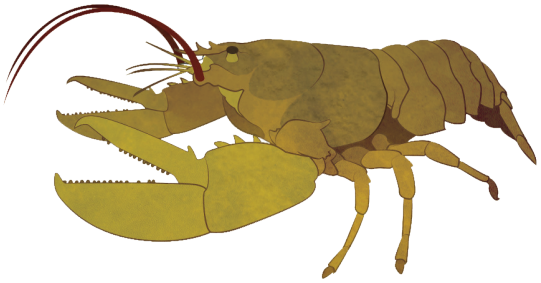
ROCKY SHORE

MARINE SCIENCE CURRICULUM

CONTENTS



ACKNOWLEDGMENTS

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This body of work was created by Thom R. Smith, a Kearsarge Regional Elementary School teacher and recipient of the 2016 Christa McAuliffe Sabbatical from the New Hampshire Charitable Foundation. The sabbatical, created in 1986 in honor of the Concord High School teacher and astronaut and administered by the Foundation, gives an exemplary New Hampshire teacher a year off with pay and a materials budget to bring a great educational idea to fruition.

Christa McAuliffe

Christa McAuliffe's inspiring life as a devoted, enthusiastic educator has been a major encouragement to me and schoolteachers all over the world. She was an outspoken advocate for the teaching profession, and even more importantly, a highly-esteemed role model to her students and colleagues. This project is dedicated to her memory.

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Mark Wiley has been instrumental in assisting with the necessary revisions of this work. He put in a tremendous amount of time and effort in examining each and every aspect of this curriculum, and provided his invaluable marine expertise to ensure this work is factual and useful for educators and students alike.

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Kate Leavitt, Sarah Toupin, and the Seacoast Science Center have been extremely influential in the formation and promotion of this curriculum. Their collaboration and resources have played a major role in the successful production of this work.

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Adam Kelley has created magnificent works for several prestigious institutions such as the Georgia Aquarium, the Connecticut Science Center, the Smithsonian, the Perot Museum, the Franklin Institute, and McGraw-Hill. He designed the cover illustration and four internal illustrations.

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The bulk of this curriculum was created in the gorgeous setting of the MainStreet MarketPlace and Gallery located in the MainStreet BookEnds of Warner bookstore. Many thanks to owner Katharine Nevins for her continued encouragement and kindness.

INTRODUCTION

The Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators

The Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators was created to provide elementary teachers and their students a comprehensive, standards-based science unit. This unit is a free, quality resource on the rocky shore ecosystem. Ecosystems are valuable life science topics taught throughout the world because of the unique interactions that occur between their organisms and physical environments, as well as the importance of maintaining the health of each ecosystem.

Studying ecosystems provides students with the opportunity to explore many important biological and ecological concepts such as interdependence, competition, adaptation, community, conservation, watersheds, short term & long term changes, invasive species and predator-prey relationships.

This curriculum is a user-friendly, professional course of study that incorporates the Next Generation Science Standards (NGSS) and the Ocean Literacy Principles (OLPs) and extensively covers the multitude of characteristics of the rocky shore, particularly the Atlantic rocky shore. It provides educators and students with a variety of educational, cross-curricular lessons that can be completed in sequence or individually.

This ecosystem unit is comprised of unit overview and schedule charts, an Atlantic rocky shore guide, Atlantic rocky shore fact sheets, and twenty-four lessons—including a summative assessment and a preparatory lesson for visiting the rocky shore. Each lesson includes the following:

- ★ Focus Question
- ★ Objectives
- ★ Materials List
- ★ Teacher Preparation List
- ★ Science Background for Teachers
- ★ Step-by-Step Procedure for Teachers
- ★ Next Generation Science Standards Alignment
- ★ Ocean Literacy Principles Alignment
- ★ Teacher Tips
- ★ Extension Suggestions
- ★ Literary Resources
- ★ Website Resources
- ★ Scientist Notebook Suggestions

. . . and more!

This beneficial curriculum was developed by the collaborative efforts of The University of New Hampshire Cooperative Extension/NH Sea Grant, The Seacoast Science Center, The New England Aquarium, Hobblebush Design, The New Hampshire Charitable Foundation, illustrator Adam Kelley and educator Thom R. Smith.

For more information, visit ENGAGEYOURSTUDENTS.ORG
or email ENGAGEYOURSTUDENTS@GMAIL.COM.

ROCKY SHORE MARINE SCIENCE CURRICULUM

Unit Schedule

	Day One	Day Two	Day Three	Day Four	Day Five
Week One	1. Toss the Blue Planet	2. Build Your Own Watershed	3. Introduction to the Rocky Shore	4. Rocky Shore Waves	4. Rocky Shore Waves
Week Two	5. The Ocean's Tides	6. Taking the Rocky Shore's Temperature	7. Create-a-Critter, Part One	7. Create-a-Critter, Part One	8. The Splash Zone
Week Three	8 The Splash Zone	9. Hungry Birds	10. The Upper Intertidal Zone	10. The Upper Intertidal Zone	11. Tide Pool Painting
Week Four	11. Tide Pool Painting	12. The Middle Intertidal Zone	12. The Middle Intertidal Zone	13. Hide and Seek	13. Hide and Seek
Week Five	14. The Lower Intertidal Zone	14. The Lower Intertidal Zone	15. Survive the Shore	16. The Subtidal Zone	16. The Subtidal Zone
Week Six	17. The Four Traits of Fish	18. The Wandering Plankton	19. Create-a-Critter, Part Two	19. Create-a-Critter, Part Two	20. Rocky Shore Algae
Week Seven	21. Rocky Shore Scoot	22. Marine Conservation	22. Marine Conservation	23. Rocky Shore Ecosystem Assessment	24. Explore the Shore (optional)

ROCKY SHORE MARINE SCIENCE CURRICULUM

Unit Overview

Lesson	Topic	Duration	Next Generation Science Standards	Ocean Literacy Principles	Focus Question	Cross-Curricular Connections*
1. Toss the Blue Planet	Ocean Size and Importance	1 Session	2-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.	OLP 1, OLP 2	How much of the Earth's crust is covered by the ocean?	Math, Social Studies, Physical Education, Writing
2. Build Your Own Watershed	Watersheds and Watershed Conservation	1 Session	2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.	OLP 1, OLP 2	What is a watershed?	Social Studies, Conservation, Engineering, Physical Education
3. Introduction to the Rocky Shore	Rocky Shore Identification	1 Session	2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.	OLP 5	What is a rocky shore?	Reading, Technology
4. Rocky Shore Waves	Waves and Change	2 Sessions	2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.	OLP 1, OLP 2	What impact do waves have on rocky shore communities?	Engineering
5. The Ocean's Tides	Tides and Change	1 Session	3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	OLP 1, OLP 2	What are the tides?	Physical Education, Math, Technology
6. Taking the Rocky Shore's Temperature	Land and Water Temperature Changes	1 Session	3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	OLP 1, OLP 3	Why is the temperature of the land and water different at the rocky shore?	Math
7. Create-a-Critter, Part One	Adaptations and Change	2 Sessions	4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	OLP 5	What is an adaptation?	Engineering, Writing
8. The Splash Zone	Zonation and Adaptation	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 5	What is the splash zone?	Art, Reading, Writing

** Cross-curricular connections include lesson extension suggestions. Extra time will need to be allotted to fit in lesson extension suggestions.*

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Unit Overview

Lesson	Topic	Duration	Next Generation Science Standards	Ocean Literacy Principles	Focus Question	Cross-Curricular Connections*
9. Hungry Birds	Shorebirds, Adaptations	1 Session	4-LS1-1. Construct an argument with evidence that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	OLP 5	Why do shorebirds have beaks that are shaped differently?	Physical Education
10. The Upper Intertidal Zone	Zonation, Adaptations	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 5	What is the upper intertidal zone?	Reading, Art
11. Tide Pool Painting	Tide Pool, Adaptations	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 2, OLP 5	What is a tide pool?	Math, Art
12. The Middle Intertidal Zone	Zonation, Adaptations	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 5	What is the middle intertidal zone?	Reading, Art
13. Hide and Seek	Camouflage, Adaptations	2 Sessions	3-LS4-2.Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.	OLP 5	What types of camouflage do ocean animals have that help them survive?	Writing, Art
14. The Lower Intertidal Zone	Zonation, Adaptations	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 5	What is the lower intertidal zone?	Writing, Art
15. Survive the Shore	Rocky Shore Crabs, Adaptations	1 Session	1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.	OLP 5	How do a crab's adaptations help it survive?	Physical Education, Music
16. The Subtidal Zone	Zonation, Adaptations	2 Sessions	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 5	What is the subtidal zone?	Writing, Art

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Unit Overview

Lesson	Topic	Duration	Next Generation Science Standards	Ocean Literacy Principles	Focus Question	Cross-Curricular Connections*
17. The Four Traits of Fish	Fish, Traits	1 Session	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.	OLP 5	What is a fish?	Math
18. The Wandering Plankton	Plankton, Marine Food Web	1 Session	5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.	OLP 3, OLP 4, OLP 5, OLP 6	Why is plankton important?	Art
19. Create-a-Critter, Part Two	The Engineering Design Process, Adaptations	2 Sessions	4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	OLP 5	What is the engineering design process?	Engineering
20. Rocky Shore Algae	Algae, Plants	1 Session	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.	OLP 5, OLP 6	What is the difference between algae and plants?	Physical Education
21. Rocky Shore Scoot	Rocky Shore Ecosystem	1 Session	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	OLP 1, OLP 2, OLP 3, OLP 4, OLP 5, OLP 6	What rocky shore facts do I know?	Physical Education
22. Marine Conservation	Marine Conservation, Recycling	2 Sessions	5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	OLP 1, OLP 4, OLP 6, OLP 7	What is marine conservation?	Conservation, Physical Education
23. Rocky Shore Ecosystem Assessment	Rocky Shore Ecosystem	1 Session	N/A	OLP 1, OLP 2, OLP 3, OLP 4, OLP 5, OLP 6	What have I learned about the rocky shore ecosystem?	N/A
24. Explore the Shore	Planning a Visit to the Rocky Shore	1 Session	5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	OLP 1, OLP 5, OLP 6, OLP 7	How can I be prepared to visit the rocky shore?	Technology, Music, Writing

** Cross-curricular connections include lesson extension suggestions. Extra time will need to be allotted to fit in lesson extension suggestions.*

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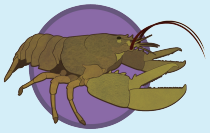
Unit Components

Component	Location	Description
Field Guide Research Project	Lesson 8	Students participate in a research project by creating a classroom field guide during reading or writing sessions. Use the **Student Field Guide** sheets (pages 75–76) for students to record or type their research. When finished, bind and laminate and bring along on a rocky shore field trip (if possible).
Rocky Shore Reading Challenge	Lesson 10	Students participate in a classroom "Rocky Shore Reading Challenge!" Each student is given a Rocky Shore Challenge Reading List (page 92) to fill out as they read either at home or at school (or both) and a My Rocky Shore Creatures template (page 93). Once students read 100 chapters (or 100 books) they have completed the Rocky Shore Reading Challenge!
Math Activities	Lesson 11	Students participate in "Tide Pool Math" activities created by the Bureau of Ocean Energy Management.
Reading Partners	Lesson 12	Students participate in a daily leveled reading activity called "Ocean Partners." Teachers create partner book packets using mailing envelopes and developmentally appropriate books on ocean topics. The book packet should contain two books and any materials your students may need for book activities. Have student partners take turns reading the book aloud for fluency development.
Writing Project	Lesson 16	Students research an ocean animal and write a story about the animal. Use Suzanne Tate's stories, along with Nancy Donovan's story *Oscar the Herring Gull* as examples. Consider using the template provided (pages 152–158) to help students format their story.
Homework/ Assessment Project	Lesson 23	Students participate in an activity that enables them to demonstrate the knowledge they have gained from the rocky shore ecosystem unit in an alternative way to a paper and pencil assessment.

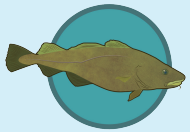
Sidebar Key



Teacher Tips
Advice on how to potentially improve various aspects of a lesson.

Extension Suggestions
Additional lessons or activities that complement a particular topic.

Books
Valuable literary options that connect to the lesson's topic.



Websites
Online tools, particularly brief videos, which connect to the lesson's topic.

Scientist Notebook
Possible science notebook entries to reinforce lesson content knowledge.

MATERIALS LIST

Lesson 1

- One inflatable globe
- Chart (page 31)
- Clipboards or hard surface

Lesson 2

Per Group:

- Large plastic container such as a dish pan
- Old newspapers or scrap paper
- Kitchen-size trash bag
- Pair of scissors
- Spray bottle full of blue-colored water (preferably dyed blue)
- Glitter or construction paper
- Copy of activity sheet (page 35) for each group member

Other:

- Blue food coloring
- Model of watershed

Lesson 3

- Print outs of four rocky shore photographs (pages 40–43)
- Scientist notebooks (if used in class)
- Poster paper/paper for groups to record their observations

Lesson 4

Per group:

- A photo of the rocky shore (from pages 40–43)
- Large plastic container such as a dish pan
- Four cups of different-sized sediment (fine sand, course sand, gravel, and large rocks)
- Pitcher of water
- Popsicle stick or plastic spoon to make waves
- Scientist notebooks (if used in class)
- Copies of activity sheet (page 51) for each student

Lesson 5

- Two "markers" for each student to stand on (i.e. carpet square, Poly Spot)
- Scientist notebooks (if used in class)

Lesson 6

Per group:

- Two aluminum foil pie pans
- Two thermometers
- One flood lamp (high watt bulb)
- One clock or stopwatch
- Sand and water
- Activity sheet per student

Lesson 7

- Rocky Shore Ecosystem Challenges activity sheet, page 60 (one per student)
- Create-A-Critter Design activity sheet, page 61 (one per student)
- 5 index cards per student
- Scissors (one per student)
- Transparent adhesive tape / tape dispensers (one per group)

Lesson 8

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, page 73)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 74)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 18)
- A large bulletin board or blank wall
- White bulletin board art paper
- White paper/index cards for each student
- Coloring utensils for each student

Lesson 8 (continued)

- Scissors for each student
- Stapler (for teacher)
- Rocky Shore Zones Table (one per student, page 73)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 74)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 18)
- Coloring utensils for each student

Lesson 9

- Herring Gull Photo Page and Spotted Sandpiper Photo Page (one per group, pages 82, 83)
- Salad tongs or whisk tongs and needle-nose pliers (two per group)
- Four different-sized objects the size of a fish, egg, blue mussel, and small insect (one set of objects per group—see Teacher Tips)
- Hungry Birds activity sheet (one per student, page 81)

Lesson 10

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, page 88)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 89)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 19)
- A large bulletin board or blank wall
- White bulletin board art paper
- White paper/index cards for each student
- Coloring utensils for each student
- Scissors for each student
- Stapler (for teacher)

Lesson 10 (continued)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, page 88)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 89)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 19)
- Coloring utensils for each student

Lesson 11

- Tide Pool T-Chart (one per student, page 97)
- Blank white paper (two per student)
- Pencils
- Watercolor paints
- Scissors
- Glue

Lesson 12

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, 102)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, 103)
- Life at the Rocky Shore Fact Sheet (for teacher reference, 20)
- A large bulletin board or blank wall
- White bulletin board art paper
- White paper/index cards for each student
- Coloring utensils for each student
- Scissors for each student
- Stapler (for teacher)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, 102)

Lesson 12 (continued)

- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ My Rocky Shore Diagram (one per student, page 77)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, 103)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, 20)
- ★ Coloring utensils for each student

Lesson 13

- ★ Camouflage Photo Cards and Definition pages (one set for the entire class, pages 108–127)
- ★ Lobster outline (one per student, page 121)
- ★ Colored pencils and/or crayons for each student
- ★ Scissors for each student
- ★ Clipboard or some other hard surface for each student
- ★ A large brown paper bag or type of bag that is not transparent
- ★ Invisible or masking tape

Lesson 14

If doing bulletin diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 133)
- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, page 134)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, pages 21–22)
- ★ A large bulletin board or blank wall
- ★ White bulletin board art paper
- ★ White paper/index cards for each student
- ★ Coloring utensils for each student
- ★ Scissors for each student
- ★ Stapler (for teacher)

If doing individual diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 133)

Lesson 14 (continued)

- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ My Rocky Shore Diagram (one per student, page 77)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, page 134)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, pages 21–22)
- ★ Coloring utensils for each student

Lesson 15

- ★ Marine Crabs: True or False activity sheet for the teacher (page 145)
- ★ Plastic cones (same number as students is preferable)
- ★ Bean bags (same number as students)
- ★ Salad tongs (same number as students is preferable)
- ★ Pinnies (two sets of four pinnies—two different colors)

Lesson 16

If doing bulletin diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 150)
- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, page 151)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, pages 23–24)
- ★ A large bulletin board or blank wall
- ★ White bulletin board art paper
- ★ White paper / index cards for each student
- ★ Coloring utensils for each student
- ★ Scissors for each student
- ★ Stapler (for teacher)

If doing individual diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 150)
- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ My Rocky Shore Diagram (one per student, page 77)

Lesson 16 (continued)

- Rocky Shore Zones Table Answer Key (for teacher reference, page 151)
- Life at the Rocky Shore Fact Sheet (for teacher reference, pages 23–24)
- Coloring utensils for each student

Lesson 17

- Is it a Fish? activity sheet for each student (page 162)
- One copy of How Are These the Same? photography sheet (page 163)
- A whiteboard or SMART Board to record student feedback

Lesson 18

- Rocky Shore Food Chain activity sheets (page 169)
- Paper, plastic or Styrofoam cups (7 per student)
- Permanent or washable markers
- Glue or tape
- A whiteboard or SMART Board to record student feedback

Lesson 19

- Engineering Design Process activity sheet (one per student, page 175)
- Create-A-Critter Engineering Design Process activity packet (at least one per student, pages 176–178)
- 5 index cards per student for each "critter" being made
- Scissors (one per student)
- Transparent adhesive tape/tape dispensers (one per group)
- Five pound bag of rice or bird seed
- Pillowcase

Lesson 20

- Algae or Plant? activity sheet for each student, if decided upon (page 182)
- Algae! bingo activity sheets (pages 185–204)

Lesson 20 (continued)

- A projector to display Algae or Plant? activity sheet, if decided upon
- A whiteboard or SMART Board to record student feedback.

Lesson 21

- Rocky Shore Scoot Task Cards (one per desk, pages 208–215)
- Rocky Shore Scoot Grid activity sheet (one per student, page 217)
- Rocky Shore Scoot Answer Key (one per student, page 216)

Lesson 22

- Plastic trash items such as milk jugs, soda rings, water bottles, DVD cases, plastic cutlery, straws, plastic bags, etc.
- Craft items such as tape, glue, and scissors
- Projector or SMART Board to show online video. YouTube Channel Episode Suggestions: "How We Can Keep Plastics Out of Our Ocean" by National Geographic, or "Ocean Trash is a Problem You Can Solve" by Ocean Conservancy.
- The projected image or print-out of Ocean Conservancy's "Top Ten Item's Found" International Coastal Cleanup graphic (page 221)
- Computers or tablets for student research
- A large paper or cloth bag
- Plain white paper

Lesson 23

- Copies of the Rocky Shore Ecosystem Assessment (one per student, pages 225–228)

Lesson 24

- Paper/pencils
- Whiteboard/SMART Board/Projector
- Computers/Printer
- Copies of Explore the Shore Tips (if decided upon, page 233)

LITERATURE LIST

Lesson 1

- ★ *National Geographic Kids First Big Book of the Ocean* by Catherine D. Hughes
- ★ *Make a Splash! A Kid's Guide to Protecting Our Oceans, Lakes, Rivers, & Wetlands* by Cathryn Berger Kaye M.A. and Philippe Cousteau

Lesson 2

- ★ *Watershed Adventures of a Water Bottle* by Jennifer Chambers
- ★ *All the Way to the Ocean* by Joel Harper
- ★ *Riparia's River* by Michael J. Caduto

Lesson 3

- ★ *Clam-I-Am!: All About the Beach* by Tish Rabe
- ★ *Kermit the Hermit* by Bill Peet

Lesson 4

- ★ *Basher Science: Oceans: Making Waves!* by Dan Green
- ★ *Tsunamis* (A True Book) by Chana Stiefel
- ★ *Where Albatross Soar: A Beachside Story of Waves and Storms* by Bryan Knowles

Lesson 5

- ★ *And the Tide Comes In . . . Exploring a Georgia Salt Marsh* by Merryl Alber
- ★ *A Day in the Salt Marsh* by Kevin Kurtz

Lesson 6

- ★ *Super Simple Things to Do with Temperature: Fun and Easy Science for Kids* by Kelly Doudna

Lesson 7

- ★ *Crabby and Nabby: A Tale of Two Blue Crabs* by Suzanne Tate
- ★ *Spiny Sea Star: A Tale of Seeing Stars* by Suzanne Tate

Lesson 8

- ★ *Oscar the Herring Gull* by Nancy M. Donovan
- ★ *A Field Guide to the Atlantic Seashore: From the Bay of Fundy to Cape Hatteras* (Peterson Field Guides) by Kenneth L. Gosner

Lesson 9

- ★ *Salty Seagull: A Tale of an Old Salt* by Suzanne Tate
- ★ *Shorebirds* by Melissa Stewart

Lesson 10

- ★ *Happy Hermit Crab, A Tale of Shell Seekers* by Suzanne Tate
- ★ *A House for Hermit Crab* by Eric Carle

Lesson 11

- ★ *Between the Tides* by Fran Hodgkins
- ★ *Ocean Soup: Tide Pool Poems* by Stephen R. Swinburne

Lesson 12

- ★ *Spiny Sea Star: A Tale of Seeing Stars* by Suzanne Tate
- ★ *Crabby and Nabby: A Tale of Two Blue Crabs* by Suzanne Tate

Lesson 13

- ★ *Ocean Hide and Seek* by Jennifer Evans Kramer
- ★ *Animal Camouflage True Books: Amazing Animals* by Vicky Franchino
- ★ *High? Low? Where Did It Go? All About Animal Camouflage* by Tish Rabe

Lesson 14

- ★ *Invasive Species Underwater* by Richard Spilsbury
- ★ *Keep Out! Invasive Species* by Sara L. Latta

Lesson 15

- ★ *Crabby & Nabby: A Tale of Two Blue Crabs* by Suzanne Tate
- ★ *A House for Hermit Crab* by Eric Carle

Lesson 16

- ★ *Lindie Lobster* by Suzanne Tate
- ★ *The Cod's Tale* by Mark Kurlansky

Lesson 17

- ★ *Flossie Flounder: A Tale of a Flat Fish* by Suzanne Tate
- ★ *DK Eyewitness Books: Fish* by Steve Parker
- ★ *What's It Like to Be a Fish?* by Wendy Pfeffer

Lesson 18

- ★ *The Magic School Bus Gets Eaten: A Book About Food Chains* by Pat Relf
- ★ *Who Eats What? Food Chains and Food Webs* by Patricia Lauber
- ★ *Plankton: Wonders of the Drifting World* by Christian Sardet
- ★ *Ocean Sunlight: How Tiny Plants Feed the Seas* by Molly Bang

Lesson 19

- ★ *Rosie Revere, Engineer* by Andrea Beaty
- ★ *Engineering: Feats and Failures* by Stephanie Paris

Lesson 20

- ★ *An Ocean Garden* by Josie Iselin
- ★ *Seaweeds* by David Thomas

Lesson 21

- ★ *DK Eyewitness Books: Seashore* by Steve Parker
- ★ *The Seaside Switch* by Kathleen V. Kudlinski

Lesson 22

- ★ *One Well: The Story of Water on Earth* by Rochelle Strauss
- ★ *Make a Splash! A Kid's Guide to Protecting Our Oceans, Lakes, Rivers, & Wetlands* by Cathryn Berger Kaye M.A.
- ★ *Follow the Moon Home: A Tale of One Idea, Twenty Kids, and a Hundred Sea Turtles* by Philippe Cousteau
- ★ *Crabby's Water Wish: A Tale of Saving Sea Life* by Suzanne Tate

Lesson 23

- ★ *The Big Test* by Julie Danneberg
- ★ *Testing Miss Malarkey* by Judy Finchler

Lesson 24

- ★ *Beachcombing: Exploring the Seashore* by Jim Arnosky
- ★ *What If Everybody Did That?* by Ellen Javernick
- ★ *One Plastic Bag: Isatou Ceesay and the Recycling Women of the Gambia* by Miranda Paul

ATLANTIC OCEAN ROCKY SHORE ZONES GUIDE

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. Although specific types of algae and animals are often found in the particular zones outlined below, living organisms can be found in different zones.

Zone	Features	Algae	Animals
Splash Zone	This zone is closest to the land and is always exposed to air except for rain or waves from major storms. It has few algae or animals because there is little shelter or food sources, as well as predatory birds.	Lichen, Cyanobacteria	Seashore Springtail, Rough Periwinkle, Herring Gull, Great Black-backed Gull, Spotted Sandpiper
Upper Intertidal Zone	This zone is mainly exposed to air except for at extreme high tides. Tide pools start to appear in the upper intertidal zone (pools of saltwater left behind when the tide goes out; many living organisms can be found in tide pools).	Cyanobacteria	Scud, Common Periwinkle, Rock Barnacle, New England Dog Whelk, Northern Hermit Crab
Middle Intertidal Zone	This zone is exposed to air and water approximately equal amounts of time.	Rockweed, Knotted Wrack	Blue Mussel, Green Crab, Green Sea Urchin, Tortoiseshell Limpet, Asian Shore Crab
Lower Intertidal Zone	This zone is almost always exposed to water except for at extreme low tides.	Sea Lettuce, Maiden Hair Algae, Coralline Algae	Smooth Periwinkle, Atlantic Rock Crab, Common Slipper Shell, Northern Sea Star, Blood Star, Frilled Sea Anemone, Bread Crumb Sponge, Clam Worm, Speckled Flatworm, Left-coiled Tubeworm, Red Chiton
Subtidal Zone	This zone is always exposed to water.	Irish Moss, Horsetail Kelp, Sugar Kelp, Shotgun Kelp, Bubblegum Algae	Mummichog, Rock Gunnel, Lumpfish, Cunner, Lobster, Jonah Crab, Orange Sheath, Golden Star

LIFE AT THE ROCKY SHORE

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The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. Although specific types of algae and animals are often found in the particular zones outlined below, living organisms can be found in different zones.

Splash Zone

Organism	Facts
Cyanobacteria	A group of aquatic bacteria that obtain their energy via photosynthesis. They are often referred to as blue-green algae, but they are not algae. This description was used to indicate their appearance. They can be found living on rocks of the rocky shore.
Lichen	A combination of a fungus and an alga (like cyanobacteria). The alga produces food while the fungus gathers water. This symbiosis enables lichen to survive harsh weather that would potentially kill a fungus or alga if they were growing alone. They can form black, yellow, or orange horizontal bands on rocks which represent different species of lichen.
Seashore Springtail	These small arthropods are wingless hexapods. They have cylindrical bodies and they are blackish-blue in color. The small hairs on their bodies act as waterproof layers. They feed primarily on dead marine animals such as mollusks. They are able to survive underwater for two days.
Herring Gull	The herring gull is an omnivore and eats almost anything including mussels, crabs, sea urchins, eggs, carrion, and garbage. They obtain their food in many ways such as diving into the water, taking it from the surface of the water, or scavenging on land.
Great Black-Backed Gull	This is the largest gull in the world. They can steal food from other birds and they can hunt other birds such as puffins. Their name indicates their broad black wings. Great black-backed gulls also hunt mussels, crabs, sea urchins, other marine invertebrates, and fish.
Spotted Sandpiper	The spotted sandpiper is a carnivore and eats insects, crustaceans, worms, mollusks, etc. They obtain their food by foraging along the edge of the ocean. While hunting for food, spotted sandpipers bob their tail up and down, earning them the nickname of "teeter-tail."

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Fact Sheets

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Upper Intertidal Zone

Organism	Facts
Cyanobacteria	A group of aquatic bacteria that obtain their energy via photosynthesis. They are often referred to as blue-green algae, but they are not algae. This description was used to indicate their appearance. They can be found living on rocks of the rocky shore.
Common Periwinkle	This snail is abundant in number at the rocky shore. Many types of shorebirds and other animals feed on this snail. They have a radula (a ribbon of tiny teeth) which they use to scrape algae off of rocks. They have gills, operculum, and they use their own mucous to attach to rocks. Other types of periwinkles include the rough periwinkle (splash zone) and the smooth periwinkle (lower intertidal zone).
Scud	Scuds, or amphipods, are tiny crustaceans that resemble shrimp in appearance. They are a translucent olive-gray color. Scuds are omnivores, feeding on both plant and animal material (often decaying plant material and dead animal matter).
Rock Barnacle	These crustaceans permanently attach their heads to a substrate by cement they produce. They create an outer shell that resembles a volcano. They filter-feed on phytoplankton by extending their feather-like legs through their operculum. They close their shells when the tide goes out.
New England Dog Whelk	These snails are identifiable by their pointed, spiral shells which have raised beads along the ridges. They are scavengers and predators. They are able to drill holes in the shells of other organisms using a radula. Their color is determined by their diet and geographical location.
Northern Hermit Crab	These crabs have soft, spirally curved abdomens. They protect their abdomens by finding and carrying empty shells, mainly from sea snails. They spend most of their life underwater, and they live in varying depths. They breathe through gills and can survive briefly out of water.

LIFE AT THE ROCKY SHORE

Fact Sheets

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Middle Intertidal Zone

Organism	Facts
Rockweed	This brown alga has a small holdfast. Its flat blades have a noticeable midrib, air bladders, and Y-shaped tips. It is a dominant algae species in the intertidal zone. It serves as an important shelter to many animals and plants.
Knotted Wrack	This brown alga has long blades with large, egg-shaped bladders found along the blades at regular intervals. The blades are long, flexible and slimy. They are a dominant algae species in the intertidal zone, and serve as shelter to animals and plants.
Green Sea Urchin	Green sea urchins are echinoderms. They have a globe-like shape that is covered with a large number of long spines. Their bodies have radial symmetry. They have five rows of paired tube feet used for movement and adhesion to rocks. They are omnivores, and their predators include crabs and shorebirds.
Green Crab	These crabs are a widespread invasive species. Their carapaces grow to a width of three and one-half inches. They feed on a variety of mollusks, worms and small crustaceans. The color of the green crab can vary from green, brown, red, or gray.
Blue Mussel	These common bivalves have a slender foot that allows them to move and hold onto substrates temporarily. They create byssal threads using a gland in their shell. These strong, threadlike anchors are used to attach securely to almost any substrate. They are filter feeders.
Tortoiseshell Limpet	These common limpets have hard, cone-shaped shells with rounded, off-center points. They have soft bodies with a large foot. The shape and foot of the limpet provides this animal with powerful suction. Their name refers to their shells' brown and white coloration.
Asian Shore Crab	These crabs from East Asia are an invasive species in North America and Europe. Their square-like carapaces can be up to two inches in width, with three teeth along the sides. They are marked with alternating light and dark bands. They are omnivores that prefer to eat other animals, especially mollusks.

LIFE AT THE ROCKY SHORE

Fact Sheets

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Lower Intertidal Zone

Organism	Facts
Sea Lettuce	This rubbery, sheet-like green alga is two cell layers thick and attaches to rocks with an unnoticeable perennial holdfast. It is an annual species that can tolerate considerable temperature fluctuations. See lettuce is edible. It can grow up to sixty centimeters long.
Maiden Hair Algae	This green alga has long and thin unbranched blades. The blades are hollow, which can be seen when air bubbles are trapped in the blades. Maiden Hair algae can survive in the rocky shore's harsh environment by tolerating wide changes in temperature and salinity.
Coralline Algae	This red algae can be red, pink, or purple in color and can be found growing on rocks and shells. It is flexible when alive and white and brittle when dead. Corallines can have the appearance and rough texture of coral. Due to its rough texture, most herbivores prefer not to eat it, but some do such as limpets and sea urchins.
Atlantic Rock Crab	These crabs have nine small teeth on the front of their carapaces. They have purplish-brown spots. They can grow new legs using regeneration. They molt as they grow, shedding their exoskeletons in the process. They move by scuttling sideways. They are edible.
Common Slipper Shell	The shape of these gastropod mollusks is influenced by the object to which they are attached. The inside of their shell resembles a slipper. They can often be found stacked on top of each other. They are filter feeders. They are sessile—remaining in the same place their entire lives.
Brittle Star	Brittle stars are echinoderms, but they are not sea stars. They are similar in appearance to sea stars, with radial symmetry and very slender arms around a central disk. Brittle stars are mainly scavengers. They got their name because they are more fragile than sea stars, losing their arms more easily. They move using their muscles, not their tube feet.
Blood Star	These echinoderms have five long and slender arms around a central disk. They range in color from tan and yellow to red or purplish. They have two rows of tube feet on each arm. Sensory cells in the skin can sense light. Their only sense organs are a red eyespot at the tip of each arm that can sense differences of light and dark. They are smaller than northern sea stars.

LIFE AT THE ROCKY SHORE

Fact Sheets

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. Although specific types of algae and animals are often found in the particular zones outlined below, living organisms can be found in different zones.

Lower Intertidal Zone (continued)

Organism	Facts
Northern Sea Star	These five-armed echinoderms are the most common sea star in Atlantic waters. Each arm has four rows of tube feet which are used to move. They eat bivalves, snails and other animals by protruding their stomachs through their mouths into their prey, which then softens their prey for digestion. They are capable of regeneration.
Frilled Sea Anemone	These large, common anemones have smooth, cylindrical bodies with up to one thousand tentacles. They can be orange, yellow, or brown in color. They can move slowly using their pedal discs. They feed on live or dead animals. They catch food with their tentacles' stinging cells.
Bread Crumb Sponge	These primitive, multi-celled sponges with glistening, bumpy surfaces are bright yellow when found in intertidal zones. They are known for the sulfuric odor they release when broken apart. They filter feed by sucking water through the openings of their surface. They get their name from how they crumble when touched.
Clam Worm	These worms have segments that possess pairs of small, paddle-shaped appendages. They have four pairs of tentacles, one pair of antennae, and one pair of fleshy lobes on their heads. When feeding, these worms extend a proboscis, which has hook-like jaws used to grasp prey. They retract the proboscis to draw food into their mouths.
Speckled Flatworm	This very common flatworm in New England is oval in shape. Their dorsal sides often have reddish-brown spots and their ventral sides are grayish-white. Their eyes are arranged in two clusters, with ten to twenty eyes in each cluster. They can grow to one inch in length.
Left-Coiled Tubeworm	These segmented marine worms are sedentary and they secrete a small, off-white tube to reside in. Their tubes form a spiral coil and the worms retreat into their tubes when above water. When below water, the worms can be seen to have green tentacles.
Red Chiton	These mollusks have an eight-piece shell. They cling to rocks with a wide, muscular organ. They are sluggish and eat algae with their radula. They often appear orange-red in color with whitish zig-zag markings.

LIFE AT THE ROCKY SHORE

Fact Sheets

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Subtidal Zone

Organism	Facts
Kelp	These brown algae have large blades, heavy stalks, and finger-like holdfasts. The horsetail kelp's wide blade is divided into strap-like strands. Sugar kelp has a ruffled blade with no midrib, and is found on more sheltered shores. Shotgun kelp has an obvious midrib and is dotted with holes. It grows in deeper water than other kelps, but is often found washed up on shores. Kelps are found year round and grow up to three meters long during the winter.
Irish Moss	Irish moss is a red alga with flattened blades that fork off from a short stalk to form fingers with round, blunt tips. They are often deep, purplish-red in color. It has a disk-shaped holdfast. It is harvested for its carrageenan, a gelatinous carbohydrate used to emulsify dairy products, baked goods, and cosmetics.
Bubblegum Algae	This red algae is an encrusting algae. It has pink coloration which resembles bubble gum. Bubblegum algae have calcium carbonate in their tissue. When the algae dies, its white skeleton remains attached to rocks or shells.
Mummichog	These brownish-green saltwater minnows can grow to a length of five inches. Their Indian name means "they go in great numbers." They are hardy fish and important food sources for larger fish. They feed on insects, small fish, crustaceans, and plant material.
Rock Gunnel	These small fish have long, thin bodies and long dorsal fins. They are gray to green in color. They are also referred to as rock eels because of their appearance. These egg layers deposit their eggs and leave them alone. The young are not cared for by their mothers.
Lumpfish	These fish have short heads and thick, round bodies that end with a lumpy tail. They do not have scales. Most of their fins are small and roundish. Their ventral fins form a sucking disk that enables them to attach themselves to substrates. They are poor swimmers. They are carnivores, eating mainly small crustaceans, mollusks and worms.
Cunner	These fish, members of the wrasse family, have oblong bodies and pointed heads. Their body colors vary and include brown, red, blue, green, and blue. They are omnivores and they feed on mollusks, crustaceans, and other invertebrates. They can grow up to seventeen inches long. Their predators include other fish and shore birds.

LIFE AT THE ROCKY SHORE

Fact Sheets

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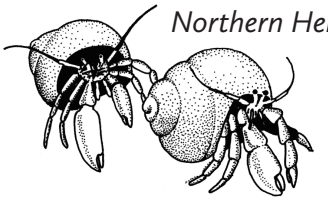
Subtidal Zone (continued)

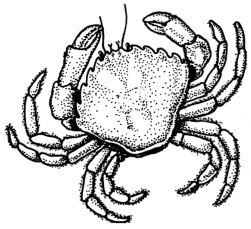
Organism	Facts
Lobster	These greenish-black crustaceans are long and have a cylindrical carapace. They are decapods with two different-sized pincers in front. One claw is heavier and blunt with rounded teeth, referred to as the "crusher." The other claw is lighter, sharp and pointed, referred to as the "cutter." They are cannibals, scavengers, and they also prey on fish, small crustaceans, and mollusks. They are nocturnal and territorial.
Jonah Crab	Jonah crabs have a round, rough-edged carapaces with small light spots. Their claws are large with dark brown-black tips. Jonah crabs can grow up to eight inches wide or more. Jonah crabs can live at depths of up to seven hundred fifty meters. They are known to move around to areas in which the temperature is comfortable to them.
Orange Sheath	These tunicates are immobile, tube-like invertebrates that grow together in groups called colonies. Their colonies can be found attached to rocks, boulders, artificial structures, and algae. They are filter feeders that eat plankton and detritus. They can be orange or red in color and they are covered in a firm jelly.
Golden Star	The centers of the individual tunicates, called zooids, form flower-shaped patterns. They are resilient organisms, tolerating a wide range of temperatures and salinities, and they can grow in polluted waters. They can out-compete native filter feeders for food and space.

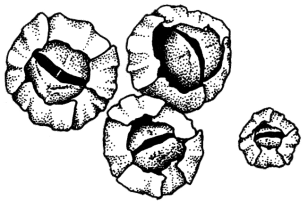
ATLANTIC OCEAN ROCKY SHORE GUIDE

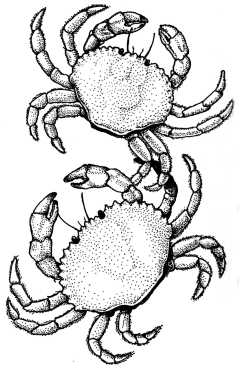
Crustaceans

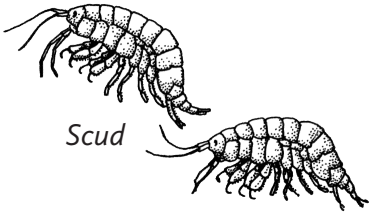
These animals often have a hard covering, called an exoskeleton, and jointed legs. The body of a crustacean is composed of three segments: the head, the thorax and the abdomen.

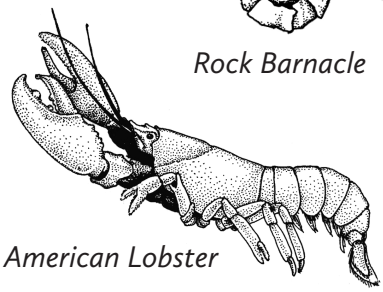

Northern Hermit Crab


Green Crab


Rock Barnacle


Rock Crab

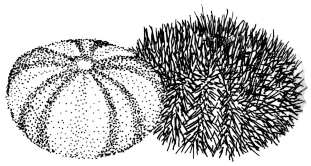

Scud


American Lobster

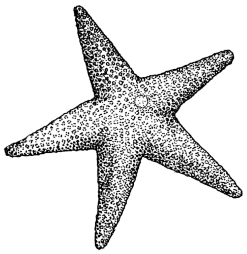
Jonah Crab

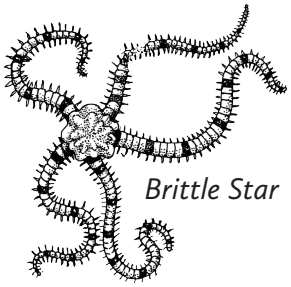
Echinoderms

The name of these marine animals means "spiny skin." They have radial symmetry, five or multiples of five arms, and shells covered by skin.


Green Sea Urchin


Blood Star

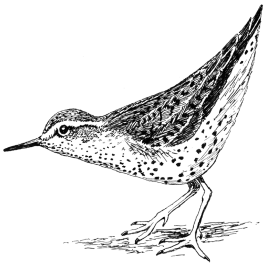

Northern Sea Star (asterias)


Brittle Star

Shorebirds

These birds are commonly found residing along seashores, estuaries, wetlands, or marshes. They are often small to medium-sized birds, distinguished by slender bills and long legs.


Great Black-backed Gull

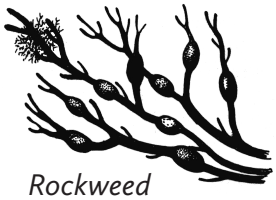

Spotted Sandpiper


American Herring Gull

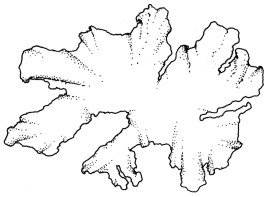
Algae

Algae are unicellular or multicellular organisms that produce food by the process of photosynthesis. Most marine algae have holdfasts, stipes and blades.

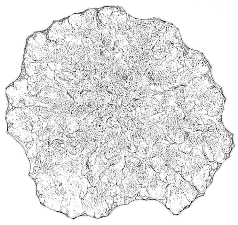
Coralline Algae



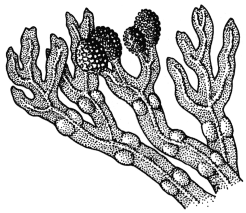
Rockweed (ascophyllum)



Sea Lettuce (ulva)

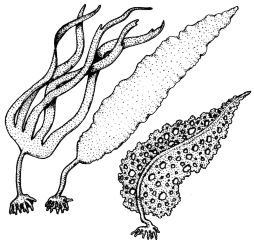


Lichen

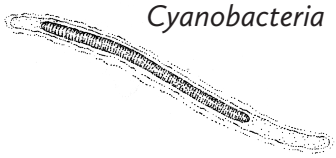


Knotted Wrack (fucus)

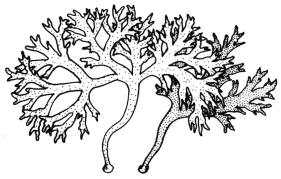
Bubblegum Algae



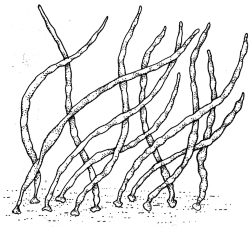
Kelps (horsetail kelp, sugar kelp, shotgun kelp)



Cyanobacteria



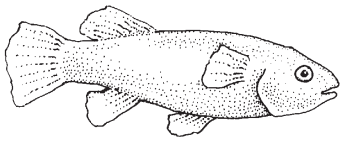
Irish Moss



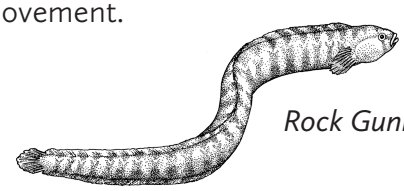
Maiden Hair Algae

Fish

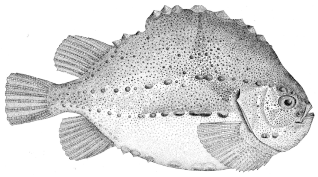
All of these animals live in water. They have gills to filter oxygen and fins to help them move through the water. They all have backbones for support and movement.



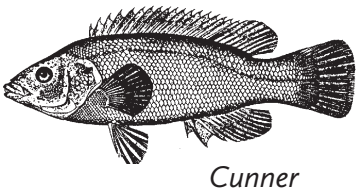
Mummichog



Rock Gunnel



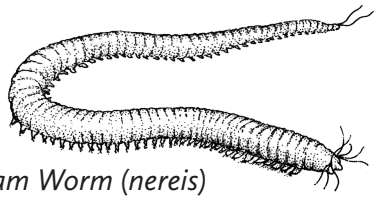
Lumpfish



Cunner

Marine Worms

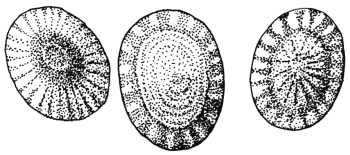
These worms are saltwater invertebrates. They can be found living under rocks, among holdfasts of algae, and in mud or sand. They can be carnivores, herbivores, or parasites. They can live at all depths of the ocean.



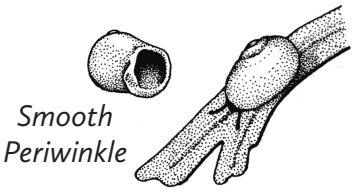
Clam Worm (nereis)

Molluscs

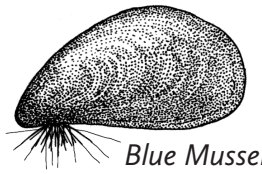
These animals are invertebrates. They have soft, unsegmented bodies. Most have an external shell which can enclose their bodies wholly or partially.



