Review safety procedures.)
3. At the site, the students are to imagine they are pioneers who have chosen to settle near a marsh because of the food and other resources available there. They will evaluate places to build cabins and find food sources.
4. Assign each group a "cabin site" to evaluate, using the student data sheets. Try to choose sites that are different (e.g. one in a low spot; one in the nearby woods; one on a point of land).
5. After evaluating their cabin sites, students should look for things the pioneers might have eaten and list them on their data sheets. If they can't decide whether something is edible, ask them how they think the pioneers would have found out (eat some; ask the Indians; compare it with similar plants they used in their home countries). You might take on the role of an advising Indian by using the food guide. After the students record what pioneers would eat, they should also record how these plants and animals get their food.

**Caution:** Students must be warned not to eat any plants they find on their field trip.



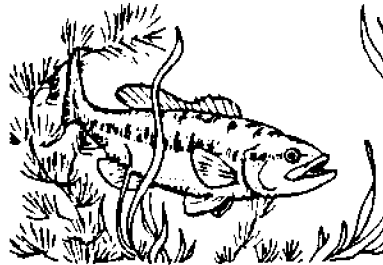
6. Gather students together. Each group should discuss the pros and cons of their various building sites and tell what they found to eat. As they were sampling for food in the marsh, the students probably noticed other creatures (namely insect) trying to eat them. The insects have been annoying to the students, but they are important in the marsh food web. How many of the animals the students found depend on insects for food? (Many - including some species of fish, frogs, turtles, birds, and other species)



Great Blue Heron



Leopard Frog



Largemouth Bass

#### Follow-up

Students used insect repellent to avoid insect bites. What could early settlers (and other animals) do to avoid insects? (Stay in breezy places; go into the water; use "natural" insect repellents, e.g. pennyroyal mint.)

## Marsh Settlers

### References

1. Gibbons, Euell. Stalking the Wild Asparagus. N.Y.: McKay Co. Inc., 1962. (food guide)
2. Medsger, Oliver P. Edible Wild Plants. N.Y.: MacMillian Co., 1962. (food guide)
3. Reid, George, K. Pond Life. N.Y.: Golden Press, 1967.
4. Ursin, Michael, J. Life In and Around Freshwater Marshes. N.Y.: Thomas Y. Crowell Co., 1973. (field guide)

### Quiz Answers

1. 1 - c; 2 - d; 3 - b; 4 - a.
2. Possible answers:
  - Biting insects
  - Keeping farm animals out of the marsh.
  - Biting insects
3. Some ways of finding edible things are better than others; in the marsh there are several possibilities.  
The pioneers could have:
  - Asked the natives (Indians)
  - Checked a book (not available to the very first explorers, but plants were recorded very early)
  - Found out by trial-and-error (sometimes the errors had dire results)
  - Watched what animals ate (not always an accurate indicator for humans)
  - Searched for things that looked similar to what they ate in their native countries before they came to America.
4. Any marsh plant or animal is a valid element of the web. If a student has connected things in a way that seems unlikely, check your field guide.

1. Draw lines to match the things found in the marsh (Column A) with their values to people (Column B).

- |                 |                 |
|-----------------|-----------------|
| <b>A.</b>       | <b>B.</b>       |
| 1. Fish         | a. Baskets      |
| 2. Marsh creeks | b. Furs         |
| 3. Beavers      | c. Food         |
| 4. Reeds        | d. Water supply |

4. Draw a food web with at least five animals or plants. Include yourself as one of the animals. You can use either pictures or names. Be sure to draw arrows to show who eats whom.

2. Pioneers lived near marshes for many reasons. What are two problems they had to deal with when settling there?

a. \_\_\_\_\_  
\_\_\_\_\_

b. \_\_\_\_\_  
\_\_\_\_\_

3. If you were a pioneer settling in a new area, how would you find out what to eat? Can you list two ways?

a. \_\_\_\_\_  
\_\_\_\_\_

b. \_\_\_\_\_  
\_\_\_\_\_

Name or describe 7 things in the marsh that pioneers might have eaten. Can you find these things in this area? Are there many or only a few of each? How do these things get their food?

Something a Pioneer would eat:	Are there many or few?	How does it get its food?
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Cabin Site #

Yes

No

Name:

1. Is the soil firm?

2. Will the site flood in the spring? (What if a beaver builds a dam in the creek nearby?)

3. Will your farm animals wander onto soft ground and become trapped in mud?

4. Are there building materials nearby?

5. Is there transportation nearby? (A creek, maybe.)

6. Is water easily available and safe to drink? (Remember you have to carry it in buckets.)

7. Can you get food easily?

8. Will bugs be a problem? (Will there be a lot of them around? More than in other places? Will you have a breeze to keep them away?)

9. Will winter winds be too cold?

10. Would you build your cabin here?

GRADE LEVELS: 5-12  
CONTENT & SKILLS: science  
SOURCE: USFWS, Freshwater Marsh  
Habitat Pack

## FRESHWATER MARSH - MARSH SUCCESSION

### Purpose

This activity helps students become familiar with some of the organisms that live in the marsh and with the gradual succession of marshes into dry land.

### Learning Outcomes

After completing this activity, the students will be able to:

- A. Arrange several pictures or descriptions of different stages of marsh succession in the correct time sequence.
- B. Indicate on an attitude scale how they feel about management of marshes.
- C. Construct a transect sample of a habitat.

### Organization

Who: Groups of 3 or 4

Where: Freshwater marsh

When: Any season - spring is preferred

Time: 1 to 2 hours

Safety: This activity takes place near open water: Caution students not to go far into open water; add snake warning if appropriate for your area.

### Materials: For Each Group

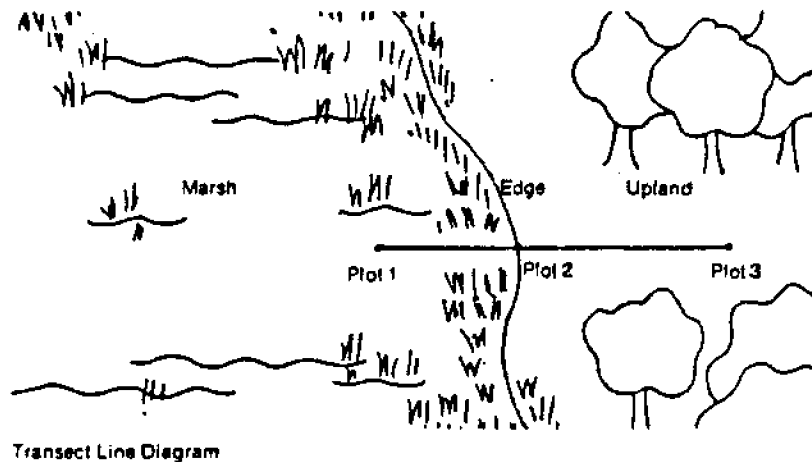
- Pond guide (1 per group, if possible)
- Insect repellent
- String, 7 meters (20 feet)
- Scraper (cup)
- White pan or tray
- Magnifying glass or hand lens (optional)

### Materials: For Each Student

- Student Data Sheet
- Pencil
- Clipboard (Masonite or stiff cardboard with a paper clip or binder clip)

## Directions

1. In the classroom, introduce the concept of succession.
2. For the field trip, make sure students dress properly. They will get their feet wet, so they should wear boots or change into old sneakers that can get muddy. Form students into groups and distribute all materials to each group.
3. At the marsh, go over safety precautions.
4. Instruct each group of students to establish a transect line at the edge of the marsh, using the 7-meter (20-ft) string. One end of the string should be staked 1 to 2 meters (3-6 ft) inside the marsh depending on water depth. The other end should be staked on dry land. The line should be at right angles (90°) to the marsh edge, as shown in the diagram.
5. Three sample plots of clipboard size should be taken along this line: plot #1 - 1 to 2 m (3-6 ft) inside marsh; plot #2 - at marsh border; plot #3 - at the upland end of the line. The plots need not be equidistant.
6. Students should define the area of their sample plots by holding their clipboards over the ground or water next to the appropriate points on the line and marking the corners with sticks.



7. Students should then look for all the different kinds of organisms - both plants and animals - they can find within the plot. Be sure they check plant leaves and look under rocks. Along one edge they should collect 2 to 3 cm (about 1 in) of soil, spread it in the tray, and check carefully for living things. On the Data Sheets, students should identify the organisms - describe, name (using the pond guide), or draw them - and record the numbers of each and where found (e.g. on a leaf, under the soil).



After they look for organisms in the soil, the students should examine the soil itself. What is its texture - fine or coarse? Is it wet or dry? What does it seem to be made of? Allow 20 to 30 minutes for each of three plots.

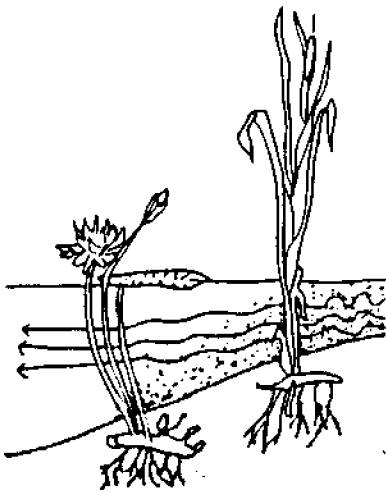
8. After the students complete each sample, they should replace all rocks and logs before going to their next plot. Through discussion, point out that the habitat should be returned as nearly as possible to its natural state so that the organisms living there may survive.
9. Gather the students together to discuss their findings. What kinds of organisms did they find in each plot? Were the organisms very similar? How were their habitats different? What signs were there that succession is actually occurring?

Discuss differences in soil among the plots. The soft soil being accumulated among the waterlilies, cattails, rushes, or sedges is the buildup of dead plant material and soil washed in from the surrounding area. What will happen as this buildup continues? How do marshes change with time? (In some cases, the buildup of soil and plant material will slowly fill the marsh.)

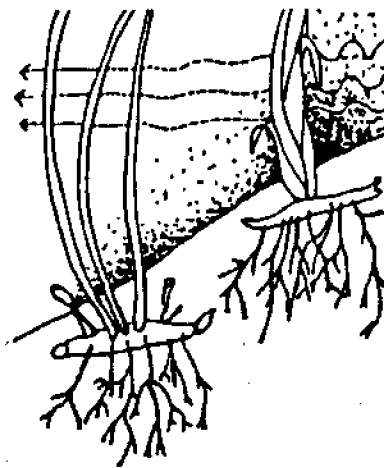
#### Followup

Now that the students have seen the natural process of change in a marsh, discuss some of the changes that can be induced by human activities and management. What would happen if development in the surrounding areas increased the amount of soil being washed into the marsh? (Increased sedimentation would cause the marsh to fill faster.) What would happen if the water level were raised? (Some plants would die and the marsh would be opened up.) Discuss how such changes affect wildlife in the marsh. (Higher water levels might open up the marsh and provide better habitat for waterfowl. However, the loss of vegetation might reduce muskrat populations since they would have less food.)

#### Soil-building Process in the Marsh



a. Water carrying eroded soil is slowed as it flows through heavily rooted bases of cattails and waterlilies.



b. Soil settles out around plant roots.



c. Dead plant material falling into the water also builds soil.

## Marsh Succession

### References

1. Klots, Elsie, B. The New Field Book of Freshwater Life. N.Y.: GP Putnam's Sons, 1966.
2. Marshall, Alexandra. Still Waters. N.Y.: William Morrow & Co., Inc., 1978.
3. Niering, William, J. The Life of the Marsh. N.Y.: McGraw Hill, 1966.
4. Our Nation's Wetlands. Council on Environmental Quality. Washington, D.C.: Government Printing Office, 1978.
5. Reid, George, K. Pond Life. N.Y.: Golden Press, 1967.
6. Ursin, Michael, J. Life In and Around Freshwater Marshes. N.Y.: Thomas Y. Crowell Co., 1975.

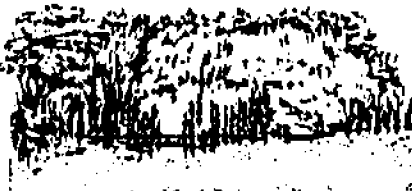
### Films

1. Cry of the Marsh. N.Y.: A.C.I. Films, 1969
2. The Everglades. Washington, D.C.: National Geographic Filmstrip, 1972.
3. One Day at Teton Marsh. Burbank, California: Walt Disney Productions, 1966.

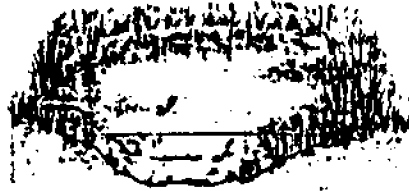
### Quiz Answers

1. The correct sequence is: B - C - A. Usually, as a marsh grows older, it fills in and becomes drier. There is progressively more emerging vegetation and less open water.
2. The students' drawings should be similar to the one in the lesson plan. The transect line should cut through the different habitat zones. One sample plot should be drawn in each zone. In this way the sampling will show different types of habitats and of marsh organisms.
3. There is no correct answer for this question. Student answers can be used to develop a class discussion on the values of marshes. How are marshes manipulated (managed)? What are some values and/or problems associated with that manipulation?
4. Upland habitat: A - tree (red oak); F - earthworm.  
Marsh habitat: B - cattail; C - turtle (Western painted turtle);  
D - bullfrog; E - muskrat

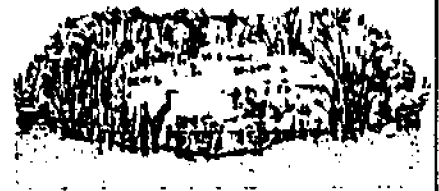
1. These pictures show a marsh growing older in three stages.



a.



b.



c.

