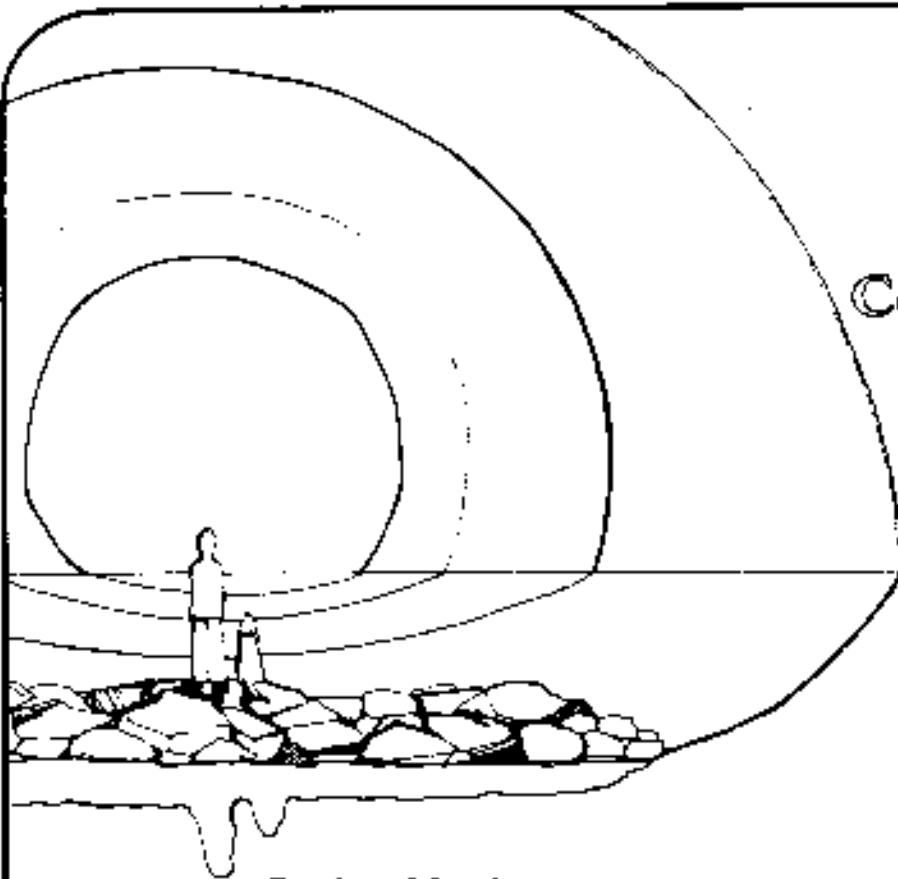


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Teacher's Activity Guide to Coastal Awareness

Sara S. Callaghan



Produced for the
Rhode Island Coastal Resources
Management Council



by the
Coastal Resources Center
University of Rhode Island
Marine Bulletin Number 23





Rhode Island Coastal Resources Management Council

This activity book was prepared as part of the Rhode Island Coastal Resources Management Council's public education program. The Council, in existence since 1971, has a mandate to preserve, protect, develop, and where possible, restore the coastal resources of the state for this and succeeding generations through comprehensive and coordinated long range planning and management. The Council has broad powers to regulate activities that affect its management plan and the coastal environment.

Down Where The Water Is: A Coastal Awareness Activity Book was written to inform youngsters about the importance and use of our coastal resources. It may be employed in a variety of ways to promote discussion and an awareness of the coastal environment. Space is provided for the child to write his own story about each picture. The last two pages of the activity book contain cut-out sentences that may be pasted below their corresponding pictures. In the classroom, *Down Where The Water Is* may be used with the *Teacher's Activity Guide to Coastal Awareness* to complement existing marine-related units, or as a new activity-oriented unit in itself.

Additional copies of *Down Where The Water Is: A Coastal Awareness Activity Book* and the *Teacher's Activity Guide to Coastal Awareness* may be obtained from the Rhode Island Coastal Resources Management Council, 83 Park Street, Providence, RI 02903, Tel. (401) 277-2476.

OUT OF PRINT

See also: RIU-E-72-003

The preparation of this booklet was financed in part by a planning grant from the National Oceanic and Atmospheric Administration, under the provisions of the Coastal Zone Management Act of 1972 (Public Law 92-583), through the Integrated Grant Administration program administered as part of Federal Regional Council grant FRC-IGA-01-07.

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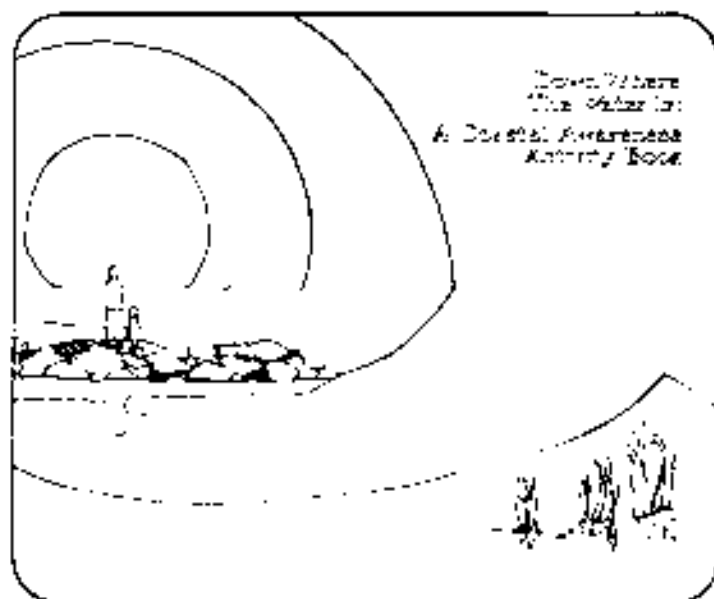
Many persons contributed their resources and time in the design and preparation of *Down Where The Water Is: A Coastal Awareness Activity Book* and the *Teacher's Activity Guide to Coastal Awareness*. Prentice K. Stout of the Marine Advisory Service and Lynne Zeitlin-Hale and Stephen B. Olsen of the Coastal Resources Center at the University of Rhode Island helped review drafts and offered suggestions and support throughout the preparation of the two books. Special assistance was provided by elementary teachers Jane Bentley, Ruth Boragine, Diane McAulay, Nancy Totten, and Nancy Wissmuller. The title, *Down Where The Water Is*, was chosen by third grade students at Jamestown School.

George L. Seavey of the URI Coastal Resources Center contributed the descriptions of many of the coastal areas for the *Teacher's Guide*. Other descriptions and drawings were provided by the Massachusetts Office of Coastal Zone Management.

Illustrations in *Down Where The Water Is* were drawn by Henrietta Crandall. Editorial and design services were provided by Martin Hanft, Larry Pearce, Alison Scott, and Ilse Silvermann of the URI Publications Office. The manuscript was typed and proofread by Lynne Ogden, Mary Jane Long, and Deborah Prefontaine.

Special appreciation is extended to the Rhode Island Coastal Resources Management Council for their continuing support of marine education programs in the state.

INTRODUCTION



Rhode Island is a state with 419 miles of beautiful shoreline. Since Colonial times, Rhode Islanders have been finding ways to use the coast. They have drawn on the coast and its water for power, transport, industry, food, homesites, waste disposal, and pleasure. Over the past decade, it has become clear that our coastal resources are not limitless. Through wise coastal management we are finding ways to direct the use and development of our coast to best benefit the overall interests of the state and the people.

To date, there has been a lack of elementary resource materials available to Rhode Island teachers to assist them in introducing the concept of coastal management into the early elementary curriculum. In an effort to make young Rhode Islanders more aware of the importance and the wide variety of uses of our coast, *Down Where The Water Is: A Coastal Awareness Activity Book* was written. In the classroom, *Down Where The Water Is* may be used with this *Teacher's Activity Guide to Coastal Awareness* to complement existing marine-related units, or as a new activity-oriented unit in itself.

The *Teacher's Activity Guide to Coastal Awareness* is interdisciplinary in nature. Traditionally, the study of marine subjects has revolved around the study of the marine sciences. Besides marine sciences, however, the *Teacher's Guide* also emphasizes other marine-related subjects such as marine art, geography, language, history, literature, and mathematics.

THE FORMAT OF THE TEACHER'S GUIDE

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

- I. *Rhode Island's Coast*
- II. *Coastal Resources*
- III. *Using Our Coast*

Section I on *Rhode Island's Coast* (corresponding to pages 2 and 3 in *Down Where The Water Is*) is made up of exercises designed to introduce to students the idea that Rhode Island is truly the "Ocean State." The geography, the physical make-up of the shoreline, and the concept of coastal management are emphasized.

Section II on *Coastal Resources* (corresponding to Activity Book pages 4-10) contains activities and explanations designed to make youngsters more aware of the importance of the natural resources along our coast. The birds, beachgrass, the fish and other plants and animals in or near the ocean, and the barrier beaches and dunes, the rocky cliffs, coastal ponds, salt marshes, and tidal creeks are all discussed.

Section III on *Using Our Coast* (corresponding to pages 11-19 in the Activity Book) gives examples of the wide variety of ways in which we use our coastal resources, and suggests related class activities. The use of our coast for food, recreation, energy, transportation, and as a location for buildings is described.

SUGGESTED USE OF THE TEACHER'S GUIDE AND ACTIVITY BOOK

The *Teacher's Guide* follows the Activity Book page by page, with *glossaries, activity ideas, resources, places to visit, and notes* identified where relevant.

The definitions in the *glossaries* are simply written so that the teacher may transfer a conceptual understanding of the ideas to the student. The vocabulary words in each glossary relate to the individual drawings and the sentences describing them at the back of the Activity Book.

The *activity ideas* presented on each page are multi-disciplinary in nature. In parentheses after each activity is the area in the curriculum where the activity may be inserted. There are four general subject areas:

Language Arts

Reading
Vocabulary
Spelling
Creative writing
Communication

Social Studies

Map studies
Community studies
History
Geography

Science and Math

Science
Measuring
Math

Art and Music

Drawing
Painting
Manipulation
Singing

The resources include books for both the teacher and student, as well as articles, magazines, and other materials relevant to the particular coastal resource or use of the coast being studied.

For more details about the *places to visit* and other field trip sites suitable for elementary children, consult the Environmental Education Field Guide listed under *General References*.

Each picture in the Activity Book is designed to promote detailed discussion of people, places, and things relating to the coast. Space is provided at the bottom of the page for the child to write his own story about the picture. The last two pages of the Activity Book contain cut-out 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. The interest and enthusiasm expressed by the teacher, as well as the student, will dictate the depth to which each page of the Activity Book is explored.

The *Teacher's Activity Guide to Coastal Awareness* should be considered an outline for use with *Down Where The Water Is: A Coastal Awareness Activity Book* in the classroom. The loose-leaf, punched format of the Teacher's Guide provides an organized outline for study of our coastal environment, upon which the teacher may build a complete resource file to suit particular curricular needs. As it may not be possible to reprint *Down Where The Water Is* once existing supplies are exhausted, please keep one clean copy aside for your future duplication needs.

GENERAL REFERENCES

1. The following resources are identified by letter as they are referred to in the text:

- (A) ECOSYSTEMS AND RESOURCES OF THE MASSACHUSETTS COAST
Written by Carl Carlizzi, Kathryn King, and William F. Newbold, Jr.
Illustrated by William F. Newbold, Jr. Institute for Man and Environment and Massachusetts Coastal Zone Management Program, 1975.

Available from Executive Office of Environmental Affairs,
100 Cambridge Street, Boston, MA 02202.

- (B) ENVIRONMENTAL EDUCATION FIELD GUIDE TO RHODE ISLAND
Written by William Crossdale, Edward Hill, and Gordon Felner.
Marine Bulletin Number 22, University of Rhode Island, 1976.

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882.

- (C) OUTDOOR BIOLOGICAL INSTRUCTIONAL STRATEGIES (OBIS)
Outdoor Biological Instructional Strategies offer both independent and sequential activities to promote the understanding of ecological relationships by youngsters. Each OBIS folio can provide an enjoyable and interesting outdoor activity. You may either select individual activity folios for inclusion in your existing environmental program or a group of folios to provide a comprehensive experience in outdoor biology. Flexibility and adaptability in selection and use of activities are major aspects of the design of OBIS materials.

OBIS Trial Edition 1 (\$8.50 + \$1.20 postage)

Adaptation--Predator/Prey (All habitats)
Animal Movement in Water (All aquatic habitats)
Animals in a Grassland (Lawns, meadows, and fields)
Attention! (All habitats)
Bean Bugs (All terrestrial habitats)
Great Steamboat Race (Streams)
Habitat Sun Prints (All habitats)
Habitats of the Pond (Ponds and lakes)
How Many Organisms Live Here? (Ponds and lakes)
Invent a Plant (All habitats)
Invent an Animal (All habitats)
Mapping a Study Site (All habitats)
Moisture Makers (All terrestrial habitats)
Natural Recycling in Soil (All terrestrial habitats)
Natural Recycling in Water (All aquatic habitats)
Out of Control (Lawn)

Plant Hunt (All terrestrial habitats)
Plants Around a Building (Building sites)
Seed Dispersal (All habitats)
Sticklers (All terrestrial habitats)
Terrestrial Hi-Lo Hunt (All terrestrial habitats)
Water Holes to Mini-Pond (All habitats)
What Lives Here? (All aquatic habitats)
Who Goes There? (All terrestrial habitats)

OBIS Trial Edition II (\$9.50 + 1.20 postage)

A Better Fly Trap (Terrestrial habitats)
Animal Anti-Freeze (Cold terrestrial habitats)
Animal Diversity (Terrestrial habitats)
Attractive Fish (Freshwater habitats)
Beach Zonation (Marine habitats)
Birdfeeder (Terrestrial habitats)
Crawdad Crab (Marine or freshwater habitats)
Flocking to Food (Marsh or freshwater habitats)
Food Chain Game (Lawn or field habitats)
Gaming in the Outdoors (Terrestrial habitats)
Hopper Circus (Beach or field habitats)
Lichen Looking (Terrestrial habitats)
Litter Critters (Woodland habitats)
Metric Capers (Anywhere)
OBIS Oil Spill (Marine or freshwater habitats)
Plant Patterns (Terrestrial habitats)
Rock Pioneers (Rocky beach habitats)
Roots and Shoots (Terrestrial habitats)
Seas in Motion (Sandy beach habitats)
Sensory Hi-Lo Hunt (Terrestrial habitats)
Sound Off (Lawn or field habitats)
The Old White Sheet Trick (Terrestrial habitats, at night)
Too Many Mosquitos (Freshwater pond habitats)
Water Breathers (Marine or freshwater habitats)

Trial Edition Sets (24 activity folios per set) are available from DISCOVERY CORNER--OBIS, Lawrence Hall of Science, University of California, Berkeley, CA 94720. (Please make check or money order payable to Regents of the University of California.)

- (O) RHODE ISLAND'S COASTAL NATURAL AREAS: PRIORITIES FOR PROTECTION AND MANAGEMENT
Written by George L. Seavey. Marine Technical Report Number 43, University of Rhode Island, Coastal Resources Center, 1975. (\$2.00)

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882. (Please make check or money order payable to University of Rhode Island.)

- (E) THE WORLD OF WATER: AN INTERDISCIPLINARY ACTIVITY GUIDE
Written by Ruth Boragine. d.d.k. Publishers, Buffalo, NY, 1977. (forthcoming)

13. MAGAZINES RELATING TO THE MARINE ENVIRONMENT

The following list of magazines are ones that are written for the non-technical person. They will supply an excellent resource file for future classroom study.

AUDUBON MAGAZINE

Membership Department
950 Third Avenue
New York, NY 10022
\$13.00 (Bi-monthly)

INFORMATION

New England Marine Advisory Serv.
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882
\$2.00 one time charge (Bi-monthly)

JOURNAL OF MARINE EDUCATION

The Aegir Corporation
P.O. Box 3085
Newport Beach, CA 92663
\$12.00 (Quarterly)

MARITIMES

Graduate School of Oceanography
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882
Free (Quarterly)

NATIONAL GEOGRAPHIC MAGAZINE

National Geographic Society
17th & M Streets, NW
Washington, DC 20036
\$10.00 (Monthly)

NATURAL HISTORY MAGAZINE

The Am. Museum of Natural History
Central Park West at 79th St.
New York, NY 10024
\$10.00 (monthly/Oct-May,
Bi-monthly/Jun-Sep)

OCEANS MAGAZINE

Oceans Magazine
P.O. Box 65
Uxbridge, MA 01569
\$12.00 (Bi-monthly)

OCEANUS MAGAZINE

Woods Hole Oceanographic
Institution
Woods Hole, MA 02543
\$8.00 (Quarterly)

SEA FRONTIERS & SEA SECRETS

International Ocean. Foundation
3979 Rickenbacker Causeway
Virginia Key, Miami, FL 33149
\$15.00 (Bi-monthly)

SKIN DIVER

Skin Diver
P.O. Box 3295
Los Angeles, CA 90028
\$9.00 (Monthly)

SMITHSONIAN MAGAZINE

Smithsonian Associates
900 Jefferson Drive
Washington, DC 20560
\$10.00 (Monthly)

UNDERWATER NATURALIST

American Littoral Society
Sandy Hook, Highlands, NJ 07732
\$7.50/Student, \$10.00/Individual,
\$12.50/Family & Library (Quarterly)

(List compiled by Prentice K. Stout, University of Rhode Island,
Sea Grant Marine Advisory Service, September, 1976.)

111. MARINE AQUARIA

After much consideration, you may feel it appropriate to have a marine aquarium in your classroom. Consult the following resources:

OCEAN IN YOUR CLASSROOM

Written by Barbara S. Waters. Cape Cod Extension Service, Railroad Avenue, Barnstable, MA 02630. (\$1.25)

Part I Introduction
Part II Setting-Up
Part III Activities
Part IV Beachcombing
Part V Bibliography

(For the elementary teacher who is ready to try an exciting adventure into the world of marine life in the classroom.)

THE AQUARIUM

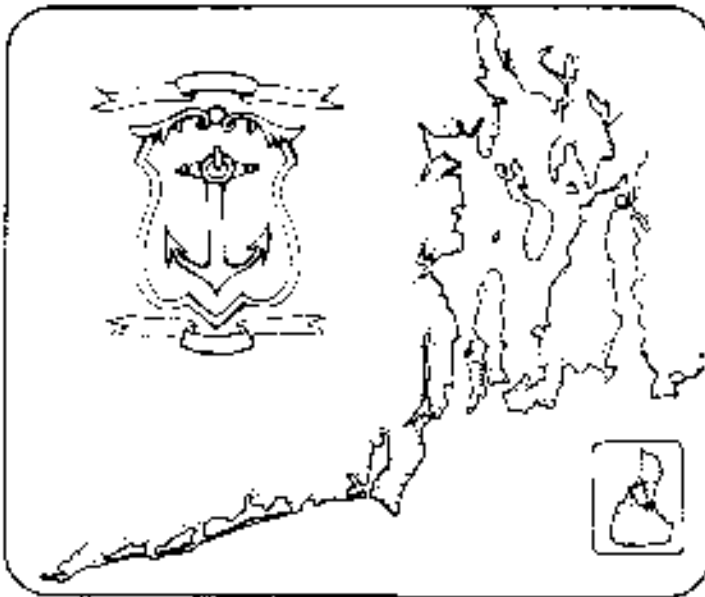
Written By Carol Bower. Children's Museum of Hartford, 950 Trout Brook Drive, West Hartford, CT 06119. (\$3.00)

IV. RHODE ISLAND MARINE EDUCATORS (RIME)

Rhode Island Marine Educators (RIME) is a group of teachers, students, and interested people who are dedicated to the concept that the oceans can and should be studied not only in the classroom, but anywhere, and at any time. Seeking a marine literate society in Rhode Island, RIME members are interested in learning more about the marine sciences, as well as marine geography, art, language, drama, history, literature, and law. To share ideas, RIME publishes a newsletter to keep its members informed of workshops, meetings, and new curriculum materials. RIME members hold a variety of beach walks, curriculum exchange meetings, lectures on topics such as salmon restoration, law of the sea, and seaweed collecting, along with workshops on laboratory methods and marine aquaria in the classroom. Membership in RIME is \$4.00 per school year, helping to offset the cost of the newsletter, lecturers, and publications.