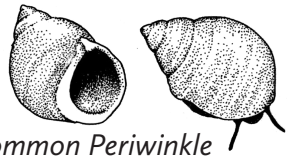
Tortoiseshell Limpet



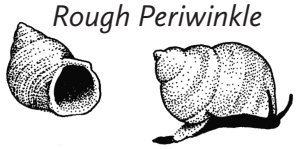
Smooth Periwinkle



Blue Mussel

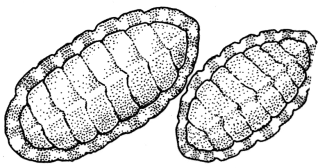


Common Periwinkle



Rough Periwinkle

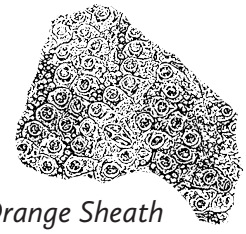
Atlantic Dog Whelk



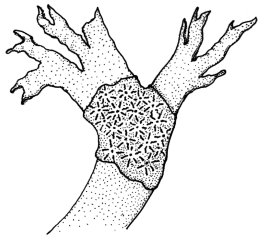
Red Chiton

Tunicates

These animals are invertebrate filter feeders, living mainly on plankton. Solitary tunicates are barrel-shaped, with firm but flexible body coverings called tunics. Colonial tunicates are groups of tiny organisms that create one system and encrust rock or hard-bodied creatures.



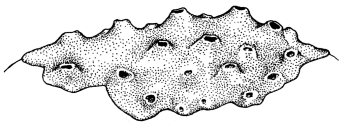
Orange Sheath



Golden Star

Sponges

These animals are invertebrates with soft, porous bodies. Their bodies draw in currents of water to extract nutrients and oxygen. They do not have organs or body symmetry.



Bread Crumb Sponge

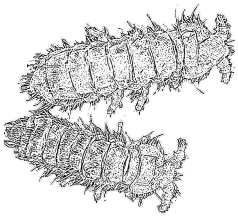
Cnidarians

These animals are simple invertebrates with symmetrical bodies and mouth openings. They have stinging cells on tentacles around their mouths. They are either bell-shaped and mobile or tube-shaped and anchored to one spot.

Frilled Sea Anenome

Arthropods

These animals are invertebrates. They have segmented bodies with many jointed legs or limbs. They also have external skeletons, called exoskeletons.



Seashore Springtail

TOSS THE BLUE PLANET

Topic
Ocean Size and Importance

Duration
One session

Vocabulary
globe
hypothesis
ocean
probability
ratio
surface

STANDARDS

Practices
Using Mathematics and Computational Thinking

Core Ideas
The Roles of Water in Earth's Surface Processes

Crosscutting Concepts
Scale
Proportion
Quantity

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2

Focus Question

How much of the Earth's crust is covered by the ocean?

Overview

Students estimate how much ocean covers the Earth's surface. Students collect data while tossing an inflatable globe back and forth to each other. Students analyze their data and interpret the results.

Objectives

Students will be able to:

- Identify how much ocean water covers the Earth's surface
- Recognize how probability impacted the results of the activity
- Infer why learning about the ocean is important

Materials Needed

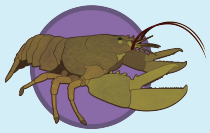
- One inflatable globe
- Chart (page 31)
- Clipboards or hard surface

Teacher Preparation

1. Obtain an inflatable globe that has land and water easily distinguishable from one another, and is easy to catch.
2. Reserve a large, open space for this activity.
3. Each student will need a copy of the chart on page 31.
4. Each student will need a transportable, hard surface to write on while participating in the activity.
5. Teachers will need easy access to a whiteboard or interactive whiteboard to write students' inferences.

Background

The ocean covers around 71% of the Earth's surface. About 97% of the Earth's water is found in the ocean. Earth's one ocean has been divided by borders into five separate oceans: the Pacific, the Atlantic, the Indian, the Arctic, and most



Teacher Tips

- ★ This activity may work better standing up or sitting down—teacher discretion is advised.
- ★ Have students call out their classmate's name before tossing the globe.
- ★ If time is limited, change the number of maximum tosses.
- ★ Consider marking students' index fingers with washable ink.

Extension Suggestions

- ★ Have students divide the classroom floor into 30% (land) and 70% (ocean) to have another visual of the amount of water that covers the Earth's surface.
- ★ Debate Prompt: Which is more important to humans—lakes and rivers or the ocean?
- ★ Writing Activity: Give students the option of writing to local government officials advocating for more protection for the ocean.

Background (continued)

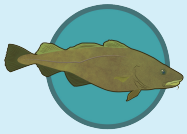
recently, the Southern Ocean. The ocean is the biggest feature on our planet; therefore it is extremely important to life on Earth because of what it provides: oxygen, food, water, climate regulation, transportation, recreation, and more.

Procedure

1. Display the inflatable globe in front of the classroom. Ask students what it is, and what features they see on the globe.
2. Ask students to predict how much of the Earth's crust is covered by the ocean. Record their answers somewhere visible to the entire class.
3. Provide students with a step-by-step overview of the activity:
    a. We are going to get into a large circle.
    b. We are going to pass the globe back and forth to each other.
    c. Each time someone catches the globe, they will tell the class whether their pointer finger is on land or the ocean.
    d. Everyone will record each student's response with a tally mark on the chart (page 31) provided.
    e. Once we have completed 100 tosses we are going to figure out, as a class, the percentages of time we touched the land and touched the ocean. This will give us an estimate of how much ocean covers the Earth's surface.
4. Ask for a couple of volunteers to demonstrate in front of the class how to carefully toss and catch the globe and determine whether they have touched land or ocean.
5. Assist students in creating a circle and begin and complete the activity.
6. After the designated amount of tosses is complete, have the class determine together the percentages of water and land that were touched.
7. Inform students that the actual percentage of ocean that covers the Earth's surface is 71 percent. Ask students why they think the class result was not exactly 71 percent (if this is the case). If their answer was exact, ask students the reason for their result.
8. Explain to students the basics of probability—the more tosses the class did, the more accurate their results would be to represent the ratio of ocean to land.

Books

- *National Geographic Kids First Big Book of the Ocean* by Catherine D. Hughes
- *Make a Splash! A Kid's Guide to Protecting Our Oceans, Lakes, Rivers, & Wetlands* by Cathryn Berger Kaye M.A. and Philippe Cousteau



Websites

- The Ocean Literacy Website and their 7 Ocean Literacy Principles
- National Geographic's Video "Why the Ocean Matters"
- One World One Ocean Campaign's video "Why the Ocean?"

Scientist Notebook

- Students can record their classmates' thoughts on why learning about the ocean is important.

Wrap-up

- Ask students how much of the Earth's crust is covered by the ocean.
- Ask students to think about how much water there is on the Earth, and ask them how much of the water they think is ocean water. Inform them that it is 97% of our Earth's water supply.
- Inform students that they are going to be learning about the ocean, and more specifically the rocky shore, for the next several weeks. Have students brainstorm why learning about the ocean is important. Record their input to review (and add to) at various times throughout the unit.

TOSS THE BLUE PLANET

Name: _____

Date: _____

Directions

Make a circle with your class and toss your globe back and forth to each other. Each time someone catches the globe, find out whether their pointer finger is on land or ocean. Place one tally mark in the correct spot on the chart. Toss the globe 100 times! Do your best to make gentle and accurate tosses.

Hint

Designate one classmate or your teacher to keep track of how many tosses you have made.

Land	
Ocean	

Now What?

In the spaces below, fill in the blanks with your results. If your class did not make 100 tosses, complete the math equation below to discover the percentage of land and the percentage of ocean you touched.

Percentage of Land: _____ / Percentage of Ocean: _____

If your class made more or less than 100 tosses:

_____ (*# of land tallies*) ÷ _____ (*# of total tosses*) = _____ (*% of land touched*)

_____ (*# of ocean tallies*) ÷ _____ (*# of total tosses*) = _____ (*% of ocean touched*)

BUILD YOUR OWN WATERSHED

Topic
Watersheds and Watershed Conservation

Duration
One Session

Vocabulary
basin
conservation
estuary
gravity
precipitation
pollutant
runoff
slope
watershed

STANDARDS

Practices
Developing and Using Models

Core Ideas
The Roles of Water in Earth's Surface Processes

Crosscutting Concepts
Patterns

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2

Focus Question

What is a watershed?

Overview

Students define the term "watershed." Students create a model of a watershed. Students identify their local watershed. Students discuss how they can protect their local watershed, and how doing so helps protect the ocean.

Objectives

Students will be able to:

- Identify the term "watershed"
- Assemble a watershed
- Describe the connection between their local watershed and the ocean

Materials Needed

Per Group:

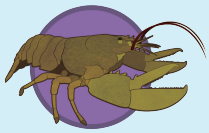
- Large plastic container such as a dish pan
- Old newspapers or scrap paper
- Kitchen-size trash bag
- Pair of scissors
- Spray bottle full of blue-colored water (preferably dyed blue)
- Glitter or construction paper
- Copy of activity sheet (page 35) for each group member

Other:

- Blue food coloring
- Model of watershed

Teacher Preparation

1. Build a model of a watershed as an example for students (roll up newspapers to create a large slope, then cut a trash bag to size and tuck it under the newspapers).



Teacher Tips

- ★ Have students develop expectations for working together as a group.
- ★ Create specific jobs for members of each group.
- ★ Write and review step-by-step group procedure for students to follow.
- ★ Check out your local dollar stores for dish pans and spray bottles.

Extension Suggestions

- ★ Four Corners Movement Game: develop five to ten questions on watershed pollution scenarios with four possible solutions (a, b, c, d). Designate the four corners of your classroom as a, b, c, and d. Have students move to the corner of the room that corresponds to the answer they believe is correct. After all students have moved, have students explain why they chose their answer, then inform them of the correct answer.
- ★ The Watershed Quest Lesson Plan at pbs.org.

Teacher Preparation (continued)

2. Prepare supplies for student groups (three to four students per group recommended)—fill each plastic container with old newspapers or scrap paper, a kitchen-size trash bag, one pair of scissors, one spray bottle full of blue-colored water, and either a bottle of glitter or a piece of colorful construction paper.
3. Plan on designating specific work spaces for groups.
4. Each student will need a copy of the activity sheet on page 35, and a pencil.
5. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input.

Background

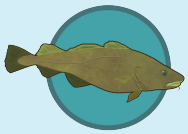
A watershed is an area of land in which all water flows down into a common basin. The water collected in a watershed, called runoff, soaks into the ground or flows downstream into rivers, lakes, and the ocean. The runoff comes from precipitation or melting snow. Runoff that reaches the ocean flows through an estuary—an area where the rivers meet the ocean and freshwater and saltwater mixes together.

Procedure

1. Ask students if they have ever heard the word "watershed" before, and ask them to attempt to define the word.
2. If students cannot come up with an accurate definition, write down this definition for all students to see: "A watershed is an area of land in which all water flows down into a common basin." Inform students that a basin is a depression or "dip" in the land where water collects, such as a lake or ocean.
3. Have student volunteers attempt to draw a watershed based on the definition on a whiteboard or interactive whiteboard. Discuss with students the various characteristics of the drawings and label them with the following terms if possible: mountain, hill, stream, river, lake, ocean, slope, runoff, precipitation, and estuary. If you have time, show students an illustration of a watershed.
4. Show students your prepared model of a watershed and inform them that they will be working together in groups to create their own watershed.
5. Discuss the steps students need to take to create their own watershed.
6. Allow students fifteen to twenty minutes to create their watershed.

Books

- ★ *Watershed Adventures of a Water Bottle* by Jennifer Chambers
- ★ *All the Way to the Ocean* by Joel Harper
- ★ *Riparia's River* by Michael J. Caduto



Websites

- ★ Find your local watershed at the "Surf Your Watershed" web page created by the United States Environmental Protection Agency.
- ★ Check out watershed facts, videos, student action and games at the Caring for our Watersheds Website.

Scientist Notebook

- ★ Students can record the definition of watershed and record or paste their observations of their watershed model.

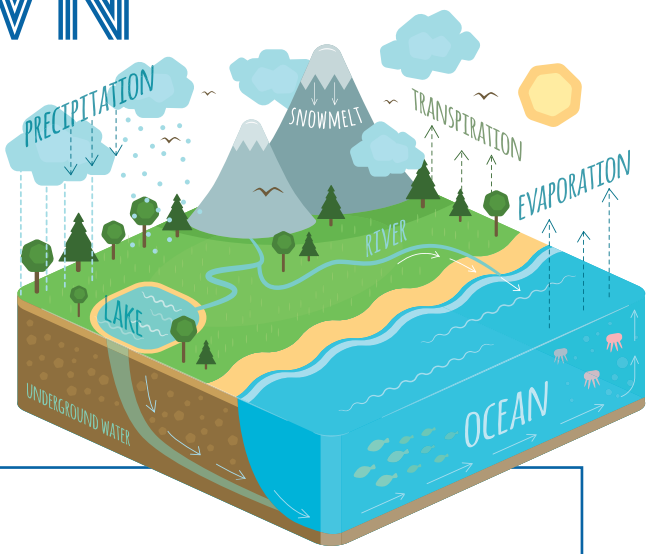
Procedure (continued)

7. Once students have completed their watersheds, have them simulate precipitation by spraying blue-colored water several times on the top of the watersheds and observe what happens.
8. Have students add glitter or very small, torn up pieces of construction paper to areas near the top of their watershed, and have them spray blue-colored water several times again and observe what happens.
9. Have students disassemble their watersheds and recycle as many materials as possible.
10. Have students fill out the activity sheet (page 35).

Wrap-up

- ★ Ask students to report what they observed when they "made" precipitation, and what happened when they added pollutants.
- ★ Have students come up with a list of pollutants that might contaminate their local watershed.
- ★ Ask students if and how these pollutants could impact the ocean.
- ★ Have students come up with ways they could prevent different types of pollution (conservation).
- ★ Conclude by addressing the fact that no matter how far away someone lives from the ocean, they can still impact the health of the ocean, as well as local waterways.

BUILD YOUR OWN WATERSHED



Name: _____

Date: _____

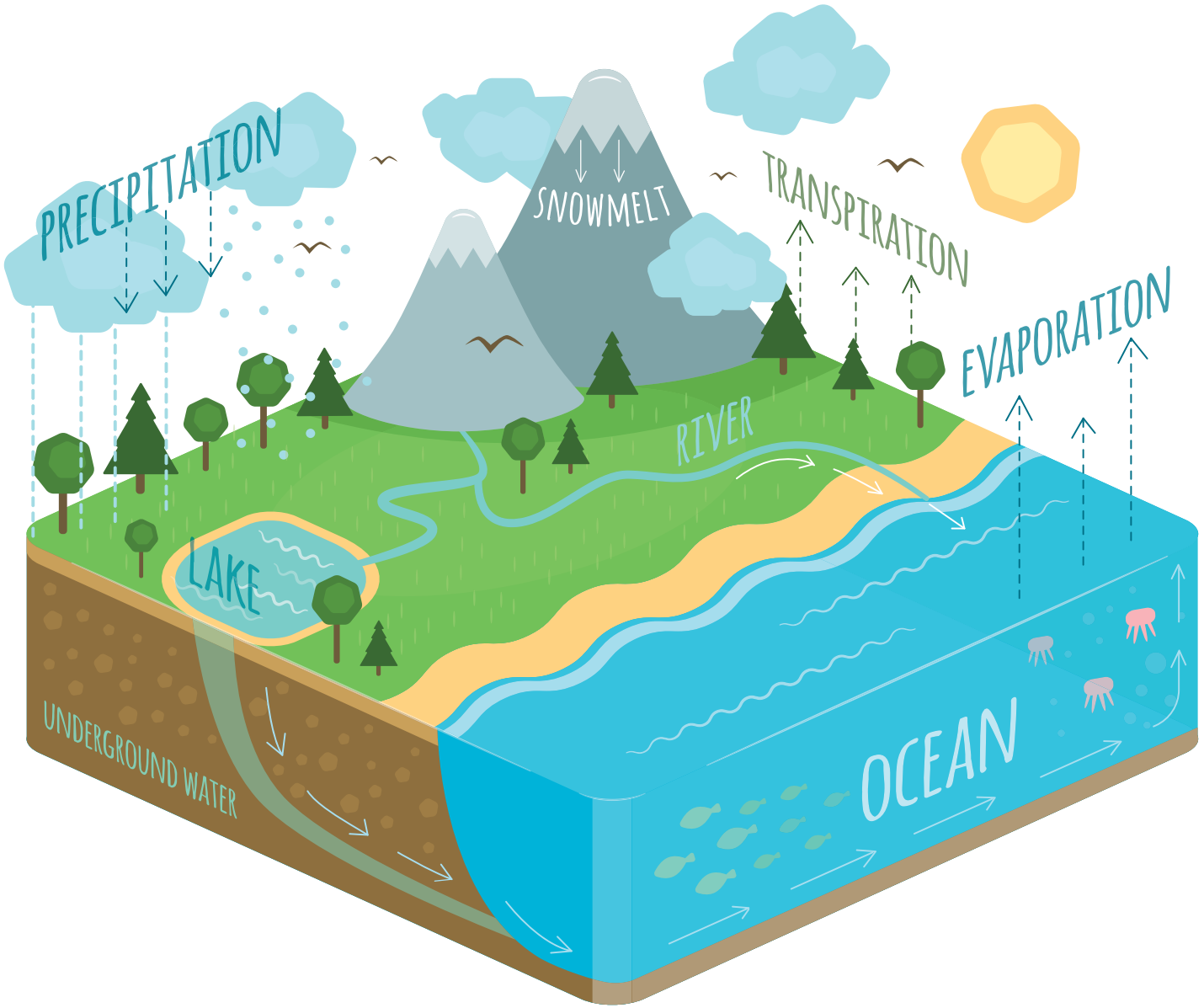
1. Draw your watershed model.

2. Record your observations of what happens when precipitation falls on your watershed.

3. Why does the water flow downhill?

4. What happened to the pollutants on your watershed?

WATERSHED DIAGRAM



INTRODUCTION TO THE ROCKY SHORE

Topic
Rocky Shore Ecosystem Identification

Duration
One session

Vocabulary
adaptations
ecosystem
environment
habitat
intertidal
rocky shore

STANDARDS

Practices
Planning and Carrying Out Investigations

Core Ideas
Biodiversity and Humans

Crosscutting Concepts
Structure and Function

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is a rocky shore?

Overview

Students discuss their prior knowledge and experiences of the rocky shore. Students will examine photographs of the rocky shore and identify features of the rocky shore. Students will define the term "ecosystem." Students will brainstorm the challenges life may face at the rocky shore.

Objectives

Students will be able to:

- ★ Identify the characteristics of a rocky shore
- ★ Define ecosystem
- ★ Make inferences on the challenges life faces at the rocky shore

Materials Needed

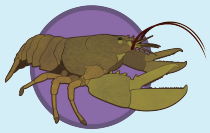
- ★ Print outs of four rocky shore photographs (pages 40–43)
- ★ Scientist notebooks (if used in class)
- ★ Poster paper/paper for groups to record their observations

Teacher Preparation

1. Print out the four rocky shore photographs (pages 40–43), preferably in color.
2. Plan on designating specific work spaces for groups.
3. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input.

Background

A rocky shore is an intertidal area that is made up of rocks, pools of water, and many plants and animals. Each species of plant life and animal life have adaptations that enable them to survive their harsh environments. These species and their habitats interact with one another to form the rocky shore ecosystem.



Teacher Tips

- ★ If following this curriculum or a different curriculum, reviewing previous lessons at the beginning of each lesson is good practice.
- ★ Consider preserving student input and questions from each lesson on your computer or chart paper.
- ★ Print out the rocky shore photographs in color, paste them to cardstock or a firm paper product, and laminate them for future use.

Extension Suggestions

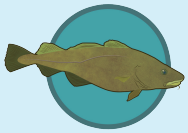
- ★ Read the "Rocky Shore Tale" (pages 44–47) Afterward, have students identify the potential dangers of living at the rocky shore and what adaptations rocky shore creatures might have to help them stay alive.
- ★ Find a website or multiple websites with live cameras observing rocky shore locations for students to observe, such as Monterey Bay Aquarium's Live Web Cam.

Procedure

1. Ask students what they can recall from the first two lessons (Toss the Blue Planet and Build Your Own Watershed). Review facts about the ocean, watersheds, and conservation. Refer back to student responses from previous lessons.
2. Inform students that now they have reviewed the importance of our oceans and how we can impact them, they are going to be spending a lot of time discovering facts about a specific, amazing area of the ocean—the rocky shore.
3. Ask students what they think a rocky shore is, and to provide as many specifics as possible. Allow for students to discuss experiences they have had, and record relevant student input.
4. Explain to students that you will be dividing them up into four groups and that each group will have their own photograph of a rocky shore. Tell them to write down as many characteristics of the rocky shore their group observes in their photograph. The group or the teacher needs to designate a recorder for this activity.
5. Divide students into four groups and give each group a photograph (pages 40–43).
6. Allow students 5–10 minutes to examine the photographs and record their findings.
7. Once students have investigated their photos, have each group share what characteristics they found and record their input for everyone to see. Students can write their answers in their science notebooks (if applicable).
8. Lead students in a discussion of what they have found, and highlight common themes:
    a. What similar things did groups find?
    b. What things did some groups find but others did not?
    c. If each group is looking at a photograph of a rocky shore, why are they observing different things?
9. Explain to students that an ecosystem is a community of interacting organisms and their environment. Consider integrating the first extension suggestion here.
10. Explain to students that the rocky shore is an ecosystem which has many characteristics because of the coming and going of the tides. Teachers and students can briefly discuss tides at this time, and students can be informed that they will be learning more about tides in future lessons.

Books

- *Clam-I-Am!: All About the Beach* by Tish Rabe
- *Kermit the Hermit* by Bill Peet



Websites

- Watch a rocky shore on a live camera at the Monterey Bay Aquarium website.
- Check out videos from the rocky shore in New Hampshire on the Seacoast Science Center's Youtube Channel.

Scientist Notebook

- Students can record the definitions of rocky shore and ecosystem, their observations of the rocky shore photograph, and their inferences of life's challenges at the rocky shore.

Procedure (continued)

11. Ask students to make inferences as to what challenges life on the rocky shore may have and record their input to refer to at a later time. Students can write their answers in their science notebooks (if applicable).

Wrap-up

- Ask students what main characteristics make up a rocky shore.
- Ask students to define the term ecosystem.
- Remind students that the characteristics they discovered have given them clues as to the challenges life on the rocky shore faces each day.
- Inform students that they will be learning about one of these challenges in their next lesson.

ROCKY SHORE, IMAGE 1

ROCKY SHORE, IMAGE 2

ROCKY SHORE, IMAGE 3

ROCKY SHORE, IMAGE 4

ROCKY SHORE TALE

by Thom R. Smith

Note: This is not scientifically-based. This story is meant to provide an engaging context for exploring the rocky shore and adaptations.

One morning you walked into your classroom and your teacher was standing by a large device with flashing lights and three large buttons. She explained to you that she had invented an ecosystem machine. If the green button is pushed, the ecosystem you live in changes into a different ecosystem. If the red button is pushed, your ecosystem changes back to what it was from the start. If the blue button is pushed . . . well, she said to never to touch that button.

Most students wanted to see if the machine worked so your teacher called on one of your classmates to push the green button. As your classmate pressed the green button, for a split second everything turned black. When everything became light again it appeared as if nothing had changed. All of the students were discouraged and your teacher apologized, not understanding why her invention had not worked.

As math class began something strange happened. Water splashed up against the windows of the school—but it hadn't rained for days and it was sunny outside. As the teacher tried to get everyone to pay attention water hit the windows again, and some of the water leaked through the open classroom windows. Everyone peered out to see what was going on when they noticed the entire schoolyard had turned into a gigantic puddle, and the puddle was rising! The principal's voice came out of the intercom, informing everyone to stay inside the building until they figured out what was going on, and to remain calm.

Your teacher shut the classroom windows as more and more water splashed against the building. She noticed that some of the water was knocking some bricks loose and cracking some windows, so she pulled down the window shades so you and your classmates wouldn't get scared. Trying to get your classmates' minds off of the flooding, she decided all of you should play a game instead. As students formed groups some began to complain that they were getting colder. The teacher apologized and explained that she can't change the temperature but encouraged all of you to put on whatever sweatshirts and coats you'd brought to school.

Your class got back together into groups to play a game to prepare for your upcoming math test. Suddenly the entire classroom shook. Then it shook again. Thinking an earthquake might be happening your teacher instructed you and your classmates to get underneath your desks immediately. She quickly took a peek outside and was astonished by what she saw. The entire school was underwater! Accidentally letting go of the window shade, the teacher allowed the window shade to go all the way up, revealing to your entire class that you were underwater! The motion of the underwater currents shook the school back and forth, making it hard for everyone to stand still. Your principal came back on the intercom, advising everyone to remain calm, and that as long as they stayed in their classrooms, all students would be safe.

ROCKY SHORE TALE *continued . . .*

Just as soon as the principal stopped talking an enormous whale swam by your classroom window! Your teacher exclaimed that she now understood what was going on. Her invention had worked! Your school had been changed from being located in a forest ecosystem to being located in a rocky shore ecosystem. What swam by the school was not a whale, but an Atlantic cod! She pressed the red button to change your ecosystem back around but nothing happened. The machine was broken! One of your classmates suggested that she press the blue button but your teacher got upset and exclaimed "Absolutely not!"

As your class watched the cod swim around your teachers' cars, the gigantic fish started to swim toward your classroom's window. Before anyone could react, the fish, mouth wide open, slammed into your classroom's window causing a large crack to form and water to start leaking into the classroom. Your teacher asked some of your classmates to help her cover the leak with duct tape, and while they did you and some of your classmates asked your teacher what would happen if the cod came back? After all, wasn't it trying to eat you all? The teacher remarked how that was a good question, and asked you what you thought your class should do.

You knew that your class couldn't leave the school building, but you knew that somehow everyone needed to hide. You suggested to your teacher that your class needed to hide the school building.

"How are we going to do that?" your teacher asked.

You suggested that everyone color seaweed designs on the window shades that faced the outdoors so that when fish see the school building they'll think nothing is there to eat.

Your teacher thought it was a great idea and informed the principal through the intercom of your idea. The principal's voice came over the intercom again telling all classrooms to color drawings of seaweed on their window shades. Your idea seemed to work as schools of fish swim by, but they did not bother your school building anymore.

While your teacher tried to fix her ecosystem machine she requested that your class pair up and read to each other in partners. Your classmates started to decide who they were going to read with when someone noticed that the water was not leaking through the window anymore, and appeared to be going down. Everyone ran to the window and was happy to see that the water was indeed going down. Once it completely disappeared, the principal came over the intercom and informed the school that everyone was safe and could continue to participate in their regular school activities.

You and your classmates requested to go outside and have some recess since you had been inside for so long. Your teacher thought that was a great idea to get some fresh air, and besides, she had had a difficult time fixing the ecosystem machine.

"It might be good for everyone to have a break," she said.

While your class played on the wet playground, some students noticed that parts of the ground were filled with rainbow-colored puddles.

"How pretty!" some classmates exclaimed.

"Why do these puddles look like rainbows?" others asked your teacher.

"The puddles look like rainbows because they are polluted," replied your teacher. "When the water came

ROCKY SHORE TALE *continued . . .*

and rose like tides some of it must have had some oil or gasoline in it."

Just then one of your classmates shouted from near the swings, calling your teacher to come quick. When everyone ran over they saw a huge sea star lying on the ground. It was as big as you and some of your classmates!

"Why isn't it moving?" one of your classmates asked.

"I'm afraid it is not alive," responded your teacher. "It has some of that rainbow-colored water on it. I'm guessing it died from being poisoned by the polluted water."

Everyone in your class frowned and did not feel like playing anymore.

As you and your classmates started walking back to the school to go inside a tremendously large shadow passed overhead. Everyone put their hands over their eyes to see what large plane or cloud was above them. The shadow passed by again, except quicker than any shadow any of your classmates had ever seen.

"Ouch!" yelled one of your classmates.

Everyone turned around and saw that a gigantic white feather had fallen on top of one of your friends! As you ran over to help your friend, your teacher shouted, telling everyone to run under the trees as fast as possible. Some students started to ask why when everyone realized—a gigantic bird was making its way toward the class with its beak wide open! Your class ran faster than it ever had before, and before you could make it to the trees everyone had to dive underneath different pieces of playground equipment —tire tunnels, the merry-go-round and more.

Your teacher shouted for everyone to stay where they were until the coast was clear of all gulls. One student admitted they had sneaked a bag of chips out onto the playground, and asked the teacher if that might distract the gull that was chasing them. Your teacher expressed that although she was unhappy that your classmate broke the rules by bringing food onto the playground, she thought that it was a great idea. Your classmate tossed his chips out into an open space, and as soon as the enormous gull started to gobble up the ranch-flavored chips your teacher and all of your classmates ran back inside the school.

Safe inside the school, your teacher began to continue to fix her ecosystem machine while the rest of the class had a snack and talked excitedly about their day. As your class finished snack and started to clean up a tremendous crash was heard. Everyone turned expecting to see their teacher and a broken machine but instead saw a terrifying sight! A crab the size of a small car had broken through the classroom window with its claw and was trying to squeeze inside. Your class tried to escape into the hall but the door was stuck . . . there was no way out! The crab pushed by the broken glass and clattered onto your classroom floor, knocking over a few desks.

"What do we do?" your class asked your teacher.

"I'm going to push the blue button everyone . . . hold on tight!" she yelled.

Your teacher raced over to her machine, past the snapping claw of the crab and slammed down the blue button. For a split second everything went black again, but when everyone could see they saw that the crab was still there. The blue button did not work . . . or did it? Everyone ran to try to hide from the crab when they

ROCKY SHORE TALE *continued . . .*

noticed they couldn't. They were stuck to the ground! Their body had become surrounded by a hard shell.

"The blue button changes humans into organisms from the ecosystem they are currently living in!" shouted your teacher. "Since we are currently living in the rocky shore ecosystem, the blue button has changed us into barnacles. Your hard shell should protect you from the crab . . . you also have an operculum on your shell which you can shut like a door to keep the crab from getting to your body. You shut your operculum and stay inside your shell until I can get my machine fixed!"

You and your classmates all shut your operculums and could not see a thing while you heard the crab scuttling around the classroom. Once in a while you could hear your teacher shouting at the crab to stay away, and you could also hear your teacher dropping her tools onto the floor—instead of arms she only had feathery feet to use to try and fix her machine. You then heard your teacher shout "Woo hoo!" and everything went black.

When you opened your eyes you could see your classroom, your classmates, and your teacher and her machine. However, the crab was gone, the floor was dry, and everything seemed to be back to normal. Your teacher apologized for putting you and your classmates in such danger, and commented that she will never use the ecosystem machine ever again unless she knows for certain that the red button is working. Your day had been full of threats—waves, tides, changing temperatures, predators, pollution, and more. You were thankful that you could visit the rocky shore ecosystem without needing to be a member of it! You will also remember to ask to go to the nurse if you ever see one of your teacher's inventions inside your classroom again. ★

ROCKY SHORE WAVES

Topic
Waves and Change

Duration
Two sessions

Vocabulary
energy
gravity
sediment
slope
tides
waves

STANDARDS

Practices
Developing and Using Models

Core Ideas
Earth Materials and Systems

Crosscutting Concepts
Stability and Change

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2

Focus Question

What impact do waves have on rocky shore communities?

Overview

Students create a model of a rocky shore. Students discuss how waves form. Students create waves using their model to identify the impact of waves on the rocky shore. Students discuss how waves impact the rocky shore, and infer how waves impact life on the rocky shore.

Objectives

Students will be able to:

- Identify features of a rocky shore
- Determine how waves can form
- Explain how waves can impact the rocky shore

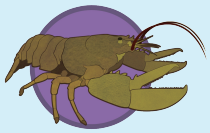
Materials Needed

Per group:

- A photo of the rocky shore (from pages 40–43)
- Large plastic container such as a dish pan
- Four cups of different-sized sediment (fine sand, course sand, gravel, and large rocks)
- Pitcher of water
- Popsicle stick or plastic spoon to make waves
- Scientist notebooks (if used in class)
- Copies of activity sheet (page 51) for each student

Teacher Preparation

1. Build a model of the rocky shore as an example for students (use four different types of sediment to create a gradual slope with the largest rocks being predominant; add water).
2. Prepare supplies for student groups (three to four students per group recommended)—fill each plastic container with a photo of the rocky shore, four cups of different-sized sediment, a popsicle stick or plastic spoon)
3. Plan on designating specific work spaces for groups.



Teacher Tips

- ★ Students are making a model of the rocky shore, so make sure the large rocks predominate.
- ★ Different-sized sediment can be purchased at local home improvement stores.
- ★ Demonstrating for students how to make waves by using the wave maker will benefit group work and their observations.

Extension Suggestions

- ★ Create a big model of the rocky shore for the classroom using a "kiddie pool." This provides the opportunity to add more props and supports the lesson with a larger example.
- ★ Have students perform the extension investigations on the Making Waves Activity Extension sheet (page 52).

Teacher Preparation (continued)

4. Each student will need a copy of the activity sheet (page 51) and a pencil.
5. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input.

Background

A rocky shore is a complex ecosystem. It is an area where the ocean meets the land, and the land is predominantly rock. Among the many large rocks are smaller rocks, sand, seaweeds and animals. The rocky shore's landscape consists of ledges, platforms, boulders and tide pools. Waves are constantly transporting and depositing sediment to various zones of the rocky shore. They are a major factor in the formation of the rocky shore ecosystem.

Waves are formed by energy passing through water, causing it to move in a circular motion. This energy often comes from the wind. They can be formed by underwater disturbances as well, such as earthquakes or volcanic eruptions. Waves are also caused by the gravitational pull of the sun and the moon—tides. Manmade objects can also create waves.

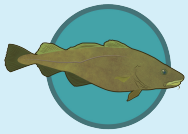
Many sizes of rocks are found on the rocky shore. Formation and displacement of sediment depends on the strength of the waves and wind as well as the slope of the land. The slope of the land can also be modified by the strength of the waves and wind and the size of the sediment present.

Procedure

1. Ask students to recall what a rocky shore looks like. Encourage them to come up with as many characteristics as possible.
2. Ask students to discuss with a classmate sitting next to them why they think a rocky shore looks the way it does. After a couple of minutes, have students share their thoughts with the class.
3. Point out that one of the reasons a rocky shore has its shape is because of the waves. Ask students how they think waves are formed. Record their answers where visible to the entire class. Make sure the following is written: wind, underwater disturbances, tides, and man-made objects. Inform students they will have a lesson on tides in the near future.
4. Show students your prepared model of a rocky shore and inform them that they will be working together in groups to create their own rocky shore.
5. Discuss the steps students need to take to create their own rocky shore, and inform them of how they are going to make waves.

Books

- ★ *Basher Science: Oceans: Making Waves!* by Dan Green
- ★ *Tsunamis* (A True Book) by Chana Stiefel
- ★ *Where Albatross Soar: A Beachside Story of Waves and Storms* by Bryan Knowles



Websites

- ★ Watch a brief video on why the ocean has waves on the National Oceanic and Atmospheric Administration website.

Scientist Notebook

- ★ Students can record how waves are formed (by energy passing through water, causing it to move in a circular motion). They can record the different ways waves can form. They can record their observations of the activity or paste their activity sheet into their notebook.

Procedure (continued)

6. Show students the activity sheet (page 51), review the questions, and advise them to follow instructions carefully.
7. Allow student groups twenty to thirty minutes to create their rocky shore, make waves, and record observations.

Wrap-up

- ★ Have groups review with the class the observations and answers they recorded on their activity sheet. If results differ, question why.
- ★ Ask students to make inferences as to what impact waves could have on living organisms at the rocky shore.
- ★ Conclude by addressing the fact that waves have a major impact on the formation of the rocky shore ecosystem.

MAKING WAVES

Name: _____

Date: _____

Make a Rocky Shore Checklist ☑

- ☐ Add cup of smallest sediment to your basin.
- ☐ Spread out sediment covering the bottom of your basin completely.
- ☐ Add cup of second smallest sediment to your plastic basin.
- ☐ Spread out sediment to cover most of the smallest sediment.
- ☐ Add cup of second largest sediment to your plastic basin.
- ☐ Spread out sediment to cover half of your second layer of sediment.
- ☐ Add cup of largest sediment to your plastic basin.
- ☐ Spread out sediment to cover half of your third layer of sediment.

Making Waves Checklist ☑

- ☐ Add water slowly to the side of your basin with the smallest sediment.
- ☐ Fill the basin until it is completely covering the smallest sediment.
- ☐ Make waves by slowly pushing water.
- ☐ Make sure you push the water in only one direction.

Record Your Observation

1. Why does the water flow downhill?

2. What caused the sediment to stop moving?

3. What types of sediment moved more? Why do you think this happened?

4. Now that you have seen the impact waves can have on the rocky shore, what inferences can you make about how waves impact life on the rocky shore?

MAKING WAVES

Name: _____

Date: _____

Activity Extension

Now that you have created a model of the rocky shore and have made some waves, try out the investigations below!

Change the Slope!

Place a book beneath one end of your basin to create a rocky shore with a larger slope.

1. What do you think will happen to the shape of the rocky shore if it has a larger slope?

_____

_____

Make some steady waves for your rocky shore with a larger slope.

2. What did you observe? Why do you think this happened?

_____

_____

Change the Size!

3. What do you think will happen to the rocky shore if you increase the size and force of your waves?

_____

_____

Make some larger, stronger waves by pushing your wave maker more forcefully.

4. What did you observe? Why do you think this happened?

_____

_____

Change the Angle!

5. What do you think will happen if you change the angle of your waves?

_____

_____

Make waves that break onto your rocky shore from different angles.

6. What did you observe? Why do you think this happened?

_____

_____

_____

_____

_____

_____

_____

THE OCEAN'S TIDES

Topic
Tides, Change

Duration
One session

Vocabulary
gravitational force
neap tides
orbit
rotation
spring tides
tides

STANDARDS

Practices
Planning and Carrying Out Investigations

Core Ideas
Forces and Motion

Crosscutting Concepts
Patterns

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2

Focus Question

What are the tides?

Overview

Students discuss the definition of tides. Students demonstrate how tides respond to the moon's gravity with a kinesthetic learning activity. Students make inferences as to how the tides might impact life on the rocky shore.

Objectives

Students will be able to:

- ★ Identify what tides are and how they occur
- ★ Dramatize the rise and fall of the tides
- ★ Infer how tides impact life on the rocky shore

Materials Needed

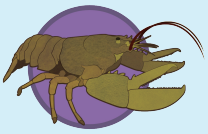
- ★ Two "markers" for each student to stand on (i.e. carpet square, Poly Spot)
- ★ Scientist notebooks (if used in class)

Teacher Preparation

1. Gather two markers for each student that can be stood on like carpet squares or Poly Spots. Avoid using an item that would need to be discarded after use.
2. Reserve a large, open area for the kinesthetic learning activities.
3. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input during the beginning and conclusion of the lesson.

Background

The tides are the steady rise and fall of the ocean water levels. Tides are caused by the gravitational interaction between the earth and the moon. The gravitational force of the moon causes the ocean to bulge out in the direction of the moon. Another bulge occurs on the opposite side of the earth because the earth is also being pulled toward the moon and away from the water on the far side. Since the earth is rotating, two tides occur each day.



Teacher Tips

- Ask your school's physical education teacher if he/she has items that would make good markers to stand on.
- Instead of having your students place the "standing markers," place them where you would prefer them to be before the lesson.

Extension Suggestions

- Have students graph where the tide will be on the day of this lesson, or on the day of their field trip if they are planning to visit the rocky shore (page 57)
- Have a student or adult film the kinesthetic group activity. Have the entire class watch the activity and provide feedback on what went right, what went wrong, and how they could improve the activity.
- Provide each student with a rubber band. Have students use their fingers to demonstrate the rise and fall of the tides, with the rubber band representing the surface of Earth's ocean.

Background (continued)

The gravitational force of the sun also impacts the tides, but because the moon is much closer to the earth, its force has a stronger impact. When the earth, the sun, and the moon are in a line, the tides are strongest. These tides are called "spring tides" and they occur during the full moon and the new moon. The weakest tides, called "neap tides," occur during quarter moons. Neap tides are the result of the gravitational forces of the moon and the sun being perpendicular to each other in regards to the earth's position.

Procedure

Part One

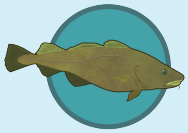
1. Have students turn to a student sitting next to them to review what they learned about waves in the previous lesson.
2. Ask one of each pair of students to relay to the class what they discussed.
3. Inform students that one way waves are formed are the tides.
4. Ask students what they know about tides. Record student input that is factual for all students to see.
5. Ask students why tides would be considered the biggest waves on the planet.
6. Write the definition of tides and the characteristics of tides for all students to see (and record if science notebooks are used).

Part Two

7. Inform students that they are going to act out the rise and fall of the tides.
8. Have students form a circle in a large, open area.
9. If there are an odd number of students, choose one student to represent the moon and have them leave the circle. If there is an even number of students, the teacher will represent the moon.
10. Give each student two markers to stand on. Tell students to take two big steps back and place one marker on the floor/ground. Tell students to take two more big steps back and place their other marker on the ground. Have students return to their original positions.
11. Inform each student that they will have a partner they will copy. Provide each student with a partner that is standing on the opposite side of the circle. Have students identify their partner by saying their name and pointing at their partner.
12. Explain to students that when the moon walks around the edge of the circle (orbiting the earth), that the students, representing the surface of the ocean, will step closer to it because of the moon's gravitational force.

Books

- ★ *And the Tide Comes In . . . Exploring a Georgia Salt Marsh* by Merryl Alber
- ★ *A Day in the Salt Marsh* by Kevin Kurtz



Websites

- ★ Watch a BrainPOP video on tides and take a quiz! (Subscription required.)

Scientist Notebook

- ★ Students can record the definition of tides and how they occur, can draw a diagram showing how tides occur, and can record inferences on how the tides might impact life on the rocky shore.

Procedure (continued)

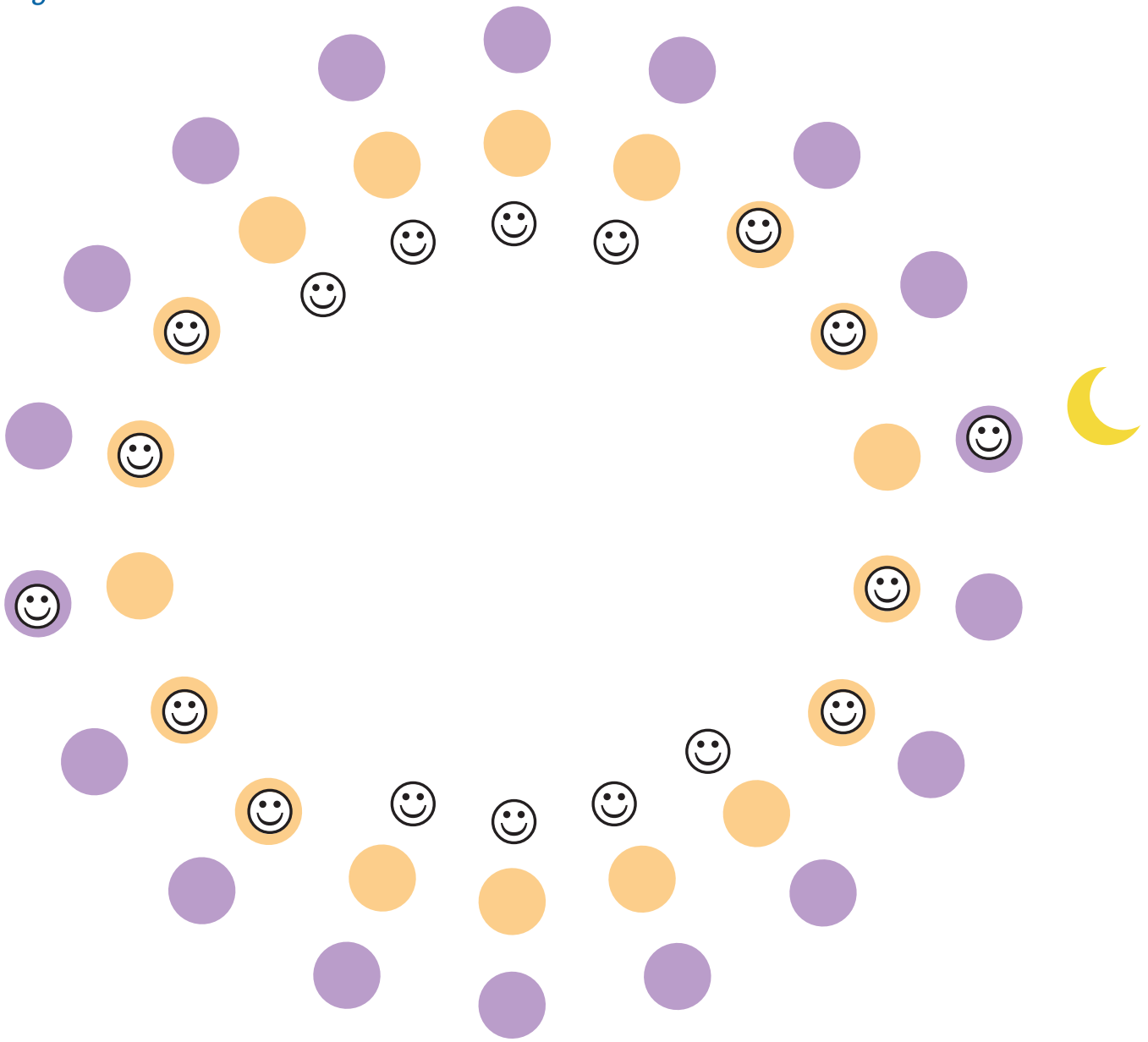
13. Explain to students that when the moon is two students away from them, they are to step onto the first marker closest to the circle. Explain to students that when the moon is directly behind them, they are to step onto the marker furthest away from the circle. Partners should be copying each other's actions because the moon's gravity pulls both the ocean and the earth, causing bulges on opposite sides of the earth. (See diagram on page 56.)
14. Have the person designated as the moon walk slowly around the circle. Have "the moon" revolve around the earth multiple times.
15. Have students pause the demonstration of the rise and fall of the tides to do the following:
    a. Assess how they are doing and how they can improve
    b. Discuss how they are demonstrating the rise and fall of the tides
    c. Identify the differences between their demonstration and what really happens (they are not demonstrating the rotation of the earth or the Sun's gravitational force on the ocean).

Wrap-up

- ★ Ask students to reflect on their kinesthetic learning activity.
- ★ Ask students to define tides and how they are caused.
- ★ Ask students to make inferences as to what impact the tides could have on living organisms at the rocky shore (students can record in science notebooks if applicable).