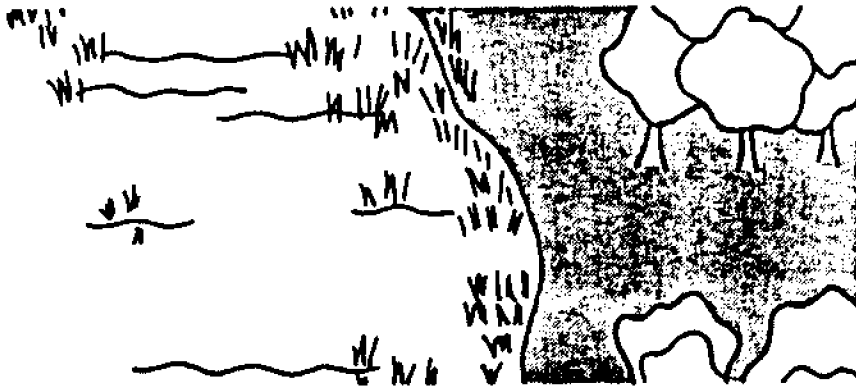
Which one would you see first? \_\_\_\_\_

Which one would you see next? \_\_\_\_\_

Which one would you see last? \_\_\_\_\_

2. How would you take a transect sample of this area?

Draw in your sampling line.



3. Do you think that marshes should be left alone for natural succession? Or, do you think that people should control succession in marshes?

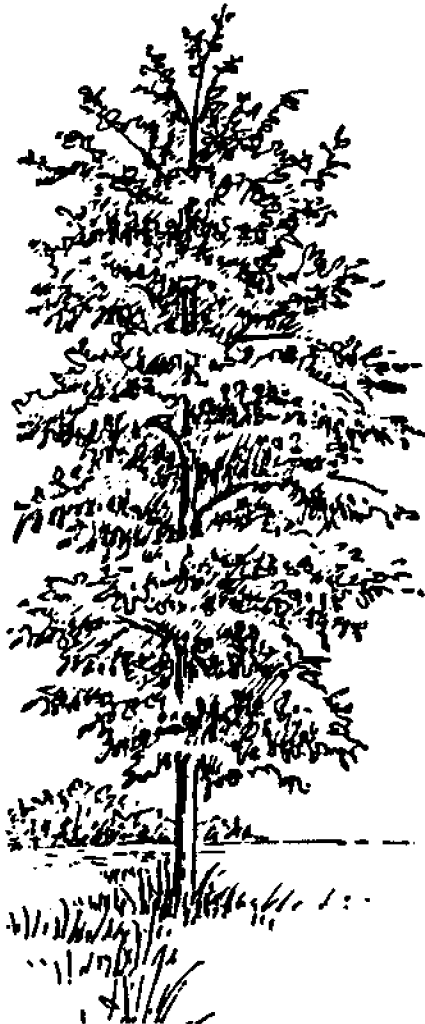
Put an X in the box that shows how you feel.

All marshes should be left alone.	Succession should be controlled only in marshes that are affected by people's actions (increased erosion or fertilizer).	Succession should be controlled in marshes wherever this control might increase wild-life populations.	Succession should be controlled in marshes wherever possible.

4. These pictures A, B, C, D, E, and F are of plants and animals found in or near a marsh.

Which ones would you expect to find in the marsh habitat?  
Which ones would you expect to find in the upland habitat?

Write MARSH or UPLAND under each picture.



A



B



C



D



E



F

Plot 1 Marsh	Soil (color, moisture, texture)		Organism (Plant or animal)	Number Found	Where Found	Plot 2 Edge	Soil (color, moisture, texture)		Organism (Plant or animal)	Number Found	Where Found	Plot 3 Upland	Soil (color, moisture, texture)		Organism (Plant or animal)	Number Found	Where Found	
	Organism (Plant or animal)	Number Found					Where Found	Organism (Plant or animal)					Number Found	Where Found				Organism (Plant or animal)

Name:

GRADE LEVELS: 5-12  
CONTENT & SKILLS: science, math,  
writing  
SOURCE: Bellefield Nature Center

## SALT MARSH FIELD STUDY

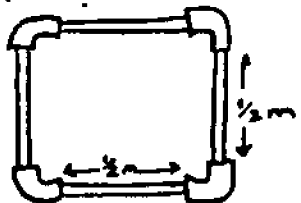
### Teacher's Guide

#### Introduction

A well-planned visit to a salt marsh can be a very worthwhile experience for you and your students. Some suggestions are made in this section to help you plan an effective study. Also enclosed with this packet are student activity sheets (color-coded in blue) which can be copied for your students.

#### Teacher Preparation

It is best to schedule a salt marsh study at or near low tide. The marsh surface is exposed at low tide and plants and animals can be readily observed. Time of year is also important. Fall and spring are excellent periods for salt marsh studies. Enclosed is the student activity sheet, "Salt Marsh Communities". Listed are the objectives and the equipment needed for the study. Most of the equipment is readily available. However, you may have to make some quadrats ( $\frac{1}{4}m^2$ ). These can be easily made from flat pieces of wood or pvc pipe. Each side should be  $\frac{1}{2}m$  in length (see picture below). The community study lasts approximately 2 hours.



Quadrat

#### Student Preparation

Before your visit, prepare the students for the study by letting them know:

1. Where they are going - It is recommended that you visit and select an appropriate area for your study. Some considerations are access, safety and whether the site is a typical salt marsh. Describe the site and its location to your students.
2. What they will be doing - Describe the kinds of activities they will be doing at the site. You may want to review the student activity sheet and objectives.
3. What they should wear and bring - Salt marshes are both wet and muddy. Insects are also abundant at times during the year. It is important that students and adult leaders be properly dressed and equipped so that they can participate in the field experience. Recommended clothes and supplies are:

- old clothes (long pants, preferably)
- old sneakers or rubber boots (& change of shoes for a long ride back)
- rain gear, if rain is likely
- insect repellent
- sun screen & hats, if sun-sensitive
- worksheets and pencils

Also, provide your students with some background information on salt marshes. Some recommended preparation activities are:

1. Review the vocabulary words included with this packet.
2. Copy and hand out the study questions. Tell your students that they should be able to answer these after they complete the study.
3. Discuss the nature and importance of salt marshes.

#### At the Study Site

1. Divide the class into work groups of 4-5 students and distribute equipment.
2. Review the data sheet and answer any questions.
3. Once everyone is clear about what they are to do, assign each group a site to begin their study (Quadrat 1 along marsh-creek edge).
4. After each group has completely analyzed site 1, have them measure a distance in a straight line toward the upland edge of the marsh. The next stop is Quadrat 2 on the data sheet.
5. Continue these procedures until everyone has analyzed the last sample site. You will want to visit each group to make sure they are following the procedures correctly and to help identify and point out the plants and animals.
6. Once everyone has finished, regroup and discuss the data and organisms observed. Possible discussion questions include:
  - Where was the cordgrass tallest, shortest? Why?
  - What plant was the most abundant?
  - Which quadrat had the most different types of plants? Why?
  - What animals did you observe and where?
  - What do you think these animals eat?
  - What eats them?
7. Gather up all live organisms collected and return to their habitats in the marsh.
8. If time, equipment and site permits, it is always fun and educational to sample the creek with a seine net. If you decide to include this in your study, make sure you have a legal net or a collecting permit from the South Carolina Wildlife and Marine Resources Department. Also, make sure the water is not too deep and it is safe from razor-sharp oysters.



### After the Field Study

In order to maximize the benefits of the field experience, it is recommended that you follow the study with activities back in the classroom. Several suggestions are made below that should enhance the learning experience for your students:

1. Use the data collected during the study to reconstruct a map of the marsh.
2. Have the students complete the study questions and discuss the answers.
3. Reconstruct a salt marsh food web using all of the organisms seen during the study. This can be done individually or as a group. A fun way to demonstrate the food web concept is to have the students represent the plants and animals and use string to connect them to what they eat. Once the food web is constructed, discuss what would happen if certain members were killed by pollution.
4. Have students research marsh organisms of their choice and prepare a report.
5. Set up a salt water aquarium to stimulate further interest. An aquarium can be an excellent starting point for activities from all subject areas.
6. Compare the salt marsh to other ecosystems: a freshwater pond, brackish marsh, or an area around your local school.
7. Research and discuss local, state and federal regulations concerning wetlands.
8. Develop a simulation game for a proposed salt marsh development such as a condominium/marina complex. Divide the class into 2-3 special interest groups (developers, fishermen, landowners, etc.) and have them support or reject the proposal. They must be prepared to defend their decision and respond to questions from other groups. Possibly a separate judging party could decide the issue.

## References

1. Gosner, Kenneth L. A Field Guide to the Atlantic Seashore from the Bay of Fundy to Cape Hatteras. Boston: Houghton Mifflin Co., 1978.
  
2. Gosselink, James. Tidal Marshes - The Boundary Between Land and Ocean. Washington: U.S. Fish and Wildlife Service, Publication No: FWS/OBS-80/15, July 1980.  
For more information contact:  
Information Transfer Specialist  
National Coastal Ecosystems Team  
U.S. Fish and Wildlife Service  
NASA - Slidell Computer Complex  
1010 Gause Blvd.  
Slidell, LA 70458
  
3. Spitsbergen, Judith. Seacoast Life: An Ecological Guide to Natural Seashore Communities in North Carolina. Raleigh, NC: NC State Museum of Natural History, 1980.
  
4. Teal, John and Mildred. Life and Death of the Salt Marsh. New York, NY: Ballantine Books, 1969.

## SALT MARSH STUDY VOCABULARY LIST

Estuary - A semi-enclosed body of water which is connected to the sea. It is an area where freshwater from land drainage mixes with sea water from the ocean. Examples: Delaware Bay, Chesapeake Bay, Winyah Bay in SC

Salt Marsh - The wetlands in an estuary typically covered by salt-tolerant plants.

Ecology - The study of the relationships between organisms and their environment.

Food Chain - The transfer of food energy from one organism to another. All food chains begin with organisms that can manufacture their own food (producers). Plants are producers and use the energy from the sun to make their own food. Organisms that cannot make their own food and rely on other organisms for food are known as consumers.

Food Web - Several interacting food chains. Feeding relationships in nature tend to be complex and organisms typically feed on a variety of food sources. Hence, when all food relationships are linked in a diagram, it looks like a web.

Detritus - Dead plant matter and associated microorganisms. Detritus is the base of the salt marsh food web.

Habitat - The place where an organism lives.

Tides - The regular rising and falling of coastal waters in response to the gravitational pull of the moon and sun. In South Carolina the tides are known as semi-diurnal which means we experience 2 high tides and 2 low tides over a 24 hour cycle.

Salinity - The amount of dissolved salts in water. It is commonly expressed in parts per thousand (o/oo) - Ocean water is approximately 35 o/oo or 35 parts salt to 1,000 parts water.

Community - All the interacting plant and animal populations in a common area.

Succession - Changes in community structure over time in response to changing environmental factors.

Ecosystem - All the living and non-living things interacting in a defined area.

## Salt Marsh Communities - Student Activity Sheet

### Introduction

In this activity you will work in a group of 4-5 people and study and record information on marsh plants and animals. Each group will receive the equipment listed below. Your instructor will tell you where you should begin the study.

### Objectives

During this activity you will:

1. Identify common plants and animals in a marsh
2. Describe assemblages or "communities" of marsh plants and animals
3. Infer what factors might cause the observed changes in community structure.

### Equipment (For each group)

quadrat ( $\frac{1}{4}$  m<sup>2</sup>)  
meter stick  
sample jar  
clipboard & pencil  
data sheet

### Procedures

Your group will begin its study at a designated spot along the edge of the marsh creek. This is sample site or quadrat 1 on your data sheet. Once at this site you should:

1. Lay the quadrat down randomly.
2. Identify and count all plants and record the information under column 1 on your data sheet.
3. Identify and count all animals and record the information. If no crabs can be seen on the marsh surface, count fiddler crab burrows and record these.
4. Measure the height of the cordgrass.
5. Describe the soil (texture, moisture content, color, odor, etc.)
6. Place a representative of each of the live animals you observe in your jar. Please do not pick any plants and remember, we only need one sample of each type of animal.

When you have completely described quadrat 1, your instructor will direct you to the next site. Repeat the procedures listed above for each site. When everyone is finished, we will share our results, discuss the live animals and return them to the marsh.

SALT MARSH COMMUNITIES

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Place: \_\_\_\_\_

QUADRATS

	1	2	3	4	5
	Distance from Water's edge: 0 M.	Distance: _____	Distance: _____	Distance: _____	Distance: _____
	Ht: _____	Ht: _____	Ht: _____	Ht: _____	Ht: _____
<u>PLANTS</u>					
<u>Cordgrass</u>					
<u>Seaweed</u>					
<u>Pickle Plant</u>					
<u>Sea Oxeye</u>					
<u>Needle Rush</u>					
<u>Marsh Elder</u>					
<u>Groundsel Bush</u>					
<u>Other(s)</u>					

ANIMALS

<u>Fiddler Crabs</u>					
<u>Square-back Crabs</u>					
<u>Ribbed Mussels</u>					
<u>Periwinkles</u>					
<u>Salt Marsh Snails</u>					
<u>Amphipods</u>					
<u>Other(s)</u>					
<u>SEDIMENT DESCRIPTION</u>					

## SALT MARSH STUDY QUESTIONS

Name: \_\_\_\_\_

1. Describe an estuary.
2. List three plants that live in salt marshes.
3. List five animals that live in salt marshes.
4. Which quadrat in your study had the greatest diversity of plants? Explain what might have caused this.
5. What is a community?
6. Describe the different marsh communities that you saw.
7. What do you think may have caused these community changes?
8. What is detritus and why is it important?
9. List 3 reasons why salt marshes are important.
10. List 3 salt marsh animals that people like to eat.
11. Do you think salt marshes should be protected? Why or why not?
12. Are salt marshes protected in South Carolina? If yes, how?
13. List three ways people use salt marshes.

