Teacher's Activity Guide to Coastal Awareness

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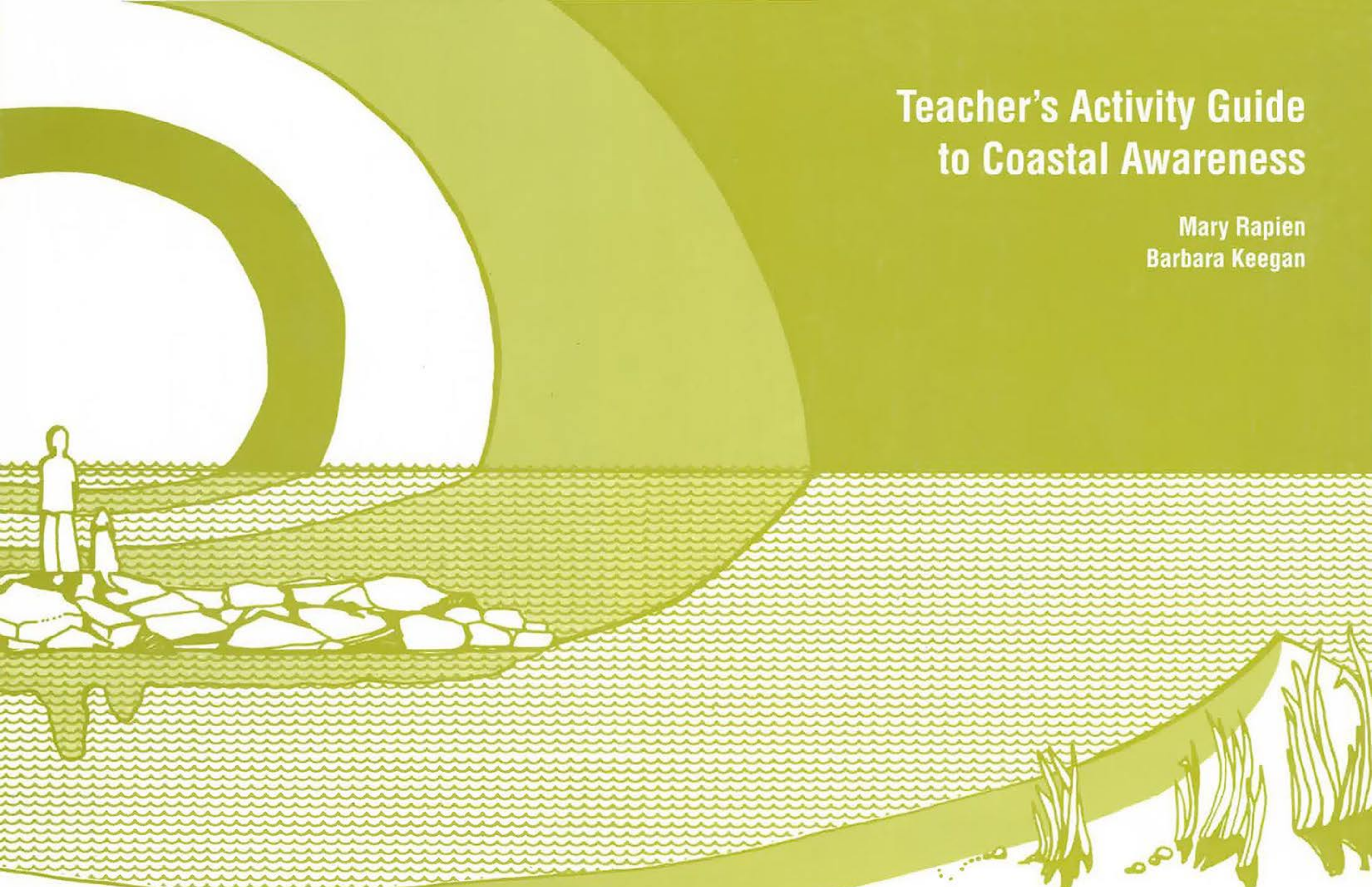

Office of Marine Programs
Graduate School of Oceanography
University of Rhode Island

Rhode Island Coastal Resources
Management Council

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Coastal Resources Management Council

Teacher's Activity Guide to Coastal Awareness

Created by:
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University of Rhode Island

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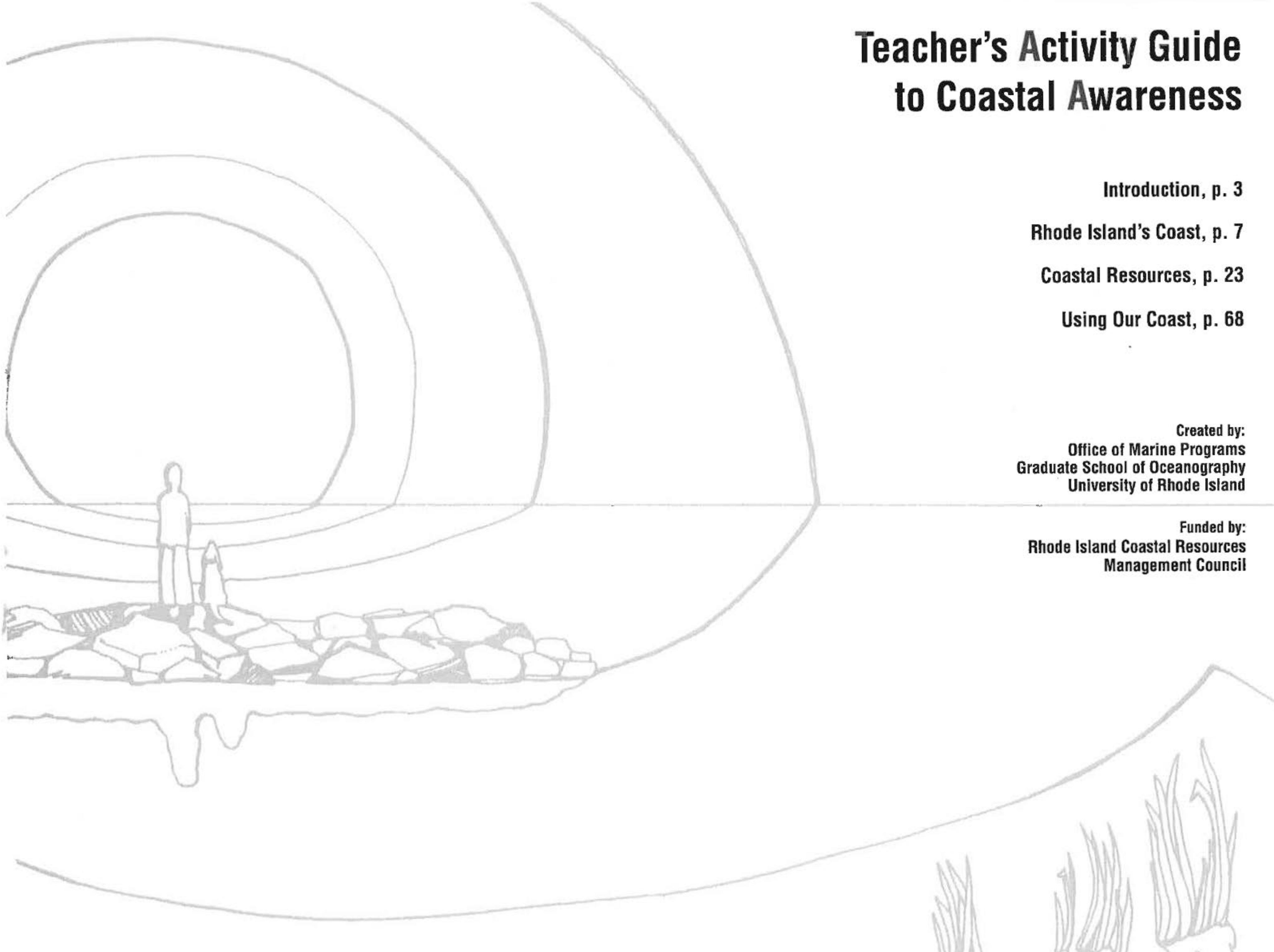

To order copies of this *Teacher's Guide* and associated *Activity Books,* contact:

Coastal Resources Management Council
Stedman Government Center, Suite 3
4808 Tower Hill Road
Wakefield, RI 02879-1900
Attn: Teacher's Guide and Activity Books

(401) 783-3370

(If writing, please provide e-mail or telephone contact information.)

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COASTAL RESOURCES MANAGEMENT COUNCIL

INTRODUCTION

This book, the *Teacher's Activity Guide to Coastal Awareness,* and its companion, *Down Where the Water Is: A Coastal Awareness Activity Book,* were originally written by Sara Callaghan Hickox and published by the Rhode Island Coastal Resources Management Council in 1977. At that time there were few resources available to Rhode Island teachers to help them introduce the concept of coastal management into the early elementary curriculum. While a much greater number of educational resources on the coastal environment exist today, there is still a need for resources focusing specifically on Rhode Island. To meet this need, the Office of Marine Programs at the University of Rhode Island has revised the *Teacher's Activity Guide to Coastal Awareness* to include updated background and resource information and standards-based activities.

The *Teacher's Guide* and the *Activity Book* are intended to be used in the classroom as either a complete unit or as supplements to an existing unit. The *Teacher's Guide* follows the *Activity Book* page by page, expanding on each topic with background information for the teacher, glossaries, activity ideas, resources, and places to visit. After each activity section, the corresponding National Science Education Standards are outlined in an easy-to-follow table. Activities cover a wide range of topics and skills. Both classroom and field activities are included.

The *Teacher's Guide to Coastal Awareness* is divided into three sections:

A. Rhode Island's Coast
B. Coastal Resources
C. Using Our Coast

Section A, "Rhode Island's Coast" (corresponding to pages 3 and 4 in *Down Where the Water Is*) is made up of exercises designed to introduce students to Rhode Island as the "Ocean State." The geography, physical characteristics of the shoreline, and coastal management issues are emphasized.

Section B, "Coastal Resources" (corresponding to *Activity Book* pages 5–11) contains activities and explanations designed to help children become more aware of the importance of the natural resources along our coast. The birds, beach grass, fish and other animals and plants in or near the ocean, barrier beaches, dunes, rocky shores, coastal ponds, and salt marshes are all discussed.

Section C, "Using Our Coast" (corresponding to *Activity Book* pages 12–19) provides examples of the wide variety of ways in which we use our coastal resources and suggests related classroom activities. The use of our coast for food, recreation, transportation, and housing is explored.

Each picture in the *Activity Book* is designed to promote a detailed discussion of people, places, and things relating to the coast. Space is provided at the bottom of the page for the children to write their own stories about the picture. The last two pages of the *Activity Book* contain cutout sentences that may be pasted below their corresponding pictures. Some teachers may wish to remove these last two pages from the *Activity Book* so that the story will not limit imaginative discussion of the pictures by the students.

We suggest asking students to keep a science journal throughout the unit. Teaching students to keep a science journal gives children a place and the time to review, reflect, and record their experiences of the science activities presented in this book. Using a journal as a tool will enable students to think more abstractly about the concrete, tangible activities presented prior to writing. Scientific reasoning skills will develop as children use scientific vocabulary such as "Today I made a hypothesis about..." in their daily writing. Perhaps a science vocabulary list could be displayed on a bulletin board labeled "Science Word Wall" for children to be reminded of the new words they have learned. The journal would also be a good place to keep charts, graphs, and worksheets that go along with the activities. Teachers may want to use journals as a means of assessment to determine whether or not students have mastered basic concepts, or to gain further insight into the future needs of their students.

Notes

Many of the resources listed in this Guide are available for perusal in the Teacher Resource Room or purchase at the Coastal Institute Bookstore at the URI Bay Campus. Call the Office of Marine Programs, (401) 874-6211 for information.

"Places to Visit" information is from *A Guide to Rhode Island's Natural Places,* 1995, Rhode Island Sea Grant. Copies can be obtained from Rhode Island Sea Grant, University of Rhode Island Bay Campus, Narragansett, RI 02882-1197.

The following notations are used throughout the Teacher's Guide:

[1] Activities written by Ruth Boragine that appeared in the original *Teacher's Activity Guide to Coastal Awareness.*

[2] Activities from the Lillian Feinstein Sackett Street Marine Science Academy, developed in partnership with the Office of Marine Programs at the University of Rhode Island 1998–2001.

[3] Standards information from *New Standards Performance Standards, Vol. 1 Elementary School,* 1997, National Center on Education and the Economy and the University of Pittsburgh.

Resources

General Resources:

Burnie, D. 1994. *Eyewitness Explorers: Seashore.* Dorling Kindersley.
A simple guide to several coastal habitats. Contains pictures and activities.

Cooper, J. 1992. *The Sea: Small Sea Creatures.* The Rourke Corporation. Contains informative text and photographs of a select number of marine animals (mostly invertebrates).

Doris, E. 1996. *Seashore Life.* Thames and Hudson, Inc. An excellent book. Contains descriptions and pictures of various habitats and organisms, along with very detailed field activity ideas.

Esbensen, B. 1993. *Sponges Are Skeletons.* Harper Collins Publishers. An introduction to the life and times of marine sponges.

Hollenbeck, K. 2002. *Ocean Life: Whales, Fish, and Other Sea Creatures.* Scholastic. A guide for teachers. Contains numerous activities, games, and resources.

Lember, B. 1997. *The Shell Book.* Houghton Mifflin Company. This book is not necessarily for children, but it is a beautiful introduction to types of shells children may see at the beach.

Morgan, S. 2001. *Looking at Minibeasts: Crabs and Crustaceans.* Thameside Press. An introduction, with photographs, to crabs and their close relatives (such as lobsters, shrimp, and isopods).

Richardson, J. 1993. *Mollusks.* Franklin Watts. Describes different types of mollusks and explains what makes a mollusk a mollusk. Contains photographs.

Sayre, A. 1996. *Seashore.* Twenty-First Century Books. Contains descriptions of various coastal habitats and activities. Also includes a section on humans and the seashore.

Taylor, L. 1998. *Jellyfish.* Lerner Publications. Introduces readers to jellyfish anatomy and habits. Includes photographs, diagrams, and suggestions for sharing the book with children.

Field Guides for Adults and Children:

Abbot, R. 1986. *Seashells of North America.* Golden Books. Colorful illustrations. Describes a little about the biology of each type of mollusk.

Dance, S. 1992. *Eyewitness Handbooks: Shells.* Dorling Kindersley. An easy to follow guide with excellent photographs.

Gosner, K. 1978. *Atlantic Seashore.* Houghton Mifflin Company. A Peterson Field Guide. Comprehensive guide to both algae and animals found at the seashore.

Hansen, J. 1992. *Seashells in My Pocket: A Child's Nature Guide to Exploring the Atlantic Coast.* Appalachian Mountain Club Books. A field guide for children. Includes a checklist. Drawings, not photographs.

Kricher, J. 1992. *Peterson First Guides: Seashores.* Houghton Mifflin Company. Includes the most common organisms students will see. Colorful and accurate illustrations.

Massie, F. 1998. *The Uncommon Guide to Common Life of Narragansett Bay.* Save The Bay. Descriptions and drawings of organisms found in Narragansett Bay. Includes descriptions of human relationships with, and impacts on each organism.

Van Dusen, B. 1993. *Beachcombers: Guide to the North Atlantic Seashore.* Massachusetts Audubon Society. A nicely illustrated, easy to follow, fold-out guide.

Periodicals:

Audubon Magazine
http://magazine.audubon.org

Narragansett Bay Journal
Narragansett Bay Estuary Program
University of Rhode Island
Narragansett, RI 02882
http://www.nbep.org
Subscriptions are free.

National Geographic Magazine
http://www.nationalgeographic.com

Natural History Magazine
http://www.amnh.org/naturalhistory

Oceanus Magazine (published by Woods Hole Oceanographic Institution)
WHOI Publication Services
P.O. Box 50145
New Bedford, MA 02745-0005
1-800-291-6458

Skin Diver
http://www.skin-diver.com

Smithsonian
http://www.smithsonianmag.si.edu

Local Resources:

These organizations offer a wide variety of information and educational programs related to Rhode Island's coast.

Audubon Society of Rhode Island Environmental Education Center
1401 Hope Street (Route 114)
Bristol, RI 02809
(401) 245-7500
http://www.asri.org

Coastal Resources Management Council
Stedman Government Center, Suite 3
4808 Tower Hill Road
Wakefield, RI 02879-1900
(401) 783-3370
http://www.crmc.state.ri.us

Frosty Drew Nature Center
Call for information about school programs (401) 365-9508
http://www.frostydrew.org

Narragansett Bay Commission
One Service Road
Providence, RI 02906
(401) 331-7110

Narragansett Bay National Estuarine Research Reserve
Rhode Island Department of Environmental Management
55 South Reserve Drive
Prudence Island, RI 02872
401-683-6780 phone
401-682-1936 fax
Write for more information and free resources including brochures and posters.

The Nature Conservancy
Rhode Island Chapter
159 Waterman Street
Providence, RI 02906
(401) 331-7110
http://nature.org/wherewework/northamerica/states/rhodeisland

Office of Marine Programs
University of Rhode Island
Narragansett, RI 02882-1197
(401) 874-6211
http://omp.gso.uri.edu

URI's Narragansett Bay Classroom offers a variety of marine and environmental short courses and for-credit courses, workshops, lectures, tours, camps, events, and activities for people of all ages. Phone 401-874-6211 to receive a free catalog.

Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02906-5767
(401) 222-6800
http://www.state.ri.us/dem

Rhode Island Sea Grant
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882
(401) 874-8842
http://seagrant.gso.uri.edu

Rhode Island Chapter Surfrider Foundation
P.O. Box 43
Narragansett, RI 02882
http://www.risurfrider.org

Save The Bay
434 Smith Street
Providence, RI 02908-3770
(401) 272-3504
http://www.savebay.org

Southeastern New England Marine Educators (SENEME)
The Rhode Island and Connecticut regional chapter of the National Marine Educators Association. Members include classroom teachers, informal marine educators, and others who have an interest in marine and aquatic environments (http://www.oceanology.org/SENEME/SENEME.html).

Internet Resources:
Oceanlink
http://www.oceanlink.island.net

Oceans and Underwater Life
http://www.libsci.sc.edu/miller/ocean.htm

All About Nature: Animal Printouts
http://wwwenchantedlearning.com/subjects/invertebrates

Sea Animal Biology, Lessons, and Activities
http://www.geocities.com/sseagraves/undersea.htm

Marine Ecosystems, Interactive and Resources, Estuaries
http://mbgnet.mobot.org/salt/index.htm

Water Pollution
http://www.col-ed.org/cur/sci/sci26.txt

Office of Marine Programs
Discovery of Coastal Environments (DOCE)
http://omp.gso.uri.edu/doce.htm

Discovery of Estuarine Environments (DOEE)
http://omp.gso.uri.edu/doee.htm
DOEE also contains links to other internet resources,
http://omp.gso.uri.edu/doee/teacher/interntl.htm

Discovery of Sound in the Sea (DOSITS)
http://omp.gso.uri.edu/dosits.htm
DOSITS also contains links to other internet resources,
http://omp.gso.uri.edu/dosits/teacher/teach1.htm

Acknowledgments

The Rhode Island Coastal Resources Management Council recognized the need for a revised edition of this book and graciously funded the project. Illustrations in *Down Where the Water Is* are the originals drawn by Henrietta Crandall in 1976. The *Teacher's Guide* and *Activity Book* were designed by Darrell McIntire. Several illustrations were created especially for this guide by Susan Cole Stone, Westerly, R.I. The title, *Down Where the Water Is,* was chosen for the original activity book by third grade students at Jamestown School. The *Teacher's Guide* was edited by Gail Scowcroft and Sara Hickox. Thanks to the Lillian Feinstein Sackett Street School faculty for developing many of the classroom activities.

RHODE ISLAND'S COAST

> **3** **Rhode Island's more than 400 miles of beautiful coastline have given it the nickname "the Ocean State."**

Narragansett Bay is a vital part of Rhode Island's geography and history. The Bay is 25 miles long and 10 miles wide, covering more than half of Rhode Island's existing shoreline. The Bay is fed with fresh water from the Blackstone, Taunton, and Pawtuxet Rivers. It was on the Blackstone River in 1793 that Samuel Slater built the first successful water-driven textile mill, thus beginning the American Industrial Revolution.

Glossary

Bay
A wide inlet of the sea, indenting the coastline.

Coastline
The area where land and sea meet.

Island
A body of land surrounded by water; smaller than a continent.

Marine
Pertaining to saltwater environments.

Ocean
The body of salt water that covers more than 71 percent of Earth's surface.

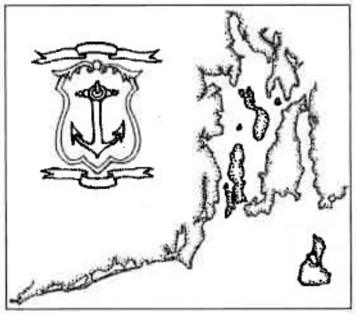
River
A natural stream of water of fairly large size flowing in a definite course from an area of higher elevation to lower elevation. (Note: the term "river" is used colloquially and incorrectly to describe narrow tidal inlets such as the Narrow "River," and other inlets of the sea such as the Sakonnet "River.")

Salinity
The total amount of dissolved salts in seawater. The average value for seawater is 35 psu (practical salinity units), or 35 parts of salt in 1000 parts of water (may also be expressed as parts per thousand, ppt).

Seawater
The water of the ocean which is distinguished from fresh water by its appreciable salinity.

Sound
A long passage of water forming a channel between the mainland and an island or connecting two larger bodies of water such as a bay and an ocean.

Activity Ideas



Rhode Island Map

Objectives:
- Students will learn Rhode Island geography.
- Students will learn and apply vocabulary pertaining to the coast.

Materials:
Index cards
Enlarged copy of the numbered and lettered map (included, Map 1)

Procedure:
1. Copy and enlarge Map 1, post in the classroom.
2. On individual index cards, write the names of each numbered body of water and lettered island.
3. As a classroom activity, have the children work together to post each index card label in its appropriate place on the map. As you go along, introduce vocabulary words listed above to describe the locations they are naming.

Where We Live

Objectives:
- Students will discover and discuss the fact that more people live along the coast than inland.
- Students will be able to pinpoint where they live in Rhode Island.

Materials:
Map (Map 2, included), one copy for each student.

Procedure:
1. Give each student a copy of Map 2, showing the most developed areas in black (where most people live and work) in Rhode Island.
2. Help the students find where they live on the map.
3. Ask the students to describe where most of the human impacts occur, and to explain why they think this is the case.
4. Then ask students what route they would take to get to the beach from where they live.

Name Game

Objectives:
- Students will learn a rhyme taught to Rhode Island children in the 1600s.
- Students will create their own memory aids.

Procedure:

1. Explain to students that four of the islands in Narragansett Bay were named in the 1600s by Roger Williams. Children of that period enjoyed reciting a rhyme made from those names: "Prudence, Patience, Hope, and Despair. And little Hog Island right over there."
2. Help the children locate all of these islands on a map of the Bay. Explain to them how rhymes and songs can help them to remember words.
3. Ask students to think of some other rhymes and songs they know that help them to remember something (the ABC song, for example).
4. As a class or in small groups have the children make up their own rhyme or song for some of the vocabulary in this book.

Standards Met[3]

Activity	Standard	
R.I. Map	G1–3	The world in spatial terms
Where We Live	G9–12	Human systems
Name Game	G1–3	The world in spatial terms
	G4–6	Places and regions

References

University of Rhode Island, Graduate School of Oceanography, Office of Marine Programs, *Discovery of Coastal Environments* Website (http://omp.gso.uri.edu/discovery/maps).

Hale, S.O. *Narragansett Bay: A Friend's Perspective.* Marine Bulletin 42, NOAA Sea Grant, University of Rhode Island.

Resources

Cottrell, H. 2001. *Atlas of Narragansett Bay Coastal Habitats.* Narragansett Bay Estuary Program Report #01-118. Narragansett Bay Estuary Program, R.I. Department of Environmental Management, Providence, R.I. Includes detailed maps of the Rhode Island coastline, with habitat types noted.

Discovery of Estuarine Environments Web site (DOEE) contains satellite images of Narragansett Bay. http://omp.gso.uri.edu/doee/maps/sat1.htm

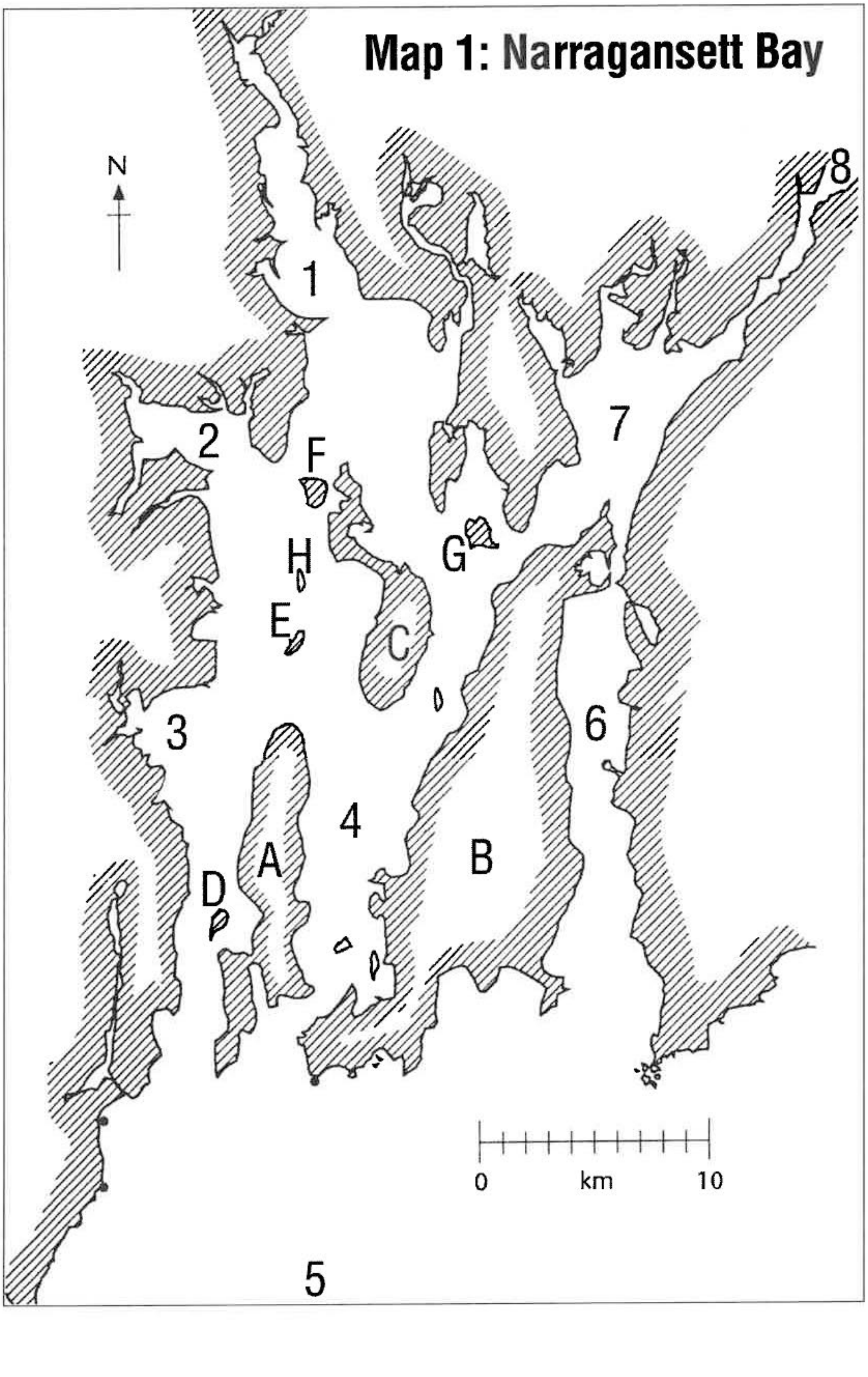
Video: *Eyewitness: Seashore.* 1996. BBC Worldwide Americas. Narrated by Martin Sheen, 35 minutes. Includes information on shorebirds, plants, and processes (including tides). Also discusses some history and myths related to the coast. Fast paced and entertaining.

Map 1: Narragansett Bay Geographic Features ▶

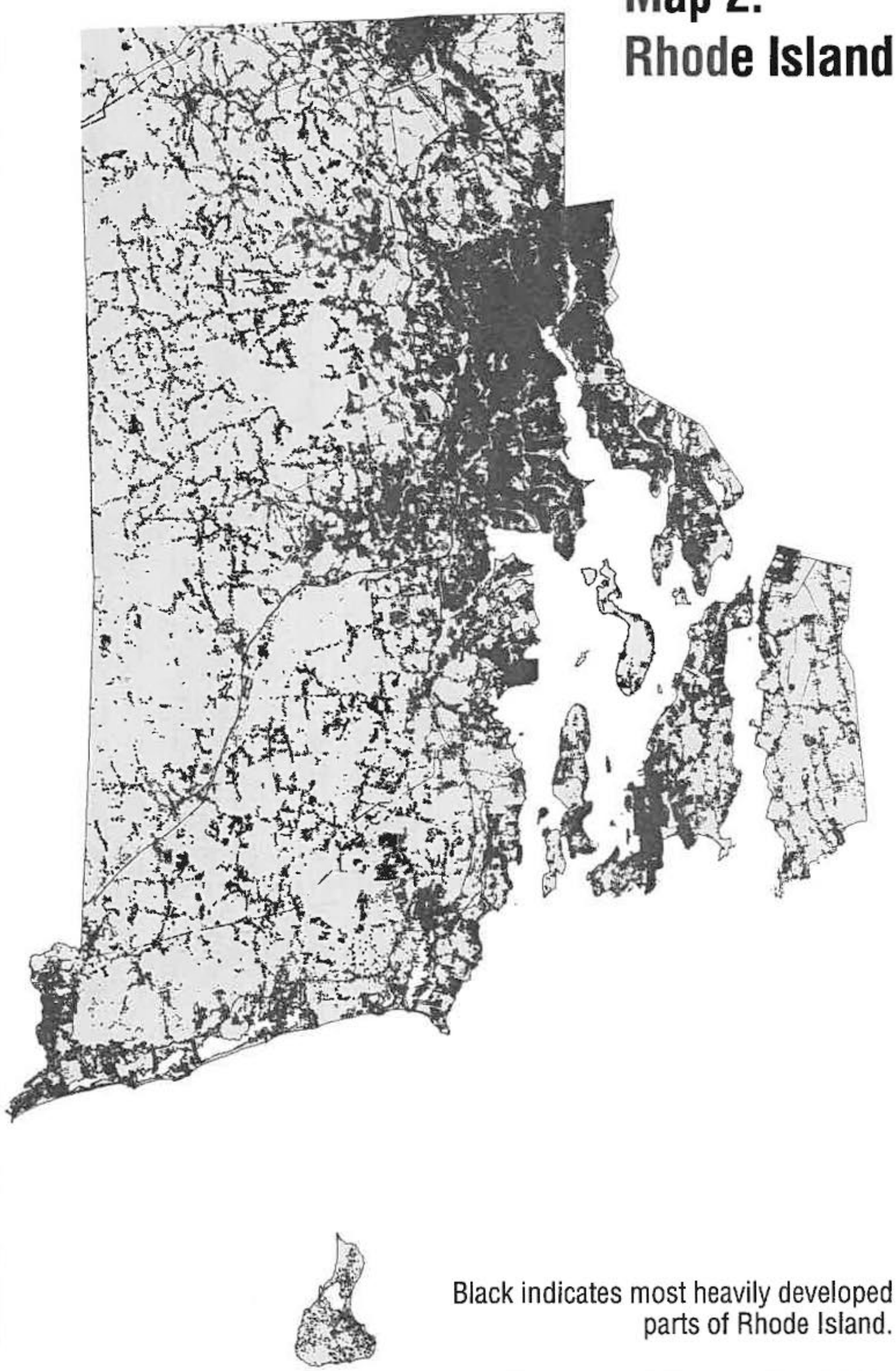
1. Providence River
2. Greenwich Bay
3. West Passage
4. East Passage
5. Rhode Island Sound
6. Sakonnet River
7. Mount Hope Bay
8. Taunton River

A. Conanicut Island
B. Aquidneck Island
C. Prudence Island
D. Dutch Island
E. Hope Island
F. Patience Island
G. Hog Island
H. Despair Island

Map 1: Narragansett Bay



Map 2: Rhode Island



Black indicates most heavily developed parts of Rhode Island.