For more information about RIME and other marine education programs in Rhode Island, contact Prentice K. Stout, Marine Education Specialist, Marine Advisory Service, University of Rhode Island, Narragansett Bay Campus, Narragansett, RI 02882. (401) 792-6211

I. RHODE ISLAND'S COAST



2 Rhode Island is a state with 419 miles of beautiful shoreline.

glossary:

BAY A wide inlet of the sea, indenting the shoreline.

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

MARINE Pertaining to a sea or the ocean.

OCEAN The entire body of salt water (seawater) that covers more than 71 percent of the 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. (The term "river" is used colloquially and incorrectly to define narrow tidal inlets such as the Narrow River and other inlets of the sea such as the Sakonnet River.)

SALINITY The measure of the quantity of dissolved salts in seawater.

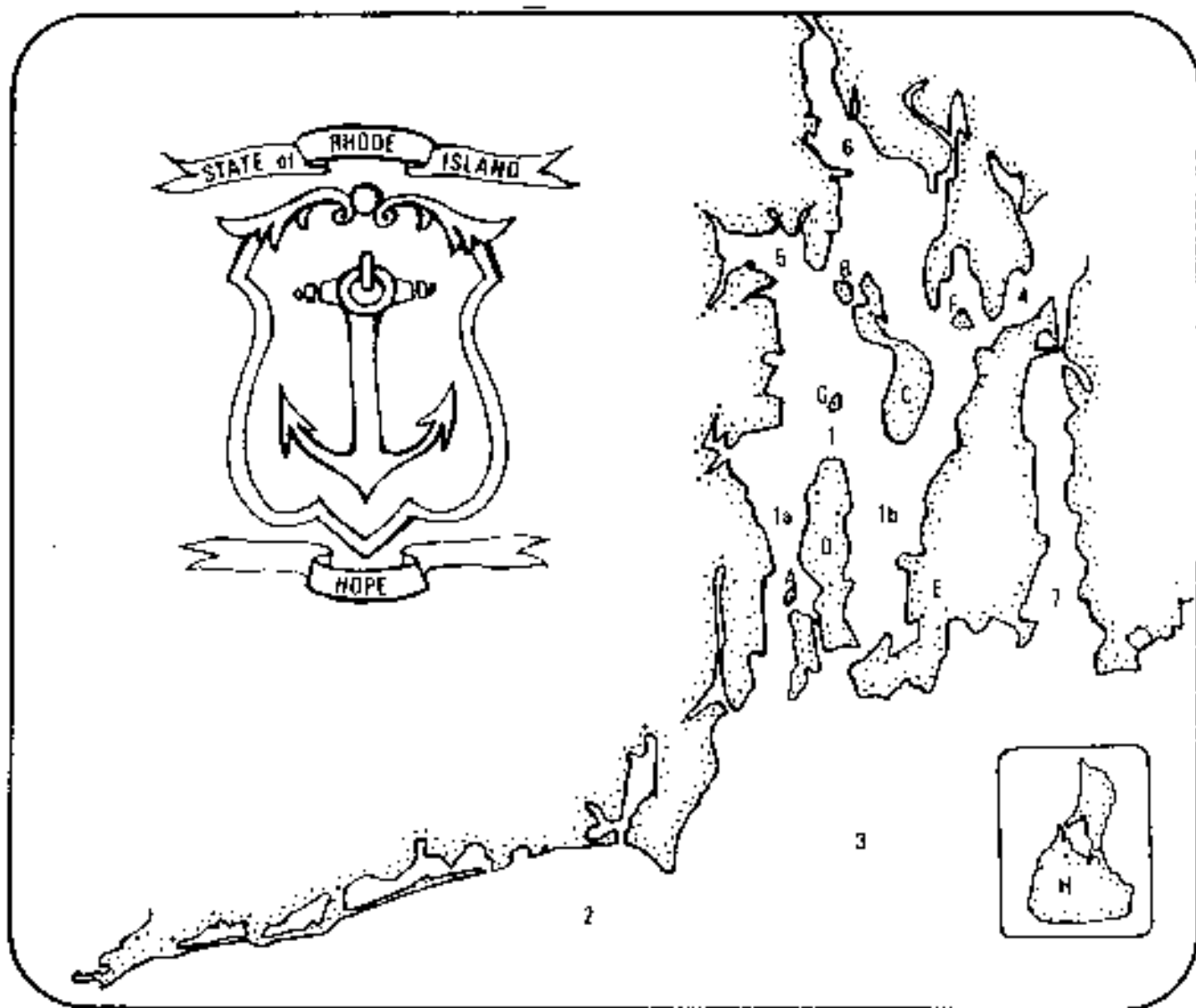
SEAWATER The water of the ocean which is distinguished from fresh water by its appreciable salinity.

SHORELINE The area where the land and sea meet.

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:

- Examine the map shown below (and on page 2 of the Activity Book):



ISLANDS

A DUTCH
B PATIENCE
C PRUDENCE
D CONANICUT
E AQUIDNECK
F HOG
G HOPE
H BLOCK

BODIES OF WATER

1 MARRAGANSETT BAY
 1a WEST PASSAGE
 1b EAST PASSAGE
2 BLOCK ISLAND SOUND
3 RHODE ISLAND SOUND
4 MOUNT HOPE BAY
5 GREENWICH BAY
6 PROVIDENCE RIVER
7 SAKONNET RIVER

- *Locate the islands in Narragansett Bay (map studies)
- *Locate the bodies of water found along the Rhode Island shore (map studies)
- *Discuss the differences between the various bodies of water, i.e. sound, bay, river (vocabulary)
- *Discuss the history of the Rhode Island state seal (history)
- *Design your own word games using the names of the islands and bodies of water found in and around Rhode Island (spelling, vocabulary)

- Locate your city or town on a map. A copy of the *Cruising Guide to Historic Rhode Island* (see resources) would be of assistance in discussing some of the historical aspects of Rhode Island's coastal towns during Revolutionary times (history, community studies, geography).
- Construct a large contour or topographical map of Narragansett Bay of chicken wire or styrofoam and papier mache. Use this large map to discuss the coastal resources and uses of the coast as they are described in the Activity Book. Paint wooden or grassy areas, cities and towns, rocky shores, beaches, and water different colors (map studies, geography, painting, manipulation).

resources:

1 CHARTS--NATIONAL OCEAN SURVEY

For the use of mariners navigating area waters (\$3.25 ea.)

- Chart No. 13223 - Narragansett Bay - New Harbor, East Passage, Conanicut Island (Jamestown) and West Passage
Chart No. 13228 - Horseneck Beach, Westport River (east & west)
Chart No. 13219 - Point Judith Pond, Wakefield area
Chart No. 13217 - Block Island
Chart No. 13215 - Block Island Sound
Chart No. 13224 - Upper Narragansett Bay (Providence River and Narragansett Bay)

- Chart No. 13225 - Providence Harbor
- Chart No. 13221 - Narragansett Bay, Mt. Hope Bay, Sakonnet River
- Chart No. 13214 - Fisher's Island Sound
- Chart No. 13218 - Point Judith, Martha's Vineyard, Buzzards Bay
and lower Narragansett Bay
- Chart No. 13205 - Block Island Sound and approaches

2 CRUISING GUIDE TO HISTORIC RHODE ISLAND



Cruising Guide To Historic Rhode Island

A guide to the historic sites of coastal Rhode Island has been prepared by the University of Rhode Island's Marine Advisory Service.

About the size of a state road map, the Cruising Guide shows the location of each point of interest and gives a brief description of its historical significance. Background information on the Colonial period (c. 1600-1790) and sketches of notable people and places up through the Revolutionary period accompany the site descriptions.

The purpose of the Cruising Guide is to enable sightseers traveling either by boat or by car to explore those of the state's historical attractions that lie within easy reach of the coastline. It is also the only public map of the state that indicates the location of shellfish beds. The Cruising Guide is designed to be used, by boat owners, in conjunction with navigational charts and cruising guides. On the back of the Guide is a color reproduction of a map of Narragansett Bay drawn by cartographer Charles Blaskowitz in 1777. The map is suitable for framing.

The Cruising Guide may be ordered by mailing a check for \$1.00 (made payable to the "University of Rhode Island") to URI Marine Advisory Service, Publications Unit, Narragansett Bay Campus, Narragansett, R.I. 02882.

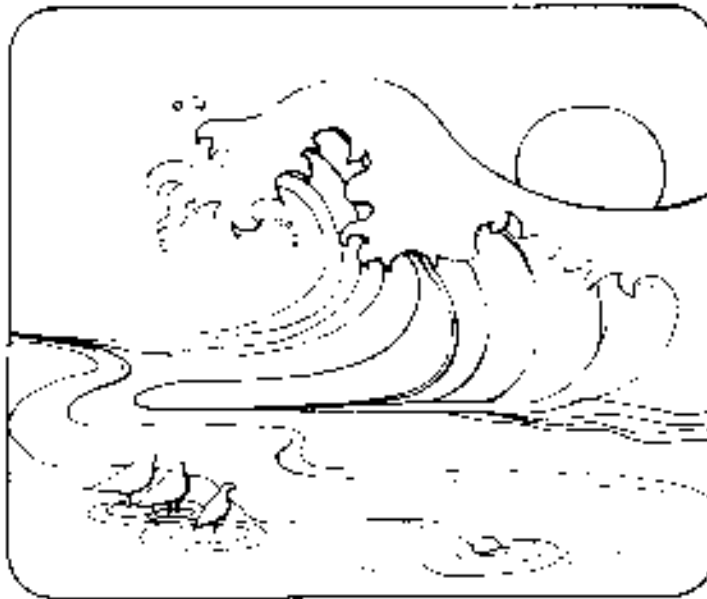
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Street _____

City or Town _____

State _____ Zip _____

Quantity _____ Amount enclosed \$ _____



3 The shoreline is where the land and sea meet.

ESTUARIES

The estuary marks the convergence of fresh water from streams and rivers with the ocean's salt water. Estuaries are found all along the Rhode Island coast where flowing fresh water meets and mixes with salt water. River mouths are usually where estuaries form. They may vary greatly in size from the small Narrow River in Narragansett to the larger Warren then Providence Rivers to one of the largest estuaries in New England, Narragansett Bay itself.

Estuaries support a significant amount and variety of biological production. They often contain habitats which are vital environments for most of the state's biological resources. Because of their productive waters, sheltered anchorages, and navigational access, estuaries have been centers of much of the coastal social and economic growth. More than anywhere else on the coast, complex systems of natural resources and human use have been created. Only with careful planning can these man-nature systems be compatible. We must become aware of ways to protect and preserve both the productivity of our estuaries and the quality of life for Rhode Islanders that they support.

Along the shallows and shores of the rivers and streams, suspended material carried downstream in the estuarine system begins to settle out, often creating large shoals that provide a base for the formation of habitats like salt marshes and tidal flat communities.

The presence of large amounts of detritus and mineral nutrients provides a rich base for the productivity of mollusks, crustaceans, worms, and small fish, resulting in an especially attractive food source for many commercial and sport fish.

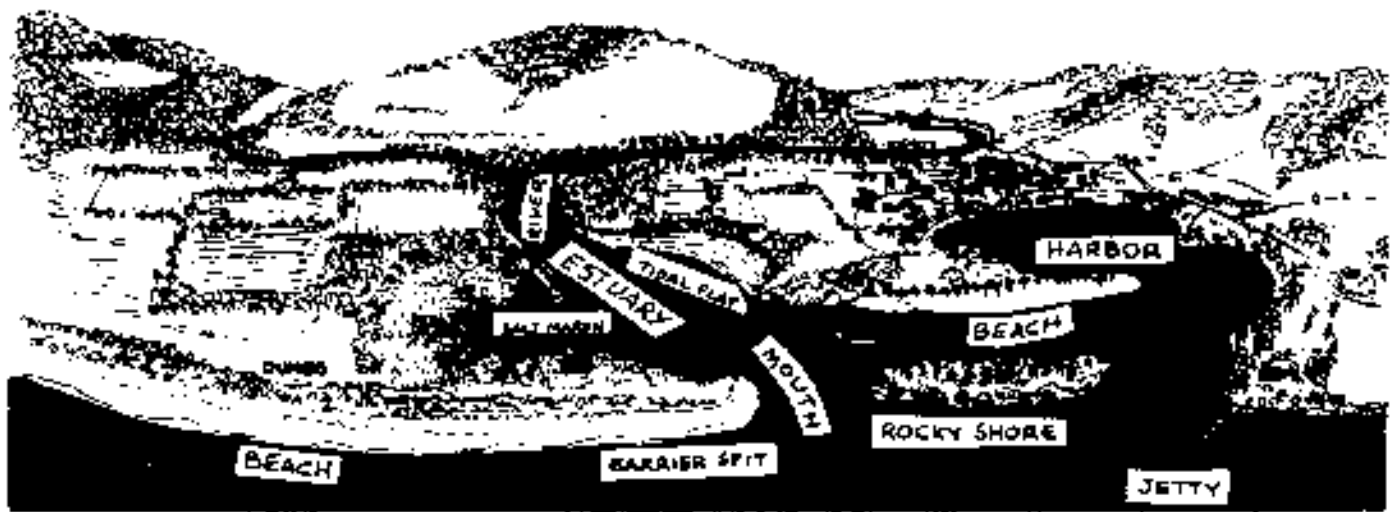
Estuaries are critical environments for many freshwater and saltwater species of fish and shellfish. Some permanently occupy the estuary and others use it as a habitat for part of their life cycles. Among the resident fish are forage species that are important in transferring food energy produced by the salt marshes, eelgrass beds, rocky shores, and plankton to larger commercial and sport species. Some important forage fish are Atlantic silversides, sticklebacks, pipefish, cunners, mummichogs, and killifish. Larger fish which seasonally enter the Narragansett Bay estuary to feed upon the forage fish include the bluefish, striped bass, cod, Atlantic mackerel, and fluke.

Many fish species require the estuary as a spawning or nursery habitat, including about two-thirds of the important commercial species, such as the menhaden, tautog, tomcod, scup, and winter flounder. In addition, other important species pass through the estuary in the process of moving upstream toward freshwater spawning areas. These anadromous fish include the American shad, alewife, and rainbow smelt. The young of these species depend upon the estuary as a source of food and as a nursery area as they drift downstream from the areas where they were spawned to where they will mature. Estuarine tidal flats are particularly productive shellfish habitats. Estuaries are also one of the few coastal ecosystems that have the salinity required by oysters.

Activities designed to make estuaries more suitable for water transport alter the normal shallow configuration of the bottom through channel and harbor dredging. Dredging creates deep zones which support little biological productivity. In addition, dredging activities have released pollutants which were formerly trapped in the bottom shoals and sediments and resuspended the sediment and polluting materials into the water.

Estuaries are influenced by certain kinds of engineering works upstream. Dams, while providing flood protection, also trap desirable detrital materials and prevent them from moving downstream into the estuarine system. At the same time, they influence the strength of river currents in the estuary, which alters the relationship between such factors as upstream saltwater penetration and the effects of the tidal bore.

Construction of navigation structures and bridges in estuarine systems can change the circulation pattern of fresh and salt water, interfering with the process of mixing and, in some cases, reducing the effective estuarine area available to species which are normal, temporary, or permanent residents. (adapted from A)



The estuary marks the convergence of fresh water from streams and rivers with the ocean's salt water. The positioning of an estuary is likely to change dramatically with the seasons and even daily with the tides. Often in the larger

estuaries a number of other coastal ecosystems are likely to be found along with man-made influences of harbors and piers, which further adds to the complexity of the environment. (A)

glossary:

COAST The seashore or the land near it.

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

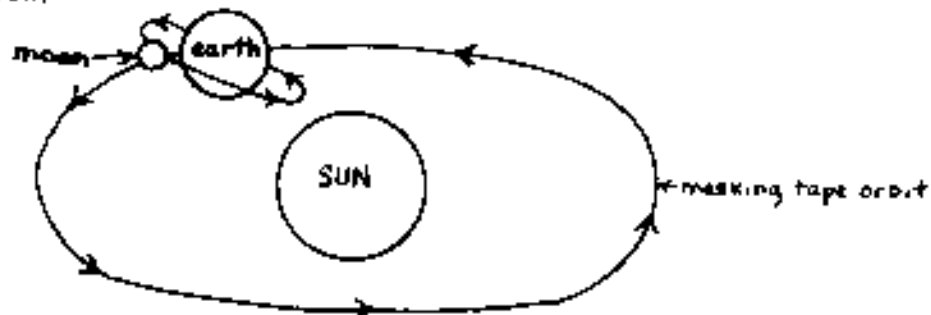
TIDE The alternating rise and fall of the surface of the ocean and of bays and rivers connected to the ocean. Tides are the result of gravitational forces between the earth and the sun and the moon.

activity ideas:

- Referring to the map on page 2 of the Activity Book, introduce the new word "estuary." Discuss the characteristics that make Narragansett Bay a major estuary on the East Coast. (vocabulary, map studies)

● HOW TIDES WORK (E)

Explaining to a group of young children what the tides are is not nearly so 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. (science, manipulation)



1) The children sit on the masking tape orbit. They pass a medium sized ball (the earth) from one to another, each child turning it once on its axis. Each child moves the earth through one day (one revolution).

2) Now have one child carry a small ball (the moon) around each child who has the "earth." Question the children toward an understanding that the moon faces different areas on earth at different times.

3) If a large globe is available, a magnified demonstration of the movement of the earth and the moon can be made.

● INVESTIGATE THE MOTIONS OF THE SEA (C)

Waves, currents, surf, tides, and winds constantly reshape beaches. Sandy beaches particularly are characterized by heavy wave action and rapidly shifting sand. Organisms are scarce on these surf-swept beaches because of the lack of stationary objects on which to anchor. However, bits and pieces of organisms from more hospitable environments often litter these beaches. Where do these remnants of organisms come from and how do they reach your activity site? This activity invites your participants to discover if the motions of the sea could be responsible for transporting this organism debris. (science, manipulation, measuring)

During this activity, visit the shore and draw attention to the bits and pieces of organisms (shells, seaweed, feathers, crab and fish skeletons, etc.) that are scattered along the beach. Ask your group how these organism remnants might have reached your activity site. Tell the participants they are going to investigate the possibility that the motions of the sea carried the organism remnants ashore. The investigation involves tossing floating, sinking, and neutrally buoyant (does not sink or float) objects into the water off the beach and observing the results.

(For complete details, See "Seas in Motion", OBIS Trial Edition, Set II)

RESOURCES:

ESTUARIES

Written by Laurence Pringle, MacMillan, 1973.