GRADE LEVELS: 7-12  
CONTENT & SKILLS: science, math,  
reading, writing  
SOURCE: Project CAPE, Marine  
Organisms in the Classroom

## BRINE SHRIMP CAPERS

### LESSON CONCEPT

Brine shrimp are useful in studying characteristics of living organisms.

### COMPETENCY GOALS

1. The learner will demonstrate the ability to experiment.
2. The learner will demonstrate the ability to control variables.
3. The learner will demonstrate the ability to interpret data.

### OBJECTIVES

1. The learner will design and carry out investigations of the responses in the brine shrimp using appropriate materials.
2. The learner will record observed information and make inferences about the results of the investigations.

### MATERIALS

For Preparation: containers for hatching brine shrimp: wide-mouth jars,  
small all-glass aquaria, glass baking dishes  
distilled or aged tap water  
non-iodized salt  
balance

For Student Activities: (per team)

- |  |                       |                      |
|--|-----------------------|----------------------|
| A. coverslip   | microscope            | B. glass baking dish |
| cotton   | slide                 | flashlight           |
| C. salt solutions: 0%, 5%, 10%, 20%, 30%, 40%, and 50% |                       |                      |
| vials  |                       |                      |
| pipette  |                       |                      |
| syracuse dish  |                       |                      |
| D. vials   | E. Food: algae water, |                      |
| pipette  | yeast and/or whole    |                      |
| syracuse dish  | wheat flour           |                      |
| 3 temperature locations                                | holding tanks for the |                      |
|  | brine shrimp          |                      |

## VOCABULARY

crustacean

phototaxis

optimum

## BACKGROUND INFORMATION

The brine shrimp (*Artemia salina*) is a tiny crustacean found in salt lakes and provides an excellent food source for filter feeders and small carnivores in a marine aquarium. Brine shrimp may be purchased from pet shops, tropical fish stores and from biological supply companies.

To hatch the eggs, make a 10% solution of non-iodized salt water by adding 100 grams of non-iodized salt to 1000 ml of distilled or aged tap water. Aged tap water is prepared by leaving tap water uncovered for three days to allow the gaseous chlorine to escape.

Place the water in one or more wide mouth jars or containers with an air stone connected to an air pump. (See Temporary Holding Tanks in the introduction of this unit.) If an air pump is unavailable hatch the eggs in shallow glass baking dishes or large culture bowls to give a large surface to volume ratio.

Sprinkle about one-fourth teaspoon of eggs over the surface of the water in each container. At classroom temperatures the brine shrimp eggs should hatch in two days.

Use the hatched brine shrimp to feed filter feeders and small carnivores in your classroom marine aquarium. The brine shrimp can be removed from their containers with a long pipette or with a poultry baster and placed near the organisms in the aquarium.

## TEACHER PREPARATION

Collect and age tap water in plastic buckets in advance of this lesson. Order the brine shrimp eggs for hatching. Prepare the series of salt water solutions for the population counts: 0%, 5%, 10%, 20%, 30%, 40%, and 50% by adding 0, 10, 20, 30, 40, and 50 grams of non-iodized salt to 100 ml of distilled or aged tap water for each respective concentration. Prepare copies of supplementary sheet 2.1.

## STUDENT PREPARATION

Ask students to bring flashlight from home.

## ACTIVITIES

### A. Microscopic Examination

1. Place a few strands of cotton fibers on a clean glass slide. Place a drop of water containing several brine shrimp on the slide and add a coverslip.
2. Examine the slide under the low power magnification. Try to locate a brine shrimp that is trapped in a cell formed by the cotton fibers.



3. Focus on an individual brine shrimp with the high power magnification and sketch it. Compare the anatomy of a brine shrimp with a crayfish and a shrimp.
- B. Response To Light
1. Place brine shrimp and some water from their container into a shallow glass baking dish. Shine a flashlight over one end of the dish. Observe how the brine shrimp respond to the light.
  2. Look up the terms photo - and - taxis. What is meant by phototaxis? Distinguish between positive and negative phototaxis.
- C. The Effect Of Salinity On Hatching
1. Your teacher has prepared the following salt water concentrations: 0%, 5%, 10%, 20%, 30%, 40%, and 50%. Obtain seven vials and label them with the salt concentrations. Count and place 50 eggs in each vial. Place the vials in an area where they will not be disturbed for two days.
  2. Swirl and pour the contents of each vial into a separate syracuse dish. Count the number of hatched brine shrimp for each salt concentration and record the data in the Hatching Data Sheet, 2.1.
  3. Prepare a histogram showing the percentage of eggs hatched in each salt concentration by plotting the data on the graph.
- D. Response To Temperature
1. Choose the optimum salt concentration for hatching and then conduct a study on the effect of temperature on hatching.
  2. Use a similar method that was used in Activity C but keep the salinity constant and vary the temperature.
  3. Try locating the vials in an incubator, at room temperature and in the vegetable bin of the refrigerator. Place a thermometer with the vials to determine the temperature of each location.
- E. Culturing Brine Shrimp
1. Try to keep the brine shrimp cultures alive by feeding. Brine shrimp will eat single celled algae, yeast and whole wheat flour.
  2. Green algae water may be pipetted into their container. If yeast or flour is used, make a suspension by adding one-fourth teaspoon of yeast or flour to 100 ml of culture water. Pour the suspension into the brine shrimp container. As the water clears, more food can be added.
  3. Once a week remove any sediment by pipetting it from the bottom of the culture container.
  4. Mark the water level so that any water lost by evaporation may be replaced. Add only distilled or aged tap water.

OBSERVATIONS AND QUESTIONS

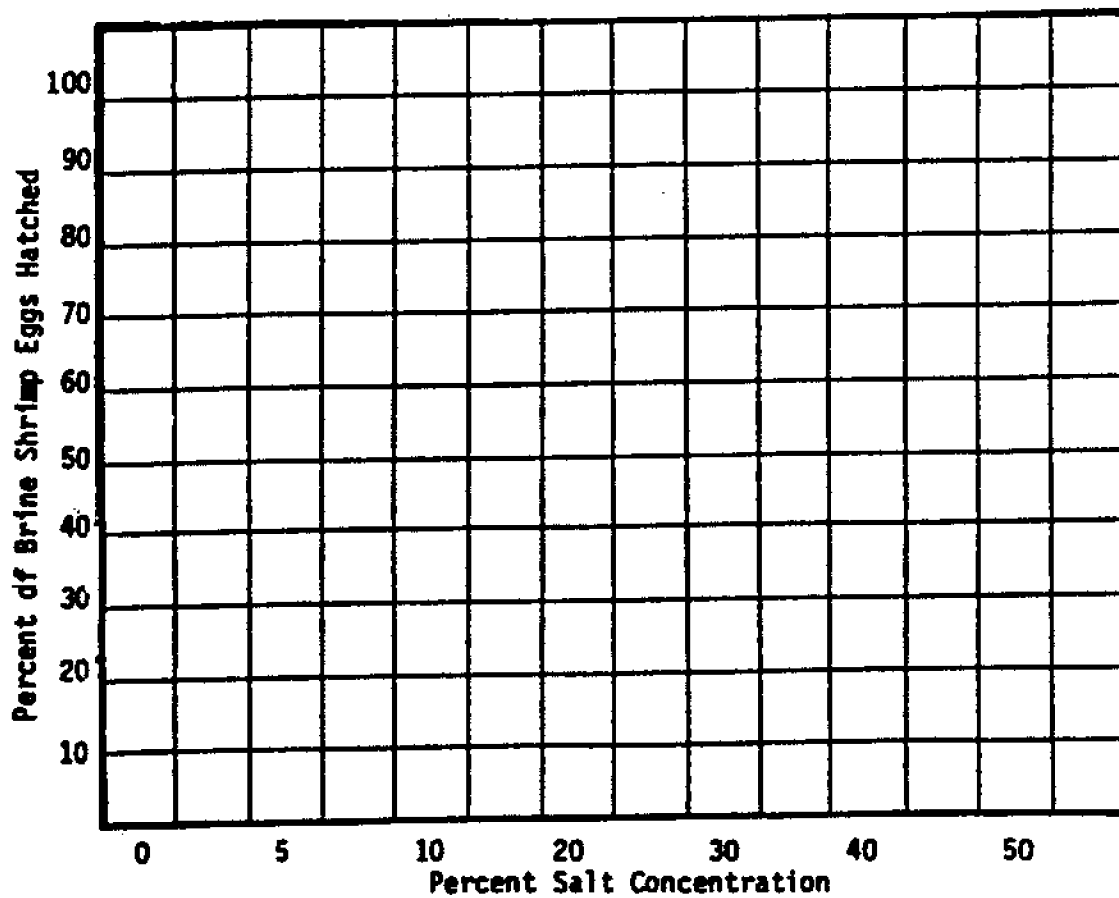
1. Sketch a drawing of a brine shrimp.
2. What anatomical features can you see?
3. What characteristics of brine shrimp relate it to other crustaceans?
4. Define phototaxis.
5. Are brine shrimp positive or negative phototactic?
6. Which concentration of salt gave the highest rate of hatching? Look up the definition for the term optimum.
7. Under which temperature conditions did the brine shrimp eggs yield the highest hatching rate? The lowest?
8. Describe an experiment to find a suitable culture method for brine shrimp.

## HATCHING DATA SHEET

The Effect of Salinity on Brine Shrimp Hatching

<i>Salt Concentration</i>	0%	5%	10%	20%	30%	40%	50%
<i>Number of Eggs Hatched</i>							
<i>Percent Hatching</i>							

HISTOGRAM: The Effect of Salinity on Brine Shrimp Hatching



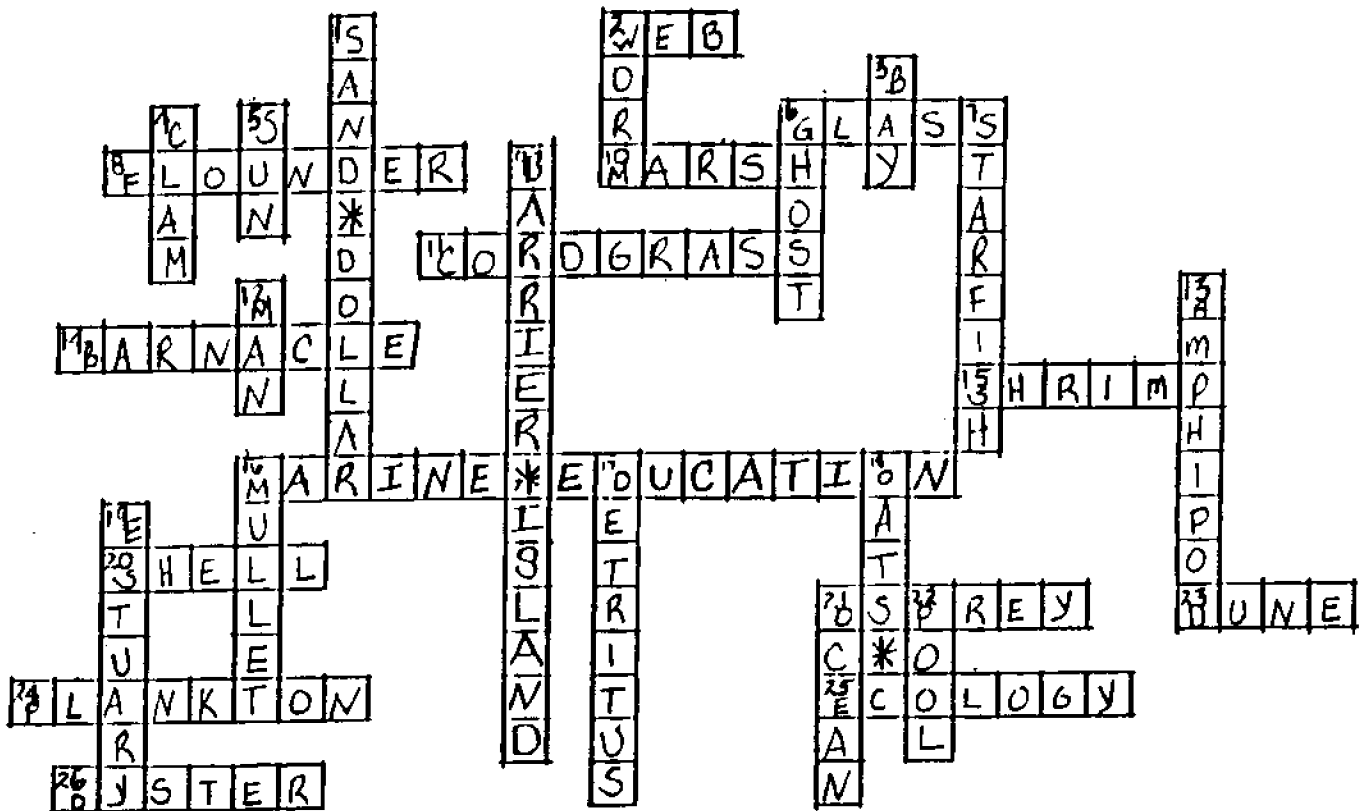
GRADE LEVELS: 2-8

CONTENT & SKILLS: science, reading,  
writing

SOURCE: original, Ben Baldy and  
J. Baxter Williamson, Jr.