Data from RIGIS. Map drawn by Peter Augus, Professor, Environmental Data Center, Department of Natural Resource Science, University of Rhode Island.

> **4** **The coastline is where the land and sea meet. This coming together of land and water provides important habitats for many plants and animals.**

Estuaries

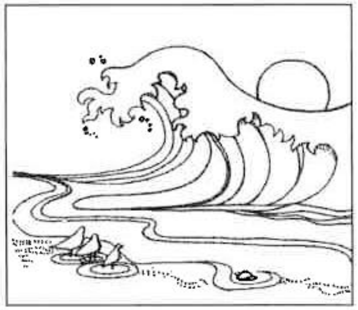
Estuaries mark the convergence of fresh water from streams and rivers with salt water from the ocean. Estuaries can be found all along the Rhode Island coast where flowing fresh water meets and mixes with salt water. Usually estuaries form at the mouths of rivers. They may vary greatly in size from the small Narrow River in Narragansett to the larger Warren and Providence Rivers to Narragansett Bay itself, one of the largest estuaries in New England.

In addition to size differences, estuaries may also differ in terms of how they were formed (geologically) and their pattern of water circulation. Narragansett Bay is a coastal plain estuary. As sea level rose due to melting glaciers and increased water temperature at the end of the last ice age (10,000 years ago), Rhode Island's low-lying coastal river valley was flooded. Coastal plain estuaries can be recognized by their shallow, gently sloping bottoms (with depth increasing toward the river's mouth). The amount of stratification (i.e. separation into density layers) of Narragansett Bay depends on location in the Bay and season. For example, in the Providence River and upper part of the Bay, stratification is high due to freshwater input. On the other hand, during times of high winds, increased tidal mixing, and decreased freshwater input, the middle and lower Bay become less stratified and more mixed.

Estuaries provide necessary habitats for a variety of plants and animals. The presence of large amounts of detritus and mineral nutrients provides nutrition for biological production. This abundance of food combined with the sheltered environment creates a perfect nursery location for larval and juvenile fish, mollusks, and crustaceans. Some of these animals make their permanent homes in estuaries while others spend only part of their life cycles there. Many species of local and migratory birds also depend on estuaries for food and nesting sites.

The recent trend of global warming is of concern to those who study or harvest food from estuaries. Already Narragansett Bay has seen a 3°C (5.4°F) rise in winter water temperature over the last 30 years. This warming may have contributed to the decline in population of commercially important ground fish (such as winter flounder) in the Bay (http://omp.gso.uri.edu/doee/doee.htm).

Sea level rise associated with global warming is also a concern. At the current rate of global warming, average sea level is projected to rise about 3–14 cm (1.2–5.5 in) by 2025 and 9–88 cm (3.5–34.6 in) by 2100. Melting of glaciers, coastal "settling" (or subsidence), and human draining of wetlands and use of water from aquifers are all factors that contribute to sea level rise. Current sea level rise in Rhode Island has been mitigated by isostatic rebound from the last glacial maximum 18,000 years ago. That is, without the weight of the ice, the land has been uplifted. With a rise in sea level, salt water would move into new areas and increased flooding of coastal areas would occur. In addition, as salt water penetrates further into the estuary, the balance between salt and fresh water would be disrupted thereby affecting the entire ecosystem.



Glossary

Density
The mass per unit volume of a substance. Basically, the weight of a substance for a given volume.

Detritus
The organic remains of plants and animals (including animal droppings), and partially decomposed materials. Detritus is an important link in many food chains.

Estuary
A semi-enclosed coastal water body with an open connection to the sea where fresh water from rivers and streams mixes with and dilutes the salt water of the ocean. Estuaries are characterized by a distinct population of animals and plants.

Habitat
The specific environment in which an organism lives.

Nutrients
Substances, such as nitrate and phosphate, needed by organisms for survival, and obtained through food and/or the surrounding environment.

Tide
The daily rise and fall of the surface of the ocean and of bays and rivers connected to the ocean. Tides are the result of gravitational forces between the earth and the sun and the earth and the moon.

Activity Ideas

Guided Reading

A guided reading is suggested to introduce students to the concept of estuaries and coastal wetlands. For this purpose, we suggest the book: *Squish! A Wetland Walk* by Nancy Luenn, illustrated by Ronald Himler. See **Resources** for full citation.

Density

Density plays an important role in the form and circulation of estuaries. Fresh river water coming in from shore tends to lie on top of the more dense salt water from the sea. The following demonstration will illustrate this phenomenon.

Objective:

- Students will observe the effects of differing densities on water placement and motion.

Materials:

1 medium-sized beaker
1 tall clear (glass or plastic) container with a wide mouth (such as a beaker)
1 eyedropper
2 contrasting colors of food dye
1 package aquarium salt

Procedure:

1. Fill medium sized beaker with tap water. Add aquarium salt (you will have to experiment with the amount that works best with the amount of water you are using). Mix thoroughly. Add the darker color of food dye and mix well.
2. Fill tall container about 3/4 full of tap water (be sure the temperature of the water is approximately the same as the water in the medium beaker) and mix in the second color of food dye.
3. Using the eyedropper, slowly and carefully add the salt water to the fresh water. This works best if you actually insert the dropper into the liquid before releasing its contents. Students should observe the salty water sinking to the bottom. As you add more and more water, a layer of mixing between the salt and fresh water should become apparent.
4. Students should draw the container of water, using color to show the location of each type of water, and be able to answer the following questions:

   a. What happened to the [color] water as it was added? Why? How was it different from the water to which it was being added?

   b. In what way does this experiment resemble an estuary?

   c. What will happen if your teacher allows the water to sit in the beaker all day?

   d. How do you think this water pattern might affect animals that live in an estuary?

Science Word Wall—Common Fish of Narragansett Bay

Objective:

- Students will discover the common fish of Narragansett Bay.

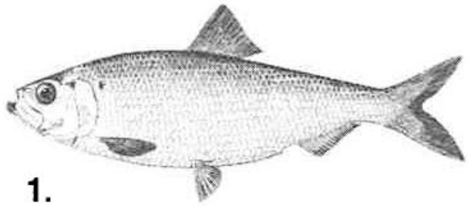
Materials:

Scissors
Fish Pictures and Names (included)
Index cards
Crayons or markers

Procedure:

1. Photocopy and enlarge the included fish pictures. Cut out the pictures and matching names.
2. Have students match the name and number of the fish with the number by its name. Then arrange the fish in alphabetical order on the wall.
3. Individually or in groups, assign students a particular fish to research. Have students discover what the fish looks like (then color the fish appropriately) and at least two facts about the fish. Facts can then be written on cards and posted on the wall for all students to read.

Fish of Narragansett Bay



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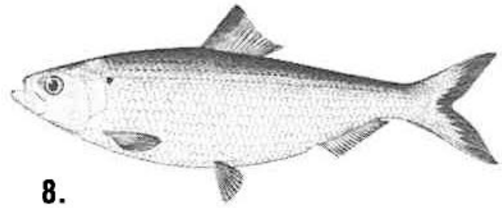

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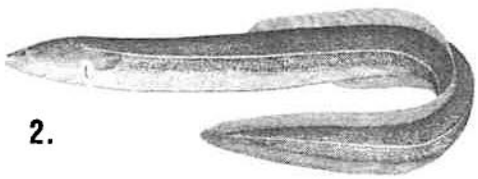

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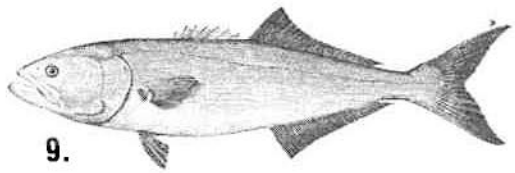

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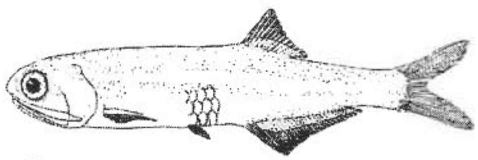

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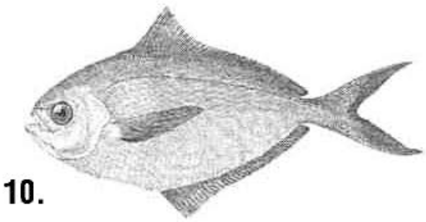

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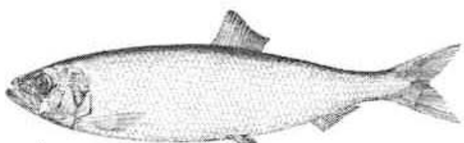

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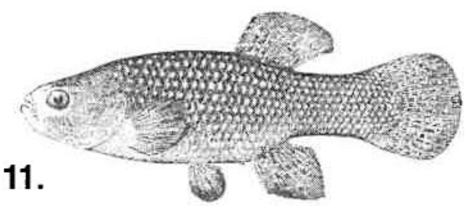

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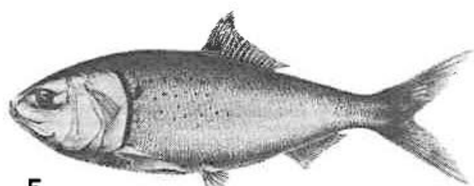

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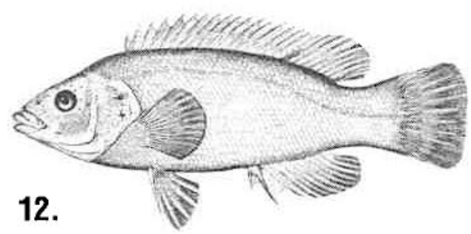

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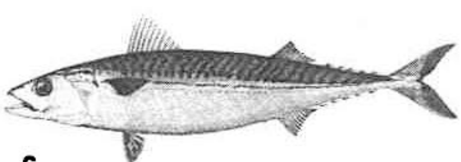

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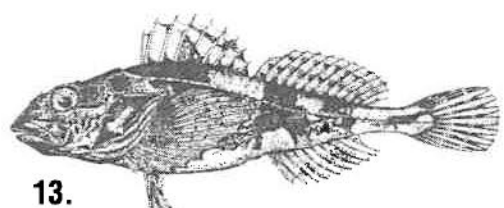

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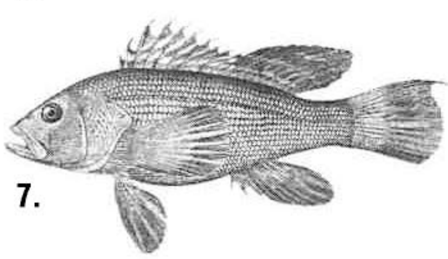

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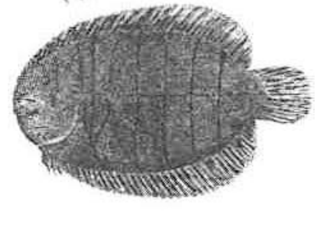
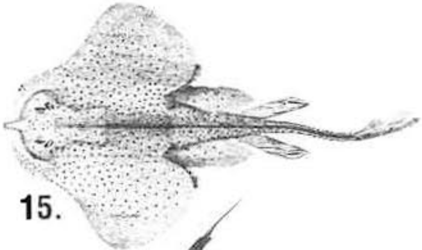


14.

Bigelow and Schroeder, *Fishes of the Gulf of Maine*

Fish of Narragansett Bay



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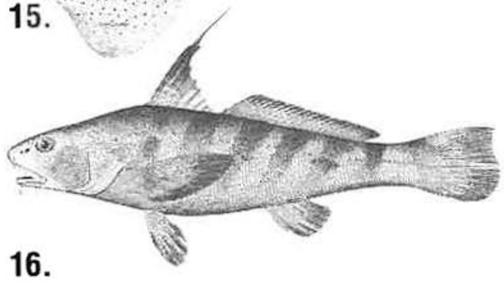

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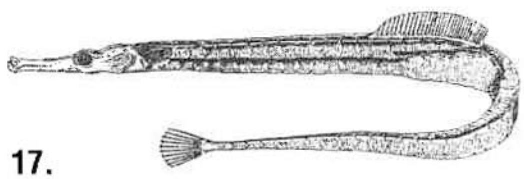

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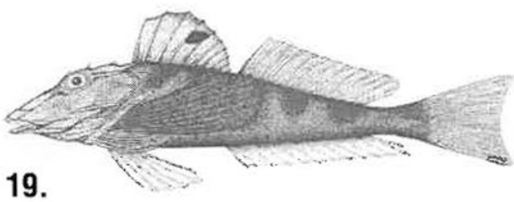

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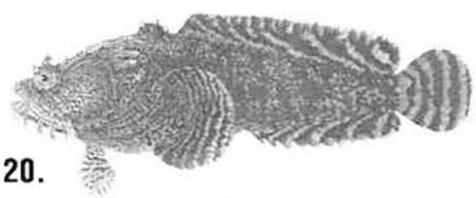

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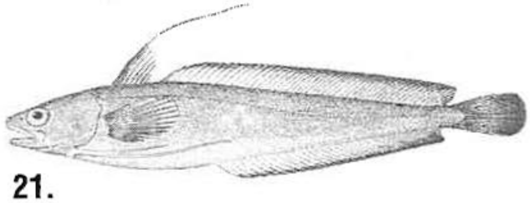

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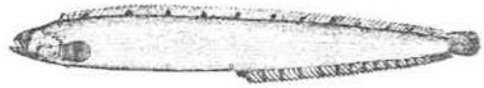

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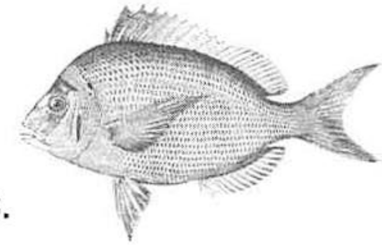

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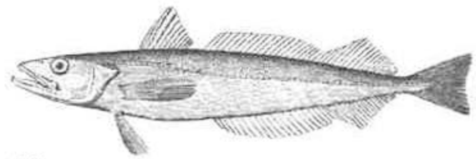

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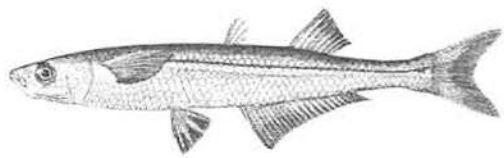

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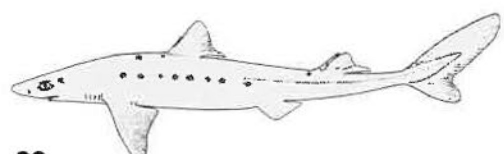

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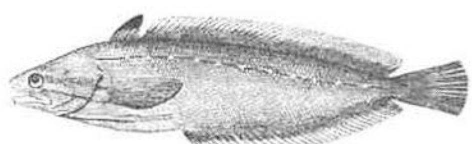

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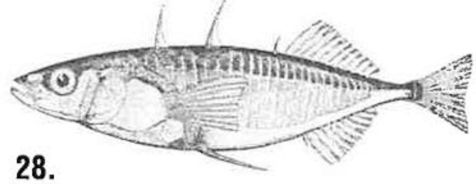
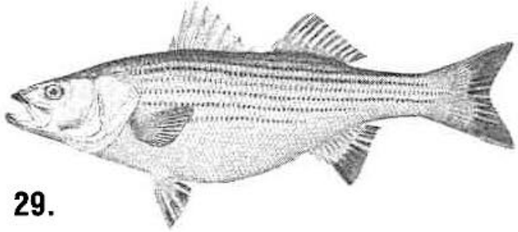


28.

Bigelow and Schroeder, *Fishes of the Gulf of Maine*

Fish of Narragansett Bay



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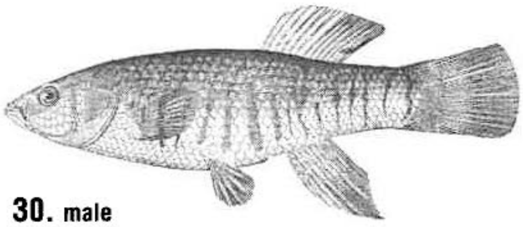

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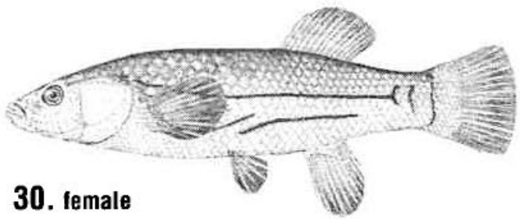

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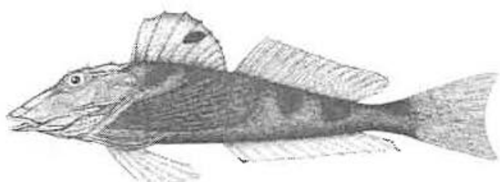

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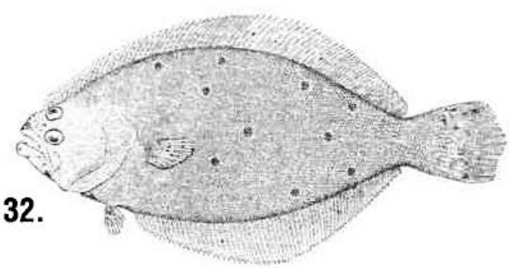

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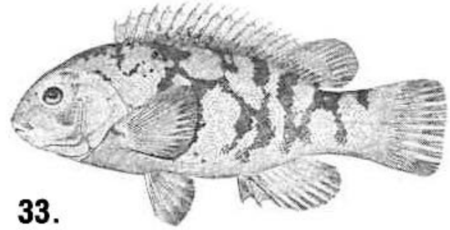

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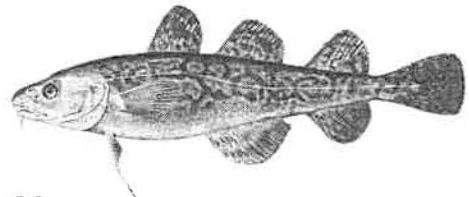

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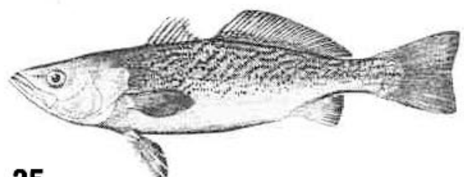

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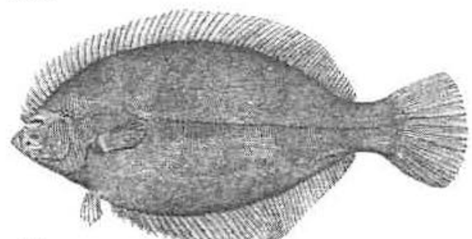

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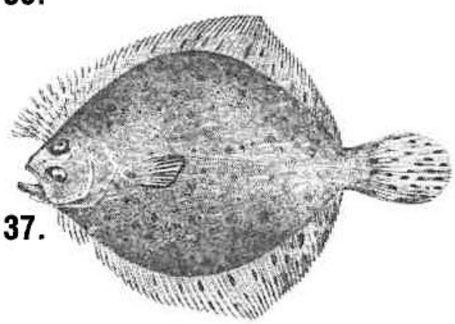


37.

Bigelow and Schroeder, *Fishes of the Gulf of Maine*

Fish of Narragansett Bay

from Cottrell, H. 2001. *Atlas of Narragansett Bay Coastal Habitats.* Narragansett Bay Estuary Program Report #01-118. Narragansett Bay Estuary Program, R.I. Department of Environmental Management, Providence, R.I.

1. Alewife
2. American Eel
3. Anchovy
4. Atlantic Herring
5. Atlantic Mackerel
6. Atlantic Menhaden
7. Black Sea Bass
8. Blueback Herring
9. Bluefish
10. Butterfish
11. Common Mummichog
12. Cunner
13. Grubby Sculpin
14. Hogchoker
15. Little Skate
16. Northern Kingfish
17. Northern Pipefish
18. Northern Puffer
19. Northern Sea Robin
20. Oyster Toadfish
21. Red Hake
22. Rock Gunnel
23. Scup
24. Silver Hake
25. Silverside
26. Spiny Dogfish
27. Spotted Hake
28. Sticklebacks
29. Striped Bass
30. Striped Killifish
31. Striped Sea Robin
32. Summer Flounder
33. Tautog
34. Tomcod
35. Weakfish
36. Winter Flounder
37. Windowpane Flounder

Carbon Dioxide, the Ocean Sink, and the Greenhouse Effect

Adapted from Betsy Stevens, *Sea Soup Teacher's Guide: Discovering the Watery World of Phytoplankton and Zooplankton,*© Tilbury House, Publishers. This activity is most suitable for middle school groups, but can be done as a demonstration for lower grades.

Objective:

- Students will create miniature greenhouses and conduct an investigation of temperature changes.

Background:

Since the beginning of the industrial revolution in the late eighteenth century, the amount of carbon dioxide in the atmosphere has increased by about 30 percent. This increase may be affecting our climate. Carbon dioxide, water vapor, and some other gases form a layer in the Earth's atmosphere. These gases prevent heat reflected off the Earth's surface from escaping into space. They absorb infrared radiation from the surface of the earth and trap heat within the atmosphere. They are commonly called "greenhouse gases" because they trap heat like a greenhouse traps heat.

As the human population increases, the burning of fossil fuels increase, and the amount of atmospheric carbon dioxide also increases. Increased greenhouse gases may result in climate changes. We know that when carbon dioxide and other greenhouse gases increase in the atmosphere more heat is trapped and the climate warms. Since the increase in greenhouse gases is relatively rapid due to human activities, temperatures may increase on a scale of centuries rather than over millennia, as they did in the past.

Oceans store huge amounts of heat as well as dissolved carbon dioxide from the air. This is called the "ocean sink." The oceans act as buffers against climate change. However, increased solar heating and evaporation produce surface waters that are warmer and saltier than normal. Eventual impacts of ocean changes are uncertain at this time.

Scientists study records of past oceanographic and climatic conditions such as seasonal variability of sea surface temperature, salinity, nutrient content, and other elements by examining natural records in deep-sea sediments, ice, and corals. Questions to be answered by scientists include:

- How have these factors varied in the distant past?
- How has this variability changed over time?
- What is the response of the ocean to atmospheric changes?
- What are the issues that should concern us?
- What can we do to reduce human impact on the atmosphere and oceans?

Materials: (per pair of students)

Copy of *Student Discovery Master 7: The Greenhouse Effect* for each student.

2- gallon jars or 2-liter clear soda bottles with labels removed and tapered portion of top cut off

1 piece of clear plastic wrap about 12" x 12"

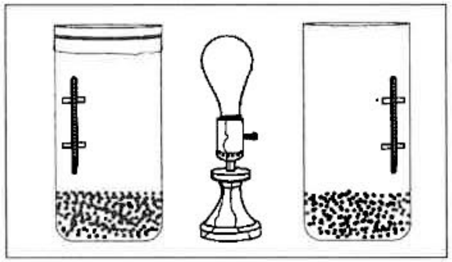
2 thermometers

1 rubber band

2 cups soil or sand

Desk lamp with at least a 100-watt bulb

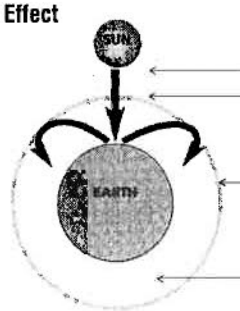
Tape



Procedure:

1. Collect and organize the materials for this investigation including data sheets for each group.
2. Divide the class into pairs.
3. Give a simple introduction to the investigation. State that the students will construct simple gallon-jar greenhouses and record the temperature in each jar for fifteen minutes. After the class has collected the temperature data, introduce the topic of "the greenhouse effect" by discussing how carbon dioxide in the atmosphere acts as a heat trap for the sun's energy reflected from the earth just as the plastic over the jar or glass in a greenhouse traps the heat energy.
4. Hand out the simple instructions and the data sheet.
5. After the students complete collecting data, allow enough time for them to graph the data and answer the questions on the student handout.
6. Discuss the results and use the results as an introduction to "the greenhouse effect."

The Greenhouse Effect



Student Discovery Master 7
The Greenhouse Effect

Name ______________________________ **Date** ____________

Class ______________ **Names of Partners** ______________________________

Challenge:

To model the greenhouse effect and record temperature data when chambers are exposed to heat.

Introduction:

The earth is surrounded by a layer of gas that acts a lot like the glass in a greenhouse. The layer of gas allows the sun's energy to come in but does not allow it all to get out. This is important because without the layer of gas trapping some heat the earth would be much colder. The trapped heat has raised the temperature of the earth about 60° F higher than it would be otherwise. The naturally occurring gases in Earth's atmosphere have created a temperature balance, and living things have adjusted to it.

Unfortunately, because the amount of these "greenhouse gases" has increased, the atmosphere may be trapping too much heat. One of the greenhouse gases, carbon dioxide, has increased about 30 percent in only 100 years. Some scientists are afraid that the earth may some day become too hot.

Why is the amount of carbon dioxide in the atmosphere increasing? As humans burn fossil fuel such as oil, coal, and gas, and burn forests, large amounts of carbon dioxide are released into the atmosphere. The oceans store huge amounts of dissolved carbon dioxide from the air, and they store heat. But the oceans have not been able to store the extra amounts released by burning so much fossil fuel and forests.

The greenhouse effect and global warming are important areas of scientific study. We do not have all the answers yet.

Instructions for Assembling Greenhouses:

1. Check to make sure you have all the materials listed.
    - 2-gallon jars or 2-liter clear soda bottles with labels removed and slanted portion of top cut off
    - 1 piece clear plastic wrap about 12" x 12"
    - 2 thermometers
    - 1 large rubber band
    - 2 cups soil or sand
    - desk lamp with at least a 100-watt bulb
    - tape

Student Discovery Master 7
The Greenhouse Effect

2. Check the thermometers to be sure they read the same temperature value. If they do not, make a note to add or subtract the error from the temperature readings made with that thermometer.
3. Place 1 cup of soil in the bottom of each jar.
4. Tape a thermometer on the inside of each jar with the scale facing out so you can read it.
5. Cover one jar with plastic wrap and secure with the rubber band.
6. Set the jars an equal distance from the light so it shines into the side of the jar. DO NOT TURN THE LIGHT ON YET. Make sure the thermometers face away from the light.
7. Which jar is the control?
8. Set up a table for recording your data. One of you will read the temperature and the other will record it.
9. Make a prediction about which jar will become the warmest.
10. Will the temperature level off as long as the light shines?
11. Now, turn on the light and record the temperatures every two minutes for 15 minutes on the data graph.
12. After 14 minutes, stop taking readings. Make graphs of your data. Be sure to fill in blanks and adjust for temperature differences between your thermometers.

Answer the following questions and hand in to the teacher:

1. What trends do you observe in each jar?

2. Was there a difference between the temperatures in each jar? Describe.

3. Did the temperature in either jar level off? Why or why not? (Hint: Does any heat escape through the glass?)

4. How does this experiment correspond to the real earth?

Extension Activity:

Research and/or discuss the possible effects of rapid and significant global warming. Among the possibilities are the impacts on health (The United States might be at risk for tropical mosquito-carried diseases); agriculture (the growing season in northern areas would be lengthened); forests (forest pests would thrive); wildlife (many species would become extinct because their habitats would shrink, shift, or disappear); and oceans (currents and fishery areas could change and coastal areas could flood).

How Tides Work[1]

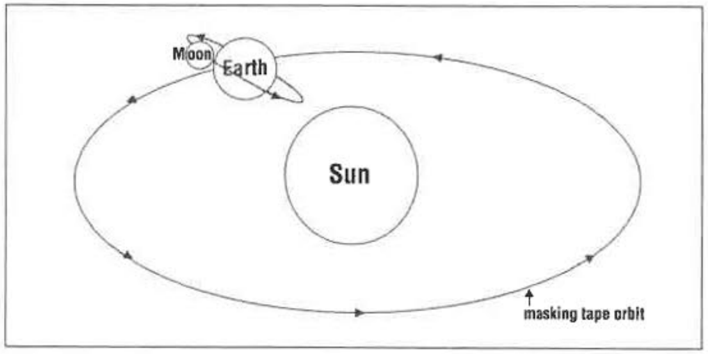
Explaining to a group of young children what the tides are is not nearly as difficult as answering the many "why" questions that follow. Generally it is sufficient for children to understand that the moon makes the tides rise by pulling on the side of the Earth that is facing the moon. The following demonstration serves as an introduction to the movement of the planets, and to improve the children's understanding of the tides.

Objective:

- Students will use their own physical presence to model the tides and what causes them.

Materials:

- Medium-sized ball
- Masking tape
- Small ball



Procedure:

1. The children sit on the masking tape orbit. They pass a medium sized ball (Earth) from one to another, each child turning it once on its axis. Each child moves the Earth through one day (one rotation).
2. Now have one child carry a small ball (the moon) around each child who has the "Earth." Question the children, leading them toward an understanding that the moon faces different areas on earth at different times.
3. If a large globe or ball is available, a furthur demonstration of the movement of Earth and the moon can be made.

Tidal Bulges[2]

In this activity, a balloon filled with water represents the oceans and is used to show how gravity affects the oceans and causes tides. The balloon and the attached pattern of Earth are a model of our planet. You'll be using Earth's gravitational pull to show how the moon causes the water in the ocean to bulge outward.

Objective:

- Students will model the role of gravity in creating tides.

Materials:

9" round balloon (blue if possible)
2" cut out of Earth (included)
Water
Tape

Procedure:

1. Fill the balloon with water and tie a knot at the mouth to keep the water inside.
2. Cut out and color one of the two inch Earth patterns included here and tape it to the middle of the balloon.
3. Support the balloon at the bottom and the top with your hands. The water in the balloon will be even around the circle of the Earth.
4. Take your hand away from the bottom of the balloon while maintaining a firm grip on the top. The balloon elongates or bulges at the bottom. The gravitational pull of Earth is pulling the water in the balloon down. This is exactly what happens to the oceans. The moon's gravity pulls the oceans towards the moon, causing the oceans to bulge outward. That's high tide.

Standards Met[3]

Activity	Standard	
Density	S1b	Position and motion of objects
	S3a	Properties of Earth materials
	S8a	Investigation through experiment
Fish of Narragansett Bay	S2a	Characteristics of organisms
	S8d	Non-experimental research using print and electronic information
Global Warming	S3c	Changes in Earth and sky
	S4a	Understanding big ideas and unifying concepts
	S6a	Uses technology and tools to gather data and extend the senses
	S6b	Collects and analyzes data
	S7b	Uses facts to support conclusions
	S8a	Conducting a fair test
How Tides Work	S3b	Objects in the sky
Tidal Bulges	S1a	Properties of objects and materials
	S3a	Properties of Earth materials
	S3b	Objects in the sky
	S3c	Changes in Earth and sky
	S4a	Big ideas and unifying concepts
	S5a	Asks questions about natural phenomena
	S5b	Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena

References

Carlozzi, C., K. King, and W. Newbold. 1975. *Ecosystems and Resources of the Massachusetts Coast.* Institute for Man and Environment and Massachusetts Coastal Zone Management Program.

Houghton, J. 1997. *Global Warming: The Complete Briefing.* Cambridge University Press.

Office of Marine Programs (University of Rhode Island) *Discovery of Estuarine Environments* Website (http://omp.gso.uri.edu/doee/doee.htm).

Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: Synthesis Report. Summary for Policymakers. An Assessment of the IPCC.

Resources

Fiction:

Cowan, C. and M. Buehner. 1997. *My Life with the Wave.* Lothrop, Lee, and Shepard Books. Based on the story by Octavio Paz, this is a beautiful book. It can be used to introduce children to the concept of an ever-changing sea.

Gay, M.L. 1999. *Stella, Star of the Sea.* Groundwood Books. A cute and imaginative story of a day at the beach. This is a good book to introduce young readers to the study of the coast, and allow them to explore the topic first with their imaginations.

Luenn, N. 1994. *Squish! A Wetland Walk.* Macmillan Publishing Co. A beautifully illustrated introduction to wetlands and the creatures that live in them.