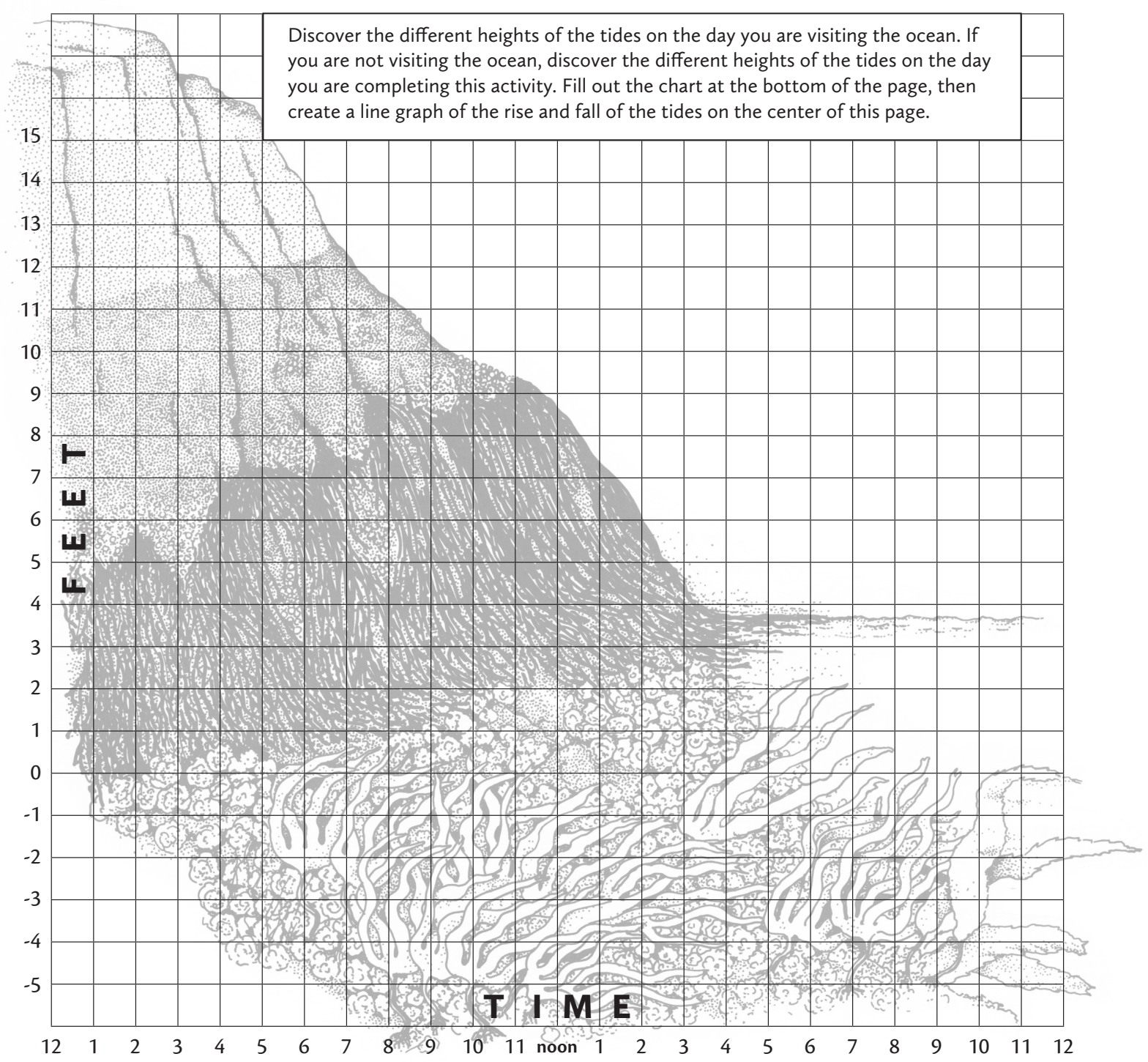
THE OCEAN'S TIDES

Learning Activity Diagram



THE OCEAN'S TIDES

Discover the different heights of the tides on the day you are visiting the ocean. If you are not visiting the ocean, discover the different heights of the tides on the day you are completing this activity. Fill out the chart at the bottom of the page, then create a line graph of the rise and fall of the tides on the center of this page.



Time of Day	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM
Height of Tide													

TAKING THE ROCKY SHORE'S TEMPERATURE

Topic
Land and Water Temperature Changes

Duration
One session

Vocabulary
absorb
density
heat energy
molecule
reflect
release
retain
temperature

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Weather and Climate

Crosscutting Concepts
Cause and Effect

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 3

Focus Question

Why is the temperature of the land and water different at the rocky shore?

Overview

Students discuss their personal experiences with temperature at the ocean or other waterways. Students investigate how the temperature varies from land to water at the rocky shore. Students make inferences as to how the temperatures might impact life on the rocky shore.

Objectives

Students will be able to:

- Discover the ability of different substances to absorb, retain and release heat at different rates
- Infer how temperatures of different substances might impact life on the rocky shore

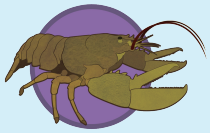
Materials Needed

Per group:

- Two aluminum foil pie pans
- Two thermometers
- One flood lamp (high watt bulb)
- One clock or stopwatch
- Sand and water
- Activity sheet per student

Teacher Preparation

1. Prepare all of the materials listed above for each group. Students need enough small rocks and water to fill three-fourths of the pie pan.
2. Make sure the lamps are plugged in and working beforehand.
3. Make sure the clocks or stopwatches are working.
4. Make sure the thermometers are working.
5. Print out the activity sheet (pages 61–62) for each student.



Teacher Tips

- To emulate saltwater in the experiment, add 35 grams of salt to every 965 grams of water.
- If necessary, review with students how to read the temperature of a thermometer.

Extension Suggestions

- If students are taking a field trip to the ocean, have them bring thermometers and record the temperature of the land and water at designated times during their visit. Have them investigate their recordings after the field trip.
- Have students add the recording of the temperature of air to their investigation. Students can prop up a thermometer in a third pie pan so it is not touching any surface and record the increase and decrease of the air temperature.

Background

As heat energy reaches a substance, the substance absorbs the heat and the temperature of the substance increases. The longer a substance is exposed to the heat source, the more heat it absorbs. If the heat source decreases in energy or is removed, the substance releases heat and the temperature of the object decreases. Some substances reflect heat rather than absorb, so the substance's temperature takes longer to increase or decrease when exposed to a heat source.

Different substances absorb, retain and release heat at different rates. Some substances absorb heat well, while other substances do not absorb heat well. For instance, dark-colored substances absorb heat more than light-colored substances. Land can absorb heat better than water because most land surfaces are darker than water. Water can also reflect the heat that reaches its surface back into the air.

The molecules of water, a liquid, are also in greater motion than molecules of land. Because water molecules are in constant motion, it takes longer for a heat source to raise the temperature of water, whereas the molecules of a solid are denser so the heat is absorbed more quickly. Because of the different densities of molecules, water also retains heat better than land and takes longer to release heat.

Procedure

Part One

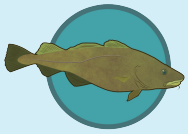
1. Review with students what they learned in the previous lesson about tides.
2. Ask students about their experiences of swimming in the ocean or lake and what they can recall about the temperature of the land and the water.
3. Most students may recall that the water was cooler than the land. Ask students why they think the water was cooler than the land and record their answers.
4. Inform students that they are going to be investigating the temperatures of land and water.
5. Clarify to students that heat and temperature are not the same thing. Heat is energy that causes objects to become warmer. Temperature is the degree of hotness or coldness of an object that can be measured using a thermometer.

Part Two

1. Inform students that they are going to work in groups to investigate the absorption, retaining, and releasing of heat by land and water.
2. Review the definitions of absorb/absorption, retain, and release.

Books

- *Super Simple Things to Do with Temperature: Fun and Easy Science for Kids* by Kelly Doudna



Websites

- Watch a clip from PBS's television show Cyberchase on the PBS LearningMedia website on how to read a thermometer.
- After the investigation, check out the Crash Course Kids YouTube Channel episode "Land and Water" which answers the question, "Which one absorbs more of the sun's energy: land or water?"

Scientist Notebook

- Students can record the definitions of absorb, retain, release and reflect. They can also record or paste their investigation observations into their notebook. Students can record their inferences of how land and water temperature could impact rocky shore organisms.

Procedure (continued)

3. Review the procedure of the investigation (the "Direction Checklist" of the activity sheet, page 61), and the students' responsibilities in their groups. Emphasize the importance of safety and working well together.
4. Review the activity sheets (pages 61–62) that each student is going to fill out in their groups.

Wrap-up

- Ask groups to refer to their activity sheets and report their findings of their investigation.
- Inform students why water takes longer to absorb and release heat than land, and why it can retain heat longer.
- Ask students to make inferences as to what impact the differences in land and water temperature could have on living organisms at the rocky shore.

TAKING THE ROCKY SHORE'S TEMPERATURE INVESTIGATION

Name: _____

Date: _____

Direction Checklist ☑

- ☐ Answer questions one and two on the next page.
- ☐ Put your thermometers under the surface of the sand and water so the thermometer bulb is completely covered.
- ☐ Place the light above the pans, turn the light on, and record the temperature of the sand and water every two minutes for twenty minutes.
- ☐ Turn the light off after twenty minutes and record the temperature of the sand and water every two minutes for twenty minutes.
- ☐ Answer questions three, four and five on the next page.

Time	Temperature	
	Land	Water
2		
4		
6		
8		
10		
12		
14		
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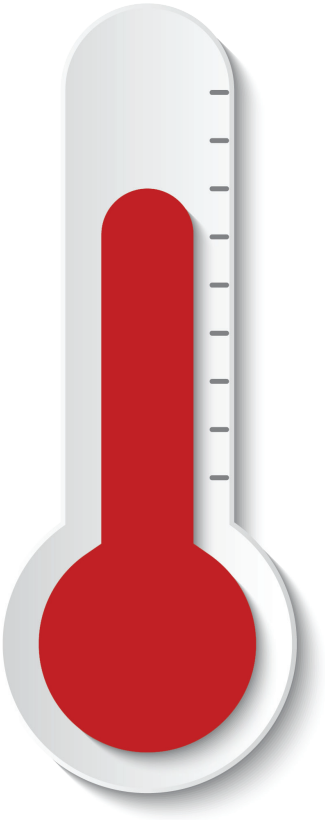
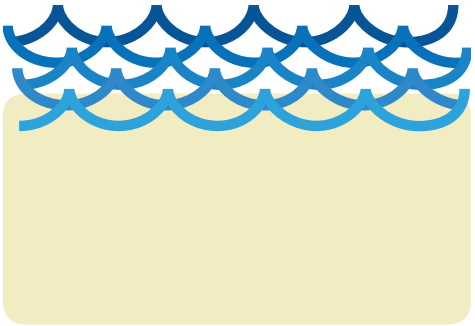




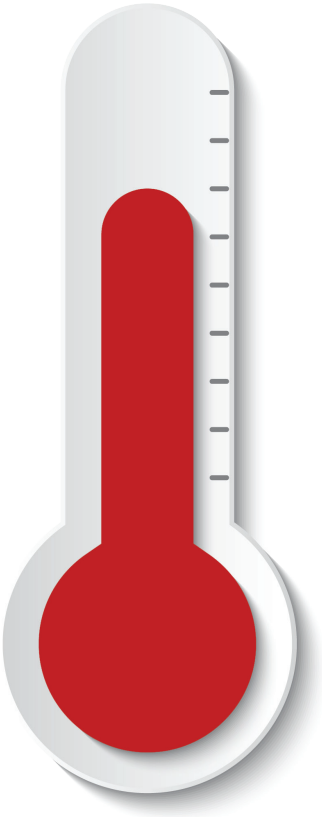
TAKING THE ROCKY SHORE'S TEMPERATURE INVESTIGATION

Name: _____

Date: _____

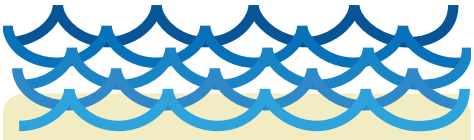
1. Do you think land or water will absorb heat more quickly? Why?

2. Do you think land or water will release heat more quickly? Why?



3. Did the land or water absorb more quickly? Why do you think this happened?

4. Did the land or water release heat more quickly? Why do you think this happened?



5. Did the land or water retain heat longer (did land or heat cool down more slowly)? Why do you think this happened?

CREATE-A-CRITTER *Part One*

Topic
Adaptations, Change

Duration
Two sessions

Vocabulary
adapt
adaptation
ecosystem
environment
pollution
predator
prey
salinity

STANDARDS

Practices
Engaging in Argument from Evidence

Core Ideas
Structure and Function

Crosscutting Concepts
Cause and Effect

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is an adaptation?

Overview

Students recall the different challenges living organisms encounter at the rocky shore. Students discuss the definition of adaptation. Students generate a list of possible adaptations living organisms may have to survive the different challenges of the rocky shore ecosystem. Students design and create a fictitious organism with adaptations that would allow it to survive the rocky shore ecosystem. Lesson 7 and Lesson 19 are connected lessons which teachers can utilize as formative pre- and post-assessments.

Objectives

Students will be able to:

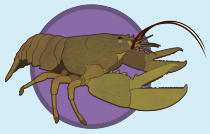
- ★ Identify the term "adaptation"
- ★ Recognize the challenges living organisms encounter at the rocky shore
- ★ Construct a fictitious rocky shore organism with adaptations

Materials Needed

- ★ Rocky Shore Ecosystem Challenges activity sheet, page 67 (one per student)
- ★ Create-A-Critter Design activity sheet, page 68 (one per student)
- ★ 5 index cards per student
- ★ Scissors (one per student)
- ★ Transparent adhesive tape / tape dispensers (one per group)

Teacher Preparation

1. Each student will need a copy of the Rocky Shore Ecosystem Challenges activity sheets and the Create-a-Critter Design activity sheet (pages 66–67, 68).
2. Separate index cards into groups of five for each student.
3. Prepare scissors—one per student.
4. Prepare transparent adhesive tape dispensers so there are enough dispensers for student groups of three to four students per group.
5. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input.



Teacher Tips

- ★ Have students share their "critters" by doing a class walk—have students leave their critters and design sheets on their desks and visit each other's creations.
- ★ Borrow tape dispensers from other teachers for this one class session to save time and money.

Extension Suggestions

- ★ Have students create a zoo plaque for the critter they created. Have students include the name of the critter, a Latin name, habitat, size, appearance, diet, threats, etc. Show students photos of plaques of animals found at zoos. Students could also include drawings of their critters as well as a map of the world indicating where their critters can be found.

Background

An adaptation is a body part or a behavior that helps a living thing survive in its environment. Rocky shore organisms need adaptations to survive the harsh and constantly changing environment of their rocky shore ecosystem. These challenges include some of the following: the waves, the tides, the temperatures, finding food, and evading predators. Other challenges to rocky shore organisms include the flux of salinity levels of the saltwater, various ranges of light, as well as human factors such as pollution and carelessness when visiting the rocky shore.

Some adaptations of rocky shore organisms include: thick shells, round shells, impermeable shells, the ability to retain water, holdfasts, secreted substances that allow organisms to attach well to rocks, spiny bodies, regeneration, exoskeletons, gathering in groups, camouflage, filter feeding, seeking crevices for shelter, burrowing abilities, ability to lower metabolic rates, and many more!

Procedure

Part One

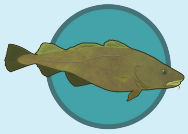
1. Ask students what humans do differently to adapt to winter weather. Have students share their answers.
2. Inform students that to adapt means to change something about your appearance, behavior or surroundings in order to make living and surviving easier.
3. Have students refer back to the inferences they have made over the past few lessons of how rocky shore organisms can survive their constantly changing ecosystem.
4. Inform students that rocky shore organisms all have something called adaptations—body parts or behaviors that help a living thing survive in its environment.
5. Have students get into groups of three or four to fill out the Rocky Shore Ecosystem Challenges activity sheet (page 67).
6. When students complete their lists, have them share their inferences and record them somewhere for all students to see. Save this list to share with the class for a future lesson! Students may bring their own sheets home, or paste them into their science notebooks (if applicable).

Part Two

7. Inform students that they are going to be creating a fictitious rocky shore organism that can survive the challenges of the rocky shore.
8. Inform students that they will be creating their "critter" with only five index cards, scissors and tape.

Books

- ★ *Crabby and Nabby: A Tale of Two Blue Crabs* by Suzanne Tate
- ★ *Spiny Sea Star: A Tale of Seeing Stars* by Suzanne Tate



Websites

- ★ Check out the Crash Course Kids YouTube Channel episode titled Living Things Change which answers the question, "What can happen to living things when the world around them changes?"
- ★ Watch a BrainPOP video on ecosystems and take the quiz! (Subscription required.)

Scientist Notebook

- ★ Students can record the definition of adaptation, ecosystem and environment. Students can paste the *Rocky Shore Ecosystem Challenges* activity sheet into their notebook.

Procedure (continued)

9. Review the Create-a-Critter Design activity sheet (page 68) with students.
10. Have students get back into their previous groups if they are not in them already so that they can share transparent adhesive tape/tape dispensers.
11. Have students create their rocky shore organisms and complete the Create-a-Critter Design activity sheets.
12. If there's time, have students share their critters and their critters' adaptations with either their groups or the entire class.
13. Collect the Create-a-Critter Design activity sheets and the students' critters for a future lesson. If desired, you can display their critters.

Wrap-up

- ★ Ask students to identify the main challenges rocky shore organisms encounter regularly.
- ★ Ask students to define "adaptation."
- ★ Remind students that adaptations are the body parts or behaviors that rocky shore organisms use to live or survive easier in their constantly changing ecosystem.

ROCKY SHORE ECOSYSTEM CHALLENGES

Name: _____

Date: _____

The chart on the next page lists five of the main challenges rocky shore organisms encounter in their effort to survive. Rocky shore organisms have adaptations that enable them to survive these challenges.

With your group, come up with a list of adaptations you think rocky shore organisms may have to survive their rocky shore ecosystem.

Tip for Students: Take turns sharing your ideas by choosing one person to start the list with one idea. Continue to share ideas by having each student share one idea, taking turns in a clockwise direction.

Challenges

Waves

Waves are constantly beating against the rocky shore. Sometimes the waves are small and gentle and sometimes the waves are large and strong. This means waves can be crashing into organisms above land, or causing the water to move around organisms living under the water.

Tides

Tides cause the level of the ocean to rise and fall twice a day. This means that some organisms spend part of the day living above the water and part of the day living under the water.

Changing Temperatures

The temperature of the rocky shore's ocean water, rocks and sand, and air can change a lot during the day and throughout the year. This means organisms need to be able to survive both warm and dry conditions, and cold and wet conditions.

Finding Food

Food can be difficult for organisms to find or eat because different types of prey have adaptations that help them hide well or allow them to defend themselves well. It can also be difficult to find food because the constant changing of the environment can move organisms away from food sources (or food sources away from organisms).

Avoiding Predators

Predators can be difficult to avoid because they have adaptations that help them hunt well. It can also be difficult to avoid predators because the constant changing of the environment can expose organisms to predators.

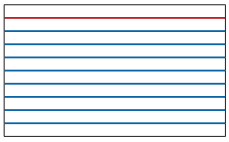
ROCKY SHORE ECOSYSTEM CHALLENGES

Name: _____

Date: _____

	Waves	Tides	Changing Temperatures	Finding Food	Avoiding Predators
Adaptations	1.	1.	1.	1.	1.
	2.	2.	2.	2.	2.
	3.	3.	3.	3.	3.
	4.	4.	4.	4.	4.
	5.	5.	5.	5.	5.

CREATE-A-CRITTER DESIGN



Name: _____

Date: _____

Draw a sketch of your critter here.

Your critter's species: _____

(for example: snail, crab, fish)

Your critter's name: _____

Your critter's adaptations:

1. _____
2. _____
3. _____
4. _____
5. _____

How do your critter's adaptations help it survive?

_____

_____

_____

_____

ROCKY SHORE ZONES: THE SPLASH ZONE

Topic
Zones, Adaptations

Duration
Two sessions

Vocabulary
adaptation
challenge
feature
splash zone
zone

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Adaptation

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the splash zone?

Overview

Note: Lessons 8, 10, 12, 14, and 16 are connected and can be taught consecutively or according to the unit schedule. Students recall what challenges rocky shore organisms encounter, as well as review the question, "What is an adaptation?" Students discover that the rocky shore has been divided into zones by marine biologists based on the average water and air exposure of each area. Students record information about the splash zone's names, characteristics, common plant life, and common animal life. Students begin to construct a bulletin board diagram or individual rocky shore zone diagram by creating the splash zone using art supplies.

Objectives

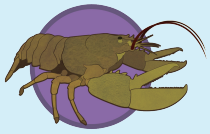
Students will be able to:

- Indicate that the rocky shore can be divided into zones
- Identify the splash zone and its features
- Recognize the challenges living organisms encounter in the splash zone and the different adaptations of organisms living in the splash zone
- Create a splash zone using art supplies

Materials Needed

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, page 73)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 74)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 18)
- A large bulletin board or blank wall
- White bulletin board art paper
- White paper/index cards for each student
- Coloring utensils for each student
- Scissors for each student
- Stapler (for teacher)



Teacher Tips

- When creating the large classroom diagram of the rocky shore, secure a piece of twine or yarn to each side of the board or wall to use as a guide to draw straight lines to designate the zones.
- While instructing students about the splash zone using the Rocky Shore Zones Table either project a copy of the table on the board or draw a table on a whiteboard to record information for all students to see.
- Make copies of the Rocky Shore Zones Table Answer Key for students with special needs to use at their own desks to either copy or highlight.

Materials Needed (continued)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, page 73)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 74)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 18)
- Coloring utensils for each student

Teacher Preparation

1. Determine whether the class will create a large diagram of the rocky shore together or each student will create their own diagram of the rocky shore using the My Rocky Shore Diagram activity sheet.
2. For the large classroom diagram:
    a. Reserve a large bulletin board or blank wall and cover it with white bulletin board art paper.
    b. Draw an outline of a rocky shore gradually descending from the top of one side of the bulletin board/wall to the bottom of the other side of the bulletin board/wall (use My Rocky Shore Diagram as an example).
    c. Measure out five equal spaces and divide the paper by drawing five sections using a black marker (use My Rocky Shore Diagram as an example).
    d. Make copies of the Rocky Shore Zones Table and the Atlantic Ocean Rocky Shore Guide for each student.
    e. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
    f. Prep scissors, drawing utensils, and white paper/index cards for each student.
3. For the individual student diagram:
    a. Make copies of My Rocky Shore Diagram, Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide for each student.
    b. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
    c. Prep drawing utensils for each student.

Extension Suggestions

- Have students participate in a research project by creating a classroom field guide during reading or writing sessions. Have each student research a particular rocky shore organism, and have them discover and record the following: habitat, body parts, movement, diet, predators, life cycle, protection, and other interesting facts. Use the Student Field Guide sheets (pages 75–76) for students to record or type their research. When finished, bind and laminate and bring along on a rocky shore field trip (if possible).

Books

- *Oscar the Herring Gull* by Nancy M. Donovan
- *A Field Guide to the Atlantic Seashore: From the Bay of Fundy to Cape Hatteras* (Peterson Field Guides) by Kenneth L. Gosner

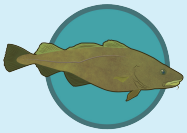
Procedure

Part One

1. Ask students if they can recall why parts of the rocky shore are under water most or all of the time, and why other parts of the rocky shore are under water very little of the time. (Answer: the tides.)
2. Inform students that the tides create natural zones at the rocky shore.
3. Ask students how they would define the term "zone."
4. Inform students that a zone can be an area of land that has particular features. Each zone of the rocky shore has particular features, including specific amounts of time they are exposed to air and water, specific living organisms, and specific challenges to an organism's survival.
5. Inform students that they are going to be learning about the five zones of the rocky shore ecosystem, and today they are going to learn about the splash zone.
6. Provide each student with a copy of the Rocky Shore Zones Table.
7. Instruct students on the names, features, algae and animal life of the splash zone.
8. Emphasize the challenges to life in the splash zone, specifically citing the organisms' adaptations that allow them to survive these challenges.

Part Two

9. Inform students that they are going to be creating a rocky shore diagram either as a class or individually.
10. If as a class:
    a. Provide each student with the Atlantic Ocean Rocky Shore Guide.
    b. Provide each student with white paper or index cards, scissors, and drawing utensils.
    c. Divide students into groups and designate each group specific organisms to draw and color for the splash zone.
    d. When finished, have students cut out their organisms, and the teacher will attach them to the bulletin board or wall diagram.
11. If individually:
    a. Provide each student with the Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram.
    b. Inform students that they are going to draw the specific organisms of the splash zone onto their My Rocky Shore Diagram.



Websites

- Watch "The Wild Classroom" video titled the "Intertidal Biome" on YouTube or their website.
- Go to "All Things Animal TV" YouTube Channel and check out their video on seagulls.

Scientist Notebook

- Students can record the definition of zones. Students can record or paste their Rocky Shore Zones Table facts. Students can record the challenges and adaptations of organisms found at the splash zone.

Wrap-up

- Have students store their Rocky Shore Zones Table, Atlantic Ocean Rocky Shore Guide, and My Rocky Shore Diagram (if applicable) in a secure place to refer to in upcoming lessons.
- Ask students to define the term "zone."
- Have students recall the features of the splash zone and its living organisms.
- Have students recall the specific adaptations of splash zone organisms.

ROCKY SHORE ZONES TABLE

Name: _____

Date: _____

Name of Rocky Shore Zone: _____

Zone Name	
Zone Features	
Zone Algae	
Zone Animals	

ROCKY SHORE ZONES TABLE

Answer Key

Name of Rocky Shore Zone: Splash zone

Zone Name	Splash zone
Zone Features	This zone is closest to the land and is always exposed to air except for rain or waves from major storms. It has few algae or animals because there is little shelter or food sources, as well as predatory birds.
Zone Algae	Lichen, Cyanobacteria
Zone Animals	Seashore Springtail, Rough Periwinkle, Herring Gull, Great Black-backed Gull, Spotted Sandpiper

STUDENT FIELD GUIDE

Organism: _____

Main Idea	Supporting Details
Habitat	
Body Parts	
Color	
Life Cycle	
Diet	
Predators	
How They Move	
Protection	
Interesting Facts	

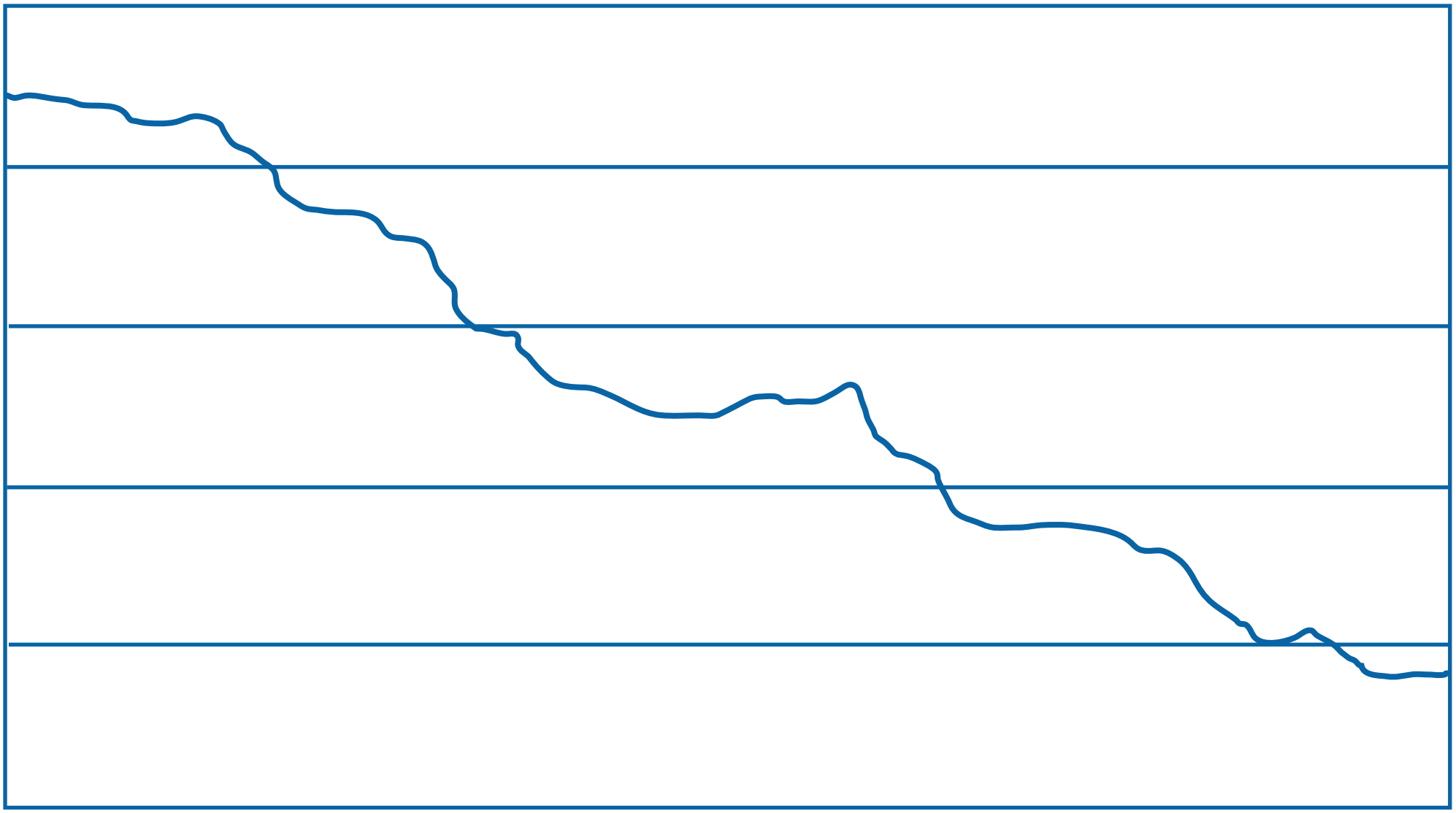
STUDENT FIELD GUIDE

*Organism:*_____

*Illustration by:*_____

MY ROCKY SHORE DIAGRAM

Name:_____



HUNGRY BIRDS

Topic
Adaptations, Change

Duration
One session

Vocabulary
adaptation
beak (bill)
carnivore
forage
lower mandible
omnivore
shorebird
upper mandible

STANDARDS

Practices
Developing and Using Models

Core Ideas
Structure and Function

Crosscutting Concepts
Cause and Effect

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

Why do shorebirds have beaks that are shaped differently?

Overview

Students examine photos of a herring gull (*Larus smithsonianus*) and a spotted sandpiper (*Actitis macularius*). Students use manmade tools that are similar to the shapes of these shorebirds' beaks to attempt to pick up objects of various sizes. Students predict what types of food these shorebirds eat and how they catch their prey based on their photo examinations and tool experiment. Students discover and record how each bird hunts and what each bird eats.

Objectives

Students will be able to

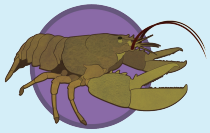
- Identify the "beak" of shorebirds and their specific functions
- Explain how different shorebirds use their beaks for different tasks
- Compare and contrast the herring gull (*Larus smithsonianus*) and spotted sandpiper (*Actitis macularius*)

Materials Needed

- Herring Gull Photo Page and Spotted Sandpiper Photo Page (one per group, pages 82, 83)
- Salad tongs or whisk tongs and needle-nose pliers (two per group)
- Four different-sized objects the size of a fish, egg, blue mussel, and small insect (one set of objects per group—see Teacher Tips)
- Hungry Birds activity sheet (one per student, page 81)

Teacher Preparation

1. Each student will need a copy of the Hungry Birds activity sheet.
2. Each group will need a copy of the Spotted Sandpiper Photo page and Herring Gull Photo page.
3. Prepare salad tongs or whisk tongs, needle-nose pliers and different-sized objects for each group.
4. Teachers will need easy access to a whiteboard or interactive whiteboard to record facts to assist with completing the Hungry Birds activity sheet.



Teacher Tips

- ★ Suggestions for objects for the manmade tool experiment include one bottle of water, one tennis ball, one pink eraser, and a small marble or pom-pom.
- ★ Use a Venn Diagram to further demonstrate the similarities and differences between the herring gull and spotted sandpiper.

Extension Suggestions

- ★ Take a walk with students outside of the school and have them observe the birds and take notes on their characteristics. Use this as either a starter for this lesson, or as an extension to further discuss the concept of adaptations and specialized body parts of birds.

Background

Birds, including those found at the rocky shore, have beaks that are different shapes and sizes. A bird's beak has two parts—the upper mandible and the lower mandible. The upper mandible grows out of the skull and does not move independently from the skull. The lower mandible can move independently like a human jaw because it is hinged. A bird's beak is covered with skin that produces a substance called keratin. The keratin helps make the beak hard and durable.

Birds' beaks have many different functions. They can be used for catching and eating prey, grooming, making nests, protection, courtship, and feeding their young. Two specific birds found at the rocky shore are the herring gull (*Larus smithsonianus*) and the spotted sandpiper (*Actitis macularius*). These two shorebirds have distinctively shaped beaks. The herring gull's beak is a large, slightly hooked yellow bill with a red spot on the end. The spotted sandpiper's beak is a straight and slender orange bill with a black tip.

The herring gull is an omnivore and eats almost anything including mussels, crabs, sea urchins, small mammals, insects, birds, eggs, carrion, and garbage. They obtain their food in many ways such as diving into the water for food or taking it from the surface of the water, scavenging for food on land, dropping prey such as clams and mussels on rocks to break them open, and they also steal from other birds.

The spotted sandpiper is a carnivore and eats insects, crustaceans, worms, mollusks, and more. They obtain their food by foraging along the edge of the ocean, lakes, and streams. They walk back and forth and then dart at their prey. Sometimes they catch insects in the air. While hunting for food, spotted sandpipers will often bob their tail up and down which has earned them the nickname of "teeter-tail."

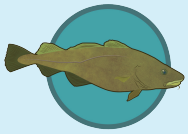
Procedure

Part One

1. Ask students what types of birds they see on the playground or in their yard.
2. Ask students to recall the differences they have seen in the types of birds they mentioned.
3. Inform students that shorebirds—birds that reside or frequently visit the ocean's shore—have similar differences such as size, color, shape, and behavior.
4. Emphasize that one major difference between shorebirds is the size and shape of their beaks, and an example of shorebirds with different-sized beaks are the herring gull (*Larus smithsonianus*) and the spotted sandpiper (*Actitis macularius*). Inform students of the Latin form of the names as well.

Books

- ★ *Salty Seagull: A Tale of an Old Salt* by Suzanne Tate
- ★ *Shorebirds* by Melissa Stewart



Websites

- ★ Check out photos and videos of the American herring gull and the spotted sandpiper at the Internet Bird Collection website!
- ★ Watch a BrainPOP video on birds and take the quiz! (Subscription required.)

Scientist Notebook

- ★ Students can record the definitions of shorebirds, forage, omnivore, and carnivore. Students can paste the Hungry Birds activity sheet into their notebook.

Procedure (continued)

5. Ask students why they think birds have different-sized beaks.
6. Inform students of the various functions of birds' beaks.
7. Inform students that they are going to look at photos of the two shorebirds mentioned, as well as use manmade tools to pick up objects that are similar in shape and size to these shorebirds, in order to predict 1) what types of prey these shorebirds hunt, and 2) how these shorebirds hunt for food.

Part Two

8. Have students get into groups of three or four to examine the Spotted Sandpiper Photo Page and the Herring Gull Photo Pages (pages 82, 83).
9. Have each student in each group take turns picking up objects with the manmade tools (salad tong or whisk tong and needle-nose pliers).
10. Have each student fill out the Hungry Birds activity sheet (page 81).
11. When students complete their predictions, have them share their predictions with the class and record them for everyone to see.
12. Share the facts of what each shorebird eats and how each shorebird hunts using the information in the "Background" section and have students record the answers on their Hungry Birds activity sheet.

Wrap-up

- ★ Ask students to identify the different functions of a bird's beak.
- ★ Ask students to recall the similarities and the differences of the herring gull and the spotted sandpiper.
- ★ Remind students that adaptations are the body parts or behaviors that organisms use to live or survive easier in their ecosystem, and that shorebirds have adaptations, too—including their beaks.
- ★ Students may bring their own sheets home, or paste them into their science notebooks (if applicable).

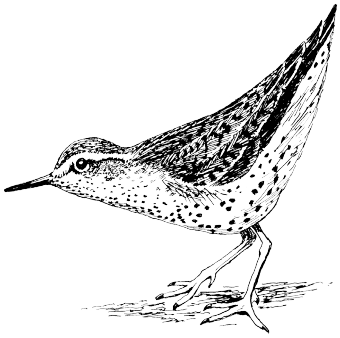
HUNGRY BIRDS

Name: _____

Date: _____

Directions

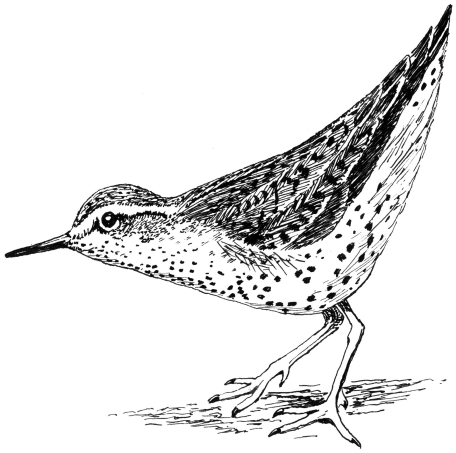
Look at the photos of the Herring Gull and the Spotted Sandpiper. Attempt to pick up objects using the tongs and the pliers. Make predictions below of how you think each bird hunts and what each bird eats.



	Herring Gull (Larus smithsonianus)		Spotted Sandpiper (Actitis macularius)	
	Your Predictions	What is Fact	Your Predictions	What is Fact
How do they hunt?				
What do they eat?				

HERRING GULLS

SPOTTED SANDPIPERS



ROCKY SHORE ZONES: THE UPPER INTERTIDAL ZONE

Topic
Zones, Adaptations

Duration
Two sessions

Vocabulary
adaptation
challenge
feature
upper intertidal zone
zone

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Adaptation

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the upper intertidal zone?

Overview

Students recall that the rocky shore has been divided into zones by marine biologists based on the average water and air exposure of each area. Students discuss what they learned about the splash zone. Students record information about the upper intertidal zone's names, characteristics, common algae life and common animal life. Students continue to construct a bulletin board diagram or individual rocky shore zone diagram by creating the upper intertidal zone using art supplies.

Objectives

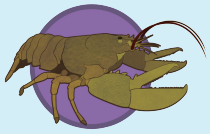
Students will be able to:

- Indicate that the rocky shore can be divided into zones
- Identify the upper intertidal zone and its features
- Recognize the challenges living organisms encounter in the upper intertidal zone and the different adaptations of organisms living in the upper intertidal zone
- Create an upper intertidal zone using art supplies

Materials Needed

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, page 88)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 89)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 19)
- A large bulletin board or blank wall
- White bulletin board art paper
- White paper/index cards for each student
- Coloring utensils for each student



Teacher Tips

- Have students use the Atlantic Ocean Rocky Shore Guide as a reference as they draw their rocky shore organisms. Use book illustrations or other printed resources if you need more examples.
- While instructing students about the upper intertidal zone using the Rocky Shore Zones Table, either project a copy of the table on the board or draw a table on a whiteboard to record information for all students to see.
- Make copies of the Rocky Shore Zones Table Answer Key for students with special needs to use at their own desks to either copy or highlight.

Materials Needed (continued)

- Scissors for each student
- Stapler (for teacher)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, page 88)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 89)
- Life at the Rocky Shore Fact Sheet (for teacher reference, page 19)
- Coloring utensils for each student

Teacher Preparation

For the large classroom diagram:

1. Make sure all students have copies of the Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep scissors, drawing utensils, and white paper/index cards for each student.

For the individual student diagram:

1. Make sure all students have copies of My Rocky Shore Diagram, Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep drawing utensils for each student.

Background

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. These zones are mainly defined by the amount of time they are exposed to water and air. Specific organisms can often be found inhabiting particular zones.

Although types of living organisms are often found in one specific zone, they can be located in different zones depending on their ability to survive in various regions of the rocky shore. Zones are not restrictive, and will vary tremendously by slope, exposure, size of loose rocks, etc. While using the term "zone" is common and helpful, it can also mislead if students think that barnacles can only exist in the "barnacle zone."

Extension Suggestions

★ Have students participate in a classroom "Rocky Shore Reading Challenge!" Each student is given a Rocky Shore Challenge Reading List (page 92) to fill out as they read either at home or at school (or both) and a My Rocky Shore Creatures template (page 93). This template can be attached to the students' desks or a location of choice. Each ten chapters (or books) a student reads, the student receives one rocky shore creature to paste to their My Rocky Shore Creatures template. Teachers can cut these images out of the Rocky Shore Reading Challenge Images sheet (pages 90–91). Once students read 100 chapters (or 100 books) they have completed the Rocky Shore Reading Challenge.

Background (continued)

Each rocky shore zone presents living organisms with challenges that risk their survival. These living organisms have adaptations that enable them to overcome these challenges and thrive in the rocky shore ecosystem conditions.

The rocky shore ecosystem is frequently divided into three zones: the upper intertidal zone, the middle intertidal zone, and the lower intertidal zone. This ecosystem can be divided more precisely into five zones: the splash zone, the upper intertidal zone, the middle intertidal zone, the lower intertidal zone, and the subtidal zone.

Procedure

Part One

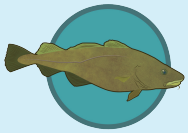
1. Ask students if they can recall how the rocky shore is divided into zones.
2. Inform students that a zone can be an area of land that has particular features. Each zone of the rocky shore has particular features, including specific amounts of time they are exposed to air and water, specific living organisms, and specific challenges to an organism's survival.
3. Have students discuss what they have learned about the splash zone by referring to their Rocky Shore Zones Table.
4. Inform students that they are going to be learning about the upper intertidal zone.
5. Instruct students on the names, features, algae, and animal life of the upper intertidal zone, having each student record facts you provide them with in their Rocky Shore Zones Table.
6. Emphasize the challenges to life in the upper intertidal zone, specifically citing the organisms' adaptations that allow them to survive these challenges.

Part Two

7. Inform students that they are going to continue to work on their rocky shore diagram, either as a class or individually.
8. *If as a class:*
    a. Have students access their Atlantic Ocean Rocky Shore Guide.
    b. Provide each student with white paper or index cards, scissors and drawing utensils.
    c. Divide students into groups and designate each group specific organisms to draw and color for the upper intertidal zone.
    d. When finished, have students cut out their organisms, and the teacher will attach them to the bulletin board or wall diagram.

Books

- ★ *Happy Hermit Crab, A Tale of Shell Seekers* by Suzanne Tate
- ★ *A House for Hermit Crab* by Eric Carle



Websites

- ★ Watch PBS Digital Studios Under H_2O video titled "The Intertidal" on YouTube.
- ★ Watch the Delaware Sea Grant YouTube Channel and their video titled "Barnacles."
- ★ Watch the Seacoast Science Center YouTube Channel and their video titled "Northern Rock Barnacle Feeding."

Scientist Notebook

- ★ Students can record the challenges and adaptations of organisms found at the upper intertidal zone.

Procedure (continued)

If individually:

a. Have students access their Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram.
b. Inform students that they are going to draw the specific organisms of the upper intertidal zone onto their My Rocky Shore Diagram.

Wrap-up

- ★ Have students store their Rocky Shore Zones Table, Atlantic Ocean Rocky Shore Guide, and My Rocky Shore Diagram (if applicable) in a secure place to refer to in upcoming lessons.
- ★ Have students recall the features of the upper intertidal zone and its living organisms.
- ★ Have students recall the specific adaptations of the upper intertidal zone organisms.

ROCKY SHORE ZONES TABLE

Name: _____

Date: _____

Name of Rocky Shore Zone: _____

Zone Name	
Zone Features	
Zone Algae	
Zone Animals	

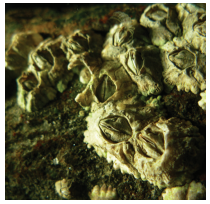
ROCKY SHORE ZONES TABLE

Answer Key

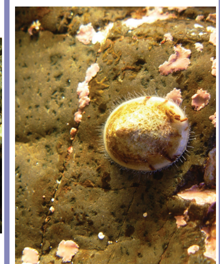
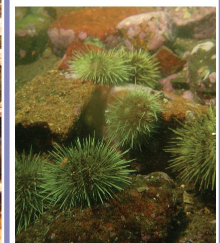
Name of Rocky Shore Zone: Upper intertidal zone

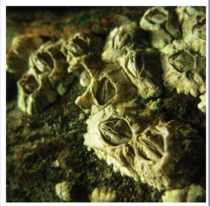
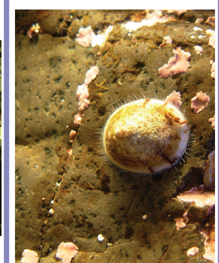
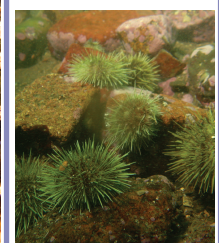
Zone Name	Upper intertidal zone
Zone Features	This zone is mainly exposed to air except for at extreme high tides. Tide pools start to appear in the upper intertidal zone (pools of saltwater left behind when the tide goes out; many living organisims can be found in tide pools).
Zone Algae	Cyanobacteria
Zone Animals	Scud, Common Periwinkle, Rock Barnacle, New England Dog Whelk, Northern Hermit Crab

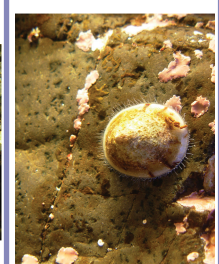
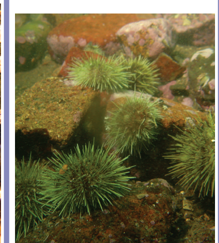
ROCKY SHORE CHALLENGE!

								
Periwinkle	Dog Whelk	Blue Mussel	Barnacle	Limpet	Green Sea Urchin	Sea Star	Green Crab	Lobster
10 Chapters	20 Chapters	30 Chapters	40 Chapters	50 Chapters	60 Chapters	70 Chapters	80 Chapters	100 Chapters

ROCKY SHORE CHALLENGE IMAGES

								
Periwinkle	Dog Whelk	Blue Mussel	Barnacle	Limpet	Green Sea Urchin	Sea Star	Green Crab	Lobster

								
Periwinkle	Dog Whelk	Blue Mussel	Barnacle	Limpet	Green Sea Urchin	Sea Star	Green Crab	Lobster

								
Periwinkle	Dog Whelk	Blue Mussel	Barnacle	Limpet	Green Sea Urchin	Sea Star	Green Crab	Lobster

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ROCKY SHORE CHALLENGE READING LIST

Name:

Book	Chapter	Date
1. _____		
2. _____		
3. _____		
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

You have earned: _____!