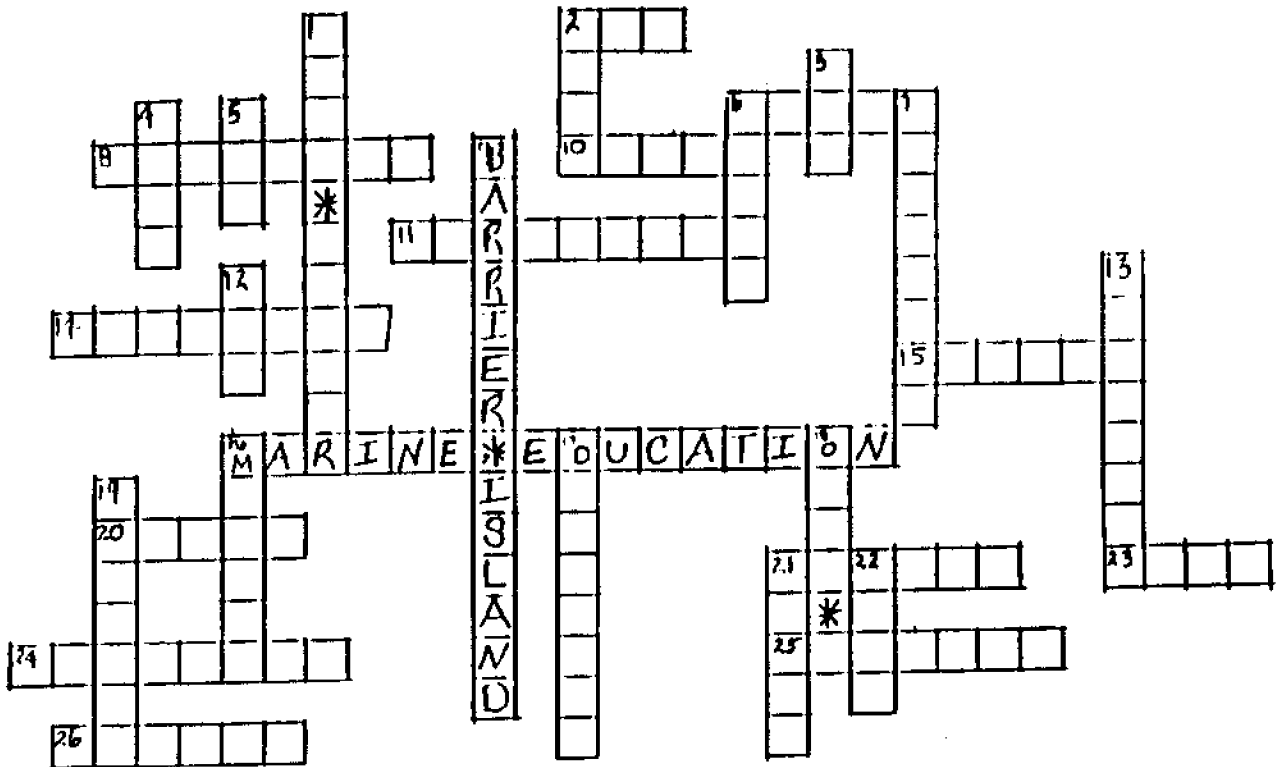
CROSSWORD PUZZLE

Answer Key



CROSSWORD PUZZLE

Name: \_\_\_\_\_



ACROSS

2. A collection of food chains, showing who eats whom.
6. \_\_\_\_\_ wort is another name for pickle plants.
8. A flat fish with two eyes on one side.
10. The salt \_\_\_\_\_ is one of the most productive ecosystems on Earth.
11. The most common plant in the salt marsh.
14. A crustacean that attaches itself to hard substances like boats and pilings.
15. A crustacean that is caught in nets; SC's #1 commercial marine crop.
16. \_\_\_\_\_ lets you realize the total effect of salt and freshwater on the environment.
20. The hard outer covering of many animals.
21. Fish hawks.
23. A beach hill caused by wind.
24. Drifting plant or animal life in the water.
25. The study of plants, animals, the environment, and their relationships.
26. A tasty bivalve; top and bottom shells are different sizes.

DOWN

1. A pancake-shaped, spiny skinned animal.
2. Polychaete \_\_\_\_\_.
3. Body of water; examples include Winyah \_\_\_\_\_ and Chesapeake \_\_\_\_\_.
4. A bivalve; examples include quahog, coquina, and cherrystone.
5. Source of energy for most food chains.
6. \_\_\_\_\_ crabs dig along dry sandy beaches.
7. Another spiny skinned animal, often with five legs.
9. A sandy strip on the oceanfront and separated from the mainland.
12. The well-being or decline of marine life is strongly influenced by this vertebrate.
13. One common name for this crustacean is sand hopper.
16. A common, silver, plankton-eating fish.
17. Decaying plant or animal matter.
18. Sea \_\_\_\_\_ are very common dune grasses.
19. Where marine and freshwater meet.
21. Covers approximately 3/4 of the Earth's surface.
22. A tidal \_\_\_\_\_ is covered at high tide and exposed at low tide.

GRADE LEVELS: 6-12  
CONTENT & SKILLS: science, writing  
SOURCE: Marine Science Project For  
Sea, Unit 6

#### TEACHER BACKGROUND - OCEAN CURRENTS

While this experiment can be done as a demonstration, it is recommended that the class be divided into small groups and that each group perform the investigations. This exercise deals with temperature and salinity currents. Emphasize that currents do exist and that they play an important and not all together understood role in the life of the oceans.

It is important that you do this experiment before your class performs it. This will give you a chance to anticipate any difficulties. Try the 3 x 5 card on the top of the flask inversion trick for yourself. It really does work. Be sure your flasks, or jars have flat lips.

Groups of 3 or 4 students allow participation by all members. Watch to see that some don't adopt a passive spectator role. Encourage careful observation and require written observations from the groups.

#### KEY - Interpretation - 1

1. Salt water is heavier. The colored salty water sank into the clear fresh water in experimental set up "a".
2. Since river water is fresh, it floats on top of the salt water until waves and currents cause the two to mix.
3. Freddy was fishing where the fresh water was standing in a layer above the salt water. Near the surface the water was the lighter river water, near the bottom the water was the more dense sea water.

#### KEY - Interpretation - 2

1. Warm water is lighter (lower density) than cool water. The warm, colored water remained in the upper flask in experimental set up "a".
2. Most heating occurs at the surface.
3. Most dilution of sea water occurs at the surface.
4. It is easier for a human to swim in salt water. The salt water makes the person more bouyant. Salt water is more dense and the same volume displaced by the person will weigh more, the person floats more easily.

5. It is easier for a human to swim in cool water. The person displaces the same volume but since the water is cooler and more dense it weighs more and the person floats more readily. A word of warning may be in order here. While a person will float more readily in cool water, the chance of excessive body heat loss increases. Cold water can lead to hypothermia. You may wish to discuss this so that your students use caution when experimenting on their own.

**KEY WORDS**

adjacent  
climate  
density  
dilution  
transport

## OCEAN CURRENTS

People have observed ocean currents for many years. Currents are masses of water that flow in a definite direction. Ocean currents are important in many ways. They affect the climate of the lands nearby. The best fishing is often found where two currents come together. Currents can help transport boats. They also transport fish and shellfish that are too young to swim great distances.

There are several types of currents. The best known are wind-caused currents where the wind actually pushes the water along the surface. There are also deep currents beneath the surface. These currents are caused mainly by differences in the density of adjacent waters.

The experiment below will let you observe two of the lesser known factors that cause currents. You will observe differences in salinity and temperature densities between two masses of water.

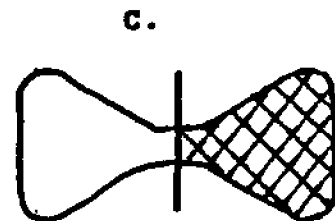
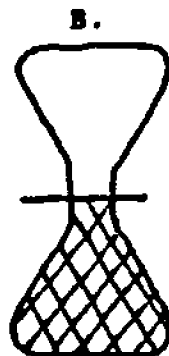
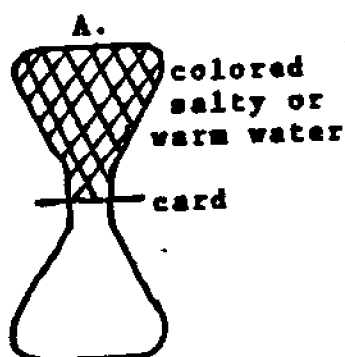
### MATERIALS

- Two 1-pint milk bottles or two 250 milliliter Erlenmeyer flasks with flat rims
- Some 3 x 5 cards
- Table salt
- Food coloring
- Paper towels or rags
- Plastic dishpan or other container suitable to catch water

### METHODS

#### Salinity Currents

1. Fill both bottles with water. Dissolve  $\frac{1}{2}$  teaspoon of salt in one bottle and add a drip of food coloring. Place a 3 x 5 card on top of the salt water bottle and carefully invert it; the upward pressure of air will hold the card in place (most of the time).
  - a. Place the salt water bottle on top of the freshwater container and have someone remove the card. (Now is the time for the dish pan!) Observe results.
  - b. Repeat No. 1 -- place fresh water jar on top of salt water jar, remove card and observe.
  - c. Repeat No. 1 -- place both jars horizontally, remove card and observe.



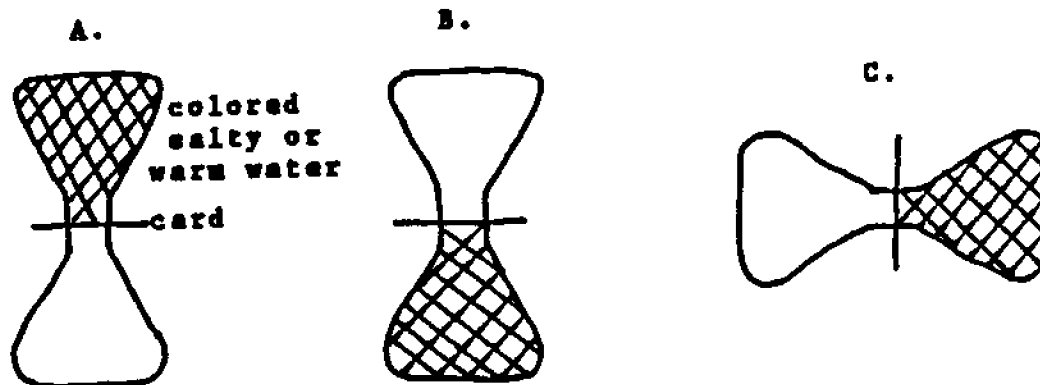


### INTERPRETATION

1. Is salt water heavier or lighter (higher or lower density) than fresh water? Explain your answer in terms of the results you obtained from the experiment.
2. What happens to river water when it flows into the ocean?
3. Freddy Fisherman was fishing at a spot near the mouth of a river. Five feet down he caught a fresh water perch. His luck was so good he let out more line. At thirty feet he caught a salt water cod. Freddy is so excited about this strange occurrence he is going to call the Sports Editor of the Post-Intelligencer. What would you tell Freddy to save him from embarrassment?

### Temperature Currents

1. Fill one bottle with warm water and the other with cool water. Add a drop of food coloring to the warm water. Do the three variations listed above in No. 1. (see diagram below).



### INTERPRETATION

1. Is warm water heavier or lighter (higher or lower density) than cool water? Explain your answer in terms of the results you obtained on the above experiment.
2. Where does most heating of ocean water take place?
3. Where does most dilution of sea water occur?
4. Is it easier for a human to swim in salty or in fresh water? Explain.
5. Is it easier for a human to swim in cool water or warm water? Explain.

GRADE LEVELS: K-7  
CONTENT & SKILLS: science  
SOURCE: NC Marine Education Manual,  
Coastal Ecology

### FOOD CHAIN CONNECTIONS - A WEB OF LIFE

- Objectives:
1. To create a food web with students to demonstrate the complex nature of food/ecological relationships.
  2. To review roles (niches) in nature.



sun



Producer



Herbivore



CARNIVORE

#### Teacher

Preparation: String or yarn cut into 8 foot lengths to tie your class of students together in a food web.

- Procedure:
1. Review some of the eating habits of marine organisms (you can go to whatever degree of complexity you desire). You need to mention plants (producers) and animals (consumers) and mention levels of consumers (herbivores, carnivores).
  2. Have the class suggest marine organisms and discuss what they eat. Write the names of these organisms on the board.
  3. To begin the string, ask for one or two volunteers to be producers (seaweeds, algae). Give them each one end of a length of string. Ask other students to be some of the animals mentioned on the board. Ask who will eat the plants. Let the plant people hand the herbivores the other end of the string. Give lengths of string to the herbivores to hand to carnivores which would eat them. (At this point, the students should see that one organism may be the food for several others and that one organism may prey upon several others.)
- Discussion:
1. When the possibilities of interacting have been exhausted and your room looks like a New Year's Eve spider web, ask the students to reflect how complex a real food web is.
  2. You may want to use the web to show how a diverse ecology can withstand some pressure. (Remove one part and see how many other components are affected.)

GRADE LEVELS: K-12  
CONTENT & SKILLS: art  
SOURCE: original, Wendy Beard Allen



### GYOTAKU - JAPANESE FISH PRINTING

Gyotaku (pronounced ghio-ta-koo) is an age-old Japanese technique of fish printing which is used to record information on the physical features of fishes. The art of Gyotaku may also add interest to a study of the external anatomy of fishes.

**Materials:** newspaper, clay or corkboard, pins, water-based block printing ink, absorbent paper (rice, construction or manila), brushes, and some fishes; the flatter, the easier to print.