Nonfiction:

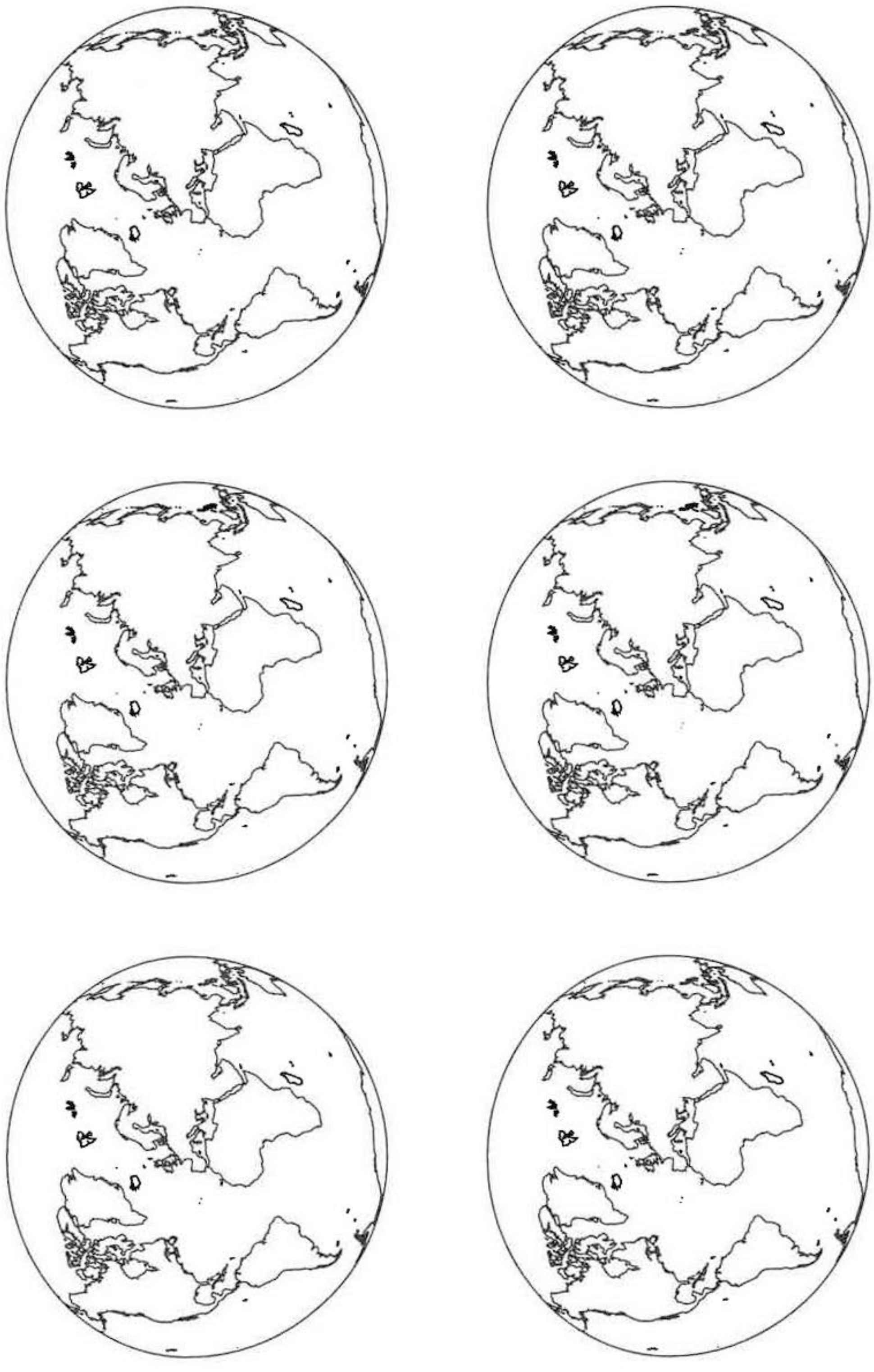
Discovery of Estuarine Environments Web site, Biota Gallery. http://omp.gso.uri.edu/doee/biota/biota2v.htm

Ely, E. 2002. *An Overview of Narragansett Bay.* Rhode Island Sea Grant, Narragansett, R.I. 8pp. A brief overview of fisheries, history, geology, and recreation on the Bay. Pamphlet available from R.I. Sea Grant, or in PDF form (http://seagrant.gso.uri.edu/bookstore).

Kavanagh, J. 2002. *Seashore Life: Educational Games and Activities.* Waterford Press, Ltd. A resource for teachers. Order by phone (1-800-434-2555) or online (www.waterfordpress.com).

Maydak, M. 1998. *Wetlands: A Wild Stickers Book.* Dog-Eared Publications. A pocket-sized collection of stickers, good for showing children the types of animals that live in wetlands.

Earth Cut Outs



5 Along our coast we find barrier beaches and dunes, rocky shores, coastal ponds, salt marshes, and tidal creeks. These are all coastal resources. The birds, beach grass, fish, and other plants and animals that live in or near the ocean are resources, too.

Humans and the Environment

Like most organisms, humans need air to breathe, food to eat, and water to drink. For all of these needs, we depend upon the world around us. Humans also have the ability, on a large scale, to change the environment in which we live. Careless actions can pollute the air or water, or damage our food supplies.

In addition to those things that we need in order to survive, humans also use other resources present in the environment such as trees for houses and paper and oil and gas for fuel. All of these materials, both the essential and nonessential, are considered natural resources.

The first people to inhabit southern Rhode Island set up their villages along the edges of salt ponds. Later, Native American people, the Narragansett, had their summer residences along the R.I. salt ponds, where they fished for food and harvested quahogs for wampum. In the winter they moved inland and made use of more land-based resources. While winter residences were more permanent, summer camps were only used for several years. They were moved to avoid overusing a particular area. Their reliance on the land and sea for food and shelter fostered a deep respect and intimate relationship with the environment. Because of this relationship, pollution and overuse of coastal resources were not problems until the arrival of European settlers.

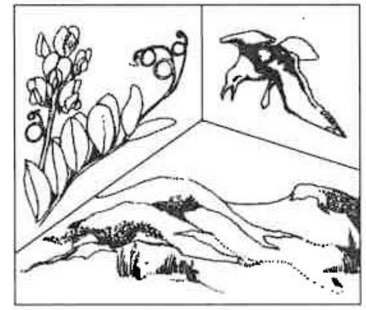
Glossary

Coastal Management
Includes first the inventory and analysis of coastal resources and then the formulation of policies and regulations that ensure the wise management, utilization, and development of coastal resources.

Coastal Resources
Anything of value within the coastal region. A coastal resource can have monetary value (oil, ports, fish), ecological value (plankton, dunes, shorebirds), cultural value (historic areas), aesthetic value (scenic bluffs, clear blue water), recreational value (marinas, beaches), or any other kind of value.

Natural Resources
Any naturally occurring material used by humans.

Wampum
Cylindrical beads made from quahog (purple wampum) or whelk (white wampum) shells. Wampum was used by Native Americans for ceremony, decoration, record-keeping, and trade.



Activity Ideas

Native Stories[2]

Oral storytelling was very important in Native American cultures since there was no written language. Storytelling was the way people passed on traditions, myths, and their history. For this reason storytellers were a vital part of the Native American culture. Most Native American stories centered on the relationship between humans and nature and explained how things came to be the way they are. In this activity your students will join in this native tradition by telling their own stories. They will have to decide what story they would like to tell, plan out the story so that it makes sense, and illustrate the story if they would like. When everyone has completed his or her story, have a storytelling celebration.

Objectives:
- Students will experience the cultural importance of storytelling.
- Students will compose and tell their own stories, following a specific formula.

Materials:
Story Guide worksheet (included)
Paper
Pencils
Crayons
A variety of Native American stories (see **Resources**)

Procedure:
1. Explain to your students the oral tradition of Native Americans and its importance in transmitting their traditions, cultural practices, and history to each generation.
2. Read one or more stories from the **Resources** list (or a Native American story of your choice). Try to find a story that relates to the coastal Woodlands Indians of this region or some other story that relates the native relationship to the sea.
3. Each student will be writing their own story and then telling it to the class. Ask each student to think of a story that he/she would like to tell.
4. Give each student a copy of the Story Guide worksheet. Students can draw pictures or write words on the sheet to plan what they will tell. Their stories don't have to be rooted in fact but should explain some aspect of the marine environment or some thing about a marine animal or plant. Try to concentrate on marine animals or something about the ocean. (Examples: why there are waves, why clams and scallops squirt water, why shorebirds run up and down the beach, or how the quahog got its name).
5. Have your students practice their stories. When everyone is ready, hold a storytelling celebration in which the students will tell their stories.

Making Wampum[2]

Native Americans wasted very little from the animals they harvested or hunted. The coastal natives of New England harvested clams and whelks for their meat but they also made use of their hard shells. Whole clam shells were used as tweezers to pluck facial hair, as utensils such as cups and bowls, and as hoe blades for gardening. Beads were carved from the shells of clams and whelks to make wampum. Natives used a bow drill to cut cylindrical or tubular pieces from the shells of mollusks. The Narragansett Indians of Rhode Island were among the few coastal New England tribes to manufacture shell beads. Purple beads were drilled from quahog or hard-shelled clam shells and thus were less available and more valuable than the white beads that were carved from whelk shells. *Wómpum* is the Narragansett word for the white whelk beads and *suckaúhock* is the term for the purple beads made from the quahog.

Contrary to popular belief, wampum was not used as money among native peoples. Wampum was strung on single strands and worn as an ornament. More complicated multiple strands were woven together to form belts that depicted pictorial messages. These belts were used to commemorate special events or to communicate messages among tribes. Some tribes used wampum for trade or gifts. It was only with the arrival of Europeans that wampum was used as money because the colonists had no coins to use for trading.

In this activity your students will make wampum beads from macaroni and create patterns from the colored beads that they will then string.

Objective:

- Students will learn how Native Americans used some of Rhode Island's natural resources.

Materials:

Dried macaroni (ditalini or other small cylindrical pasta)
Food coloring
Rubbing alcohol
Yarn or string
Plastic sandwich bags (one for each color)
Graduated cylinders or measuring spoons
Paper towels
Newspaper

Procedure:

1. Cover the work surface with newspaper in case there are any spills. You may want to divide your students into teams that will dye macaroni a specific color. That way all the macaroni will be dyed and dry at the same time.
2. Prepare the macaroni "beads" by putting 2 tablespoons (30 ml) of rubbing alcohol into a plastic bag. Have the students measure out this quantity into the bags (or into weighing boats or some other small receptacle that is easily handled by the children).
3. Add several drops of food coloring to the bag and shake to mix alcohol and color.
4. Pour desired amount of macaroni into the bag.
5. Hold the bag tightly closed and shake until the macaroni is well coated.
6. Spread the macaroni out on paper towels to dry (takes about ten minutes).*
7. Repeat this process with other colors.
8. While you're waiting for the macaroni to dry, discuss how Native Americans used beads to create a pattern that had a meaning. Explain that they will be creating a pattern using colored macaroni.
9. Give each student a handful of several colors of macaroni.
10. Have them lay out several patterns using their colored macaroni.
11. They should choose their favorite pattern and string the macaroni on yarn or string.

*Note: Don't touch the dyed macaroni with your hands until it is dry, otherwise the color will transfer to your hands as well. Colored macaroni should not be eaten.

Related activities:

a. Assign a value to each color of macaroni. Have students determine the value of their strand of wampum.
b. Challenge your students to make a four-strand pattern. It will be easier to accomplish this if they plan the pattern on graph paper.

Coastal Resources

Objectives:

- Students will explore some of Rhode Island's coastal resources.
- Students will share their knowledge with the rest of the class.

Materials:

Pencils
Colored pencils
Writing paper
Posterboard
Markers
Short readings on beach grass, lobsters, quahogs, and piping plovers (included)

Procedure:

1. Read the following paragraphs about some of Rhode Island's coastal resources to the students (or have them read the paragraphs aloud or by themselves).
2. Ask students to respond to the following questions, either in a discussion or through writing:

a. In what way is each of these organisms a natural resource?
b. How would you explain to your parents and friends why each is important to us, and why we must all take responsibility for protecting them?
c. How might we help to preserve each of them?

3. Have students share their answers with the class, perhaps by making posters to illustrate their responses.

Standards Met[3]

Activity	Standard	
Native Storytelling	S2c	Organisms and environments
	S7c	Communicates in a form suited to the purpose and the audience
	S8d	Non-experimental research using print and electronic information
Making Wampum	S5f	Works individually and in teams to collect and share information and ideas
	A5a	The student works with others to complete a task
Coastal Resources	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts (cause and effect)
	S7b	Uses facts to support conclusions

References

Narragansett Indians: Life Along the Bay. (R.I. Sea Grant) http://seagrant.gso.uri.edu/G_Bay/Inhabitants/sekatau.html

Cottrell, H. 2001. *Atlas of Narragansett Bay Coastal Habitats.* Narragansett Bay Estuary Program Report #01-118. Narragansett Bay Estuary Program, R.I. Department of Environmental Management, Providence, R.I.

Ely, E. (updated by A. Argentieri). 2002. *Salt Ponds of Rhode Island White-paper.* Rhode Island Sea Grant.

New York State Department of Environmental Conservation. http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/piplfs.html

Resources

Fiction:

Connolly, J.E. 1985. *Why the Possum's Tail is Bare and Other North American Indian Nature Tales.* Stemmer House Publishers. A collection of Native American stories. Although there are not many stories in this collection dealing with marine or aquatic topics, they can be used as models for the storytelling activity suggested here.

Holling, H.C. 1967. *Pagoo.* Houghton Mifflin. The story of a hermit crab and his travels. The illustrations in this book are excellent.

Non-Fiction (Seashore):

Arthur, A. 1989. *Eyewitness Books: Shell.* Alfred A. Knopf, Inc. An introduction to animals with shells, including mollusks and crustaceans.

Parker, S. 1989. *Eyewitness Books: Seashore.* Alfred A. Knopf, Inc. An overview of where land meets sea.

Video:

Eyewitness: Shell. 1996. BBC Worldwide Americas. Narrated by Martin Sheen. 35 minutes. Includes information on mollusks, turtles, and crustaceans. Shell formation and historical and mythical aspects are also discussed.

Non-Fiction (Native Americans):

Doherty, K. and Smolinski, D. 1994. *The Narragansett.* Rourke Publishing Group.

Flanagan, A.K. 1998. *The Wampanoags* (A True Book). Children's Press. Contains a list of print and online resources.

Koller, J. 1999. *Nickommoh! A Thanksgiving Celebration.* Atheneum Books. Beautifully illustrated and authentic narrative about a Narragansett People's thanksgiving celebration.

Newman, S.P. 2000. *The Pequots.* Franklin Watts. Contains a list of print and online resources.

Simmons, W. 1991. *The Narragansett.* Chelsea House Publishers.

Places to Visit

East Beach, Moonstone Beach, Trustom Pond, Quicksand Pond
Piping Plovers nest on these beaches from April–mid-September.

Haffenreffer Museum of Anthropology
300 Tower St.
Bristol, RI 02809
(401) 253-8388, http://www.brown.edu/Facilities/Haffenreffer/

Len Cabral, nationally renowned Native American storyteller
www.lencabral.com for booking and tape orders.

Narragansett Indian Tribal Historic Preservation Office
228 Carolina Nooseneck Rd.
Richmond, RI 02896
(401) 539-1190

Pequot Museum, Mashantucket, CT
http://www.pequotmuseum.org

Story Guide

I want to tell you about this animal, plant, or feature of the ocean:

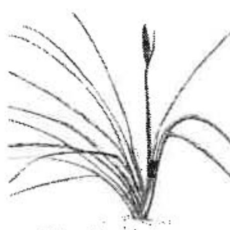
And why it . . .

This is the whole story:

Coastal Resource Readings

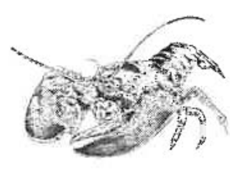
Quahog

Quahogs are a type of clam living in clay, sand, mud, or gravel at the bottom of Narragansett Bay. All clams are mollusks, related to snails, squid, and mussels. Like mussels, quahogs have two opening and closing halves to their shell—the word for this is bivalve. Many years ago, before Europeans came to this country, Native Americans used beads made from quahog shells to create wampum, which was then used in ceremony, as gifts, and for trading. Today, many Rhode Islanders enjoy eating these animals—either clams that they catch themselves or those caught by commercial fisherman.



Beach Grass

Beach grass is a plant that grows well in the salty, sandy environment of the beach. Just like grass in the park keeps soil from washing away in the rain, beach grass helps to keep sand dunes in place. When you go to the beach, you will notice that people are asked to keep off the beach grass and walk on the boardwalks. This is because the plant is easily damaged. Once the plant is damaged, the shape of the beach will change.

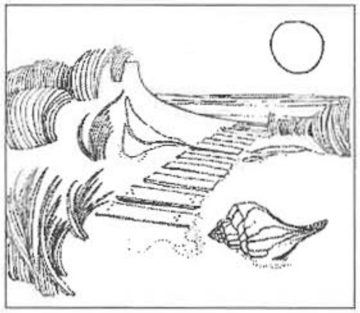


Lobster

Lobsters live on rocky bottoms of Narragansett Bay. They are crustaceans, related to crabs and shrimp. Many people like to eat lobsters, so they are caught by commercial fishermen in great numbers to then be sold to individuals and restaurants.

Piping Plover

Piping plovers are small birds that dig very shallow nests directly in the sand on beaches during the summer in Rhode Island. Piping plovers eat small marine animals such as worms, insect larvae, crustaceans, and mollusks. They are "threatened" in the United States partly because beach traffic (including unaware beach goers) and development of coastal areas destroy their nests.



6 **Beach grass grows along the beaches and helps form sand dunes. We can help protect the dunes by walking on boardwalks or marked trails and not on the beach grass.**

Coastal Pond Complexes

Rhode Island's coastal ponds (referred to as salt ponds by Rhode Islanders) and barrier beaches were formed by rising sea levels after the last glaciation. As waters rose, depressions in the coast were filled in and small estuaries created. Meanwhile, longshore drift (currents parallel to the shore) deposited sand just offshore. Continued accumulation caused the estuary to become isolated from the ocean, thus forming a salt pond and its associated barrier beach (see http://omp.gso.uri.edu/doce.htm for more information). During storms, tidal levels rise and a breachway that connects the pond to the ocean can be formed. Breachways allow for exchange of water and organisms between the ponds and the sea. Humans have modified this process by digging permanent breachways in most of Rhode Island's coastal pond complexes.

Salt ponds are constantly being modified by processes of erosion and sediment transport. Currently, average sea level is rising at approximately one foot per century. If this rate continues, the entire coastal pond/barrier beach system of Rhode Island will migrate landward. This occurs because severe storms cause high energy waves that remove sand from the seaward side of the barrier beach, and deposit it on the seaward side of the pond. As a result, the ponds will become shallower and smaller.

Rhode Island's coastal pond complexes consist of the pond, the barrier beach with its sand dunes, salt marshes, breachways, and in some cases coves, and freshwater wetlands and streams. All of these seemingly independent features are actually very closely interrelated. In many cases altering one will produce some variation in the physical quality of another.

Salinity in the coastal ponds varies depending on the amount of freshwater input and the amount of saltwater input. Physical separation of salt and freshwater sources can cause differing salinity within the pond. This allows organisms with a wide range of salinity tolerance to coexist, thus leading to greater diversity within the pond as a whole.

Development of the land surrounding Rhode Island's salt ponds has been on the rise. The 1990s saw a 12.5 percent increase in average population living in the four towns that surround the salt ponds. This is almost three times the percentage of growth for the entire state during that same period!

With development comes pollution. Residents in most of the pond region use individual sewage disposal systems. Some of these are old, inadequate, or ill-maintained. As a result, wastewater may contaminate groundwater that flows into the ponds. Increased nitrates from waste make their way into the water. In turn this may lead to eutrophication and anoxia. With wastewater contamination also comes the danger of fecal coliform bacteria contamination. This has led to some permanent shellfish closures in several of the ponds.

Recently strides have been made toward restoring Rhode Island's salt ponds. This effort became necessary in 1996 when the ship *North Cape* spilled 828,000 gallons of oil, damaging eelgrass beds and killing birds, lobsters, and shellfish. The restoration off the R.I. coast, near the salt ponds, continues today. (See http://www.darp.noaa.gov/neregion/ncape.htm for details about the effects of this spill and restoration following the spill).

Sand Beaches

Sandy beaches are among the most inhospitable habitats for marine organisms along the Rhode Island coast. Constant wave exposure and wind energy make the beach itself quite unstable. The instability caused by shifting sands prohibits higher plants and seaweed from anchoring, thereby leaving only unicellular algae and imported detritus from salt marsh and eelgrass habitats as the staple food source.

In addition to substrate instability, organisms on sand beaches must adapt to high wave energy and drying and heat in the summertime. Therefore, most beach animals are small deposit or filter feeders that live buried in the sand. Crabs, snails, and clams are some common beach invertebrates. In addition, beach fleas, flies, crabs, and beetles can be found in abundance along the high tide line, feeding on detritus left by the retreating water.

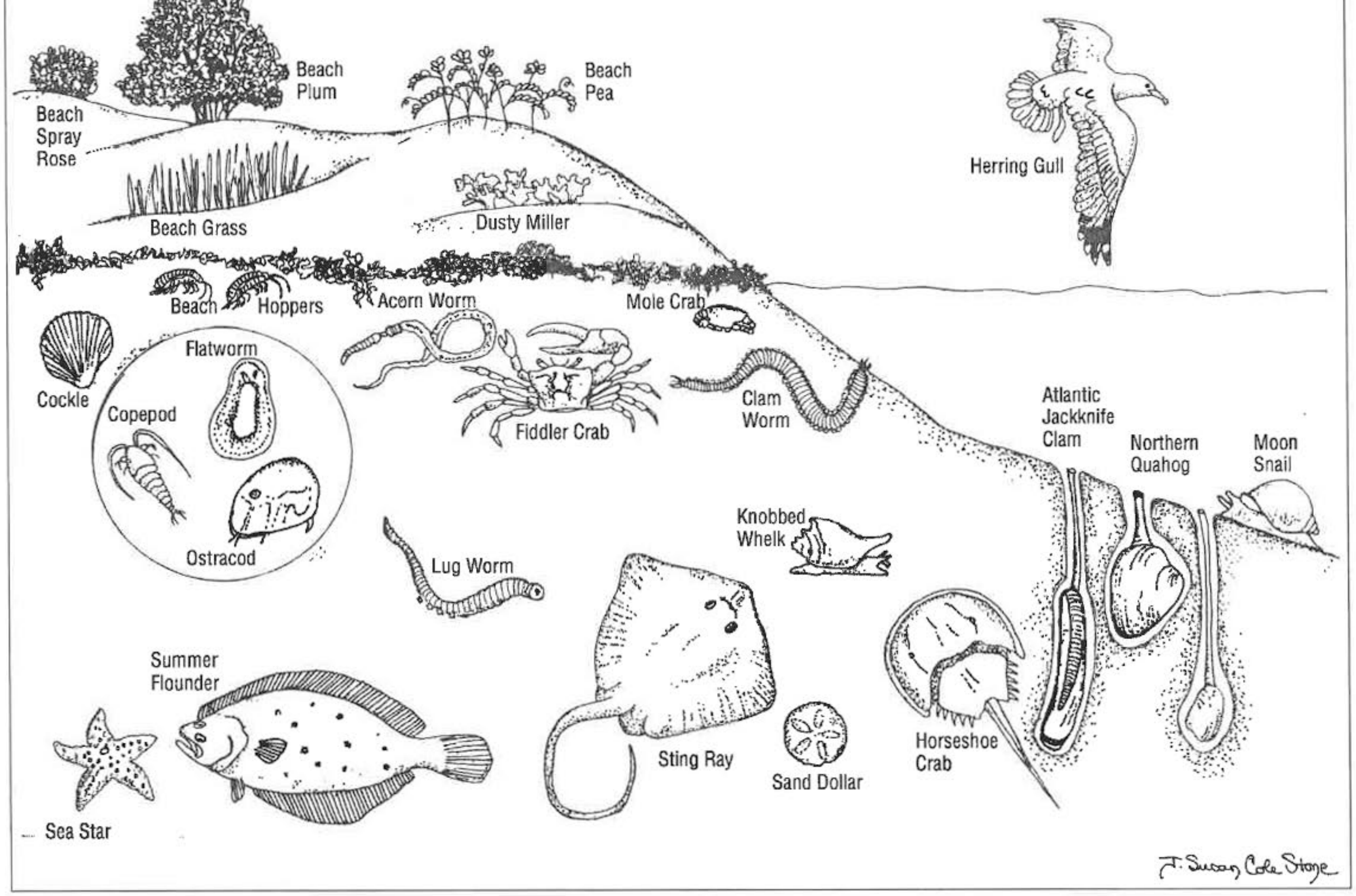
Birds, including terns, gulls, and plovers, often build their nests in the high beach area (seaward of the dunes). Clams and crabs are good food sources, as are small invertebrates feeding along the high tide line. Unfortunately, the areas in which these birds nest are also areas of high human traffic, both pedestrian and vehicular. Such human impacts can destroy nests, killing eggs and hatchlings.

Dune plants such as beach grasses also suffer from human impact. Beach grass is important as a stabilizer of the dunes. Its extensive root system keeps the sand in place and allows the dunes to maintain their integrity both as habitat and as our first line of defense against storms and hurricanes.

Seasonal differences in beach structure can be observed. During the winter heavy storms cause beach erosion, leading to a steeper, more narrow beach profile. In contrast, there is an influx of sand during the summer causing the beach to be rebuilt. However. large summer storms will also remove sand from the beach. For more than 30 years, students at the University of Rhode Island's Graduate School of Oceanography have been graphing beach profiles and calculating sand volume at East Beach in Charlestown, R.I. This gives us a good picture of how the beach changes in the short term (due to storms, seasons, etc.) and how it is changing over the long term (go to http://omp.gso.uri.edu/doce2.htm and click on "history" under barrier beach to see examples).

In Rhode Island, sand beaches are found from Westerly to Sakonnet. Erosion of beach sand can be a serious problem for people who own property along the coast. Groins have been built in some places to prevent erosion, but this can cause problems as well. Groins also prevent the longshore currents from depositing sand on the downstream side of the groin. Thus while sand volume is maintained on one side of the structure, it is lost on the other.

Sandy Beach Community



Glossary

Anoxia
A condition of no oxygen, which may be brought on by poor water circulation or over-utilization of oxygen due to some event (such as a large die-off).

Barrier Beach
A beach parallel to the shore but separated from the mainland by a small lagoon (salt pond).

Beach
The sandy or pebbly area of the shore washed by the tide and waves. This is where land and water meet.

Beach Grass
A grasslike plant with a network of underground roots and stems that help anchor and build the dunes.

Boardwalk
An elevated pathway across the dunes constructed of wooden planking that provides access to a beach without disturbing the beach grass.

Breachway
A natural or man-made inlet cutting through a barrier beach (or island), thereby connecting the salt pond to the ocean. (See http://omp.gso.uri.edu/discovery/barrierbeach/physchar/g15.htm#bott for a photo of the Charlestown breachway).

Coastal Pond Complex
Land/water complexes that consist of a barrier beach, sand dunes, marsh, and pond. In some cases small offshore islands and freshwater wetlands and streams are included.

Deposit Feeder
An animal which feeds on dead or decaying matter in the water column or on the sediment.

Dune
A hill or ridge of sand piled up by the wind.

Eutrophication
The process of polluting a body of water with an overabundance of nutrients. This leads to excessive growth of algae which can then give rise to anoxic conditions.

Fecal Coliform
Bacteria found in human feces. The most well known is *E. coli.*

Filter Feeder
An animal which feeds by filtering small animals and plants from the water column.

Glacial Till
Sediments deposited by a glacier as it melts.

Groin
A man-made structure jutting out from shore, perpendicular to the beach. Groins can be used to retard sand erosion.

Sand
A mixture of tiny grains of different types of disintegrating rocks and shells found along beaches.

Wetland
Areas that are covered by salt or fresh water for at least part of the year. Bogs, freshwater marshes, saltwater marshes, swamps, ponds, and lakes are examples of wetlands.

Activity Ideas

Land or Sea?

This project should be completed on a field trip to the beach.

Objective:

- Students will discover that three types of items can be transported by the ocean tides, winds, and currents: those from land, those from the sea itself, and those put there by humans.

Materials:
Land or Sea worksheet (included)
Pencils
Clipboards

Procedure:

1. On a field trip to the beach, divide the students into teams of two. Give each team a clipboard, pencil, and a copy of the Land or Sea worksheet.
2. Explain to students that items they see on the beach may have come from the sea itself (crab remains, seaweed, etc.), from land (driftwood, leaves), or from human sources (sea glass, litter). Tell them they are to look at what is on the beach and use their worksheet to record what they find under the correct heading.
3. When they have categorized the items they have seen, allow students to collect some natural materials from the beach to make collages or mobiles.
4. Point out to students the danger of litter (animals may suffocate from or ingest plastic bags, etc.). Arrange for the class to "clean up the beach" while they are there.
5. Back in the classroom, give students some time to make their collages or mobiles. When all of the children are finished, have each student present his or her project to the class, and describe what was found on the beach and what category each item belongs in.

Sand[2]

Since sand is so important in the formation of a salt pond and the barrier beach that separates it from the ocean, let's investigate the different origins of sand. Sand can be made of many different materials—it doesn't have to be mineral or rock in origin. What we call sand is really just a range of particle sizes. If a particle is between two millimeters and 20 micrometers in size, it is classified as sand.

Objective:

- Students will discover the origin and investigate the properties of sand.

Materials:
Sand samples from different places (including R.I. salt ponds)
Magnifying lenses or loupes
Water
Vinegar
Eyedropper
Black construction paper
Sand worksheet (included)

Procedure:

1. Ask the students to brainstorm about the word sand. Describe all the places you might find sand. What color is sand? Where do you think sand comes from? What is it made from? Chart their answers.
2. Explain to the students that there are two types of sand: biological and nonbiological sand. Biological sand comes from the breakdown of the skeletons of sea animals—shells, coral, zooplankton (foraminifera), or even pieces of sea urchin spines. Nonbiological sand comes from the weathering and erosion of rocks and minerals.
3. Put the students into small groups and give them samples of various types of sand that you have collected and labeled (with name or place, state, or country where the sand was found), including at least one sample from a salt pond in Rhode Island. Have the students pour some of the sand from the first sample on a piece of black construction paper. Show the students how to examine the color and shape of the sand grains, and what it is made of, with the help of a magnifying lens. Have the students chart their answers on the worksheet provided (one worksheet per sample per student). Do the same for all of the sand samples. Have the students note if each sample of sand is biological or nonbiological in origin. Separate the samples of sand into the two groups.
4. Explain to the students that biological sand is made up of calcium carbonate (the same material that makes up your bones). If the sand is biological, the calcium carbonate will react with the vinegar by forming bubbles of carbon dioxide. With an eyedropper, add some vinegar to some of your sample of sand. Observe the reaction closely with a magnifying lens to see whether most of the particles react with the vinegar. (Even the nonbiological sand will contain some particles of calcium carbonate), ask the students to categorize all the samples of sand as biological or nonbiological sand using the vinegar test. Have them explain how they arrived at their conclusion.

Standards Met[3]

Activity	Standard	
Land or Sea?	S2a	Characteristics of organisms
	S4a	Big ideas and unifying concepts
Sand	S1a	Properties of objects and materials
	S2a	Characteristics of organisms
	S2c	Populations and their effect on environments
	S3a	Properties of Earth materials
	S5a	Asks questions about natural phenomena
	S5f	Works individually and in teams to collect and share data
	S7a	Represents data and results in multiple ways

References

Carlozzi, C., K. King, and W. Newbold. 1975. *Ecosystems and Resources of the Massachusetts Coast.* Institute for Man and Environment and Massachusetts Coastal Zone Management Program.

Ely, E. (updated by A. Argentieri). 2002. *Salt Ponds of Rhode Island Whitepaper.* Rhode Island Sea Grant.

Garrison, T. 2002. *Oceanography: An Invitation to Marine Science.* Thomson Learning, Inc.

Office of Marine Programs (University of Rhode Island), *Discovery of Rhode Island Coastal Environments* (http://omp.gso.uri.edu/doce2.htm). Includes a virtual field trip to East Beach and Ninigret Salt Pond.