ROCKY SHORE CHALLENGE READING LIST

Name:

Book	Chapter	Date
1. _____		
2. _____		
3. _____		
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

You have earned: _____!

MY ROCKY SHORE CREATURES

Name: _____

Periwinkle	Dog Whelk	Blue Mussel	Barnacle	Limpet	Green Sea Urchin	Sea Star	Green Crab	Lobster

TIDE POOL PAINTING

Topic
Tide Pool, Adaptations

Duration
Two sessions

Vocabulary
adaptation
intertidal zones
tide
tide pool

STANDARDS

Practices
Engaging in Argument from Evidence

Core Ideas
Ecosystem Dynamics, Functioning, and Resilience

Crosscutting Concepts
Scientific Knowledge Assumes an Order and Consistency in Natural Systems

OCEAN LITERACY PRINCIPLES

OLP 2, OLP 5

Focus Question

What is a tide pool?

Overview

Students make inferences of what a tide pool is based on their prior knowledge and experiences. Students identify the term "tide pool." Students listen to the book *Between the Tides* by Fran Hodgkins (or another book on tidal pools) and create a T-Chart of the knowledge they learned from the reading. Students illustrate the knowledge they have learned from the non-fiction book by creating a mixed-media piece of art.

Objectives

Students will be able to:

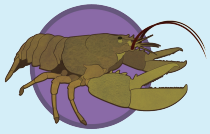
- Identify the term "tide pool"
- Identify different organisms that reside in a tide pool
- Explain how a tide pool is formed, how it can be a harsh environment, and what adaptations organisms have that enable them to survive in a tide pool
- Illustrate a tide pool using mixed-media by referring to the knowledge they have attained

Materials Needed

- Tide Pool T-Chart (one per student, page 97)
- Blank white paper (two per student)
- Pencils
- Watercolor paints
- Scissors
- Glue

Teacher Preparation

1. Each student will need a copy of the Tide Pool T-Chart activity sheet.
2. The teacher will need a copy of Fran Hodgkins' book *Between the Tides*. Other tide pool books could be substituted for this lesson.
3. Prepare art supplies for each student.
4. Teachers will need easy access to a whiteboard or interactive whiteboard to record Tide Pool T-Chart feedback.



Teacher Tips

- ★ Instead of students drawing organisms, teachers can print out actual photographs or illustrations of tide pool organisms for students to cut out and paste to their watercolor painting.
- ★ Read the story to the students more than once.
- ★ Students could fill out their Tide Pool T-Chart as the story is being read.

Extension Suggestions

- ★ Have students participate in "Tide Pool Math" activities created by the Bureau of Ocean Energy Management.

Books

- ★ *Between the Tides* by Fran Hodgkins
- ★ *Ocean Soup: Tide Pool Poems* by Stephen R. Swinburne

Background

Tide pools are shallow bodies of saltwater that are left behind when the tide recedes. Tide pools are found in the intertidal zones of the rocky shore. Tide pools are homes to many organisms that need to be able to survive very harsh conditions. These harsh conditions include the power of the waves and currents, the fluctuation of temperature, the fluctuation of salinity and oxygen levels, and the openness to predators.

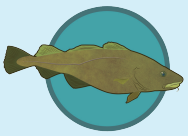
Procedure

Part One

1. Ask students to recall the definition of a tide.
2. Ask students to define the word "pool."
3. After listening to student answers, ask students to use their knowledge of tides and experiences with pools to infer what the term "tide pool" means.
4. Tell students and write visibly for all students the definition of a tide pool: a shallow body of saltwater that is left behind when the tide recedes (goes out).
5. Explain to students that tide pools occur in the intertidal zones and are the home to many organisms that need to be able to survive very harsh conditions.
6. Ask students why a tide pool would be considered a harsh place to live.
7. Inform students that you are going to read a book about tide pools titled *Between the Tides* by Fran Hodgkins. Ask them to listen closely for the different adaptations each organism has that are mentioned in the book.
8. When the reading is finished, assist students in filling out their Tide Pool T-Chart.

Part Two

9. Inform students that they are going to be creating a tide pool painting.
10. Provide students with the following steps to help guide them as they create their tide pool painting:
    a. Have your blank paper in a horizontal (hot dog) position.
    b. With a pencil, draw a line three-fourths from the bottom of the paper.
    c. With a pencil, draw an outline of a tide pool showing the rocks beneath and above the water (i.e. from the point of view of a sea urchin).
    d. With watercolor paints, paint the rocks above the water but not under the water.



Websites

- ★ Check out a quick time-lapse video of a tide pool as the tide comes in at the Seacoast Science Center's YouTube Channel titled "Rising Tide."
- ★ Check out a video on a tide pool touch tank and its many organisms on the Seacoast Science Center's YouTube Channel titled "#OceanRunnerNH: Tide Pool Touch Tank."
- ★ Have students participate in a short interactive activity of identifying tide pool organisms on the PBS LearningMedia website titled "Exploring Tidepools."

Scientist Notebook

- ★ Students can record the challenges and adaptations of organisms found at the upper intertidal zone.

Procedure (continued)

e. Paint the sky above the tide pool a darker blue and the water a lighter blue (or use the same blue paint but water it down more to paint the water).

f. Let the paint dry.

g. While the paint is drying choose at least five tide pool organisms to draw on another blank piece of paper using colored pencils, markers or crayons. Make sure the size of the organisms will look accurate as students will be pasting them to their paintings. If possible, attempt to draw them using their adaptations.

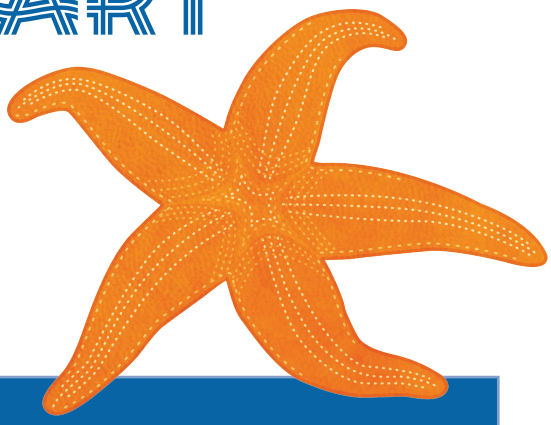
h. When the paint is dry and the drawings are complete, cut out and then paste the drawings to the painting.

11. Have students share their paintings with partners and/or the class by pointing out the organisms they created and discussing the adaptations of each organism.

Wrap-up

- ★ Ask students to identify the term "tide pool."
- ★ Ask students to recall the location of tide pools, and the different organisms that can be found in a tide pool.
- ★ Ask students to recall the different adaptations organisms of tide pools possess.
- ★ Students may bring their T-Charts home, or paste them into their science notebooks (if applicable). Teachers can display student artwork or send home with students.

TIDE POOL T-CHART



Name: _____

Date: _____

Tide Pool Organisms	Adaptations

ROCKY SHORE ZONES: THE MIDDLE INTERTIDAL ZONE

Topic
Zones, Adaptations

Duration
Two sesssions

Vocabulary
adaptation
challenge
feature
middle intertidal zone
zone

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Adaptation

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the middle intertidal zone?

Overview

Students recall that the rocky shore has been divided into zones by marine biologists based on the average water and air exposure of each area. Students discuss what they learned about the splash zone and upper intertidal zone. Students record information about the middle intertidal zone's names, characteristics, common algae life and common animal life. Students continue to construct a bulletin board diagram or individual rocky shore zone diagram by creating the middle intertidal zone using art supplies.

Objectives

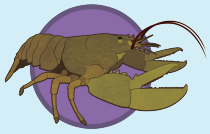
Students will be able to:

- Indicate that the rocky shore can be divided into zones
- Identify the middle intertidal zone and its features
- Recognize the challenges living organisms encounter in the middle intertidal zone and the different adaptations of organisms living in the middle intertidal zone
- Create a middle intertidal zone using art supplies

Materials Needed

If doing bulletin diagram activity:

- Rocky Shore Zones Table (one per student, 102)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- Rocky Shore Zones Table Answer Key (for teacher reference, 103)
- Life at the Rocky Shore Fact Sheet (for teacher reference, 20)
- A large bulletin board or blank wall
- White bulletin board art paper



Teacher Tips

- Have students use the Atlantic Ocean Rocky Shore Guide as a reference while they draw their rocky shore organisms. Use book illustrations or other printed resources if you need more examples.
- While instructing students about the middle intertidal zone using the Rocky Shore Zones Table, either project a copy of the table on the board or draw a table on a whiteboard to record information for all students to see.
- Make copies of the Rocky Shore Zones Table Answer Key for students with special needs to use at their own desks to either copy or highlight.

Materials Needed (continued)

- White paper/index cards for each student
- Coloring utensils for each student
- Scissors for each student
- Stapler (for teacher)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, 102)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, 103)
- Life at the Rocky Shore Fact Sheet (for teacher reference, 20)
- Coloring utensils for each student

Background

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. These zones are mainly defined by the amount of time they are exposed to water and air. Specific organisms can often be found inhabiting particular zones.

Although types of living organisms are often found in one specific zone, they can be located in different zones depending on their ability to survive in various regions of the rocky shore. Zones are not restrictive, and will vary tremendously by slope, exposure, size of loose rocks, etc. While using the term "zone" is common and helpful, it can also mislead if students think that barnacles can only exist in the "barnacle zone."

Each rocky shore zone presents living organisms with challenges that risk their survival. These living organisms have adaptations that enable them to overcome these challenges and thrive in the rocky shore ecosystem conditions.

The rocky shore ecosystem is frequently divided into three zones: the upper intertidal zone, the middle intertidal zone and the lower intertidal zone. This ecosystem can be divided more precisely into five zones: the splash zone, the upper intertidal zone, the middle intertidal zone, the lower intertidal zone and the subtidal zone.

Procedure

Part One

1. Ask students if they can recall how the rocky shore is divided into zones.

Extension Suggestions

★ Have students participate in a daily leveled reading activity called "Ocean Partners." Create partner book packets using mailing envelopes and developmentally appropriate books on ocean topics. On the front of the packet paste a picture of the book to be read, along with a list of teacher expectations (i.e. write one fact from each page or draw a picture of your favorite animal and write three facts about it). If desired, label the envelope with a color according to reading level. Laminate the envelope so it can be used repeatedly. The book packet should contain two books and any materials your students may need for book activities. Have student partners take turns reading the book aloud for fluency development

Procedure (continued)

2. Inform students that a zone can be an area of land that has particular features. Each zone of the rocky shore has particular features, including specific amounts of time they are exposed to air and water, specific living organisms, and specific challenges to an organism's survival.
3. Have students discuss what they have learned about the splash zone and upper intertidal zone by referring to their Rocky Shore Zones Table.
4. Inform students that they are going to be learning about the middle intertidal zone.
5. Instruct students on the names, features, algae, and animal life of the middle intertidal zone, having each student record facts you provide them with in their Rocky Shore Zones Table.
6. Emphasize the challenges to life in the middle intertidal zone, specifically citing the organisms' adaptations that allow them to survive these challenges.

Part Two

7. Inform students that they are going to continue to work on their rocky shore diagram, either as a class or individually.
8. *If as a class:*
    a. Have students access their Atlantic Ocean Rocky Shore Guide.
    b. Provide each student with white paper or index cards, scissors and drawing utensils.
    c. Divide students into groups and designate each group specific organisms to draw and color for the middle intertidal zone.
    d. When finished, have students cut out their organisms, and the teacher will attach them to the bulletin board or wall diagram.

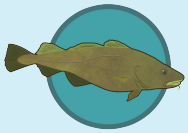
    If individually:
    a. Have students access their Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram.
    b. Inform students that they are going to draw the specific organisms of the middle intertidal zone onto their My Rocky Shore Diagram.

Wrap-up

★ Have students store their Rocky Shore Zones Table, Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram (if applicable) in a secure place to refer to in upcoming lessons.

Books

- ★ *Spiny Sea Star: A Tale of Seeing Stars* by Suzanne Tate
- ★ *Crabby and Nabby: A Tale of Two Blue Crabs* by Suzanne Tate



Websites

- ★ Watch the Delaware Sea Grant YouTube Channel and their video titled "Blue Mussels."
- ★ Watch the Seacoast Science Center's YouTube Channel Episode titled "OceanRunnerNH Crackly Crabs."
- ★ Watch the Vimeo video titled "Echinoderms: Sea Star Time-lapse: Eating Mussel.

Scientist Notebook

- ★ Students can record the challenges and adaptations of organisms found at the middle intertidal zone.

Wrap-up (continued)

- ★ Have students recall the features of the middle intertidal zone and its living organisms.
- ★ Have students recall the specific adaptations of the middle intertidal zone organisms.

ROCKY SHORE ZONES TABLE

Name: _____

Date: _____

Name of Rocky Shore Zone: _____

Zone Name	
Zone Features	
Zone Algae	
Zone Animals	

ROCKY SHORE ZONES TABLE

Answer Key

Name of Rocky Shore Zone: Middle intertidal zone

Zone Name	Middle intertidal zone
Zone Features	This zone is exposed to air and water approximately equal amounts of time.
Zone Algae	Rockweed, Knotted Wrack
Zone Animals	Blue Mussel, Green Crab, Green Sea Urchin, Tortoiseshell Limpet, Asian Shore Crab

HIDE AND SEEK

Topic
Camouflage, Adaptations

Duration
Two sessions

Vocabulary
adaptations
camouflage
changing color
concealing coloration
counter Illumination
countershading
disguise
disruptive coloration
masking
mimicry
transparency
warning coloration

STANDARDS

Practices
Developing and Using Models

Core Ideas
Natural Selection

Crosscutting Concepts
Cause and Effect

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What types of camouflage do ocean animals have that help them survive?

Overview

Students recall types of natural and manmade camouflage from prior knowledge. Students define the term "camouflage." Students observe photographs of organisms with different types of camouflage. Students participate in a memory game with the objective of correctly matching organisms with their types of camouflage. Students demonstrate their knowledge of cryptic coloration by participating in a game of hide and seek in which they color lobsters to blend in with their classroom backgrounds.

Objectives

Students will be able to:

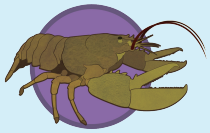
- Identify the term "camouflage"
- Identify different types of camouflage that ocean creatures possess
- Explain how camouflage adaptations help organisms survive
- Participate in games which require them to demonstrate their knowledge of different types of camouflage

Materials Needed

- Camouflage Photo Cards and Definition pages (one set for the entire class, pages 108–127)
- Lobster outline (one per student, page 128)
- Colored pencils and/or crayons for each student
- Scissors for each student
- Clipboard or some other hard surface for each student
- A large brown paper bag or type of bag that is not transparent
- Invisible or masking tape

Teacher Preparation

1. Each student will need a copy of the Lobster Outline activity sheet.
2. The teacher will need to print out the Camouflage Photo Cards and Definition pages.



Teacher Tips

- Make sure students are aware that lobsters can't change color—that their camouflage is concealing coloration (lobsters can be different colors).
- Students will take a varying amount of time coloring their lobsters. Have students bring scratch paper or a book to read when they go to the perimeter of the classroom to color.
- While students seek out lobsters, encourage the other students not to look around the classroom and accidentally reveal the hidden lobsters.

Teacher Preparation (continued)

3. Prepare art supplies for each student.
4. Students will need a large space to play the memory game and the hide-and-seek game.

Background

Camouflage is the use of materials or coloration for concealment. Animals use camouflage to hide by blending in with their surroundings or by disguising themselves as something else. The purpose of animal camouflage is survival—either to hide from predators or to hide from prey.

There are several types of camouflage in the ocean animal kingdom, including the following:

- Concealing coloration—when an animal hides itself against a background of the same color.
- Disruptive coloration—when an animal has spots, stripes or patterns making it difficult for a predator or prey to see its outline.
- Mimicry—when an animal copies another animal's appearance to avoid predators.
- Transparency—when an animal has a body that is clear and hard to be seen.
- Changing color—when an animal can change their skin tone to blend in with their surroundings.
- Counter-illumination—when an animal lights up its body from the inside, so the outline of its dark body can't be seen.
- Masking—when an animal uses something in its environment to hide itself.
- Countershading—when an animal has a dark back and a light belly to hide from predators or prey.
- Warning coloration—when an animal has coloring that warns a predator that an animal is not pleasant to eat or poisonous.
- Disguise—when an animal uses its shape to blend in with its surroundings.

Some organisms residing in the rocky shore such as lobsters, crabs, and sea urchins use camouflage to survive. Lobsters and crabs have concealing coloration which allows them to blend in with their surroundings. Sea urchins use masking to hide themselves.

Procedure

Part One

1. Ask students to recall types of camouflage they are knowledgeable about.

Extension Suggestions

- After reviewing the different types of camouflage, have students participate in the following writing prompt: "If you could choose to have one of the types of camouflage discussed today, which one would it be? Why?"
- Have students research the types of animal camouflage that exists in their own neighborhoods.
- Collect and print photographs demonstrating animal camouflage and have students observe them from far away to see if they can spot the hidden animal.

Books

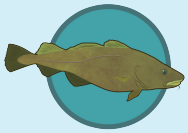
- *Ocean Hide and Seek* by Jennifer Evans Kramer
- *Animal Camouflage True Books: Amazing Animals* by Vicky Franchino
- *High? Low? Where Did It Go? All About Animal Camouflage* by Tish Rabe

Procedure (continued)

2. Ask students to define the word "camouflage."
3. Inform students that camouflage is the use of materials or coloration for concealment.
4. Ask students why animals would need camouflage.
5. Inform students that there are many different types of camouflage, and that ocean animals, including rocky shore animals, use camouflage to survive—whether to find food or to prevent becoming food.
6. Show students, one by one, the camouflage photos. After showing each photo, ask students how they think each animal is using camouflage. After listening to student feedback, show students the name and definition of each type of camouflage.
7. Shuffle the camouflage photos and definition pages and place them face down in a large area. Have students circle around the camouflage photos and definitions. Pick one student to choose two cards, with the goal of the student to find the camouflage photo that matches the camouflage name and definition. Having students participate in a clockwise order, taking one turn at a time, continue to play the game until the class has found all the matches of the types of camouflage.

Part Two

8. Inform students that they are going to be playing a hide and seek game, except that they won't be hiding themselves, but lobsters that they are going to color.
9. Have students silently look around the room for a place that they would like to hide their lobster. Tell them to carefully consider where they would like to hide their lobster, and what colors they would need to have in order to do so.
10. Provide students with the following directions about the hide and seek game:
    a. Every student will receive a blank lobster to color after they have chosen a spot to hide their lobster.
    b. Every student will take their blank lobster, clipboard or other hard surface, coloring utensils and scissors to a spot along the perimeter of the classroom. Students must be sitting in an area in which a classmate can not view their lobster.
    c. Every student will draw their lobster with their backs against the wall of the classroom.
    d. When finished, students will cut out their lobster.



Websites

- ★ Check out a video about animal camouflage on the SciShow Kids' YouTube Channel titled "Camouflage: Animal Hide and Seek."
- ★ Have students participate in a variety of interactive "hidden animal games" to find and learn about animals using camouflage on the Sheppard Software website.
- ★ Watch a BrainPOP video on camouflage and take the quiz! (Subscription required.)

Scientist Notebook

- ★ Students can record the definition of camouflage. Students can list the different types of camouflage.

Procedure (continued)

e. When students have finished cutting out their lobster, they are to raise their hand to let their teacher know that they have completed coloring.

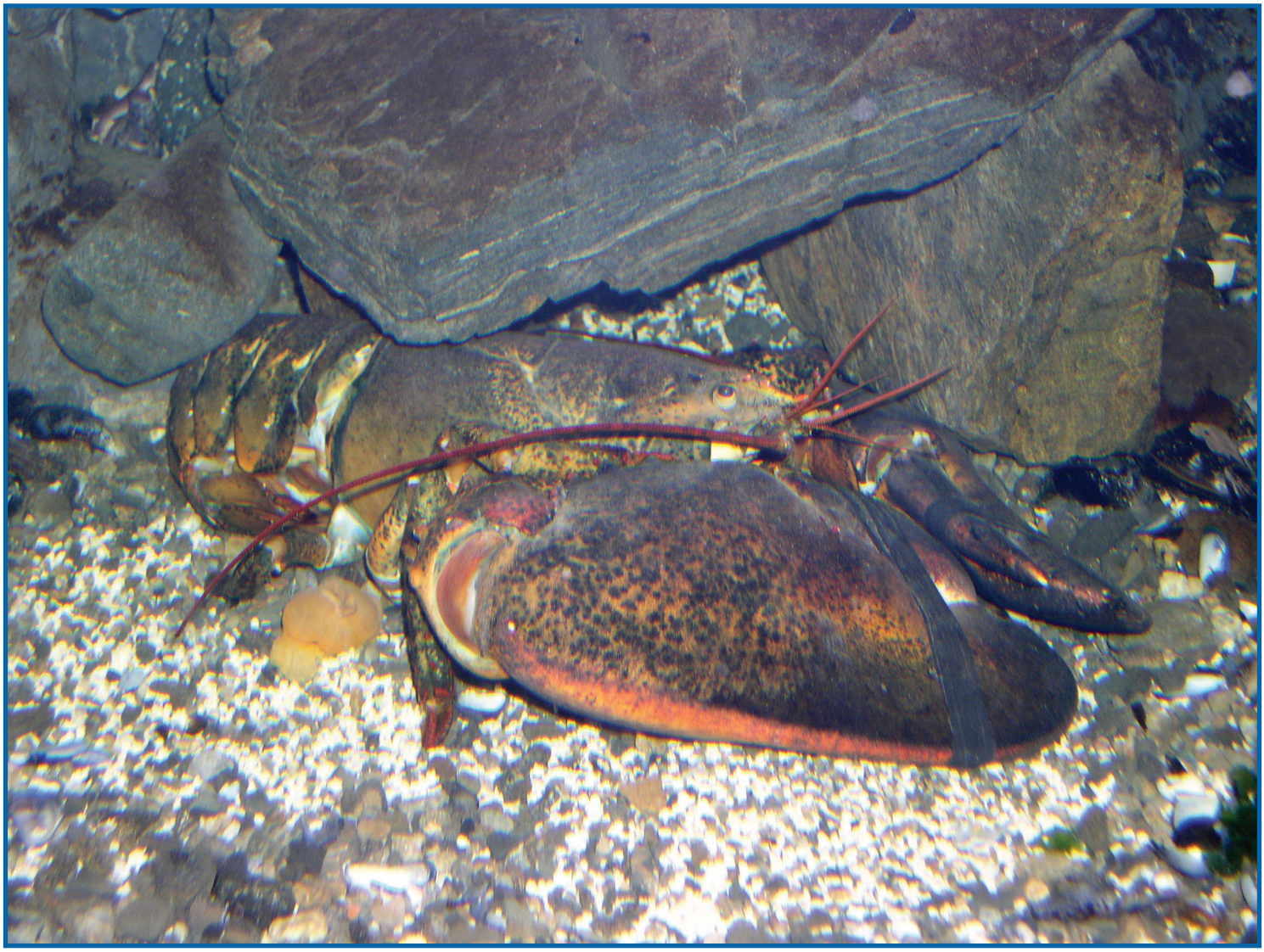
f. After the student has written their name on the back of the lobster, the teacher will collect the lobster in a paper bag or a bag that is not transparent.

11. Once students have completed coloring, cutting out their lobsters and turning them into their teacher, half of the students are to hide their lobsters while the other half of the students are to either close their eyes or wait outside of the classroom. The teacher will need to assist students in taping the lobsters to classroom backgrounds.
12. Once all lobsters are hidden, allow students to seek them out for five minutes. Inform students they are to remain silent as they search and find the lobsters. Once the five minutes are up, have students share which lobsters they found.
13. Repeat steps 11 and 12 with the other half of the class hiding their lobsters and the rest of the class seeking them out.

Wrap-up

- ★ Ask students to identify the term "camouflage."
- ★ Ask students to recall the different types of camouflage ocean animals use to survive.
- ★ Ask students to recall the different types of animals that use camouflage at the rocky shore.
- ★ Students may bring their lobsters home, or the lobsters can remain camouflaged throughout the classroom during the rocky shore unit.

Camouflage Photo Card 1
Lobster



Concealing Coloration

An animal hides itself against a background of the same color.

Camouflage Photo Card 2
Fairy Basslet

Disruptive Coloration

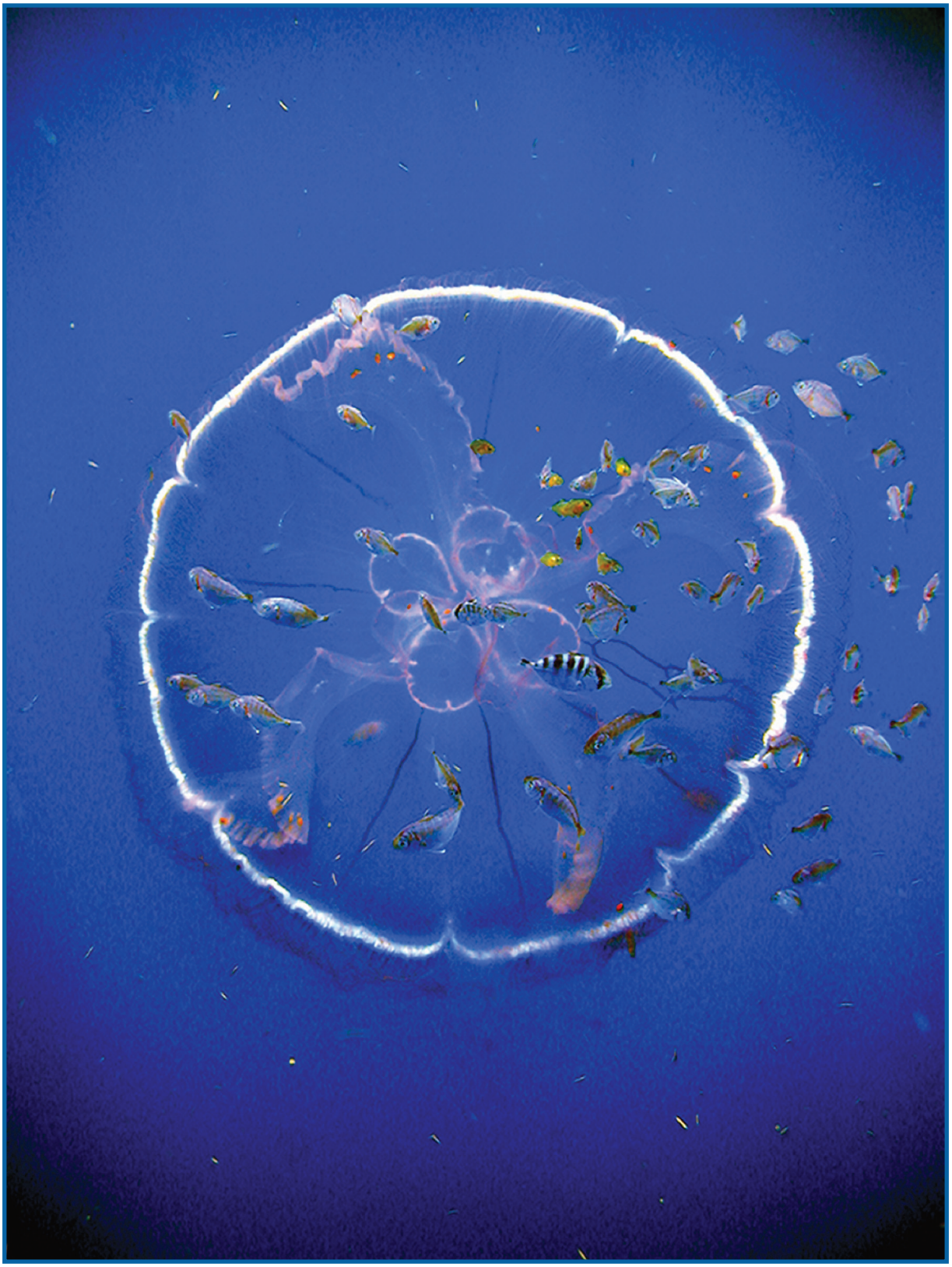
An animal has spots, stripes or patterns making it difficult for a predator or prey to see its outline.

Camouflage Photo Card 3
Mimic Octopus

Mimicry

An animal copies another animal's appearance to avoid predators.

Camouflage Photo Card 4
Moon Jellyfish



Transparency

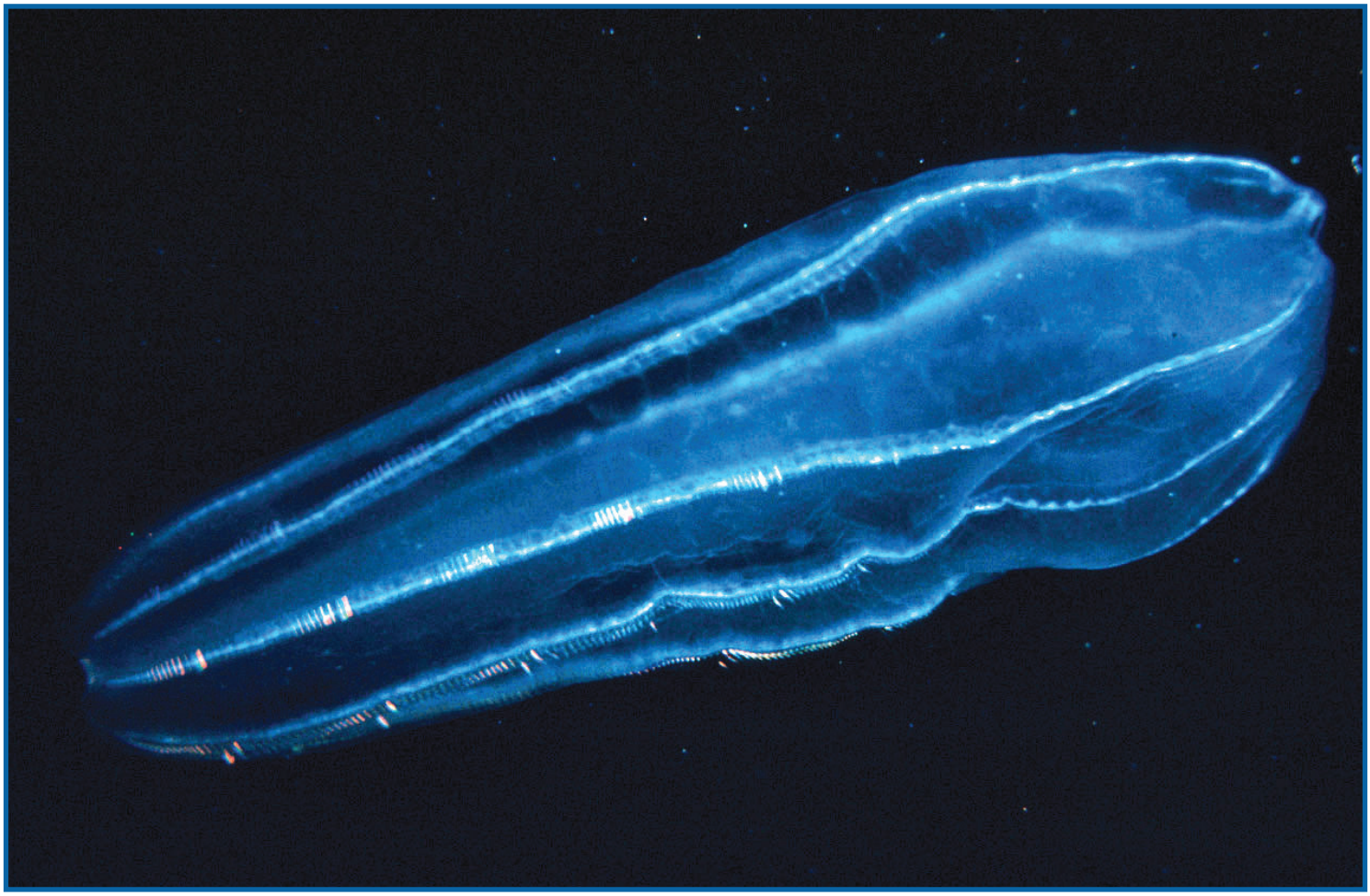
An animal has a body that is clear and hard to be seen.

Camouflage Photo Card 5
Cuttlefish

Changing Color

An animal can change its skin tone to blend in with its surroundings.

Camouflage Photo Card 6
Zooplankton



Counter-illumination

An animal lights up its body from the inside
so the outline of its dark body can't be seen.

Camouflage Photo Card 7
Green Sea Urchin

Masking

An animal uses something in its environment to hide itself.

Camouflage Photo Card 8
Great White Shark

Countershading

An animal has a dark back and a light belly to hide from predators or prey.

Camouflage Photo Card 9
Lionfish

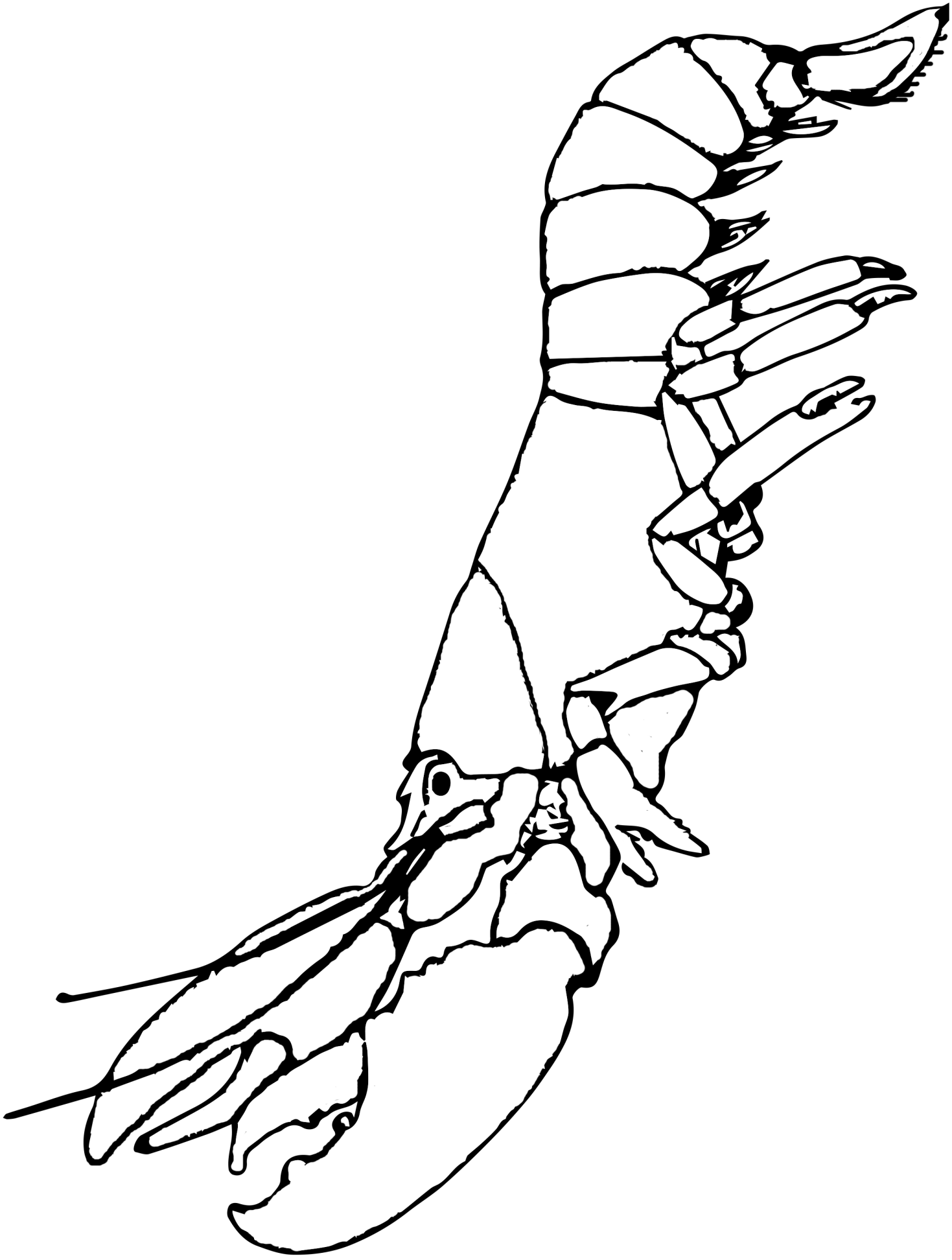
Warning Coloration

An animal has coloring that warns a predator that an animal is not pleasant to eat or poisonous.

Camouflage Photo Card 10
Leafy Seadragon

Disguise

An animal uses its shape to blend in with its surroundings.



ROCKY SHORE ZONES: THE LOWER INTERTIDAL ZONE

Topic
Zones, Adaptations

Duration
Two sessions

Vocabulary
adaptation
challenge
feature
lower intertidal zone
zone

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Adaptation

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the Lower Intertidal Zone?

Overview

Students recall that the rocky shore has been divided into zones by marine biologists based on the average water and air exposure of each area. Students discuss what they learned about the splash zone, upper and middle intertidal zones. Students record information about the lower intertidal zone's names, characteristics, common algae life and common animal life. Students continue to construct a bulletin board diagram or individual rocky shore zone diagram by creating the lower intertidal zone using art supplies.

Objectives

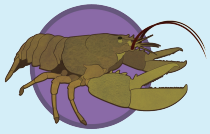
Students will be able to:

- ★ Indicate that the rocky shore can be divided into zones
- ★ Identify the lower intertidal zone and its features
- ★ Recognize the challenges living organisms encounter in the lower intertidal zone and the different adaptations of organisms living in the lower intertidal zone
- ★ Create a lower intertidal zone using art supplies.

Materials Needed

If doing bulletin diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 133)
- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, page 134)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, pages 21–22)
- ★ A large bulletin board or blank wall
- ★ White bulletin board art paper
- ★ White paper/index cards for each student
- ★ Coloring utensils for each student



Teacher Tips

- Have students use the Atlantic Ocean Rocky Shore Guide as a reference while they draw their rocky shore organisms. Use book illustrations or other printed resources if you need more examples.
- While instructing students about the lower intertidal zone using the Rocky Shore Zones Table, either project a copy of the table on the board or draw a table on a whiteboard to record information for all students to see.
- Make copies of the Rocky Shore Zones Table Answer Key for students with special needs to use at their own desks to either copy or highlight.

Materials Needed (continued)

- Scissors for each student
- Stapler (for teacher)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, page 133)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 134)
- Life at the Rocky Shore Fact Sheet (for teacher reference, pages 21–22)
- Coloring utensils for each student

Teacher Preparation

For the large classroom diagram:

1. Make sure all students have copies of the Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep scissors, drawing utensils, and white paper/index cards for each student.

For the individual student diagram:

1. Make sure all students have copies of My Rocky Shore Diagram, Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep drawing utensils for each student.

Background

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. These zones are mainly defined by the amount of time they are exposed to water and air. Specific organisms can often be found inhabiting particular zones.

Although types of living organisms are often found in one specific zone, they can be located in different zones depending on their ability to survive in various regions of the rocky shore. Zones are not restrictive, and will vary tremendously by slope, exposure, size of loose rocks, etc. While using the term "zone" is common and helpful, it can also mislead if students think that barnacles can only exist in the "barnacle zone."

Extension Suggestions

★ Provide students with the following facts: Green crabs were introduced to the Atlantic coast more than 250 years ago. Asian shore crabs were first seen on the Atlantic coast in 1988. Both types of crabs are considered invasive species—organisms that are not native to an ecosystem and are likely to cause harm to the ecosystem they have entered. Green crabs are the most abundant predators along New Hampshire's coastline. Asian shore crabs are also fierce predators. Both crabs have a large impact on their prey's population. Provide the following writing prompt to students, having them discuss their answers after the writing prompt is complete: 1) Do you think an invasive species should ever be considered a native species? Why or why not? Refer to *New Hampshire Wildlife Journal*'s article "Hitchhikers and Stowaways: Invasive Species Threaten New Hampshire's Coastal Ecosystems" by Ethan Nedeau.

Background (continued)

Each rocky shore zone presents living organisms with challenges that risk their survival. These living organisms have adaptations that enable them to overcome these challenges and thrive in the rocky shore ecosystem conditions.

The rocky shore ecosystem is frequently divided into three zones: the upper intertidal zone, the middle intertidal zone, and the lower intertidal zone. This ecosystem can be divided more precisely into five zones: the splash zone, the upper intertidal zone, the middle intertidal zone, the lower intertidal zone, and the subtidal zone.

Procedure

Part One

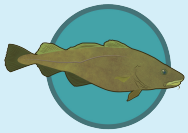
1. Ask students if they can recall how the rocky shore is divided into zones.
2. Inform students that a zone can be an area of land that has particular features. Each zone of the rocky shore has particular features, including specific amounts of time they are exposed to air and water, specific living organisms, and specific challenges to an organism's survival.
3. Have students discuss what they have learned about the splash zone, upper and middle intertidal zones by referring to their Rocky Shore Zones Table.
4. Inform students that they are going to be learning about the lower intertidal zone.
5. Instruct students on the names, features, algae, and animal life of the lower intertidal zone, having each student record facts you provide them with in their Rocky Shore Zones Table.
6. Emphasize the challenges to life in the lower intertidal zone, specifically citing the organisms' adaptations that allow them to survive these challenges.

Part Two

7. Inform students that they are going to continue to work on their rocky shore diagram, either as a class or individually.
8. *If as a class:*
    a. Have students access their Atlantic Ocean Rocky Shore Guide.
    b. Provide each student with white paper or index cards, scissors, and drawing utensils.
    c. Divide students into groups and designate each group specific organisms to draw and color for the lower intertidal zone.
    d. When finished, have students cut out their organisms, and the teacher will attach them to the bulletin board or wall diagram.

Books

- ★ *Invasive Species Underwater* by Richard Spilsbury
- ★ *Keep Out! Invasive Species* by Sara L. Latta



Websites

- ★ Watch O'Chang Studios' YouTube episode titled "Attack of the Green Crabs" and discuss invasive species.
- ★ Watch the Seacoast Science Center's YouTube Channel episode titled "Anemones in Time Lapse."

Scientist Notebook

- ★ Students can record the challenges and adaptations of organisms found at the lower intertidal zone.

Procedure (continued)

If individually:

a. Have students access their Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram.

b. Inform students that they are going to draw the specific organisms of the lower intertidal zone onto their My Rocky Shore Diagram.

Wrap-up

- ★ Have students store their Rocky Shore Zones Table, Atlantic Ocean Rocky Shore Guide, and My Rocky Shore Diagram (if applicable) in a secure place to refer to in upcoming lessons.
- ★ Have students recall the features of the lower intertidal zone and its living organisms.
- ★ Have students recall the specific adaptations of the lower intertidal zone organisms.

ROCKY SHORE ZONES TABLE

Name: _____

Date: _____

Name of Rocky Shore Zone: _____

Zone Name	
Zone Features	
Zone Algae	
Zone Animals	

ROCKY SHORE ZONES TABLE

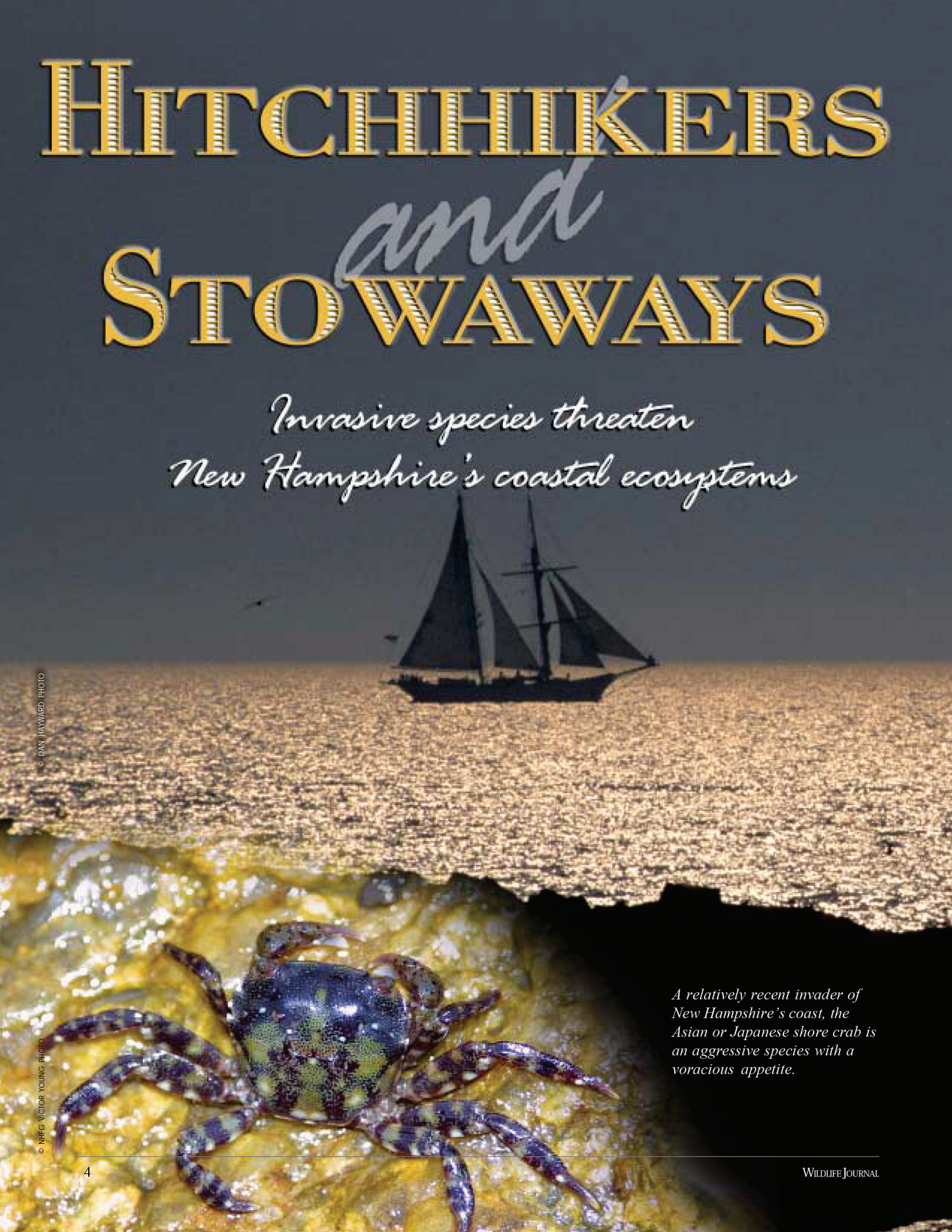
Answer Key

Name of Rocky Shore Zone: Lower intertidal zone

Zone Name	Lower intertidal zone
Zone Features	This zone is almost always exposed to water except for at extreme low tides.
Zone Algae	Sea Lettuce, Maiden Hair Algae, Coralline Algae
Zone Animals	Smooth Periwinkle, Atlantic Rock Crab, Common Slipper Shell, Northern Sea Star, Blood Star, Brittle Star, Frilled Sea Anemone, Bread Crumb Sponge, Clam Worm, Speckled Flatworm, Left-coiled Tubeworm, Red Chiton

Hitchhikers and Stowaways

Invasive species threaten New Hampshire's coastal ecosystems



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A relatively recent invader of New Hampshire's coast, the Asian or Japanese shore crab is an aggressive species with a voracious appetite.