- Procedure:**
1. Set up a work area with a covering of newspaper.
  2. Wash fish with soap and water to remove its slimy coating. Be careful not to scrub off the scales, if possible. (Save any lost scales for another fishy activity, see follow-up list below.)
  3. Dry fish well.
  4. Place fish on work spot and prop up any sagging fins with a combination of pins and clay or corkboard.
  5. Paint a thin coat of ink onto fish, covering all parts except the eye which gives an interesting effect if left clear or painted later.
  6. Lay a piece of paper over the fish and carefully press it against the fishes' surface.



It may take several tries to get a full impression of the fish but be persistent, learn from your rejected prints and remember to include that tricky fin or mouth region the next time.

The fish should receive a fresh coat of ink prior to each printing. Sometimes, however, two or three acceptable but lighter prints can be obtained before reinking is necessary.

**ABOVE ALL, HAVE FUN EXPERIMENTING WITH COLORS, PATTERNS AND DIFFERENT FISHES!**

**Clean-up:** Fishes may be washed and stored in a refrigerator or freezer for future printings or they may be dissected and contribute to a lesson on the internal anatomy of fishes.

**Follow-ups:** Identify the fish species and label the print, write a short story about the fishes' habits, make a collage which places the fish in its natural surroundings, study a scale and determine the fishes' age by counting its annual growth rings...

## HOW TO CATCH ATTACHERS

### Pre-Lab

#### Concept

Some animals live attached to a substrate and some do not.

#### Facts:

Many aquatic organisms are adapted to attach themselves to solid substrates.

The ability to attach protects organisms from water movements such as currents and waves.

When plant life attaches to solid objects, it serves as a food supply for animal life.

Microslides can be suspended in aquaria filled with natural seawater collected on a field trip, or in quiet, protected tidal pools in the field.

Manmade objects in the sea (oil drilling platforms, artificial reefs, etc.) often attract many attaching organisms.

#### Suggested Prerequisite Skills:

Students should be acquainted with the principal groups of microscopic marine algae and small marine animal life.

#### Student Performance Objectives:

Given different samples of seawater, students will find marine organisms attaching themselves to solid objects.

Given different slides, students will determine whether the attached marine organisms are producers or consumers, and which ones serve as food for marine predators and grazers.

#### Materials, Times and Cautions

##### Materials

Small aquaria or plastic dishpans

Natural seawater

Microslides

String

Clay

Dowel stick rod

Fluorescent or gro-light source

Microscope

Air pump

Tubing and air stones

## How to Catch Attachers

### Student Lab

#### GENERAL INFORMATION

Many marine organisms are adapted to attach themselves to solid objects or surfaces called the substrate. This provides protection against the many water movements such as currents, the pounding of waves, etc.

Photosynthetic plants which attach to solid objects (piers, boats, rocks on the shoreline, etc.) serve as food for animal life, some of which also is attached, or which crawls over the substrate; burrows into it, or grazes on the attached organisms as they swim in the water nearby.

#### OBJECTIVES

To observe which marine organisms attach themselves to a solid substrate.

To determine from the solid substrate, which organisms are producers and which are consumers.

#### MATERIALS

Small aquaria or plastic dish pans

Natural seawater

Microslides

String

Clay

Fluorescent or gro-light

Microscope

Air pump

Tubing

Airstones

#### PROCESSES

##### Student Discovery Activity

1. Place a supply of recently collected natural seawater in a small aquarium or plastic dish pan.
2. Put a dowel stick across the aquarium and keep it in place with a small portion of clay.
3. Suspend two or three slides from the dowel so that they almost, but do not actually, touch the bottom.
4. Place an air source in the aquarium, operating low enough so the water is not agitated and the slides do not hit each other or the container.
5. After 48 hours, remove the slides from the tank.

6. Cover the slides with one large or several small cover slips and examine through a compound microscope.
- Observing 7. How soon did you notice material sticking to the slides?
8. Record the types of organisms you find and state whether they are producers (example, diatoms, blue-green and green algae) or consumers (example, stalked ciliates, nematodes, rotifers, etc.)
- Observing 9. Was the material living organisms or just detritus?
- Predicting 10. What type of living marine organisms do you think you will find?
- Comparing 11. Compare the plant life with the animal life. Which one did you find more of, plant life or animal life?
- Inferring 12. What forms of marine life do you think use the attached organisms as food?
13. Remove about half the seawater from your tank every two to three days and add fresh seawater.
- Inferring 14. Why do you think an oil drilling platform attracts many marine organisms?
- Designing  
an  
experiment 15. Design an experiment to find out which type or texture of substrate attracts different organisms. Does a rough or smooth surface attract more?

## How to Catch Attachers

### Post-Lab

#### Possible Answers to Questions

7. A few organisms will attach themselves fairly soon but in most cases there should be a large number attaching themselves to the substrate (side) within 48 hours.
9. Some material on the slide may be crystals and detritus.
11. This answer will vary, depending upon where the source of seawater was collected. Sometimes the seawater will contain mostly diatoms, sometimes blue-green algae, and on other occasions colonies of stalked ciliates.
12. Worms, copepods and small fish.
14. Attached organisms on a drilling rig platform serve as a source of food to fish. Also, some "hiding places" are created by platform structures.
15. Answers will vary.

#### Discussion

This activity may be unsuccessful several times but very successful the next! It depends on the type of organisms present in the water you collect. If it is collected near a rocky shore (artificial rocky area such as groins, jetties, etc, or an oyster reef) there will be sufficient micro-organisms to demonstrate a small community of attached organisms within a few days.

If the slides do not have too much marine life visible, collect the material on the sides or bottom of the aquarium. Scrape and examine these masses - they are organisms which would be found attached in the natural seawater habitat.

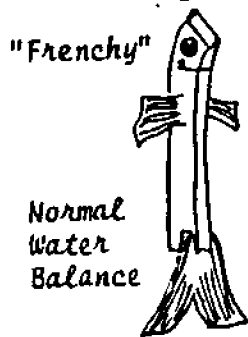
#### Follow-Up

Repeat this activity but change the variables:

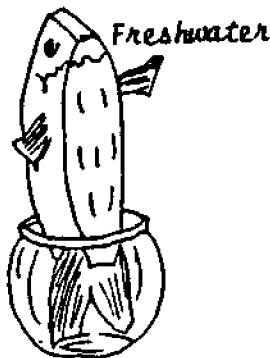
1. Use different materials as suspended substrates.
2. Change the texture and size of the substrate.
3. Change the temperature of the seawater and the amount of light that penetrates the water.

WHAT HAPPENS WHEN A SALT WATER FISH GOES "UP THE CREEK" OR  
 INVESTIGATING OSMOREGULATION

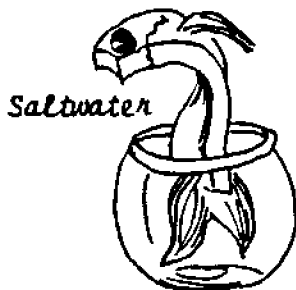
1. Background: Osmosis is the flow of water through a semi-permeable membrane (semi-permeable membranes allow only water



molecules to pass through) from high to low concentrations of water. Thus, marine fish with body fluids containing higher concentrations of water than the seawater surrounding them constantly lose water through cell membranes. Freshwater fish with body fluid water concentrations lower than lakes or streams will gain water. Both tendencies must be countered to preserve body fluid water balance. A few fish or invertebrates survive where salinities range both above and below body fluid water concentrations. Most are adapted to only one end of the spectrum and thus are confined to marine or fresh water, and cannot tolerate the variable environment of estuaries.



Marine bony fish (as opposed to cartilaginous fish like sharks) lose water through gills and mouth and would become dehydrated except for adaptations designed to restrict water loss. These adaptations include (1) drinking seawater and excreting salt through the gills to offset the loss; (2) conserving water usually lost as urine by an elaborate kidney system. Freshwater fish on the other hand, do not drink large quantities of water and do excrete copious amounts of dilute urine. When fish enter estuaries, they must be able to adjust their water balance (osmoregulate). Marine fish have this ability to a greater degree than do freshwater fish. The adaptability of marine fish is largely dependent on low permeability of their body surfaces to water (thick scales and mucous membrane) and extraordinary salt regulating activities of gills and kidneys. Most estuarine fish return to the sea for spawning.



2. Objectives: To investigate how changes in the concentration of water affect the water balance in living cells.

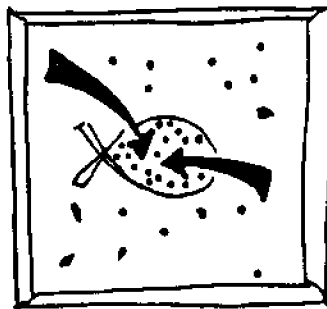
3. Teacher

Preparation: There are several experiments to demonstrate this phenomenon. This one is the easiest. Cut a fresh potato into slices. Place half the slices in a bowl with tap water and the other half in a bowl with salty water. Have the students feel the potatoes at the start and then feel them after 30 minutes or more. The potato slices cannot



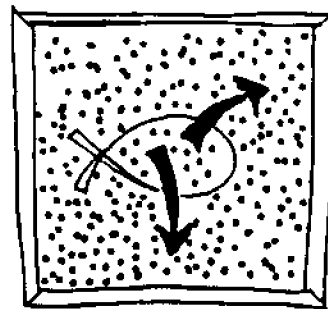
regulate their water balance and therefore are altered by their environment. This represents what would happen if a fresh water fish were dropped into the sea or a marine fish dropped into a lake - both would die eventually. Estuarine organisms have mechanisms for maintaining water balance as explained above.

4. Procedure: Feel the potato slices in both tap and salt water at the start of the period. Repeat this at the end of the period and record the changes which have occurred.
5. Discussion: 1. What happened to the potato slices left in fresh water? Relate this result to a marine fish being dropped into fresh water, what would happen to it? (Potato slice becomes very stiff, cells have absorbed maximum amount of water. A marine fish would also swell and probably his cells would burst.)
2. What happens to potato slice left in salty water? Relate this result to a freshwater fish dropped into the ocean. (Potato slice becomes limp; cells have lost water and become dehydrated. A fresh water fish would become dehydrated.)



FRESHWATER

High Concentration of  
Water Outside Cell.  
Water Flows In.  
Result: Bloat



SEAWATER

Higher Concentration of  
Water in Cell.  
Water Flows Out.  
Result: Descication

GRADE LEVELS: 7-12  
 CONTENT & SKILLS: science, reading,  
 writing  
 SOURCE: Marine Science Project For  
 Sea, Unit 9-12, Part II

TEACHER BACKGROUND - KEYS TO THE KINGDOM

Keys are an important tool in the identification of unfamiliar organisms. In this activity your students will have an opportunity to examine two keys and to construct a key of their own. It is important to emphasize that most keys are restricted to the organisms found in a particular area. Local keys are useful because the restricted number of organisms treated reduces the number of very fine distinctions which would have to be made if large numbers or many similar organisms were included on a single key. Since keys are an artificial construct, different keys can be designed to "key out" the same group of organisms. The most common type of key and the one introduced in this activity is the dichotomous key, a key with two choices at every level. Ideally, the choices are simple "yes" and "no" items ("the item is red" vs "the item is not red") and the discriminating features are things which can be verified by direct observation ("the item is  $\frac{1}{2}$  inch or longer in length" vs. "the item is less than  $\frac{1}{2}$  inch in length"). The alternatives should be quantifiable ( $\frac{1}{2}$  inch or longer rather than "big" or "small"). A good way to introduce the concept of dichotomous keys is to construct a key (in front of the class) to discriminate between the various members of the class. In theory, you could make the key so complete that at the end of each branch you would have one student's name. In practice, this detail is not necessary. It is helpful to key at least one student all the way to the end. The steps might be as follows:

- 1a Students male (list all male names) go to .....2
- 1b Students not male (list other students' names) .....
- 2a Over six feet tall (list all names) go to .....3
- 2b Six feet or less in height .....
- 3a Blue eyes .....Bill Bailey
- 3b Non-blue eyes .....

Elicit the discriminants from your class to further increase the interest and participation. In the above example, you would want to emphasize the fact that the only blue eyed male over six feet tall in the class is Bill Bailey. In order that your students may understand how keys are constructed, it is recommended that you have available professionally made keys for your students to observe. A display of keys will also show your students the wide variety, large number and importance of keys in the life sciences. In activity three, the students construct a key to discriminate between various hardware items. Hardware was chosen to show the arbitrary nature of keys and to show that their use is not limited to living things.

Duplicate the activity pages for "Keys of the Kingdom". One set is recommended per student. Students may do these activities individually or in pairs or small groups. There is much merit in exchanging the keys

prepared in "Activity Three" between groups and in having the groups use the key they receive to sort out the hardware items for which the key was constructed to identify. You may wish to introduce the activities briefly on the day prior to their use and assign the reading of the introduction and activity sections as homework.

#### Activity One:

If possible place on a front desk an example of each of the items mentioned. Identify the objects on the desk and/or shown in the picture in the text. It is quite possible that some of your students may not be familiar with a paper spindle. Have your students quickly read through the key so that they have a general idea of its use. There should be little difficulty with the first key. After the students are sure they understand how it works, assign different groups the responsibility of identifying one of the objects by following the key. For example, one group might begin with the pencil and follow it from number 1 until it is identified. Provide scratch paper and have your students write down the numbers of the steps they follow from number 1 through identification. Upon completion the students should be asked to: identify the basis the writer used in preparing the key to separate the objects in the key. In this particular case, the objects were separated on the basis of physical characteristics. You should be able to elicit this response from your students.

Ask the students to suggest how the key could be varied while still using physical characteristics so that a different sequence could be followed. For example, they might suggest the following:

- 1a. Object has a sharp point at one end.
- 1b. Object does not have a sharp point at one end.

It is important that the student realize that in an artificial key there is no one right way to begin.

#### Activity Two:

Following the same procedure as before, ask the students to look through the key and designate different groups to trace the various items. Again, have them write down the numbers of the steps they follow.