Seavey, G. 1975. *Rhode Island's Coastal Natural Areas: Priorities for Protection and Management.* Marine Technical Report Number 43. University of Rhode Island, Coastal Resources Center.

Segar, D. 1998. *Introduction to Ocean Sciences.* Wadsworth Publishing Company.

Resources

Fiction:

Kruusval, C. 1997. *Beach Day.* R&S Books. A cute story for beginning readers about a girl who is afraid to go into the water until she learns to catch crabs.

Non-Fiction:

Capogna, V. 2000. *Did You Ever Wonder About Things You Find at the Beach?* Benchmark Books. Answers some basic questions about sand, tides, and objects found on the beach.

McMillan, B. 1993. *A Beach for the Birds.* Houghton Mifflin Company. Beautifully photographed, this book describes how migratory terns use the beach for food and nesting. The comparisons with human uses of the beach will help engage young readers.

Strang, C., C. Halversen, and K. Hosoume. 1996. *On Sandy Shores: Teacher's Guide.* LHS GEMS, University of California at Berkeley. Presents a unit of sandy shore exploration. This book contains activities that can be done in the classroom.

Wyler, R. 1991. *Seashore Surprises.* Julian Messner. Introduces children to items they might find at the beach. Also includes ideas for investigation of the concepts discussed.

Places to Visit

East Beach, Charlestown

A barrier beach associated with Ninigret Pond. The Charlestown breachway separates East Beach from Charlestown Beach.

Ninigret National Wildlife Refuge

A tidal pond.

Trustom Pond National Wildlife Refuge and Moonstone Beach, South Kingstown

A salt pond and its barrier beach

Quonochontaug Pond, Breachway, and Beach, Charlestown

Students can view all components of a coastal pond complex, along with year-round and migrant birds. Note that access to the pond and breachway is separate from access to the beach.

Land or Sea?

As you look on the beach, what do you see? The objects you find may have come from the sea itself, the land, or from humans. Write the name of each item you see under the correct word on this worksheet.

Sea	Land	Humans

Sand

This sample is from:
Use a magnifying lens to look closely at your sample of sand.

1. Draw a picture of some of the sand grains you see. Use crayons to show what colors are in your sample.

2. What shapes are your sand grains? Are they rounded, jagged, or are there some of each?

3. Can you tell by looking at your sand whether it is biological or nonbiological? How can you tell the difference? Which is it?

4. What happened when you added vinegar to your sample? Now can you tell if your sand is biological or nonbiological? Which is it? How do you know?

7 **In the summer, the beautiful pink and white blossoms of the salt spray rose are seen growing in sandy places all along the shore. In the fall, blossoms fall off, revealing a "hip" in their place. The bright red hips become food for small wild animals and birds.**

As its name implies, the salt spray rose (*Rosa rugosa*) is very tolerant of sea spray. In fact, although it is naturally found in beach environments, people often plant them by roadways that are salted in the winter. The salt spray rose is native to Korea, Japan, and northern China, but now can be seen along the Rhode Island coast and elsewhere in the United States. The rose hips are an important food source for migratory birds and other animals. In addition, the extensive root system of the salt spray rose helps to anchor the sand and preserve the dunes. These plants should therefore be left in their natural state.

Edible Plants

The beaches, intertidal areas, marshes, and dunes sport a whole host of edible plants often overlooked by the novice beachcomber. Have you ever thought of making jam of rose hips, flour from cattail pollen, a salad of scurvy grass, seabeach orach, and goosetongue, or dill pickles from sea purslane?

Learning to identify those wild plants that are edible may take a bit of study and time on the part of the interested forager. Actually locating the edible fruits, nuts, buds, leaves, stems, blossoms, sprouts, tubers, roots, and seeds at their peak seasons in the wild may take even more effort. The ability of the forager to properly distinguish between edible and poisonous plants is of obvious importance. Advice was given by Euell Gibbons regarding the first discovery of a long-sought plant by an amateur forager. Rather than gather the first specimen encountered, one should meditate on this single specimen to sharpen one's awareness to the plant and its surroundings. Only then will other plants of the same species become truly visible among a dense mixture of plants in their natural environment.

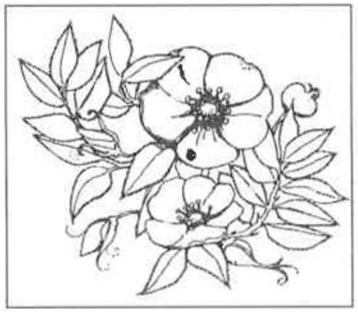
Recipes for salads, cooked vegetables, desserts, seasonings, jams and jellies, pickles, breads, and beverages can be found in many books about marine plants. Some are as common as the beach plum jelly and cranberry relish every New Englander has at least heard of, if not already tasted. Others are as exotic as a breakfast cereal made of strand wheat grits, sweet pickles made from freshly-gathered glasswort, and candy made of young scotch lovage leafstalks.

Many of the reportedly edible plants found in New England should not be considered as much more than survival food. However, others are accepted as good for eating.

Glossary

Rose Hips
The fruits of the salt spray rose. The hips are green in the summer, turn to orange, then red in the fall. The hips may be used to make rose hip jam.

Salt Spray Rose (Beach Rose)
A shrubby rose with pink or white blossoms that grows in thickets in sandy areas along the coast. The salt spray rose provides a protective habitat for small animals like birds, rodents, and rabbits.



Activity Ideas

Rose Hip Jam

Students may enjoy making and taste-testing rose hip jam.

Objective:
- Students will make their own rose hip jam, discovering for themselves that some wild plants are edible.

Materials:
1 cup prepared ripe rose hips
1-1/2 cups water
Juice of one lemon
3 cups sugar
1 package powdered pectin
Blender
Saucepan
Hot plate or stove-top
Sterilized jars for storage

Procedure:
1. Prepare ripe rose hips by cutting off both the stem and blossom ends, making a slit down the side of each hip, and removing the seeds.
2. Place one cup prepared hips, 3/4 cup water, and juice of one lemon in blender. Blend until smooth.
3. With blender running, add three cups sugar. Blend five minutes or until sugar is completely dissolved.
4. Mix one package powdered pectin in 3/4 cup water, bring to boil, and boil hard for one minute. Pour into blender and blend all ingredients for one minute more.
5. Pour into sterilized jars and store in refrigerator (or in freezer if for more than one month).
6. Let students try jam on crackers or bread. Have them describe the experience in their science journals. What did the jam taste like? Did they enjoy it? Were they surprised by the way it tasted?

Effect of Salt on Plants

Objective:

- Students will conduct an experiment to show that many plants are intolerant to conditions, such as salt exposure, along the coast.

Materials:

2 flower pots for each experimental setup
Oat grass seeds (available in pet stores as "cat grass")
Potting soil (preferably with no fertilizer)
2 vessels to be used for watering
Rulers
2 (1 for each plant) data sheets per setup (included)
Pencils

Procedure:

1. Students can be divided into pairs or groups, or this can be done as a class.
2. Each group should fill two pots to within an inch of the top with soil.
3. Plant the grass by spreading 1 tablespoon of seeds on the top of the soil in each pot. Amount of seeds can be varied based on size of the pots, as long as the same amount is planted in each pot.
4. Cover the spread seeds with about 1/2 inch of soil.
5. One pot is going to be the control. This one will be watered every day with regular tap water. The second pot will be the experimental grass. This one will be watered every day with a saltwater solution (30 parts per thousand—mix two Tbsp. table salt with one liter tap water). Use the same amount of water for each plant, each day.
6. Students should keep a daily diary (data sheet included) of observations on their plants. They should note:
   a. When sprouts appear
   b. What color the blades are each day
   c. Height of blades
   d. Which pot has more sprouts/blades
7. At the end of the experiment (ten days), students should compare their data for each plant. Which one sprouted first? At the end of the experiment, which was greener? Taller? Have students write a paragraph in their science journals comparing and contrasting the two plants. Is oat grass a plant that would grow well where the salt spray rose grows? The students should find that oat grass does not grow well under saline conditions.

Standards Met[3]

Activity	Standard	
Rose Hip Jam	S2c	Organisms and environments
Effects of Salt on Plants	S2a	Characteristics of organisms
	S2c	Organisms and environments
	S6a	Uses technology and tools
	S7a	Represents data and results in multiple ways
	S8a	Conducting an experiment

Resources

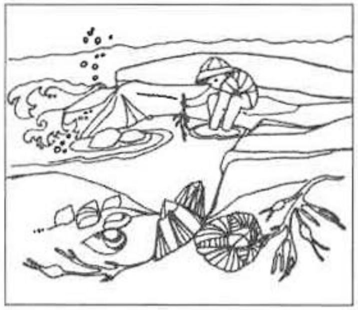
Duncan, W. and M. Duncan. 1987. *The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts.* The Smithsonian Institution. Contains beautiful photographs.

Gibbons, E. 1962. *Stalking the Wild Asparagus.* David McKay Company, Inc.

Seymour, T. 2002. *Foraging New England.* Falcon. A Falcon guide. Describes native edible plants, how to identify them, where to find them, and how to prepare them.

Effects of Salt on Plants Data Sheet ____________
Plant

Day	Are there sprouts?	Height	Color	How many blades?
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



8 **The rocky shore provides habitat for many marine plants and animals. These creatures must adapt to rough waves and times of day with no water at all.**

Rocky Outcrops

One of the most popular scenic rocky coast areas in Rhode Island is Beavertail Point on Conanicut Island. The rocks that make up these cliffs were part of an island off of the African coast 550 million years ago. We know this because fossil trilobites found within the rock at Beavertail are identical to those found in Africa. Plate tectonics brought that island (and its rocks) to the Rhode Island coast at Beavertail. Then, as a result of a collision more than 250 million years ago between the African and North American continents, the rocks in this area were faulted and folded. Thus, visitors to Beavertail see metamorphic phyllite rock with intrusions of quartz.

While rocky coasts are relatively stable (that is, they generally change form only over geologic time scales), there are forces acting constantly upon them. Glaciation, weathering, and sea exposure all take their toll.

Biology of Rocky Coasts

Like other coastal areas, the rocky coast and its tide pools are home to a distinct flora and fauna. Variability in water level, temperature, and salinity, as well as high wave action, create a harsh environment. As a result, plants and animals have developed a wide range of adaptations. Fish and crabs hide in crevices and under rocks. Algae such as Irish moss, rockweed, and knotted wrack have holdfasts which keep them tightly attached to the rocks. In addition, rockweed and knotted wrack have airbladders to keep their fronds afloat. Blue mussels also attach themselves tightly to the rocks by means of byssal threads. The ability to close their shells when not feeding keeps them from drying out during low tide. Periwinkles and dog whelks are also able to prevent desiccation by sealing the opening to their shells. The presence of a hard shell itself provides an advantage in terms of retaining moisture and protection from wave action.

The astute observer will notice that organisms along the rocky coast follow a zonation pattern indicative of certain physical and biological factors. Physical determinants include amount of moisture, wave activity, temperature, and amount of suitable substrate (since many rocky shore organisms are sedentary). Biological factors responsible for zonation have been well studied and include predation and competition.

In addition to the teeming tidepools, shorebirds can be found in great numbers nesting on rocky outcrops. The cliffs offer shelter and safety for water birds, and the low level of human disturbance and lack of predatory animals make these suitable places for gulls, terns, geese, and black ducks to raise their young.

Glossary

Algae
Simple plants, without true stems, leaves, or roots. They can be unicellular (protists) or multicellular.

Barnacle
A cone-shaped marine animal found attached to floating or fixed objects along the coast. It feeds by extending curved, jointed legs, or cirri, from its calcareous shell into the seawater to catch food. It is a common fouling organism and is frequently found on rocks, pilings, and the bottom of ships.

Desiccation
The process of drying out. Shells of rocky shore animals help prevent desiccation at low tide.

Intertidal
The area along the shoreline that is exposed at low tide and covered by water at high tide.

Periwinkle
A small marine snail with a thick, spiral, conical shell. It usually lives in shallow ocean water, often in the intertidal zone. Periwinkles often live in thick masses, encrusting the rocks. They are used as bait and some species are edible.

Rocky Cliff
Formed millions of years ago, rocky cliffs are the most erosion-resistant areas along the shore. They provide a habitat for many beautiful marine organisms and nesting shorebirds, and are often scenic areas.

Seaweed
Any of the multicellular plants growing in the sea—specifically marine algae like kelp, rockweed, and sea lettuce.

Tide Pool
A low spot in rocks or sand that holds water when the tide is out. Tide pools provide a habitat for organisms that can withstand highly variable moisture, salinity, and temperature conditions as well as high winds and pounding waves.

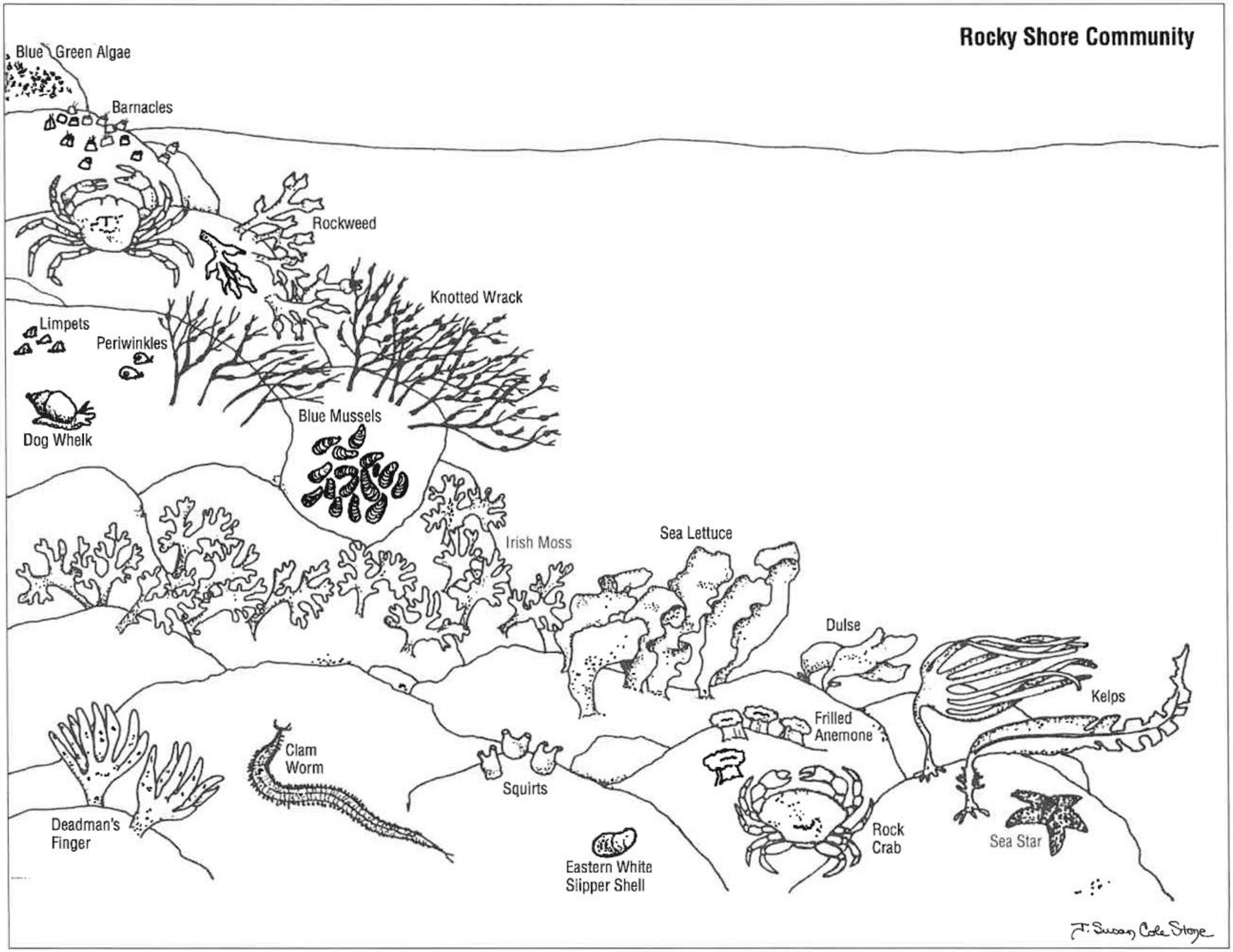
Activity Ideas

Rocky Shore Matching Game

This activity can be done as a class or in small groups.

Objectives:

- Students will identify some rocky shore organisms.
- Students will practice classifying objects as plants, animals, or nonliving.


Rocky Shore Community
Blue Green Algae
Barnacles
Rockweed
Knotted Wrack
Limpets
Periwinkles
Dog Whelk
Blue Mussels
Irish Moss
Sea Lettuce
Dulse
Kelps
Frilled Anemone
Clam Worm
Squirts
Deadman's Finger
Eastern White Slipper Shell
Rock Crab
Sea Star
J. Susan Cole Stone

Materials:
Cardboard (or other) box
Pictures of rocky shore inhabitants (included)
Index cards, card stock, or other heavy paper
Wall space

Procedure:
1. Cut out pictures of rocky shore inhabitants and paste to index cards or heavy paper or cardboard. Students can participate in this part by coloring and pasting the pictures themselves.
2. On the wall, place the headers "Animal," "Plant," and "Nonliving."
3. Place all pictures in the box and mix them up.
4. Have students pick a picture from the box (without looking) and place the picture under the correct heading on the wall.
5. If a student makes a mistake, ask them if they know of what they are holding a picture. Allow input from the other students until the student holding the picture reaches the correct decision.
6. Repeat for all pictures.

Scavenger Hunt

A scavenger hunt at the rocky shore can encourage children to look more closely at the plants and animals found there. Fort Getty is an ideal place for this trip. If you are unable to leave the classroom, students can take a virtual field trip to Beavertail on the URI Office of Marine Program's *Discovery of Coastal Environments* Web site (see reference below).

Objectives:
- Students will observe rocky shore organisms in their natural habitat.
- Students will learn to recognize species of plants and animals, and associate them with their common names.

Materials:
Pencils
Clipboards
Scavenger Hunt worksheet (included)
Field guides (see Resources and Introduction)

Procedure:
1. Prior to the field trip, help students learn to recognize some of the animals and plants they can expect to find. Lists of resources containing information and photographs or drawings of rocky shore organisms can be found at the end of this section and in the introduction to this book. As you go through the pictures with students, discuss the identifying features of each organism.
2. Divide students into teams of four or fewer. Give each team a pencil, clipboard, worksheet, and, if there are enough, a field guide.
3. Have students walk around the shore looking for the organisms on their lists. Teachers and adult chaperones should walk around to groups of students and see what they have found, and assist them in identifying animals and plants.

Helpful Hint:
You may want to bring buckets and have children collect one of each organism to share with the class before leaving the field trip site.

Drying and Preserving Seaweed

Objectives:
- Students will develop techniques for collecting and preserving seaweed.
- Students will identify and catalog specimens.

Materials:
Dishpans
Heavy white paper
Piece of cloth (~8.5" x 11")
Newspaper
Flower press or heavy books

Procedure:
1. Collect representatives of as many types of seaweed as possible. Preservation can be done in the field or in the classroom after a field trip. Just remember to keep algae moist until ready.
2. Fill two dishpans with water (seawater if in the field, tap water can be used if in the classroom).
3. Use one dishpan to rinse each piece of algae to be preserved.
4. In the other dishpan, place rinsed algae. Place a sheet of white paper in the water, directly underneath the algae. Arrange algae on paper, and lift both (algae on top of paper) out of the water.
5. Place cloth over the seaweed. Then place paper, seaweed, and cloth between layers of newspaper.
6. Mount all specimens in this way and then place all in a flower press or underneath some heavy books.
7. While seaweed is drying (over the course of several days to a week), replace wet newspaper with dry sheets twice a day.
8. When seaweed and paper are dry, the seaweed should be stuck to the paper. Have students write on the paper what type of seaweed it is, and where and when it was collected.

Note:
Seashore Life, by Ellen Doris (see Introduction for full reference) contains detailed instructions and photographs about drying and preserving seaweed (pages 36–37).

Rocky Shore Adaptations[2]

Like animals everywhere, tide pool creatures are specially adapted for the life they live and the place they live in. For example, barnacles can open and close their shells. When the shells open under water, their feathery legs come out and sweep food into their shells. Mussels open their shells, take in water and plankton, and strain out the plankton. Clams open their shells and two tubes come out of the side. These are the clam's siphons. The clam pulls water (and all the food it contains) in through one siphon and spits out water and anything else it doesn't want through the other. Crabs grab at food with their claws pulling it apart and fighting one another for it. The snail uses its long sharp tongue (radula) to drill a hole through the mussel shell and eat the soft body inside. In this activity, students will study how animals' feeding adaptations increase the potential for their survival.

Objectives:

- Students will discover how adaptations make organisms suited for different lifestyles.
- Students will conduct an exploratory experiment, record data, and graph results.

Materials:

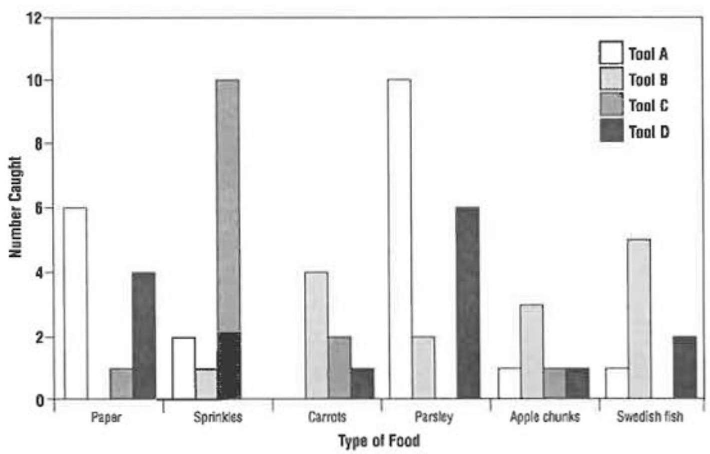
Clothespins	Sprinkles	Parsley
Toothpicks	Carrot slices	Apple chunks
Feathers	Craft sticks	Swedish fish
Net	Small paper or plastic cups	Tub of water
Small bits of paper	Plastic sandwich bags (one for each student)	Puffed cereal

Procedure:

1. Give each student a cup of puffed cereal and a craft stick.
2. Tell the students to eat the cereal using the craft stick as an eating utensil. Explain that they can use their fingers to hold the craft stick and cup, but they cannot pick up the cereal with their fingers.
3. After one minute of feeding, gather students for discussion. Ask them what happened when they tried to eat the cereal.
4. Ask students to think about different tools required to eat different foods. Would you use a straw to eat a watermelon? Would you eat soup with a fork?
5. Brainstorm about different "tool" adaptations animals use to acquire food.
6. Explain to the class that they are going to play a simulation game. Each student will pretend to be an animal found at the rocky shore.
7. Students should be sitting in groups of four. Distribute a variety of tools that students will use to gather food. The clothespin will represent the crab's claw. The toothpick will represent a snail's sharp tongue. The net represents the mussel's straining ability. And the feather will represent the barnacle's legs. Each student chooses a tool—there should be one of each type for each group of four students.
8. Put some "food" (small bits of paper, sprinkles, carrot slices, parsley, apple chunks, Swedish fish) in a tub of water.
9. Give a signal and let the students start gathering "food" with their chosen tools. Tell students to store their food in a plastic bag. Once the students have exhausted the food source, discuss the difficulties they encountered getting different types of food.
10. As a class, have students list the types and amounts of food collected by each animal adaptation. Students can then make bar graphs of the results (see example).

Tool	Paper	Sprinkles	Carrots	Parsley	Apple chunks	Swedish fish
Tool A	6	2	0	10	1	1
Tool B	0	1	4	2	3	5
Tool C	1	10	2	0	1	5
Tool D	4	0	1	6	1	2

Rocky Shore Adaptations



Standards Met[3]

Activity	Standard	
Rocky Shore Matching Game	S2a	Characteristics of organisms
	S4a	Big ideas and unifying concepts
Scavenger Hunt	S2a	Characteristics of organisms
	S2c	Organisms and environments
	S8b	Conducts a systematic observation
Drying Seaweed	S2c	Organisms and environments
	S7a	Represents data and results in multiple ways
	S8b	Conducts a systematic observation
Rocky Shore Adaptations	S2a	Characteristics of organisms
	S4a	Big ideas and unifying concepts
	S6b	Collects and analyzes data
	S7a	Represents data and results in multiple ways
	S8a	Conducts an experiment

References

Barnes, R and Hughes, R. 1988. *An Introduction to Marine Ecology.* Second Edition. Blackwell Science, Ltd.

Seavey, G. 1975. *Rhode Island's Coastal Natural Areas: Priorities for Protection and Management.* Marine Technical Report Number 43. University of Rhode Island, Coastal Resources Center.

Office of Marine Programs (University of Rhode Island) *Discovery of Rhode Island Coastal Environments* Website (http://omp.gso.uri.edu/doce2.htm).

Resources

Nonfiction:

Bredeson, C. 1999. *Tide Pools.* Franklin Watts. A close look at tides as well as the life left behind.

Morgan, S. 2000. *Life in... A Tide Pool on the Seashore.* Thameside Press. Discussion of tide pool biology, including food webs. Wonderful photographs.

Shahan, S. 1996. *Barnacles Eat With Their Feet: Delicious Facts About the Tide Pool Food Chain.* The Millbrook Press. Excellent photographs of individual organisms and descriptions of each organism's place in the food web.

Steele, P. 1999. *Small Worlds: A Tidal Pool.* Crabtree. Some discussion of adaptations. More nice photographs.

Wright, A. and Peck, M. 1992. *At Home in the Tide Pool.* Charlesbridge. Vibrant illustrations, identifies individual organisms.

Places to Visit

Note: Teachers should visit a suggested area prior to a class field trip to make sure it is safe and appropriate for young children.

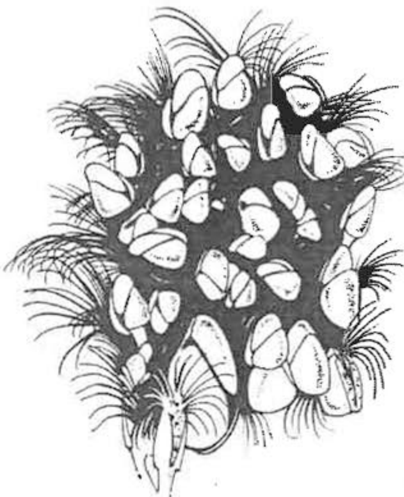
Beavertail State Park, Conanicut Island
Go at low tide when tide pools are abundant. Zonation is visible. This site is appropriate for older children.

Fort Weatherill State Park, Conanicut Island
More appropriate for older children.

Fort Getty Park, Conanicut Island
Excellent for beachcombing and animal collecting. Scavenger hunt activity works well here. Mud flat habitat can also be explored at low tide. This site is especially good for younger children.

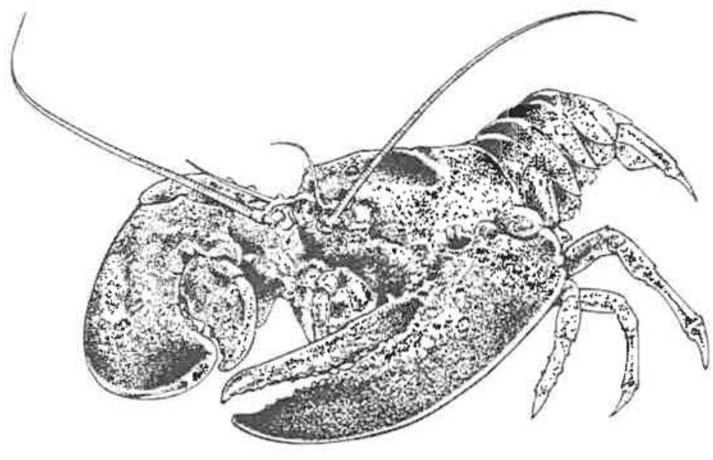
Purgatory Chasm, Middletown
Steep, scenic cliff, good spot to view geological formations.