Invasive, exotic, introduced, non-native, alien.....these are fighting words! People consider themselves native to the place of their birth—regardless of their family history—and carry that honor proudly. "A New Hampshire native? Well, pull up a chair and have a cup of coffee!" Plants and animals are not given that same birthright, especially ones that are economically or ecologically destructive. It doesn't matter if a species arrived in New Hampshire 200 years ago or two years ago—if they cause trouble, they are forever scorned. Hemlock woolly adelgids, gypsy moths, Dutch elm disease, Eurasian water milfoil and purple loosestrife are just a handful of species that will always raise the ire of New Hampshire's citizens. Sure, we brought them all here, but that is beside the point (right?). We also brought countless species that we embrace warmly. Earthworms, honeybees, apple trees and rainbow trout do not belong in New Hampshire, but what kid doesn't like to search for nightcrawlers on the evening before a fishing trip? What family doesn't enjoy an autumn Sunday in the apple orchards?

By Ethan Nedeau

Unwitting Voyageurs

When sailing ships began to bring Europeans to the New World, they not only carried the people and supplies to create a paradise in the image of the motherland, but they also carried plant and animal "hitchhikers" that—like the people—would forever change North American ecosystems. Thousands of hitchhiking marine species have been brought to North America, beginning more than 500 years ago.

Wooden ships moored in European seaports were colonized by shipworms (which are actually molluscs) and gribbles (isopods); these two species have voracious appetites for wood. They bored into boat hulls, creating a labyrinth of holes and tunnels that weakened the wood. This created an ideal living situation for creatures specialized to attach to surfaces or live within spaces, including algae, sponges, barnacles, anemones, bryozoans, tunicates, molluscs and tube-building crustaceans. Collectively, we call these "fouling organisms" because they foul surfaces that we would like to keep clean. Crabs, fish and snails are among the species that take refuge in the shelter that fouling communities provide. A single ship setting sail for America could have carried dozens or even hundreds of species in or on its hull: unwitting voyageurs.

Ships carrying an unusually light load were unstable in the water, so ballast (weight) was added to fix the problem. At first, sailors used dry ballast consisting of materials they could scrape from near the docking area. This was usually sand, rock or other debris that was chock-full of tiny marine and terrestrial animals and plants. Once the ship reached its destination, dry ballast was unloaded along with the creatures that survived the journey. Hundreds of years later, ships began using water ballast instead of dry ballast. Seawater—along with phytoplankton, zooplankton, larval fish and invertebrates—was pumped into ballast tanks. Once a boat reached its destination, thousands of miles away, the water was released and millions of organisms were poured into the local ecosystem to start a new home.

Commercial fisheries and aquaculture became a very effective vector for invasive species. By the late 1800s, adult oysters were being transported all across the world. Oysters were packed in crates with mud, vegetation and water from their native habitat. American oysters from New England were sent to far corners of the world and oysters from other oceans were sent here. Today, commercial shipping, fisheries, aquaculture and oil platforms continue to play a role in the spread of marine invasive species.

Invaders on New Hampshire's Shores

Ships from Europe arrived in New Hampshire's waters by the early 1600s, and years later, from all across the world. These ships carried thousands of foreign species to coastal waters and estuaries. Most of these species failed to become established—perhaps too few individuals were released to reproduce and sustain a population; or they might not have found New Hampshire's waters to their liking; or they could not compete with the natives. Others may have gained a foothold very early on and by the time scientists began doing careful surveys—two or three centuries later—the species might have become so widely distributed and harmonious with the native community that scientists may have mistaken them for native. A few species—the worst of the worst—shook the foundation of our native ecosystems and threatened the prosperity of our coastal communities.

Some of New Hampshire's marine invasive species are obvious. Most people admire or study the ocean from the shore—standing in salt marshes, gathering crabs and snails among boulders at low tide or strolling along the beach. Green crabs and periwinkles are two of the most common species in these habitats, allowing people to see first-hand how dominant non-native species can become. But most never witness the ecological damage that some invasive species are causing further offshore.

New Hampshire's Least Wanted

Crabs

Some invaders eat their way into an ecosystem by outmuscling native competitors and eating almost everything. Green crabs (*Carcinus maenas*) were introduced to the mid-Atlantic more than 250 years ago. They scuttled up the coast, spreading through New England and into the St. Lawrence region by the 1950s. They are now one of the most abundant predators along our coastline, feasting among eelgrass, shellfish beds and rocky intertidal areas. Their strong claws can crush shells of small clams, scallops, mussels and oysters.

Though green crabs have held reign as the toughest thugs in the neighborhood, there are new contenders that may soon take over. Asian shore crabs (*Hemigrapsus sanguineus*) have rapidly eaten their way northward to Maine since being first seen in New

continued on next page

© USGS PHOTO

Sea Squirts Slime Seabed

Recent news reports document the alarming spread of *Didemnum sp.* or "sea squirt" infesting waters off New Hampshire. Late last year, researchers found dense, slimy colonies present in an area of at least 40 square miles on the Georges Bank seabed. Sea squirts reproduce rapidly and have no known predators, making them a potential threat to marine habitats, aquaculture and commercial and recreational marine fisheries. Scientists are rushing to learn more about the current and future impact of the species on our marine resources and what can be done to stop the spread. When you're on the coast, be on the lookout for *Didemnum* (a Google search for *Didemnum* will lead you to the U.S. Geological Survey's Woods Hole Science Center, which has lots of pictures for accurate identification of the species in its various forms), and report sightings to e-mail address *pvalentine@usgs.gov*.

Jersey in 1988. In the lab, a single Asian shore crab ate 150 juvenile snails and 170 juvenile mussels in one day! The eating contest between green crabs and Asian shore crabs in New Hampshire's coastal waters will certainly have a profound effect on their hapless prey.

Algae

With a name like deadman's fingers, you know the invasive green algae means trouble. Originally from Japan, it was brought to North America—and eventually New England—on shells of transplanted oysters. This species (*Codium fragile tomentosoides*) has tightened its grip on shallow subtidal and intertidal marine habitats in the Gulf of Maine in the last thirty years. It thrives in shallow water and often outgrows native kelp and eelgrass—two irreplaceable native species that provide habitat for countless others. To make matters worse, our champion native herbivores, green sea urchins, prefer to eat tastier foods. Other herbivores have taken up the fight, including snails and sea slugs, but *Codium* is definitely winning. Even though you may never go snorkeling to witness its abundance, you can still get an inkling of what is happening offshore from the enormous amounts of *Codium* that storms tear from the ocean bottom and deposit on beaches and shorelines.

Diseases

Not all invasive species can be plucked from the water. Several diseases have been introduced into New Hampshire's waters, causing sickness and death among our wildlife that is difficult to chronicle. Three oyster diseases—Dermo disease, MSX and Bonamia oyster disease—exist in New Hampshire and have wreaked havoc on most populations (keep in mind that oyster populations were mainly non-native to begin with). These parasitic protozoans were introduced to New Hampshire's waters with infected oysters transported from the mid-Atlantic or southeast coast. They flourish in the summer when water temperatures are warmest. Oysters had enough troubles with coastal pollution and overfishing, so these diseases only added insult to injury. New Hampshire is working to improve conditions for oysters, but may have to import strains with disease resistance because ridding an ecosystem of a disease is nearly impossible. Thus, the cycle of species introductions and reintroductions will likely continue.

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Fouling Species

This ragtag group of hitchhikers and stowaways has crossed the high seas ever since humans first built boats and began exploring the globe. While these species are certainly adaptable and have good dispersal abilities, most would not have had the wherewithal to cross oceans on their own, and thus they cemented or encrusted themselves to our vessels. Blue mussels, barnacles, bryozoans, tunicates, sponges and worms are the most common types of fouling species. The easiest way to find them is to visit ports and harbors at low tide—piers, docks and wharves (as well as natural habitats) are often smothered with fouling communities and many of the species are not native. While many are innocuous, some may have profound effects on ecosystems, fisheries and marine industries. The white lace bryozoan

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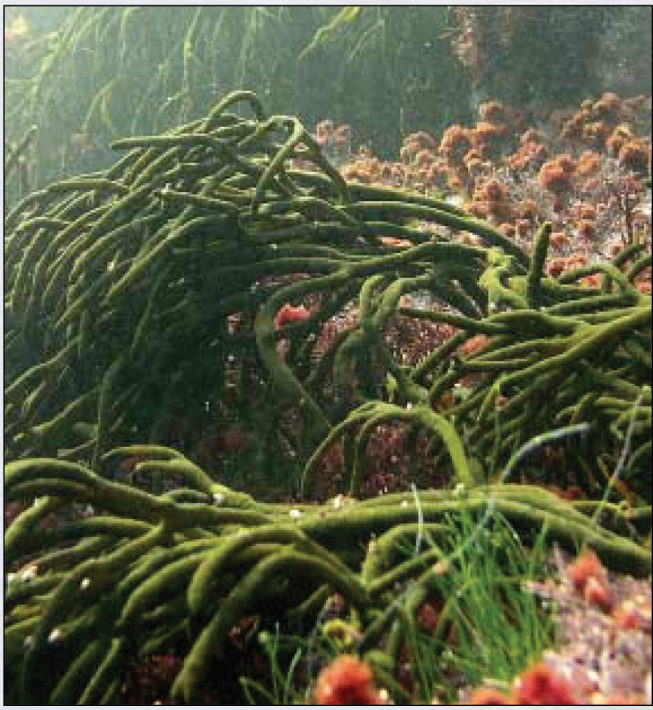

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Introduced to the Atlantic coast centuries ago, green crabs (left) are being threatened by a new invader, the ravenous Asian crab. Deadman's fingers, an invasive green algae (right), is taking over tidal habitats in the Gulf of Maine.

Smooth periwinkle. A prized food in northern Europe, periwinkles were introduced in Canada for food, then spread throughout New England in the 1800s bringing a disease harmful to fisheries.

(*Membranipora membanacea*) smothers and kills native plants and has devastated native kelp forests in the Gulf of Maine. The colonial tunicate *Didemnum sp.* forms large, gruesome colonies that cover rocks, docks, gravel bottoms, mussels, oysters, or any other firm substrate; they have even been found offshore in Georges Bank *(see sidebar on page 6)*.

Forever Changed

Before you go off with your scoop and pail to "do your part" by making garden compost out of green crabs, periwinkles or other well-known invasive species, be aware that—unfortunately—your efforts are likely to have no effect on the ecosystem. Once species become firmly established, it is nearly impossible to get rid of them. Mother Nature sometimes finds clever ways to shift the balance and keep species from eating everything or carpeting the ocean, but often not before species go extinct and ecosystems are forever changed.

We have made so many mistakes that we should have learned at least one important lesson: keep out invasive species. Sure, accidents happen, but often because of ignorance, laziness or misguided efforts to make things better. There are several species in southern New England creeping toward New Hampshire to join ranks with other invasives. Carefully regulating the use of ballast water, cleaning boats before entering our waters, and closely regulating fisheries and aquaculture industries will help stop their spread. Monitoring programs—using New Hampshire's citizens armed with knowledge and a watchful eye—may help detect invasives early enough to eradicate them. Residents and visitors come to New Hampshire's seacoast area for the high quality of life; we must do our best to thwart those invasive species that threaten to spoil it. WJ

Visit harbors at low tide to see stowaways like blue mussels and barnacles (right), fouling species that disperse with the shipping trade.

Ethan Nedeau (www.biodraw versity.com) is a biologist, nature writer, illustrator and graphic artist. He is not native to New Hampshire.

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What Can I Do?

Yes, it's a big ocean, but there *are* things you can do—or avoid doing—that can help prevent or reduce new introductions.

- Always discard unused fishing bait and packing material in the trash bin; live bait species may be invasive.
- Clean off all boats and boat trailers, canoes, kayaks, and diving and fishing gear of all plants and animals before going into a body of water.
- Never discard fish or aquatic pets or plants in the wild *(see page 19).*
- Contact your elected officials to let them know you care, and encourage them to act to prevent and reduce invasives from various pathways.

www.protectyourwaters.net

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SURVIVE THE SHORE

Topic
Rocky Shore Crabs, Adaptations

Duration
One session

Vocabulary
adaptation
Asian shore crab
claws
concealing camouflage
exoskeleton
green crab
jonah crab
northern hermit crab
rock crab

STANDARDS

Practices
Constructing Explanations and Designing Solutions

Core Ideas
Structure and Function

Crosscutting Concepts
Structure and Function

OCEAN LITERACY PRINCIPLE

OLP 5

Focus Question

How do a crab's adaptations help it survive?

Overview

Students recall the term "adaptation." Students make inferences of what challenges crabs face on the rocky shore. Students make inferences of what adaptations crabs have to overcome their challenges. Students will dramatize their knowledge of crab adaptations by participating in a physical education game.

Objectives

Students will be able to:

- ★ Identify the term "adaptation"
- ★ Identify challenges and adaptations of rocky shore crabs
- ★ Dramatize their knowledge of crab adaptations through a physical education game

Materials Needed

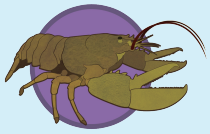
- ★ Marine Crabs: True or False activity sheet for the teacher (page 145)
- ★ Plastic cones (same number as students is preferable)
- ★ Bean bags (same number as students)
- ★ Salad tongs (same number as students is preferable)
- ★ Pinnies (two sets of four pinnies—two different colors)

Teacher Preparation

1. Students need a large open space to play Survive the Shore—a gymnasium, field, or empty classroom.
2. Place traffic cones randomly throughout the large open space.
3. Place bean bags at the far end of the large open space.
4. Place salad tongs at the beginning of the large open space.

Background

Crabs are decapod crustaceans and are covered with a thick shell called an exoskeleton. Crabs are invertebrates (animals without a backbone). They have flattened bodies, two feeler antennae, and two eyes located on the end of stalks.



Teacher Tips

- ★ Inform students they are going to be participating in a physical education game the day prior to this lesson so they have appropriate clothing.
- ★ Students with physical limitations can be given different roles in the "Survive the Shore activity (i.e. the teacher's role, a different predator, etc.)
- ★ Consider giving some students the role of hermit crabs in the "Survive the Shore" activity. Their goal can be to cross the tide pool to retrieve an empty shell. Make sure to designate a different object to represent a shell.

Background (continued)

Crabs are ten-legged animals that walk sideways. They have five pairs of legs and the first pair is known as the claws. There are over six thousand species of crab living around the world: marine crabs, freshwater crabs, and terrestrial crabs. Crabs can be as small as the pea crab (only a few millimeters wide) and as big as the Japanese spider crab (a leg span up to thirteen feet). Marine crabs breathe underwater using gills. Marine crabs are scavengers. Their diet primarily consists of worms, clams, mussels, other crabs, and other invertebrates.

A marine crab's challenges include shorebirds, fish, other crabs, humans, and their harsh environment (power of the waves and currents, the fluctuation of temperature, the fluctuation of salinity and oxygen levels, and the openness to predators).

A marine crab's adaptations include: their hard exoskeleton, their claws, and their concealing coloration—when an animal hides itself against a background of the same color.

Five Rocky Shore Crab Facts

Northern Hermit Crab

The Northern Hermit Crab has a soft and long, spirally curved abdomen. The vulnerable abdomen can be protected from predators by an empty seashell found and carried by the hermit crab, into which its whole body can fit. Most often hermit crabs use the shells of sea snails. The tip of the hermit crab's abdomen is adapted to clasp strongly onto the inside of the snail shell. These crabs spend most of their life underwater and they live in varying depths of saltwater from shallow shorelines to deep sea bottoms. They breathe through gills and can survive briefly out of water.

Rock Crab (Cancer irroratus)

The Rock Crab has nine small teeth on the front of the carapace beside each eye. The carapace reaches a width of up to five and one quarter inches. These crabs are similar in color to the Jonah crab. The two species can be identified by the purplish-brown spots on the Rock Crab which contrast the yellow spots of the Jonah Crab. Rock crabs can live from above the low tide line to as deep as 2,600 feet.

Jonah Crab (Cancer borealis)

Jonah crabs have a round, rough-edged carapace with small light spots. Their claws are large with dark brown-black tips. Jonah crabs can grow up to eight inches wide or more. Jonah crabs can live at depths of up to 750 meters. They are known to move around to areas in which the temperature is comfortable to them.

Extension Suggestions

- ★ Have students participate in Otago University's rocky shore activity titled "Survivor Seashore" on page 18 of their *New Zealand Rocky Shore Activities* (found online).
- ★ Music lesson: Ask students to close their eyes and listen to "Carnival of the Animals: The Aquarium" by Camille Saint-Saens. Play the song several times, and ask students to come up with pictures in their minds of what the music might represent. After listening, inform students of the name of the song and the musician. Show students the work of art titled "Ocean Life" by Christian Schussele. Help students come up with their own choreography to move along to Saint-Saens' music, and to represent the different organisms in Schussele's work of art.

Background (continued)

Green Crab (Carcinus maenas)

The green crab is a widespread invasive species, listed among the 100 "world's worst alien invasive species." It grows to a carapace width of three and a half inches. They feed on a variety of mollusks, worms and small crustaceans. Green crabs have traveled all around the world on ships' hulls and in packing materials. The color of the green crab can actually vary, from green, brown, red, or gray.

Asian Shore Crab (Hemigrapsus sanguineus)

The Asian Shore Crab is a species of crab from East Asia. It is now an invasive species in North America and Europe. It has a squarish carapace which can be up to two inches in width, with three teeth along the sides. It is marked with alternating light and dark bands. The Asian Shore Crab is an "opportunistic omnivore" that prefers to eat other animals, especially mollusks, when possible.

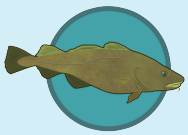
Procedure

Part One

1. Read Suzanne Tate's *Crabby & Nabby: A Tale of Two Blue Crabs* (or another book about crabs) to the students.
1. Ask students to recall the definition of an adaptation.
2. Ask students if they know the names of different types of crabs. Ask them what information they know about these types of crabs.
3. Inform students that they are going to learn about crabs found at the rocky shore by participating in a "true or false" movement activity. Direct students to move to one side of the classroom if they think a statement you read is true, and direct students to move to another side of the classroom if they think a statement is false.
4. Inform students that the activity is not to test their knowledge, but to improve their knowledge of rocky shore crabs, and it is fine if they do not know the answers.
5. Encourage students to choose "true" or "false" based on their own thinking—not their friends' thinking.
6. Keep a tally of correct and incorrect answers on a whiteboard or SMART Board—based on the majority feedback.
7. Have students stand up while the teacher reads each true or false statement twice (from the Marine Crabs: True of False activity sheet), and allow time for students to make a decision and move to the designated "true" or "false" area. Inform students of the correct answer after the entire class has made their choice.

Books

- ★ *Crabby & Nabby: A Tale of Two Blue Crabs* by Suzanne Tate
- ★ *A House for Hermit Crab* by Eric Carle



Websites

- ★ Check out a video of a hermit crab shell exchange on the BBC Earth YouTube Channel titled "Amazing Crabs Shell Exchange—Life Story."
- ★ Check out the Mocomi Kid's YouTube Channel Episode titled "Why do crabs walk sideways?"

Scientist Notebook

- ★ Students can record the dangers and adaptations of crabs living on the rocky shore. Students can paste their Marine Crabs: True or False activity sheet into their notebook.

Procedure (continued)

8. When all statements have been read and students have completed the activity, review all of the statements and the correct answers with the students.

Part Two

9. Inform students that they are going to be participating in a physical education activity in which students are going to be crabs attempting to survive the rocky shore's harsh environment.
10. Provide students with the instructions on page 143 before playing the game.

Wrap-up

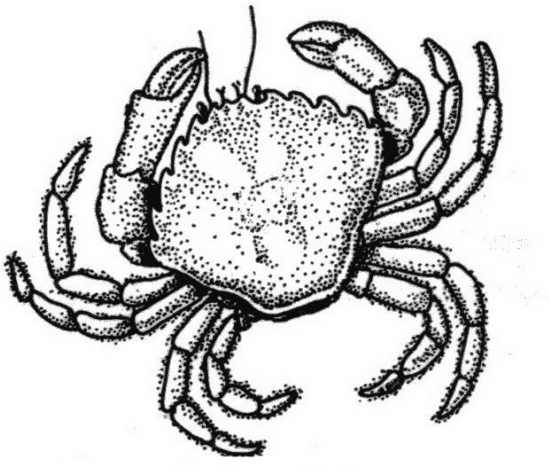
- ★ Ask students to identify the term "adaptation."
- ★ Ask students to recall the challenges crabs face and adaptations crabs need in order to survive.
- ★ Ask students to give feedback on the "Survive the Shore" activity. Ask them what they enjoyed about the activity and what was challenging. Ask students what decisions they made that enabled them to survive, and what decisions they made that were harmful to their survival.
- ★ Students may bring their Marine Crabs: True or False activity sheet home, or paste them into their science notebooks (if applicable).

SURVIVE THE SHORE GAME

Instructions

Purpose of the Game

1. The purpose of the game is for students who represent crabs to crab-walk across the tide pool to get food, and to make it back safe to their shelter where they began their crab-walk.
2. Their large open space represents a tide pool.
3. The cones represent rocks or seaweed for the crabs to use to hide from predators or hold on to when big waves crash on the shore.
4. The bean bags represent food for the crabs.
5. The salad tongs represent the crabs' claws.



Roles of the Students & Teacher

1. Most students are going to be crabs wearing a certain color pinny attempting to make it from one side of the tide pool to retrieve food and then back to the other side of the tide pool (their shelter).
2. At least four students (depending on class size) are going to be placed by the teacher on the perimeter of the tide pool. These students are going to alternate back and forth from being crabs to being gulls. When they are crabs they will wear a different color pinny than the crabs in the tide pool. When they are gulls, they will wear no pinnies.
3. The teacher's role is to shout out different warnings of crab attacks, gull attacks or crashing waves to the crabs in the tide pool.

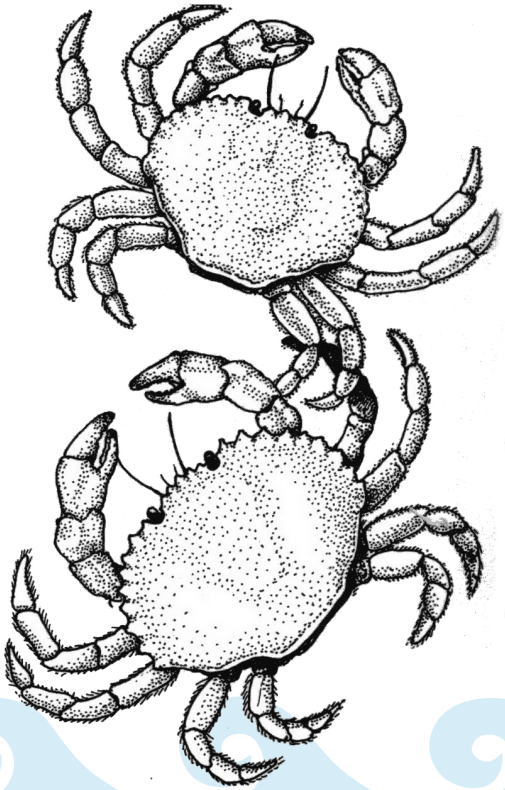
Directions

1. Students who are crabs retrieving food line up at the end of the tide pool that is opposite the end of the tide pool where food (bean bags) have been placed.
2. Students who are crabs/gulls that are preying upon the crabs in the tide pool are placed in positions the teacher assigns. These crabs/gulls may not move until the teacher shouts "Crab Attack!" or "Gull Attack!" Have these students begin as crabs with different-colored pinnies on.
3. Students that are crabs retrieving food get in a crab-walk position (body facing up with hands and feet facing down) after having placed a salad tong (claw) on their stomach and under their pinny.
4. When the teacher shouts "Food!" the crabs retrieving food being crab-walking. The crabs/gulls on the perimeter of the tide pool stay in place.
5. When the teacher shouts out "Crab Attack!" the crabs on the perimeter of the tide pool crab-walk toward the crabs in the tide pool. They are attempting to "eat" the crabs in the tide pool. If they touch a crab in the tide-pool that crab has been eaten and must start over where they began. Crabs in the tide pool may find safe spots by finding a cone (rock or seaweed) and touching it. If they are touching a cone they cannot be eaten because they are hidden from predators. When the teacher shouts "Crab Attack Back!" the crabs on the perimeter of the tide pool must return to their assigned positions and take off their pinnies so they can be gulls next.

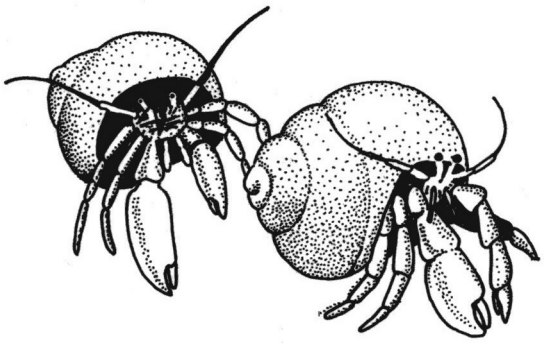
SURVIVE THE SHORE GAME

Instructions continued . . .

6. When the teacher shouts out "Gull Attack!" the gulls on the perimeter of the tide pool can only walk (with arms outstretched) toward the crabs in the tide pool. They must attempt to tag the crabs in the tide pool. If they touch a crab in the tide-pool that crab has been eaten and must start over where they began. Again, crabs in the tide pool may find safe spots by finding a cone and touching it. When the teacher shouts "Gull Attack Back!" the gulls on the perimeter of the tide pool must return to their assigned positions and put on their pinnies so they can be crabs again.
7. When the teacher shouts out "Crashing Waves!" all of the crabs in the tide pool have seven seconds (depending on the size of the large area) to find a cone to touch (to hold onto for safety). There is not a maximum number of crabs that can touch one cone.
8. When seven seconds is up the teacher shouts "Crash!" and everyone must freeze. All the crabs who are not touching a cone must return to the beginning. When the teacher shouts out "Receding Waves!" crabs may begin to move around again.
9. When crabs in the tide pool reach food (the bean bags) they must pick the food up and place it on their stomachs using their salad tongs. Students may leave the salad tongs behind—but make clear to the students that crabs wouldn't actually leave their claws behind! Crabs in the tide pool must return to the side of the tide pool they began (their shelter) and they are proclaimed to be "Survivors of the shore!"
10. The teacher may alternate shouting out "Crab Attack!" "Gull Attack!" and "Crashing Waves!" whenever he or she desires. This activity can last as long as the teacher deems it appropriate, but it is necessary to take breaks and switch tide pool crabs with preying crabs/gulls as well.



MARINE CRABS: TRUE OR FALSE



Marine Crab Statements	Correct Answers
Most crabs have a hard shell called an exoskeleton.	True
Crabs are a type of echinoderm.	False, crabs are crustaceans. Echinoderms are ogranisms such as sea stars, sea urchins, and sand dollars.
Crabs have eight legs.	False, crabs have ten legs.
Marine crabs breathe underwater using gills.	True
Crabs do not eat other crabs.	False, crabs do eat other crabs. They are scavengers, and they also eat worms, clams, mussels, and other invertebrates (animals without backbones).
Another name for a crab's shell is carapace.	True
Hermit crabs grow their shells.	False, hermit crabs live inside shells of other organisms.
Shorebirds like to eat crabs.	True
Crabs have eyestalks	True.
All crabs walk sideways.	False, some crabs like the hermit crab walk forward and back. Most crabs do walk sideways because their legs are on the side of their body and their joints bend outward.

ROCKY SHORE ZONES: THE SUBTIDAL ZONE

Topic
Zones, Adaptations

Duration
Two sessions

Vocabulary
adaptation
challenge
feature
subtidal zone
zone

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Adaptation

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the subtidal zone?

Overview

Students recall that the rocky shore has been divided into zones by marine biologists based on the average water and air exposure of each area. Students discuss what they learned about the splash zone, upper, middle, and lower intertidal zones, and the subtidal zone. Students record information about the subtidal zone's names, features, common algae life, and common animal life. Students continue to construct a bulletin board diagram or individual rocky shore zone diagram by creating the subtidal zone using art supplies.

Objectives

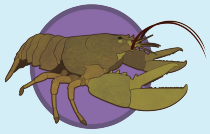
Students will be able to:

- ★ Indicate that the rocky shore can be divided into zones
- ★ Identify the subtidal zone and its features
- ★ Recognize the challenges living organisms encounter in the subtidal zone and the different adaptations of organisms living in the subtidal zone
- ★ Create a subtidal zone using art supplies.

Materials Needed

If doing bulletin diagram activity:

- ★ Rocky Shore Zones Table (one per student, page 150)
- ★ Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- ★ Rocky Shore Zones Table Answer Key (for teacher reference, page 151)
- ★ Life at the Rocky Shore Fact Sheet (for teacher reference, pages 23–24)
- ★ A large bulletin board or blank wall
- ★ White bulletin board art paper
- ★ White paper / index cards for each student
- ★ Coloring utensils for each student



Teacher Tips

- Have students use the Atlantic Ocean Rocky Shore Guide as a reference while they draw their rocky shore organisms. Use book illustrations or other printed resources if you need more examples.
- While instructing students about the subtidal zone using the Rocky Shore Zones Table, either project a copy of the table on the board or draw a table on a whiteboard to record information for all students to see.
- Make copies of the Rocky Shore Zones Table Answer Key for students with special needs to use at their own desks to either copy or highlight.

Materials Needed (continued)

- Scissors for each student
- Stapler (for teacher)

If doing individual diagram activity:

- Rocky Shore Zones Table (one per student, page 150)
- Atlantic Ocean Rocky Shore Guide (one per student, pages 25–27)
- My Rocky Shore Diagram (one per student, page 77)
- Rocky Shore Zones Table Answer Key (for teacher reference, page 151)
- Life at the Rocky Shore Fact Sheet (for teacher reference, pages 23–24)
- Coloring utensils for each student

Teacher Preparation

For the large classroom diagram:

1. Make sure all students have copies of the Rocky Shore Zones Table and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep scissors, drawing utensils, and white paper/index cards for each student.

For the individual student diagram:

1. Make sure all students have copies of My Rocky Shore Diagram, Rocky Shore Zones Table, and Atlantic Ocean Rocky Shore Guide.
2. Thoroughly review the Rocky Shore Zones Table Answer Key and Life at the Rocky Shore Fact Sheet.
3. Prep drawing utensils for each student.

Background

The rocky shore ecosystem is naturally divided into zones by the tidal movement of the ocean. These zones are mainly defined by the amount of time they are exposed to water and air. Specific organisms can often be found inhabiting particular zones.

Although types of living organisms are often found in one specific zone, they can be located in different zones depending on their ability to survive in various regions of the rocky shore. Zones are not restrictive, and will vary tremendously by slope, exposure, size of loose rocks, etc. While using the term "zone" is common and helpful, it can also mislead if students think that barnacles can only exist in the "barnacle zone."

Extension Suggestions

- ★ Have students research an ocean animal and write a story about the animal. Use Suzanne Tate's stories, along with Nancy Donovan's story Oscar the Herring Gull as examples. Consider using the template provided (pages 152–158) to help students format their story. Use websites such as National Geographic for Kids and Animal Fact Guide for research. Consider having students pick names of animals out of a hat to determine which animal they research, giving them one or two chances to "trade" for an animal of their choice afterward.
- ★ Invite a younger classroom to go on a pretend field trip to your classroom's finished rocky shore bulletin board (or individual diagrams) project. The younger classroom could fill out pretend permission slips, and your students can play the role of rocky shore guides.

Background (continued)

Each rocky shore zone presents living organisms with challenges that risk their survival. These living organisms have adaptations that enable them to overcome these challenges and thrive in the rocky shore ecosystem conditions.

The rocky shore ecosystem is frequently divided into three zones: the upper intertidal zone, the middle intertidal zone, and the lower intertidal zone. This ecosystem can be divided more precisely into five zones: the splash zone, the upper intertidal zone, the middle intertidal zone, the lower intertidal zone, and the subtidal zone.

Procedure

Part One

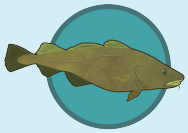
1. Ask students if they can recall how the rocky shore is divided into zones.
2. Inform students that a zone can be an area of land that has particular features. Each zone of the rocky shore has particular features, including specific amounts of time they are exposed to air and water, specific living organisms, and specific challenges to an organism's survival.
3. Have students discuss what they have learned about the splash zone, upper, middle, and lower intertidal zones by referring to their Rocky Shore Zones Table.
4. Inform students that they are going to be learning about the subtidal zone.
5. Instruct students on the names, features, algae, and animal life of the subtidal zone, having each student record facts you provide them with in their Rocky Shore Zones Table.
6. Emphasize the challenges to life in the subtidal zone, specifically citing the organisms' adaptations that allow them to survive these challenges.

Part Two

7. Inform students that they are going to continue to work on their rocky shore diagram, either as a class or individually.
8. *If as a class:*
    a. Have students access their Atlantic Ocean Rocky Shore Guide.
    b. Provide each student with white paper or index cards, scissors, and drawing utensils.
    c. Divide students into groups and designate each group specific organisms to draw and color for the subtidal zone.
    d. When finished, have students cut out their organisms and the teacher will attach them to the bulletin board or wall diagram.

Books

- ★ *Lindie Lobster* by Suzanne Tate
- ★ *The Cod's Tale* by Mark Kurlansky



Websites

- ★ Watch National Geographic Kids Nature Boom Time's YouTube episode titled "Kelp Forest."
- ★ Watch PBS Kids Wild Kratt's YouTube episode titled "Swimming with the Lobster."
- ★ Watch the Gulf of Maine Research Institute's YouTube episode titled "Blue lobster molting."

Scientist Notebook

- ★ Students can record the challenges and adaptations of organisms found at the subtidal zone.

Procedure (continued)

If individually:

a. Have students access their Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram.

b. Inform students that they are going to draw the specific organisms of the subtidal zone onto their My Rocky Shore Diagram.

Wrap-up

- ★ Have students store their Rocky Shore Zones Table, Atlantic Ocean Rocky Shore Guide and My Rocky Shore Diagram (if applicable) in a secure place to refer to in upcoming lessons.
- ★ Have students recall the features of the subtidal zone and its living organisms.
- ★ Have students recall the specific adaptations of the subtidal zone organisms.

ROCKY SHORE ZONES TABLE

Name: _____

Date: _____

Name of Rocky Shore Zone: _____

Zone Name	
Zone Features	
Zone Algae	
Zone Animals	

ROCKY SHORE ZONES TABLE

Answer Key

Name of Rocky Shore Zone: Subtidal zone

Zone Name	Subtidal zone
Zone Features	This zone is always exposed to water.
Zone Algae	Irish Moss, Horsetail Kelp, Sugar Kelp, Shotgun Kelp, Bubblegum Kelp
Zone Animals	Mummichog, Rock Gunnel, Lumpfish, Cunner, Lobster, Jonah Crab, Orange Sheath, Golden Star

WRITE YOUR OCEAN ANIMAL STORY

Name: _____

Date: _____

Draw a picture of your animal:

Describe your animal

Size (weight, height): _____

Color: _____

Special Characteristics (what makes your animal unique):

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Write Your Ocean Animal Story (continued)

Setting (where your animal lives): _____

Draw the setting of your story:

Food (what does your animal eat?):

1. _____

2. _____

3. _____

Dangers (predator, boats, etc.):

1. _____

2. _____

3. _____

Write Your Ocean Animal Story (continued)

Your character's name: _____

Descriptive words of your character:

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

Your character's problem (predator, some sort of danger: _____

_____

_____

What does the problem look like?

How does your character solve the problem? (With a special characteristic? A human's help?) _____

_____

_____

_____

Your Ocean Animal Story in Order

Beginning: Main characters and setting are introduced.
Middle: The problem to the story is introduced.
End: The solution to the problem is revealed.

Beginning: Introduce your ocean animal by describing it. What does it look like? How big is it? What are its special characteristics? Describe where your animal lives.

Your Ocean Animal Story in Order

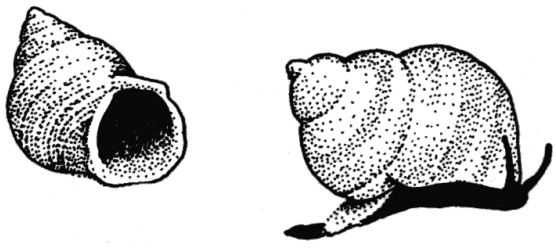
Middle: Tell the reader your animal's problem. Describe the problem your animal has using many details. Explain efforts to solve the problem that did not work.

Your Ocean Animal Story in Order

End: Tell your reader how your animal solves the problem. Use many details to describe how the animal solved the problem. Now that the problem is solved, what does the animal do?

Your Ocean Animal Story

- ★ Your quest is to write a story about an ocean animal.
- ★ A good story has a beginning, middle and end.
- ★ A good story has a problem and a solution.
- ★ Enjoy learning about your animal, and then create a main character.
- ★ Educate your reader by writing an exciting story that has many facts about your animal.



THE FOUR TRAITS OF FISH

Topic
Fish, Traits

Duration
One session

Vocabulary
backbone
fin
fish
gill
trait
vertebrae

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Inheritance of Traits

Crosscutting Concepts
Patterns

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is a fish?

Overview

Students list organisms they believe to be fish. Students infer what traits determine that an organism is a fish by examining their list. Students discover the four main traits of fish. Students classify animals as being fish or different organisms.

Objectives

Students will be able to:

- ★ Identify the four main traits of all fish
- ★ Recognize the difference between fish and other organisms
- ★ Compare and contrast fish and other organisms

Materials Needed

- ★ Is it a Fish? activity sheet for each student (page 162)
- ★ One copy of How Are These the Same? photography sheet (page 163)
- ★ A whiteboard or SMART Board to record student feedback

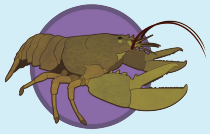
Teacher Preparation

1. Make copies of Is it a Fish? Activity sheet (page 162)
2. Make one copy of How Are These the Same? photography sheet (page 163) or be prepared to display it on a projector for the class.
3. Have a whiteboard or SMART Board available to record student feedback.

Background

The four main traits of all fish include the following:

1. All fish live in water.
2. All fish have gills to filter oxygen from their water environment.
3. All fish have fins to help them move through the water.
4. All fish have backbones (vertebrae) for support and movement.



Teacher Tips

- ★ When completing the Is it a Fish? activity sheet consider pairing up partners of varying ability levels so that they might assist each other.
- ★ Show a recommended website video after listing the four main traits of fish and before the Is it a Fish? activity.
- ★ Have a device nearby to fact check any student feedback regarding characteristics of fish/types of fish and share out information immediately.

Extension Suggestions

- ★ Have students participate in the Monterey Bay Aquarium's lesson titled, "Decode a Fish," found on their educational website.
- ★ Provide students with the average length of each fish from the Is it a Fish? activity sheet. Have students create a bar graph that conveys the length of each fish to create a visual comparison of the fish sizes

Background (continued)

Most fish are cold-blooded except for the Tuna family and the Mackerel shark family. There are more than 27,000 different species of fish. The largest fish is the whale shark, measuring up to 51 feet long. The smallest fish is the Stout Infantfish measuring up to 8 millimeters long. Most fish have a skeleton made of bone, but some fish (like sharks) have skeletons made of cartilage.

Procedure

Part One

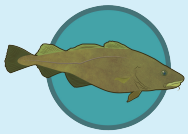
1. Show students the How Are These the Same? photography sheet using a projector or SMART Board. Ask students, "How are these organisms the same?" Confirm correct answers and politely acknowledge incorrect answers.
2. If students did not come up with the answer, "They are all fish," inform students that the four organisms shown are indeed all fish. Confirm correct answers, politely acknowledge incorrect answers, and research answers if you are unsure.
3. Ask students why all of the organisms on their list and projected on the board are fish? What traits (characteristics) does an organism have to make it a fish?
4. Write on a board or large piece of paper, "Four Traits of Fish" and beneath this heading write down any correct answers.
5. When students are done inferring what main traits all fish have, complete the list:
    a. All fish live in water.
    b. All fish have gills to filter oxygen from their water environment.
    c. All fish have fins to help them move through the water.
    d. All fish have backbones (vertebrae) for support and movement.
6. Suggest that students memorize the initials "WGFB" to assist them in remembering the four main traits of fish: "Water, Gills, Fins, Backbone."

Part Two

7. Inform students that they are going to be working in pairs to complete an activity called, "Is it a Fish?"
8. Pass out the Is it a Fish? activity sheet and review instructions with students.
9. When all students have completed the assignment have pairs of students share their answers as you review each fish or "not fish."

Books

- ★ *Flossie Flounder: A Tale of a Flat Fish* by Suzanne Tate
- ★ *DK Eyewitness Books: Fish* by Steve Parker
- ★ *What's It Like to Be a Fish?* by Wendy Pfeffer



Websites

- ★ Check out a video outlining the four main traits of a fish on Dunedin Aquarium's YouTube Channel titled, "What Makes a Fish a Fish?"
- ★ Have students play the online game "Ocean Animals" on Sheppard Software's website.

Scientist Notebook

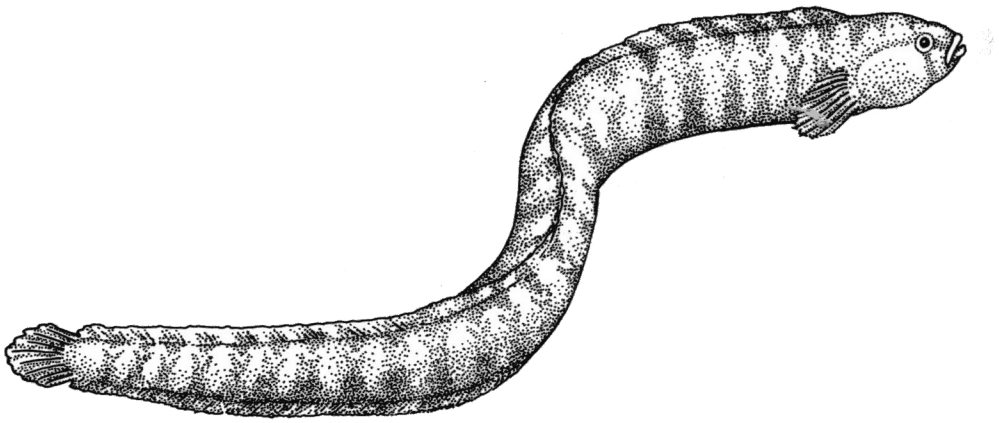
- ★ Students can record the four main traits of fish. Students can paste their Is it a Fish? activity sheet into their notebook.

Procedure (continued)

10. Have students compare and contrast the fish and other organisms on the Is it a Fish? activity sheet by asking them how the fish and other organisms are the same, and how they are different.

Wrap-up

- ★ Ask students to identify the four main traits of a fish (WGFB).
- ★ Ask students to recall the different types of fish they were exposed to in today's activity.
- ★ Ask students to recall how fish are similar to other organisms in the ocean, and how they are different.



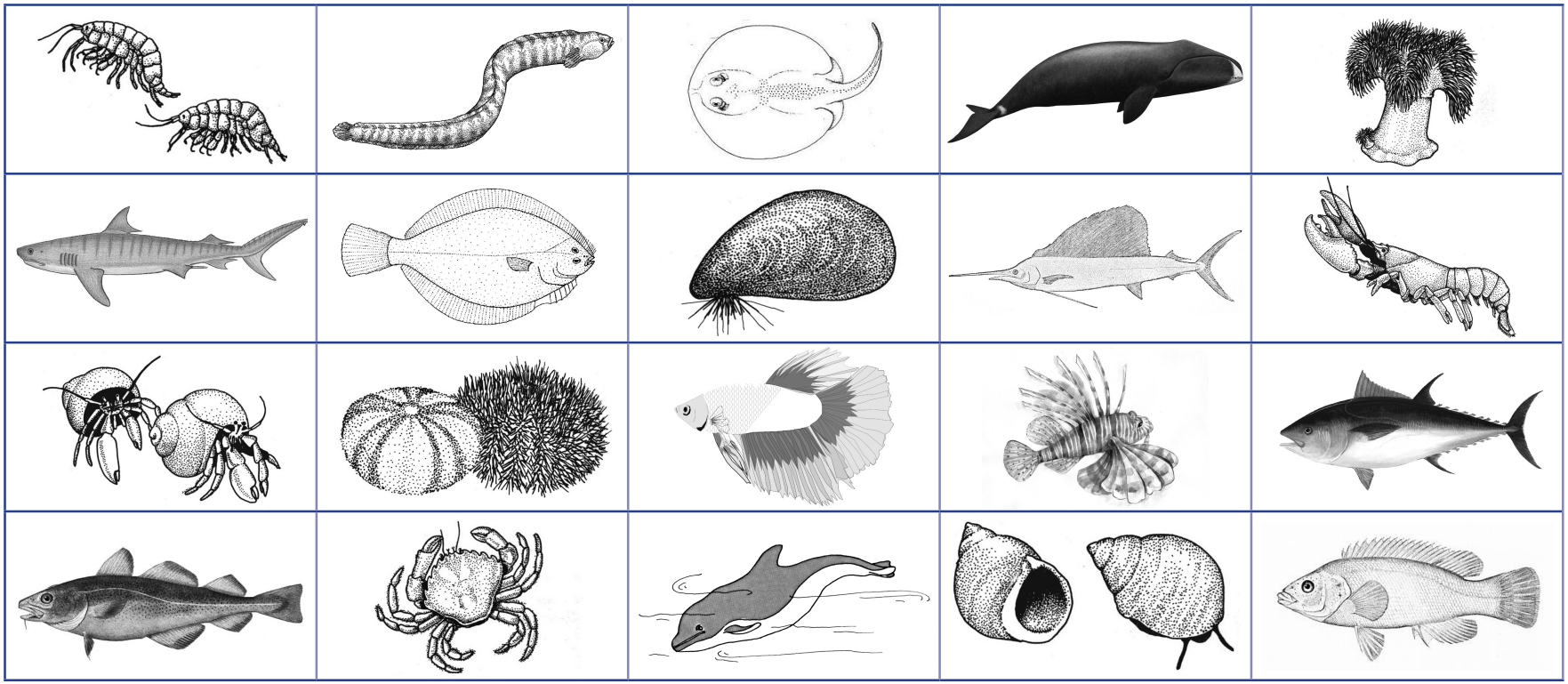
IS IT A FISH?