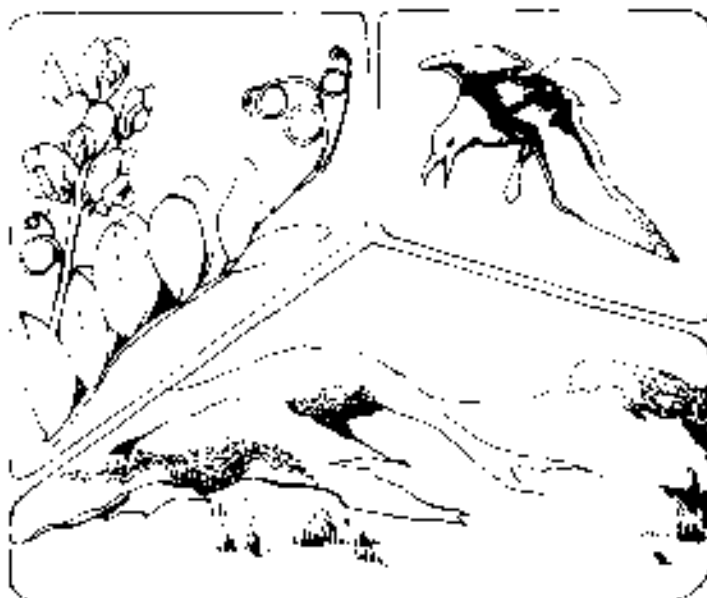
(An overview of estuaries; what they are, how they are formed, and their importance to the marine ecosystem--upper elementary.)

WATCH THE TIDES

Written by David Greenhood. Illustrated by Jane Castle, Holiday House, Inc., 1961.

(Graphic descriptions of how tides work and why we have them-- age 7-8, grades 2,3,4.)

II. COASTAL RESOURCES



- 4 Along our coast we find barrier beaches and dunes, rocky cliffs, 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.

COASTAL RESOURCES

The beach pea, great blackback gull, and sand dune pictured above are all coastal resources. Like our more well-known natural resources--the plants and animals that live in and near the fresh water environment of our lakes and rivers--our natural resources found near the ocean (coastal resources) are equally important.

glossary:

- COASTAL MANAGEMENT** Includes first the inventory and analysis of coastal resources and then the formulation of policies and regulations which insure 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.

activity ideas:

● OCEAN WORD GAME

Make a list of coastal resources and other words that are related to the marine environment. (vocabulary, spelling)

A anemone, Atlantic, aquarium
B barrier beach, beach grass, beach pea, bluefish, bay, boat, breakwater, barnacle
C clam, cod, coral, crab, coastal pond, cliff, cargo ship
D dune, dock, dolphin
E estuary, eel grass
F flounder, fish, fin, fisherman, fiddler crab
G green crab, great blue heron, gull, gill
H herring, horseshoe crab, harbor, hurricane
I iceberg, ichthyologist
J jellyfish
K kelp
L lighthouse, lobster
M marsh, mackerel, mussel, marina
N nautical
O oyster, octopus
P periwinkle, plankton, Pacific, port
Q quahog
R reef
S shark, starfish, scallop, salt spray rose, snail, seaweed, shoreline, sand, ship
T tide, tidal pool, tautog, tuna, trawler, tanker
U urchin
V vessel
W wave, walrus
X
Y yacht
Z zooplankton

● "S" WORD GAME

Make a list of all marine-related words that begin with the letter "s". (vocabulary, spelling)

seaweed	sailboat	submarine
salt spray rose	starboard	skin dive
shoreline	squid	SCUBA
sea gull	school	sunken treasure
snail	starfish	sound
seahorse	shell	sediment

surge
shark
sand
surf

salinity
seal
striped bass
scallops

sea
scales
salmon
skate

resources:

1 PAGOO

Written by Holling Clancy Holling, Houghton-Mifflin, 1967.

(A classic for children about a hermit crab growing up, and all the creatures he meets in the sea--excellent illustrations.)

2 THE CRAB FROM YESTERDAY

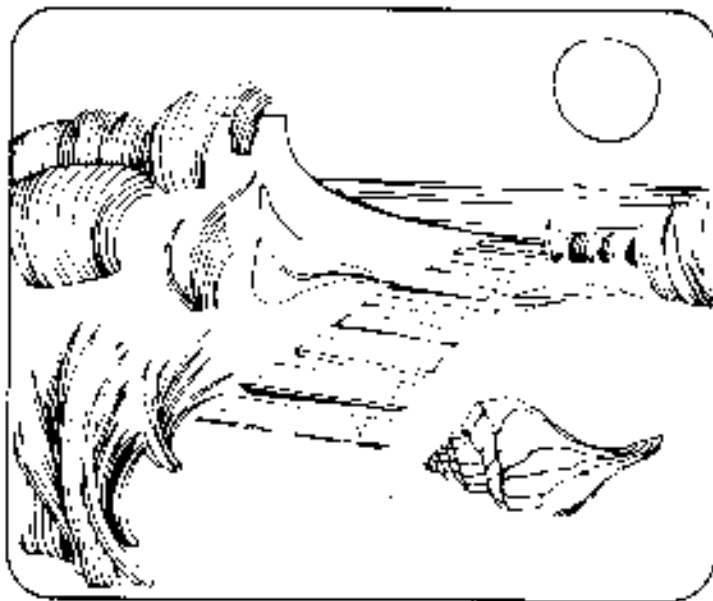
Written by John F. Waters, Frederick Warne and Co., 1970.

(A story about the horseshoe crab, the harmless but much feared "living fossil"--excellent pastel illustrations.)

3 THY FRIEND, OBADIAH

Written by Brinton Turkey, Viking Press, New York, 1969.

(A story about a herring gull.)



- 5 Beach grass grows along the beaches and helps to 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

Ten thousand years have passed since the last continental glacier covered Rhode Island with a thick sheet of ice. Since that time the general contour of our coastline has changed considerably. Rising sea level and the continuing processes of wind and wave erosion have combined to modify many irregular, highly exposed and less resistant portions of the shoreline once covered by glacial soils. These materials have since been deposited in nearby sheltered, shallow or less turbulent areas. Nowhere is this process more evident than along our southern coast, where an almost continuous line of sandy beaches has been formed where once there were none at all.

As these beaches were forming, small bays or coves became enclosed between them and the northern upland. Today these confined bays form a series of coastal ponds along Rhode Island's south shore. Each is surrounded on three sides by glacial till and on the south by a more recent barrier beach. If average sea level continues to rise at its present rate of approximately one foot per century, and natural processes continue to alternately build up and erode the barrier beaches, this entire coastline will slowly migrate inland. The ponds, in turn, will become shallower and smaller. Within a few thousand years, a short period of geologic time, some may even disappear as a result of the same natural processes from which they began. By careful management, man can avoid hastening these natural processes. We should not compete, but instead learn to live in harmony with them.

Rhode Island's coastal pond complexes consist of the pond, the barrier beach with its sand dunes, salt marshes, and in some cases coves, and freshwater wetlands and streams. All of these

seemingly independent features are actually very closely inter-related. In many cases altering one will produce some variation in the physical quality of another.

The ponds vary considerably in size ranging from approximately 10 to 2000 acres. Several have been moderately developed along portions of the shoreline while others remain largely in their natural state. Most of the ponds are connected to the sea by a small breachway through the barrier, the presence of which often determines the character of the pond. In some cases these breachways have been permanently stabilized with rip-rap walls. A few of the smaller ponds do not have active breachways and are, therefore, more brackish. Most of the ponds are shallow. Several of the ponds receive considerable fresh water runoff from upland streams which increases water mixing and causes differing hydrologic conditions to exist in different locations of a pond. This usually increases species diversity within the entire aquatic system by providing habitats for a variety of animals adapted to different salinity regimes. (D)

SAND BEACHES

Sandy shores are the most unstable, and consequently the least biologically productive coastal ecosystems found along the Rhode Island shore. Similar to rocky shores, the sand beaches are fully exposed to wave and tidal energy. Unlike rocky shores, the substrate is unconsolidated and unstable. Higher plants can find no anchorage, so that only unicellular algae are present to manufacture food within the beach habitat.

Sand beach environments are found from Westerly to Sakonnet. They are most prevalent where glacial materials are present to contribute sands, gravels, and cobbles for beach formation. The major stress factors influencing the lives of sandy beach plants and animals are high wave energy and summer drying and heat. The surface materials of sand beaches are subject to almost continuous movement. Wave and tidal forces shift sand up, down, and along the beach. Washing by waves cleans the sand of water-holding organic and fine mineral particles, allowing rapid drainage.

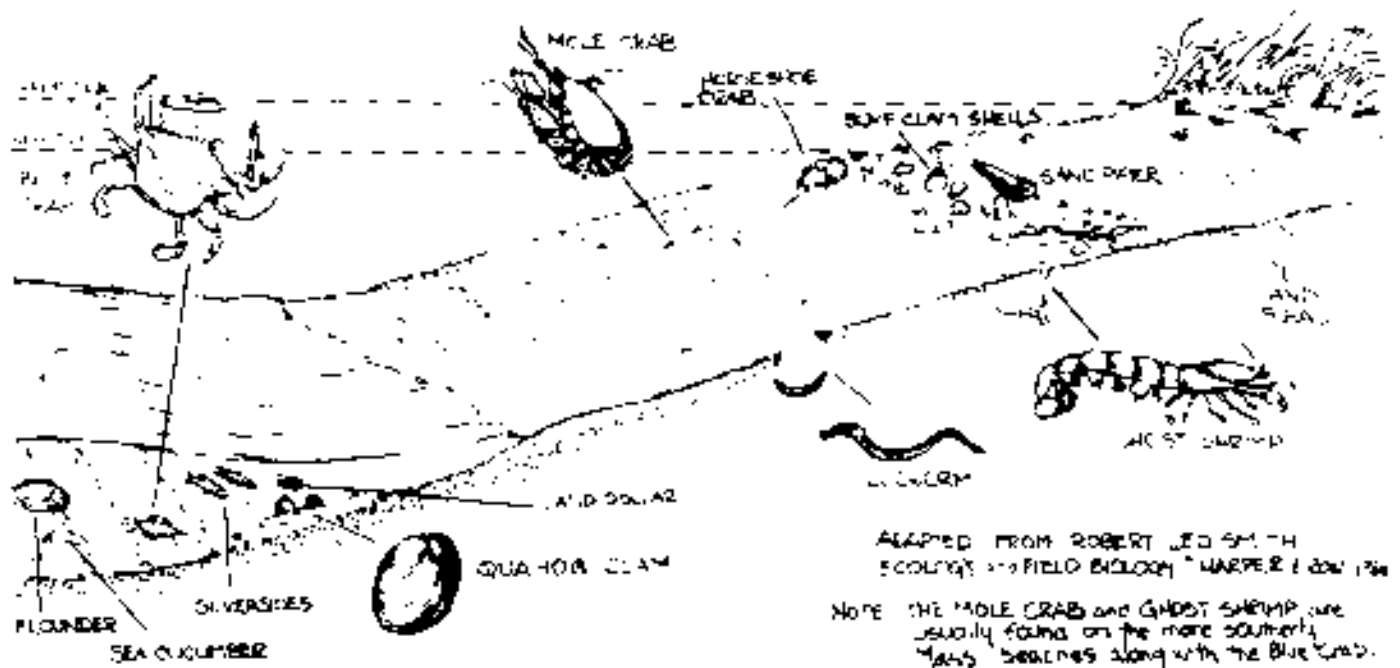
Because there is so little opportunity for food-producing plants to exist on the beach, animal life is supported by imported detritus that originates, for example, in the highly productive salt marsh and eelgrass habitats. Few large animals are adapted to the sandy beach environment, though their population may be high where coastal currents, tides, and waves are effective in importing a detrital food base. Most beach animals

are filter or deposit feeders that must live below the surface of the sand, extending their siphons and tentacle plumes into the flooding tidewaters for feeding. Crabs and snails also emerge from their burrows on the incoming tide to search for food. Beach fleas, flies, crabs, and beetles flourish along the high tide line where they feed on the detritus left by the retreating water.

Terns and gulls find the high beach a suitable nesting site with nourishment for their chicks nearby. Gulls commonly carry scallop and clam shells to nearby roads and parking lots where they can be dropped and easily shattered, their meat quickly eaten.

Seasonal stresses greatly influence sand beach organisms. Winter storms erode the beach and deposit the sand in offshore bars, thus steepening and narrowing the beach profile. As summer approaches, these deposits are shifted back and the beach rebuilt. As waves transport sediments to the shore from bars and shoals, the beach profile becomes wider and flatter. (See drawing of a Sandy Beach)

A Section of Sandy Beach (6)



Only species adapted to the constant stress of pounding waves and shifting sands can inhabit sandy beaches. If it is an ecosystem that produces very little of its own food and depends on the tides and waves to import organic matter. The animal species are generally small in size, have a high fecundity, and are subject to wide fluctuations in population.

Beach organisms are especially sensitive to vehicular traffic. Nesting birds are disturbed by traffic. Nests are sometimes destroyed, particularly those of terns, which prefer the more open lower beach where traffic is heaviest.

In some instances groins have been successful in retarding beach sand erosion. But at the same time they prevent sand from moving naturally along the beach front, and hold back sand which would normally nourish beaches and spits further down the beach. This not only disturbs the equilibrium of the beach system, but also interferes with the wishes of property owners who are trying to maintain their beaches downstream from these structures.
(adapted from A)

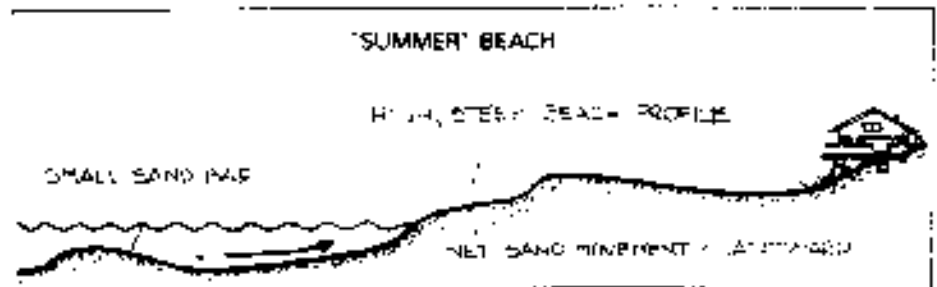
glossary:

- BEACH** A shoreline area washed by waves and composed of loose granular material.
- BARRIER BEACH** A beach, parallel to the shore, but separated from the mainland by a small body of water.
- BEACHGRASS** A grass-like 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 which provides access to a beach without disturbing the beachgrass.
- 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.
- DUNE** A hill or ridge of sand piled up by the wind.
- SAND** A mixture of tiny grains of different types of disintegrating rocks and shells found along beaches.
- WETLAND** Any bog, freshwater marsh, saltwater marsh, swamp, pond or lake.

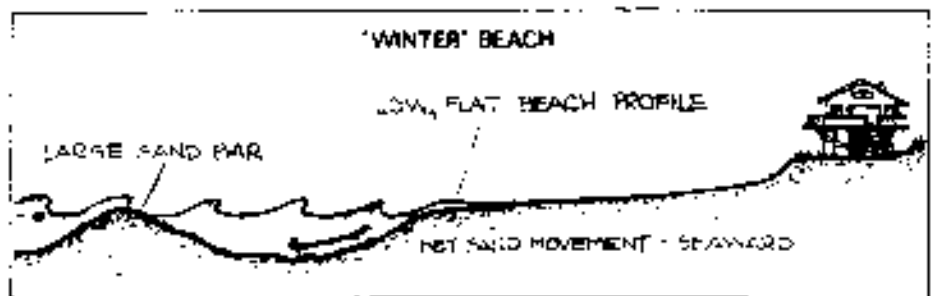
activity ideas:

- When visiting the beach, collect small bits of driftwood, shells, claws, rocks, feathers, and rope. Remembering the "Investigate The Motions of the Sea" activity for page 3 of the Activity Book, discuss where the bits and pieces of material might have come from and how they ended up in the litter strewn about the beach. Use these treasures to make collages, mobiles, or sand castings. Notice if the beach looks like a "summer beach" or a "winter beach." Why? (manipulation, science)

Most sand beaches are very susceptible to weather changes over the seasons. During periods of calm weather, usually during the summer months, the gentle wave action causes a net sand movement onto the beach. This normally creates a high steep beach profile with a steep scarp at the water's edge and a small offshore sand bar.



In contrast to the calm conditions of summer, winter often brings numerous storms and powerful, erosive waves. The winter beach face is characterized by a low, flat profile with the scarp much further back on the beach face and a large sand bar off shore. A caution to property buyers: before buying beach front property be sure to inspect the property after stormy conditions when the beach is likely to be reduced in size. (A)



● SAVING OUR BARRIER BEACHES

"Not realizing the damage they are causing, people walk through the beachgrass and drive their beach buggies and motorcycles across the dunes. Although a hardy plant, beachgrass has one great weakness; because the brittle stalks snap easily the grass cannot survive trampling. Only a few people crossing a dune at the same point will kill a strip of grass. Wind erosion follows, making a cut into the dunes through which waves may flow during the next big storm. The pressure of man is relentless and it increases each year. Unless steps are quickly taken many of our remaining undeveloped barriers will be badly damaged and their beauty and effectiveness as protection against storms much reduced."²

We can all help save our beaches by using boardwalks where they are provided and taking care not to walk on the beachgrass. If your class is interested in specific steps, like helping to plant beachgrass or build a boardwalk, that they can take toward saving our barrier beaches, consult the booklet entitled, How to Build and Save Beaches and Dunes⁴ and local conservation officials. (community studies, communication)

places to visit:

- 3* Norman Bird Sanctuary, Middletown
- 5 Sachuest Refuge, Middletown
- 7 North End, Block Island
- 15 Purgatory Chasm, Middletown
- 24 Trustom Pond National Wildlife Refuge and Moonstone Waterfowl Refuge, South Kingstown
- 32 Barrier Beach and Salt Water Pond, Charlestown

note:

*Details of all *Places to Visit* preceded by a number correspond to entries in the Environmental Education Field Guide to Rhode Island. (B) Please consult this brochure for a complete description of each field trip site, including information on activities that may be carried out there, grade level, fee, and prior arrangements.

resources:

1 A HANDBOOK FOR BEACH STROLLERS

Written by Donald J. Zinn. Marine Bulletin Number 12, University of Rhode Island, 1973. (\$3.00)

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882. (Please make check or money order payable to University of Rhode Island.)

2 BARRIER BEACH POSTER/BROCHURE

Written by Stephen B. Eisen and John A. Jagschitz. Marine Bulletin Number 19, University of Rhode Island, Coastal Resources Center.

3 "BEACH LIFE AT EBB TIDE"

Written by John H. Lorei. The New York State Conservationist, August-September, 1969.

Individual copies may be ordered from Department of Environmental Conservation, 50 Wolf Road, Colonie, NY 12205.

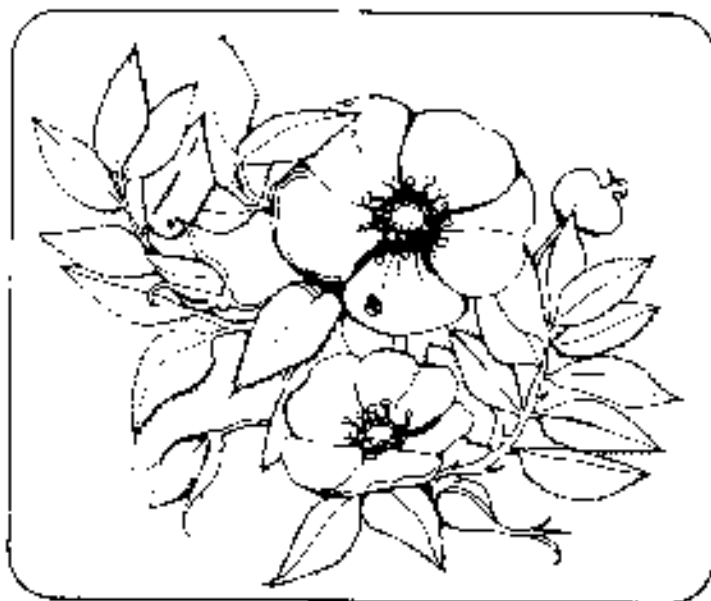
4 HOW TO BUILD AND SAVE BEACHES AND DUNES

Written by John A. Jagschitz and Robert C. Wakefield. Marine Leaflet Number 4, University of Rhode Island, Marine Advisory Service.