This key deliberately has several weaknesses built into it which should come out in discussion. When the students, many of whom will be frustrated, have completed the activity, again ask them to identify the basis the writer used in preparing the key to separate the objects in the key.

The answer here would be that the key is based on the function of the object as opposed to the physical characteristics. At this point, ask the students to discuss what problems they had with the key. The built-in weaknesses should become evident very soon. The following problems should be identified and discussed.

1. The terms "large" and "small": are relative and, hence, vague.
2. The process of holding papers in sections 4, 5, and 6 is confusing.

3. In the initial separation of the groups in #1, the term "implement used for writing" is used. Whether or not one wishes to consider an eraser as a writing tool is questionable. One could certainly look at it two ways.
4. The numbering sequence in this key is different from that in the first key and is basically more difficult. It might be pointed out to students that various letter combinations could be used or a mixture of numbers and letters.
5. Students should also note that the vocabulary used in any key has to be appropriate for the people who will be using it.
6. From the discussion, it should also become evident that a key for many organisms should be brief but clarity is most important and should not be sacrificed.

#### Activity Three:

At this point, students will have identified many of the problems with the key and will offer many suggestions. Direct the students to use this information to prepare a dichotomous key utilizing the hardware items on their desks. Generally, four students working together form a good group. It is helpful to make a board with each of the items fixed and labeled so that students can call the items by their appropriate title.

After the keys are prepared by the students they should be exchanged with other groups. The new students should attempt to use the key.

Have the "user" groups prepare a written evaluation of the key they received. The evaluation should include: the number of items they were correctly able to identify using the key; weaknesses in the key; and improvements which should be made in the key.

In your discussion of the keys point out the various ways in which the keys have been started indicating again that in an artificial key there is not one way which is necessarily correct.

It is often observed that the boys tend to be familiar with the hardware items and, therefore, tend to group things which have similar functions together whereas girls more often rely on the physical characteristics of the items for discrimination.

Notes on the Selection of the Hardware Items for use in Preparing a Key:  
To increase the challenge, it is a good idea to include among the hardware items a number of specialty items with which your students have little familiarity. Include such items as: escutcheon pins, roofing nails, rivets, wire nuts, etc.

Among the items should be several that vary only in size, i.e., washers differing in size of opening, wood screws of the same length but varying thicknesses, etc. The object is to force the students to observe closely and identify quantitatively the characteristics necessary to separate the items.

## KEY

There is no one "correct" key to separate the items. A workable key is one which uses characteristics which can be observed and agreed upon to distinguish the items.

## KEY WORDS

analyze

classifying

dichotomous key

key

organisms

paper spindle

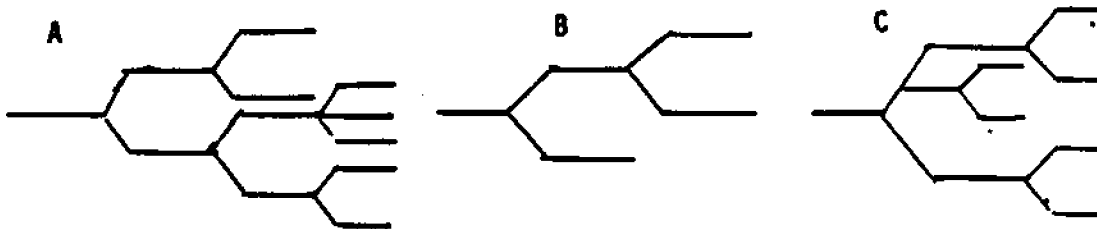
projection

This activity originally appeared in: Guide to Marine Ecology Research... a curriculum for secondary students. A Marine Ecology Research Project publication.

## Keys To The Kingdom

The seas are full of life. Even Jacques Cousteau can't identify every plant or animal he comes upon in his adventures. How do people deal with this vast assortment of creatures? Because ecology involves studying the relationships among organisms, it is important to be able to identify the organisms present in a study area. To solve the problem of identification biologists have developed various systems for grouping organisms and methods for identifying them easily and efficiently. Once a preliminary survey of an area has been made, a device called a "Key" is developed for classifying the plants and/or animals in a manner which allows subsequent identification by others studying the area. Just as door keys only open certain locks, identification keys will only work for the organisms and in the area for which they were designed. Keys are very handy. For example, using an appropriate key to identify a fish which you may find, rather than sorting through thousands of pictures of fish or a key to all of the fishes of the Pacific Coast, is a simple and efficient procedure when you understand how a key is organized and you are familiar with its use.

Keys can be designated in different ways, but the most common are called dichotomous (di-kot-e-mus) keys. The term means double branching. Which of the following diagrams would be dichotomous?



In a dichotomous arrangement, you are always offered two choices. The following activities are designed to give you an understanding of how a dichotomous key is organized and a chance to construct one. With this background, you should have few problems using dichotomous keys to common forms of sea life.

### ACTIVITY 1

#### Materials:

Key # 1, Key to Common Objects Found on a Desk

#### Procedure:

Following your teacher's instructions, analyze "Key # 1, Key to Common Objects Found on a Desk."

### ACTIVITY 2

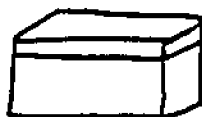
#### Materials:

Key # 2, Key to Common Objects Found on a Desk

Procedure:

Following your teacher's instructions, analyze "Key # 2, Key to Common Objects Found on a Desk."

OBJECTS



Key # 1

A KEY TO COMMON OBJECTS FOUND ON A DESK

- 1a Object made entirely of metal ..... 2
- 1b Object not made entirely of metal ..... 5
- 2a Object has no thin metal projections ..... 4
- 2b Object is flat at one end with a sharp projection coming from the center ..... 3
- 3a Flat end is no larger than 1 cm ..... thumb tack
- 3b Flat end (base) is at least 5 cm in diameter ..... paper spindle
- 4a Object is made of bent wire ..... paper clip
- 4b Object is "box shape" with a hinged lid ..... card box
- 5a Object made entirely of rubber ..... eraser
- 5b Object may have rubber in part ..... 6
- 6a Object is long, thin, has graphite inside and has rubber at one end ..... pencil
- 6b Object is long, thin, has removeable cap, but does not have rubber at either end ..... fountain pen

KEY # 2

A KEY TO COMMON OBJECTS FOUND ON A DESK

1. Object is used in the process of writing ..... 2  
Object is not used in the process of writing ..... 4
2. Object has a cap and contains a fluid which is imparted to  
paper with the process of writing ..... fountain pen  
Object does not contain fluid ..... 3
3. Object is long and slender, containing a dark, solid material  
used to mark paper in the process of writing ..... pencil  
Object is made of rubber and used to "eradicate" or  
remove lines in the process of writing ..... eraser
4. Object is used to keep papers together ..... 5  
Object is used to attach papers to a wall or  
solid object ..... thumb tack
5. Object is small and metal and used to keep small numbers  
of paper sheets together ..... paper clip  
Object is used to keep larger number of sheets together ..... 6
6. Object holds papers together by securing them on a  
metal shaft with a sharp point ..... spindle  
Object is designed to arrange papers of uniform size so they  
do not spill and become mixed up ..... card box

ACTIVITY 3

Materials:

An assortment of 10 or more different hardware items such as nuts, bolts, machine screws, wood screws (flat head, round head and Phillips head), nails (including specialty nails), washers, wing nuts, cotter pins, lock washers, etc.

Procedure:

Your teacher will give you a series of objects which you may consider to represent a collection of common life forms found in a lake, river or bay. Based on the knowledge gained in Activities # 1 and #2, prepare a "Key to Common Hardware Objects" which would be appropriate for any student in your class. Your success is directly related to the ease with which others in the class can use your key.



GRADE LEVELS: 2-12  
CONTENT & SKILLS: science, math,  
writing  
SOURCE: Marine Science Project For  
Sea, Unit 6

#### TEACHER BACKGROUND - THE MARINE AQUARIUM

This exercise consists of three activities. All of the activities center on the marine aquarium in your classroom. If you do not have a marine aquarium, the activities can be modified for use with a fresh-water system or omitted.

Duplicate the three pages of activities. One set per student. Provide additional Animal Identification pages as needed. Activity one is a simple listing of the animals present in the aquarium. Provide reference materials that describe the animals your aquarium contains. Let the students discover the identities with your aid.

Activity two gives the student a chance for a more in-depth look at some of the animals in the tank. Again provide the reference materials for the students to complete the forms.

Activity three is a simple log of water temperature along with additional observations. You can either take the readings yourself and post them on the board or you can have groups of students take and post the readings.

The temperature should be recorded at the same time each day. If you have your students record the temperature at several times during the day you may notice differences. These observed changes can be a springboard for a discussion designed to find correlations between the temperature changes and classroom activities. For example, the temperature may go down each day at recess time because the classroom door is left open, etc.

These activities can be done individually.

#### KEY WORDS

aquarium

appendages

identification

marine aquarium

observation

pH

predator

## THE MARINE AQUARIUM

The marine aquarium in your class contains salt water and salt water animals. Marine animals are very interesting to watch. We can also learn about the marine environment from the animals in the aquarium. Use the marine aquarium to do the next activities. List the animals you can see in your aquarium.

Fill out an animal identification form for as many animals as you can.

Make and record daily observations on the marine aquarium.

### THE MARINE AQUARIUM - ANIMAL INVENTORY LIST

NO.	ANIMAL NAME	NO.	ANIMAL NAME
1.	_____	21.	_____
2.	_____	22.	_____
3.	_____	23.	_____
4.	_____	24.	_____
5.	_____	25.	_____
6.	_____	26.	_____
7.	_____	27.	_____
8.	_____	28.	_____
9.	_____	29.	_____
10.	_____	30.	_____
11.	_____	31.	_____
12.	_____	32.	_____
13.	_____	33.	_____
14.	_____	34.	_____
15.	_____	35.	_____
16.	_____	36.	_____
17.	_____	37.	_____
18.	_____	38.	_____
19.	_____	39.	_____
20.	_____	40.	_____

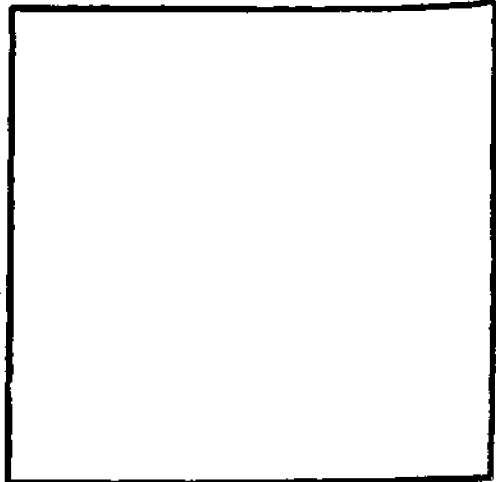
THE MARINE AQUARIUM - ANIMAL IDENTIFICATION

1. Name of animal: \_\_\_\_\_

2. Color of animal: \_\_\_\_\_

3. Describe shape of animal: \_\_\_\_\_

4. Describe how animal moves: \_\_\_\_\_



If the animal is not moving, describe how it could possibly move. \_\_\_\_\_

Draw your animal

Why is there a need for this animal to be able to move: \_\_\_\_\_

5. Number and description of appendages (arms or legs): \_\_\_\_\_

6. Approximate size of this animal in centimeters: \_\_\_\_\_

7. What do you think this animal eats: \_\_\_\_\_

8. Describe how you think this animal eats: \_\_\_\_\_

9. Name of predator (enemy): \_\_\_\_\_

10. How does this animal protect itself: \_\_\_\_\_

11. What interesting characteristics or habits does this animal have: \_\_\_\_\_

THE MARINE AQUARIUM - OBSERVATIONS AND MEASUREMENTS

	Mon.	Tues.	Wed.	Thurs.	Fri.
Water temperature					
	Mon.	Tues.	Wed.	Thurs.	Fri.

List anything added or taken from the aquarium:

Observations:

GRADE LEVELS: 5-8  
CONTENT & SKILLS: reading, social studies  
SOURCE: NC Marine Education Manual,  
Coastal Beginnings

### MAROONED ON A BARRIER ISLAND

Objective: To simulate how man develops a culture by adapting to his environment.