Name: _____

Date: _____

List the Four Traits of Fish:
1.
2.
3.
4.

Directions: If you think it is a fish, circle the picture. If you do not think it is a fish, leave it blank.



IS IT A FISH?

Answer Key

Row One (left to right)

1. scud (not a fish)
2. gunnel (fish)
3. yellow stingray (fish)
4. bowhead whale (not a fish)
5. frilled sea anemone (not a fish)

Row Two (left to right)

1. tiger shark (fish)
2. flounder (fish)
3. blue mussel (not a fish)
4. sailfish (fish)
5. lobster (not a fish)

Row Three (left to right)

1. hermit crab (not a fish)
2. sea urchin (not a fish)
3. betta (fish)
4. lionfish (fish)
5. bluefin tuna (fish)

Row Four (left to right)

1. Atlantic cod (fish)
2. green crab (not a fish)
3. porpoise (not a fish)
4. common periwinkle (not a fish)
5. cunner (fish)

HOW ARE THESE THE SAME?

Seahorse	Bluespotted Stingray
	
Ribbon Eel	**Hammerhead Shark**
	

THE WANDERING PLANKTON

Topic
Plankton, Marine Food Web

Duration
One session

Vocabulary
energy
food chain
food web
phytoplankton
plankton
zooplankton

STANDARDS

Practices
Developing and Using Models

Core Ideas
Interdependent Relationships in Ecosystems

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 3, OLP 4, OLP 5, OLP 6

Focus Question

Why is plankton important?

Overview

Students recall rocky shore organisms and make inferences about their diets. Students outline a rocky shore food chain. Students identify the first link in the rocky shore (and marine) food chain—plankton. Students recognize the difference between a food chain and a food web. Students discover the importance of plankton to marine life and all life on Earth. Students create a rocky shore food chain model that begins with the sun, followed by phytoplankton, zooplankton, barnacle, dog whelk, rock crab, and herring gull.

Objectives

Students will be able to:

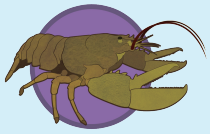
- Define the terms "plankton," "phytoplankton," and "zooplankton"
- Recognize the difference between food chains and food webs
- Discover the importance of plankton to marine life and life on Earth
- Create a model of a rocky shore food chain which conveys that energy in animals' food was once energy from the sun

Materials Needed

- Rocky Shore Food Chain activity sheets (page 169)
- Paper, plastic or Styrofoam cups (7 per student)
- Permanent or washable markers
- Glue or tape
- A whiteboard or SMART Board to record student feedback

Teacher Preparation

1. Make copies of Rocky Shore Food Chain activity sheet (page 169).
2. Prepare groups of seven cups for each student.
3. Prepare permanent or washable markers for each student.



Teacher Tips

- ★ Consider having students draw their own illustrations of the items on the food chain.
- ★ Show a recommended website video on food chains and food webs, as well as on plankton during the lesson.
- ★ Make sure the cups for the activity are of a sufficient size, and that the markers being used are adequate (i.e. won't wipe off cup easily).

Extension Suggestions

- ★ Have students participate in the Ask a Biologist lesson titled, "It's a plankton eat plankton world," found on the Arizona State University's Ask a Biologist website.
- ★ Have students create a food chain or food web of organisms that reside in their local environment.

Teacher Preparation (continued)

4. Prepare glue or tape for each student.
5. Have a whiteboard or SMART Board available to record student feedback.

Background

Plankton are microscopic organisms drifting in the ocean. The term plankton comes from the Greek word meaning "wanderer" or "drifter." There are two types of plankton: phytoplankton and zooplankton. Phytoplankton stands for "plant plankton" and zooplankton stands for "animal plankton."

Phytoplankton are small plants that are the base of the marine food chain. Small organisms (and large organisms such as whales) eat phytoplankton. Larger organisms eat the smaller organisms that have consumed phytoplankton. The food chain continues, and sometimes humans enter the food chain as people around the world eat large quantities of fish.

Phytoplankton include different types of algae and bacteria. Phytoplankton are mainly comprised of diatoms and dinoflagellates. Phytoplankton live near the surface of the ocean because they need sunlight to grow. They also need nutrients to grow that can be found in the ocean waters. They are very important to the ocean and all life on Earth. They are the first link in the marine food web. Around a quarter of the oxygen we breathe comes from the Earth's rainforests. More than two-thirds of the oxygen we breathe comes from oxygen produced by phytoplankton!

Zooplankton are microscopic organisms that eat other plankton. Zooplankton consist of larval stages of larger animals such as mollusks, crustaceans, fish and jellyfish. Some zooplankton are single-celled animals. Other zooplankton are tiny crustaceans such as krill and copepods. Krill and copepods are two of the most abundant animals on Earth.

Procedure

Part One

1. Ask students to recall a species of shorebird. Ask students what the specific shorebird eats. Take one of their answers (such as crab) and ask students what that species of animal eats. Continue this pattern of questioning until student answers come to a filter feeder such as a barnacle.
2. Ask students what a barnacle (or other filter feeder) might eat.
3. Inform students that filter feeders such as barnacles or blue mussels eat plankton.

Books

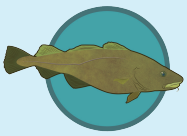
- ★ *The Magic School Bus Gets Eaten: A Book About Food Chains* by Pat Relf
- ★ *Who Eats What? Food Chains and Food Webs* by Patricia Lauber
- ★ *Plankton: Wonders of the Drifting World* by Christian Sardet
- ★ *Ocean Sunlight: How Tiny Plants Feed the Seas* by Molly Bang

Procedure (continued)

4. Ask students to attempt to define plankton.
5. Inform students that plankton are microscopic organisms drifting in the ocean. Some plankton are algae or bacteria (phytoplankton) and some plankton are animals (zooplankton).
6. Inform students that plankton comes from a Greek word meaning "wanderer" or "drifter."
7. Ask students where they believe most of their oxygen comes from. Inform students that over two-thirds of the oxygen we breathe comes from phytoplankton.
8. Inform students that plankton is often the base of most marine food chains, which means it is the smallest organism of a food chain. Ask students what they believe plankton eats. Inform students that zooplankton eats other zooplankton or phytoplankton. Inform students that phytoplankton gets its energy from the sun and nutrients found in ocean waters.
9. Ask students to define a food chain. Inform students that a food chain is a single path of how organisms get their food. A food chain begins with the sun providing energy to plants, and plants being eaten by animals.
10. Ask students what the difference is between a food chain and a food web. A food chain is a single path, whereas a food web shows how several paths of plants and animals are interconnected.
11. Show students examples of a food chain and a food web, such as an image from the sciencebob.com website.

Part Two

12. Inform students that they are going to create a marine food chain using cups, markers and a Rocky Shore Food Chain activity sheet.
13. Have students cut out the images on the Rocky Shore Food Chain activity sheet, adhere one to each cup, then label each image on the bottom of the cup using a marker.
14. When students have completed their marine food chain, have students get into pairs. Advise students to take turns mixing up their partner's cups, and then to challenge their partner by timing them to see how fast they can place their food chain in order (from the sun first to the herring gull last).



Websites

- ★ Check out "The Secret Life of Plankton," a video on the life of a fish that started out as plankton, on TED-Ed's YouTube Channel.
- ★ Check out an image of a rocky shore food web on the Young People's Trust For the Environment's website under their "Videos, Fact Sheets and Downloads" tab.
- ★ Have students play the "c.o.o.l. projects food web game" on coolclassroom.org to learn facts about marine organisms and place them in the correct feeding levels. You can print out the food web when complete.

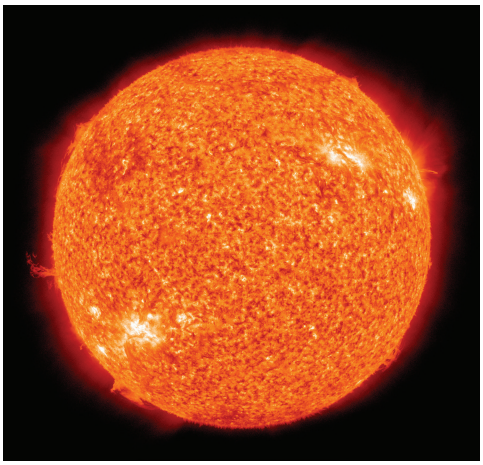
Scientist Notebook

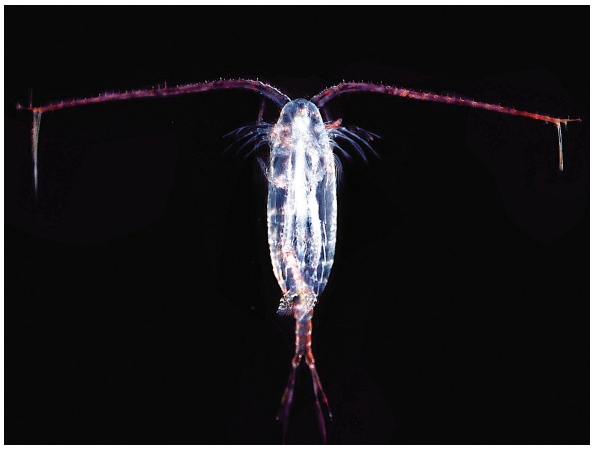
- ★ Students can record the definitions of plankton, phytoplankton, zooplankton, food chain, and food web.

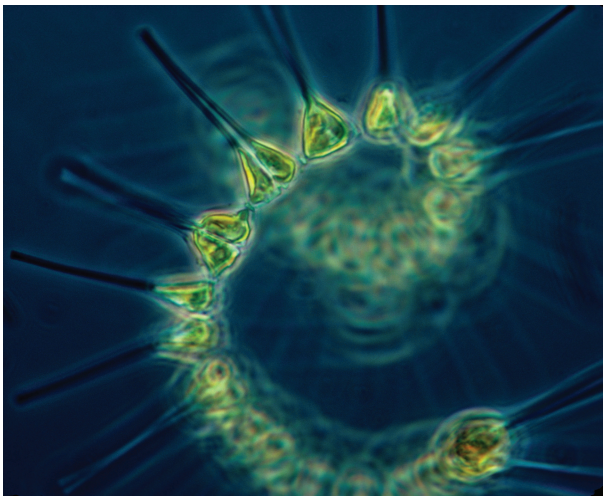
Wrap-up

- ★ Ask students to define the terms "plankton," "phytoplankton," and "zooplankton."
- ★ Ask students to recall the difference between a food chain and a food web.
- ★ Ask students to recall the importance of plankton to marine life, and to all life on Earth.

ROCKY SHORE FOOD CHAIN







CREATE-A-CRITTER *Part Two*

Topic
Engineering Design Process, Adaptations

Duration
Two sessions

Vocabulary
adaptation
constraint
design
engineer
engineering design process
prototype

STANDARDS

Practices
Engaging in Argument from Evidence

Core Ideas
Structure and Function

Crosscutting Concepts
Cause and Effect

OCEAN LITERACY PRINCIPLES

OLP 5

Focus Question

What is the engineering design process?

Overview

Students recall the different adaptations living organisms possess at the rocky shore. Students recall the definition of adaptation. Students discover the engineering design process. Students design, create, and test a fictitious organism with adaptations that would allow it to survive the rocky shore ecosystem using the engineering design process. Lesson 7 and Lesson 19 are connected lessons which teachers can utilize as formative pre- and post-assessments.

Objectives

Students will be able to:

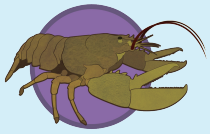
- Identify the engineering design process
- Recall the many different types of adaptations living organisms possess at the rocky shore
- Construct a fictitious rocky shore organism with adaptations using the engineering design process

Materials Needed

- Engineering Design Process activity sheet (one per student, page 175)
- Create-A-Critter Engineering Design Process activity packet (at least one per student, pages 176–178)
- 5 index cards per student for each "critter" being made
- Scissors (one per student)
- Transparent adhesive tape/tape dispensers (one per group)
- Five pound bag of rice or bird seed
- Pillowcase

Teacher Preparation

1. Each student will need a copy of the Engineering Design Process activity sheet.
2. Each student will need a copy of the Create-A-Critter Engineering Design Process activity packet.
3. Separate index cards into groups of five for each student (students may create more than one "critter").



Teacher Tips

- ★ *Warning*: If doing this extension with younger children, inform them beforehand of your intention to potentially crush their creation.
- ★ Placing the bird seed or rice in a freezer bag before tying it up in a pillowcase will decrease the possibility of "the wave" from leaking.
- ★ Testing student critters at a separate place in the classroom or a different location altogether will help to add variety and movement to the lesson.

Teacher Preparation (continued)

4. Prepare scissors—one per student.
5. Prepare transparent adhesive tape dispensers so there are enough dispensers for student groups of three to four students per group.
6. Prepare one pillowcase filled with five pounds of rice or bird seed. Make sure the pillow case is securely tied so no rice or bird seed can escape the pillowcase.
7. Teachers will need easy access to a whiteboard or interactive whiteboard to record student input.
8. If saved, teachers should refer back to the student inference list of adaptations they thought rocky shore organisms might have to survive the rocky shore ecosystem (from lesson seven).

Background

The engineering design process is a series of steps engineers follow to come up with a solution to a problem. Sources differ on the number of steps the engineering design process should have. This lesson features the five major steps of the engineering design process—ask, imagine, plan, create, and improve. **Ask**: What is the problem? What are the constraints? **Imagine**: Brainstorm ideas to solve the problem and choose the best one. **Plan**: Draw a diagram and gather needed materials. **Create**: Follow the plan and test the prototype. **Improve**: Determine what can be done to make the design better and repeat the engineering design process.

An adaptation is a body part or a behavior that helps a living thing survive in its environment. Rocky shore organisms need adaptations to survive the harsh and constantly changing environment of their rocky shore ecosystem. These challenges include some of the following: the waves, the tides, the temperatures, finding food, and evading predators. Other challenges to rocky shore organisms include the flux of salinity levels of the saltwater, various ranges of light, as well as human factors such as pollution and carelessness when visiting the rocky shore.

Some adaptations of rocky shore organisms include: thick shells, round shells, impermeable shells, the ability to retain water, holdfasts, secreted substances that allow organisms to attach well to rocks, spiny bodies, regeneration, exoskeletons, gathering in groups, camouflage, filter feeding, seeking crevices for shelter, burrowing abilities, ability to lower metabolic rates, and many more!

Extension Suggestions

- Have students brainstorm classroom problems that have the potential to be solved using the engineering design process, then have students work in pairs or in groups to attempt to solve the problem using the engineering design process.

Books

- *Rosie Revere, Engineer* by Andrea Beaty
- *Engineering: Feats and Failures* by Stephanie Paris

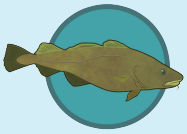
Procedure

Part One

1. Ask students how they solve problems. If necessary, provide examples of problems they might have: arguing with siblings, not understanding class work/homework, unable to perform a sports maneuver, etc.
2. Ask students what they do if they try to solve the problem and it does not work.
3. Inform students that steps they take to solve their problems are similar to steps engineers take to solve problems.
4. Inform students that an engineer is a person who designs and builds things to solve a problem. Inform students that there are different types of engineers such as mechanical, chemical, civil and electrical engineers.
5. Inform students that engineers solve problems using the engineering design process.
6. Provide each student with a copy of the Engineering Design Process activity sheet.
7. Discuss with students each step of the process, and have them record the details of each step on the Engineering Design Process activity sheet.
8. After completing the activity sheet, inform students that engineers need qualities such as patience, creativity, and grit to solve problems.

Part Two

9. Inform students that they are going to be using the Engineering Design Process to test and improve their fictitious rocky shore organism from lesson seven.
10. If possible, refer back to the student inference list created in lesson seven of the adaptations students thought rocky shore organisms might have to survive the rocky shore ecosystem.
    a. Have students compare their knowledge of the many types of adaptations they learned about in previous lessons with the inferences they made in lesson seven.
11. Provide students with the rocky shore organisms they created.
12. Ask students to examine the Engineering Design Process activity sheet and determine what step of the process they are currently on with their "create-a-critter" activity.
13. Inform students that they are now on the "create" step, and they need to test their critters to see if the adaptations they designed and constructed will help their critter to survive.



Websites

- ★ Check out the Crash Course Kids YouTube Channel episodes titled "What's an Engineer," and "The Engineering Process."
- ★ Watch a rap of the engineering design process on Baba Bomani's YouTube Channel episode titled "Engineering Design Process (lyric video)."
- ★ Check out NASA Goddard's YouTube Channel video titled "NASA for Kids: Intro to Engineering."

Scientist Notebook

- ★ Students can record the steps of the Engineering Design Process in their notebooks.

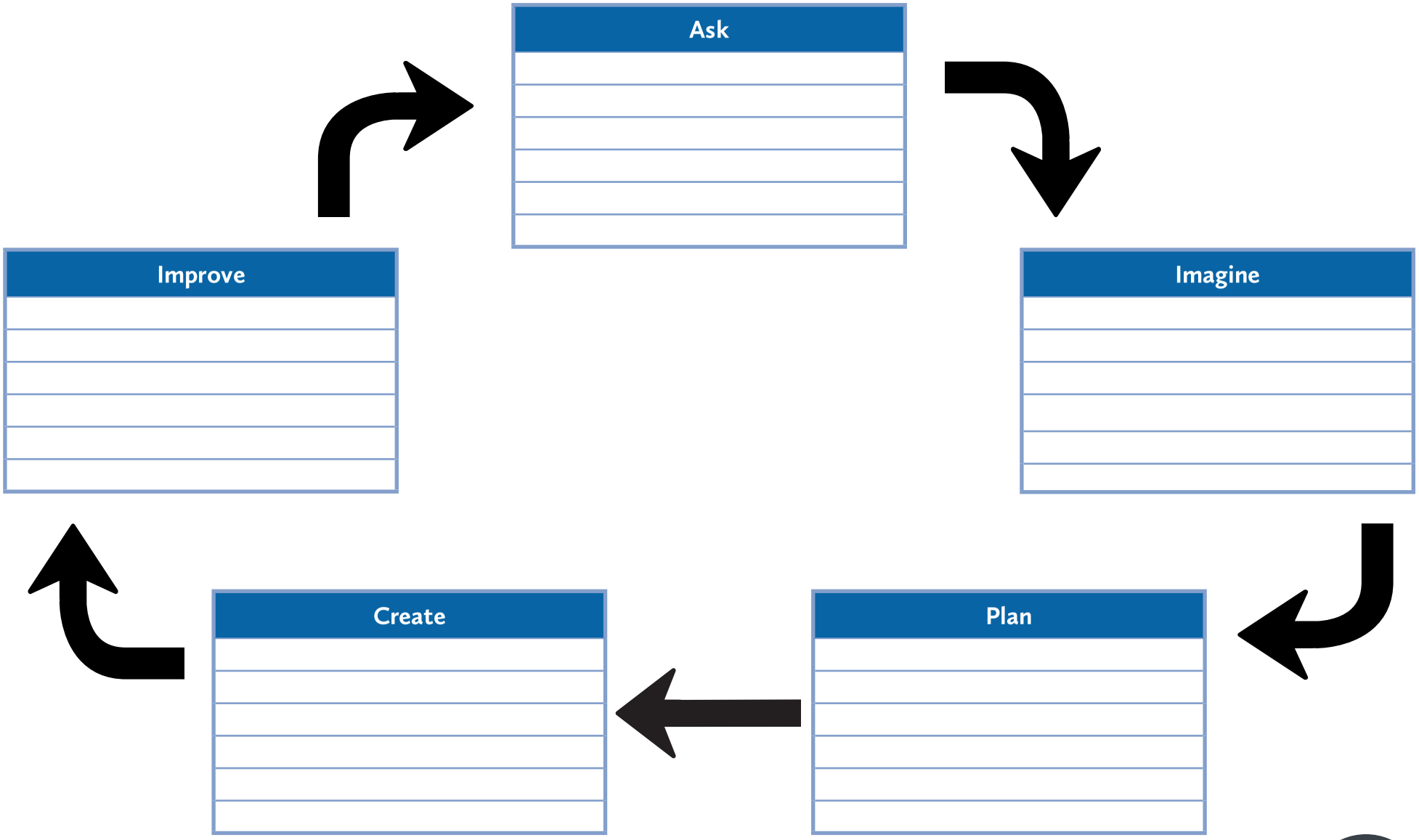
Procedure (continued)

14. Inform students that you will be testing each critter's adaptations by having a "wave" crash on top of it.
    a. Show students "the wave," which is the pillowcase filled with rice or birdseed.
    b. Have each student come up one-by-one with their critter and drop "the wave" onto their critter from a standing or elevated position.
    c. After each student's critter is crashed upon by "the wave," have students show thumbs up (survived), thumbs down (did not survive) or thumbs sideways (not sure), to indicate how they feel the student's critter fared.
    d. The majority vote should determine whether or not the critter survived in every circumstance, unless you as the teacher feel as though students are not being accurate or are too indecisive.
15. After the testing using "the wave" is complete, have students gather into groups of four and provide them with the Create-A-Critter Engineering Design Process activity packet.
16. Have students fill out the packet and complete every step of the Engineering Design Process, including testing their new critter with "the wave."

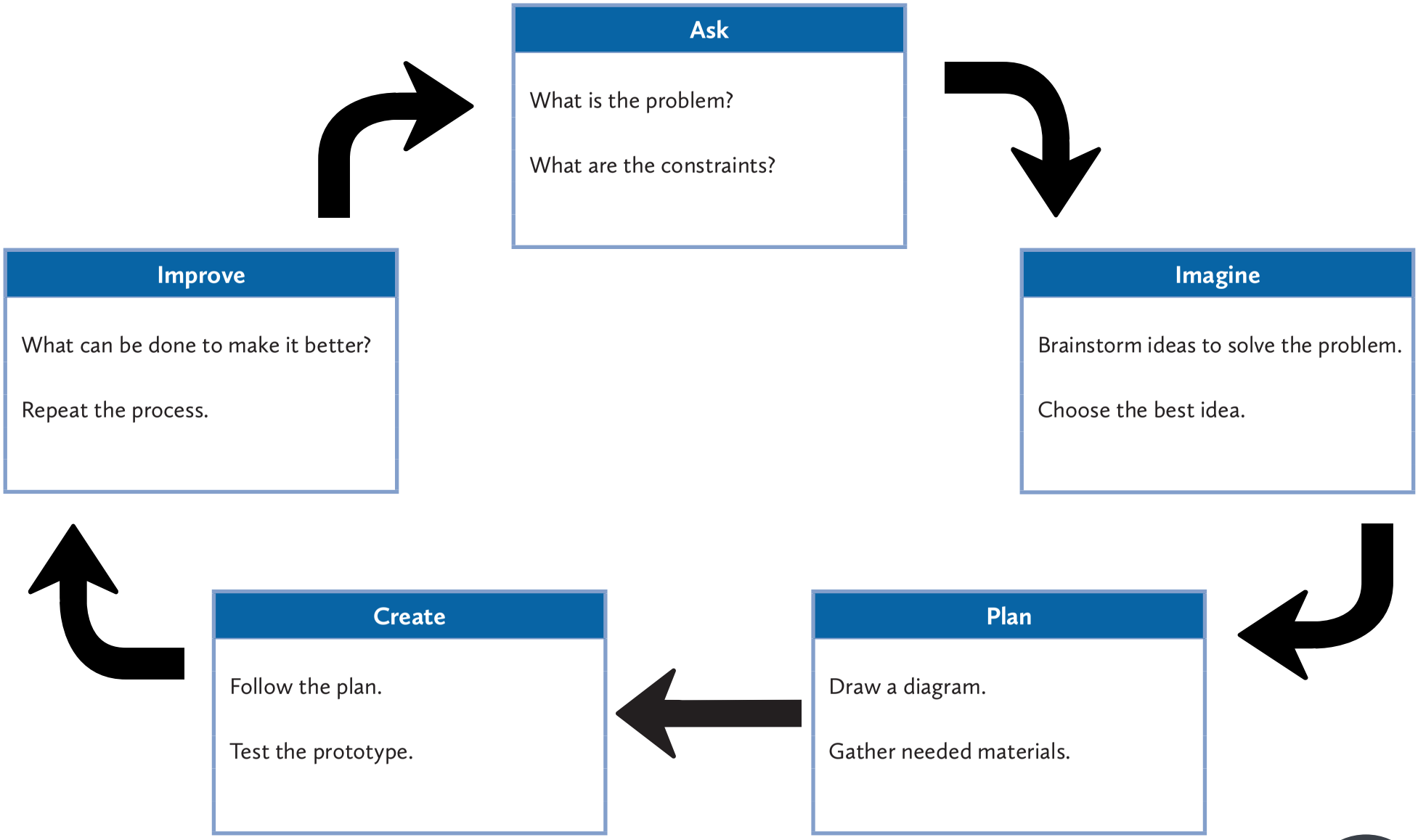
Wrap-up

- ★ Ask students to identify the steps of the engineering design process.
- ★ Ask students to recall adaptations of rocky shore organisms that enable them to survive their harsh environment.
- ★ Encourage students to continue using the engineering design process to create more critters at home (with their parents' permission), as well as to solve other problems.

ENGINEERING DESIGN PROCESS



ENGINEERING DESIGN PROCESS

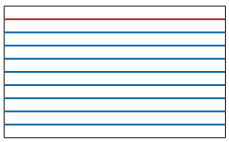


CREATE-A-CRITTER

Engineering Design Process

Name: _____

Date: _____



Ask

What is the problem?

What are the constraints?

Imagine

Ways to solve the problem:

1.

2.

3.

What is the best idea?

CREATE-A-CRITTER

Engineering Design Process

Plan

Draw a diagram of the best idea.

Gather needed materials.

CREATE-A-CRITTER

Engineering Design Process

Create

Follow the plan (the best idea).

Test the prototype.

What worked well?

What did not work well?

Improve

What can be done to the prototype to make it better?

Repeat the engineering design process!

ROCKY SHORE ALGAE!

Topic
Algae, Plants

Duration
One session

Vocabulary
algae
blade
holdfast
leaf
photosynthesis
plant
root
stem
stipe
vascular system

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Variation of Traits

Crosscutting Concepts
Patterns

OCEAN LITERACY PRINCIPLES

OLP 5, OLP 6

Focus Question

What is the difference between algae and plants?

Overview

Students recall the different types of rocky shore algae they have learned about in previous lessons. Students recall the different characteristics of algae at the rocky shore. Students examine photographs of algae and plants and identify the observable differences. Students discover the main differences between algae and plants. Students identify different types of rocky shore algae.

Objectives

Students will be able to:

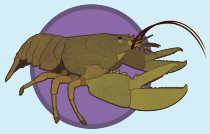
- ★ Recall different types of rocky shore algae and their characteristics
- ★ Discover the difference between algae and plants
- ★ Identify different types of rocky shore algae

Materials Needed

- ★ Algae or Plant? activity sheet for each student, if decided upon (page 182)
- ★ Algae! bingo activity sheets (pages 185–204)
- ★ A projector to display Algae or Plant? activity sheet, if decided upon
- ★ A whiteboard or SMART Board to record student feedback.

Teacher Preparation

1. Make copies of Algae or Plant? activity sheet for each student, if decided upon.
2. Make one copy of Algae! bingo calling cards activity sheet and cut out calling cards (page 184).
3. Print out Algae! bingo board activity sheets for each student.
4. Have a projector available to display Algae or Plant? activity sheet, if decided upon.
5. Have a whiteboard or SMART Board available to record student feedback.



Teacher Tips

- ★ Display an Algae! bingo board activity sheet using a projector while playing the game to indicate the correct answer visually.
- ★ Have students write the correct name of each algae (or bacteria) on their Algae! bingo board activity sheet while playing the game.
- ★ Have students color each algae with the correct color while playing the Algae! bingo game.

Extension Suggestions

- ★ Take a nature walk and have students record the plants they observe using cameras or by drawing diagrams. When they return to the classroom, have students do research on at least three of their plants to learn about what they are, their special characteristics, and if they are actually plants or not.
- ★ Have students create a Venn Diagram on plants and algae.

Background

Plants produce their own food using nutrients in the soil and sunlight by photosynthesis. Plants are multicellular. Plants have roots, stems and leaves. A plant's roots hold the plant in place. Most plants are immobile. A plant has a vascular system which allows for the uptake and transport of water and nutrients. Plants are mostly terrestrial.

Algae produce food with sunlight by photosynthesis and by absorbing nutrients from the water. Algae can be unicellular or multicellular. Many algae have holdfasts, stipes and blades (or fronds). Holdfasts are root-like organs that attach to substrates but do not absorb anything. Some algae are free-floating. Algae absorb nutrients directly from the water through surface tissues. Algae are mostly aquatic.

Procedure

Part One

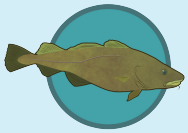
1. Ask students to recall as many types of algae and bacteria they have learned about from previous lessons. Record their answers on a whiteboard or SMART Board.
2. Review each algae and ask students to recall their characteristics. Record their answers. Remind students of the names of each algae reviewed in class and their characteristics if necessary.
3. Either display the Algae or Plant? activity sheet using a projector, or hand out a copy of the Algae or Plant? activity sheet to each student.
4. Have students examine each plant or algae one-by-one, and have them briefly discuss in partners whether they think it is a plant or algae, and why.
5. Have students share their inferences.
6. Explain to students whether they are correct or not, and why.

Part Two

7. Inform students that they are going to be playing an algae bingo game.
8. Show students one of the Algae! bingo board activity sheets. Ask students to identify each algae before playing the game.
9. Pass out Algae! bingo board activity sheets to each student.
10. Have students circle the free space in the middle of their bingo board activity sheets.
11. Place the Algae! bingo calling cards in a hat or container and pick out one at a time, explaining to students to circle the correct algae called.

Books

- *An Ocean Garden* by Josie Iselin
- *Seaweeds* by David Thomas



Websites

- Check out a video about rocky shore seaweed titled "OceanRunnerNH: Getting the Scoop on Seaweed," on the Seacoast Science Center's YouTube Channel.
- Watch a BrainPOP video on algae and take the quiz! (Subscription required.)
- Watch a slideshow created by The Children's University of Manchester titled "What are Algae?" on The Children's University of Manchester website under the science and micro-organisms tabs.

Scientist Notebook

- Students can record the definition of algae. Students can write the differences of plants and algae.

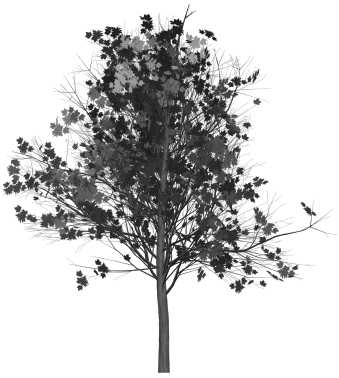
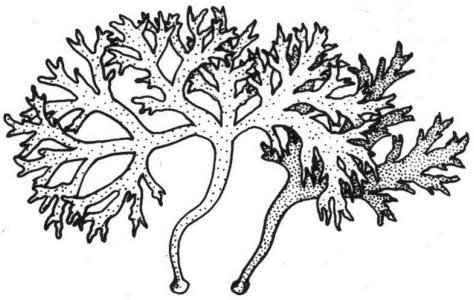
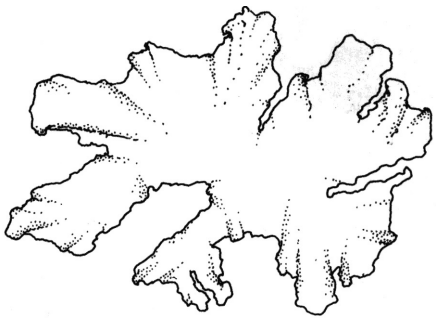
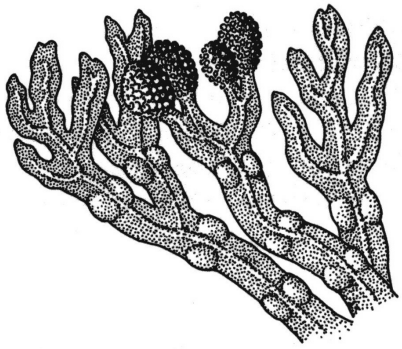
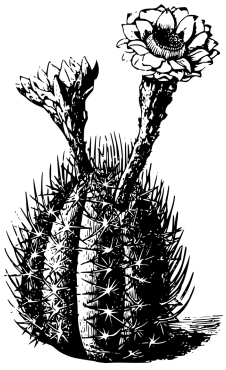
Procedure (continued)

12. Once a student or students has circled three-in-a-row they are to shout, "Algae!"
13. Play the game at least a few times so that each algae is "called" multiple times.

Wrap-up

- Ask students to identify the term "algae."
- Ask students to recall the differences between algae and plants.
- Ask students to recall the main types of algae found at the rocky shore.

ALGAE OR PLANT?

1 	2 
3 	4 
5 	6 
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ALGAE OR PLANT?

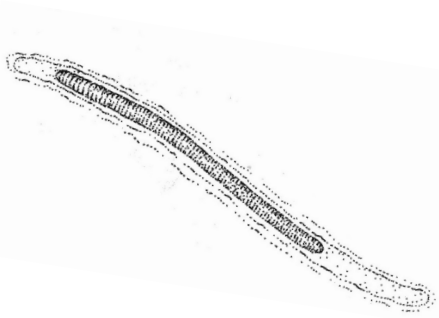
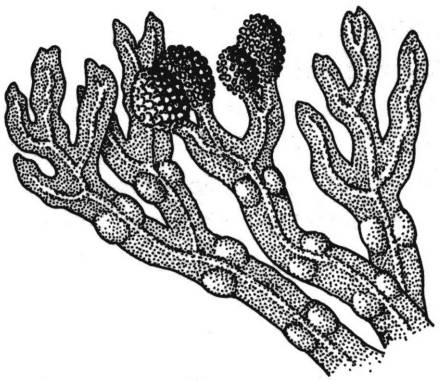
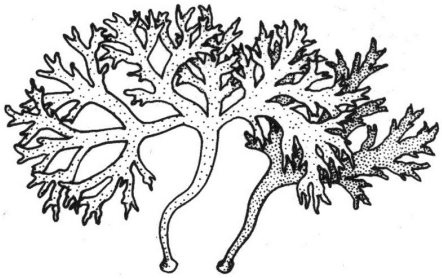
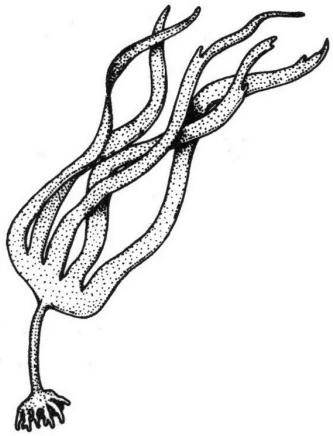
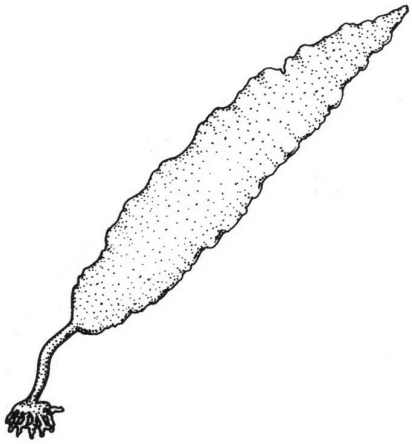
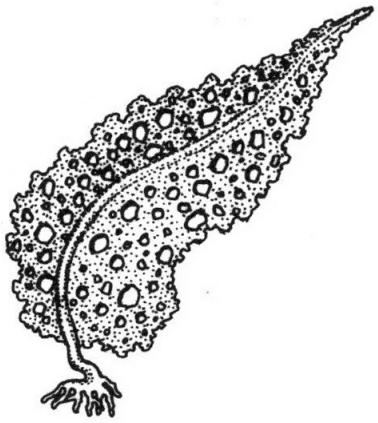
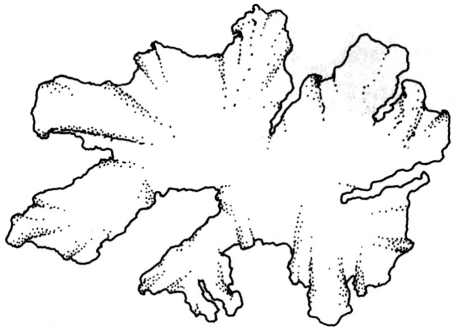
Answer Key

1. plant
2. algae
3. algae
4. algae
5. plant
6. plant
7. algae
8. plant

ALGAE! CALLING CARDS

Cyanobacteria	**Irish Moss**
Knotted Wrack	**Rockweed**
Horsetail Kelp	**Shotgun Kelp**
Sugar Kelp	**Sea Lettuce**

ALGAE! *Game Board*

		
	**FREE**	
		

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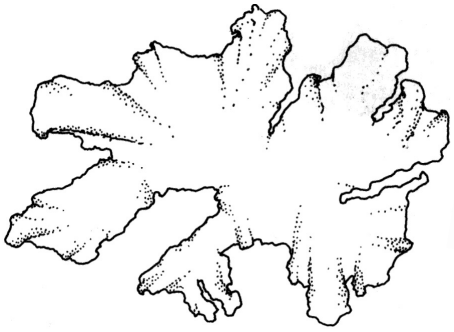
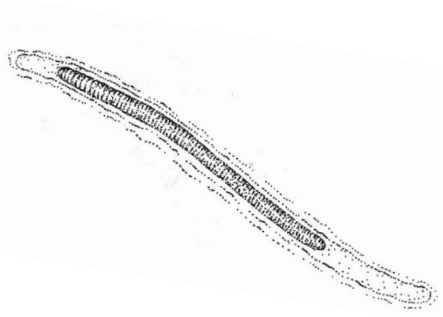
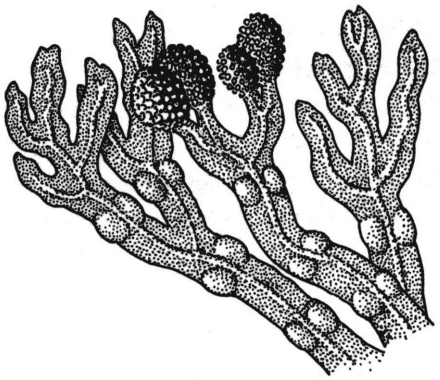
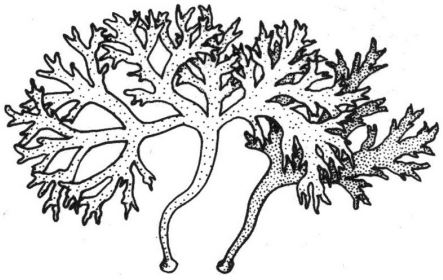
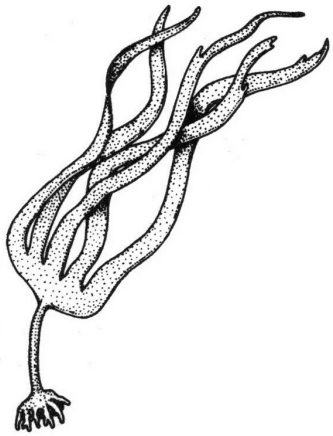
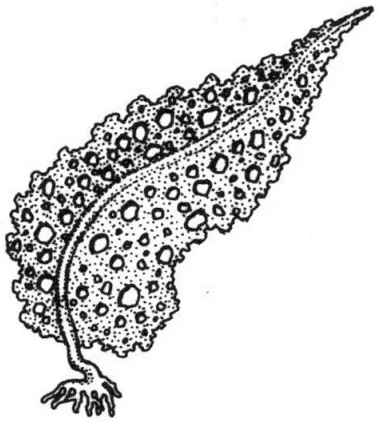
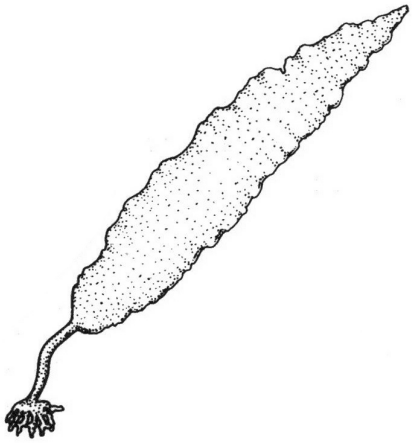
		
	**FREE**	
		

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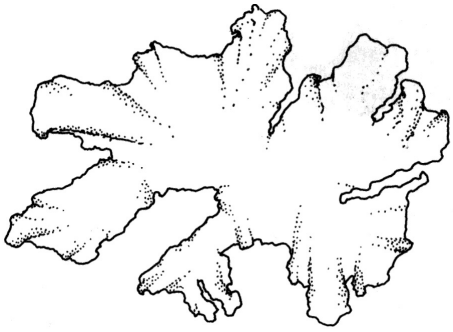
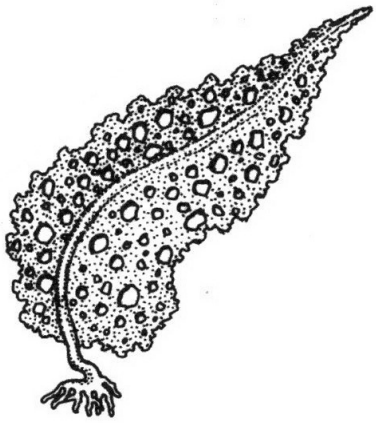
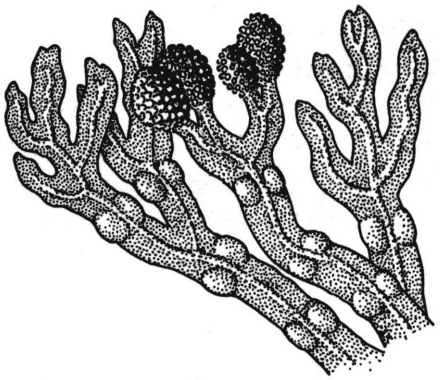
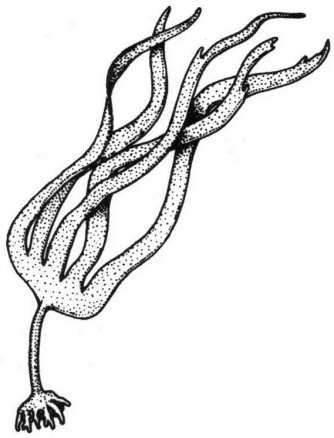
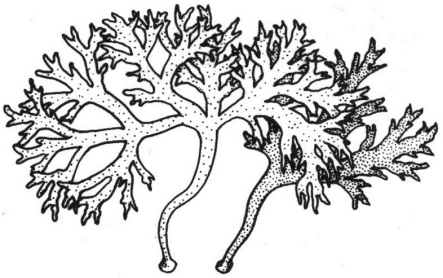
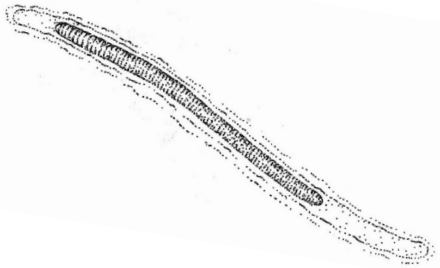
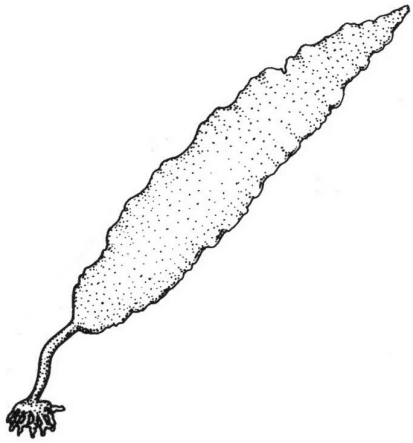
		