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882.

5 THE LIFE OF THE SEASHORE: OUR LIVING WORLD NATURE SERIES

Written by William H. Anos. McGraw-Hill, New York, NY, 1966.



- 6 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, the bright red rose hips become food for small wild animals and birds.

glossary:

ROSE HIPS The fruits of the salt spray rose. The hips are green in the summer, then 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:

● EDIBLE PLANTS

Many of us have delighted in feasting on a supper of lobster, clams, mussels, and oysters, sweet and white potatoes, onions, hot sausage, and just-picked sweet corn steamed on a bed of fresh rockweed. And the more ingredients for the big steamer we dug and gathered ourselves, the more enjoyable was the dinner. Steamer ingredients are the obvious seashore edibles, but 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 rosehips, flour from cattail pollen, a salad of

scurvey 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, breadstuffs, 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 a candy made of young scotch fougave leafstalks.

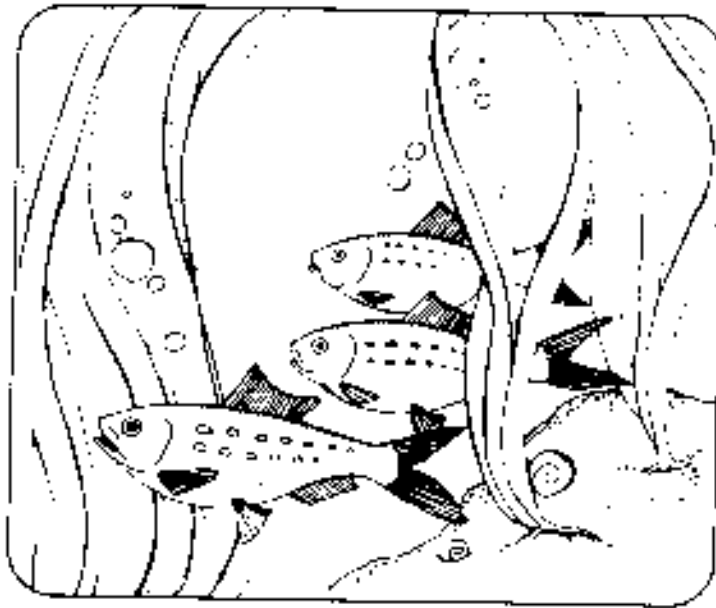
Many of the reportedly edible plants found in New England should not be considered as much more than survival food. However, many are accepted as good for eating.

● ROSE HIP JAM RECIPE (manipulation, measuring)

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. Place 1 c. prepared hips, 3/4 c. water, and juice of 1 lemon in blender. Blend until smooth, and with blender running, add 3 c. sugar. Blend 5 minutes or until sugar is completely dissolved. Mix 1 package powdered pectin in 3/4 c. water, bring to boil, and boil hard for 1 minute. Pour into blender and blend all ingredients for 1 minute more. Pour into sterilized jars and store in refrigerator (or in freezer if for more than one month).³

resources:

- 1 STALKING THE BLUE-EYED SCALLOP
Written by Euell Gibbons. David McKay Company, Inc., 1964.
- 2 STALKING THE HEALTHFUL HERBS
Written by Euell Gibbons. David McKay Company, Inc., 1966.
- 3 STALKING THE WILD ASPARAGUS
Written by Euell Gibbons. David McKay Company, Inc., 1962.



- 7 The eel grass that grows in sheltered waters is a home for young fish and snails.

EELGRASS BEDS

Beds of subtidal eelgrass are very important food production and nursery areas. This perennial plant is found in waters of varying salinity in depths ranging from just under low tide level to twenty feet below the sea's surface. Look for it in places where sunlight penetrates to the ocean floor, currents are not too swift, wave disturbance is low, and bottom sediments are favorable to plant growth. Eelgrass beds flourish 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.

The character of the substrate is one of the factors determining the success of eelgrass. The plant prefers fine sediments ranging from sandy mud to fine sand. Where finer mud materials prevail, an overlay of protecting sand is essential to prevent moving water from stirring up and suspending particles of mud in the water, diminishing sunlight penetration, and thus reducing the productivity of eelgrass.

Eelgrass beds provide a variety of ecological services. They offer a substrate for other plant and animal life. They are consumed directly as food by grazing animals. They provide security to organisms requiring calm, protected waters and shelter from predators. They cycle nutrients in the subtidal coastal waters and provide a habitat for an array of marine animals such as winter

flounder, pipe fish, scallops, brittle stars and jellyfish. They are a critical nursery area for bay scallops, which can only survive their first month of life by attaching themselves to eelgrass stems. Eelgrass nourishes the crabs, mollusks, worms, shrimps, and sea urchins which feed on detritus that plants provide. Snails, crabs, fish and waterfowl feed directly on the leaves and stems and on the attached plants and animals. Brant geese and other waterfowl depend on eelgrass as an important element of their diet.

Disaster struck the eelgrass beds of the North Atlantic coast in 1931. A "wasting disease" destroyed 99 percent of the standing stock. Brant and coastal populations of Canada goose and black duck declined rapidly when the grass beds were lost. Other marine populations—clams, crabs, and bay scallops—were reduced apparently because the critical supply of eelgrass detritus and protected nursery grounds were eliminated.

In 1950, a small stand became established near the rocky shores of Massachusetts and the entire community of eelgrass organisms there once again stabilized. Eelgrass has also returned to more southerly areas, and scallops and waterfowl have also returned in growing numbers.

Eelgrass primarily propagates by seeds and rhizomes. The growth rate and reproduction of eelgrass varies with the seasons because the plants are sensitive to water temperature. After a dormant or near-dormant period in winter, eelgrass growth accelerates in March or April, with flowering, seed development and seed germination occurring in May. While summer growth is rapid, warmer water temperatures discourage persistence of developed leaves and stems. During the summer months, these continuously break off and provide a supply of detritus for filter and deposit feeders. There is a brief resurgence of accumulated growth in the early fall just before colder conditions in November cause a general dieback of the stems and leaves. This results in the release of the plant's largest contribution of detritus to other members of the eelgrass community.

Major stresses for these plants to endure are the effects of dredging and the disappearance of the substrate in which they root. Increased silt and the flow of pollutants from industrial and urban wastes, sewage disposal, and oil spills further hamper the ability of eelgrass to survive. (adapted from A)

glossary:

EELGRASS A marine grass that grows on sand and mud-sand bottoms in shallow coastal waters.

HABITAT A place where a particular plant or animal normally grows or lives.

SNAIL A small animal having a well developed spiral shell into which the animal can withdraw for protection.

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.

Materials

Fish (fresh or frozen)

Ink (water soluble block printing ink, acrylic, etc.)

Paper (gravestone rubbing paper, rice paper, construction paper, etc.)

Small paint brush

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 against the "grain" of the scales so ink will accumulate in these areas and make a better print. 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 the fish does not move and smear the print.

5. Sign print. Give name of fish, date, etc.

Various papers and inks can be used. Experiment with paper absorbancy. Fish can be washed, dried and reused. Generally, the thicker the ink and thinner the paper, the better the print. Try using different colored inks on various areas of the fish. (Painting, manipulation)



- When fish printing activity is completed, wash and dry the fish, then dissect it as part of a biology unit. The general anatomy of the fish, digestive system, or reproductive system may be emphasized. (science, manipulation)
- Try to design and draw or construct a 'new' fish. Experiment with colors, shape of body and fins, size, and location of eyes and mouth. Write a story to explain how your 'new' fish is different from ordinary fish. (drawing, manipulation, science, creative writing)

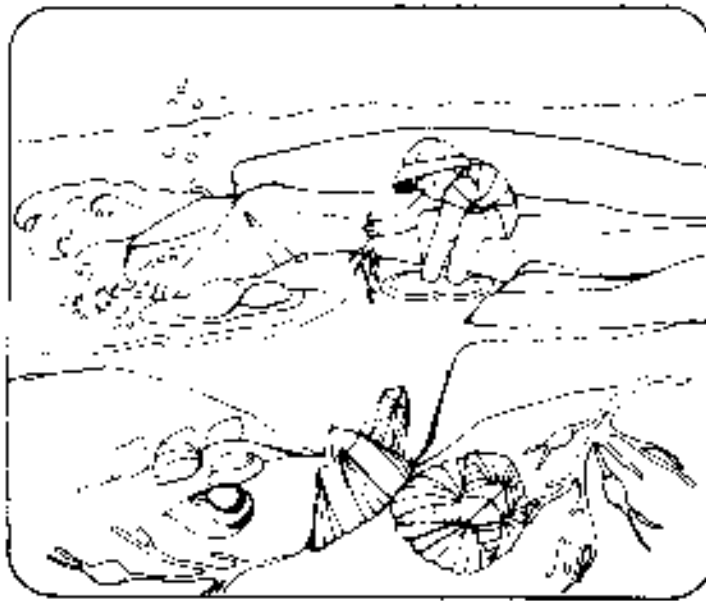
places to visit:

- Perryville Hatchery Tour, South Kingstown
- Lafayette Hatchery Tour, North Kingstown
- 32 Barrier Beach and Salt Water Pond, Charlestown
- 90 Gilbert Stuart Birthplace (Herring Run), North Kingstown
- New England Aquarium, Boston, Massachusetts
- Mystic Marinelife Aquarium, Mystic, Connecticut

resources:

- 1 FISH OUT OF SCHOOL
Written by Evelyn Shaw. Illustrated by Ralph Carpenter. Harper and Row, New York, 1970

(ages 4-8--a well illustrated book telling about schooling behavior in fish, especially herring.)



8

A treasure chest of seaweed and creatures like the periwinkle and barnacle live in tidal pools along our rocky shores.

SCENIC CLIFFS AND ROCK OUTCROPS

Rhode Island's location along the eastern seaboard and its geologic history provide an unusual and diverse mixture of coastal features. Rhode Island has large stretches of rocky coastline, islands, and sheer escarpments usually found in more northerly locations like the coast of Maine. These features form a significant kind of Rhode Island coastal natural area.

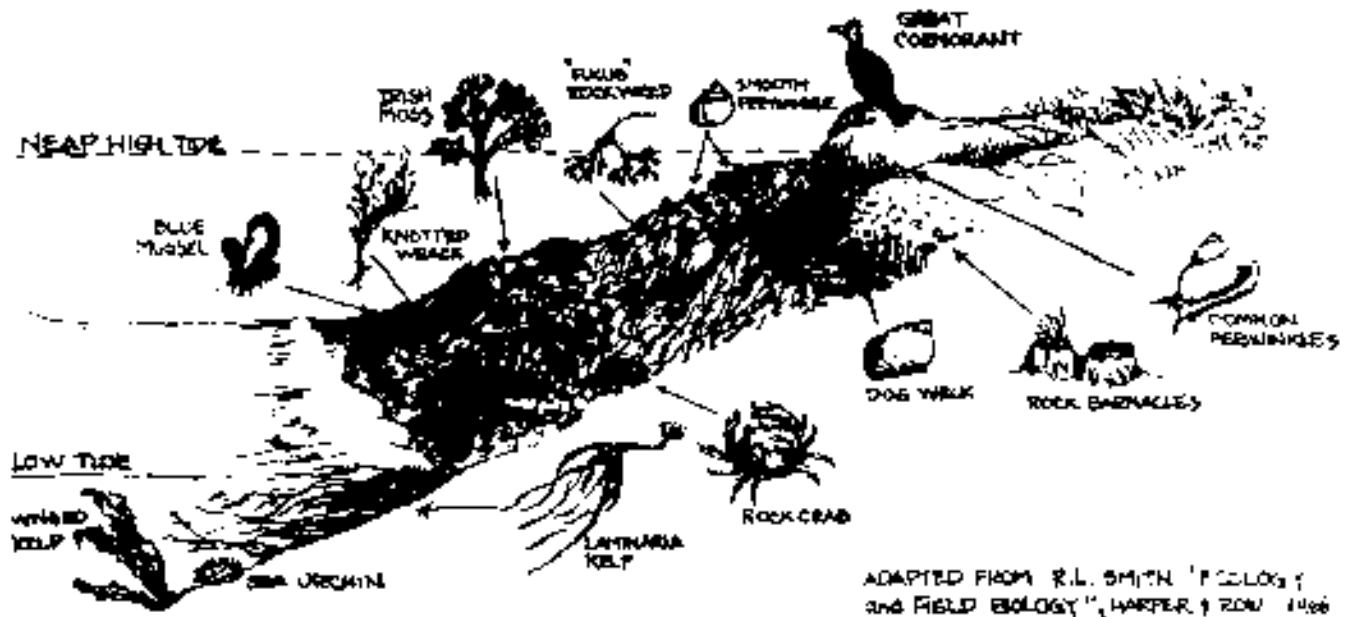
While most beaches, salt marshes, and other highly erodable and constantly changing areas are geologically recent, most rocky cliffs and outcrops were formed millions of years ago. They are the result of geologic forces active over extensive periods, including underground volcanics, submerged sedimentation, fracture, intrusions, offshore mountain building pressures and uplift to name just a few. More recently, glaciation, weathering, and continued exposure to the sea have contributed to a gradual but often imperceptible modification of these highly resistant areas. Because of their usual occurrence in highly exposed and dangerous coastal locations, most cliffs and rock outcrops are less prone than other areas to severe disturbance by man. As a result, most are still to a large extent in their natural state.

While these areas are significant to Rhode Island primarily for their scenic qualities, they possess distinct geologic, historical and biologic values, too. Most have been the object of considerable study by college and university geology classes for a number of years. Mineral collectors constantly discover interesting specimens where natural erosion periodically exposes new veins or crystal concentrations. Many areas contain a wide variety of mineral and rock types. Geologist Alonzo Quinn has specifically referred to nearly all of the rocky cliff areas as among the most interesting and significant locations in Rhode Island.¹ Several have played a role in Rhode Island's historic past, as a site either for an important structure like a lighthouse or for a significant historical and cultural event.

The biological role of many cliff and rocky shoreline areas is often overlooked. Many small offshore outcrops and islands are particularly valuable to nesting shorebirds. These areas are little disturbed by man or predatory animals, and nesting success can be quite high. Gulls, terns, geese, and black ducks are all known to use these small isolated sites for nesting. Tidal pools are also prevalent along our rocky coasts, and offer a unique environment for many plant and animal species that have adapted to extremely harsh environmental conditions. These organisms must withstand highly variable moisture, salinity, and temperature conditions as well as high winds and pounding waves. (See drawing of a Rocky Shore)

The scenic and recreational qualities of rocky and steep coastal areas have been well recognized in the past. Many of these areas have been used for years as tourist attractions, scenic overlooks, and low intensity recreation sites. State recreation maps already designate several as significant scenic view sites. However, efforts to formally protect these sites or even recognize their need for protection have not been as great as for other shoreline features. To a degree, this is understandable. They are usually not as fragile, ecologically significant, or endangered as wetlands or other coastal areas where the potential for natural or man-made disturbance is high. As a result, their continued existence is largely taken for granted. A recent proposal to quarry one of the state's major coastal rocky cliff areas and use the material for Lower Bay hurricane barrier fill indicated that this type of feature can be very vulnerable. With increased population pressures along the coast, and with subsequent developmental, recreational and economic demands, efforts must begin to insure that the aesthetic qualities of our rocky coastline remain intact. By doing so, a significant portion of our valuable tourist trade may be protected as well. (adapted from D)

A Section of Rocky Shore (a)



ADAPTED FROM R.L. SMITH "ECOLOGY AND FIELD BIOLOGY", HARPER & ROW 1966

The many plants and animals associated with the rocky shore have adapted to their difficult environment by developing means of firmly attaching themselves

to rock. The tides determine their distribution or zonation by the amount of exposure to the elements that a particular species can endure.

glossary:

- ALGAE** Simple plants, without true stems, leaves, or roots.
- 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 ships' bottoms.
- 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 plant growing in the sea, specifically marine algae like kelp, rockweed, and sea lettuce.
- TIDAL POOL** A unique environment for many plant and animal species. Found along our rocky shores, tidal 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:

- **PLACE A BARE ROCK IN THE INTERTIDAL ZONE AND WATCH TO SEE WHICH ORGANISMS COLONIZE IT AND WHEN THEY ARRIVE (C)**

Rocks, pilings, and other solid surfaces in the intertidal zone (between the high tide and low tide marks) are often covered with marine organisms such as seaweeds, mussels, barnacles, snails, and starfish. Where do these organisms come from? Do they arrive by themselves? Which organisms arrive first? How soon do they appear on a new surface?

This activity investigates the process of colonization: the establishment of a population of organisms in an area where that organism did not appear before. You can observe this process by introducing new surfaces (Pioneer Rocks) into the intertidal zone in the spring of the year and monitoring the developments of these surfaces. If you observe your Pioneer Rocks for a long enough period of time (possibly several months) you may see some of the pioneer organisms replaced by other populations. Succession is the replacement of one population with another. This process will continue until the plants and animals on your Pioneer Rocks look just like those on the surrounding rocks. (science, measuring)

(For complete details, See "Pioneer Rocks," OBIS Trial Edition, Set 1.)

● SEAWEED (E)

Marine algae (seaweed) recycle our supply of oxygen during the process of photosynthesis just as plants and trees on the land do. At the base of the food pyramid, marine algae provide food and shelter for many marine organisms. An excellent chapter on seaweed which many children can read and understand by themselves is found in The Beachcombers Book.³

Collecting and drying seaweed in the classroom provides an excellent opportunity for the children to expand their research skills. Many books on marine botany offer directions for drying, identifying, and labeling seaweed specimens.

● EDIBLE PLANTS AND ANIMALS

When visiting a tidal pool or rocky shore, collect some of the more unusual plant and animal species like periwinkles, mussels, or Irish moss (be sure to check first with the Department of Natural Resources, 83 Park Street, Providence, RI, to see if collecting specimens in a particular area you visit is permitted). Try cooking them in the classroom. The Uncommon Cookbook⁴ offers many new and interesting recipes for the more unusual plants and animals. (measuring, science, communication)

places to visit:

- 2 Ocean Drive Marsh, Newport
- 15 Purgatory Chasm, Middletown

resources:

- 1 RHODE ISLAND GEOLOGY FOR THE NON-GEOLOGIST
Written by A. W. Quinn. Rhode Island Department of Natural Resources, Providence, RI, 1973.
- 2 "SOME MARINE ALGAE OF NEW YORK STATE"
Written by James Flore and George F. Schumacher. The New York State Conservationist, August-September, 1963.

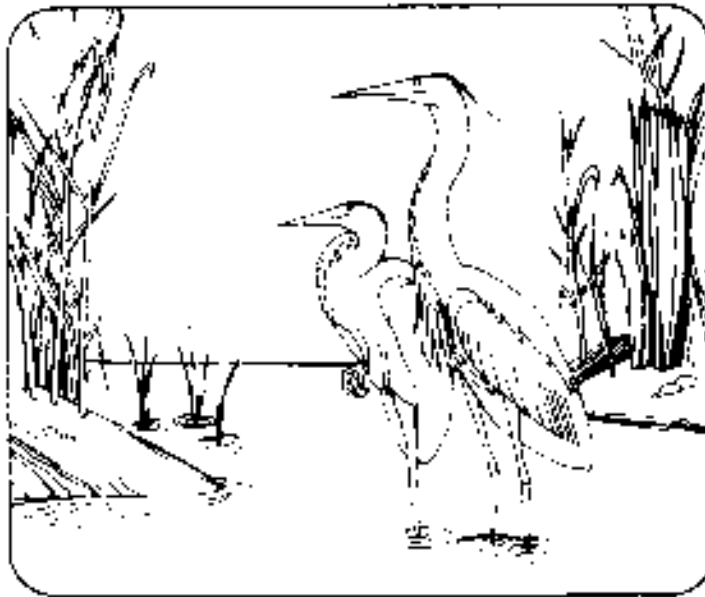
Individual copies may be ordered from Department of Environmental Conservation, 50 Wolf Road, Colonie, New York 12205.