Teacher

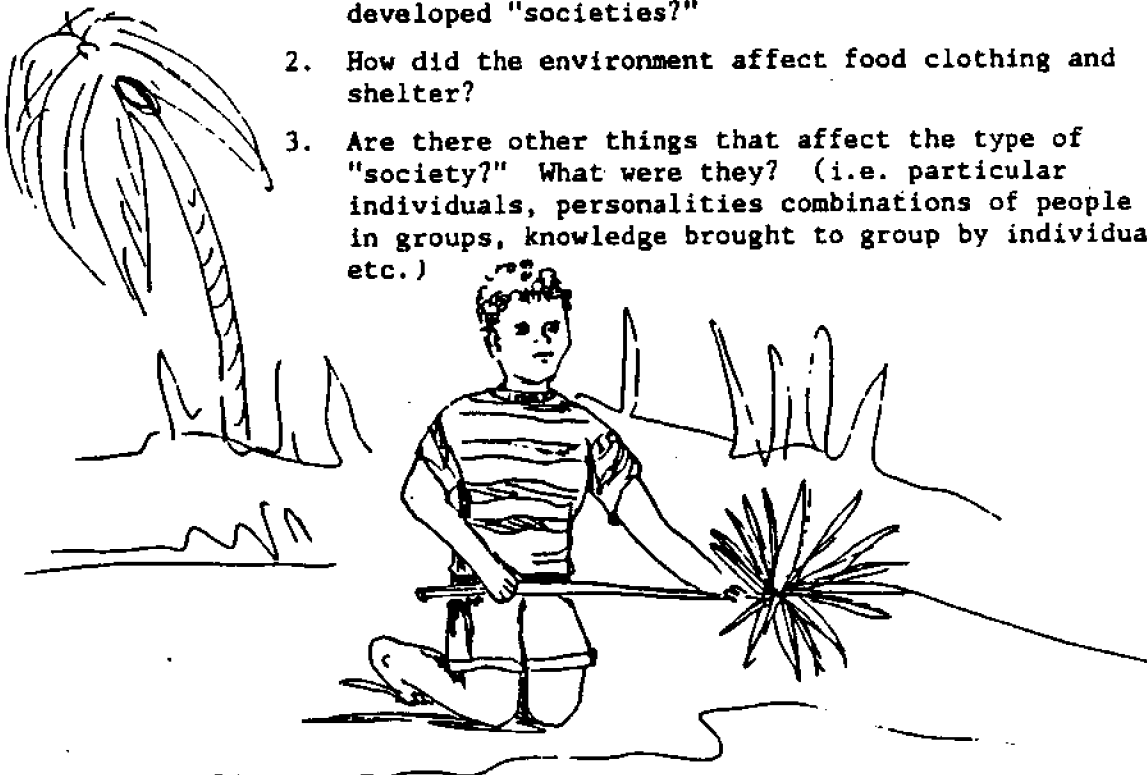
Preparation: List the following items on the board:

fresh water	grasses	snakes
salt water	turtles	raccoon
maritime forest	muskrats	shore and sea birds
salt marshes	rabbits	crustaceans
sand dunes	squirrel	shell fish
shells	deer	fish

Divide the class into small groups.

Activity: Inform the students that they are marooned on an uninhabited barrier island with nothing but the "clothes on their backs." It is spring and they must use the above available natural resources to develop a system of living. This should include a means of providing food, clothing and shelter. Depending on the level of the students, an economic system, government and religion can also be developed.

- Discussion:
1. What similarities and differences exist in the newly developed "societies?"
  2. How did the environment affect food clothing and shelter?
  3. Are there other things that affect the type of "society?" What were they? (i.e. particular individuals, personalities combinations of people in groups, knowledge brought to group by individuals, etc.)



GRADE LEVELS: 2-9  
CONTENT & SKILLS: science, math,  
writing  
SOURCE: Marine Science Project For  
Sea, Unit 4

#### TEACHER BACKGROUND - OBSERVING THE LIVING CRAB

This is a lab exercise involving one or two hours. It may be done over two days. The crab is an ideal laboratory specimen in most areas because:

1. It is easy to keep alive and is relatively available.
2. It is large enough so that the various parts can be seen without the aid of a microscope.
3. It shows outstanding specialization of appendages. Form and function can be easily related.
4. If you choose the right kind of crab, you can have a very nice dinner after the exercise is completed!

#### WHERE TO GET CRABS

If you live near the coast you can probably collect your own crabs. Fiddler crabs are easily obtained in the salt marsh at low tide. With a little work, stone crabs or blue crabs can be taken with a net or crab pot. Be sure to check local regulations for size and number limits and for season length. Crabs may also be obtained from fish wholesalers. A live crab is best but a frozen crab will allow much of the exercise to be completed. Biological supply houses also supply live crabs at a reasonable cost. For example: Carolina Biological Supply, 2700 York Road, Burlington, North Carolina 27215. Pet shops often sell hermit crabs for pets. Most of the exercise could be completed using hermit crabs.

**Cautions:** Crabs need to be kept moist. They can be entirely submerged in salt water, but they will also do well if they are partly submerged. Crabs have a rather strong grip. Avoid being gripped! Grasp the crab across the back. Watch the action of the pincers. A preview of crab handling is recommended before doing this exercise with your class. This exercise may be done as a demonstration or as a small group activity. Groups of three or four students is ideal. If student groups perform the activity, it is best to use small shore crabs. Demonstrate the proper handling methods to the students and observe the handling carefully.

#### KEY WORDS -

abdomen	habitat
antennae	pincers
appendages	stalks
aquarium	structures
average	survive
caliper width	swimmerets
	weight

OBSERVING THE LIVING CRAB

The crab is a very interesting creature. Carefully watch this animal. How do its body structures help it to survive in its habitat?

Watch a live crab in an aquarium.

1. How does the crab move? \_\_\_\_\_  
\_\_\_\_\_
2. How many appendages (legs, etc.) does the crab have? \_\_\_\_\_  
\_\_\_\_\_
3. Can the crab swim? \_\_\_\_\_  
\_\_\_\_\_
4. What appendages does the crab use in walking? \_\_\_\_\_  
\_\_\_\_\_
5. Are any of the crabs forming new appendages? \_\_\_\_\_  
\_\_\_\_\_
6. How does the crab dig in the sand? \_\_\_\_\_  
\_\_\_\_\_
7. How does the crab catch live food? \_\_\_\_\_  
\_\_\_\_\_
8. What appendages are used in getting food to the mouth? \_\_\_\_\_  
\_\_\_\_\_
9. Can you see where water enters the gill chamber? \_\_\_\_\_

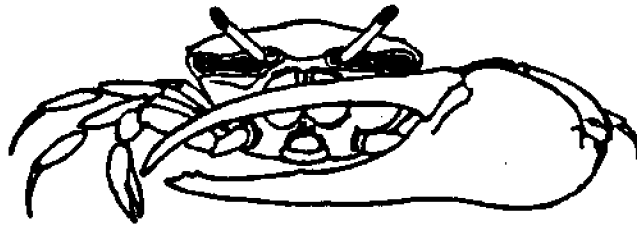
Use your drawing of the crab to help you find the following:

The eyes on stalks

The heavy pair of pincers

The four pairs of walking legs

Lift up the abdomen and observe the feather-like appendages called swimmerets.



Fiddler Crab

10. Look at the shape of the abdomen. What sex is your crab? \_\_\_\_\_
11. Can you find the antennae that are near the eyes? \_\_\_\_\_
12. How wide is your crab (caliper width)? \_\_\_\_\_
13. How wide is the widest crab in the class? \_\_\_\_\_
14. How wide is the narrowest crab in the class? \_\_\_\_\_
15. Estimate (make an educated guess) the width of the average crab.  
(A crab about halfway in-between the biggest and smallest). \_\_\_\_\_
16. Find the true average. Do the Following:
  - a) add all of the widths.
  - b) divide by the number of crabs measured.Your answer is the average.

See how powerful your crab's pincers are. DO NOT PUT YOUR FINGER IN-BETWEEN THEM. Place your pencil in between the pincers. Try to lift up the crab using your pencil. Be careful not to lift the crab too high. You only need to see if he is powerful enough to lift his own weight.

17. Can your crab hold up his own weight with one pincer?

\_\_\_\_\_

18. Can you lift yourself up from the ground with only one arm?

\_\_\_\_\_

19. Pound for pound, who do you think is stronger?

\_\_\_\_\_



GRADE LEVELS: 4-7  
CONTENT & SKILLS: math  
SOURCE: Marine Science Project For  
Sea, Unit 4

#### TEACHER BACKGROUND - OPEN FOR BUSINESS

This activity permits your students to make some simple economic comparisons of two hypothetical businesses. The activity also provides some practice with practical work problems. Again, the choice is up to you regarding how to handle the activity. You may elect to have the students work independently or in small groups. Each student or group should have a copy of the exercise. Duplicate the needed material prior to class use.

#### OPEN FOR BUSINESS - TEACHER KEY

1.  $1,500 \text{ lbs} \times \$2.00/\text{lb.} = \$3,000.$
2.  $800 \text{ lbs.} \times \$3.00/\text{lb.} = \$2,400.$
3. SEASALMON FARMS, INC. looks like the best investment.
4.  $\$250.00 + \$1,000 + \$300.00 = \$1,550.$
5.  $\$75.00 + \$200.00 + \$600.00 = \$875.$
6. SEASALMON FARMS has the greatest expenses for one year.
7.  $\$3,000 - \$1,550 = \$1,450.$
8.  $\$2,400 - \$875.00 = \$1,525.$
9. WATERBED OYSTER CO. has the largest net profit.
10. The best investment is the WATERBED OYSTER CO.

OPEN FOR BUSINESS

Lucky you! You have just won one thousand (\$1,000) dollars in the MacDonald's "Name that Burger" contest. Since you are now a rich person, all of your friends want to help you spend your money. You have decided to start a business. There are two choices which sound good to you. One is a salmon farm. The other is an oyster bed. You will have to use the information below to pick which business to buy.

SEASALMON FARMS, INC.

Income:

Pounds of salmon sold a year ..... 1,500  
Price per pound ..... \$2.00

Expenses:

5,000 salmon eggs ..... \$250.00  
Fish food ..... \$1,000.00  
Packing and delivery ..... 300.00

WATERBED OYSTER CO.

Income:

Pounds of oyster meat sold a year .. 800  
Price per pound ..... \$3.00

Expenses:

Oyster spat ..... \$75.00  
Oyster shells ..... \$200.00  
Shucking and delivery ..... \$600.00

PLEASE SHOW YOUR WORK

1. What is the total income of the SEASALMON FARMS, INC. for one year? (Hint: Multiply the number of pounds times the price per pound.)
  
  
  
  
  
  
  
  
  
  
2. What is the total income of the WATERBED OYSTER CO. for one year?

3. From the total incomes, which business looks like the best investment for your winnings?
4. What are the total expenses for SEASALMON FARMS, INC. for one year? (Hint: Add each expense item to find the total.)
5. What are the total expenses for WATERBED OYSTER CO. for one year?
6. Which business has the greatest expenses for a year of operation?

As president, your salary will be the NET PROFIT from the operation of your business. Net profit is the total income minus the total expenses.

7. What is the net profit for SEASALMON FARMS, INC. for one year?
8. What is the net profit for WATERBED OYSTER CO. for one year?
9. Which business has the largest net profit?
10. Which business is the best investment?

**GOOD LUCK AND DON'T FORGET TO HAVE A GRAND OPENING SALE!**

GRADE LEVELS: K-12

CONTENT & SKILLS: science, writing,  
math

SOURCE: NNEMEP, What Adventures Can  
You Have in Wetlands, Lakes,  
Ponds, and Puddles?

### PICKLE JAR PONDS AND PLASTIC PUDDLES

Objective: To create indoor wet environments for observation and study.

#### Materials:

- Several large glass jars
- Living plants and animals collected from the pond
- A children's plastic swimming pool

#### Timing:

One class period for establishing the environment, up to several more for observation and study.

#### Procedure for a Pickle Jar Pond:

Obtain large glass containers for each small group of students; three students to a jar is a workable number. The lunch program in your school may have two- or three-gallon jars with lids.

Each jar will become its own closed system. Plan for one period of creating the systems with ingredients brought from home by students or perhaps gathered by the class on a field trip. If you use tap water, allow it to dechlorinate for forty-eight hours before you introduce living organisms. It is better to use pond water.

Place a small amount of sand in the bottom of your pickle jar pond. Add rooted aquatic plants such as Elodea and floating ones, such as duckweed. Include small animals like snails, and small fish, and water insects. Make the jar airtight and place it in a sunny window. The first class could include the use of field guides to identify and learn about the plants and animals being observed. During the first few days organisms may have to be added or removed to achieve a balanced system. The amount of light may also need to be changed.

You will want to have your students observe carefully and respond to thought-provoking questions based on their observations. You may wish to have each group keep a journal of thoughts, observations, and answers over a period of time. The ponds will last all year.

- How does your closed system differ from ecosystems in nature?
- What food chains do you have in your pond?
- What is the ecological niche of each organism, plant, and animal?
- What niches are occupied by organisms you cannot see? You may wish to introduce microscope use here.
- Study, with field guides and other books, the morphology and physiology of microscopic organisms.

- Write about the flow of energy through your ecosystem.
- Undertake a population count of the macroscopic animals in your pond. Graph the results.

You may wish to have groups undertake experiments such as altering the amount of light available. You may wish to divide your pond into small jars first, so as to provide control on your study. What happens when we tamper with our balanced system?

#### Procedure for a Plastic Puddle

To create a plastic puddle you will need a small children's swimming pool, preferably of hard plastic form. With the student's help in bringing jars of pond water and pond life to school, create a puddle environment indoors. You'll want the water to fill the pool to a depth of 15 cm or less. Introduce hay, salamander eggs, algae, frog egg masses, aquatic insects, and so on.

This is a good spring activity. You are creating an environment which in nature study is called a vernal pond - a brief seasonal body of water rich in aquatic life.

Allow time each day to observe the pond. Another unit in this series, Have You Been to the Shore Before? provides good aquarium observation activities.



GRADE LEVELS: 7-12  
CONTENT & SKILLS: science, reading  
SOURCE: High School Marine Science  
Studies, Fluid Earth

## SAND STUDY

### Background

By identifying components of sand we can tell what sand is made of and where it probably came from. Sands can be classified by the source into two types. The first type, called abiogenic sand, is made of eroded pieces of rocks. The second type, called biogenous sand, is made of the skeletal remains of plants and animals.

### Abiogenic sands

Abiogenic sands are inorganic mineral sands. Abiogenic sand particles are formed as rocks break down through the processes of weathering and erosion. Weathering is the slow breakdown of rocks caused by water, chemicals in the air and in plants, and by temperature changes. Erosion refers to the work that water and wind does to level the land. Loose fragments of broken rocks are called sediment. Sediment is of any size including boulders, gravel, sand and mud.