Rocky Shore Matching Game

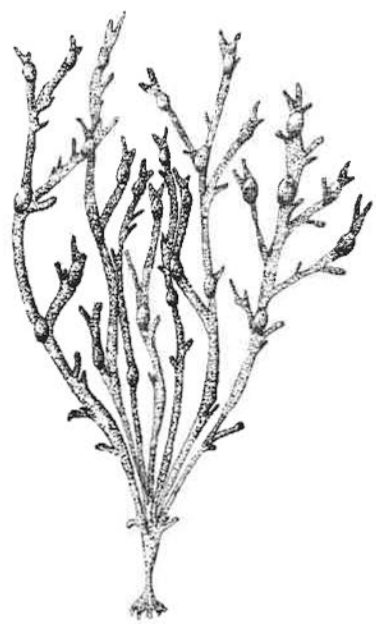


Barnacles

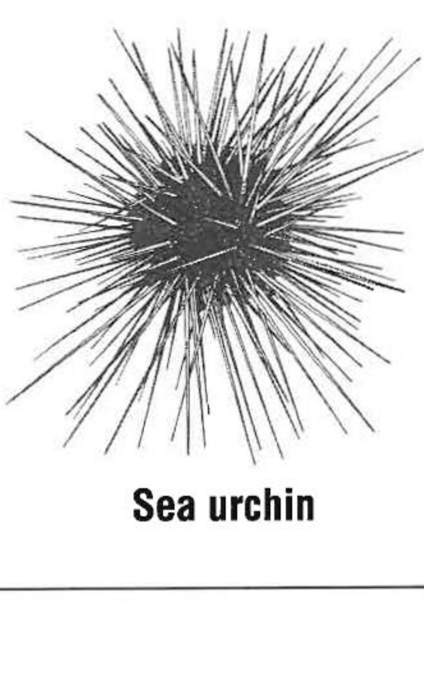
Cormorant



Lobster

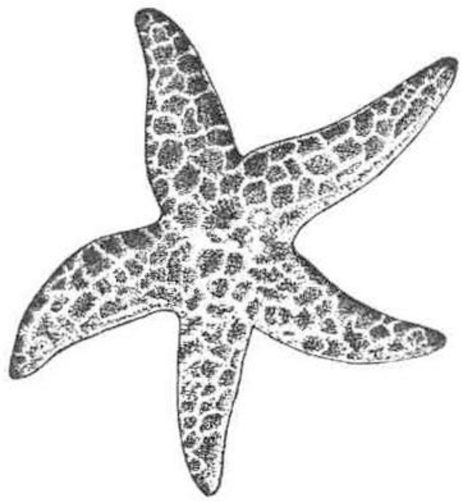


Knotted wrack

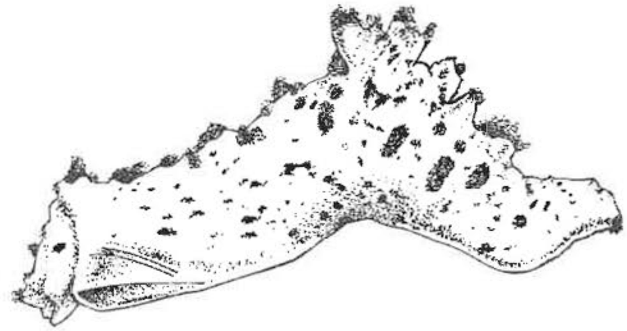


Sea urchin

Rocky Shore Matching Game

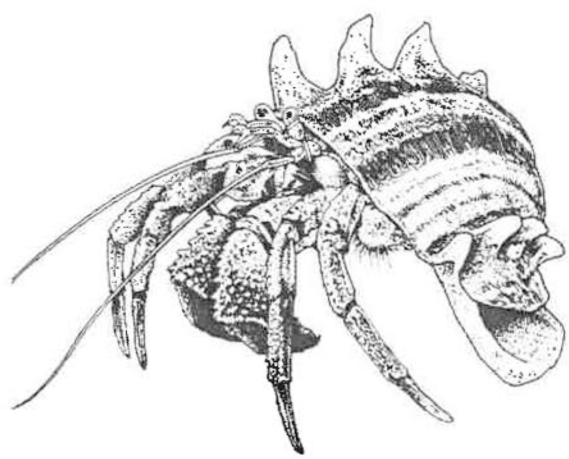


Sea star



Sea slug

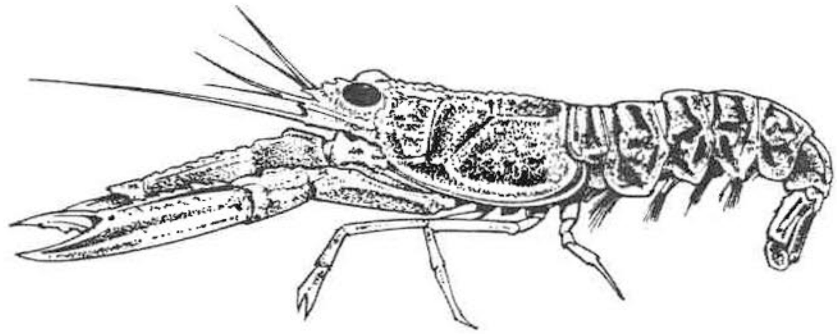
Sea gull



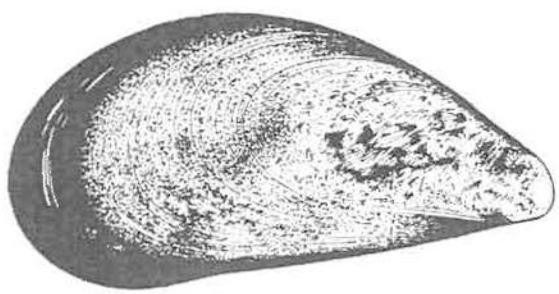
Hermit crab

Sea anemone

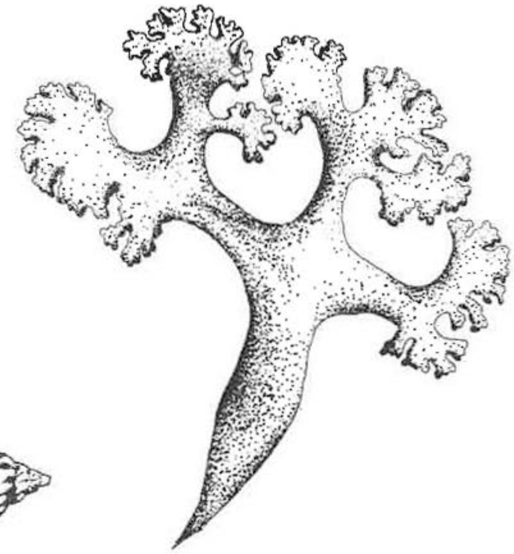
Rocky Shore Matching Game



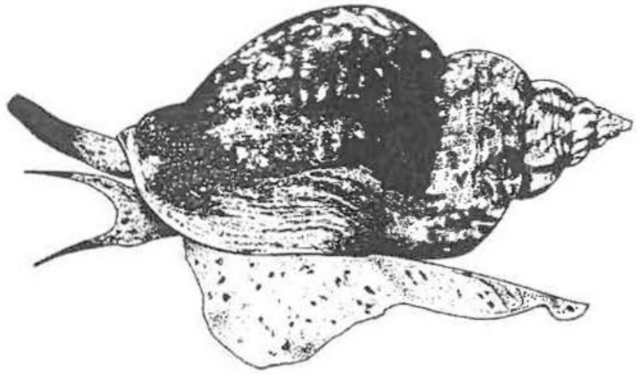
Shrimp



Blue mussel



Irish moss



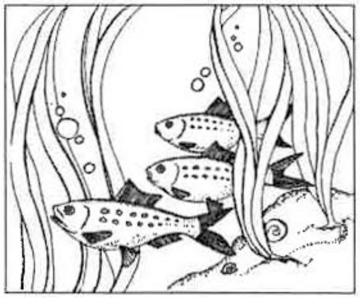
Dog whelk

Rocky Shore Scavenger Hunt

Species	A few?	Some?	Many?	Location (describe where you found them)
Blue-green algae (crustose)				
Lichens				
Dulse				
Rockweed				
Knotted wrack				
Irish moss				
Coralline algae				
Sea potatoes				
Kelp				
Sea lettuce				

Rocky Shore Scavenger Hunt

Species	A few?	Some?	Many?	Location (describe where you found them)
Sand flea				
Periwinkle				
Barnacle				
Dog whelk				
Sea urchin				
Sea star				
Blue mussel				
Rock crab				
Hermit crab				
Limpet				
Sea anemone				
Sponge				
Clam worm				
Jellyfish				
Lobster				
Shrimp				
Clam				



9 **The eelgrass that grows in sheltered waters is a home for young fish and snails.**

Eelgrass Beds

Eelgrass is a type of sea grass (not a true grass, but it does have leaves, stems, and roots). It is a perennial plant that can be found in water of depths from just under low tide level to twenty feet below the sea's surface, in fine sediments (sandy mud–fine sand). Like all plants, eelgrass relies on sunlight for photosynthesis, and therefore must live only in places where sunlight extends to the ocean floor. Eelgrass beds grow well in salt ponds, bays, and at the mouths of estuaries and tidal creeks. Some of the more important eelgrass communities in Rhode Island are found along the south shore.

Eelgrass beds are extremely productive. While a few animals, such as some fish and birds, do feed directly on the plant, many others (crabs, mollusks, worms, shrimps, and sea urchins) subsist on detritus from the decaying plants. Still others graze on epiphytic algae (growing on the eelgrass leaves). Eelgrass also nourishes offshore communities as detritus is exported with tidal and storm processes. The presence of functional roots in these plants is thought to contribute to their efficient production.

In addition to its importance as a food source, eelgrass provides habitat for a variety of animals. The calm, protected waters in which it grows combined with the shelter provided by the plants themselves creates a secure environment for scallops (which can only survive their first month of life by attaching themselves to eelgrass stems), brittle stars, jellyfish, pipefish, shrimp, juvenile flounder, eels, and bluefish.

The life cycle of eelgrass is tied to the seasons. During the winter, due to the cold temperatures, the plants are dormant. They begin to grow more rapidly in March or April, and in May they flower and produce seeds and rhizomes. Plants grow quickly in the summer, but the warm water causes leaves and stems to break off continuously, thus providing a constant source of detritus. In early fall, growth rates increase again, and then by November leaves and stems have died off.

In 1931, a wasting disease struck the North Atlantic coast, destroying 99 percent of the eelgrass standing stock. Brant, Canada goose, and black duck populations quickly decreased with the loss of eelgrass beds. Abundance of clams, crabs, and bay scallops were also reduced, likely because the crucial supply of eelgrass detritus and protected nursery grounds was eliminated. Since then, eelgrass beds have been subjected to the harmful effects of pollution, coastal development, and dredging.

Today, there are less than 100 acres of eelgrass left in Narragansett Bay. Restoration efforts are underway. In 2002, Save The Bay (a nonprofit conservation group dedicated to improving the quality of Narragansett Bay) transplanted 30,000 whole plants, and sowed more than 30,000 seeds.

Glossary

Eelgrass
A marine plant, similar to grass, that grows on sand and mud-sand bottoms in shallow coastal waters.

Rhizome
Horizontal, underground stem. Used by some plants (like eelgrass) as a means of propagation.

Activity Ideas

Fish Printing

The Japanese art of fish printing is called *Gyotaku* (*Gyo* means fish, *Taku* means print). The Chinese began making fish prints over 600 years ago as a means of recording fish catches. It was developed into an art form by the Japanese.

Objective:

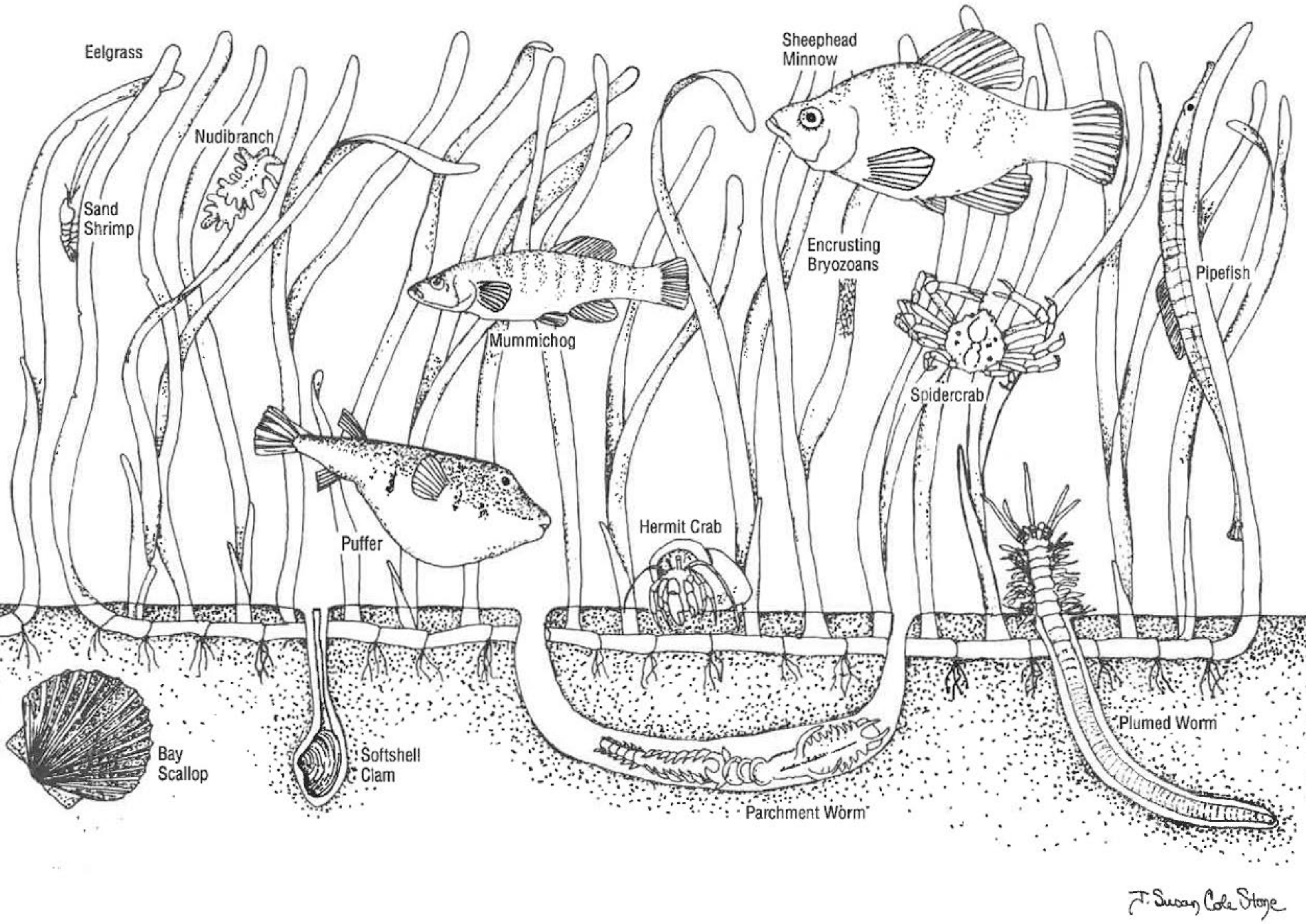
- Students will combine science and art as they practice a traditional means of recording data.

Materials:
Fish, fresh or frozen (rubber fish can be used)
Ink (water soluble block printing ink, acrylic, etc.)
Paper (gravestone rubbing paper, rice paper, construction paper, etc.)
Small paint brush

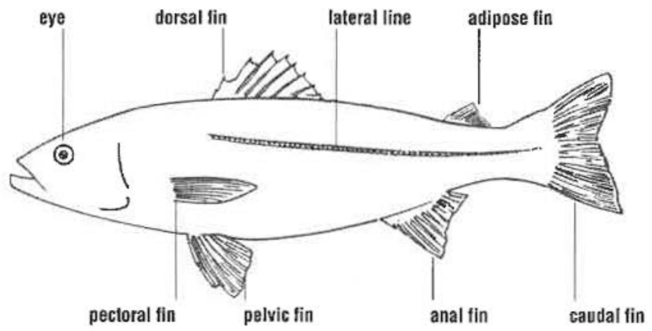
Procedure:

1. Obtain fish (small flat flounder or scup work well). If fish are to be used right away, wash and pat dry. For use later, wash, dry, and freeze fish in plastic bags. Defrost approximately two hours before use.
2. With a small brush gently paint one side of the fish with ink. Make sure all areas are covered including the fins. Use very little ink. Brush from the head of the fish to the tail. Most people use too much ink the first time, so you will have to experiment.
3. Take paper and gently but firmly press down on fish. Rub evenly over all areas, especially head and fins. Do not move paper while pressing.
4. Carefully lift paper up, making sure fish does not move and smear the print.
5. Don't forget to sign, print, and label with name of fish, date, and location caught.
6. After washing and drying the fish, and after the students' prints have dried, point out to them the external parts of the fish (see diagram). Have them label those parts on their own prints.

Eelgrass Community



External Fish Anatomy



Eelgrass Adaptations[2]

Objective:

- Students will create a model to discover form and function in eelgrass.

Materials:

Green plastic trash bags cut into one-inch wide strips
Small aquarium or clear plastic shoe box
Stapler
Water
Wooden board to fit inside the bottom of the aquarium
Rocks
3 round pencils or dowels as long as the width of the aquarium

Procedure:

1. Make artificial eelgrass by cutting 12 strips, one inch wide, from the plastic garbage bag. The length should be the same as the depth of the container that will be used for the demonstration.
2. Staple one end of each strip around the center area of the board. Place the board into the bottom of the container. Use the rocks to help the board stay submerged when you fill it with water.
3. Place the dowels crosswise under the aquarium. These are the rollers.
4. Fill the aquarium to within one inch of the surface with water.
5. Create small waves in the container by gently moving it back and forth over the rollers.
6. Observe the motion of the eelgrass. Have the students describe how it moves.
7. Without splashing water out of the container, make stronger waves. Now describe how the eelgrass moves.
8. Talk to the students about how the shape of the leaves helps eelgrass to survive in the constantly moving water.

Create A Fish

Objectives:

- Students will explore form, function, and adaptation in fish.
- Using this knowledge, students will create their own fish and describe its characteristics and their relationship to the environment.

Materials:

Fish Adaptations, pages one and two (included)
Colored pencils, markers, crayons
Colored paper
Drawing paper
Scissors
Glue

Procedure:

1. Describe to the students how animals are adapted to live in specific environments. For example, fish live in water, so their bodies are designed for swimming. Beyond that, even various species of fish are further adapted. Flounder have one flat side and both eyes on "top" so that they can live on the bottom of the ocean. Many deep-sea fish create their own light (bioluminescence) in order to capture prey and identify others of their kind in the dark ocean depths.
2. Have the students explore and discuss the pictures provided (Fish Adaptations page two). Where do you think each of these fish live based on its physical characteristics? Using the information about adaptations provided on Fish Adaptations page one, guide students to the correct answers.
3. Now, ask students to design and draw or construct their own fish. Let them experiment with colors, shape of body and fins, size, and location of eyes and mouth. Ask them to explain, in story form, where their fish lives, and to describe at least three physical features that make it well suited to that environment.

Standards Met[3]

Activity	Standard	
Fish Printing	S2a	Characteristics of organisms
	S7a	Represents data and results in multiple ways (artwork)
Eelgrass Adaptations	S2a	Characteristics of organisms
	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts
Create a Fish	S2a	Characteristics of organisms
	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts

References

Barnes, R. and R. Hughes. 1988. *An Introduction to Marine Ecology.* Second Edition. Blackwell Science, Ltd.

Carlozzi, C., K. King, and W. Newbold. 1975. *Ecosystems and Resources of the Massachusetts Coast.* Institute for Man and Environment and Massachusetts Coastal Zone Management Program.

Garrison, T. 2002. *Oceanography: An Invitation to Marine Science.* Thomson Learning Inc.

Save The Bay Eelgrass Restoration Website (http://www.savebay.org/bay issues/restoreprojects.htm).

Resources

Nonfiction:
New England Aquarium. 1991. *Do Fishes Get Thirsty? Questions Answered.* The New England Aquarium. Common questions about physiology, reproduction, and habits of fresh and saltwater fish are clearly answered.

Pfeffer, W. 1996. *What's It Like to be a Fish?* Harper Collins. A very basic introduction to how fish swim and breathe.

Sill, C. 2002. *About Fish: A Guide for Children.* Peachtree. An excellent read aloud book for young children.

Smith, C.L. 2000. *National Audubon Society First Field Guide: Fishes.* Scholastic, Inc. A good reference book for children as well as a guide to fish they are most likely to see.

Video:
Eyewitness: Fish. 1994. BBC Wildvision. Narrated by Martin Sheen. 35 minutes. Discusses fish anatomy and life cycles, including salmon migrations. Evolution, myth, and history are also touched on.

Coming soon (2003)—Eelgrass restoration video from Save The Bay. Call 272-3540 for information.

Website:
Rhode Island Habitat Restoration Portal http://www.edc.uri.edu/restoration An excellent resource for learning about habitat restoration. Includes links to educational programs throughout Rhode Island.

Places to visit

Lafayette Trout Hatchery
(401) 294-4662, Call for tour information.

Perryville Trout Hatchery
(401) 783-5358, Call for tour information.

Fort Getty, Jamestown
King's Beach, Ocean Drive, Newport
Both of these places have excellent eelgrass beds in which children can wade and seine. Detailed instructions on how to use a seine net can be found in *Seashore Life,* by Ellen Doris (see Introduction for full reference).

Fish Adaptations

Angler Fish: This is a deep-sea angler. Its bioluminescent (light-producing) lure allows it to attract prey. Sharp teeth and a large stomach give the fish versatility to feed on a wide size range of prey—a useful adaptation in a low-food environment.

Hatchet Fish: Hatchet fish live in what is known as the "twilight zone." Photophores (light producing organs) on the fish's belly make it blend in to its surroundings as viewed from below, while a dark back allows it to blend in as viewed from above. Hatchet fish have tubular eyes and an upturned mouth so they can search for and capture their prey from below.

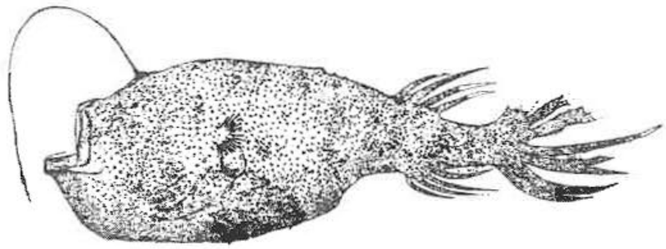
Seahorse: Seahorses have one of the most unusual shapes for a fish. Their flexible tail allows them to anchor themselves to seaweed.

Lanternfish: Lanternfish live in the deep sea where there is very little light. The photophores on their bellies and heads are species-specific and allow them to recognize others of their kind.

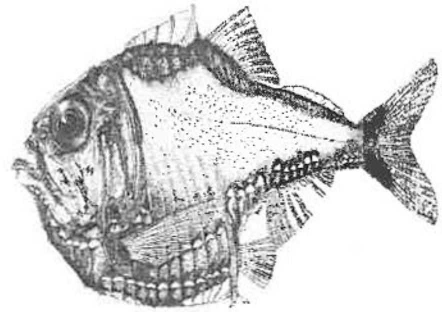
Summer Flounder: Flounder exhibit another unusual shape. Their flat underside (which is actually a side and not the belly of the fish) allow them to lie flat on the bottom where they live. They also have both eyes on the "upper" side of their body so that they can see out of both eyes while lying flat on the bottom. In addition, flounder are able to change color to blend in with their surroundings.

Tuna: Tuna are large, open ocean predators. Their shape is one designed for speed and power.

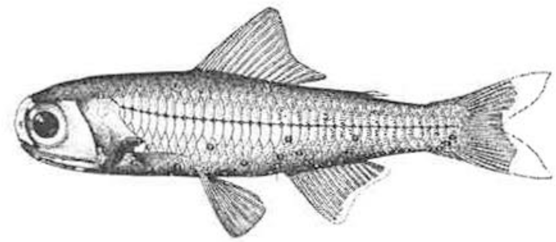
Fish Adaptations



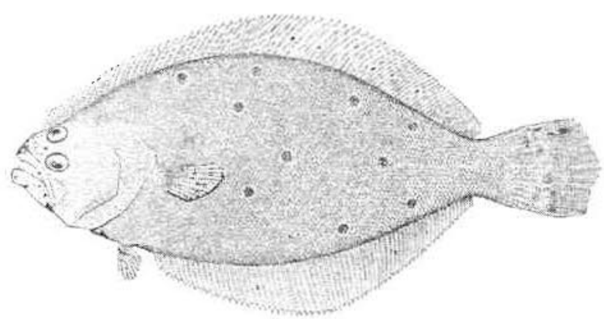
Angler Fish



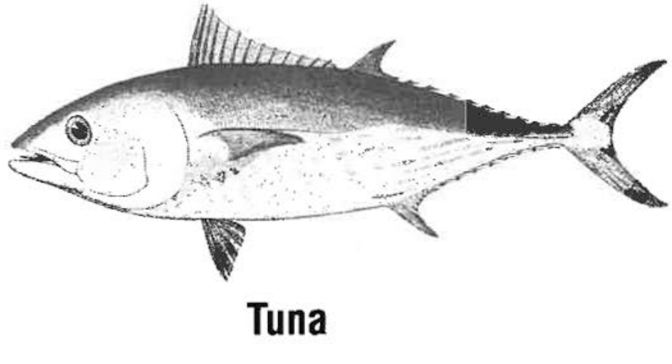
Hatchet Fish



Lantern Fish



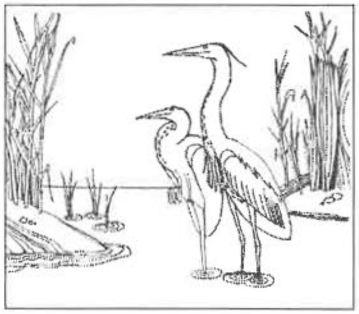
Summer Flounder



Tuna

Seahorse

Bigelow and Schroeder, *Fishes of the Gulf of Maine*



10 **Birds like the great blue heron often feed in salt marshes. They eat the little fish and snails that live there.**

Salt Marshes

Rhode Island's salt marshes were formed less than 6000 years ago. During the last glacial retreat, sea level began to slowly rise, eventually filling in some low-lying coastal areas. A muddy or sandy intertidal zone develops into a salt marsh when the most adapted salt marsh plants (i.e. those that can withstand high salinity and submersion) colonize the area. The presence of these plants then facilitates sedimentation, thereby raising the shore level. This allows other species to begin to flourish. Thus salt marshes often show a succession of species with both time and space. New marshes are continually being formed, as evidenced by the many narrow, "fringe marsh" areas along much of the Rhode Island coast.

Rhode Island salt marshes are low, flat areas subject to submersion with high tidal influx. They are characterized by dense vegetation consisting of low-growing herbaceous plants, in particular: smooth cordgrass (*Spartina alterniflora*), salt meadow grass *(Spartina patens)*, spike grass (*Distichlis spicata*), and black rush *(Juncus gerand)*. In general, diversity of plant species increases with size of the marsh.

The importance of salt marshes to marine and coastal communities cannot be overstated. Many species of fish use this habitat as a breeding and nursery ground. In addition, the marsh plants act as nutrient traps, food sources, and buffers against storms and flooding. Wetlands such as salt marshes are also extremely efficient at clearing water of pollution. As water moves over the marsh, inorganic nitrogen compounds and metals are removed by attachment to clay-sized particles in the mud. The presence of this nitrogen then contributes to salt marsh production.

Salt marshes also provide important habitat for larger animals. Birds, both year-round residents and migrators, rely on them for food (snails, insects, crustaceans, small fish, and plants) and nesting sites. In addition, mammals such as foxes, skunks, raccoons, and mice feed and find shelter in the salt marsh.

In 1996 there were 3700 acres of salt marsh left in Narragansett Bay. Although the exact amount of salt marsh present before colonization by Europeans is unknown, it is believed that approximately half has been destroyed. In fact, a large portion of downtown Providence and Quonset Point stand on filled coastal wetlands.

Glossary

Great Blue Heron
A gray-blue American wading bird with a long neck and legs, long tapering bill, large wings, and soft plumage.

Salt Marsh
A low, flat area regularly inundated by tidal waters. Marshes are densely vegetated with low-growing non-woody plants especially adapted to saline conditions.

Activity Ideas

Shorebirds

Objectives:

- Students will conduct research using books and/or the internet.
- Students will investigate the diverse habits of Rhode Island shorebirds.
- Students will work independently and in groups.

Materials:

Shorebird pictures (included)
Large index cards
For the Birds worksheet (included)
Shorebird Summary worksheet (included)
Colored pencils
Flute's Journey: the Life of a Wood Thrush by L. Cherry (optional)

Procedure:

1. (Optional) Guided Reading Lesson
   To introduce the topic of migration and the importance of habitat preservation, read *Flute's Journey: the Life of a Wood Thrush* to the class. On a map of the Western Hemisphere, chart the migration pattern followed by Flute to provide children with a visual aid.
2. Divide students into groups of four. Assign each group a different shorebird.
3. Each student should receive a picture of their bird and a copy of the *For the Birds* worksheet. They may wish to draw or trace and color their bird.
4. Explain to students that some birds live in Rhode Island year-round while for other birds Rhode Island is merely a summer home.
5. Assign each student in the group a different question from the worksheet to investigate. You can use library time in school, provide resources in the classroom, or allow students to work on their own. Students should also find out the coloration of their bird.

6. When the students have answered their individual questions, allow them to take time to explain their results to the other students in their group. Each student should then answer all questions on their own sheet.
7. Have students write the answer to their question on an index card with their colored picture of the bird to be posted on the wall or bulletin board as shown here. Students who are researching the habitat, food, or nests may want to draw a picture rather than writing the information.

Name/Picture	Migration	Habitat	Food	Nests

8. As students post their cards, with the birds in alphabetical order, ask them to present the material to the rest of the class.
9. After all groups have hung their work, have each student fill out a copy of the *Summary* worksheet provided.

Standards Met[3]

Activity	Standard	
Shore Birds	S2a	Characteristics of organisms
	S2b	Life cycles of organisms
	S2c	Organisms and environments
	S5f	Works individually and in teams
	S8d	Conducts non-experimental research using print and electronic information

References

Barnes, R. and R. Hughes. 1988. *An Introduction to Marine Ecology.* Second Edition. Blackwell Science, Ltd.

Garrison, T. 2002. *Oceanography: An Invitation to Marine Science.* Thomson Learning, Inc. A basic oceanography textbook.

Office of Marine Programs (University of Rhode Island) *Discovery of Rhode Island Coastal Environments* Website (http://omp.gso.uri.edu/doce2.htm).

Save The Bay Website (http://www.savebay.org/bayissues/statebay/saltmarshes.htm).

Seavey, G. 1975. *Rhode Island's Coastal Natural Areas: Priorities for Protection and Management.* Marine Technical Report Number 43. University of Rhode Island, Coastal Resources Center.

Thurman, H. and A. Trujillo. 2002. *Essentials of Oceanography.* Seventh Edition. Prentice Hall. A basic oceanography textbook.

Resources

Fiction:

Cherry, L. 1997. *Flute's Journey: the Life of a Wood Thrush.* Harcourt Brace and Company. Although this book is not about a shorebird, it beautifully illustrates the implications of bird migrations, and the hazards these birds face as their winter and summer habitats are threatened.

Nonfiction:

Fleisher, P. 1999. *Webs of Life: Salt Marsh.* Benchmark Books. Contains beautiful photographs of marsh organisms.

Latimer, J.P. and K. Nolting. 1999. *Peterson Field Guide for Young Naturalists: Shorebirds.* Houghton Mifflin Company. An excellent guide for beginners. Contains both drawings and photos, along with tips for viewing.

Miller, S. 2000. *Shorebirds: From Stilts to Sanderlings.* Franklin Watts. Part of the *Animals in Order* series. Discusses general taxonomy relationships between organisms.

Places to Visit

Galilee Bird Sanctuary, Narragansett
Here students can see salt marsh restoration in progress. The north side of the road represents the original salt marsh, while the south side is the restored marsh.

Matunuck Management Area (Succotash Salt Marsh), South Kingstown
Located on Point Judith Pond.

Fox Hill Salt Marsh, Jamestown

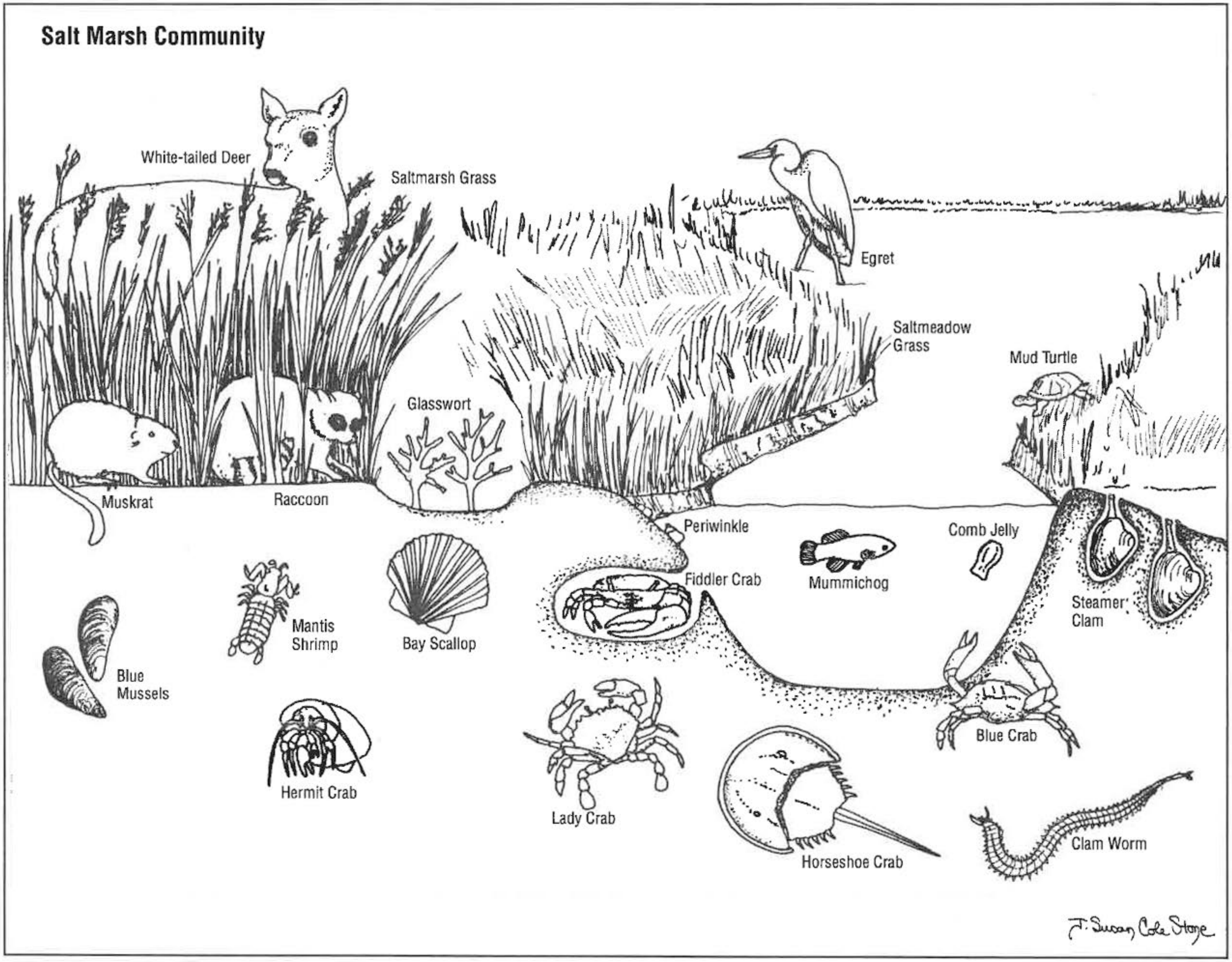
Bissel Cove, North Kingstown

Buckeye Brook Marsh, Warwick

Colt State Park, Bristol

Touisset Marsh Wildlife Refuge
An Audubon Society refuge.