- 3 THE BEACHCOMBER'S BOOK
Written by Bernice Kohn. Viking Press, NY, 1970.
- 4 THE UNCOMMON COOKBOOK
Edited and illustrated by Phyllis Coggins. University of Maine Sea Grant Program, 1976. (\$1.50)

Available from Publications Office, Maine Sea Grant Program, New Harbor, Maine 04554. (Please make check or money order payable to University of Maine.)

- 5 THE WORLD WITHIN A TIDEPPOOL
Written by Robert Silverberg. Wybreth and Tally, 1972.

(An excellent book about the tidepool environment and the adaptations of the animals that live there.)



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

SALT MARSHES

Among Rhode Island's most valuable coastal features are the salt marshes. For years scientists have recognized these as being important as juvenile fish habitat and food sources, as wildlife habitat, as nutrient traps, and as buffers against storms and flooding. Laws protecting salt marshes, therefore, have been enacted in many states, including ours. The general consensus has been that since coastal wetlands provide distinct public benefits, they should be protected against inappropriate activities.

Rhode Island's salt marshes began to form more than 3,000 years ago. In shallow estuaries where water turbulence was minimal, salt-tolerant grasses began to grow. Without any direct competition from other upland species, they grew rapidly and soon became stabilized into large flat marshlands. As sea level slowly rose over the centuries, these marshes have edged both farther inland and higher, building to a large extent on their own undecayed plant remains. The seaward edges have become submerged or have eroded away. But new marshes are continually being formed, as evidenced by the many narrow, "fringe marsh" areas along much of the Rhode Island shore.

Even though Rhode Island has an extensive, 400-mile coastline, which includes the perimeters of many islands and small inlets, there are only about 4,000 acres of salt marsh, making it one of the least abundant land forms in the state. According to a recent federal wetlands inventory, many acres have been eliminated by filling and excavation.⁷ The scarcity of salt marshes in Rhode Island

is in itself one reason for carefully managing those that remain. The study concludes that "obviously, Rhode Island can ill afford any further loss of marshes."

All Rhode Island salt marshes are readily identified as low, flat areas regularly inundated by tidal waters. During periods of extreme high tide they can be totally submerged. Marshes are densely vegetated with low-growing herbaceous, or non-woody, plants especially adapted to saline conditions. The number of plant species found in a marsh usually increases with its size; thus, some smaller fringe marshes may contain only one species. However, there are four predominant plants which are listed in Rhode Island law to identify the presence of a salt marsh: salt marsh grass (*Spartina alterniflora*), salt meadow grass (*Sparganium patens*), spike grass (*Distichlis spicata*), and black rush (*Juncus gerardi*). All are present in most sizable marshes. The faunal composition of marshes is also quite distinctive.

Rhode Island salt marshes are indispensable as natural life-support systems. Many species of fin and shellfish and the birds that feed upon them are dependent during at least part of their life cycle on tidal marshlands. Teal (1969) states that two-thirds of the commercial catch of fish and shellfish landed on the east coast of the United States is of species that spawn or exist during part of their lives in marshes and associated estuaries.⁵ These include menhaden, alewives, shad, striped bass, bluefish, blackback flounder, shrimp, blue crabs, oysters, and many others. Marshes are particularly valuable to the juvenile stages of these species, providing protection and a vital nursery area in which to grow. According to Teal, the success of the sport fisheries depends even more on the existence of marshes than does the commercial fishery.

The most obvious wildlife inhabitants of the marsh are birds. Most birds, however, are near the top of complex food chains and inhabit the marsh only because the organisms on which they feed--snails, insects, crustaceans, small fish and plants--are abundant there. In a recent study of one small three-acre Rhode Island salt marsh, well over 1.5 million grass shrimp were observed during one month alone.⁶ These large numbers of invertebrates support numerous birds including herons, egrets, sandpipers, plovers, and many species of ducks. Several birds, including the clapper rail and the sharp-tailed and seaside sparrows, almost totally depend on the salt marsh ecosystem for food and a nesting habitat. Our Rhode Island marshes play a particularly significant role for migrating shorebirds and waterfowl since these marshes are located near the middle of the Atlantic Flyway. Mammals such as raccoons, skunks, white-footed mice, and foxes, although less conspicuous, play an active role in the marsh ecosystem as well. (D)

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:

● IDENTIFYING SEASHORE BIRDS

If you have visited the shore--from the beaches and marshes to rocky cliffs--you have probably seen gulls and many other birds. But how many of these birds can you identify? With a little practice and the help of a good bird identification book and a pair of binoculars, you can easily learn to recognize many seashore birds by their color, size, shape, and other distinctive features. Several bird books are listed in the *RESOURCES* section.

● USE YOUR "BEAKS" TO SEARCH FOR ORGANISMS THAT A BIRD MIGHT EAT (C)

You can usually find a variety of plants and animals living in the marshes and tidal flats. These organisms attract many different kinds of shorebirds. During a low tide, hundreds of shorebirds may feed on a tidal flat at the same time. Birds, like other groups of animals, have developed diversified feeding features that enable each kind of bird to feed on certain types of foods. Because the diversity of shorebirds is matched by the diversity of tidal organisms, the feeding competition is mainly among members of the same species. Thus, many different kinds of shorebirds can feed together.

In this activity, the youngsters pretend to be shorebirds searching for food. Each participant receives a "beak" and a "stomach". The kids use their "beaks" (trowels, spoons, sticks) to search for organisms that a bird might eat, and place them in their "stomachs" (milk carton half or other suitable container). After searching for food, the "birds" gather to examine the contents of their "stomachs." The activity closes with the kids trying to discover how real shorebirds find their food. This is a good introductory activity for a marsh or a tidal flat. (communication, manipulation, science)

(For complete details, see "Flocking To Food", OBIS TRIAL Module, Set 11)

places to visit:

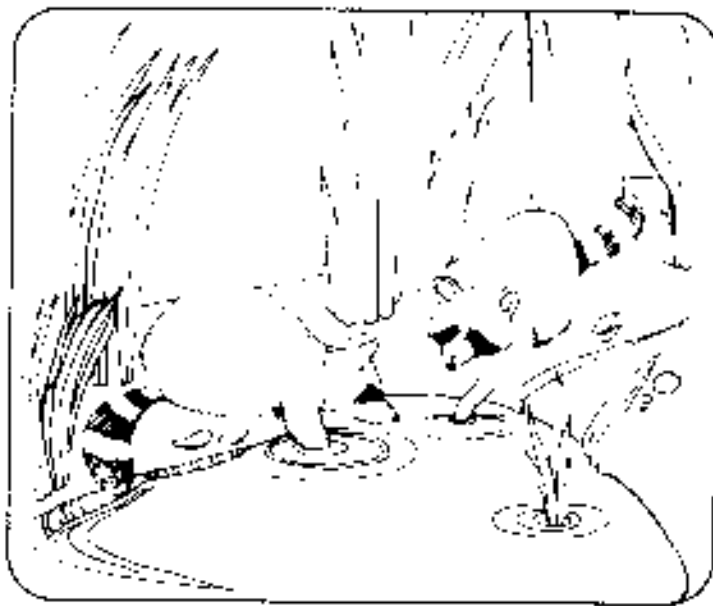
- 2 Ocean Marsh Drive, Newport
- 3 Norman Bird Sanctuary, Middletown
- 5 Sachuest Refuge, Middletown
- 7 North End, Block Island
- 8 Seapocket Marsh, Tiverton
- 24 Truston Pond National Wildlife Refuge and Moonstone Waterfowl Refuge, South Kingstown

resources:

- 1 A FIELD GUIDE TO THE BIRDS
Written by Roger T. Peterson. The Riverside Press, Cambridge, MA, 1960.
- 2 AMERICAN WATER AND GAME BIRDS
Written by A. L. Rand. E. P. Dutton and Co., New York, NY, 1956.
- 3 BIRDS OF NORTH AMERICA
Written by C. S. Robbins, B. Brunn, and H. S. Zim. Golden Press, New York, NY, 1966.
- 4 "ECOLOGY OF A NEW ENGLAND SALT MARSH"
Written by S. W. Nixon and C. A. Oviatt. Ecological Monographs, 43(4), 1973.
- 5 LIFE AND DEATH OF THE SALT MARSH
Written by J. A. Teal and M. Teal. Little, Brown, Boston, MA, 1969.
- 6 LIFE HISTORIES OF NORTH AMERICAN GULLS AND TERNS
LIFE HISTORIES OF NORTH AMERICAN MARSH BIRDS
LIFE HISTORIES OF NORTH AMERICAN SHORE BIRDS, PART I
LIFE HISTORIES OF NORTH AMERICAN SHORE BIRDS, PART II
Written by Arthur Cleveland Bent. These books are available at your book dealer, or write for a free catalog to Dept. Nat., Dover Publications, Inc., 180 Varick St., New York, NY 10014.
- 7 SUPPLEMENTARY REPORT ON THE COASTAL WETLANDS OF RHODE ISLAND
United States Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Boston, MA, 1965.
- 8 THE FIRST BOOK OF SWAMPS AND MARSHES
Written by Frances C. Smith, Franklin Watts., Inc., 1969.

(The complete book about wetlands, with emphasis on their ecology and their importance to the marine community as a whole nupper elementary)

- 9 THE SHOREBIRDS OF NORTH AMERICA
Written by Gardner D. Stout. Viking Press, New York, NY, 1967.



10

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

PRODUCTIVITY OF A SALT MARSH

The salt marsh is an important ecosystem. These highly productive biological communities, varying in size from tiny pockets to many acres, are always located in the intertidal areas behind barrier beaches, bordering pools of quiet water, or along the banks of tidal rivers.

Salt marshes add greatly to the aesthetic diversity of the coastal landscape, providing a source of recreational enjoyment through fishing, shellfishing, birdwatching, and general nature appreciation in all seasons of the year.

The salt marsh can be viewed as a "machine" transferring food and chemicals back and forth between the productive marsh and the open sea. As such, it fills an important role in maintaining the physical-biological character of the near-shore.

As in all biological systems, vegetation serves a variety of roles in the marsh. It is able to use solar radiation and nutrients to produce food, reduce extreme temperatures, and add organic material to the marsh soil. While marsh plants use a large amount of the food they produce in order to survive in their rigorous environment, the remainder is available to be used as a source of nutrients by other plants and animals. This contribution can be substantial compared with the productive contribution of wheat fields, deserts, and oceans, making the salt marsh one of the most productive of all ecosystems.

As do all intertidal biotic communities, the salt marsh exhibits definite zones in the arrangement of its plant and animal species. (See cross section of a Salt Marsh) The limits of the marsh zones are determined by the plants' responses to varying salinity and the frequency of tidal flooding. This zonation is most easily seen in the occurrence of the marsh's two dominant plant species; the coarse, broad-leafed salt marsh cordgrass; and the smaller salt meadow cordgrass. The spacial occurrence of these two species marks the position of the low and high marsh zones. The high marsh zone is flooded only during extreme high tides and during storms.

Bordering the upper zone between high marsh and land are seaside goldenrod, blackrush and panic grass. The higher marsh ground that receives influxes of fresh water is often colonized by cattails and *Phragmites*-(*reeds*).

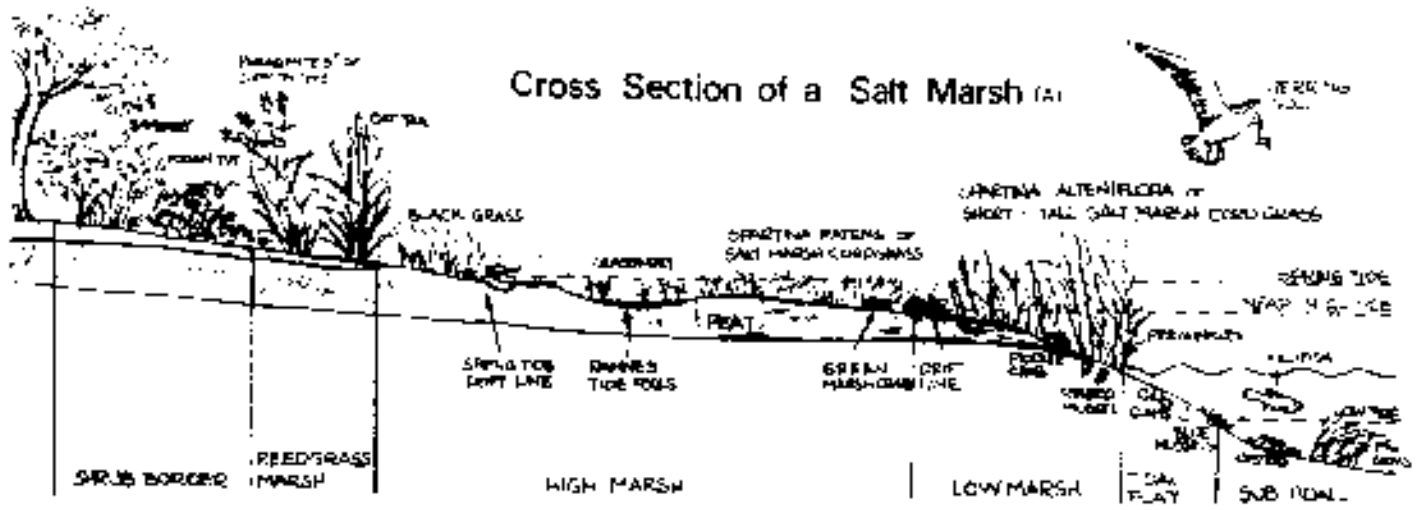
A most unusual plant species, glasswort, thrives in high concentrations of salt. It is often found within pannes, the shallow depressions in the high marsh filled by the flooding tide. Water is retained in the pannes, where salt concentrations rise due to evaporation, allowing glasswort to live without competition from plants that are less tolerant of salt.

Also contributing to the high productivity of the marsh, although not as obvious as the marsh grasses and border plants, are the microscopic algae that cover the muddy surface of the marsh. They appear as slicks of green and gold and are essential food sources for small invertebrate animals.

After the growing season, most of the plants die back and their leaves and stems become detritus. Decomposers, which are primarily aquatic bacteria, fungi, and protozoans, break down the detritus into minerals, gasses and water. Nutrient materials released by the decomposers are recycled and returned to the soil and water where they can be reabsorbed by plants. Broadleaf cordgrass decays more quickly than salt meadow cordgrass because it is flooded daily and lacks any physical buffer to protect it from tidal destruction.

During the winter months, the algae continue to replicate their populations, supplying food to the marsh system. Marsh plants, bacteria, and animals consume only some of the available food energy produced in the marsh. The remainder is exported by the tides, rivers, and littoral drift to help provide nourishment for life in the estuarine and coastal waters.

Cross Section of a Salt Marsh (A)



Many animals seek food, nesting sites, and shelter in the salt marsh. Clams, worms, and burrowing shrimps dwell in the tidal flats and marsh creek banks. At low tide, feeding crabs, shore birds, and insects explore these areas. Birds are attracted to the salt marsh in great numbers. Marsh wrens, seaside sparrows, sharp-tailed sparrow, clapper rails, great blue herons, snowy egrets, and others visit the marsh to nest and feed. Insects and their larvae are plentiful and provide a suitable diet for some birds and their young, while mussels, clams, and crabs are sought by larger birds and mammals. Marine animals follow the incoming tide to search for crabs, snails and worms. At low tide, marsh hawks and short-eared owls patrol the marsh in pursuit of mice and small birds.

In fall and winter, many migrating animals enter the marsh on their way to warmer climates. Herons, shorebirds, and other aquatic birds poke out worms, crabs, clams, and larvae living in the marsh mud.

Despite their importance to the general productivity of the coastal and oceanic environment, salt marshes have been disturbed in many ways by man. Thousands of acres of salt marsh have been destroyed by direct filling to provide sites for development along the shoreline. Other marshes have been used as convenient dumping grounds for dredge spoils.

Stresses of all types are increasing. Management of salt marsh and related ecosystems is necessary if this most productive and important coastal resource is to continue its generous contribution to the ecological well-being and productivity of the coastal zone and ocean. (adapted from A)

glossary:

- BIVALVE** Having a shell composed of two distinct parts. The most familiar bivalves are the 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.
- DETRITIS** Organic or inorganic loose matter formed of the remains of plants and animals or the disintegration of rocks. Detritis constitutes a sediment found on the ocean bottom and is an important link in many food chains.
- FIDDLER CRAB** A type of crab with pincers on the first pair of legs and 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 ninety percent occurs on each level--for instance, it would take about 1,000 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 animals that includes snails, octopuses, mussels, clams, oysters, and squid. Mollusks have soft 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 by secreted threads. Mussels are usually dark colored, growing in masses on floating objects, underwater structures, on rocks and rocky cliffs, covering mudflats in the intertidal zone, and boring into rock.

activity ideas:

● FOOD CHAIN SONG

A song to emphasize a natural food chain found in the ocean. (singing)

"Think About Your Troubles"
from the album The Point by Harry Nilsson

lyrics:

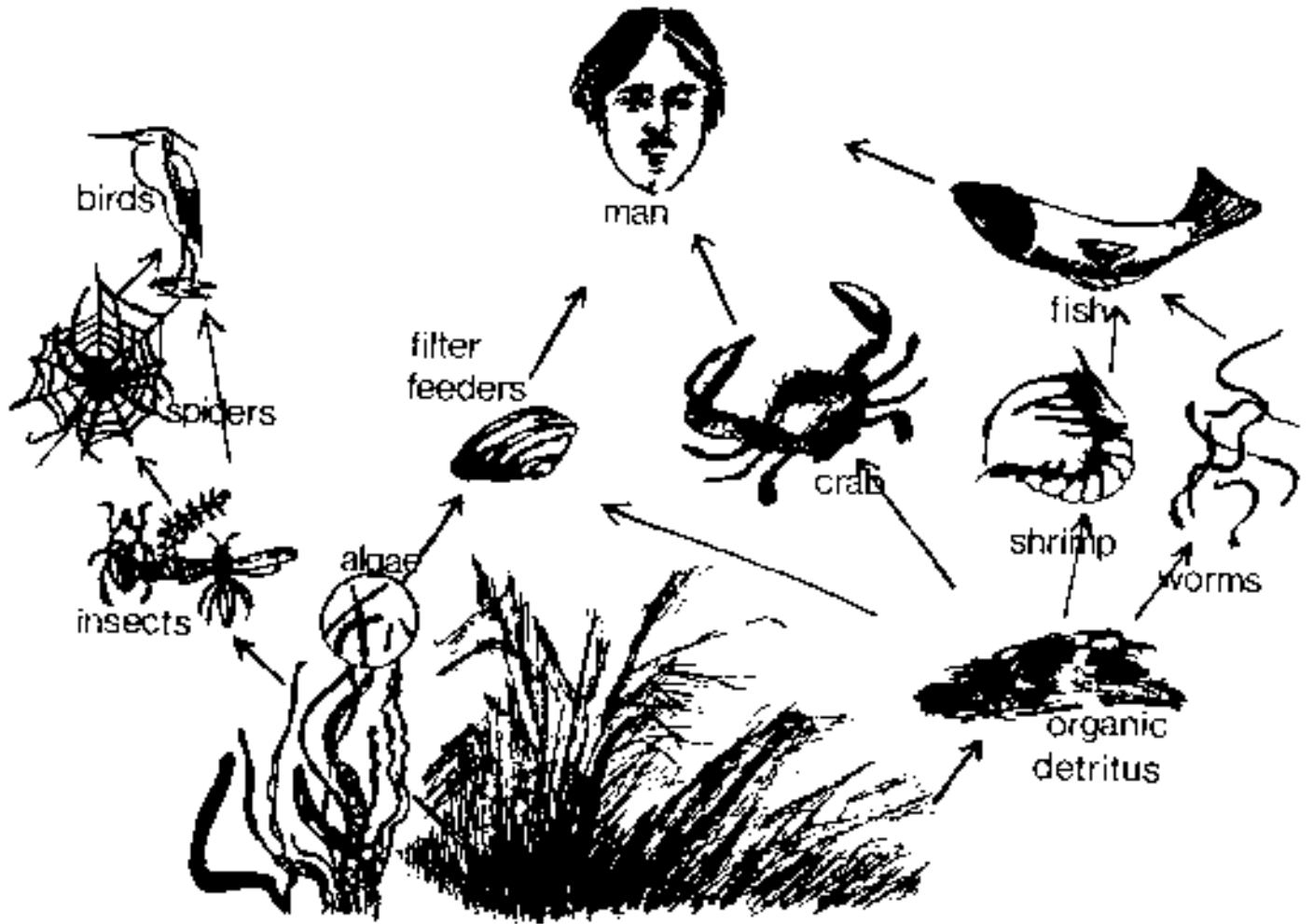
To be swept up by a current
To be eaten by some fishes
And swallowed by a whale
Who grew so old
He died and left his body
To the bottom of the ocean
And the sea did what it oughta
And soon there's salty water