	**FREE**	
		

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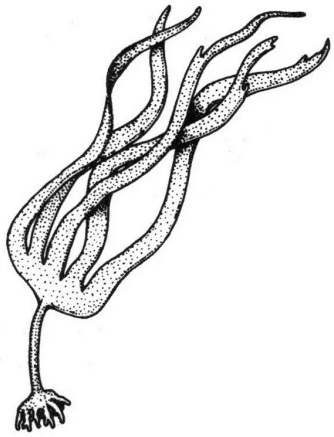
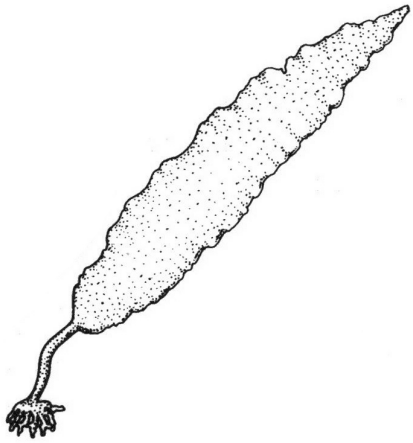
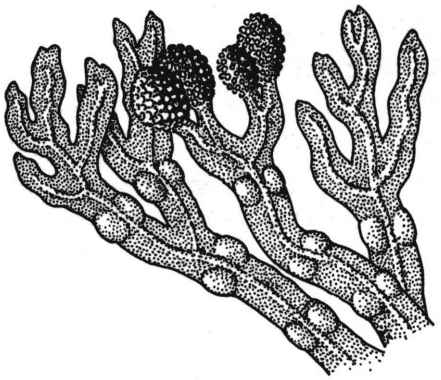
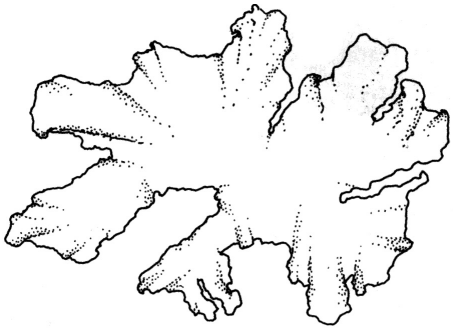
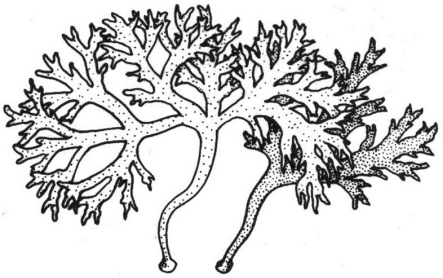
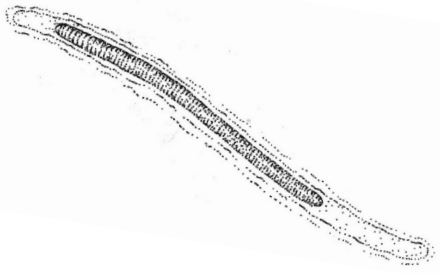
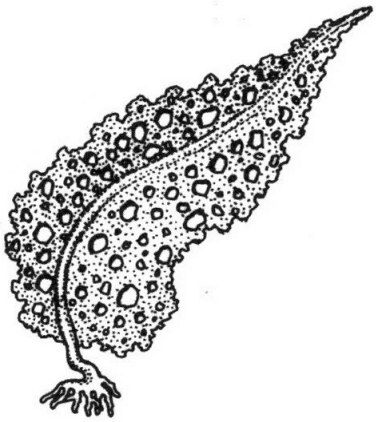
		
	**FREE**	
		

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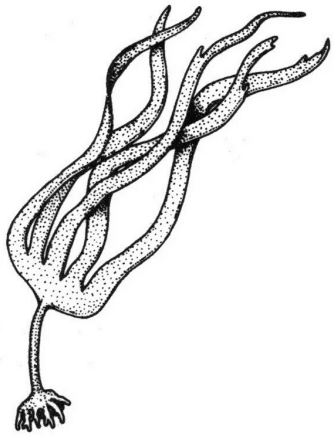
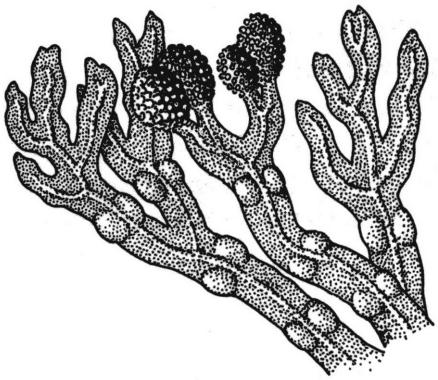
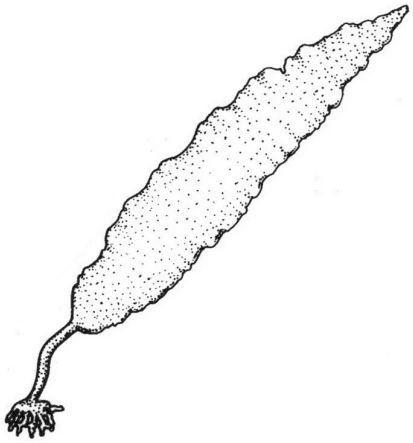
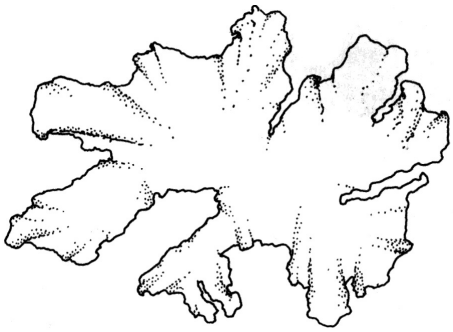
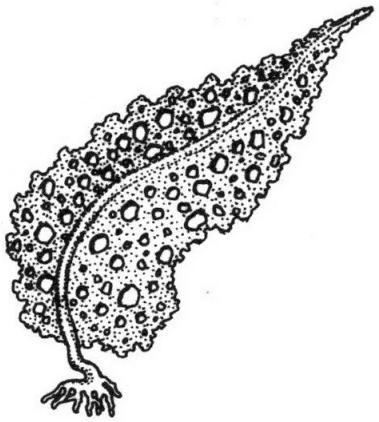
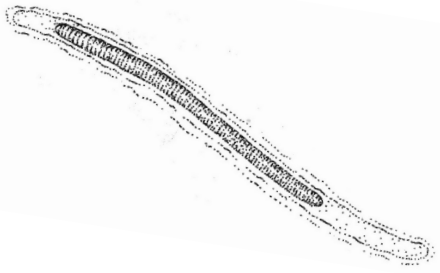
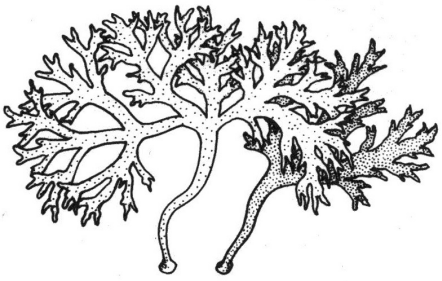
		
	**FREE**	
		

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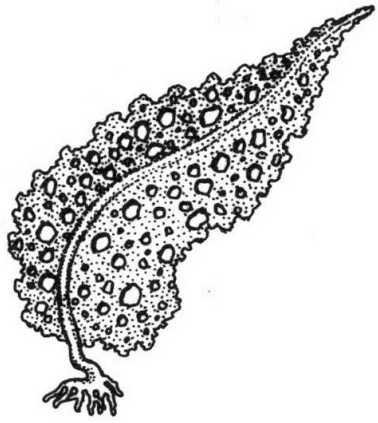
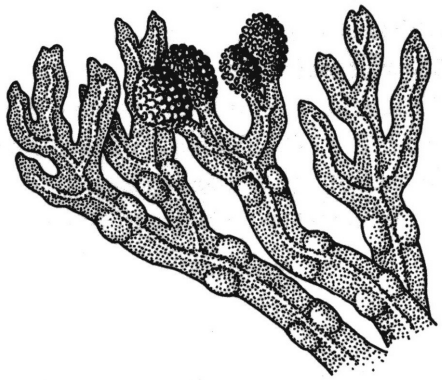
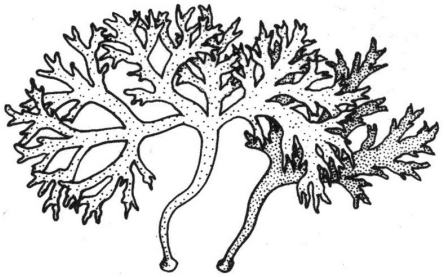
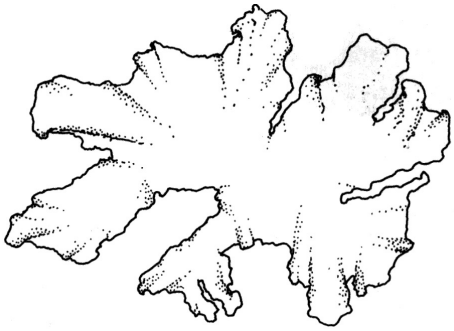
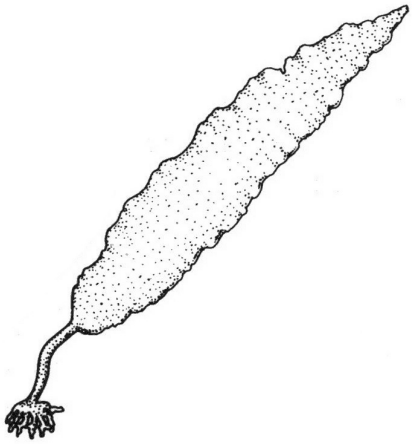
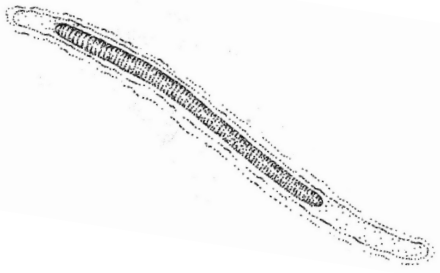
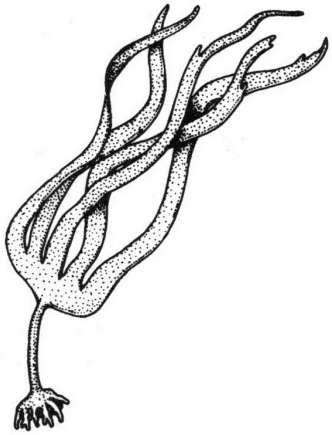
		
	**FREE**	
		

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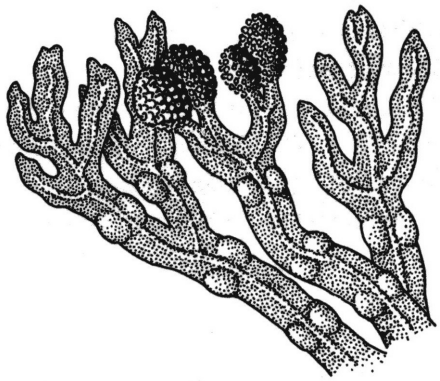
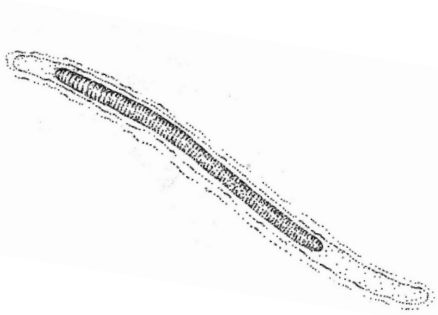
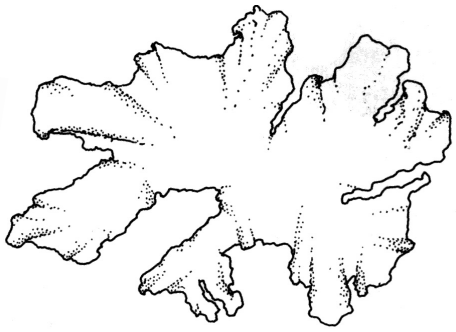
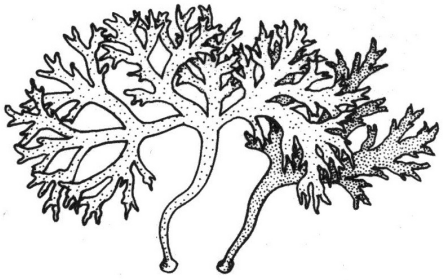
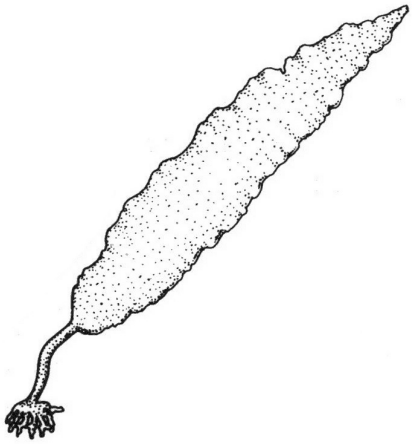
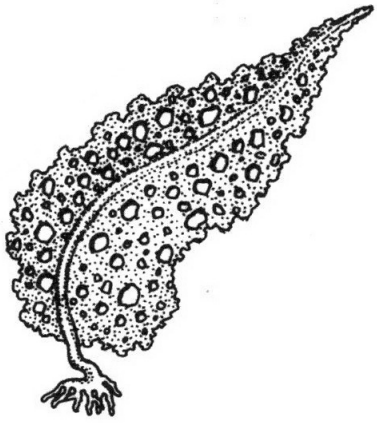
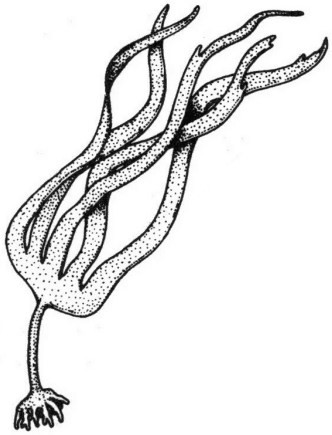
		
	**FREE**	
		

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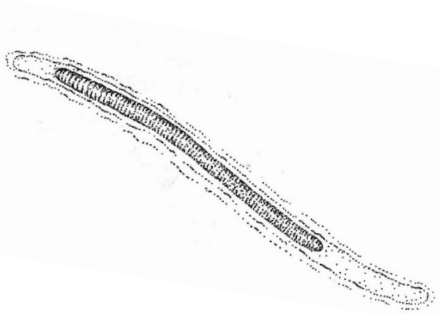
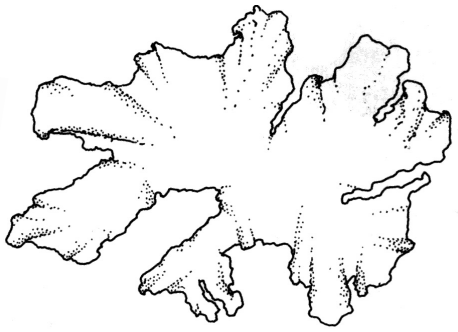
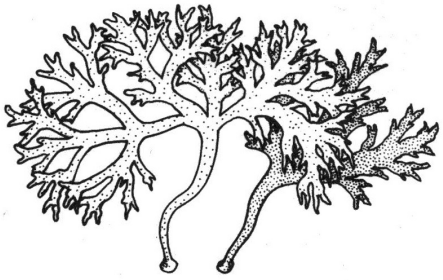
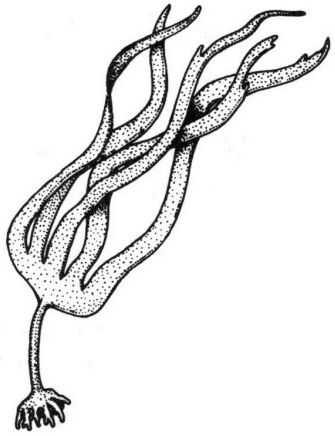
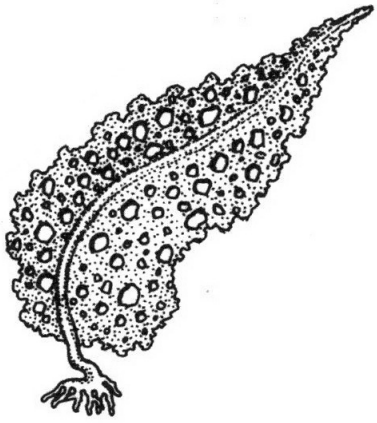
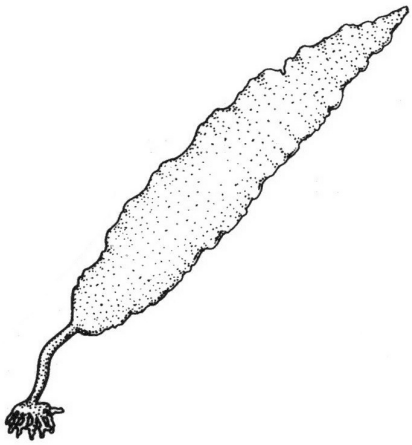
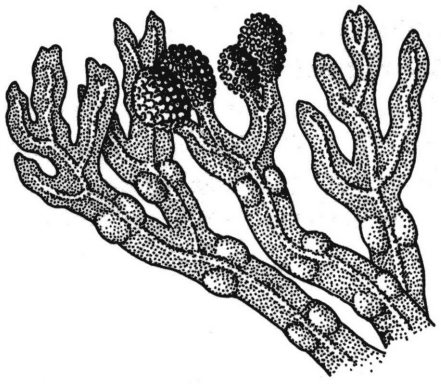
		
	**FREE**	
		

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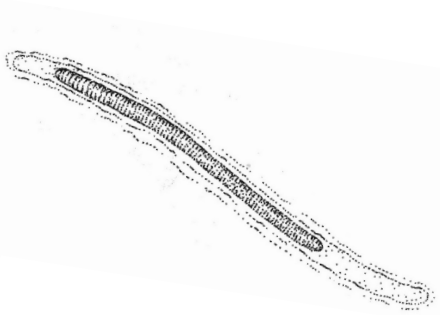
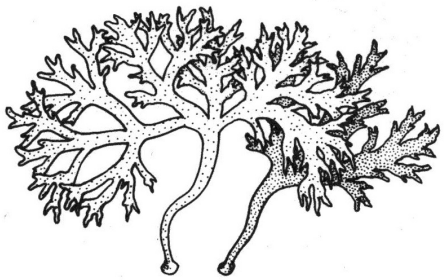
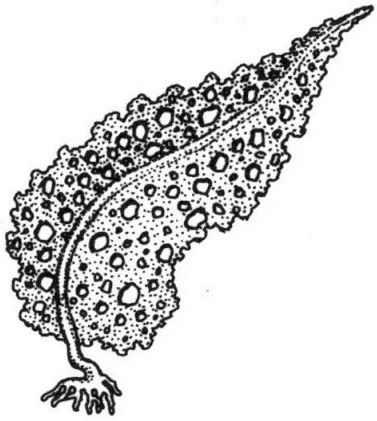
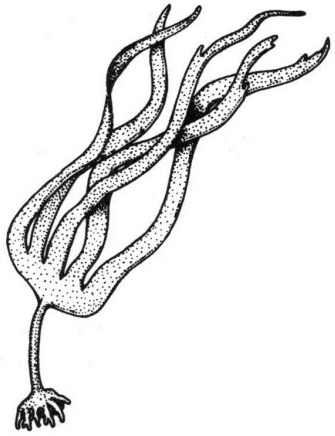
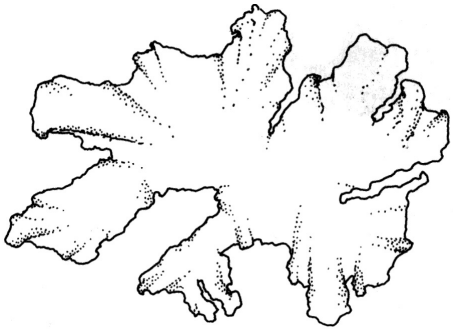
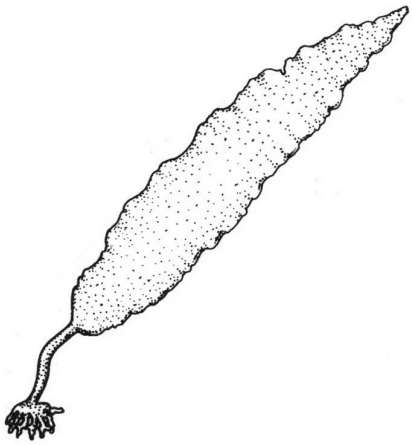
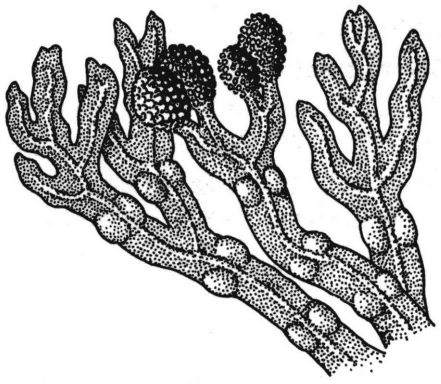
		
	**FREE**	
		

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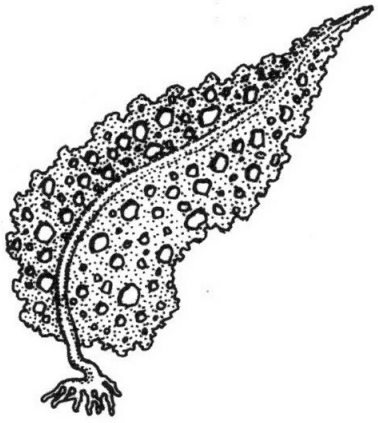
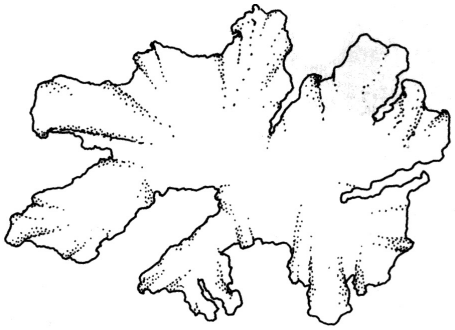
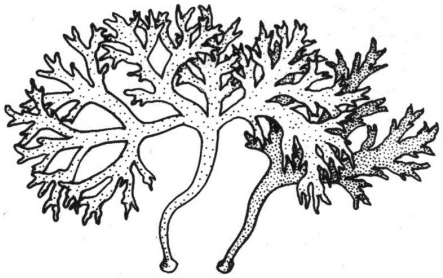
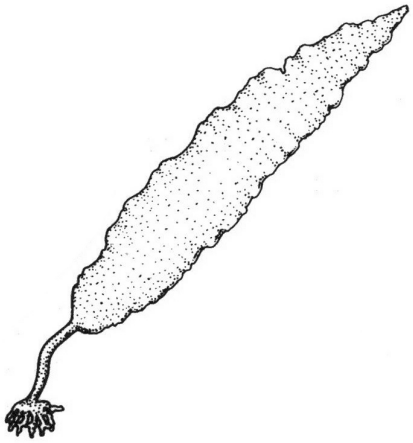
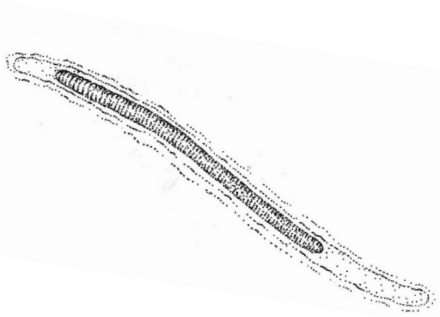
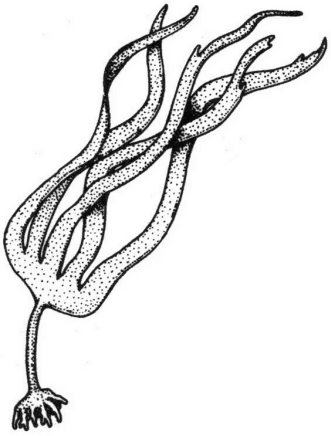
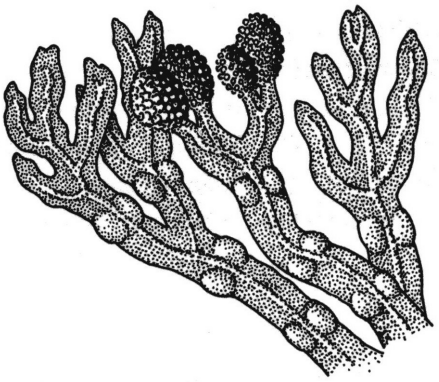
		
	**FREE**	
		

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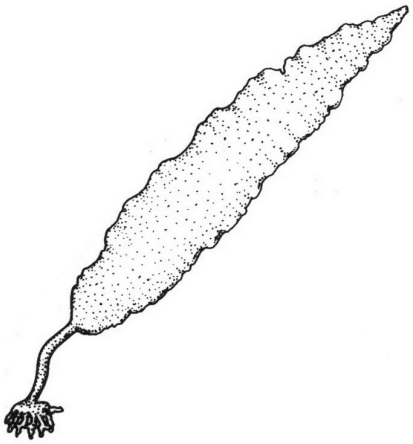
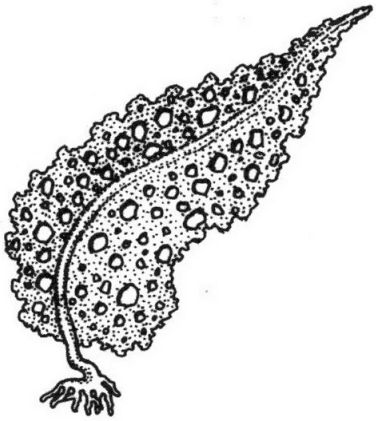
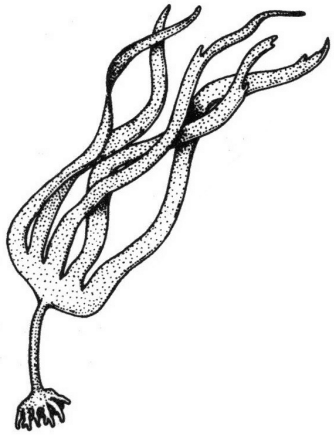
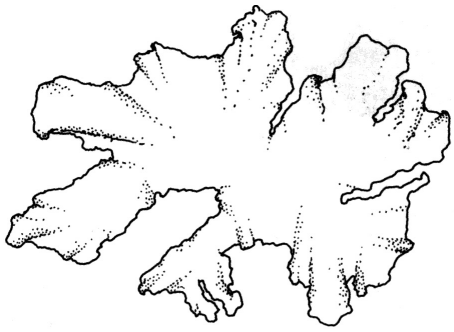
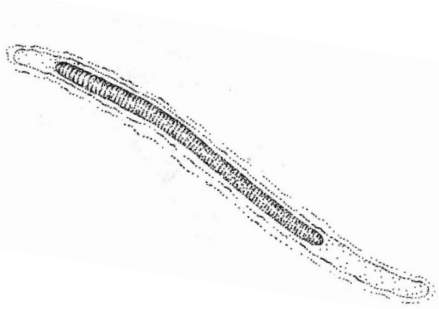
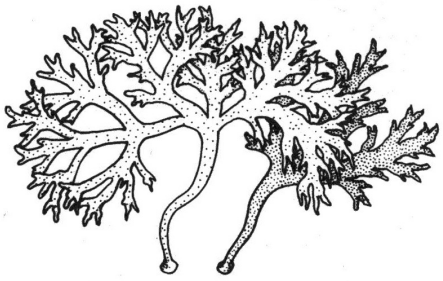
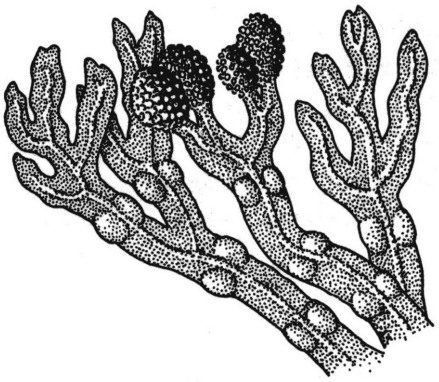
		
	**FREE**	
		

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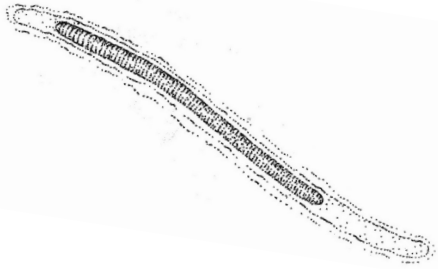
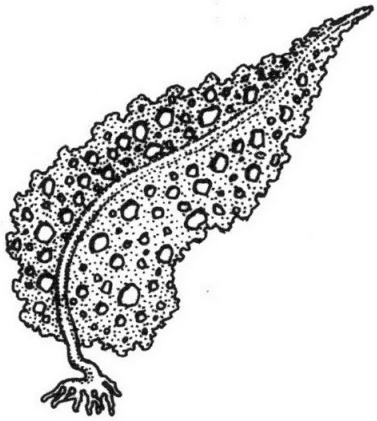
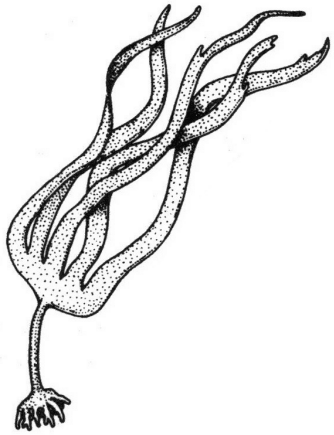
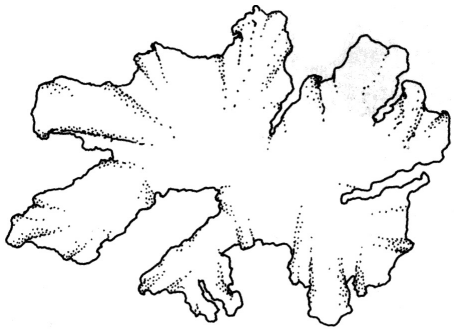
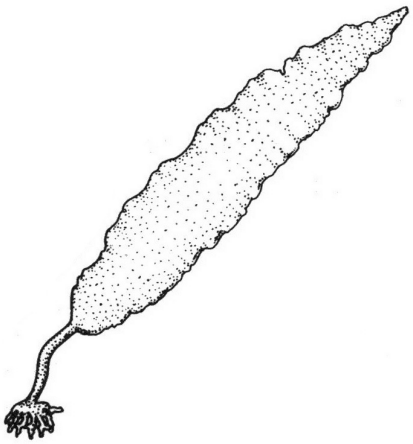
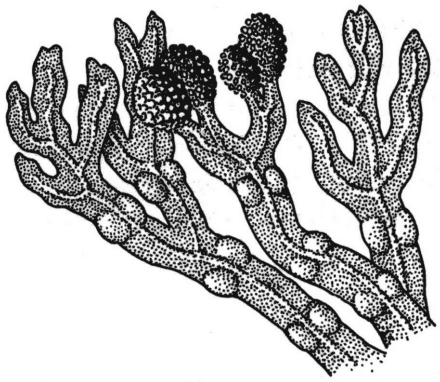
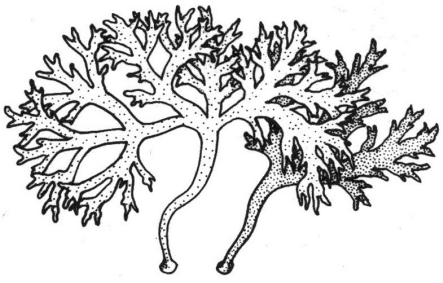
		
	**FREE**	
		

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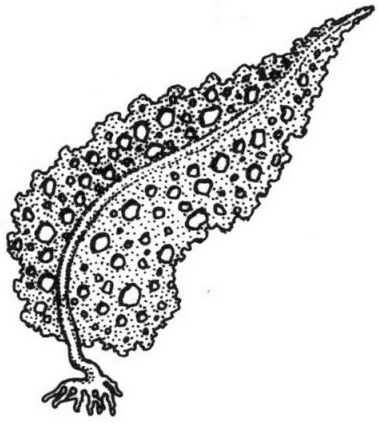
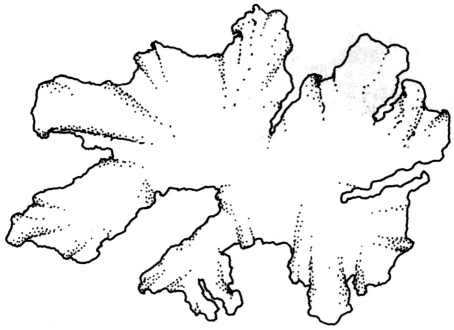
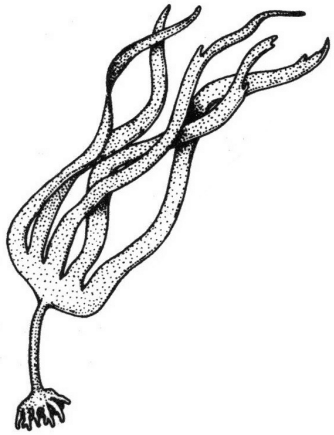
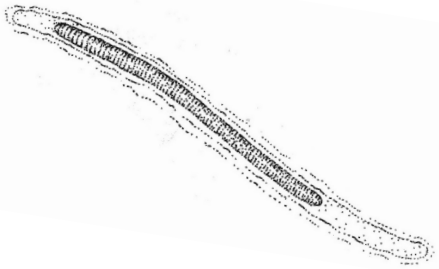
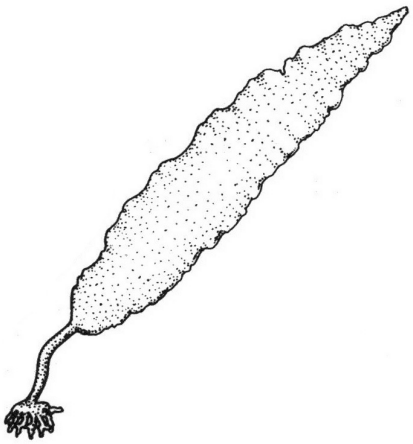
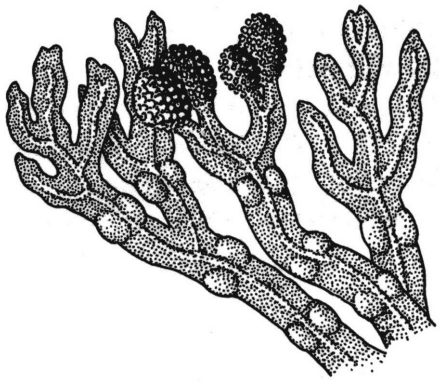
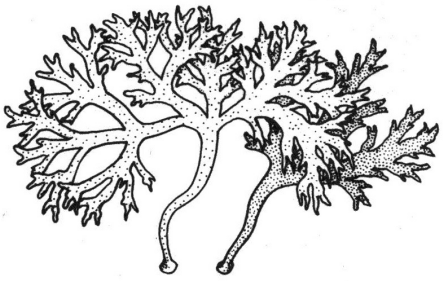
		
	**FREE**	
		

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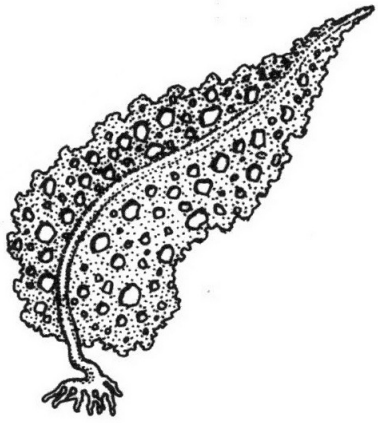
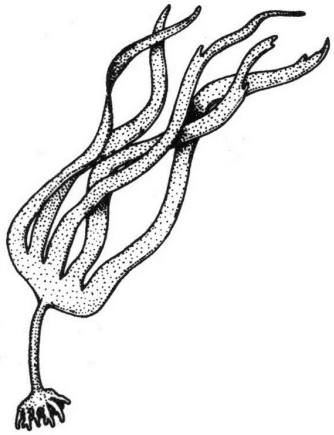
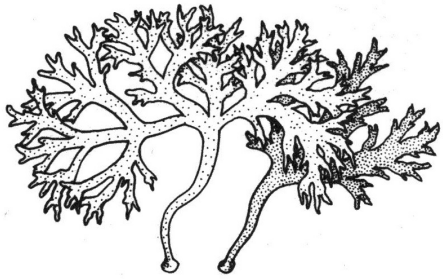
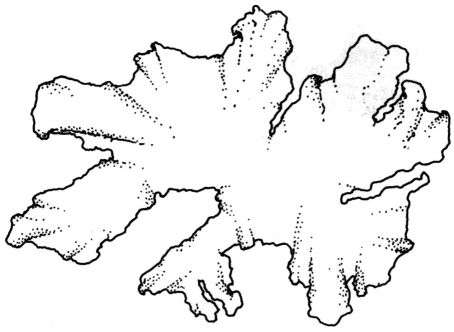
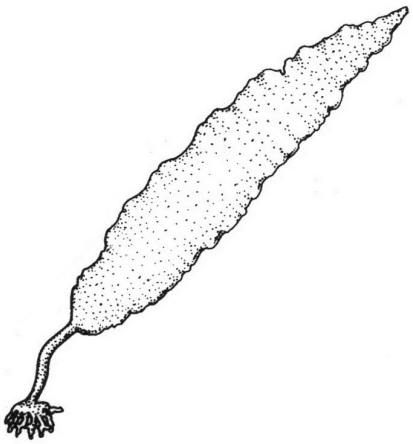
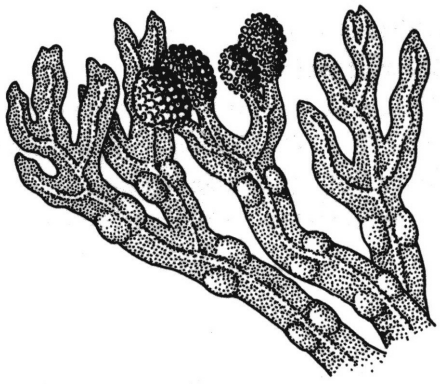
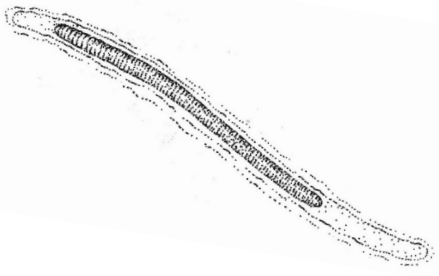
Game Board

		
	**FREE**	
		

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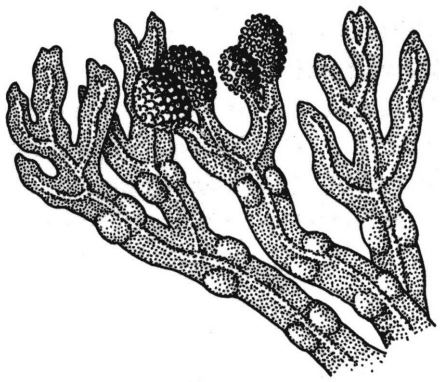
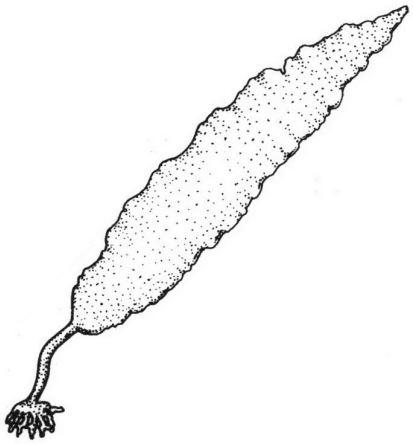
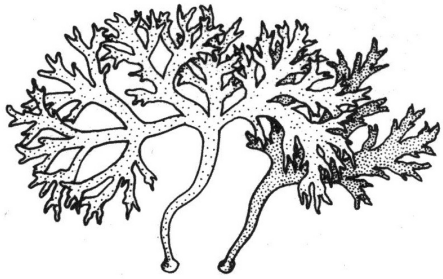
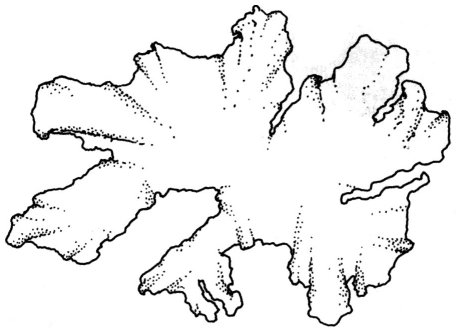
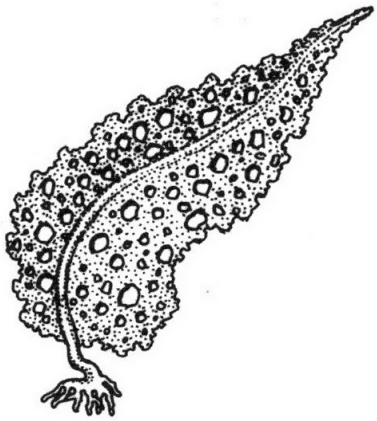
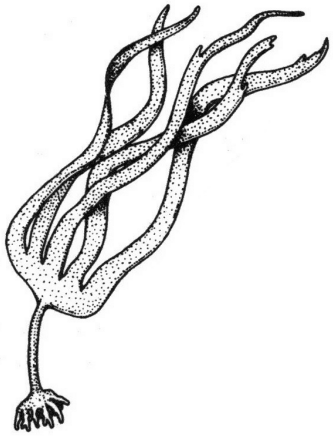
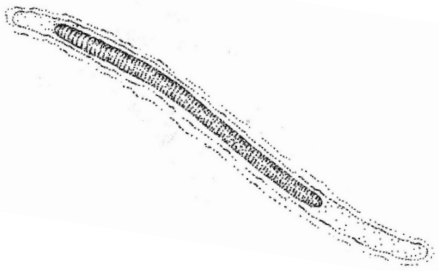
		
	**FREE**	
		

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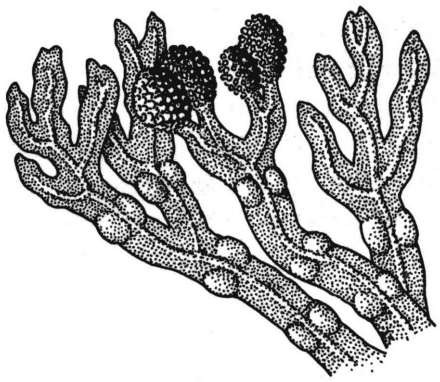
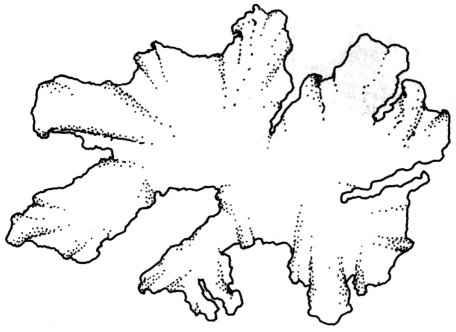
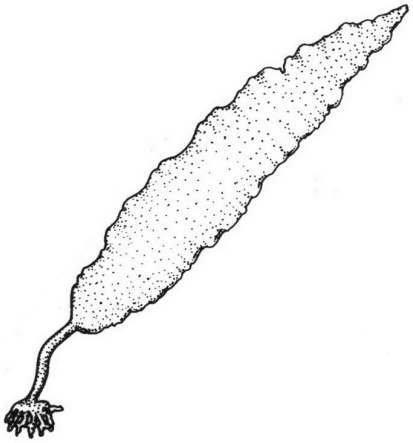
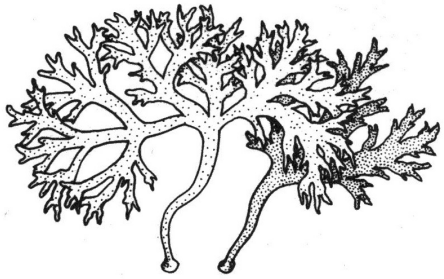
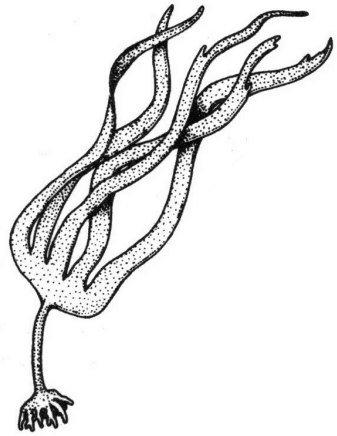
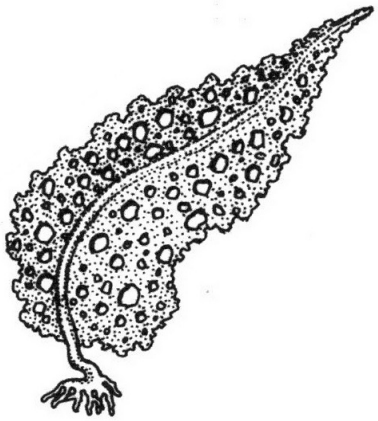
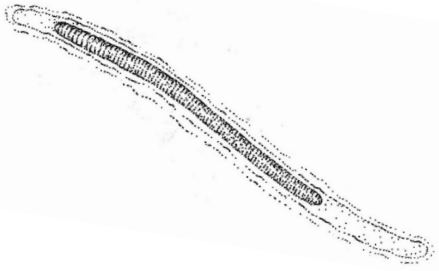
		
	**FREE**	
		

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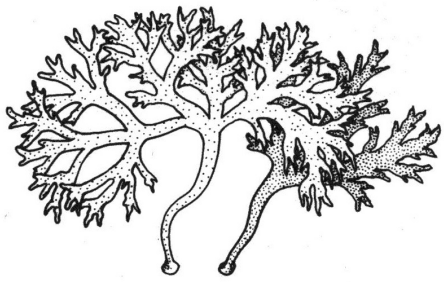
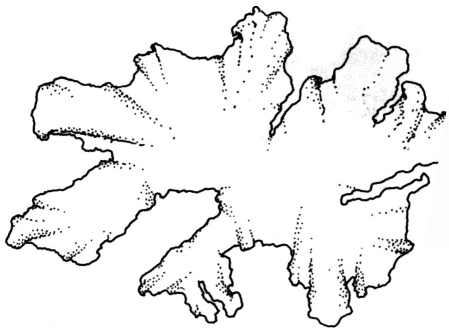
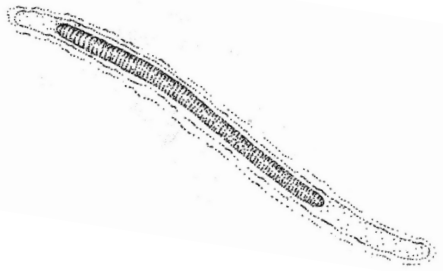
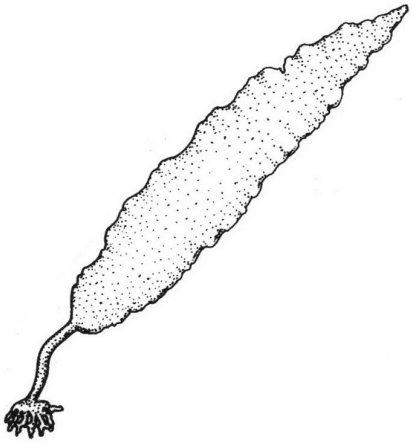
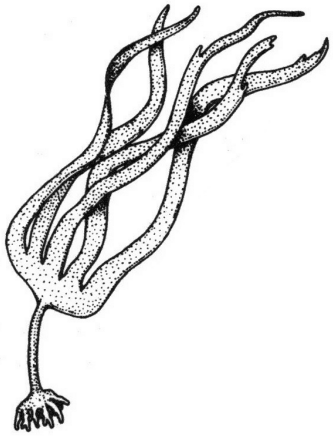
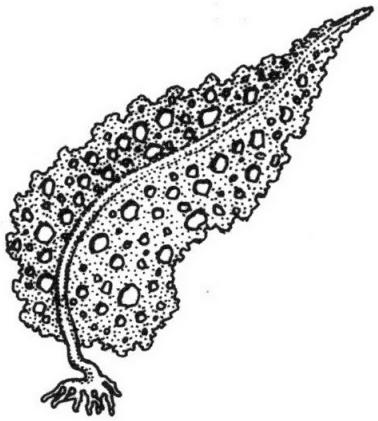
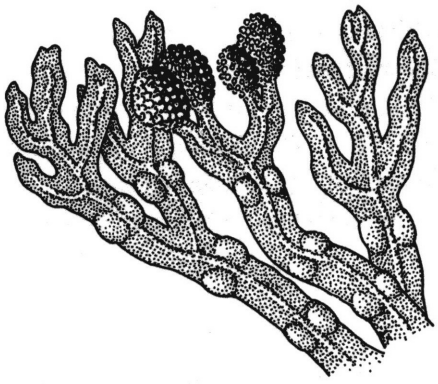
		