Abiogenic sands are formed from rocks in the continental crust or from rocks in oceanic crust of the earth. The continental crust includes most of the major dry continental land masses of the world. Mountains in the continental crust are composed mostly of granite. Mineral sands formed by the breakdown of granite usually contain quartz and feldspar. Quartz and feldspar break down more slowly than does mica or dark minerals like magnetite, which are also common in granite. Because they resist chemical and physical breakdown, quartz and feldspar are referred to as resistant minerals. Most sand beaches along the coasts of the continental U.S.A. are called quartz sands because quartz is the most abundant resistant component.

The oceanic crust is the second source of abiogenic sand. The oceanic crust is made up of volcanic material called basalt. Volcanic islands, lava from volcanic eruption and the bottom substrate of the ocean basins are all made of basalt. Basalt is denser than granite and it is darker in color (black, grey or brown) because it is richer in minerals containing heavy metals such as iron and manganese. Basalt contains no quartz, but it does contain resistant minerals called olivine and obsidian (volcanic glass). Smaller amounts of other less resistant inorganic minerals are also found in basalt sands.

### Biogenous sands

The skeletal remains of plants and animals are a second source of sands. Biogenous sands are also called organic sands or biological sands. They are sometimes called calcium sands (or limey sands) because the chemical composition of most of the skeletal remains is calcium carbonate, the same material our bones are made of.

A simple chemical test that can be performed to distinguish calcium biogenous sands from inorganic abiogenic sands is to drop vinegar or other acid onto a pinch of sand particles. If the sand contains calcium carbonate, the particle will react with the acid to form bubbles of carbon dioxide.

Most biological sands are composed of fragments of corals, coralline algae, and mollusks. They also include other resistant biological fragments such as sea urchin spines, and sponge spicules. Some of the components are the skeletal remains of entire organisms such as the micromolluscs or the single-celled foraminifera. Usually biological sands are described by their largest component, as for example coral sands or coralline algae sand.

Materials - per sand specimen

- 1 sand sample
- 1 petri dish
- toothpicks
- diluted white glue (in small container)
- 1 small capped vial (for picked specimens), optional

Procedure

1. Read this description of sand components given in Table 1. Refer to this information as you carry out the procedures below.
2. Learn to identify the common components found in sand.
  - a. Obtain samples of different kinds of sand. If not already done, rinse each sand sample with fresh water and air dry before continuing.
  - b. Place 10-20 grams of a sand sample into a clean, dry petri dish. Clearly number and label the dish telling where the sand came from. Also, record sample number and source in Table 2.
  - c. Using a stereo dissecting microscope, view the sand at 10X or 20X. Be sure the sand is spread out in a thin layer in the petri dish. Use a toothpick to move the sand particles.
  - d. Locate the components of sand. Look at the color and shape of the grains. Compare what you see with descriptions in Table 1.
  - e. Glue several grains of each sand component that you find in the sample into Table 2.

- Place one drop of diluted white glue in the appropriate square.
  - Transfer the sand particles, touch them with the moistened end of a toothpick. The particles will cling to the toothpick. Use your fingers or another toothpick to brush the particles off the moistened toothpick into the glue.
  - Allow the glued samples to dry.
- f. Repeat procedures a-e using other sand samples. If possible, include sand from lakes, rivers, and several different seashore locations.

#### Summary Questions

1. Describe each of the sand samples you analyzed in terms of components of sand. What components did you find that are not listed in Table 1? (Use other reference books.)
2. Compare the components of sand samples from continental beaches or offshore areas with volcanic island beaches or offshore areas. Compare the biogenous components of sands from the temperate zone with sands from tropical areas.
3. How do you think particle size is related to the slope of a beach?
4. Use references to find out the following:
  - a. How do loose unconsolidated sands and sediments become sedimentary rocks, including beachrock, mudstone, sandstone and limestone? What fossils are often found in these rocks?
  - b. How does weathering and erosion break down and transport rocks? How does sand get to the shoreline and what happens to it after it gets there?



## References

McFall, Christie. 1966. Wonders of Sand. Dodd Mead Publishers. New York.

## Further Investigations

1. Make a report on the economic importance of sand. Report on one or more of the following:
  - a. How valuable sandy beaches are to people in real estate, or in the recreational or tourist industry.
  - b. How sand is used in making products such as glass, crystal, or cement, and abrasives.
  - c. How and where people are sieving sand today for heavy minerals (such as gold) and for gems (such as diamonds).
  - d. How the petroleum industry analyzes dredged or drilled sediment specimens for evidence of petroleum or glass.
2. Find out how oceanographers and geologists have used sand and sediment samples in such studies as (a) ancient seas (b) changes in the earth's climate (c) shifts in the earth's magnetic poles and (d) continental drift.
3. Find references describing and explaining (a) the "painted desert" and (b) acoustical sands that make sounds when walked on (such as Barking Sands Beach on the island of Kauai in Hawaii).
4. Make a report describing your local beach. Include (a) average size of sand particles on the beach (b) sand composition (c) width and elevation of the berm (d) slope of the foreshore and inshore (3) the existence (or lack) of a bar, sand dunes and a sea cliff or bluff.
5. Design a project to verify the relationship between particle size and slope. (Measure slope angle, and collect data on particle size.)
6. Start a class "Sand Bank". As you or your friends and relatives travel, bring back sand samples to deposit in the collection. Show the location of each sand sample on a large world map.

Table 1. GLOSSARY OF COMMON COMPONENTS OF SAND.

Components of Terrigenous Sand

Basalt: black lava flows are basalt. As they erode, they may form dull black, grey, or brownish red colored grains of gravel and sand.

Feldspar: feldspar is clear, yellow or pink squarish crystals with smooth, glossy or pearly luster.

Garnet: garnets are usually amber or beer bottle color, but some are light pink. Look for a diamond-shaped grain with twelve faces. Perfect crystals are rare because the ocean waves round off the edges rapidly. (Frequently used in making sandpaper.)

Granite: grains are usually light-colored to pink with a salt and pepper pattern made up of inter-grown mineral crystals all about the same size.

Magnetite: magnetite is an iron ore which forms a black crystal resembling a double pyramid. It shines like a metal and is attracted to a magnet.

Mica: shiny, paper thin, flexible sheets; light colored or white, translucent.

Olivine: olivine is a shiny crystal colored various shades of green that may be transparent or translucent, found in basalt.

Quartz: quartz grains are clear or transparent resembling small pieces of broken glass. Quartz comes from granite and sandstone erosion. It is the most abundant mineral found in continental sand.

Volcanic Glass: hot black lava forms black, shiny glass particles when rapidly cooled.

Other: "beach glass" is formed when broken shards of man-made glass are rounded and frosted by wave action. Other man-made substances may also be found on the beach.

Components of Biogenous Sand

Bivalve Mollusk Fragments: pieces of clam, oyster or mussel shells may appear white, grey, blue or brown. Usually not shiny. Slow to dissolve in acid.

Coral: fragments of coral rubble are common in tropical sand. Even when worn smooth, coral may be identified by its many small rounded holes where individual coral polyps used to live.

Coralline Algae: common types are (1) finely branched or coral-like stone plants that are colored white or pink to lavender (2) flakes or plates of tan to brown from *Halemida* and (3) encrusting lavender coats over rocks or coral that bleaches to white when dried.

Foraminifera: called "Forams" for short, these are the skeletons of one-celled animals (protozoans). They may be white and shiny, clear or covered with sand grains. They look like tiny shells except that their apertures are small and slit-like or pore-like. Forams have a small hole where the living animal extended false feet to catch food.

Micromolluscs: tiny shells of all types with large apertures.

"Puka" Shell: "puka" is Hawaiian for "hole". These "shells" appear like shiny pearl-like discs with a puka in the center. They are the tops of cone shells.

Sea Urchin Spines: spines may be white, purple, black, beige, or green. These needle-like structures may appear to have designs. Viewed under a microscope, tiny sea urchin spines may appear to have a crystalline structure.

Sponge Spicules: usually clear and transparent or whitish, large sponge spicules may resemble the three-pointed logo for the Mercedes Benz automobile.

Miscellaneous: tiny shells of all types with large apertures.

Table 2. MICROSCOPIC IDENTIFICATION OF SAND COMPONENTS.

Components of Sand	Sand Sample Location			
	1. ___	2. ___	3. ___	4. ___
<b><u>A. Abiogenic Components</u></b>				
Basalt				
Feldspar				
Garnet				
Magnetite				
Mica				
Olivine				
Quartz				
Other				
<b><u>B. Biogenous Components</u></b>				
Bivalve Mollusk Fragments				
Coral				
Coralline Algae				
Foraminifera				
Micromollusks				
"Puka" Shells				
Sea Urchin Spines				
Sponge Spicules				
Other Animal Parts:				

SOURCE MATERIALS AND ORDERING INFORMATION

PROJECT

MATERIALS

- |  |   |
|--|---|
| <p>1. Bellefield Nature Center<br/>P.O. Box 1413<br/>Georgetown, SC 29442</p>  | <p>Materials provided with field studies conducted by Bellefield Nature Center</p>  |
| <p>2. Curriculum Research and Development Group<br/>University of Hawaii<br/>1776 University Ave.<br/>Honolulu, HI 96822</p>                           | <p>*<u>High School Marine Science Studies (HMSS)</u>, complete set of student texts and workbooks (\$37.50)<br/><u>Coastal Problems and Resource Management</u> (write for a price listing)</p>   |
| <p>3. Marine Science Project: FOR SEA<br/>17771 Fjord Dr. NE<br/>Poulsbo, WA 98370</p>   | <p>*4, <u>Marine Science Career Awareness</u><br/>*6, <u>Marine Science Activities</u><br/>7-8, <u>Marine Biology &amp; Oceanography</u><br/>*9-12, <u>Marine Biology &amp; Oceanography</u>, Parts I &amp; II<br/>(\$25.00/unit)</p>   |
| <p>4. North Carolina Marine Education Manual<br/>UNC Sea Grant College Prog.<br/>Box 8605<br/>North Carolina University<br/>Raleigh, NC 27695-8605</p> | <p><u>Coastal Geology</u>, UNC-SG-78-14A (\$1.00)<br/><u>Sea Water</u>, UNC-SG-78-14B (\$1.00)<br/>*<u>Coastal Ecology</u>, UNC-SG-78-14C (\$1.50)<br/>*<u>Coastal Beginnings</u>, UNC-SG-78-14E (\$2.00)<br/>*<u>Connections</u>, UNC-SG-82-1F (\$2.00)</p>  |
| <p>5. Northern New England Marine Education Project<br/>Marine Advisory Program<br/>30 Coburn Hall<br/>University of Maine<br/>Orono, ME 04469</p>     | <p><u>Have You Been to the Shore Before?</u><br/>*<u>What Adventures Can You Have In Wetlands, Lakes, Ponds, &amp; Puddles?</u><br/><u>What is Our Maritime Heritage?</u><br/><u>How do People Use Lighthouses and Navigational Charts?</u><br/><u>Is Our Food Future in the Sea?</u><br/><u>Do You Know Our Marine Fish?</u><br/><u>Do You Know Our Marine Algae?</u><br/><u>What are the ABC's of Marine Education?</u><br/>(all units \$5.00. Make checks payable to Marine Advisory Program.)</p> |
| <p>6. Project CAPE<br/>Dare County Schools<br/>P.O. Box 640<br/>Manteo, NC 27954</p>   | <p>*<u>Marine Organisms in the Classroom</u> (\$3.50)<br/><u>Wanchese Harbor-Community Development</u> (\$3.00)<br/><u>A Guide to Field Studies for the Coastal Environment</u> (\$3.50)<br/><u>A Guide to Fossil Collecting in Coastal North Carolina</u> (\$2.50)<br/><u>A Guide to Field Trip Sites in Coastal North Carolina</u> (\$2.50)</p>   |

PROJECT

7. Sea Grant College Program  
Texas A&M University  
College Station, TX 77843

8. US Fish & Wildlife Service  
Office of Extension Education  
Washington, D.C. 20240

MATERIALS

Investigating the Marine Environment and  
Its Resources, TAMU-SG-401 & tape set  
(\$20.00)

\*Marine Organisms in Science Teaching,  
TAMU-SG-80-403 (\$4.00)

\*Freshwater Marsh Habitat Pac  
Endangered Species Issue Pac  
(may be out of print, write for information)

\*Sources of activities included in Sampler

SEA SAMPLER EVALUATION

Please complete and return to: SEA SAMPLER, USC Baruch Marine Lab, PO Box 1630, Georgetown, SC 29442. Thank you.

School District: \_\_\_\_\_ Date: \_\_\_\_\_

Grade(s) or other learner group you teach: \_\_\_\_\_

Subject(s) you teach: \_\_\_\_\_

1. Please evaluate the activities you have used on a scale of 1 (ineffective) - 3 (very effective) and comment on their strengths and weaknesses.

A Beach Study 1 2 3

comments: \_\_\_\_\_

Freshwater Marsh-Marsh Settlers 1 2 3

comments: \_\_\_\_\_

Freshwater Marsh-Marsh Succession 1 2 3

comments: \_\_\_\_\_

Salt Marsh Field Study 1 2 3

comments: \_\_\_\_\_

Brine Shrimp Capers 1 2 3

comments: \_\_\_\_\_

Crossword Puzzle 1 2 3

comments: \_\_\_\_\_

Currents 1 2 3

comments: \_\_\_\_\_

Food Chain Connections 1 2 3

comments: \_\_\_\_\_

Gyotaku 1 2 3

comments: \_\_\_\_\_

How to Catch Attachers 1 2 3

comments: \_\_\_\_\_

Investigating Osmoregulation 1 2 3

comments: \_\_\_\_\_

Keys to the Kingdom 1 2 3

comments: \_\_\_\_\_

The Marine Aquarium 1 2 3

comments: \_\_\_\_\_

Marooned 1 2 3

comments: \_\_\_\_\_

(more)