(20 seconds introduction of splash and bubbles: 55 seconds of song)

● SURVIVE AS AN ANIMAL IN A MAKE-BELIEVE FOOD CHAIN BY GETTING ENOUGH TO EAT WHILE AVOIDING BEING EATEN (C)

Feeding relationships are often difficult to observe. In this activity, youngsters gain some understanding of these relationships by assuming the roles of animals, playing tag, and simulating feeding relationships. Popcorn is spread over a lawn area. The kernels of popcorn represent plants, (or detritus formed from plant material) which are food sources for the plant eaters. Some youngsters play worms (often plant eaters), some play fish (which eat worms), and some play man (who eats fish). The object of the game is for each animal to get something to eat without being eaten before the "day" (five minutes) is over. In nature, the populations of plants and animals are usually large enough to insure continuation of the species if some are lost. In this game, populations (plants, worms, fish, and man) are so small, that the survival of even one of each kind will be considered an indication of a "balanced," ongoing community. (See drawing of Marsh Food Web) You can repeat this game many times during one activity session. With each repeat encourage the youngsters to change rules of behavior and numbers of each kind of animal until a "balance" is achieved in your plant-worm-fish-man food chain. (manipulation, communication, science) (For complete details See "Food Chain Game," OBIS Trial Edition, Set II)

MARSH FOOD WEB



places to visit:

- 1 Fox Hill Pond, Jamestown
- 2 Ocean Drive Marsh, Newport
- 3 Norman Bird Sanctuary, Middletown
- 4 Emilie Ruecker Wildlife Refuge, Tiverton
- 5 Sachuest Refuge, Middletown
- 8 Seapowet Marsh, Tiverton
- 11 Marsh Meadows Wildlife Preserve, Conanicut Island

note:

Please note the typesetting error: Racoons should be spelled RACECONS in the Activity Book.

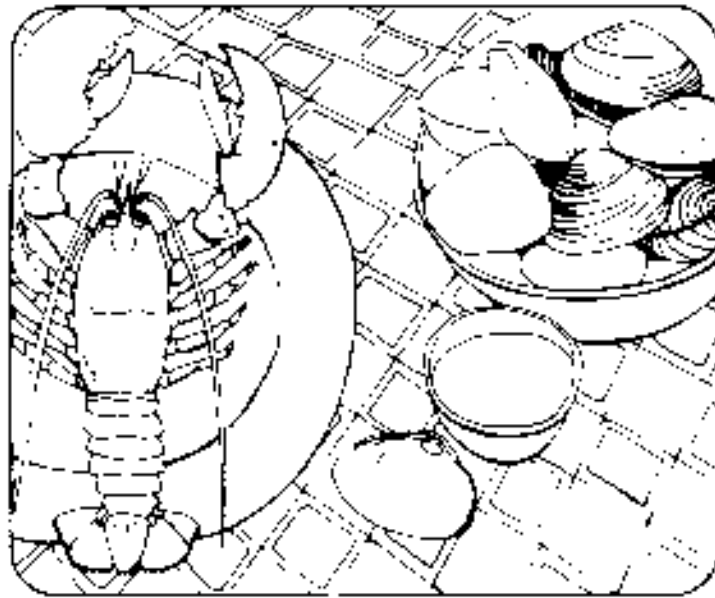
resources:

- 1 "THE NATURE OF A TIDAL MARSH"
Written by Carl N. Shuster, Jr. The New York State Conservationist,
August-September, 1966.

(An excellent discussion of the biology of a tidal or salt marsh with a color two-page insert of "The Life of a Tidal Marsh in Rhode Island.")

Individual copies may be ordered from Department of Environmental Conservation, 50 Wolf Road, Colonie, NY 12205.

III. USING OUR COAST



- 11 People like to eat clams too. They dig for steamers and quahogs at low tide. We can't have clambakes without clams!

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.

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

SHELLFISH Any of a variety of marine animals including clams, lobsters, crabs, snails, scallops, oysters, mussels, octopuses, squids, barnacles, and shrimp.

activity ideas:

- Plan a trip to a nearby seafood market in your town. Call first to find out when it is convenient for your class to visit. While there, take time to examine all kinds of seafoods (science, creative writing).

- *Observe the different kinds of mollusks--those with two part shells (bivalves like the oyster and clam), those with one spiral shell (like the conch), and those with no shell (like the squid). (See drawing of Rhode Island Shellfish)

- *Observe the differences between different species of crab (red crab, blue crab, jonaab crab)

- *How are the lobsters kept alive at the seafood market? Study the anatomy of the lobster. How do you tell the difference between a male and female lobster? (See drawing of lobster anatomy)

- *Write your own recipes describing ways to prepare the seafoods you have seen. Many cookbooks found in libraries and in your own kitchen provide good resources for pictures of seafoods and ideas for different ways to serve them.

● RHODE ISLAND INDIANS AND FOOD FROM THE SEA

Discuss the seafoods eaten by Indians living in Rhode Island during Colonial times. (history)

"The Indians hunted for deer and wolf with bow and arrow and with spear. They caught tautog (black-fish) and striped bass with bone hooks, nets, and weirs; they set snares for beaver and muskrat. They gathered clams, quahogs, oysters, and lobsters in the shallows, and cooked them over hot stones: the origin of the clambake. Evidence of Narragansett feasts can be seen today in the windrows of discarded shells along Apponaug (where he roasts oysters) Cove. The blue-black part of the quahog shell was used for wampum.¹² Perhaps the cove was also a Narragansett "mint."¹²



BAY QUAHOG



OCEAN QUAHOG



SURF CLAM



BAY SCALLOP



SOFT-SHELLED CLAM



CONCH



OYSTER

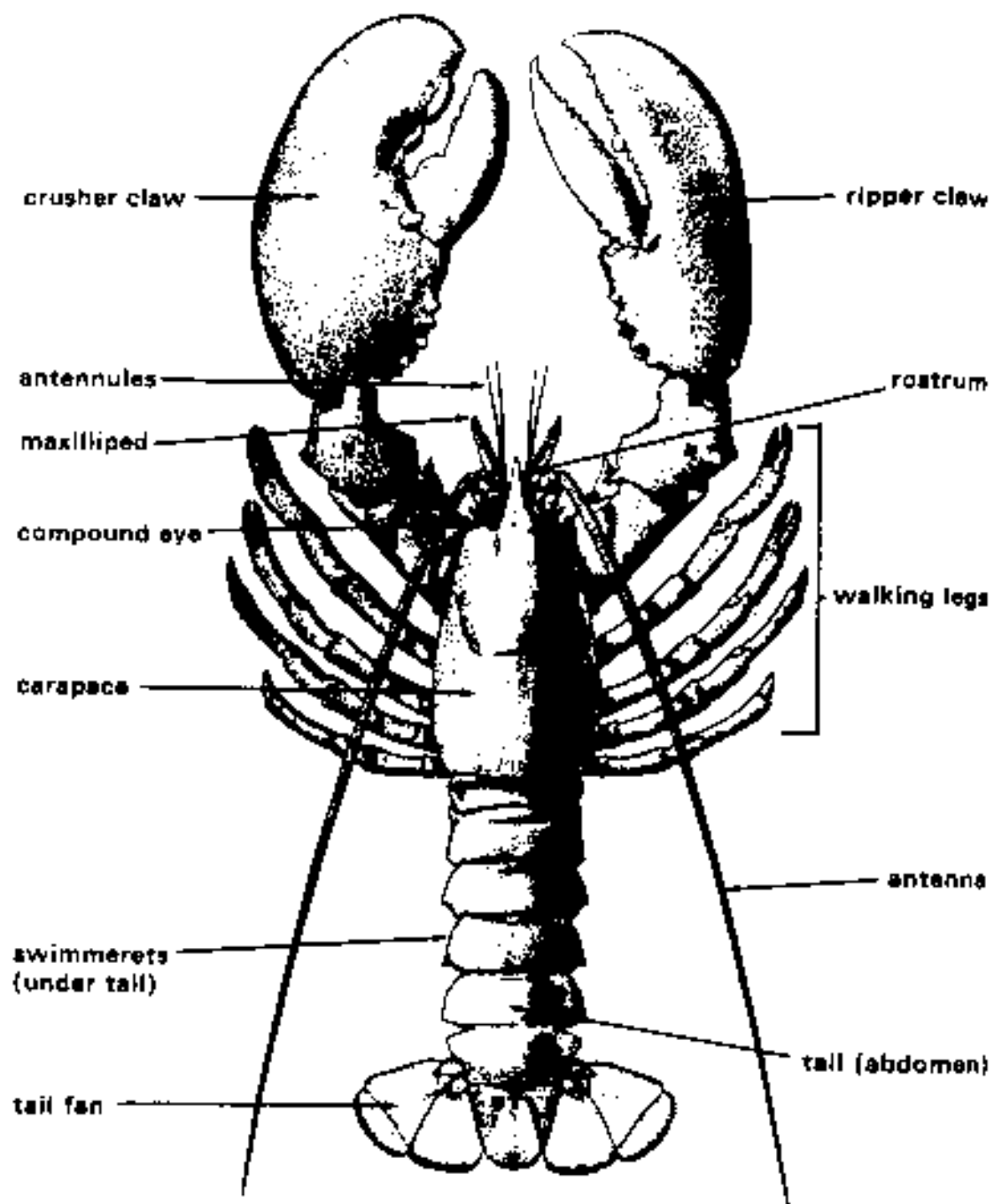


SEA SCALLOP



MUSSEL

RHODE ISLAND SHELLFISH



The American Lobster

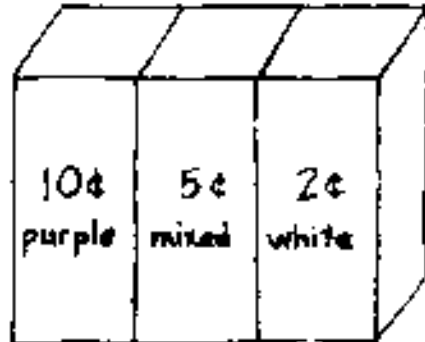
THE LOBSTER: ITS LIFE CYCLE by Herb Taylor,
© 1975 by Sterling Publishing Co., Inc., NY 10016

● WAMPUM: AMERICAN INDIAN BEACHCOMBERS (E)

Coastal Indians, before their domination by white man, used wampum (pieces of shells smoothed by the coastal elements) as a currency with which to trade for goods. To them, purple wampum was more valuable than white wampum. Wampum is easily found on area beaches. On a field trip the children may collect their own wampum. If this is not possible, the teacher may supply a collection. The procedure for earning and spending wampum must be determined by each teacher based on the program of his or her own class. This activity might become part of a reward system in a behavior modification program. (measuring, history, community studies) Perhaps the children could earn privileges in a manner such as this:

- Indian Research: Add a fact to the fact book-----5¢
- Read an Indian story on tape to share it-----2¢
- Write an Indian story based on what you have learned--5¢
- Make an Indian artifact to add to the museum-----10¢

1. Sort the wampum by color into 3 boxes.
2. Decide how much each color of wampum is worth.
3. Decide ways in which the children may earn wampum.
4. With the wampum children may buy: free project time, art materials, etc.



(3 milk cartons stapled together and covered with paper)

resources:

1 "CLAMBAKES: THE ULTIMATE COCKOUT"

Written by Bill Foster. Time-Life Series, Family Creative Workshop, Plenary Publications International, Inc., 1974, pp. 468-477.

(A colorful article describing how to prepare a clambake,)

2 CAUISING GUIDE TO HISTORIC RHODE ISLAND

Written by Neil Ross, Marine Advisory Service, University of Rhode Island, 1976 (see order form under Activity Book page 2 section).

3 THE AMERICAN LOBSTER: THE BIOLOGY OF HOMARUS AMERICANUS

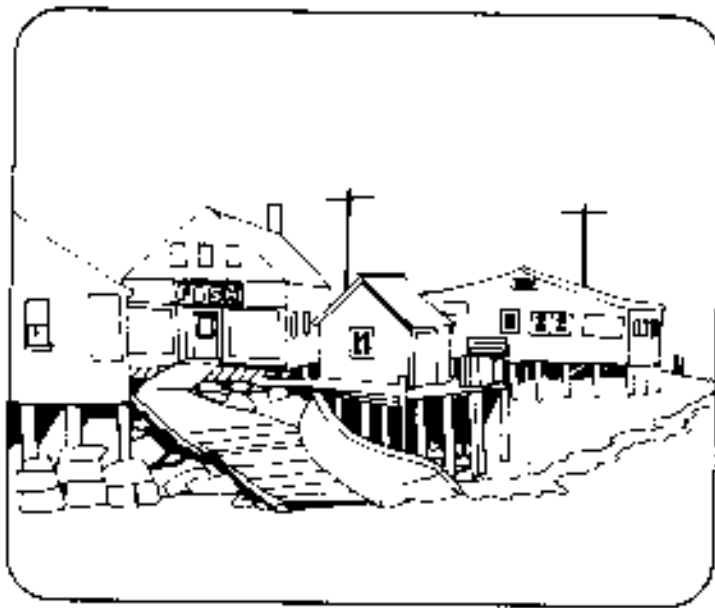
Written by J. Stanley Cobb. Marine Technical Report Number 49, Department of Zoology, University of Rhode Island, 1976. (\$2.00)

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882. (Please make check or money order payable to University of Rhode Island.)

4 THE LOBSTER: ITS LIFE CYCLE

Written by Herb Taylor. Sterling Publishing Company, Inc., New York, NY, 1975

(An excellent description of the life cycle of the lobster complete with illustrations and numerous color photographs--suitable for children in upper elementary.)



- 12 People also build houses, stores, and hotels along the shore. Sometimes they are built on stilts to keep them above the high water and big waves that come with storms.

HURRICANES AND BARRIER BEACHES

The barrier beaches are the first line of defense against the sea; they suffer the full force of ocean storms. In the past 350 years, every seven or eight years on the average, Rhode Island has been hit by a hurricane. Thirteen of these caused severe coastal flooding.

What can happen on the barriers is illustrated by the effects of the 1938 hurricane. At that time summer cottages and homes lined most of the south shore barrier beaches. When the hurricane struck in the late afternoon of September 21, 1938, the destruction was staggering. Hundreds of people were cut off from the mainland, and 48 people died on the barriers alone. During the height of the storm the combination of sustained high winds and low atmospheric pressure made sea level rise nine to twelve feet above normal, submerging the lower dunes. Waves swept over the barriers and across the ponds. Property damage on the barriers was over ten million dollars. All but the few barriers with high, well vegetated dunes were reduced to little more than sand spits.

In the years that followed, beachgrass became reestablished and the dunes began to rebuild. Within a decade people had begun to forget the storm; many houses were rebuilt where other had been washed away. When the next major storm struck in August, 1954, there was another crop of houses to be destroyed. This time the authorities had plans for evacuating people and only one life was lost on the south shore barrier beaches. Property damage was about six million dollars.

Today the number of houses on these same barriers is again increasing. Many of these houses are built where dunes should be, limiting the effectiveness of the barrier as a storm buffer. Experience should have taught us that barriers are best left in their natural state.¹

glossary:

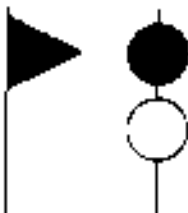
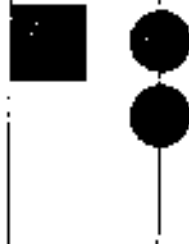

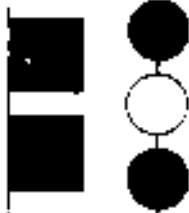
BREAKWATER A structure, usually of rock or concrete, designed to break the force of waves and protect a shore area, harbor, or beach. The groin, jetty, and sea wall are all forms of breakwaters.

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 equalling one nautical mile per hour (one nautical mile = 6,076 ft; 13 knots = 15 mph).

activity ideas:

- Make a list of the kinds of buildings you have seen built in shoreline areas. This list may include vacation houses, hotels, recreation buildings, bait shops, seafood markets, restaurants, ship chandleries, and boat builders and repair shops. Discuss how all of the structures are built to withstand the forces of waves, wind, and high water. Are some built on stilts? Do others have cement sea walls to protect them? How are they different from ordinary structures built inland? Is it sometimes better to not build in every area along the shore? Which types of natural areas are very important ecologically and are best left undisturbed? (community studies, science)
- When storms exist in areas near the ocean they affect the operation of ships at sea as well as people on land. Ships head for a protected harbor, and if the storm is severe enough, people who live and work on land near the sea begin to board up windows and evacuate low-lying areas. Standard warning display signals are described below:

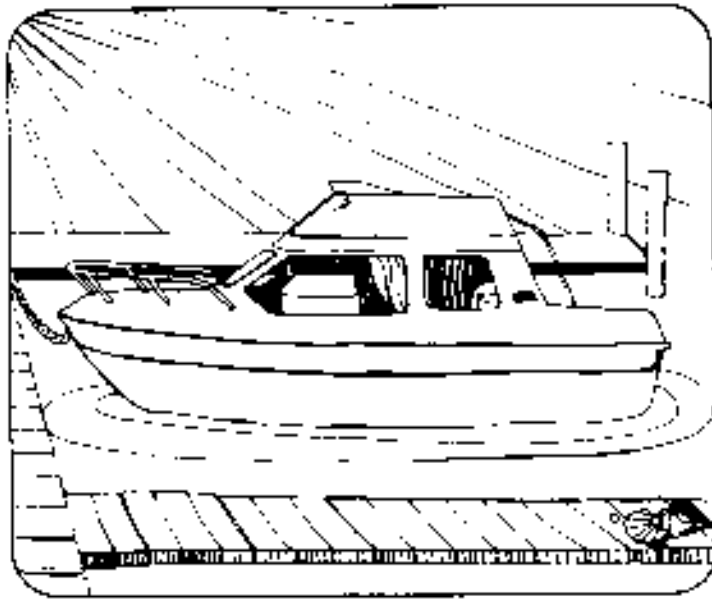
<p>SMALL CRAFT*</p> 	<p>DAYTIME: Red Pennant.</p> <p>NIGHTTIME: Red Light Over White Light.</p> <p>Indicates: Forecast winds as high as 33 knots and sea conditions considered dangerous to small-craft operations.</p>	<p>STORM</p> 	<p>DAYTIME: Square Red Flag With Black Square Centered.</p> <p>NIGHTTIME: Two Red Lights.</p> <p>Indicates: Forecast winds 48 knots and above no matter how high the wind speed. If the winds are associated with a tropical cyclone hurricane, storm warnings indicate forecast winds of 48-53 knots.</p>
<p>GALE</p> 	<p>DAYTIME: Two Red Pennants.</p> <p>NIGHTTIME: White Light Over Red Light.</p> <p>Indicates: Forecast winds in the range 14-47 knots.</p>	<p>HURRICANE</p> 	<p>DAYTIME: Two Square Red Flags With Black Squares Centered.</p> <p>NIGHTTIME: White Light Between Two Red Lights.</p> <p>Indicates: Forecast winds of 64 knots and above, displayed only in connection with a hurricane.</p>

- From red and black construction paper or fabric, construct small craft, gale, storm, and hurricane warning flags. Keep track of weather conditions and fly the appropriate flag in your classroom when storm conditions prevail. Consult your local newspaper weather column for information on wind speed and wave height on Narragansett Bay. Check with your local Coast Guard station for advice regarding other precautionary measures that should be taken in the event of severe storms. (reading, measuring, manipulation, science)

resources:

- 1 BARRIER BEACH POSTER/BROCHURE
Written by Stephen B. Olsen and John A. Jagschitz. Marine Bulletin Number 19, University of Rhode Island, Coastal Resources Center.
- 2 MARINE WEATHER SERVICES
Weather Bureau, U.S. Department of Commerce, Environmental Science Services Administration.

Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.



- 13 Rows of docks found in marinas along the coast are safe places for people to keep their pleasure boats.

glossary:

- DOCK** A structure to which a boat is tied or where passengers and gear are loaded or unloaded.
- HARBOR** A protected area of water where ships and boats are kept.
- MARINA** A waterfront facility serving recreational boaters, usually including docks, fuel, storage, repair services, boat and accessory sales, and other related services.

activity ideas:

- Have the youngsters imagine they are owners of a boat. (communication, drawing, creative writing) Ask them the following questions:

•What kind of boat is it? How long is it?
 (A rowboat, canoe, small sailboat--like a sunfish, speedboat, power cruiser, cruising sailboat) Draw a picture of the boat. Label the parts (bow, stern, mast, boom, engine, deck, keel, propeller)

•What would be the advantages of having one kind of boat over another?

Rowboat
 can go in shallow water
 uses "people" energy

Sailboat
 quiet
 uses wind energy

Power cruiser
 faster, goes backward
 goes when wind is calm

*How many feet or inches of water would your boat need so that its hull doesn't touch the bottom? (several inches for a rowboat, several feet for a sailboat with a keel)

*Where would you keep the boat when it is not being used? (tied to a dock at a marina, on a mooring, beached on the shore, on a trailer)

*If kept at a marina, what kind of services would you want provided by the marina? (electricity, showers, telephone, storage, repair, water, fuel)

*What items would you want aboard the boat? (oars, paddle, outboard engine, sails, radio, life jackets, water skis, navigation charts, compass, toilet, stove, anchor)

*Which of these items would help make for safe boating? Why?

- Visit a local marina (Labor Day to mid-October and winter to early spring are the least busy times for marina operators)

*Examine the docks. Why are some docks removed from the water in the winter?

If boats are kept in the water in the winter, have the marina operator explain how he keeps ice from freezing around the boats and damaging them. (science)

*If boats are stored at the marina, examine their bottoms. Why are so many painted with a red or blue paint? Explain how anti-fouling paint works. Try to find a boat with barnacles, like those found growing along rocky shores, growing on the bottom. If it is low tide examine the pilings supporting the docks. What forms of marine life do you see growing there? (science)

*Often in the winter, marinas attract ducks and geese. Bring along a bird book to help in identifying the various species. The youngsters may also enjoy feeding them stale bread crumbs.

resources:

1 BOATING IN RHODE ISLAND

Available from Rhode Island Department of Economic Development,
One Waybosset Hill, Providence, RI 02903.

(Outlines yachting and boating facilities in Rhode Island waters, including navigation charts listing, boating laws, and water safety tips.)

2 For further information on boating and boating safety, contact:

U.S. Coast Guard

U.S. Coast Guard Auxiliary

U.S. Power Squadrons

Department of Natural Resources, Division of Boating Safety

Red Cross Chapters



- 14 Commercial fishermen make their living in Narragansett Bay and the Sounds. They land their catches at Newport, Galilee, and other ports.

COMMERCIAL PORTS

Larger port facilities serving commercial fishing and ocean-going vessels occur in major embayments and estuaries along the coast. In most instances, port facilities require major alterations in the sea and river bottom for the development of deep water channels and harbor and turning basins. Port facilities commonly include piers, docks, dry docks, warehouses, storage tanks, fuel depots and processing or manufacturing industries. They are served by major access roads, railroads and trans-shipment staging areas. Because of their size and complex services, commercial ports use extensive shoreline acreage. (A)

glossary:

COMMERCIAL FISHERMAN A person whose occupation is to catch fish.

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

activity ideas:

● MARINE-RELATED OCCUPATIONS

Use the idea of being a commercial fisherman (one marine occupation that most children can relate to) to stimulate discussion of the wide variety of marine-related occupations.³

Ask the children to make a list of other marine-related occupations (they may know friends or relatives engaged in these kinds of occupations). In guiding them, remember that marine-related occupations cover a wide variety of fields. Scientific careers encompass oceanographers, biologists, technicians, meteorologists, and ecologists. Professional careers include government related jobs, the armed services (U.S. Coast Guard, Navy, Corps of Engineers), engineers, sea-food processors, and operators of other marine businesses. Technical careers may be found in building and boat repair, sales, maritime operations, and commercial fishing. (community studies, creative writing)

● FISHERKIDS GAME (E)

This activity uses both reading and math skills to explore fishing as an occupation. (reading, math, writing) Two or three children may play at a time.

1. Spin the dial to see how many spaces you can move.
2. Keep track of the number of pounds of fish you catch with each spin of the dial.
3. Choose a card when landing on the squares with the drawing of the fish.
4. The first fishing boat back to port wins the game.

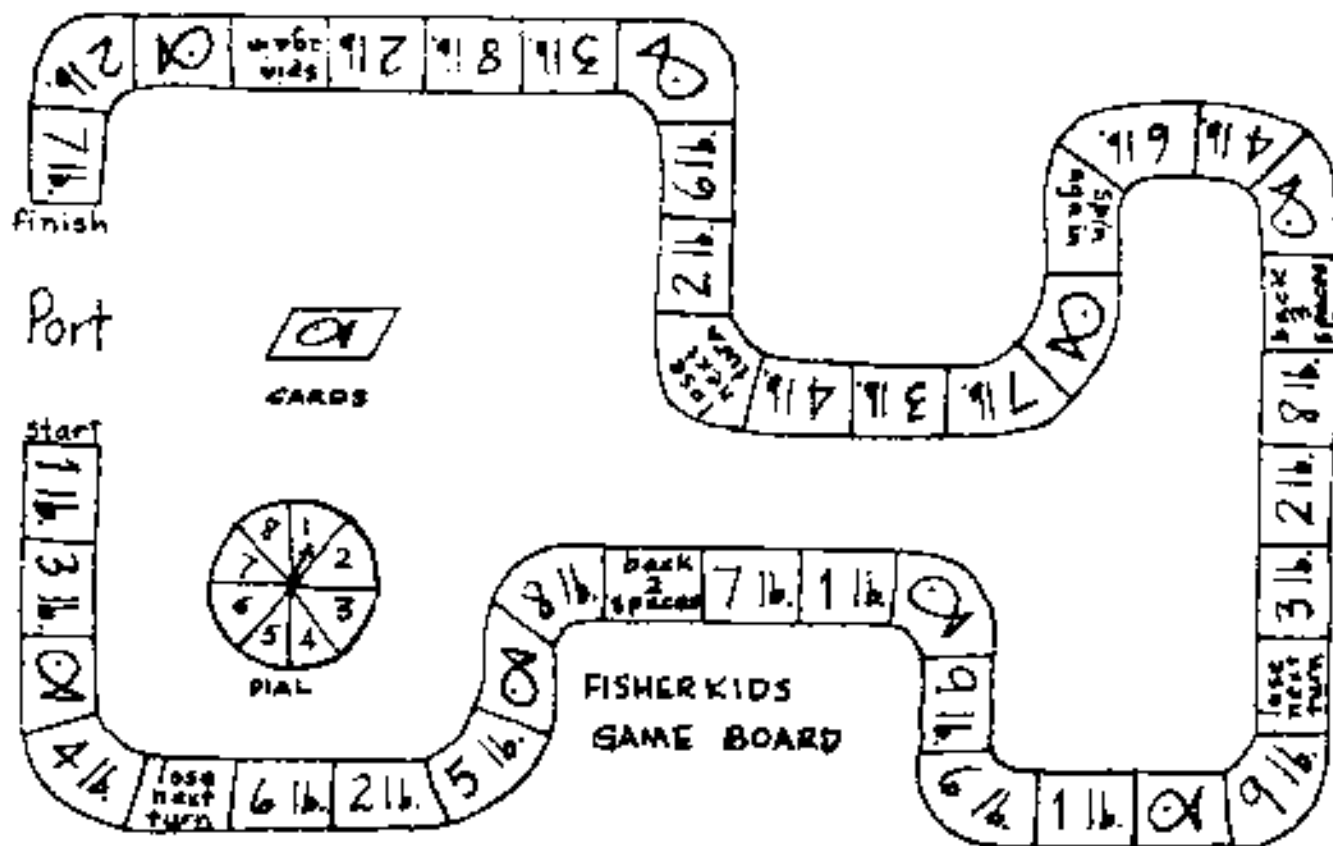
Design your own cards:

You have a hole in your net. Next 3 turns you catch only 1 pound each turn.

A storm causes you to get lost. Go backwards on your next turn.

If you have already caught 25 pounds of fish, go forward 10 spaces.

If you have less than 15 pounds, bad luck. Go back 3 spaces.



places to visit:

Mystic Seaport, Mystic, Connecticut
 New Bedford Whaling Museum, New Bedford, Massachusetts

resources:

- 1 COMMERCIAL MARINE FISHES AND FISHERIES IN RHODE ISLAND
 Written by Stephen B. Olsen and David K. Stevenson. Marine Technical Report Number 34, Coastal Resources Center, University of Rhode Island, 1975. (\$3.00)

Available from University of Rhode Island, Marine Advisory Service, Narragansett Bay Campus, Narragansett, RI 02882. (Please make check or money order payable to University of Rhode Island.)

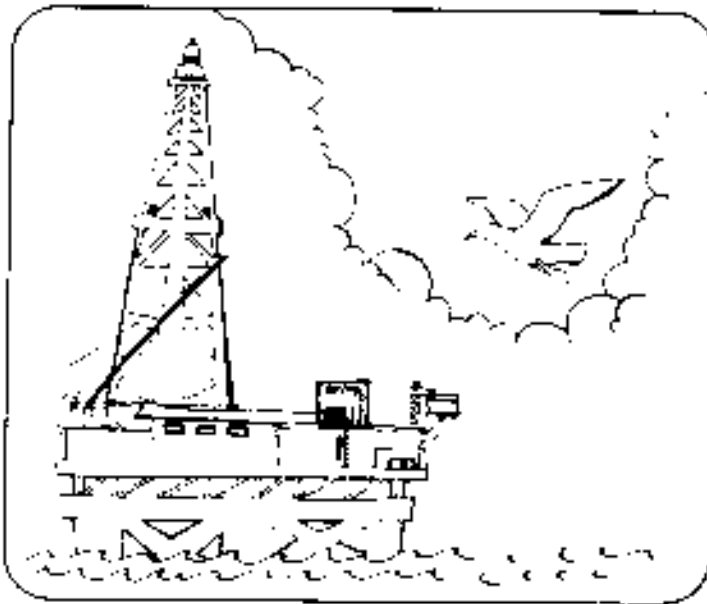
- 2 HIDE AND SEEK FOG
 Written by Alvin Tresselt. Illustrated by Roger Duvoisin. Lathrop, Lee, and Shepard, Co, Inc., New York, NY, 1965.

(A book about lobstermen, fishermen, and everyday people who live near the ocean and experience the coming and going of the fog.)

3 MARINE CAREER SERIES: MARINE-RELATED OCCUPATIONS, A PRIMER
FOR HIGH SCHOOL STUDENTS

Edited by Prentice K. Stout and Sara S. Callaghan, Marine
Memorandum Number 4T, Marine Advisory Service, University
of Rhode Island (Revised, Jan., 1977).

Available from University of Rhode Island, Marine Advisory Service,
Narragansett Bay Campus, Narragansett, Rhode Island, 02882.



15 Far out in the ocean, people are exploring for oil.

OFFSHORE EXPLORATION

If the U.S. is to minimize dependence on foreign energy sources, as much of our oil and gas as possible must come from domestic supplies. But it's increasingly more difficult to find oil and gas reserves on land.

That leaves the offshore areas, where the prospects for finding additional oil and gas deposits are quite encouraging. Geologists estimate the recoverable reserves of oil underlying our continental shelf may be more than the U.S. has consumed in its history. The outlook for natural gas also appears excellent, particularly along the East Coast.

The petroleum industry has turned seaward because it has had to. Today, as domestic reserves of oil and gas dwindle in relation to consumption, the offshore search is more urgent than ever. The new adventurers are embarked on a sea venture that can have far-reaching significance for our country and our people.

glossary:

OIL RIG A structure for well drilling and later for pumping oil from beneath the ocean floor to the surface. The oil, in turn, is transported to refineries on land where it is turned into commercial petroleum products.

activity ideas:

● ESTIMATE THE ENVIRONMENTAL IMPACT OF A SIMULATED OIL SPILL (C)

In these days of oil shortages and heightened environmental awareness, great efforts are being made to prevent oil spills. Yet, despite precautionary measures, oil spills from ships, offshore drilling operations, and pipe lines, in addition to natural seepage, will probably continue. As past spills have so tragically demonstrated, a major oil spill can take a devastating toll on wildlife.

In this activity, youngsters create a simulated oil spill with popcorn tossed onto the water and estimate the environmental impact of the artificial disaster. (You can substitute dry leaves, sawdust, or wood shavings for the popcorn.) The kids pretend to be environmental experts who have been rushed to the scene of an "oil spill" to estimate its impact.

The group is divided into buddy teams (pairs) and one or two buddy teams are assigned to each of the following impact areas: landscape, plant life, animal life, and human activities. The teams work on the assumption that anything the popcorn touches will be covered with oil. This activity follows well after the "Sea in Motion" activity for Page 3 of the Activity Book. (science, manipulation) (For complete details, see "OBIS Oil Spills," OBIS Trial Module, Set II)

resources:

1 THE HOW AND WHY OF UNDERSEA DRILLING

The American Petroleum Institute,
1801 K Street, N.W., Washington, D.C. 20006

2 THE NEW ADVENTURES

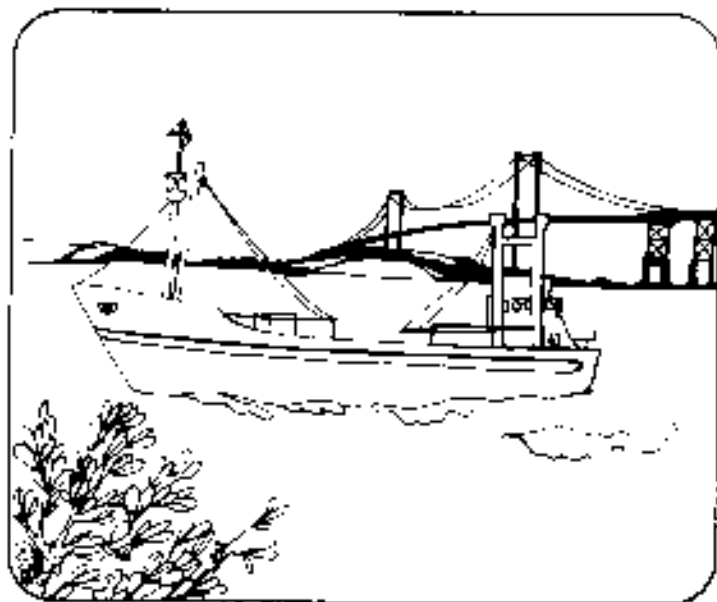
Why do they search for gas and oil offshore?
What are the risks they take?
Do they pollute our coastal waters?

Available from Standard Oil Company (New Jersey), 1251 Avenue of the Americas, New York, NY 10020

3 THE SEAL AND THE SLICK

Written by Don Freeman. Viking Press, New York, NY, 1970.

(A good book for reading to young children. It is well illustrated with watercolors, and has a soft-sell message about oil pollution.)



16

Cargo ships and tankers travel up and down the coast carrying oil and goods from all over the world to ports like Providence and Tiverton.

glossary:

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

CARGO SHIP A ship used for transporting packaged products like bales of cotton, automobiles, and bags of coffee beans.

activity ideas:

● SHIPBUILDING MATERIALS (E)

Materials:

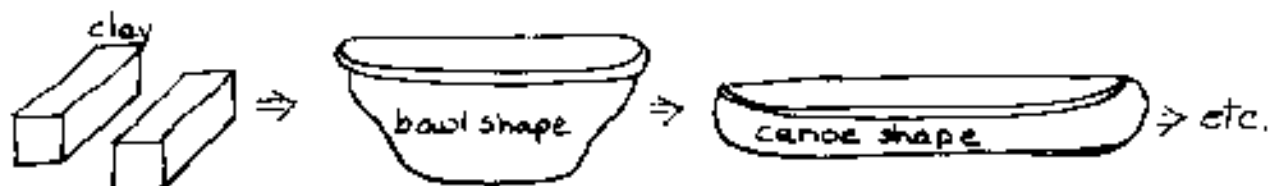
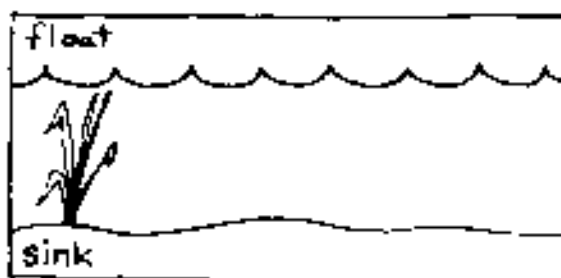
Balance or scale and 30cc plastic medicine cups
Oil-based clay and aluminum foil
Newspaper (to soak up the water)
Marbles or other sinkers of uniform weight

Procedure:

1. Introduce the clay and buckets of water to the children with instructions to make the clay float. Encourage them to analyze and record their successes and failures. This activity may be used in a learning center or as a group activity. In either case, children benefit from sharing each other's discoveries.