Norman Bird Sanctuary, Middletown
Call 401-846-2577 for information regarding guided bird walks and school programs.


Salt Marsh Community
White-tailed Deer
Saltmarsh Grass
Egret
Saltmeadow Grass
Mud Turtle
Glasswort
Muskrat
Raccoon
Periwinkle
Comb Jelly
Fiddler Crab
Mummichog
Steamer Clam
Mantis Shrimp
Bay Scallop
Blue Mussels
Blue Crab
Hermit Crab
Lady Crab
Horseshoe Crab
Clam Worm
J. Susan Cole Stone

Rhode Island Shorebirds Summary Worksheet

Bird	Does it migrate?	Habitat	Food	Nest

For the Birds

This report is about the ______________________________

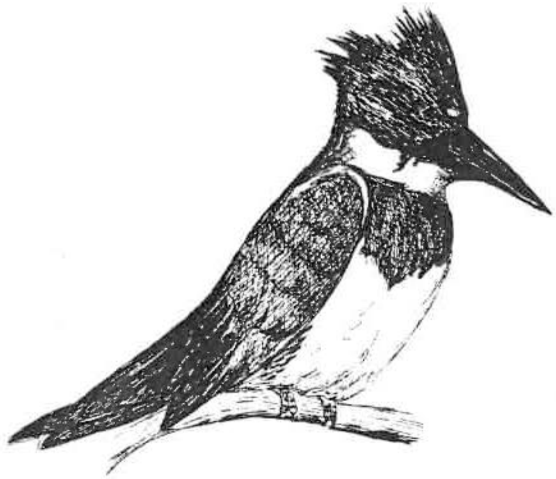
1. Does this bird migrate? When would you expect to see it in Rhode Island?

2. What kind of habitat does this bird live in while it is in Rhode Island?

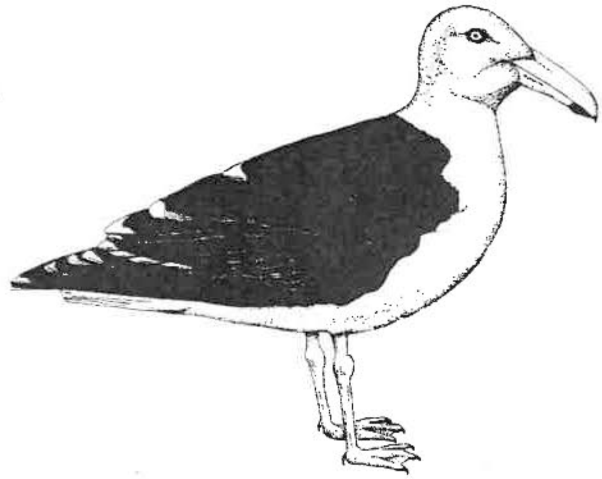
3. What does this bird eat in Rhode Island?

4. Does this bird breed in Rhode Island? If so, where does it build its nests? What do the nests look like?

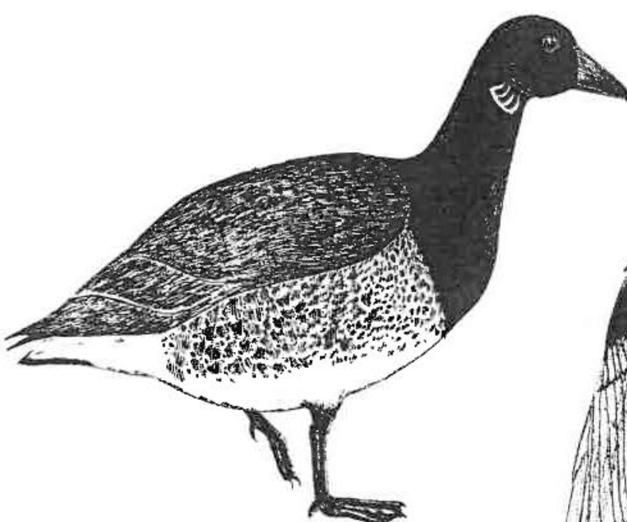
Rhode Island Shorebirds



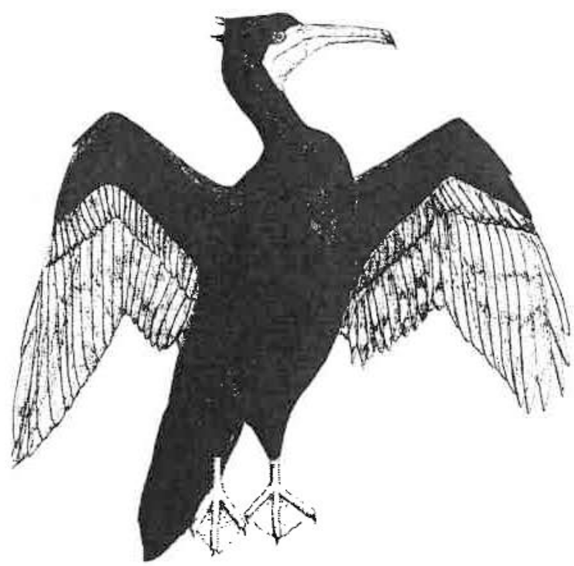
Belted Kingfisher



Great Black-Backed Gull

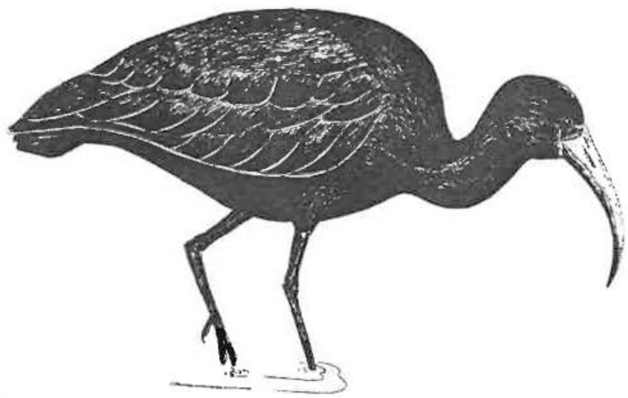


Brant Goose



Double-Crested Cormorant

Rhode Island Shorebirds



Glossy Ibis

Great Egret

Great Blue Heron

Osprey

11 **At night raccoons come to the marsh to eat clams, mussels, and fiddler crabs.**

Food Webs

All organisms need energy to maintain physical and physiological function. Some, like plants, can utilize energy from the sun directly (autotrophs). Others need to ingest carbon in the form of plants or other animals (heterotrophs).

Communities are made up of animals and plants, some of which rely on others as a source of food (= energy). This dependence gives rise to often complex food webs.

Productivity of a Salt Marsh

Found in intertidal areas behind barrier beaches, bordering pools of still water, and along banks of estuaries, salt marshes are highly productive biological communities. In fact, they rival some of the most productive ecosystems on earth, including wheat fields.

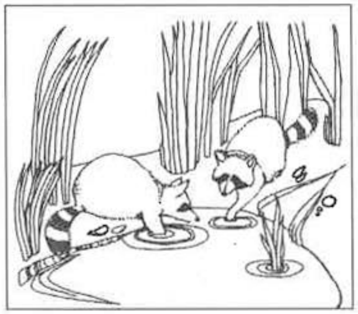
Like most intertidal communities, salt marshes show distinct zonation in the distribution of plants and animals. The low marsh is characterized by the dominance of salt marsh cordgrass, *Spartina alterniflora*, while the high marsh is dominated by salt meadow cordgrass, *Spartina patens*, and other less salt tolerant species. Cattails and reeds *(Phragmites)* can be found in this zone. Between the high marsh and land, one can find seaside goldenrod, black rush, and panic grass.

Glasswort is an example of a plant that is well adapted for the harsh conditions in a salt marsh. This organism grows well in water with high salt concentrations. It can be found in pannes, shallow depressions in the high marsh area. Pannes are filled with water by the incoming tide. As the tide goes out, the water is retained and evaporates, causing a rise in salt concentration. Adaptation to high salinity reduces competition and allows glasswort to thrive in this specialized habitat.

Vegetation in the marsh uses radiation from the sun to photosynthesize, providing energy for the plants themselves and other organisms. Nutrients are readily available due to the fixed nature of marsh plants and the tidal cycle, which brings nutrients in. While some grazers (insects, some birds) feed directly on the marsh plants, others, such as periwinkles, are actually eating epiphytes—small plants and algae growing on the leaves of larger plants. Not to be forgotten are the microscopic plants and animals (phytoplankton and zooplankton) that flow in and out with the tides. Worms, clams, and mussels feed on this "sea soup" as it washes over them.

Most of the plant production in a salt marsh is available in the form of detritus. In the fall, the stems and leaves turn brown and begin to decay. Decomposers (bacteria, fungi, and protozoans) break down this plant material, releasing nutrients back into the environment to be used for the following year's growth.

Although salt marshes are coastal environments, the productivity of these communities can have a substantial impact on offshore environments. Some marshes are largely cut off from the open ocean and are therefore net importers of organic material. Other marshes have much more contact with the open ocean and are net exporters of organic material.



Glossary

Bivalve
Mollusks having a shell composed of two distinct, hinged parts. The most familiar bivalves are clams, mussels, scallops, and oysters.

Clam
Many kinds of bivalve mollusks, especially certain edible kinds like the soft-shelled clam (steamer) and the hard-shelled clam (quahog).

Community
An integrated, mutually adjusted group of plants and animals inhabiting a natural area.

Fiddler Crab
A type of crab with pincers on the first pair of legs, found all along the shore. The male crab has one enlarged claw and the female crab has two small claws. They live in burrows and emerge to get balls of mud, from which they get their food.

Food Chain
A sequence of living organisms in which the members of one level feed on those in the level below it, and are in turn eaten by those above it. Plants are on the lowest level of all. Energy in the form of food is transferred along the food chain, but a loss of about 90 percent occurs on each level—for instance, it would take about 1000 pounds of plant matter to produce 100 pounds of even the smallest animals.

Food Web
The interconnected food chains of a biotic community.

Mollusk
A large phylum of invertebrate animals that includes snails, octopuses, mussels, clams, oysters, and squid. Mollusks have soft, unsegmented bodies, frequently covered by a shell secreted by the mantle (a portion of the body wall that lines the shell).

Mussel
A bivalve mollusk that attaches to substrates using secreted threads called byssal threads. Mussels are usually dark colored, growing in masses on floating objects, underwater structures, rocks and rocky cliffs, covering mudflats in the intertidal zone, and boring into rock.

Plankton
Animals (zooplankton) and plants (phytoplankton), mostly microscopic, that have little or no ability to swim and depend on the currents and tides for transport. Some zooplankton are the larvae of larger benthic or free-swimming animals.

Activity Ideas

Food Chain Poem and Mobile

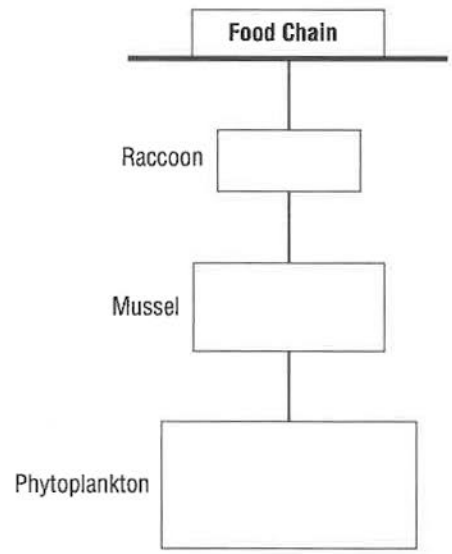
Objectives:
- Students will explore and understand the structure of a simple food chain.
- Students will write an original poem following guidelines of the genre.

Materials:
Hanger or dowel for mobile
String or yarn
Hole punch
Heavy paper or card stock
Food Chain Poems worksheet (included)
Sea Dreams: Poems from Under the Waves by N. Siegen-Smith (optional)

Procedure:
1. Explain to students that they are going to be writing poems to help them understand food chains. To get them thinking like poets, a guided reading using *Sea Dreams: Poems from Under the Waves* (see Resources for full citation), or another appropriate book of poetry would be useful.
2. Have students, as a class, brainstorm some possible salt marsh food chains. Write their ideas on the board.
3. Divide students into groups of three and assign one food chain to each group.
4. Within groups, each student should choose one organism in the chain to write a short (four line) poem about. Use the poem guidelines provided or create your own.
5. Students can write their poems on rectangular pieces of card stock and illustrate them themselves, or they can write them on cut out shapes of the organism they are writing about. You may want to adjust the size of each card to represent the number of organisms at that level. For instance, there are more phytoplankton than mussels and more mussels than raccoons in the ecosystem, so the phytoplankton card would be the largest and the raccoon card would be the smallest. You may also wish to laminate their poems.
6. Punch a hole at the top of each poem card and at the bottom of the top two organisms. Use the string to attach the organism at the base of the food chain to the bottom of the organism that eats it, and the top of that organism to the bottom of the one that eats it. The highest organism should then be tied to the dowel or hanger, creating a mobile.

Example Poem:
With little hands and
A mask on its face
Raccoon eats a mussel
And leaves a shell in its place

Example Mobile:



Is This a Zooplankter or a Phytoplankter?

Objective:
■ Students will experience the difficulty scientists sometimes face in determining whether an organism is a plant or animal. They will learn that it is not always obvious from simply the way an organism looks.

Materials:
Copy for each group *Student Discovery Master 3: Sort a Plankton Sample* (included). Note: Be sure to block off the answer key when making copies for the class!

Procedure:
1. Divide the class into groups of two to three and give each group a copy of *Student Discovery Master 3: Sort a Plankton Sample.*
2. Have students cut the pages into separate cards.
3. Challenge the class to sort their cards into two categories, animals and plants.
4. After five to ten minutes, encourage the students to move around the room looking at the way others sorted their plankton sample.
5. Now, use the overheads to show the actual groupings, and encourage the class to argue why they might disagree with the groupings. For example, ask if any pair will state why they did not include specimen A as a plant. What characteristics of an animal or plant does that specimen illustrate? (Depending on your class, you might like to keep a tally of how many pairs categorized each of the twelve organisms as a plant, or as an animal. This will clearly illustrate why classifying organisms is not always an easy task even for professional scientists who specialize in taxonomy.)

For class discussion or a written assignment (homework):
1. Which specimens were the most difficult to categorize?
2. Is size a good indicator of whether something is a plant or an animal?
3. Are visible characteristics always good indicators of how organisms are related? Explain your answer.
4. What other characteristics of organisms might help in determining whether they are related?
5. Give an example of two organisms that look like they are closely related, but actually are not. (An example is a black bear and a panda, or a whale shark and a baleen whale.)

What Will I Grow Up to Be?

Objective:
■ Students will attempt to match planktonic larvae with adults, learning that animals may take different forms at different stages in their lives.

Background:
Plankton contains multitudes of different kinds of organisms: single photosynthetic cells; larval forms of sea stars, crabs, lobsters, worms, fish, snails, clams, oysters, and young shrimp. Many marine biologists study plankton. They gather samples and examine the samples under the microscope to determine what species are present and how many of each species are in the sample. Using the plankton data samples from many areas and data taken from the same areas but during different seasons or year to year, they can then compare the data and note changes in diversity and population size. It helps fisheries biologists to predict whether the oyster set (larval oysters settling and attaching to rocks and shells) will be good that year. Or, the lobster catch in eight years can be predicted by the relative number of lobster larvae in the plankton samples. The number and type of plankton also are good indicators of the food availability for the organisms which prey on plankton such as herring, basking sharks, and jellyfish. The impact of major freshwater floods on the population of organisms in an estuary can be measured by sampling the plankton. However, to identify the groups to which the organisms in the plankton sample belong requires training, perseverance, and skill.

Your class can begin to appreciate the training necessary by trying to match the planktonic organisms in our "sample" with the illustrations of adult marine organisms.

Materials:
Copy for each student *Student Discovery Master 4: What Will I Grow Up to Be?* (included). Note: Be sure to block off the answer key when making copies for the class!

Procedure:
1. Review the question, "Plant or Animal?" and discuss what other types of plankton exist besides phytoplankton. Lead the students in discussing that many animals in the sea reproduce by shedding eggs and sperm into the water where fertilization occurs. The fertilized eggs grow into tiny larvae and become part of the zooplankton. The animal plankton

(zooplankton) feed on phytoplankton. When the animal larvae in the zooplankton grow large enough, they change form again and become adults. Sometimes this means that the larval stage changes into a sedentary stage. An example is an oyster that swims in its larval stage, and is stuck on a rock or shell as an adult. Only a few eggs survive to adulthood. Most eggs and larvae are eaten by plankton feeders. Larvae are a very important part of the food web.

2. Hand each student a copy of *Student Discovery Master 4: What Will I Grow Up to Be?* Let the students discuss among themselves which critter grows into which adult. Chances are that they will have to guess many of them because the plankter looks so different from the adult.
3. Point out that larval forms can look very similar to each other, while their adult forms are very different. Why might larval forms be so similar? Could a hard-shelled tiny clam float as plankton as well as the soft larval form? Could a sea star larva float if it was covered with a tough, spiny coat like its parent? Could it swim? Does a lobster larva need claws?

Standards Met[3]

Activity	Standard	
Food Chain Poem	S2c	Organisms and environments
	E5b	Produces work in at least one literary genre that follows the conventions of the genre
Zoo- or Phytoplankter	S2a	Characteristics of organisms
	S4a	Big ideas and unifying concepts
	S7b	Uses facts to support conclusions
What will I...Be?	S2a	Characteristics of organisms
	S2b	Life cycles of organisms
	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts
	S4d	Science as a human endeavor

References

Barnes, R. and R. Hughes. 1988. *An Introduction to Marine Ecology.* Second Edition. Blackwell Science, Ltd.

Carlozzi, C., K. King, and W. Newbold. 1975. *Ecosystems and Resources of the Massachusetts Coast.* Institute for Man and Environment and Massachusetts Coastal Zone Management Program.

Resources

Fiction:

Carle, E. 1987. *A House for Hermit Crab.* Simon and Schuster. Classic story of a hermit crab adjusting to life in a new shell.

Siegen-Smith, N. 2002. *Sea Dreams: Poems From Under the Waves.* Barefoot Books. A wonderful compilation of short, simple ocean poems by various authors. Beautifully illustrated by Joel Stewart. Excellent for reading aloud to students and for providing examples and inspiration for students to write their own poems.

Non-Fiction:

Cerullo, M. 1999. *Sea Soup: Phytoplankton.* Tilbury House.
Cerullo, M. 2001. *Sea Soup: Zooplankton.* Tilbury House.
These books discuss the characteristics and importance of plankton in an exciting and readable way. Beautiful photographs.

Gates, D. 1975. *Seasons of the Salt Marsh.* The Chatham Press. A detailed look at life and zonation in the salt marsh. Contains an illustrated guide to commonly found organisms.

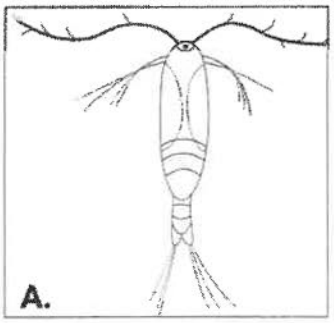
Kalman, B. and J. Langille. 1998. *What are Food Chains and Webs?* Crabtree Publishing Company. An easy to understand introduction to food chains and food webs. Explains the different levels (producer, consumer, etc.) and gives examples.

Stevens, B. 1999. *Sea Soup Teacher's Guide: Discovering the Watery World of Phytoplankton and Zooplankton.* Tilbury House. A companion to Cerullo's *Sea Soup: Phytoplankton and Sea Soup: Zooplankton.* Contains instructions for conducting a field study, including making a plankton net.

Student Discovery Master 3
Sort a Plankton Sample

Name ______________________________ Date ______________

Class ______________ Names of Partners ______________________________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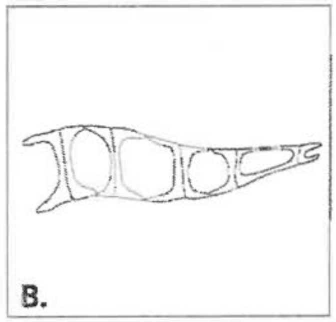
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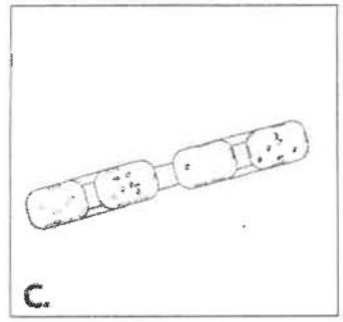
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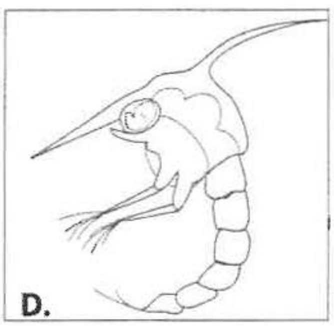
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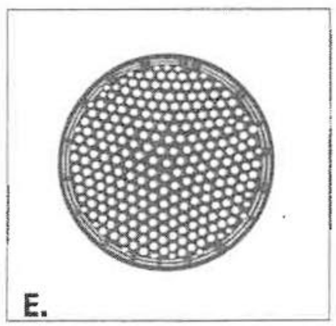
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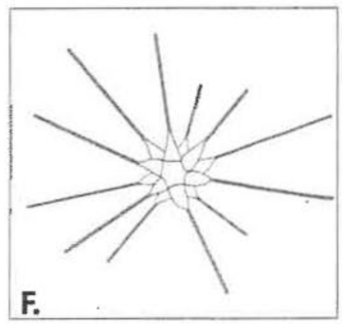
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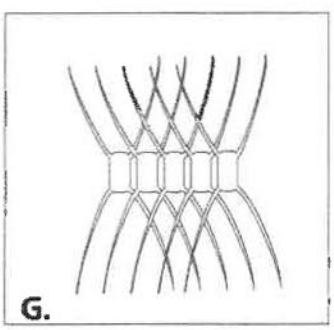
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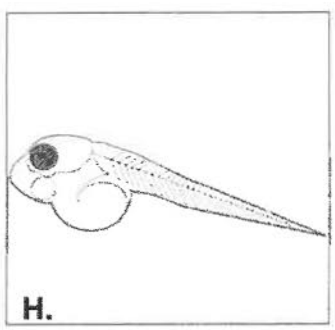
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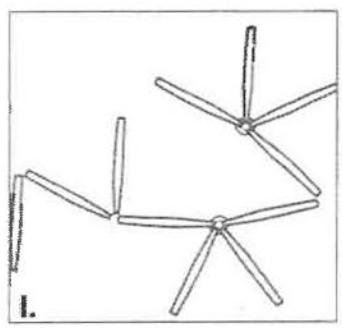
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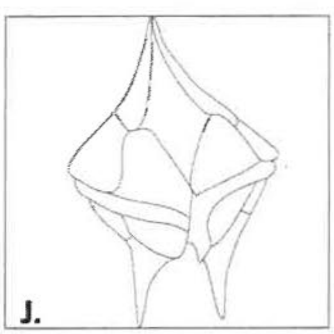
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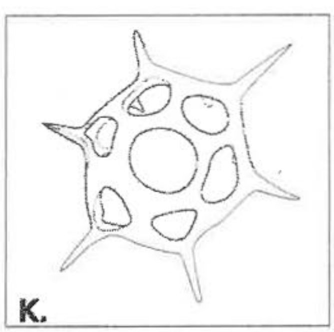
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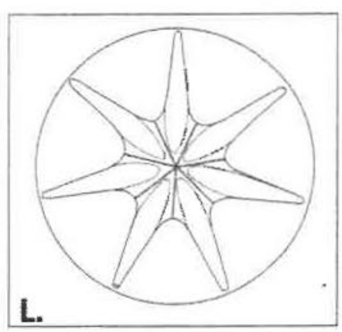

L.

Answer Key: A. zooplankton B. phytoplankton C. phytoplankton D. zooplankton E. phytoplankton F. phytoplankton G. phytoplankton H.zooplankton I. phytoplankton J. phytoplankton K. phytoplankton L. phytoplankton

Student Discovery Master 4
What Will I Grow Up To Be

Name ______________________ **Date** __________

Class __________ **Names of Partners** ______________________

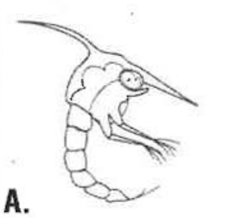
Challenge:

Match the plankter to the adult it will become!

Plankton includes many young or larval forms of animals that grow and change into adults that look very different from the larvae. Most planktonic larvae look somewhat alike because they have similar life styles. They are tiny, and they can only eat tiny things. They have to stay up in the water. If they sank, they would not find food.

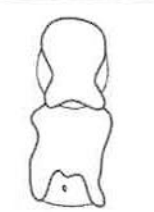
Discuss with other students what plankter grows into what adult. When you have made a decision, draw a line between the two. Continue until you have matched all the zooplankters with the adults forms

Your teacher will go over this with the class.



A.

Sea star



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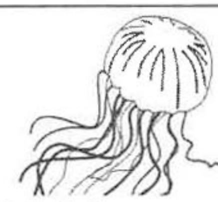
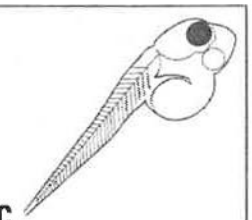
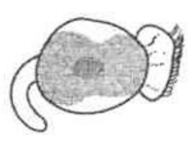


Jellyfish



C.

Clam



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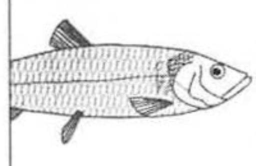
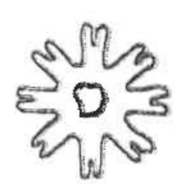


Fish



E.

Crab

Answer Key: A. crab B. sea star C. fish D. clam E. jellyfish

Food Chain Poems

What animal or plant are you writing about?

If it is an animal, what does it eat? If it is a plant, what does it need for energy?

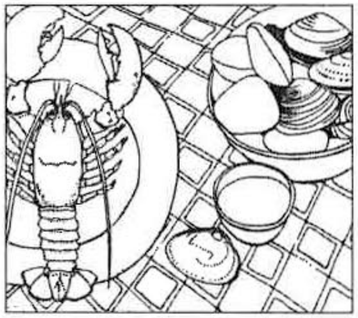
Try writing your poem using the following formula:

In the first and second lines, describe two characteristics of the animal or plant.

In the third line, tell us what the animal or plant eats or needs.

____________________eats/needs____________________

In the last line, tell us what the animal or plant does with the food or energy it now has. For an extra challenge, try rhyming this line with the second line.



12 People like to eat food from the sea too. They catch and eat fish, lobsters, mussels, and clams.

Food From the Sea

Seafood is an important part of the diet of many of the world's people, especially coastal populations. Here in Rhode Island, the popularity of seafood has been illustrated by the tradition of summer clambakes. Traditional clambakes, a long-standing Native American practice, take place on the beach at the end of the summer. Clams, potatoes, onions, corn, lobsters, fish, mussels, lemons, and sometimes sausages are steamed together on a bed of hot rocks and wet seaweed, in a pit dug on the beach. It is believed that this tradition was taught to the early New England settlers by Native Americans. In the nineteenth century, as people had a little more leisure time, the clambake became a popular pastime.

Seaweed

Most people are aware that seaweed is common in Asian dishes. What many do not realize, however, is that seaweed extracts are commonly used in the United States as additives to many popular foods. There are three compounds used: carrageenans come from red algae and are used for gelling and stabilizing food and cosmetics; alginates come from brown algae and are used as thickeners, stabilizers, and for making foods more creamy; and beta carotene from green algae is used as a yellow-orange food coloring.

Glossary

Clambake
A banquet of seafoods cooked together in steam, usually featuring lobsters, clams, fish, sausage, potatoes, and corn on the cob.

Quahog
A type of hard-shelled clam that has free-swimming larvae but lives buried in the sand or mud when it matures.

Shellfish
Any of a variety of marine invertebrates that are consumed by humans. Examples include clams, lobsters, crabs, snails, scallops, oysters, mussels, octopuses, squids, and shrimp.

Steamer
A type of soft-shelled clam that lives buried in the mud in intertidal areas.

Activity Ideas

Seaweed Popcorn[2]

Objective:
- Students will taste seaweed and learn that it can be used as a food source.

Materials:
Popcorn (microwave buttered type)
Seaweed (dulse) flakes
Napkins

Procedure:
1. Pop the popcorn.
2. Sprinkle the seaweed flakes onto the popcorn, as you would salt. Mix so that the seaweed is evenly distributed.
3. Eat and enjoy!

Sea Chips[2]

Objective:
- Students will taste seaweed and learn that it can be used as a food source.

Materials:
Kelp
Oil
Frying pan
Paper towel
Spoon

Procedure:
1. Cut kelp (any kind) into bite sized squares.
2. Fry in oil until crisp.
3. Remove from oil and place on paper towel.
4. Allow to cool.
5. Enjoy with cheese dip (melt one large block Velveeta cheese and salsa together in crock pot or microwave).

Seaweed Sleuths

Objectives:

- Students will discover that algae is a part of some of their favorite foods.
- Students will recognize the names of algae derivatives.

Materials:

A few common seafood items (tuna, other fish, clams, mussels, shrimp, etc.)
Various food items containing seaweed extracts (see worksheet for suggestions)
Seaweed Sleuth worksheet (included)
Samples of red, green, and brown seaweed

Procedure:

1. Bring into class some common seafood items and food items containing seaweed. Place them all in the front of the room and ask the students to point out the items that contain something from the sea. Most likely, the children will point out only the obvious, common seafood.
2. Ask students what they would say/think if you told them that ALL of the items you have brought contain something from the sea. Give them a few minutes to write their thoughts in their science journals. Explain to them that although they may never have eaten a whole piece of seaweed, they have eaten extracts from seaweed quite frequently. Explain what those extracts are and why they are used (see background information above). Show the students samples of seaweed from the supermarket or from Rhode Island beaches.
3. Show the children how to find and read the nutrition and ingredient information on the various food items, and let them practice picking out the words "carrageenan," "alginate," and "beta carotene."
4. Send students home with the *Seaweed Sleuth* worksheet. Explain to them that they should take their sheet home and check the boxes that apply for each item. If it is not possible for students to take the worksheet home, you can bring the materials in and let them do the activity in the classroom.
5. To reinforce the knowledge of why we use extracts from seaweed, ask students to describe, in their science journals, what the items that contain seaweed are like and how they are different from those that do not contain seaweed. In class, have students share their answers and make a chart in the front of the room with all of their responses.

Standards Met[3]

Activity	Standard	
Seaweed Popcorn	S2c	Organisms and environments
	S4b	The designed world
Sea Chips	S2c	Organisms and environments
	S4b	The designed world
Seaweed Sleuths	S4b	The designed world
	S4c	Personal Health
	S7a	Represents data and results in multiple ways

Resources

Neustadt, K. 1997. *Clambake: A History and Celebration of an American Tradition.* University of Massachusetts Press.

Peters, R. and J. Madama. 1992. *Clambake: A Wampanoag Tradition.* Lerner Publishing Group.

Smithsonian Ocean Planet Website *(http://seawifs.gsfc.nasa.gov/ocean_planet.html).* Contains lesson plans, including one on algae in the home.

Treat, R. 1995. *The Seaweed Book: How to Find and Have Fun With Seaweed.* Star Bright Books. A guide to seaweed for children. Contains recipes and activities.

Seaweed Sleuth

Item	Contains seaweed extract	Contains carrageenan	Contains alginate	Contains beta carotene
Brownie mix				
Ice cream				
Bread				
Soda				
Salad dressing				
Soup broth				
Toothpaste				
Mouthwash				
Sour cream				
Mayonnaise				
Yellow and orange cheese				
Mozzarella or parmesan cheese				

13 **We also build towns, cities, and homes along the coast. Some buildings are on top of stilts to keep them above high water and big waves from storms.**

Hurricanes are among Earth's most powerful storms. They are formed over tropical waters when a large amount of warm moist air rises, creating a low pressure center around which the air rotates. The Saffir-Simpson scale defines hurricanes by their wind speed. A Category 1 storm has winds of 74–95 miles per hour (mph), a Category 2 has winds of 96–110 mph, a Category 3 has winds of 111–130 mph, a Category 4 has winds of 131–155 mph, and a Category 5 hurricane has winds equal to or greater than 156 mph.