	**FREE**	
		

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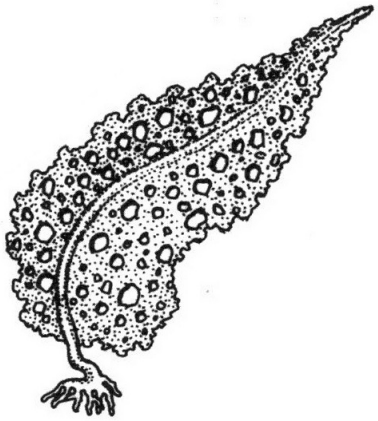
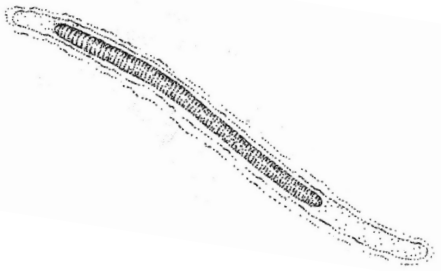
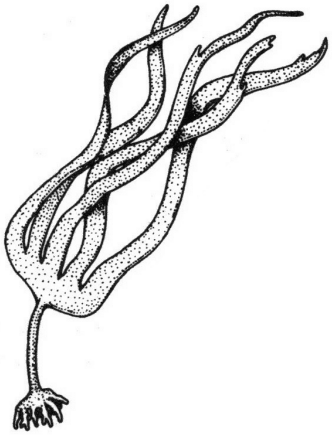
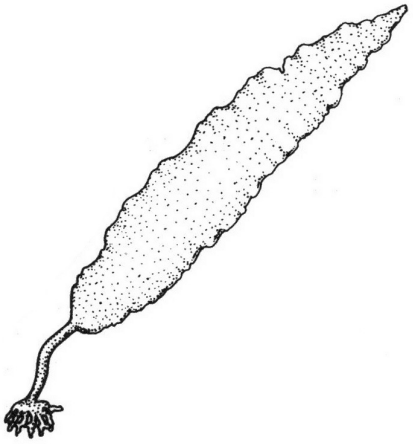
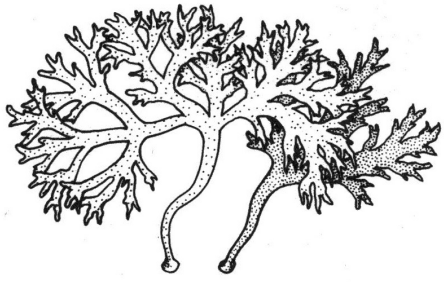
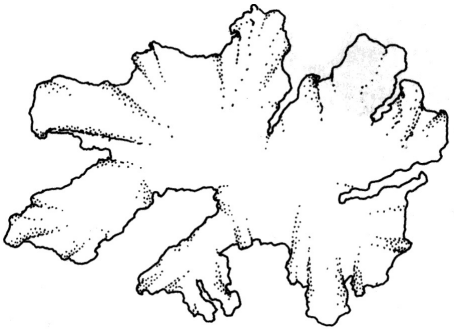
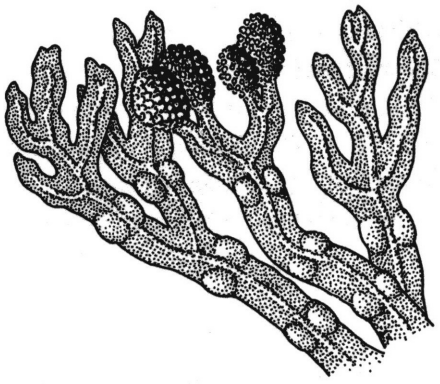
		
	**FREE**	
		

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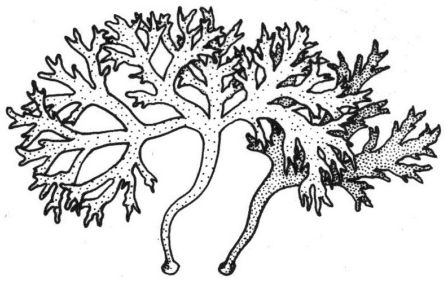
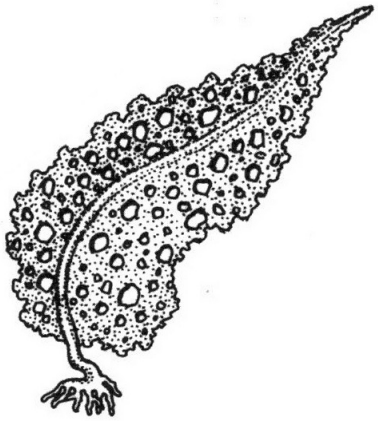
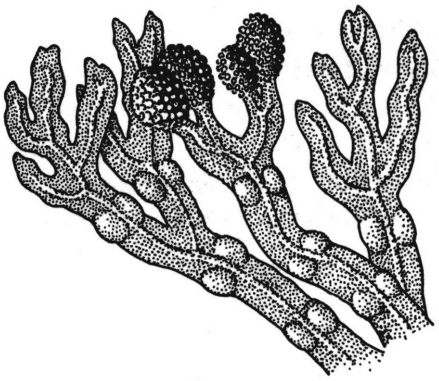
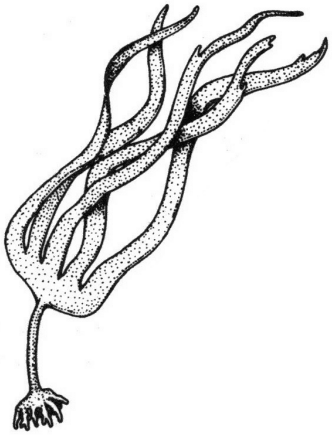
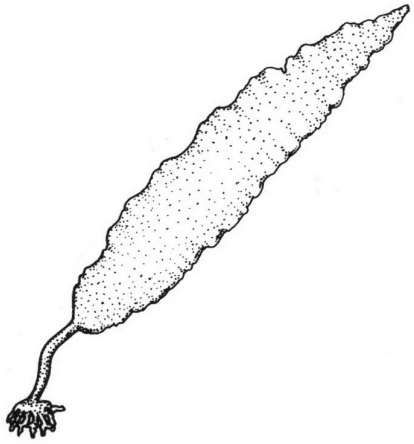
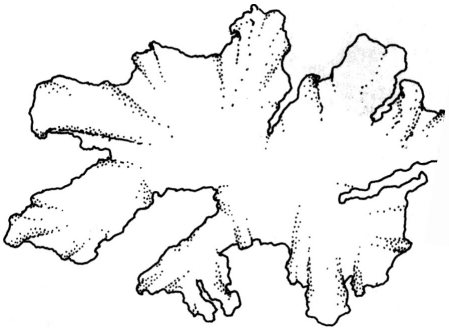
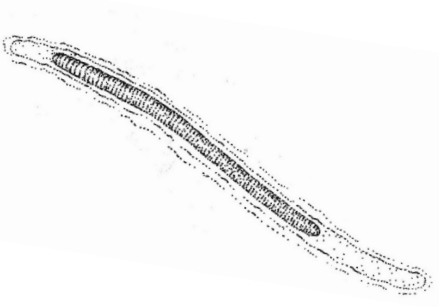
		
	**FREE**	
		

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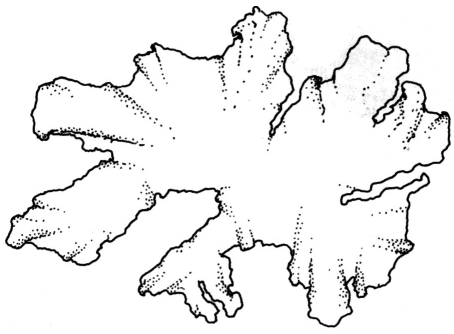
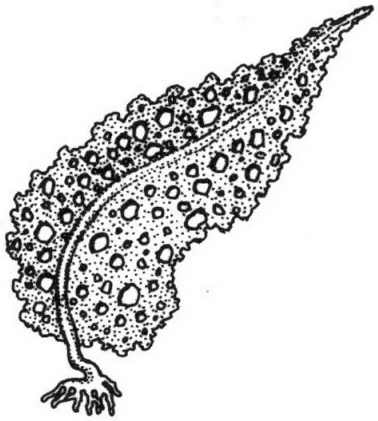
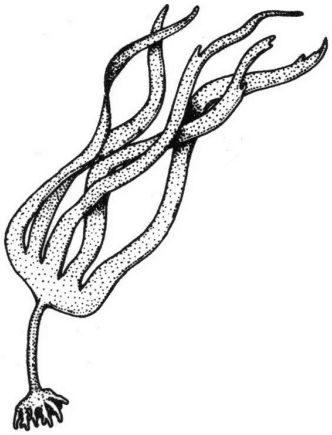
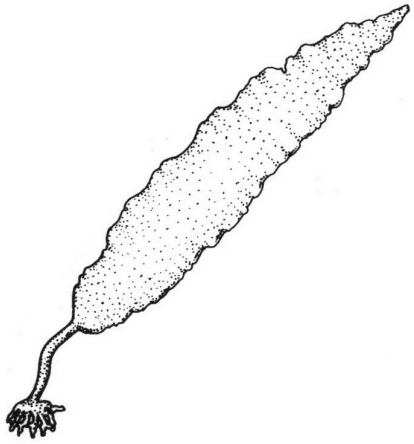
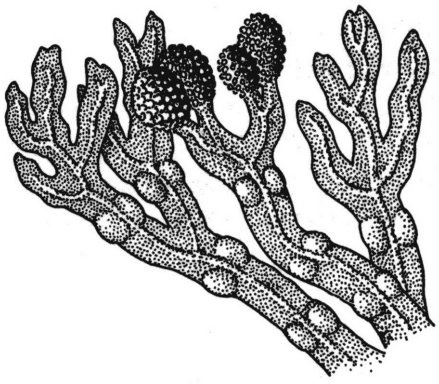
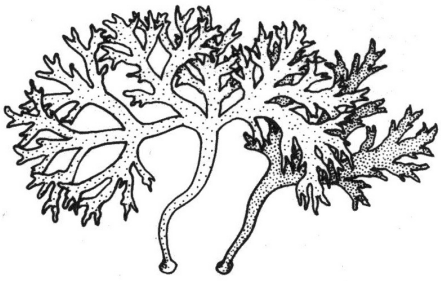
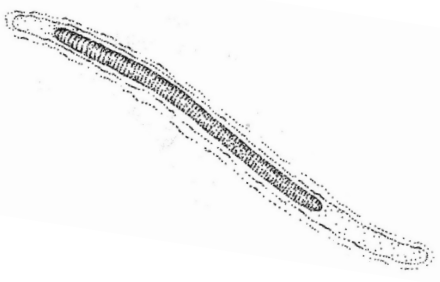
		
	**FREE**	
		

ROCKY SHORE SCOOT!

Topic
Rocky Shore Ecosystem

Duration
One session

Vocabulary
N/A

STANDARDS

Practices
Analyzing and Interpreting Data

Core Ideas
Ecosystem Dynamics, Functioning, and Resilience

Crosscutting Concepts
Systems and System Models

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2, OLP 3, OLP 4, OLP 5, OLP 6

Focus Question

What rocky shore facts do I know?

Overview

Students recall facts they have learned from the Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators. Students identify knowledge areas they need to strengthen.

Objectives

Students will be able to:

- ★ Recall facts about the rocky shore including animals, algae, zones, and conditions of the rocky shore
- ★ Identify strengths and shortcomings in terms of personal knowledge of the rocky shore ecosystem
- ★ Review facts about the rocky shore ecosystem to enhance their knowledge

Materials Needed

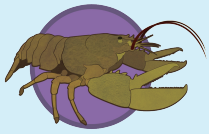
- ★ Rocky Shore Scoot Task Cards (one per desk, pages 208–215)
- ★ Rocky Shore Scoot Grid activity sheet (one per student, page 217)
- ★ Rocky Shore Scoot Answer Key (one per student, page 216)

Teacher Preparation

1. Make copies of Rocky Shore Scoot Task Cards, cut out cards and place one on each desk or available surface.
2. Make copies of Rocky Shore Scoot Grid activity sheets for each student.
3. Make copies of the Rocky Shore Scoot Answer Key for each student.

Background

The facts covered in this movement activity are from the lessons of the Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators. The activity's content is comprised mostly of rocky shore ecosystem facts, but also contains facts about the ocean in general and watersheds.



Teacher Tips

- ★ Play music during the Rocky Shore Scoot activity—similar to musical chairs—and stop the music when you exclaim, "Scoot!"
- ★ If there are students in class that have difficulty with reading the task cards or writing down answers, have them pair up with partners who can assist them, or consider having the entire class work together in partners.

Extension Suggestions

- ★ Play a "rocky shore identity game." Write the names of rocky shore animals or algae on index cards—one per student. Tape one card to the back of each student. Have students spread out in a large area and ask each other "Yes" or "No" questions in attempt to discover the animal or algae that has been taped to their backs. Play until all students discover their animal or algae name.

Procedure

Part One

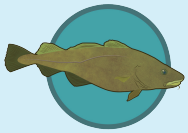
1. Inform students that they are going to be participating in a movement activity called "Rocky Shore Scoot!"
2. Have students place their Rocky Shore Scoot Grid activity sheets on a clipboard, book, or other transportable, hard surface.
3. Provide students with the following instructions:
    a. When the teacher says, "Scoot!" move to any desk in the room and read the task card.
    b. Decide what the task card is asking you to do.
    c. Answer the task card's question and write it in the grid square on your activity sheet that matches the task card's number (i.e., if you solve task card number seven, write the answer down in grid number seven of your activity sheet).
    d. Wait for the teacher to say "Scoot!" to move to the next task card.
    e. If you do not complete your answer when the teacher says "Scoot," move on to the next task card, and try to return to the previous task card on another movement turn.
    f. When you have completed all the task cards, or when the teacher says there is no more time for the activity, return to your desk.
4. Have students participate in the Rocky Shore Scoot activity and say "Scoot!" intermittently several times until most or all of the students have visited each task card.
5. When you have determined that the activity is complete, review the answers to the questions with the class using the Rocky Shore Scoot Answer Key.
6. Make sure to have students circle the answers they got incorrect so they can review those questions later.

Part Two

7. Inform students that they are going to be reviewing their incorrect answers with a partner.
8. Have students get into partners and hand out answer keys to each student, or to each set of partners.
9. Partners are to exchange their Rocky Shore Scoot Grid activity sheets with one another.

Books

- ★ *DK Eyewitness Books: Seashore* by Steve Parker
- ★ *The Seaside Switch* by Kathleen V. Kudlinski



Websites

- ★ Check out the Crash Course Kids YouTube Channel episode titled "The Life Hydrologic."
- ★ Watch the Cape Cod National Seashore's YouTube Channel episode titled "The Intertidal Zone."

Scientist Notebook

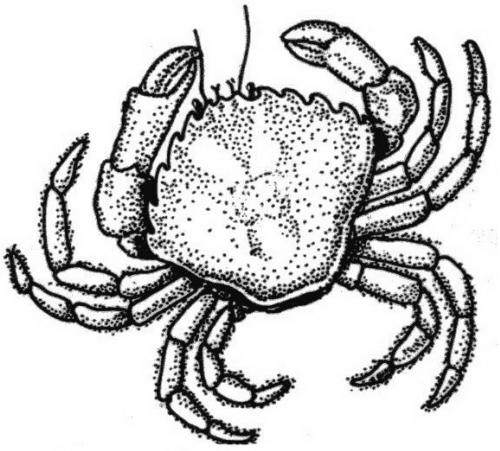
- ★ Students can record the questions and answers of the task cards they struggled with in their notebooks.

Procedure (continued)

10. One partner will "quiz" the other partner on the answers he/she did not get correct, using the answer key as a guide. When finished, partners will reverse roles.
11. After having reviewed their incorrect answers, have partners review their correct answers.

Wrap-up

- ★ Ask students which questions they struggled answering correctly.
- ★ Have students brainstorm ways they can remember the facts they struggled to answer correctly.



Rocky Shore

SCOOT

What percent of the Earth's crust is covered by the ocean?

1

Rocky Shore

SCOOT

What do you call an area of land in which all water flows down into a common basin?

2

Rocky Shore

SCOOT

A community of interacting organisms and their environment is called an _____.

3

Rocky Shore

SCOOT

Which ecosystems are intertidal areas made up of rocks, pools of water, and many algae and animals?

4

Rocky Shore

SCOOT

A _____ is formed by energy passing through water. Wind, earthquakes, and tides can help form them.

5

Rocky Shore

SCOOT

What is the steady rise and fall of the ocean water levels called?

6

Rocky Shore

SCOOT

What is the main cause of the tides?

7

Rocky Shore

SCOOT

As heat energy reaches a substance, the substance _____ the heat.

8

Rocky Shore

SCOOT

What is a body part or a behavior that helps a living thing survive in its environment called?

9

Rocky Shore

SCOOT

Which rocky shore zone has the least amount of water exposure?

10

Rocky Shore

SCOOT

_____ _____ are shallow bodies of saltwater that are left behind when the tide recedes.

11

Rocky Shore

SCOOT

Which rocky shore zone has the least amount of water exposure?

12

Rocky Shore

SCOOT

This rocky shore zone is only covered by water during high tide.

13

Rocky Shore

SCOOT

This rocky shore zone is exposed to air and water an almost equal amount of the time.

14

Rocky Shore

SCOOT

_____ is the use of materials or coloration for concealment.

15

Rocky Shore

SCOOT

This type of camouflage occurs when an animal hides itself against a background of the same color.

16

Rocky Shore

SCOOT

This rocky shore zone is almost always covered in water except for extreme low tides.

17

Rocky Shore

SCOOT

Most crabs are covered with a thick shell called an _____.

18

Rocky Shore

SCOOT

This rocky shore zone is always exposed to water.

19

Rocky Shore

SCOOT

All fish have _____ to filter oxygen from the water.

20

Rocky Shore

SCOOT

All fish have _____ for support and movement.

21

Rocky Shore

SCOOT

The name "plankton" comes from the Greek word meaning _____.

22

Rocky Shore

SCOOT

More than two-thirds of the oxygen we breathe is produced by _____.

23

Rocky Shore

SCOOT

Some rocky shore organisms eat by straining their food from the saltwater. This method of eating is called _____ _____.

24

Rocky Shore

SCOOT

Some algae have root-like organs that help them attach to rocks. They are called _____.

25

Rocky Shore

SCOOT

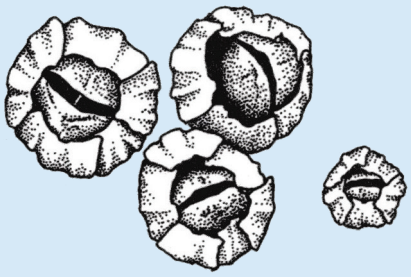
Algae, like plants, produce food with sunlight by the process of _____.

26

Rocky Shore

SCOOT

What is this animal?

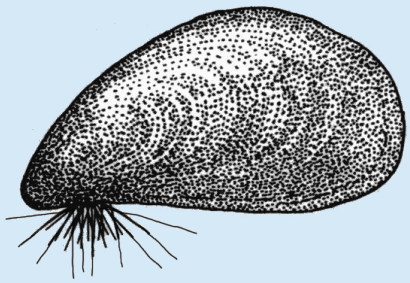


27

Rocky Shore

SCOOT

What is this animal?

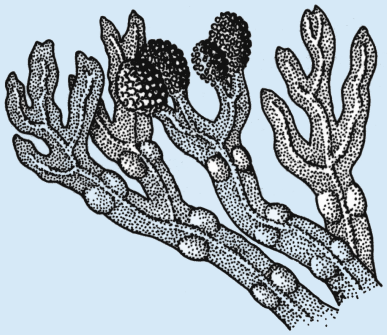


28

Rocky Shore

SCOOT

What is this type of algae?



29

Rocky Shore

SCOOT

What is this type of algae?

30

ROCKY SHORE SCOOT!

Answer Key

Task Card Numbers

1. Around 71%
2. Watershed
3. Ecosystem
4. Rocky shore ecosystems
5. Wave
6. The tides
7. The gravitational force of the moon
8. Absorbs
9. Adaptation
10. Splash Zone
11. Tide pools
12. Spotted sandpiper
13. Upper intertidal zone
14. Middle intertidal zone
15. Camouflage
16. Concealing coloration
17. Lower intertidal zone
18. Exoskeleton
19. Subtidal zone
20. Gills
21. Backbones (vertebrae)
22. Drifter
23. Phytoplankton
24. Filter feeding
25. Holdfasts
26. Photosynthesis
27. Barnacles
28. Blue mussels
29. Rockweed
30. Knotted Wrack

ROCKY SHORE SCOOT GRID

Name: _____

Date: _____

1.	2.	3.	4.	5.	6.
7.	8.	9.	10.	11.	12.
13.	14.	15.	16.	17.	18.
19.	20.	21.	22.	23.	24.
25.	26.	27.	28.	29.	30.

MARINE CONSERVATION

Topic
Marine Conservation, Recycling

Duration
Two sessions

Vocabulary
conservation
marine
marine conservation
recycle
reduce
reuse

STANDARDS

Practices
Obtaining, Evaluating, and Communicating Information

Core Ideas
Human Impacts on Earth Systems

Crosscutting Concepts
Science Addresses Questions About the Natural and Material World

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 4, OLP 6, OLP 7

Focus Question

What is marine conservation?

Overview

Students define the terms "conservation" and "marine conservation." Students discover facts about ocean pollution. Students design and create a recycled product out of plastic trash. Students discover the differences between reuse, reduce, and recycle.

Objectives

Students will be able to:

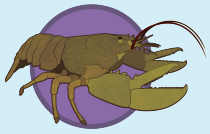
- Define conservation and marine conservation
- Discover ocean pollution facts
- Design and create a recycled product
- Recognize the difference between reuse, reduce, and recycle

Materials Needed

- Plastic trash items such as milk jugs, soda rings, water bottles, DVD cases, plastic cutlery, straws, plastic bags, etc.
- Craft items such as tape, glue, and scissors
- Projector or SMART Board to show online video. YouTube Channel Episode Suggestions: "How We Can Keep Plastics Out of Our Ocean" by National Geographic, or "Ocean Trash is a Problem You Can Solve" by Ocean Conservancy.
- The projected image or print-out of Ocean Conservancy's "Top Ten Item's Found" International Coastal Cleanup graphic (page 221)
- Computers or tablets for student research
- A large paper or cloth bag
- Plain white paper

Teacher Preparation

1. Reserve computers or tablets (one per student).
2. Collect plastic trash items (see ideas for items above).
3. Prepare craft items such as tape, glue, and scissors for students.



Teacher Tips

- ★ Consider putting plastic trash items at specific "work tables" so students can work in groups when designing and creating their recycled products.
- ★ Have students work in partners when doing research for recycling ideas to prevent the possibility of individual students getting off-task.
- ★ Let students choose which online video they would like to watch—inform them of the titles and an overview of each video's content.

Extension Suggestions

- ★ Take a cleanup walk around the school or neighborhood with your students. Before going on the walk, discuss the importance of being safe near roadways and parking lots and the importance of not picking up dangerous or unknown items. Provide students with trash bags, recycling bags, and gloves. When the cleanup walk is complete, review with students how much they cleaned up and how much of the trash they can recycle.

Teacher Preparation (continued)

4. Prepare to show an online video on ocean conservation using a projector or SMART Board (recommended videos above).
5. Prepare to project Ocean Conservancy graphic (page 221) or print out for each student to see.
6. Get a large paper or cloth bag.
7. Gather plain white pieces of paper for each student.

Background

Conservation is the protection of things found in nature. Conservation requires the wise use of Earth's natural resources. Conservation includes taking action to preserve natural resources.

Three ways to conserve resources is by reducing, reusing, and recycling. The process of reducing is using fewer things so less trash is created. The process of reusing is using things over and over again instead of throwing them away. The process of recycling is turning potential trash into something that can be used.

Marine conservation is the protection and preservation of ecosystems in oceans and seas. Marine conservation includes preventing damage caused by humans to marine ecosystems and restoring damaged marine ecosystems.

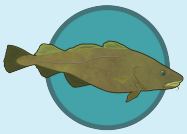
Procedure

Part One

1. Have students sit in their seats and begin walking around the room with a paper or cloth bag. Put items made out of plastic into the bag without explaining to students what you are doing. If you take any items off of student desks, reassure them that you will return their items.
2. Take all of the items out of your bag and place them on a desk in front of the classroom.
3. Ask students what all of the items have in common. If students do not come up with the answer, inform them that each item is made out of plastic.
4. Ask students where plastic items go when they are done being used.
5. Inform students that plastic items have three main destinations: landfills, the ocean, and recycling centers.
6. Ask students how much plastic they think ends up going into the ocean.
7. Inform students that researchers have estimated that about 4 million to 12 million metric tons of plastic washed offshore in 2010 alone, or about 1.5% to 4.5% of the world's total plastic production—enough to cover every foot of coastline on the planet. One metric ton equals 2,205 pounds.

Books

- ★ *One Well: The Story of Water on Earth* by Rochelle Strauss
- ★ *Make a Splash! A Kid's Guide to Protecting Our Oceans, Lakes, Rivers, & Wetlands* by Cathryn Berger Kaye M.A.
- ★ *Follow the Moon Home: A Tale of One Idea, Twenty Kids, and a Hundred Sea Turtles* by Philippe Cousteau
- ★ *Crabby's Water Wish: A Tale of Saving Sea Life* by Suzanne Tate



Websites

- ★ Listen to Jack Johnson singing his song "The 3 R's" on the Explore.org YouTube Channel.
- ★ Watch a BrainPOP video on recycling and take the quiz! (Subscription required.)
- ★ Play the "Coastal Cleanup" game on the Discovery Kids website.

Scientist Notebook

- ★ Students can record the definitions of conservation and marine conservation.
- ★ Students can draw or paste a diagram of their recycled product.

Procedure (continued)

8. Show students the Ocean Conservancy graphic showing the top ten items found by an international coastal cleanup crew. Ask students how many of the top ten items are made out of plastic (seven).
9. Have students watch one of the suggested online videos above, or another video of your choice on marine conservation.

Part Two

10. Ask students if they know what the processes of reducing, reusing, and recycling are.
11. Inform students of each process and provide examples.
12. Inform students that today they are going to be participating in the process of recycling.
13. Show students all of the plastic trash items you have collected.
14. Inform students that they are going to be researching ways plastic items are recycled, and then they are going to be designing and creating their own recycled plastic products out of the plastic items you have collected.
15. Have students research plastic recycling ideas on student-friendly search engines such as www.kidtopia.info.
16. Inform students that they can either imitate ideas they found using their research or they can come up with their own ideas on how to make a plastic recycled product.
17. Have students collect plastic trash items and draw a diagram of their plastic recycled product before they create their product.
18. Once students have collected their plastic items and designed their product they can create their plastic recycled product using the items you have provided for them.

Wrap-up

- ★ Ask students to identify the terms "conservation" and "marine conservation."
- ★ Ask students to identify the terms "reduce," "reuse," and "recycle."
- ★ Ask students why people should know about marine conservation and why people should reduce, reuse, and recycle.

COASTAL CLEANUP

Top 10 Items Collected

Ocean Conservancy

1. CIGARETTE BUTTS
2,127,565

2. PLASTIC BEVERAGE BOTTLES
1,024,470

3. FOOD WRAPPERS
888,589

4. PLASTIC BOTTLE CAPS
861,340

5. STRAWS, STIRRERS
439,571

6. OTHER PLASTIC BAGS
424,934

7. GLASS BEVERAGE BOTTLES
402,375

8. PLASTIC GROCERY BAGS
402,122

9. METAL BOTTLE CAPS
381,669

10. PLASTIC LIDS
351,585

ROCKY SHORE ECOSYSTEM ASSESSMENT

Topic
Rocky Shore Ecosystem, Assessment

Duration
One session

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 2, OLP 3, OLP 4, OLP 5, OLP 6

Focus Question

What have you learned about the rocky shore ecosystem?

Overview

Students apply the knowledge they have acquired throughout the Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators by solving a variety of problems on an assessment.

Objectives

Students will be able to:

- ★ Demonstrate the knowledge they have acquired from their participation in a rocky shore marine science unit

Materials Needed

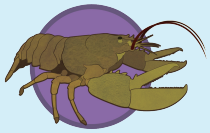
- ★ Copies of the Rocky Shore Ecosystem Assessment (one per student, pages 225–228)

Teacher Preparation

1. Make copies of the Rocky Shore Ecosystem Assessment (one per student).
2. Prepare enough sharpened pencils and scratch paper for each student to use during the assessment.

Background

The Rocky Shore Marine Science Curriculum: An Ecosystem Unit for Elementary Educators is comprised of twenty-four lessons. The twenty-third lesson is the assessment, and the twenty-fourth lesson is a preparatory lesson for classrooms planning on visiting the rocky shore. Only students who have participated in lessons one through twenty-two should be taking this assessment.



Teacher Tips

- Do not let reading or writing become a hindrance to students from demonstrating what science knowledge they know. Allow students who need writing assistance to have scribes, and read anything students would like read aloud from the assessment.
- Consider having students choose reasonable areas in the classroom where they would prefer to take the assessment.
- Providing students with brief stretching or breathing exercises during the assessment could benefit them greatly.

Extension Suggestion

- Have students participate in an activity that enables them to demonstrate the knowledge they have gained from the rocky shore ecosystem unit in an alternative way to a paper and pencil assessment. This could include making a poster, making a podcast, writing a letter, drawing a comprehensive illustration, etc.

Procedure

Part One

1. Have students participate in a brief movement activity before taking this assessment. Gonoodle.com is one valuable resource where you can find short, productive movement activities for students.
2. Have students find a silent reading book to keep at their seats for when they have finished the assessment.
3. Hand out sharpened pencils and scratch paper for students to use during the assessment.
4. Explain to students that they are going to be taking an assessment that reviews facts that they have learned during their rocky shore ecosystem unit.
5. Encourage students to do their best, and inform them that if they come to a question they are not sure how to answer, that they should answer that question to the best of their abilities and move on to the next question.
6. Explain to students that you can read questions or parts of questions to them if they need assistance with the reading.
7. Explain to students that you cannot help them answer questions or provide them with the definitions to any vocabulary.
8. Inform students that if they have any questions or need to use the restroom during the assessment that they are to raise their hands and wait for the teacher.
9. Inform students that when they complete their assessment they are to raise their hands, wait for the teacher to collect their assessment, and then read silently until all assessments are completed or until the teacher stops the assessment time.

Part Two

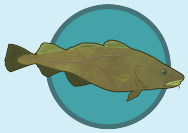
10. Pass out the assessments to each student and have them begin.
11. Provide movement breaks for students during the assessment if necessary.
12. Collect all of the assessments and resume normal class studies.

Wrap-up

- Review all of the questions with students when all assessments are completed.
- Ask students if they feel they have learned a lot about the rocky shore ecosystem.

Books

- ★ *The Big Test* by Julie Danneberg
- ★ *Testing Miss Malarkey* by Judy Finchler



Websites

- ★ Have students check out the video titled "A Pep Talk From Kid President to You" on the SoulPancake YouTube Channel before the test.
- ★ Have students watch the video titled "Test-Taking Tips Movie" on the drseverson YouTube Channel before the test.

Scientist Notebook

- ★ Students can record the answers to the questions from the assessment they answered incorrectly.

Wrap-up (continued)

★ Ask students if there are other things they would like to know about the rocky shore ecosystem and take a list of their requests. Provide students with the knowledge they were requesting if possible at a later time.

ROCKY SHORE ECOSYSTEM ASSESSMENT

Name: _____

Date: _____

Multiple Choice

Read the following questions carefully and fill in the circle of the best possible answer.

1. What percent of the earth's crust is covered by the ocean?

   (A) 41%
   (B) 71%
   (C) 91%
   (D) 11%

2. A watershed is . . .

   (A) an area of land in which all water flows down into a common basin.
   (B) an area of water in which all water flows down into a common ocean.
   (C) an area of water in which all land flows down into a common ocean.
   (D) an area of land in which all water flows down into different basins.

3. A community of interacting organisms and their environment is called an . . .

   (A) environment.
   (B) estuary.
   (C) ecosystem.
   (D) entrance.

4. A rocky shore ecosystem has the following:

   (A) sand, rivers, plants, and insects.
   (B) rocks, lakes, algae, and no animals.
   (C) sand, pools of water, algae, and lizards.
   (D) rocks, pools of water, algae, and animals.

5. Wind, earthquakes and tides can all help form...

   (A) changes in water temperature.
   (B) changes in salinity.
   (C) waves.
   (D) predators.

6. The rise of ocean levels twice a day and the fall of ocean levels twice a day are called . . .

   (A) tides.
   (B) currents.
   (C) waves.
   (D) ecosystems.

Matching

Write the letter of the fact next to the correct rocky shore zone.

7. Splash zone ____
8. Upper intertidal zone ____
9. Middle intertidal zone ____
10. Lower intertidal zone ____
11. Subtidal zone ____

A. This zone is always under water.

B. This zone is under water except for extreme low tides.

C. This zone is under and above water almost equal amounts of time.

D. This zone is above water except for high tides.

E. This zone only gets wet from rain, spray from waves, and during strong storms.

Fill-in-the-Blanks

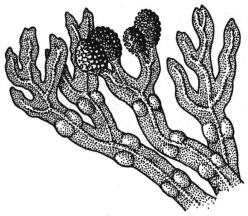
Read each sentence carefully and fill in the blanks with the correct answer from the word box.

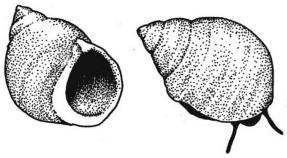
exoskeleton	absorb	tide pools	masking
moon	herring gull	camouflage	adaptation

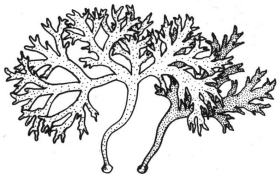
12. The main cause of the tides is the gravitational pull from the _____.
13. As the sun shines on the rocky shore, the water and rocks _____ the heat.
14. A body part or a behavior that helps a living thing survive in its environment is called an _____.
15. _____ _____ are shallow bodies of saltwater that are left behind when the tide recedes.
16. The _____ _____ is a shorebird that is an omnivore, and eats almost anything including mussels, crabs, sea urchins, eggs, and garbage.
17. _____ is the use of materials or coloration for concealment.
18. _____ occurs when an animal uses something in its environment to hide itself.
19. Most crabs are covered with a thick shell called an _____.

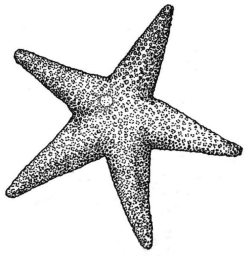
Picture Identification

Write the letter of the algae or animal name next to the correct picture.

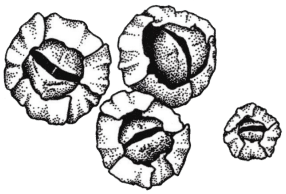
20. _____ 

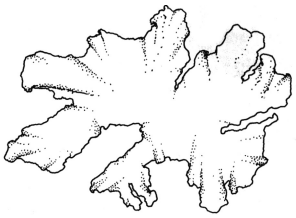
21. _____ 

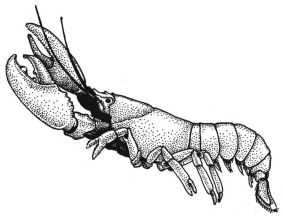
22. _____ 

23. _____ 

24. _____ 

25. _____ 

26. _____ 

27. _____ 

a. barnacles

b. sea star

c. sea lettuce

d. knotted wrack

e. rockweed

f. periwinkle

g. lobster

h. Irish moss

Problem-Solving

Read the following questions carefully and answer them with as much information as possible.

28. There are different types of fish that live in the subtidal zone of the rocky shore such as the rock gunnel, the mummichog, and the lumpfish. What are three different traits of fish?

_____

_____

_____

_____

Problem Solving (continued)

29. There are two types of plankton: phytoplankton and zooplankton. Plankton, microscopic organisms drifting in the ocean, are very important. Provide at least two reasons why plankton are very important.

30. Algae and plants are not the same thing. Explain how algae and plants are alike, and how they are different.

31. The rocky shore ecosystem is a harsh environment. What are three of the challenges rocky shore organisms need to overcome so they can survive?

32. A rocky shore organism lives most of its life in the middle intertidal zone. This zone is under water about half of the day and above water about half of the day. Name at least two kinds of adaptations that would help an organism survive the middle intertidal zone.

ROCKY SHORE ECOSYSTEM ASSESSMENT

Answer Key

Multiple Choice

1. b
2. a
3. c
4. d
5. c
6. a

Matching

7. e
8. d
9. c
10. b
11. a

Fill-in-the-Blanks

12. moon
13. absorbs
14. adaptation
15. tide pools
16. herring gull
17. camouflage
18. masking
19. exoskeleton

Picture Identification

20. e
21. f
22. h
23. b
24. d
25. a
26. c
27. g

Problem-Solving

28. The four traits of fish are they all live in water, filter oxygen using gills, have fins and backbones. (Accept any three traits as being correct.)
29. Plankton is very important because phytoplankton is the base of the marine food chain. Many animals eat phytoplankton and humans eat animals that eat phytoplankton. A lot of the oxygen we breathe comes from oxygen produced by phytoplankton (estimated around two-thirds). Types of zooplankton (like copepods and krill) are some of the most abundant animals on Earth. (Accept any two facts as being correct.)
30. Algae and plants are alike because they both produce food using the process of photosynthesis. Plants and algae are different because plants have roots and most algae have holdfasts. Plants eat using a vascular system but algae absorb nutrients directly from the water. Plants live mostly on land and algae lives mostly in water. (Accept the one "alike" answer and one or more of the "different" answers as being correct.)
31. Challenges rocky shore organisms face include: the force of waves, the rise and fall of the tides, the change in water temperature, the change in air temperature, the change in the water's salinity levels, finding food, and avoiding predators. (Accept three facts as being correct.)
32. Adaptations that would help an organism survive the middle intertidal zone include an ability to catch food like filter feeding or strong claws, an ability to stay wet/moist when exposed to air such as a covering like a barnacle, an ability to avoid predators such as an exoskeleton or a type of camouflage. (Accept two or more of the facts as being correct.)

EXPLORE THE SHORE

Topic
Planning a Visit to the Rocky Shore

Duration
One session

Vocabulary
conservation
expectations
guidelines

STANDARDS

Practices
Obtaining, Evaluating, and Communicating Information

Core Ideas
Human Impacts on Earth Systems

Crosscutting Concepts
Science Addresses Questions About the Natural and Material World

OCEAN LITERACY PRINCIPLES

OLP 1, OLP 5, OLP 6, OLP 7

Focus Question

How can I be prepared to visit the rocky shore?

Overview

Students create expectations for a classroom visit to the rocky shore. Students discover appropriate guidelines for visiting the shore. Students write a poem or song to help them remember their expectations.

Objectives

Students will be able to:

- Identify expectations for a visit to the rocky shore
- Discover appropriate guidelines for a visit to the rocky shore
- Write a form of literature that outlines their rocky shore expectations

Materials Needed

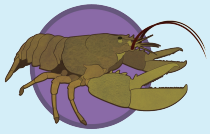
- Paper/pencils
- Whiteboard/SMART Board/Projector
- Computers/Printer
- Copies of Explore the Shore Tips (if decided upon, page 233)

Teacher Preparation

1. Reserve computers or tablets (one per student).
2. Prepare enough paper/pencils for each student.
3. Make sure to have a whiteboard/SMART Board available to record student feedback.
4. Print out copies of Explore the Shore Tips for each student if decided upon by the teacher.

Background

The rocky shore, like any ecosystem, needs to be treated by humans with care and respect. It is important that when visiting an ecosystem humans understand what steps they need to take to ensure the safety of the organisms that live there, as well as what steps they need to take to ensure their own safety. Considering the size and fragility of many of the rocky shore's organisms, it is vital that



Teacher Tips

- ★ Seek the assistance of the school's music teacher to help students create one song about expectations when visiting the rocky shore.
- ★ Have students work only on computers/tablets to draft, revise and edit their song or poem to expedite the lesson.
- ★ For struggling writers, type the rocky shore expectations and then print it out for students to refer to when creating their song or poem.

Extension Suggestions

- ★ Have students come up with a list of expectations to use when visiting their local ecosystems (i.e., forest, lake) or their school's nature trail (if possible).
- ★ Prepare a scavenger hunt for students to participate in or find a premade scavenger hunt online.

Background (continued)

those visiting the rocky shore be knowledgeable of how to conduct themselves appropriately so that they can do their part to conserve the ecosystem. It is also important that humans visiting any ecosystem be aware of the dangers they might encounter.

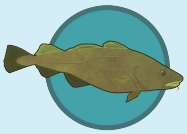
Procedure

Part One

1. Ask students what stories they can recall that have giants as main characters. Suggestions may include giants from the *BFG* by Roald Dahl, or the giant from *Jack and the Beanstalk*.
2. Ask students what they think life would be like if we had giants as tall as skyscrapers walking around our town.
3. Ask students if they can make a connection between the topic of giants and visiting the rocky shore. Assist students if necessary in determining the connection that a human visiting the rocky shore is similar to a giant visiting their town.
4. Ask students what kind of "giants" they think they should be when visiting the rocky shore.
5. Inform students that they are going to work in partners to come up with at least five expectations of how they should behave when they visit the rocky shore.
6. Assist students with their partnerships, provide them with paper and pencils if necessary, and allow them five to ten minutes to come up with expectations.
7. Have partners share their expectations and record their feedback on a whiteboard or SMART Board. Put check marks next to "repeat" expectations.
8. Determine the "Top Five" or "Top Seven" tips you would prefer the students to remember and either circle them or highlight them for later use.
9. Inform students that it is not only important to consider how to behave when planning a visit to the rocky shore, but it is also important to plan on making the visit enjoyable and educational.
10. Share and review the Explore the Shore Tips document with students using a projector or SMART Board, or print out a copy for each student.
11. Point out similarities between the student list of expectations and the Tide Pooling Tips document if possible.

Books

- *Beachcombing: Exploring the Seashore* by Jim Arnosky
- *What If Everybody Did That?* by Ellen Javernick
- *One Plastic Bag: Isatou Ceesay and the Recycling Women of the Gambia* by Miranda Paul



Websites

- Check out "Exploring for Tide Pool Creatures!" on the Brave Wilderness YouTube Channel. Have students pay close attention to how the tide poolers treat the animals and the rocky shore.
- Watch "Monterey Bay Aquarium Tide Pool Tips with Jim Covel" on the Pottery Barn Kids YouTube Channel. Compare the tips Jim Covel provides with the ones students have already reviewed.

Scientist Notebook

- Students can record their expectations for visiting the rocky shore and the tide pool tips they learned.

Part Two

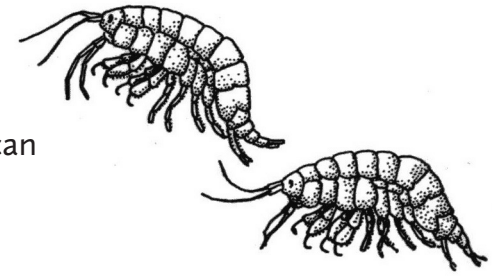
12. Inform students that they are going to be working with their previous partners to write either a song or poem to help them remember their "Rocky Shore Expectations."
13. Provide paper/pencils for partners to use to write their song or poem drafts.
14. Assist students with revising and editing their work.
15. Allow students to "publish" their song or poem of expectations using a computer or tablet with printing capabilities.
16. Have students print out their finished poem or song of expectations and have them share with the class if they feel comfortable doing so.

Wrap-up

- Ask students to identify the expectations they created as a class and that the teacher decided upon.
- Ask students to recall as many tips as possible from the Explore the Shore Tips document.

EXPLORE THE SHORE TIPS

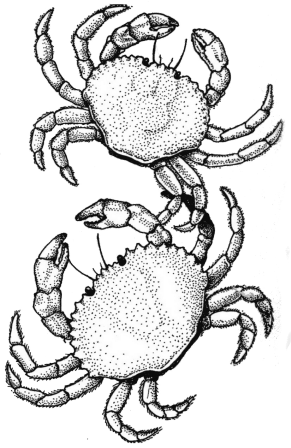
by Mr. Smith



1. **Check the Tides**—Explore the shore at LOW tide. You can find local tide charts online.

2. **Protect the Feet**—Wear appropriate footwear. The rocky shore is tough on the toes. Old shoes and water shoes work.

3. **Wait for It**—Be patient while you search for creatures in a tide pool. Observe and move around slowly.



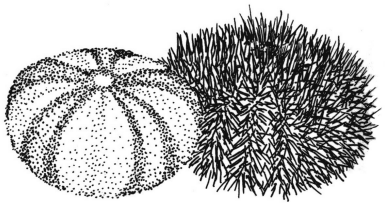
4. **Look out Below**—Rocky shore creatures don't prefer to sunbathe. Look under seaweed, rocks, and overhangs.

5. **Easy Does It**—Be very gentle when holding rocky shore creatures, and return them exactly where you found them.

6. **Don't Move**—Rocky shore creatures like sea stars and limpets hold on tight. Do not move them, you'll hurt them.

7. **Resist Temptation**—Taking objects from the rocky shore can impact the ecosystem negatively. Take photos instead.

8. **Move Slow**—Expect to slip every step, step to the lowest point every time, and lean forward and not backward.



9. **Bring a Bin**—Bring a plastic container to observe creatures more closely and for extended amounts of time.

10. **Make it Fun**—Plan a scavenger hunt. Choose specific algae and animals to look for and see what you can find!

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