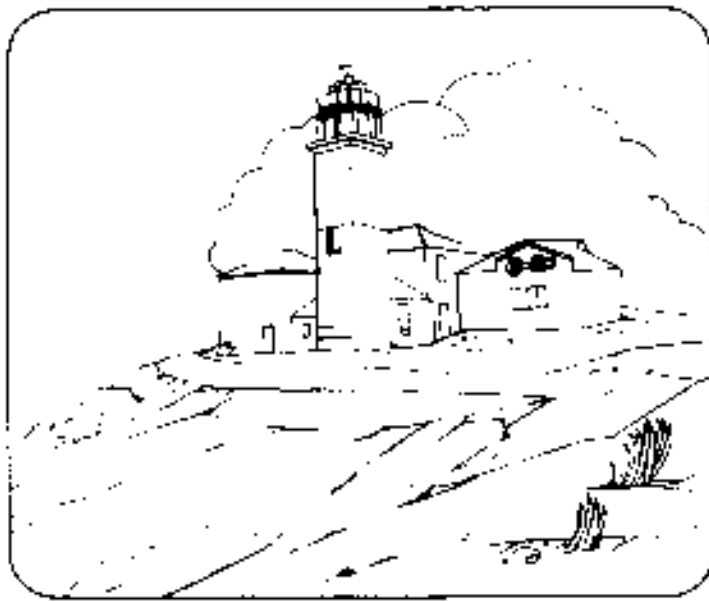
2. A class of 8 or 9 year old children began by making clay-shaped fish, whales, buoys, etc. This was a valuable part of their learning experience that led to discussions about real fish and other objects that float.
3. Encourage the children to experiment with a variety of objects from school or from home to see if they will float. List them or tape them where they belong.
4. Once the children have begun to make "bowl"-like shapes that float, have them experiment with uniform weights. How can you make your clay float with sinkers in it?
5. Have a simple balance available. Compare the weight of the boat to the weight of the maximum number of sinkers it will hold. Children may wish to save successful boats for a record of their work. When these boats are displayed together, similarities and differences can be observed, discussed and recorded. The children may wish to draw their boats. Is the clay thick or thin? Is the boat deep or shallow? Are the most successful boats wide at the bottom or narrow?
6. Now that the children have had a couple of sessions working with the clay, give them 30cc medicine cups to float next to their clay boats. Compare them. How many sinkers will they hold? CONCEPT: The material that the boat is made of will make a difference in its ability to float and the amount of cargo it can carry.
7. Give each child a 6" square of regular aluminum foil. Challenge them to make it float. Encourage individual charts, descriptions, stories, etc. as well as group experience stories. (measuring, manipulation)

SINK	FLOAT
rock	balloon
marble	cork



resources:

- 1 TEACHER'S GUIDE FOR CLAY BOATS
Webster Division, Mc Graw-Hill Book Company, New York, NY,
1969.



17

The ships are safely guided into Narragansett Bay by lighthouses at Point Judith and Beavertail Point.

glossary:

FRESNEL LENS (pronounced fray-NEL) A type of lens invented in 1821 by an obscure French physicist. The Fresnel lens is used today to light virtually every lighthouse in the world.³

LIGHTHOUSE A tower with a powerful light at the top, which guides navigators at night.

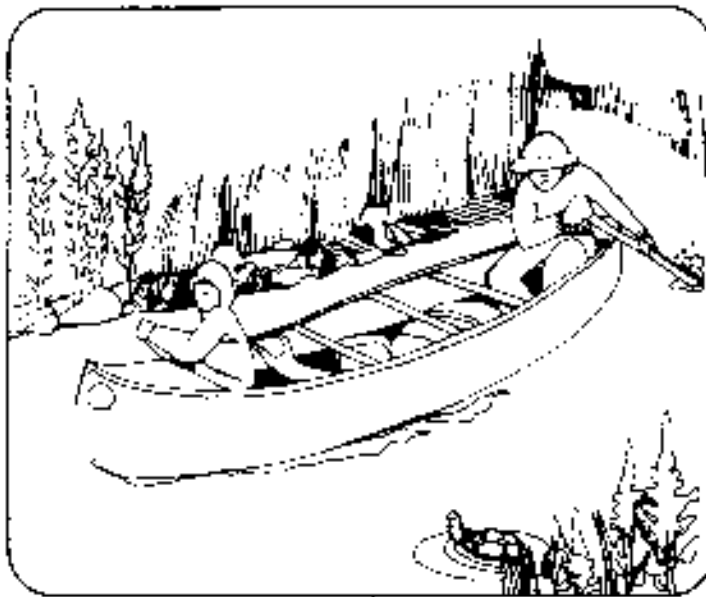
places to visit:

- 9 Beavertail, Conanicut Island
U.S. Coast Guard Station, Point Judith
U.S. Coast Guard Station, Castle Hill
U.S. Coast Guard Light Station, Watch Hill

resources:

- 1 "BEACONS OF THE SEA: A HISTORY OF LIGHTHOUSES"
Written by John Bunker, Oceans Magazine, No. 5, 1971. pp. 11-23.

- 2 THE LITTLE RED LIGHTHOUSE AND THE GREAT BRIDGE
Written by Swift and Ward, Harcourt, Brace, and World, Inc.,
1942.
- 3 "THE UNKNOWN TALE OF HOW 'FRESNEL'S' FANCIES LIT THE LIGHTHOUSES
OF THE WORLD"
Written by Lindy Lindquist. Oceans Magazine, November, 1975,
pages 58-63.



18

The coast is also a place for people to play. Canoeing, fishing, and bird-watching are favorite pastimes of many Rhode Islanders.

activity ideas:

● BEACH MURAL (E)

Materials:

The children must help to determine the materials to be used in this project. The list might well begin with:

paste	scissors
paper	sand
paint	glue

Procedure:

If the children are familiar with the processes of choosing a group leader and making group decisions, it may not be necessary for the teacher to do any of the actual organizing. If the children are not familiar with the group process, they will need to be guided through it the first few times. A valuable part of learning to make group decisions is making mistakes and correcting them, so don't be too anxious to impose teacher direction. There is no absolute method or process.

A mural of a beach can be just about anything the children want it to be. They may wish to emphasize the wildlife at the seashore or activities of people canoeing, swimming, picnicking, flying kites, building sand castles, collecting objects, etc.,

or they may wish to show the barrier beach and tidal marsh behind it. The list of possibilities is endless.

This activity is likely to be most successful when the children have already been exposed to the concepts covered previously in this book. (manipulation, painting, drawing, communication)

● MOBILE (E)

The skills that children can develop while making mobiles are numerous. They observe, predict, make and test hypotheses, manipulate, and communicate. The children may choose a theme for their mobiles such as life in the tidal marsh, or make a more generalized "beach mobile." Given a degree of independence, children will generally adjust the degree of difficulty of their work to their abilities, interests, and attention span.

Materials:

Twigs or stiff wire

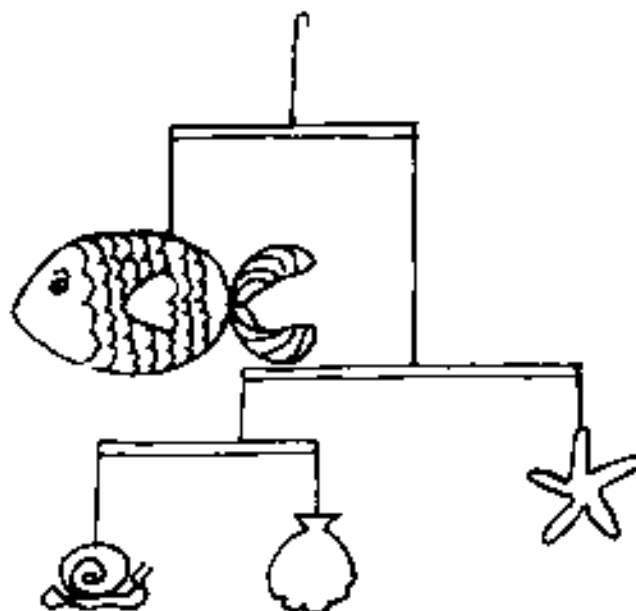
String, yarn, or nylon fishing line

Opened paper clips or Christmas tree ornament hangers

Objects collected from the beach or cardboard, paint, and scissors for making their own objects.

Procedure:

Introduce the concepts of balance and movement of the mobile to the children. Demonstrate the basic principles of construction and help the children decide on a theme or topic for the mobile. This project works best when two or three children work as a team. This serves as a good atmosphere for verbal interaction too. (measuring, communication, manipulation)



- When discussing pages 18 and 19 of the Activity Book, compare the different types of recreational activities seen on the two pages. (communication, creative writing)

*What are the seasons shown in each picture (fall or spring vs. summer)? Note the different types of clothing being worn by the people in the pictures.

*What kinds of sounds would the people be hearing (a canoe gliding quietly over a tidal creek with sounds of birds and insects in the background vs. waves crashing on the shore and sounds of children playing)?

*Note the different kinds of boats seen in the two pictures. (canoe vs. sailboat)

*List other forms of recreation one might do near the shore. Write a story about experiences you have had at the shore.

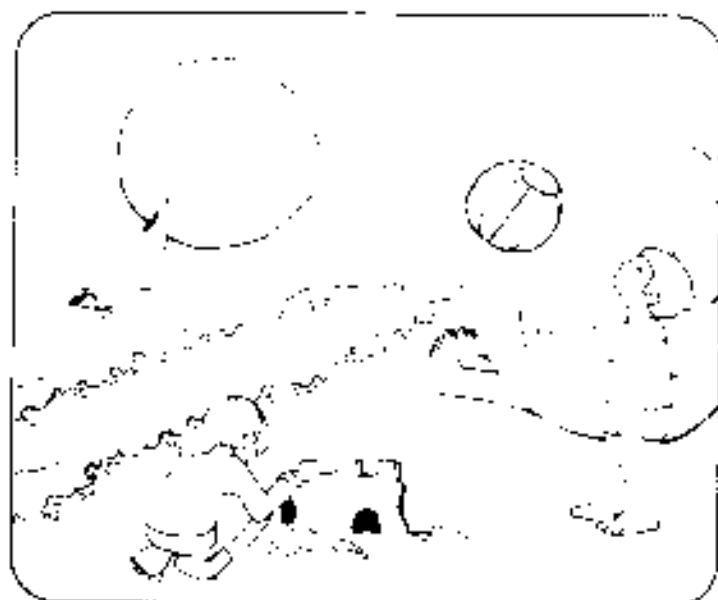
- Introduce a discussion summarizing all the different uses of the coast. Emphasize how some uses of the coast are conflicting with other uses.

Examples of conflicting uses of the coast include:

sport fishing vs. commercial fishing
dredging vs. shellfishing
ocean dumping vs. commercial fishing
wildlife sanctuary vs. housing development
cheap energy vs. pollution controls

resources:

- 1. TEACHERS GUIDE FOR MOBILES: EXPERIMENTS WITH BALANCE AND MAKING CONSTRUCTIONS
Webster Division, McGraw-Hill Book Company, New York, NY, 1966.

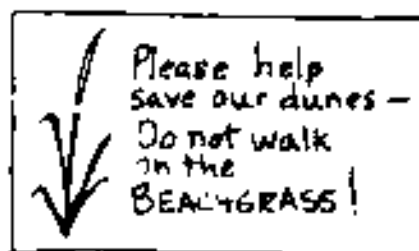


- 19 Everyone likes to swim, sunbathe, and picnic at the beach. What happens to our coast and its many resources is important to every Rhode Islander. We must all work to help protect and preserve our coast and our ocean.

activity ideas:

● POSTERS: PRESERVING THE COASTAL ENVIRONMENT (E)

Ask the children to suggest ways in which they might share what they have learned about the need to preserve the coastal environment with other children in their school. Among the topics which might be covered are the preservation of sand dunes and beachgrass, water pollution and its effects on coastal and tidal marsh life, and littering. Though the children may find other valuable projects to pursue, one possible activity is for the children to make posters and to invite other teachers in the building to display them. Some of the more verbal, confident children may enjoy introducing the concepts of coastal management depicted in his poster to the children in the class where the poster is being displayed. Generally speaking, the fewer the number of words on the poster, the more effective its message will be. Crayon, paint, cut and paste, collage, or any other combination of these may be used. (manipulation, painting, drawing, community studies)



SUMMARY

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activity ideas:

Use page 20 of the Activity Book with the picture of the fiddler crab to allow the children to write their own stories or express their own ideas about Rhode Island's coast. (creative writing)
Emphasize the three topics covered in the Teacher's Guide:

- I. *Rhode Island's Coast*
- II. *Coastal Resources*
- III. *Using Our Coast*

CROSSWORD PUZZLE

The crossword puzzle uses many of the words found in the glossary throughout the Teacher's Guide. (vocabulary, spelling, reading)
Use the DOWN and ACROSS sentences provided or write your own to fit the capabilities of your class. The answers are found on the following page.

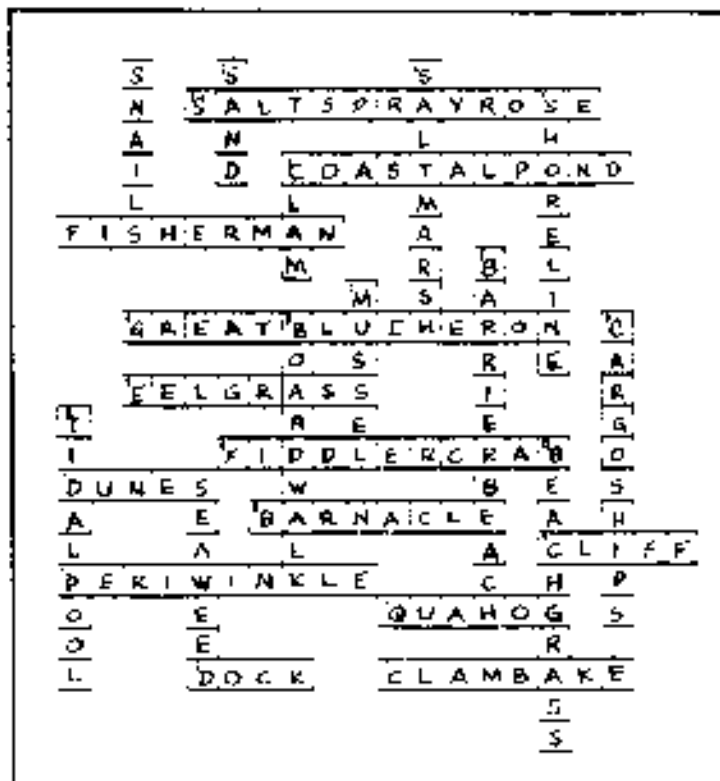
CROSSWORD PUZZLE ANSWERS

ACROSS

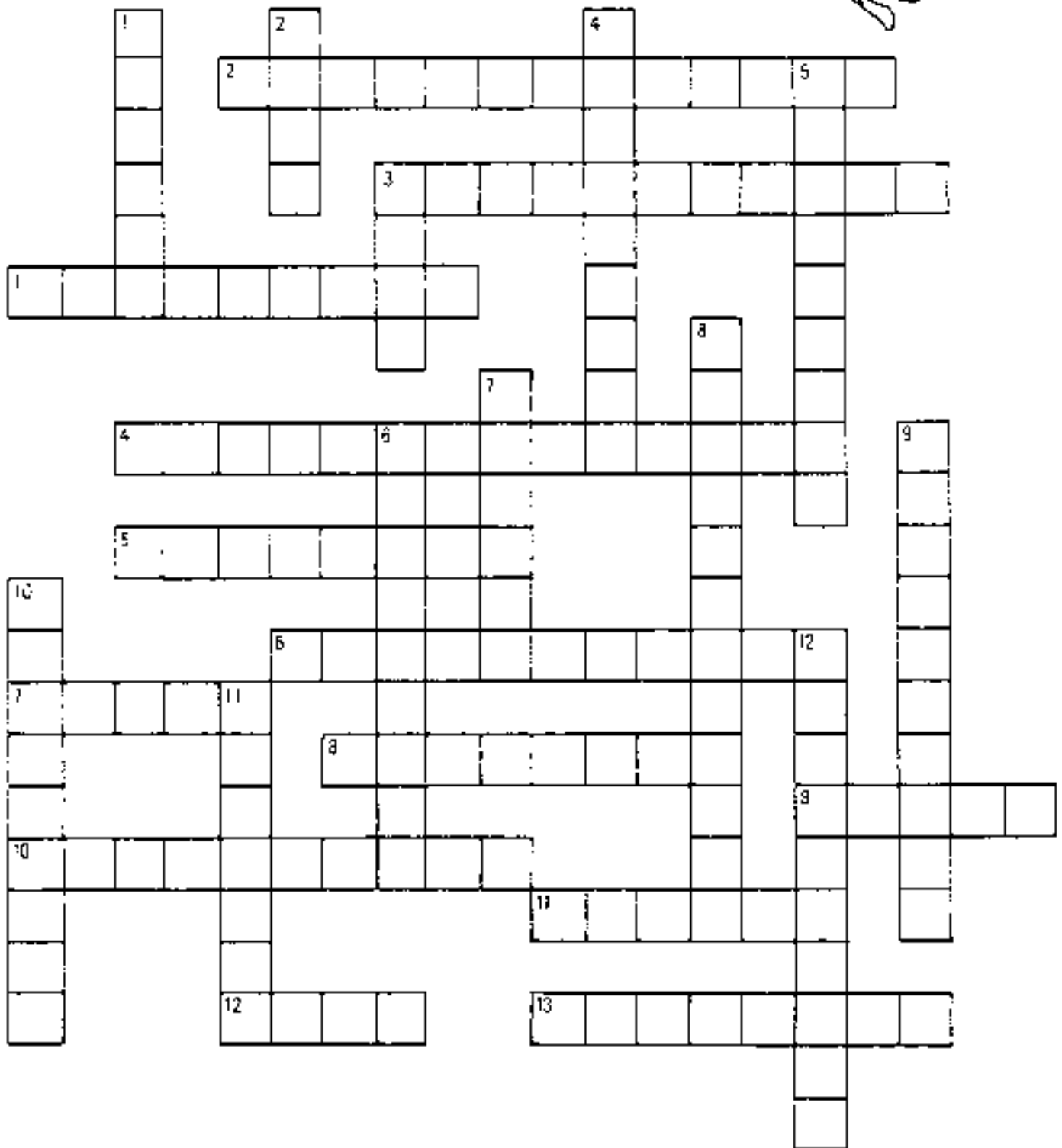
- 1 FISHERMAN
- 2 SALT SPRAY ROSE
- 3 COASTAL POND
- 4 GREAT BLUE HERON
- 5 EELGRASS
- 6 FIDDLER CRAB
- 7 DUNES
- 8 BARNACLE
- 9 CLIFF
- 10 PERIWINKLE
- 11 QUAHOG
- 12 DOCK
- 13 CLAMBAKE

DOWN

- 1 SNAILS
- 2 SAND
- 3 CLAM
- 4 SALT MARSH
- 5 SHORELINE
- 6 BOARDWALK
- 7 MUSSEL
- 8 BARRIER BEACH
- 9 CARGO SHIP
- 10 TIDAL POOL
- 11 SEAWEED
- 12 BEACHGRASS



COASTAL RESOURCES CROSSWORD PUZZLE



CROSSWORD PUZZLE

ACROSS

1. A person whose occupation is to catch fish is a commercial _____.
2. Rose hips are the fruits of the _____.
3. A _____ complex is made up of a barrier beach, sand dunes, marsh and pond.
4. The _____ is a large gray-blue wading bird.
5. A marine grass that grows on sandy bottoms in shallow coastal waters is called _____.
6. A _____ lives in burrows and is found all along the shore.
7. Sand _____ are hills or ridges of sand that are piled up by the wind.
8. A cone-shaped marine animal often found on rocks, pilings, and ships' bottoms is called a _____.
9. A rocky _____ is an area along the shore where birds often build their nests.
10. A type of small snail that grows in thick masses on the rocks along the shore is called a _____.
11. A _____ is a hard-shelled clam.
12. A _____ is where people tie up their boats.
13. Lobsters, clams, fish, potatoes, and corn on the cob are all part of a New England _____.

DOWN

1. Small animals with spiral-shaped shells are called _____.
2. _____ is a mixture of tiny grains of different types of rock and shell found along beaches.
3. A quahog is a type of _____.
4. Raccoons and other small animals often come to the _____ to find food.
5. The land and the sea meet at the _____.
6. By walking on a _____ instead of the beachgrass, we can help save the sand dunes.
7. A dark-colored bivalve mollusk that attaches to rocks by secreted threads is called a _____.
8. A _____ is a type of beach that is parallel to the shore, but separated from the mainland by a small body of water.
9. A ship used for transporting packaged products like bales of cotton and bags of coffee beans is called a _____.
10. Plants and animals that can withstand highly variable moisture, salinity, and temperature conditions as well as high winds and pounding waves are often found living in a _____.
11. A plant like kelp that lives in the sea is called _____.
12. _____ helps to anchor and build the dunes with its network of underground roots and stems.