On September 21, 1938, a powerful hurricane with winds reaching up to at least 186 miles per hour (~161 knots) crashed ashore in Southern New England. Approximately 488 people were killed and 1754 injured. The total economic loss was between $250 million and $330 million.

As well as being our first line of defense against ocean storms, barrier beaches are also a popular location for houses, resorts, and recreation. This buildup along the shore contributed to the loss of property and lives during the 1938 hurricane, and it continues to be a potential problem today. On average, Rhode Island is affected (either brushed or hit) by a hurricane or tropical storm every seven to eight years.

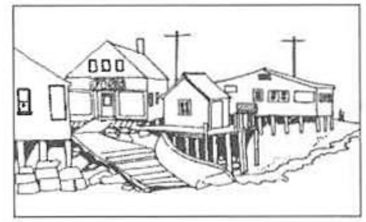
Fortunately, modern technology allows meteorologists and ocean scientists to monitor and track hurricanes quite well. Information gathered by satellites, aircraft, weather balloons, ships, and radar provides detailed information about the structure and path of the hurricane, allowing meteorologists to give homeowners, tourists, and others along the coast warning that a hurricane is going to hit. As a result, the loss of human life is usually far less than it was in 1938. For example, during the 2002 hurricane season, 12 named tropical storms gave rise to 4 hurricanes, yet only 15 lives were lost due to those 12 storms combined.

Glossary

Breakwater
A structure, usually of rock or concrete, designed to break the force of waves and protect a shore area, harbor, or beach. The groin, jetty, and seawall are all forms of breakwaters.

Hurricane
A severe tropical cyclone in the North Atlantic Ocean, Caribbean Sea, Gulf of Mexico, or the Eastern North Pacific off the west coast of Mexico. Hurricane force winds are those above 64 knots.

Knot
A unit of speed equaling one nautical mile per hour (one nautical mile = 6076 feet; 13 knots = 15 miles per hour).



Activity Ideas

Home is Where the Habitat Is

Objectives:
- Students evaluate the pros and cons of building along the coast.
- Students will explain why some coastal areas should not be built upon.

Materials:
Information and student projects from previous sections of this book and the associated activity book.
Pencils
Writing paper

Procedure:
1. Brainstorm with the students about why people like to build their homes and cities along the coast. Direct them toward answers such as aesthetic value and proximity to waterways for transport of goods.
2. Next, ask the students to look at their activity books and recall the habitats they have discussed. What other creatures live along the coast?* What happens when humans move in? Are some of these habitats better for humans than others? Are there some places humans should not live on the coast? Why?
   *A guided reading of *A House for Hermit Crab* by Eric Carle will help students remember and relate to the creatures they have been studying.
3. Have each student choose a habitat (barrier beach, salt marsh, rocky shore, eelgrass bed) and pretend that they are going to build a house and move in near or in that habitat. Ask them to write a story detailing their move: Why did they choose that habitat?, What else lives there? What will happen to the animals and plants that live there when the student moves in?

Variation:
Have students write their stories from the perspective of an organism already living in their chosen habitat.

Building For Bad Weather

Objective:
- Students will examine the devastation of hurricanes and think of ways to reduce the damage.

Materials:
Drawing paper
Crayons, colored pencils, markers
Writing paper
Books about hurricanes (see **Resources**)

Procedure:
1. Begin by explaining to students what a hurricane is and the types of damage it can cause. A guided reading of *Hurricanes: Earth's Mightiest Storms* or *The Magic Schoolbus Inside a Hurricane* may be helpful.
2. Ask students if they can think of any ways that people might protect themselves and their communities from damage during a hurricane. Photographs (like those included in the resources listed below) may be helpful.
3. Have each student draw a building or community that they design to withstand the heavy winds and high water associated with a hurricane. On another sheet of paper or in their science journals, ask students to describe their building/community, answering questions such as:
   a. What protective structures are there? (e.g. walls, stilts, etc.)
   b. What are the buildings made out of?
   c. How far away from the coastline are the buildings?
   d. What should a person who lives in your building/community do in case of a hurricane?
4. Hang the students' artwork around the room.

Standards Met[3]

Activity	Standard	
Home is Where...	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts
	S5d	Evaluates different points of view
	S7b	Uses facts to support conclusions
Building for Bad Weather	S3c	Changes in Earth and sky
	S4a	Big ideas and unifying concepts
	S4b	The designed world
	S4c	Personal and environmental safety
	S5c	Identifies problems, proposes and implements solutions

References

Gordon, B. (Ed.). 1996. *Hurricane in Southern New England.* The Book and Tackle Shop, Watch Hill, R.I. A collection of essays detailing destruction and shoreline changes caused by the 1938 hurricane. Contains photographs.

"Shift in Wind at Hurricane Center" *Providence Sunday Journal,* December 15, 2002. This article describes the 2002 hurricane season and explains that women are finally breaking into the male-dominated field of meteorology.

Resources

Fiction:

Cole, J. and B. Degen. 1995. *The Magic School Bus Inside a Hurricane.* Scholastic, Inc. Packed with scientific explanations for weather in general and hurricanes in particular.

Nonfiction:

Burby, L. 1999. *Tropical Storms and Hurricanes.* PowerKids Press. A good introduction for young readers.

Challoner, J. 2000. *Eyewitness Books: Hurricane and Tornado.* Dorling Kindersley. Describes a broad range of extreme weather including climate change, fog, and El Niño.

Chambers, C. 2001. *Hurricanes.* Heinemann Library. Describes how hurricanes form, how they are tracked, and the destruction they can cause. Also includes a section on how some plants and animals deal with hurricanes.

Hopping, L. 1995. *Hurricanes!* Scholastic. Written in chapter form, this is a good book for reading aloud or for students to read on their own.

Lauber, P. 1996. *Hurricanes: Earth's Mightiest Storms.* Scholastic Press. Begins with a vivid description of the 1938 New England hurricane.

Video:

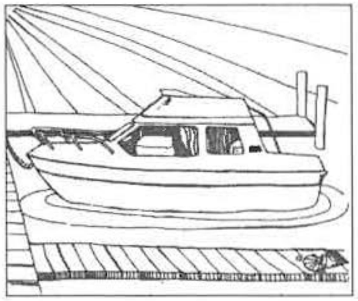
Narragansett Bay: A Friend's Perspective. 1987 WJAR-Channel 10 and Hospital Trust. Shows footage of the 1938 and 1954 hurricanes.

Places to Visit

Fox Point Hurricane Barrier
This barrier was built after Hurricane Carol. Call (401) 467-7950 for more information or to arrange a tour.

High-Water Marks
A couple of buildings in downtown Providence have plaques showing high-water levels during significant storms in R.I. history. The Biltmore Hotel, at Dorrance and Washington streets, shows the high-water level during the 1938 hurricane. At Market House (South Water and College streets) one can see water levels from the 1938 hurricane and from the 1815 tidal wave known as the "Great Gale."

14 **People enjoy boating along our coast. On any given day you might see a rowboat, kayak, motorboat, or sailboat on the water or tied up at docks like this one.**



Boating is one of the most common recreational activities on Narragansett Bay. In addition to privately owned motorboats, rowboats, kayaks, and canoes, charter boats and ferries can also be seen on the Bay. In 1930, the America's Cup sailboat race began to draw boaters and visitors to Newport. Boatbuilding is also a lucrative business in many communities on the Bay.

Glossary

Dock
A structure to which a boat is tied, or where passengers and gear are loaded and/or unloaded.

Harbor
A protected area of water where ships and boats are anchored.

Marina
A waterfront facility serving recreational boaters, usually including docks, fuel, storage, repair services, boat and accessory sales, and other related services.

Activity Ideas

If I Had a Boat

Objective:
- Students will discuss the types of boats and design one of their own.

Materials:
Paper
Pencils
Crayons, markers, or colored pencils
Scraps of colored paper and other collage materials
If I Had a Boat worksheet (included)

Procedure:
1. Discuss with students the different types of boats and what they are used for. You may want to use a guided reading of *This Boat, Boats,* or *All Kinds of Ships* (see **Resources**). What reasons do people have for boating? Include vocabulary for parts of a boat.
2. Explain to the students that they are now going to pretend they each have a boat of their own.
3. Give each student a copy of the worksheet *If I Had a Boat.* Have them work through the sheet, then draw, decorate, and name their boats.
4. Create a bulletin board display with a "dock." Allow each student to place their boat at the dock. As they do so, have them describe their boats to the class.

Sink or Float

Objectives:
- Students will activate prior knowledge to hypothesize about what will happen before the activity is conducted.
- Students will individually test objects, discuss what happened, and record results on a chart.
- Students will discuss differences and similarities of the properties of materials used in the test.

Materials:
Bucket (half filled with water)
Plastic tarp (if activity is to be conducted inside)
At least one of all the materials listed on the *Sink or Float* worksheet
Sink or Float worksheet (included)
An enlarged version of the *Sink or Float* chart (can be on a chalkboard or white board, or large sheet of paper)

Procedure:
1. Display a large version of the *Sink or Float* chart in front of the the classroom. Give each child a copy of the same chart.
2. Explain to the children that they are going to pretend they are scientists and test hypotheses (ideas based on prior knowledge about what will happen). They are going to decide whether an object will sink or float, and determine what makes an object do one or the other. Invite the children to ask any questions they may have prior to the activity.
3. Ask children to hypothesize (or guess) what will happen when each object on the list is dropped into a bucket half filled with water. (This activity works well outside, but if done inside use a plastic tarp under the water bucket).
4. After all of the children have had a chance to make guesses out loud, ask them to go ahead and check off on their own sheets what they think is going to happen when each object is dropped into the bucket. Check to make sure they are recording in the proper column.
5. Have each child select an object to test individually in front of the class. The children then will be able to discuss what they thought might happen. After the object sinks or floats, have the children mark on their own

sheets what happened. Mark these results on the chart in front of the class as well.

6. The children should then categorically see which objects sink or float in the water by reading their charts. (This activity may require more attention with children who have difficulty reading charts and recording information in the proper columns).
7. The children should begin to observe similarities and differences in properties of the materials as the results on the chart are read aloud by the teacher.
8. If children are keeping a science journal, results may be recorded and reflected upon in their notebooks.

Standards Met[3]

Activity	Standard	
If I Had a Boat	S4b	The designed world
Sink or Float	S1a	Properties of objects and materials
	S5c	Uses evidence to construct explanations
	S5d	Evaluates different points of view
	S5e	Identify problems, evaluate outcomes
	S5f	Works individually and in teams

Resources

Fiction:

Coffey, M. and E. Fernandes. 1998. *A Cat in a Kayak.* Annick Press, Ltd. In this story, Victor the veterinarian uses his trusty kayak to bring a number of creatures home to Cloud Island.

Nonfiction:

Collicutt, P. 2001. *This Boat.* Farrar Straus Giroux. An excellent book for guided reading with very young children.

Kentley, E. 1992. *Eyewitness Books: Boat.* Alfred A. Knopf. In the tradition of Eyewitness Books, this one is an excellent introduction to types of boats and the history of boats.

Reit, S. 1978. *All Kinds of Ships.* Golden Press Western Publishing Co. A good source for illustrations and descriptions of different types of boats.

Robbins, K. 1989. *Boats.* Scholastic. Another good source for types of boats.

If I had a Boat

What kind of boat would it be?

Why did you choose this kind of boat?
For what would you use it?

How many inches or feet of water must your boat be in so that it does not touch the bottom?

Where would you keep your boat when it is not being used?

What items would you want or need to have aboard your boat?

Draw a picture of your boat. Label the parts. You may also wish to name and decorate your boat.

Sink or Float

Object	Hypothesis		Results	
	Sink	Float	Sink	Float
Cork				
Oyster cracker				
Popsicle stick				
Copper penny				
Nickel				
Metal toy car				
Film canister				
Pencap				
Plastic can rings				
Glass jar				
Leather				
Cardboard				
Rubber band (or eraser)				
Wire				
Styrofoam peanut				
Real peanut in shell				
Bubble wrap				
Popcorn				
Dental floss				
Cloth				
Rock				
Shell				
Pottery				
Pillow stuffing				
Macaroni				
Rope or twine				
Wood bark				
Leaf				
Sandpaper				
Aluminum foil				
Hair roller				
Plastic spoon				
Ring				
Apple seed				
Avocado pit				
Bone (chicken/fish)				
Rubber ball				

15 **Some people, like commercial fishermen and women, make their living from Narragansett Bay.**

Commercial Fishing in Narragansett Bay

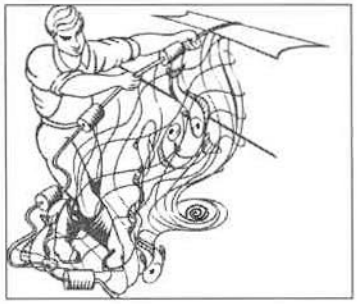
While commercial fisheries have always been economically important to Rhode Island, the nature of those fisheries has changed over the years. In the early 1900s, the Narragansett Bay oyster was the most commercially important species in the Bay. The population went into decline in the middle of the century, due to some combination of predation, hurricane damage, poaching, and pollution. While there was a brief resurgence of this species in the late 1990s, numbers have since declined again.

Currently, the main fisheries resources in Rhode Island are: quahog, American oyster, soft shelled clam, lobster, cancer crab, winter flounder, summer flounder, tautog, bluefish, striped bass, scup, squid, butterfish, menhaden, little skate, winter skate, and dogfish. Of these, the quahog is currently the most commercially important. Fishing methods include: trawls, gill nets, fish traps, lobster and fish pots, clam rakes, dredges, and SCUBA. In the year 2000, the commercial value of all fishery resources landed (i.e. caught) throughout Rhode Island was 73 million dollars. This figure has been relatively stable for the last decade due to a decline in fish abundance combined with an increase in fishing effort and an increase in the price per pound. Of those resources landed by Rhode Island fishermen, approximately 5 percent of finfish, 75 percent of shellfish, and 20 percent of lobster are actually from Narragansett Bay. The rest come from Rhode Island Sound, Block Island Sound, and federal waters offshore.

Of the fisheries resources listed above, nine out of seventeen are either currently overfished or at risk. A stock is said to be overfished when its biomass is below the threshold necessary for successful reproduction and recruitment. Overfishing is a problem that affects fisheries throughout the world. Currently, approximately 30 percent of fish stocks are depleted, with an additional 40 percent being fished at their uppermost limit.

In addition to overfishing, pollution of coastal waters can damage fisheries. Shellfish (such as quahogs, oysters, and mussels) are particularly vulnerable. Because these animals are filter feeders, they bring into their bodies any toxins, including pollutants, heavy metals, and toxic algae, contained in the water. These toxins are then concentrated in the body of the animal and consumed by humans and other predators. Currently, one quarter of Narragansett Bay's total area is permanently closed to harvesting shellfish due to pollution problems. In addition, other areas may be temporarily closed at various times due to specific conditions such as overflowing storm drains.

Another environmental concern for the fishing industry is bycatch. Bycatch are the organisms that are caught along with the target organism but not used. Even if these animals are let go after they are caught, they often stand little chance of surviving. Bycatch often makes the news because of the public fondness for particular animals, such as marine mammals, turtles, and sharks, which can be inadvertently caught in various types of fishing gear. For example, in the 1990s public awareness and action helped environmentalists win a campaign to get tuna fisheries to decrease the number of dolphins drowned in gill nets.



Other Ocean Related Careers

For people who are interested in making the ocean their workplace, there are many other exciting career options. The following is a list of only some of the possibilities:

Ship's Crew—work aboard a commercial or private boat
Ocean Engineer—design the technology used for ocean study and travel
Marine Biologist—study ocean life
Biological Oceanographer—study ocean life and related habitat structure
Chemical Oceanographer—study ocean chemistry
Geological Oceanographer—study ocean geology
Physical Oceanographer—study the physics of the ocean
Marine Educator—teach others about the ocean
Environmental Educator—teach about the ocean in the context of the whole environment and conservation
Aquarium Staff—care for animals and/or design exhibits

Glossary

Bycatch
Nontarget organisms, including unwanted species and undersized individuals, caught in fishing gear.

Commercial Fisherman
A person whose occupation is to catch fish.

Overfishing
The process of depleting a fish stock to the point at which its biomass is below the necessary threshold for successful reproduction and recruitment.

Port
A place along the shore where commercial ships come to load or unload their cargoes.

Recruitment
In this context, the amount of fish reaching the appropriate age or size to be exploited in the fishing industry.

Activity Ideas

Commercial Fishing[2]

Objectives:

- Students will explore different fishing methods useful for target species.
- Students will discover that sometimes we catch unintended organisms.
- Students will conduct an investigation and record their results.

Materials:

Various floating objects (small—coconut flakes, assortment of cereals, etc.; medium—birthday candles, crayons; large—scraps of foil pressed into different sizes)
3 or 4 pieces of plastic mesh with various sized openings (e.g. fruit bags, onion bags, etc.)
Large dishpan
Commercial Fishing worksheet (included)
Rulers

Procedure:

1. Organize students into small groups. Provide each group with a tub of water, pieces of mesh and an assortment of floating objects of various sizes.
2. Have the students place the floating objects in the water.
3. Instruct one child to hold two corners and another child to hold the other two corners.
4. Have the students drag the net along the bottom of the tub, then lift up their net to examine their catch.
5. Ask each student to record objects caught and the length of each object on the worksheet provided.
6. Repeat for each size mesh.

Extension activity:

Assign a "value" to each type of object (e.g. some might be good for eating, some might be bycatch, etc.). Ask students to evaluate their catches and discuss problems with the method, along with potential solutions.

Overfishing[2]

Objective:

- Students will create an art project to illustrate the reality of overfishing.

Materials:

Mesh produce bags (the type of bags potatoes and onions are shipped in), cut up into 8.5" x 11" pieces
Construction or colored paper
Scissors
Glue
Colored pencils or markers
Photos of fish, cetaceans, and sea turtles cut from magazines (optional)

Procedure:

1. Discuss the problem of overfishing with students.
2. Give each student a sheet of blue construction paper and a piece of a mesh bag.
3. Provide other colors of construction paper, markers, and scissors so that the students can design and cut out a number of fish. Have students glue the fish onto the blue construction paper to represent an enormous catch of fish. If magazine pictures are available, have them cut out fish to include in their fish catch collage.
4. Make sure some students include whales, dolphins, sea turtles, sharks, and other marine life in their nets too.
5. Glue the mesh piece over the top of the pictures of the fish and other marine life. Glue around the edges and hold down so the mesh adheres to the paper. Leave enough room at the top of the collage for writing (cut the mesh a little shorter before gluing if necessary).
6. Have students write a sentence about the effect of overfishing at the top of their papers.
7. You may wish to hang the students' collages together on a bulletin board or suspend them from monofilament line hung from the ceiling.

Helpful Hints:

Have posters or images of fish, cetaceans, sea turtles, and other marine life so that the students can accurately draw the animals. You may have them do research on what types of fish are caught locally and have them draw only those types of fish. An alternate idea is to divide the class into groups and assign each group a part of the world's oceans. Each group has to research what kinds of fish are caught in their part of the world and accurately draw those fish and whatever else is caught for their collage. For example, one group may be assigned the Eastern Tropical Pacific Ocean. Tuna is the big fishery there and the fishermen use dolphins to spot tuna and then spread their nets around the dolphins. Consequently, fishermen trying to catch tuna may catch dolphins in their nets.

Discussion Questions:

a. Why do fishermen catch too many fish?
b. Do people eat all of the fish that are caught? What are some fish used for?
c. What will happen if we catch so many fish that there aren't any left?
d. Can you think of any ways that we can keep from catching too many fish and other marine animals?

Standards Met[3]

Activity	Standard	
Commercial Fishing	S1a	Properties of objects and materials
	S4b	The designed world
	S5e	Identifies problems
	S5f	Works individually and in teams to collect and share information and ideas
	S6a	Uses technology and tools to gather data and extend the senses
	S7b	Uses facts to support conclusions
	S8b	Conducts a systematic observation
Overfishing	S2a	Characteristics of organisms
	S2c	Organisms and environments
	S4a	Big ideas and unifying concepts
	S4d	Science as a human endeavor
	S5e	Identifies problems; proposes and implements solutions
	S8c	A design such as building a model

References

Department of Environmental Management, Rhode Island. 2002. *Stock Status of Marine Resources and Summary of Fisheries Management in Rhode Island.* A report to the Rhode Island General Assembly. Available in PDF form (http://www.state.ri.us/dem/topics/mftopics.htm).

Office of Marine Programs (University of Rhode Island) *Discovery of Estuarine Environments* Website (http://omp.gso.uri.edu/doee/doee.htm).

Thurman, H. and A. Trujillo. 2002. *Essentials of Oceanography.* Seventh Edition. Prentice Hall. A basic oceanography textbook.

Resources

Fiction:

Woodman, N. 1999. *Sea-Fari Deep.* National Geographic Society. A look at ocean exploration, featuring the JASON Project.

Nonfiction:

Ballard, B. 1992. *Explorer.* Turner Publishing, Inc. A pop-up book that takes children on six expeditions with Dr. Bob Ballard. Offers a look at what it's like to explore the ocean depths.

Kurlansky, M. 2001. *The Cod's Tale.* G.P. Putnam's Sons. By the author of the book for adults, *Cod: A Biography of the Fish That Changed the World.* Contains beautiful illustrations and historical references.

Markle, S. 1995. *Pioneering Ocean Depths.* Atheneum Books for Young Readers. An easy to understand introduction to the methods scientists use for studying the sea floor. Includes hands-on activities.

McAlary, F. and J. Love Cohen. 1993. *You Can Be a Woman Marine Biologist.* Cascade Pass, Inc. A woman marine biologist's story. Can be purchased with an interactive CD-ROM.

Sea Grant Marine Careers Website (http://www.marinecareers.net). Contains information about various marine careers, including profiles of people currently in the field.

Montery Bay Aquarium (http://www.mbayaq.org/lc/kids_place/kidseq_asp).

Ocean Link (http://oceanlink.island.net/career/career2.html).

Careers in Oceanography, Marine Science, and Marine Biology (http://scilib.ucsd.edu/sio/guide/career.htm/).

Women Exploring the Ocean (http://www.womenoceanographers.org).

Places to Visit

Galilee Fishing Port and Plant
Teachers can call the Point Judith Fishermen's Association for plant tours: (401) 782-1500.

Local harbors, seafood shops, and marinas

Commercial Fishing

1. List the objects caught with each net. Measure each object and record its length below.

Small mesh

Object	Length

Medium mesh

Object	Length

Large mesh

Object	Length

2. With which mesh did you catch the most items? The least?

3. Was there a difference in size of items caught with different sizes of mesh? Describe the difference.

4. Which net would you use if you wanted to catch very small animals? Which would you use if you wanted to catch very large animals?

16 **Commercial ships can also be seen on the Bay transporting goods to and from the state.**

There are three main commercial ports on Narragansett Bay: They are in Providence, Newport, and Quonset-Davisville. Rhode Island imports include automobiles and quarried stone. In order to maintain ports such as these, periodic dredging must be done. This involves the removal of sediment, thereby keeping the channel deep enough for commercial ship traffic. Dredging projects are closely monitored for biological and physical effects so that detrimental impacts to the benthic habitat can be minimized.

Invasive Species

Ships have allowed humans to transport themselves and commercial goods throughout the world. However, sometimes we also unknowingly transport other creatures. When a ship unloads its cargo in some faraway port, it must then take on water (called ballast) in order to weight the ship so that it will sit at an appropriate depth in the water. This water is then dumped when the ship reaches its next destination. Unfortunately, when the ship takes on ballast water it also takes on any animals or plants living in that water. Often these are larval forms of animals such as mollusks, fish, and crabs and other crustaceans.

There are other ways new species can be introduced to an ecosystem. In the past, people have purposefully introduced new species to provide food or to attempt to clear up the problem of another new organism. Ships also may have various plants and animals attached to their hulls as they move in and out of various ports (we call these fouling organisms).

With an increased global economy, such invasive species (as they are called) have become a greater problem. While many of these species simply cannot survive in the new environment and die off, others are able to thrive. These invaders may then out-compete native species and wreak havoc on the ecosystem. A familiar example is the zebra mussel, which has taken over much of the Great Lakes system. Zebra mussels have pushed out many of the native bivalves and have reproduced so well that they are known to clog pipes (bio-fouling).

Here in Rhode Island, some of our very common and familiar coastal species are actually invaders. The common periwinkle found all over our rocky shores came here from Canada where it was introduced by Europeans in the 1840s as a food source. The green crab was introduced 200 years ago as a fouling organism from Europe. These days you will mostly find green crabs in the subtidal zone due to the presence of a more recent invader in the intertidal zone, the Asian (or Japanese) shore crab. The Asian shore crab was introduced via ballast water to New Jersey from Japan in 1988. Since then, the crab has become the most common intertidal crab in southern New England. In all, 21 introduced species have been identified in Narragansett Bay.

Oil Pollution

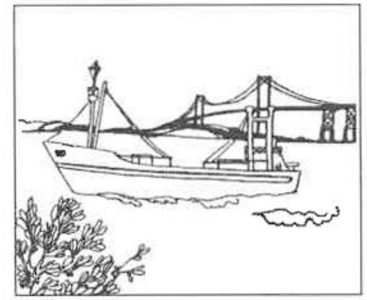
About 700 million gallons of oil end up in the world's oceans each year. Half of that comes from land-based sources, when used engine oil is washed down sewers or not disposed of properly.

Although only five percent of the oil that ends up in the ocean comes from large oil spills, such accidents can have catastrophic consequences. Marine birds, mammals, fish, and invertebrates can be killed by ingesting the oil or from indirect effects such as damaged feathers and fur (oil destroys the insulation effects of feathers and fur) and other physical impairments such as liver damage and blindness.

In 1989, the *Exxon Valdez* ran aground in Prince William Sound, Alaska. Eleven million gallons of oil were spilled, covering 1,300 miles of coastline (more than three times the length of Rhode Island's coast!). An estimated 250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles, 22 orcas, and billions of salmon and herring eggs were killed. This does not include those animals dying later from indirect effects. In addition, even after a decade, some populations have not recovered.

Closer to home, the *North Cape* ran ashore on Moonstone Beach in southern Rhode Island in 1996. Approximately 828,000 gallons of home heating oil were spilled, killing 2,300 marine birds, nine million lobsters, 19 million surf clams, and over 500,000 kilograms of marine biomass including crabs, mussels, and worms.

On November 19, 2002 the *Prestige* sank off the coast of Spain, spilling 2.5 million gallons of oil. The ship contained about 22.5 million gallons of oil and as of December 6, 2002 was still leaking from the ocean floor. Currently there is a fishing ban along three hundred miles of the Spanish coastline, and the ecological and economic ($42 million, as of November 22, 2002) effects of the spill are yet to be determined.



Glossary

Ballast Water
Water taken on by a ship after its cargo has been unloaded, to adjust for the weight of the lost cargo.

Cargo Ship
A commercial ship used for transporting products like bales of cotton, automobiles, and bags of coffee beans.

Fouling Organism
An organism that causes harm by living in or on manmade structures such as boats and pipes.

Invasive Species
A species that does not naturally occur in a specific area and whose introduction does, or is likely to, cause economic or environmental harm or harm to human health.

Tanker
A commercial ship used for transporting bulk items like oil, wheat, and molasses.

Activity Ideas

Which Boat?

Objectives:
- Students will recognize different types of boats.
- Students will describe the different ways in which we use boats.

Materials:
4 pages of boat drawings (included)
1 page of boat names (included)
2 category pages (included)
Colored pencils (or crayons)
Scissors

Procedure:
1. Begin by discussing the different types of boats people use. Some of the books mentioned in Section 13 of this guide will be useful here.
2. Give each student one copy of each handout (two pages of drawings, one sheet of names, two category pages).
3. Students should begin by coloring the boats and cutting them out.
4. When they have done this, help them to match the names of boats with the pictures.
5. Explain to students that people use boats for many different purposes. Some boats are for enjoyment (pleasure), and other boats are for working (commercial). Ask them to place each of their boats on the correct category sheet. Discuss their rationale for each choice.

Standards Met[3]

Activity	Standard	
Which Boat?	S4a	Big ideas and unifying concepts
	S4b	The designed world
	S5c	Uses evidence from reliable sources
	S7b	Uses facts to support conclusions

References

Cute, K. 2002. "Unwelcome Tourist: Asian Crab Invades Bay." *Narragansett Bay Journal.* Volume 1, Number 3.

National Marine Fisheries Service (NMFS) Office of *Exxon Valdez* Oil Spill Damage Assessment and Restoration (http://www.fakr.noaa.gov/oil).

North Cape Oil Spill (http://www.darp.noaa.gov/neregion/ncape.htm).

Office of Marine Programs (University of Rhode Island) *Discovery of Estuarine Environments* (http://omp.gso.uri.edu/doee/doee.htm). Contains a list of Rhode Island's invasive species, where they came from, and how they probably got here.

The *Prestige* Oil Spill Information from various news agencies, including:
The Providence Journal 11/22/02
The Tehran Times 11/26/02
The Washington Times 11/21/02

Resources

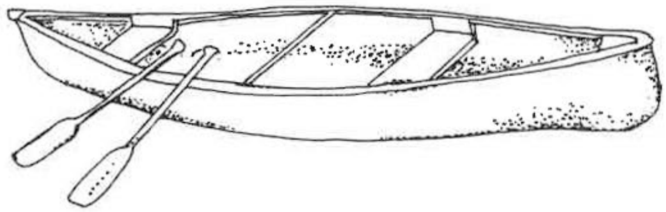
Non-Fiction:

Blashfield, J. and W. Black. 1991. *Oil Spills.* Childrens Press, Inc. Contains detailed information about oil spills, including damage to the ecosystem and methods for cleaning them.

Talen, M. 1991. *Ocean Pollution.* Lucent Books, Inc. Discusses a variety of ocean pollution including sewage, garbage dumping, and oil pollution.

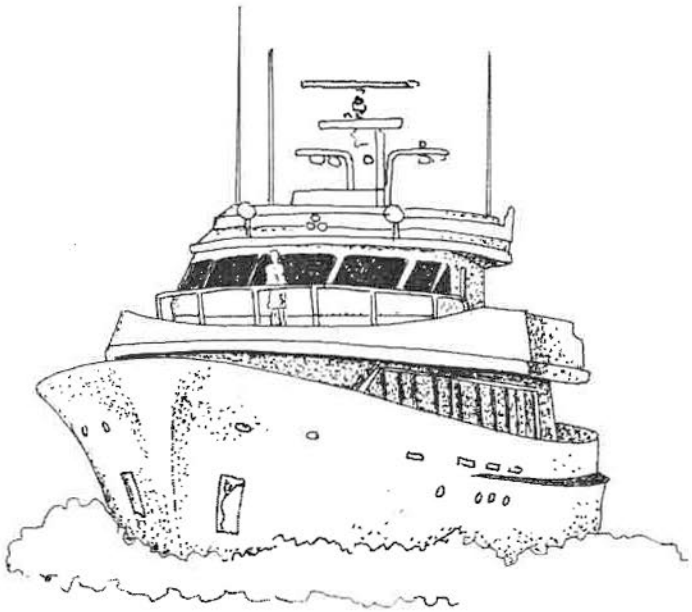
Kentley, E. 1992. *Eyewitness Books: Boat.* Alfred A. Knopf.

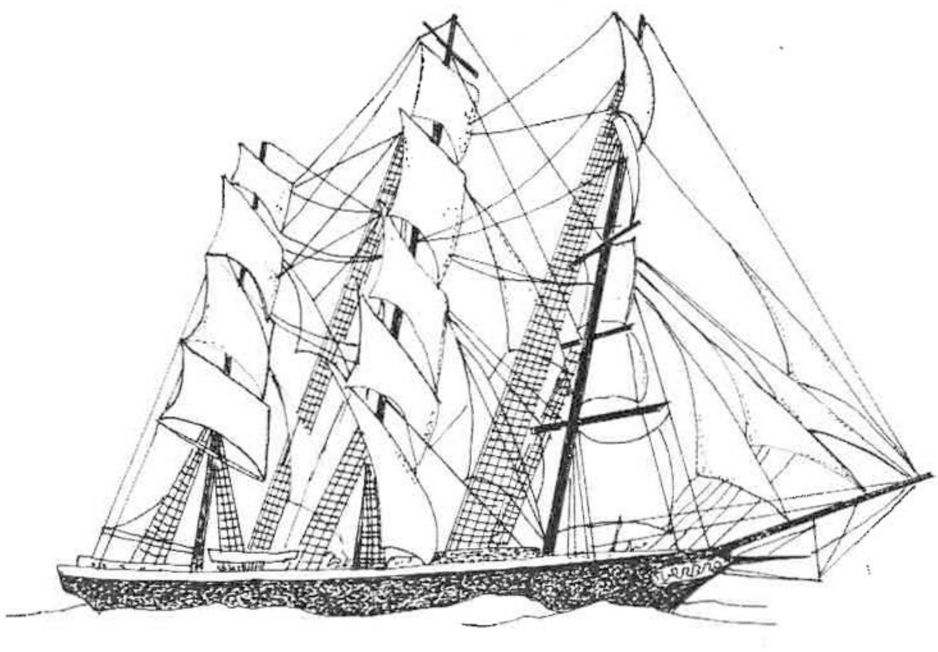
Which Boat?



Drawings by J. Susan Cole Stone

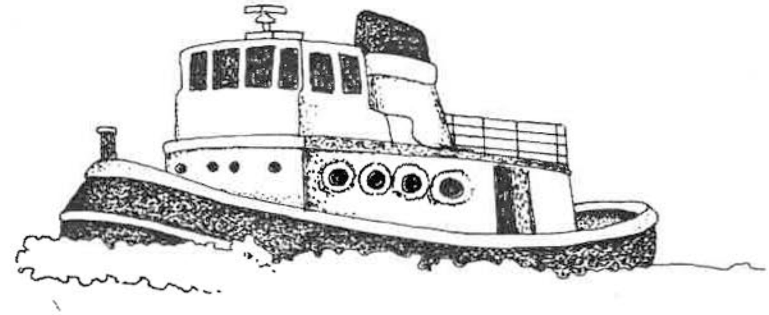
Which Boat?

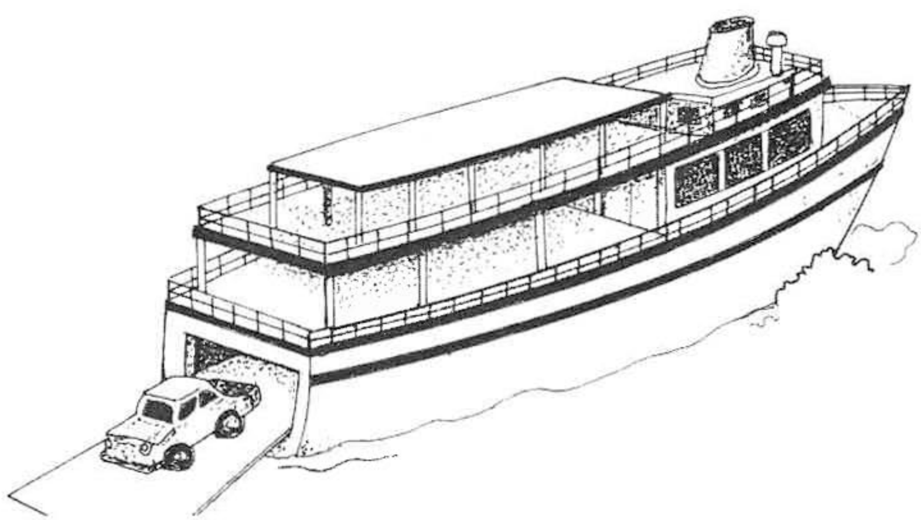


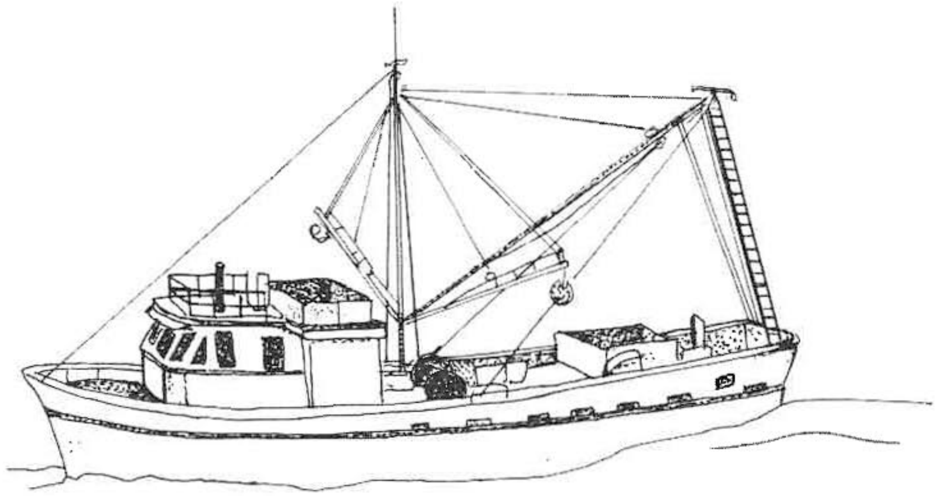


Drawings by J. Susan Cole Stone

Which Boat?

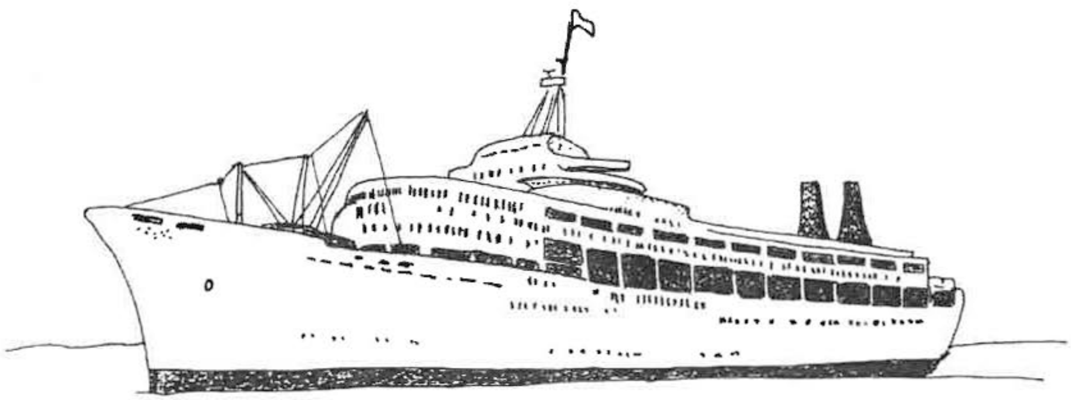


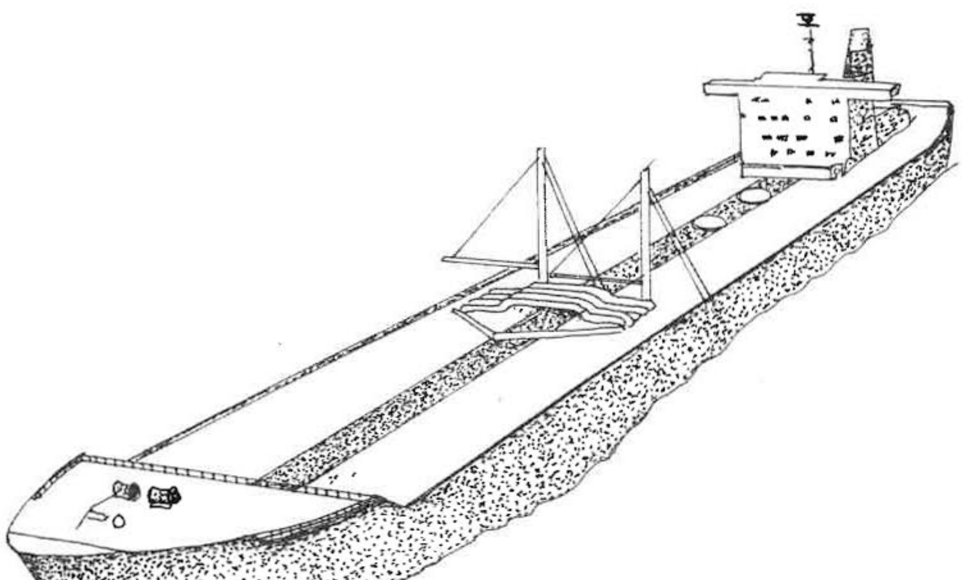


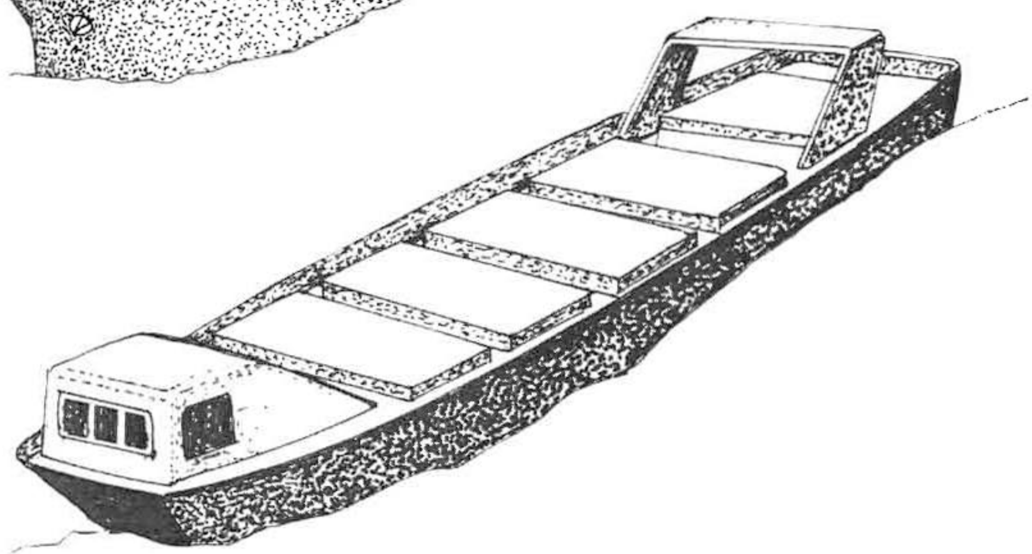


Drawings by J. Susan Cole Stone

Which Boat?







Drawings by J. Susan Cole Stone

Which Boat—Names

Canoe

Rowboat

Motor Boat

Yacht

Sailboat

Clipper Ship

Tugboat

Ferry

Fish Trawler

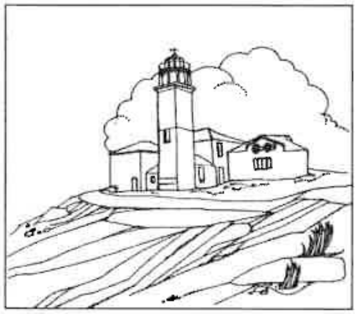
Passenger Cruise Ship

Oil Tanker

Barge

Commercial Boats

Pleasure Boats



17 Lighthouses are located along the coast to guide ships safely through the Bay.

The first lighthouses were likely nothing more than stone towers built to house a fire to guide fishermen and other sailors home. One of the earliest lighthouses, the Pharos of Alexandria, was built around 2300 years ago and is considered one of the Seven Wonders of the Ancient World.

Since then, lighthouses have developed considerably. The need for both warnings (to keep boats off the rocks) and navigational aids (to let sailors know where in the world they are) led to current lighthouse designs. In order for ship's crews to know their location during the day, various daymarks were employed. A daymark is the pattern and color of a lighthouse. At night, lighthouses (and therefore location) can be identified by the characteristic pattern of flashing or steady light. Foghorns are also employed to signal ships on foggy days when lights are difficult to see.

The invention of the Fresnel (pronounced "frA•nel") lens in 1822 by Louis Fresnel made the lights even more powerful as warnings and navigational aids, allowing for a multitude of flashing combinations. Each lens consists of hundreds of pieces of glass, surrounding the bulb, that intensify the light by focusing it into a single beam.

Before modern technological advances such as electricity and automatic light systems, a keeper was responsible for lighting the lamp each night and extinguishing it in the morning. Lighthouse keepers had a busy and solitary existence. Many of these keepers have become legendary for their dedication and, sometimes, heroism. One of the most famous of these is Ida Lewis. One of few female lighthouse keepers, Ida Lewis took over care of the Lime Rock lighthouse when her father fell ill, and is best known for her daring rescues at sea. Now the only lighthouse in the U.S. that still has a keeper is the light at Boston Harbor.

In 1749, Beavertail Lighthouse was the first lighthouse built in Rhode Island and the third in the United States. Although the original light no longer stands, visitors to Beavertail today can see its replacement, built in 1856, and walk through a lighthouse museum. Visitors can also see where the 1938 hurricane exposed the foundation of the original lighthouse tower, which stood 100 ft. from the newer tower.

Erosion has been a problem for other lighthouses as well. In 1840, the Stonington Harbor Lighthouse in Connecticut had to be torn down and rebuilt on the other side of the harbor. Block Island Southeast Lighthouse was moved 300 feet back away from the sea in 1993 in order to avoid losing the lighthouse to erosion of the cliffs.

Navigation Today

Current technology has made lighthouses less necessary as navigational aids. The Global Positioning System (GPS) uses triangulation to pinpoint locations. The GPS uses 24 satellites orbiting 12,000 miles above the Earth in addition to numerous receivers belonging to military and civilian users. Each satellite transmits a signal that can be interpreted by the receivers. With precise atomic clocks on board each satellite, the receiver uses information about the signal and the time it was transmitted in order to calculate the distance from the satellite. Information from three or more satellites allows the exact position of the receiver to be determined. The system must be continually updated to preserve the accuracy of satellite position and time.

Glossary

Daymark
The pattern and colors of a lighthouse, useful for identification during the day.

Fresnel Lens
A type of lens invented in 1822 by the French physicist Louis Fresnel. The Fresnel lens is used today to light virtually every lighthouse in the world.

Global Positioning System (GPS)
A system of satellites and receivers that uses triangulation to pinpoint exact locations. GPS is a powerful navigational tool.

Lighthouse
A tower with a powerful light at the top which guides navigators by day and night.

Activity Ideas

Make a Lighthouse Scene[2]

Objective:
- Students will create their own model lighthouses.

Materials:
Paper plate
Paper cup
Small piece of cardboard tube
Empty half-pint milk carton
Construction paper
Cellophane
Tape
Glue
Scissors

Procedure:

1. The paper plate will be the island. Color it or use construction paper to make grass, rocks, and tidepools. Cellophane can be crumpled and used to make water.
2. The paper cup is the tower. Cover it with construction paper and draw windows and a door. Turn the cup open-side-down on the paper plate and glue it firmly.
3. Cover the piece of cardboard tube with yellow construction paper and draw window panes on it. Glue it to the top of the cup to make the lantern.
4. To make the lantern roof, cut out a circle of black paper about the diameter of the bottom of the paper cup. Make a slit from the edge to the center of the circle. Curl the paper into a cone until you have a nice little cap, then tape it. Glue this cap to the lantern.
5. For the keeper's house, cover the milk carton with construction paper. Draw windows and doors, then glue the house to the paper plate.

Extension activity:
Have each student create a lighthouse with a unique color and pattern (daymark). Place lighthouses in various parts of the room and have children create their own navigational charts of the classroom using their lighthouses as guides.

Ida Lewis' Daring Rescues

Ida Lewis was one of few female lighthouse keepers. She was well-known for a number of brave rescues at sea.

Objectives:

- Students will investigate the life of Ida Lewis and her career as a light house keeper.

Materials:
Ida Lewis timeline (included)
Other Ida Lewis resources (see **Resources**)
Ida's Rescue worksheet (included)

Procedure:

1. Describe and discuss the life of Ida Lewis with your students. The timeline included here can be used in conjunction with the following internet resources:
   http://users.sitestar.net/~cypress/ida.htm
   http://www.lighthouse.cc/limerock/history.html
   And a poem:
   http://www.uscg.mil/hqlg-cp/history/Ida%20Lewis%20Bio.html
   (see **Resources**)
2. After describing some of Ida's heroic adventures, have the children go back to their seats with a copy of the sheet *Ida's Rescue*. Ask them to choose one of her rescues and complete the picture with as much detail as they can recall.
3. Students should label their drawings and write a sentence on the back of the picture describing the scene they have drawn.
4. After the students have completed their drawings and descriptions, go around the room and have each child explain what is happening in their picture (they can simply read their sentences on the back of the page as they show the picture to the class).

Ida Lewis Makes a Rescue at Lime Rock
Artist, John Witt
Courtesy of the United States Coast Guard

Standards Met[3]

Activity	Standard	
Make a Lighthouse Scene	S4b	The designed world
Ida Lewis	Reading Standard 2, Getting the meaning	

References

Berenstain, M. 1979. *The Lighthouse Book.* David McKay Co., Inc. Presents an easy to understand history of lighthouses.

Grubbs, B. 1999. *Using GPS: GPS Simplified for Outdoor Adventures.* Falcon Publishing, Inc. A practical guide to using GPS in the field.

Roberts, B. and R. Jones. 1996. *New England Lighthouses.* Chelsea House. A short history and photograph of each lighthouse. Also contains a wonderful essay about Ida Lewis and her rescues.

Teacher's Lighthouse Resource for K–4. From the U.S. Coast Guard. Available at: http://www.uscg.mil/hq/g-cp/history/WEBLIGHTHOUSES/lighthouse_curriculum.html

Resources

Block Island Southeast Lighthouse Foundation
P.O. Box 524
Block Island, RI 02807

Lighthouse Preservation Society
P.O. Box 763
Rockport, MA 01966

U.S. Lighthouse Society
244 Kearny St.
San Francisco, CA 94108

A GPS tutorial can be found at www.trimble.com/gps/index.html

Fiction:

Minahan, J. 1995. *Abigail's Drum.* Pippin Press. A fictionalized account of how two lightkeeper's daughters drove the British away from a New England town during the War of 1812.

Swift, H. and L. Ward. 1942. *The Little Red Lighthouse and the Great Gray Bridge.* Harcourt, Brace, and World, Inc.

Non-Fiction:

Fleming, C. 1996. *Women of the Lights.* Albert Whitman and Company. Inspiring stories about several women light keepers, including Ida Lewis.

Shannon, T. 1969. *Sentinels of Our Shores: The Story of Lighthouses, Lightships, and Buoys.* Golden Gate Junior Books. Illustrations by Charles Payzant, based on official Coast Guard photographs. This book chronicles the history and evolution of lighthouses.

Places to Visit

Beavertail Lighthouse and Museum
The museum contains photos of Rhode Island lighthouses and keepers, as well as a model Fresnel Lens. Tours can be arranged between April 1 and November 15 by calling (401) 423-3270. For more information, visit the website of the Beavertail Lighthouse Museum Association (http://www.beavertaillight.org/menu.html).

Rose Island Lighthouse
(401) 847-4242, (www.roseislandlighthouse.org)

Ida Lewis
Courtesy of the United States Coast Guard

Ida Lewis Timeline

Adapted from http://www.awomanaweek.com/Lewis.html

1842 Ida is born Idawalley Zorada Lewis on February 25.

1858 Four young men capsize their boat in Newport Harbor because one of them had climbed the mast and was rocking the boat to tease his friends. None of them could swim and they would have drowned had Ida not rescued them. Ashamed of having been rescued by a girl, the boys told few people about the episode.

1866 Ida comes to the rescue of a drunken sailor in the dead of winter.

1867 Three negligent sheepherders lose a valuable sheep into the water during a storm. In their attempt to retrieve the sheep, they find themselves in need of rescuing. Ida not only rescues the men but the sheep as well.

1869 Two soldiers from Ft. Adams are rescued by Ida when their sailboat overturns in a storm.

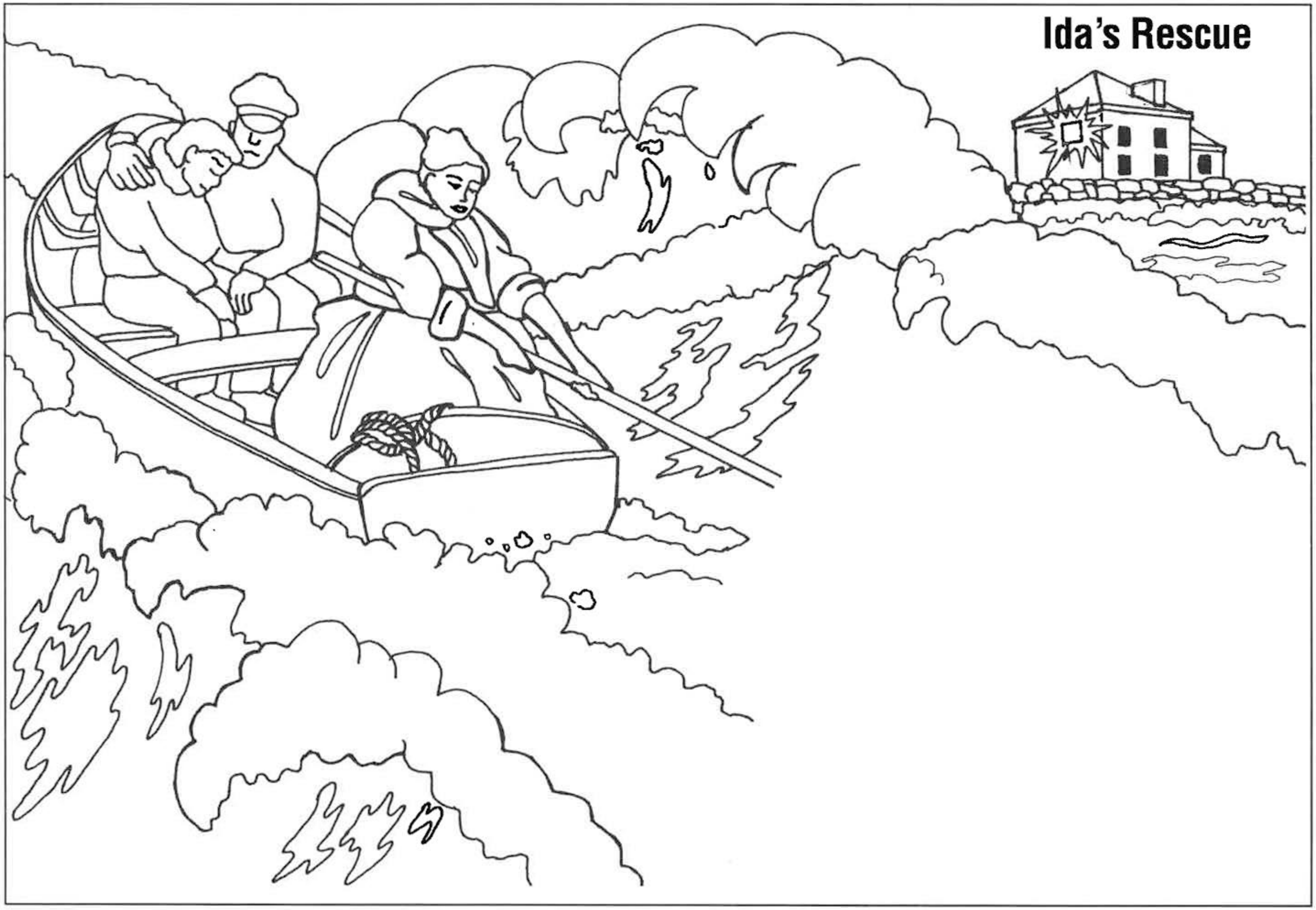
1872 Ida's father dies and she is named official keeper of the Lime Rock Lighthouse by the U.S. government.

1906 Ida's last rescue at Lime Rock. A friend of Ida's fell off her boat. Ida came to her rescue at once. During her 39 years at Lime Rock, Ida Lewis saved 18–25 lives.

1911 Ida dies on October 24. All boats in Newport Harbor toll their bells in her honor.

1924 Rhode Island legislature officially changes the name of Lime Rock Lighthouse to the Ida Lewis Lighthouse.

Ida's Rescue



Drawings by J. Susan Cole Stone

18 **Rhode Islanders and visitors like to relax and play along the coast. They enjoy boating, fishing, swimming, and relaxing on the beach.**

Tourism

Every year millions of people come to Rhode Island for vacations, conferences, or business trips. They relax on the beaches, in boats, and enjoy the beautiful weather and scenery that Rhode Island has to offer. In the year 2000, 15.7 million people visited the state while another 34.5 million people just passed through. That same year, the tourist industry accounted for 38.9 thousand jobs and $3.26 billion in sales revenues.

Activity Ideas

Dioramas

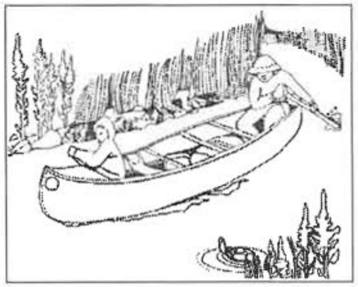
Objective:

- Students will explore their own interactions with the coast by placing themselves in a beach scene.

Materials:
Shoeboxes (1 for each student)
Glue
Scissors
Markers
Colored paper
Index cards
Cardboard
Household or outdoor objects that students may wish to use

Procedure:

1. Begin with a guided reading of *Sandcastle* or *How Will We Get to the Beach* (see **Resources** for complete citations) to get students thinking about the beach and how people (especially themselves) like to use it.
2. Have each student create a diorama (using a cardboard shoebox) of a beach scene. They should include themselves in their dioramas, doing what they like to do (or wish they could do) at the beach. Students can then write a description of their scene on a large index card attached to the top of the box.
3. Ask children to describe their scene to the class. They may also wish to name their beach if it is one they have been to and enjoyed.
4. Display the childrens' dioramas throughout the room.



Beach Mural

Objective:

- The students will work in groups to create a mural of the beach.

Materials should be determined by each group of students. They will likely include:
Scissors
Glue
Colored paper
Paint
Markers
Beach items: sand, shells, etc.
Large sheets of plain paper

Procedure:

1. Divide students into working groups of approximately four students each.
2. Explain to students that as a group they will be creating a mural depicting some aspect of the beach. They should decide in their group what they would like to show. For example, groups might want to illustrate animal and plant life at the rocky or sandy shore, people enjoying the beach, structure of a barrier beach, or any of the coastal environments studied throughout this guide.
3. Let groups decide what materials they will use and who will be responsible for what tasks.
4. Have students create their murals and hang them around the classroom.

Seashore Mobile or Collage

Objective:

- Students will create mobiles or collages using objects from the beach or their own depictions of such objects.

Materials:

Twigs or stiff wire
String, yarn, or nylon fishing line
Opened paper clips or Christmas ornament hangers
Objects collected from the beach
Cardboard
Colored paper
Paint
Markers
Scissors
Glue

Procedure:

1. Introduce the concepts of balance and movement of mobiles to the students. If you are doing collages, talk to the students about symmetry and balance in design.
2. Children can work individually or in groups for this project. Help each child or group decide on a theme for their mobile/collage.
3. Students should construct their mobiles/collages using found objects and/or beach objects they have created. Students should work on getting their mobiles to balance when hung, or creating symmetry in their collages.
4. When completed, mobiles or collages should be displayed around the room.

Standards Met

Activity	Standard	
Dioramas	S2c	Organisms and environments
	S4c	Personal health
Beach Mural	S2c	Organisms and environments
	S7a	Represents data in multiple ways (artwork)
Seashore Mobile	S1a	Properties of objects and materials
	S7a	Represents data in multiple ways (artwork)

References

Office of Travel, Tourism, and Recreation. 2001. Rhode Island Travel and Tourism Research Report. Volume 18:1. University of Rhode Island, Kingston, R.I. Available online (www.uri.edu/ottr).

Resources

Fiction:

Inkpen, M. 1998. *Sandcastle.* Harcourt Brace and Co. Part of the "Little Kipper" series. A good guided reading for children in K–1.

Luciani, B. and E. Tharlet. 2000. *How Will We Get to the Beach.* North-South Books. A guessing-game story about a young woman's trip to the beach. Excellent for reading aloud to young children.

Activity books:

Levy, B. 1996. *Sea Life Follow-the-Dots.* Dover. A Dover "little activity book."

Pomaska, A. 1988. *The Little Seashore Activity Book.* Dover. A Dover "little activity book."

19 **In order to make sure that future generations of Rhode Islanders can enjoy our coastline and appreciate the habitat it provides for other animals and plants, it is everyone's responsibility to learn about and preserve this precious natural resource.**

Activity Ideas

Cause and Effect

Talking to children about protecting the environment is a perfect time to reinforce the idea of "cause and effect." Explain to students that all of our actions have consequences. Remind them of some of the things they learned about previously: oil spills and invasive species, for example.

Objective:

- Students will demonstrate knowledge of cause and effect related to the marine environment.

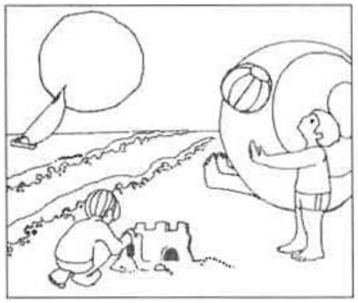
Materials:
Index cards
Two boxes (or hats or jars—something to draw cards from)

Procedure:

1. Prior to class, the teacher will need to prepare index cards with various scenarios written on them. On one card write the cause and on a separate card write an effect.
   Some examples:

Cause	Effect
Oil spill	Birds' feathers are damaged
Walking on beach grass	Dunes are destroyed
Building homes on the beach	Habitat is destroyed
Sailing throughout the world	Organisms are transported to places they don't belong
Leaving plastic bags at the beach	Animals may suffocate
Picking up litter	The beach is safer for animals
Fencing in plover nests	The eggs and chicks are protected
Overfishing one species	Species may become extinct

   Note that some of these effects may also be used as causes. For older children, you may want to create chains of cause and effect. Also, you may want to include multiple effects for a single cause.
2. Put "cause" cards in one box and "effect" cards in another.
3. Explain to students that the actions of human beings have effects on the ocean environment. For example, rising global temperatures (caused in part by increased carbon dioxide emissions into the atmosphere) have disrupted the recovery of overfished flounder in Narragansett Bay (see *The Providence Journal*, December 15, 2002).
4. Divide the class in half. Half of the students will draw "cause" cards and the other half will draw "effect" cards.
5. Explain to students that they are going to play a matching game. Each student will stand up and read the cause or effect on their card. For older children, you may want to play this like charades and have them act out the scene. The student who believes he or she has a matching card should then get up and join the first student at the front of the room. When all students have found their match, ask each set to explain their scenario.
6. As each set explains their cause and effect, record what they have said on a large sheet of paper or on the chalkboard at the front of the room. When the children return to their seats, they may copy the chart onto a sheet of paper for themselves or in a science journal.



Conservation Posters

Explain to students how their actions can affect the coastal environment. Discuss the reasons for certain rules and explain how students can do their part to protect the coastal environment by following these rules themselves, and by sharing their knowledge with their families and friends. Examples include:

1. Do not feed the birds.

Feeding the birds can cause them to overpopulate particular areas and to become dependent on humans for food. It can also lead to aggressive behavior or delays in migration. Furthermore, a diet of human foods can cause malnutrition and disease. Environmental degradation may also result from the high concentration of birds in particular localities.

2. Take out what you bring in.
It is important to always bring a bag with you to take your garbage out when you leave. Plastic bags look quite a bit like jellyfish when they float along in the water, and can end up choking or suffocating animals such as turtles and fish that mistake the bag for food. Six-pack rings can also be harmful as birds can get their heads stuck in the rings.

3. Walk only on designated boardwalks.
Remember that beach grass is very important for stabilizing and protecting the dunes. Beach grass is also very fragile—the stems break easily. Boardwalks are there to protect the grass and keep the dune environment safe.

Ask students to brainstorm about some other ways in which they might protect the coastal environment. Then have students create posters to display their ideas. Have the students' work posted someplace in the school (cafeteria, library, hallway, etc.) where all students will be able to see them.

Standards Met[3]

Activity	Standard	
Cause and Effect	S2c	Organisms and environments
	S42	Big ideas and unifying concepts
Conservation Posters	S2c	Organisms and environments
	S7c	Communicates in a form suited to the purpose

Resource

Baines, J. 1991. *Protecting the Oceans.* Steck-Vaughn Co. An overview of threats to the ocean and how we can protect it.