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Introduction

What is science?
Teaching science is sometimes seen as overwhelming, especially if you do not think you are a “science person” or have a science background. We may fear that a young person will ask us a question that we do not have an answer to. While one aspect of science is the body of knowledge that we have that helps us understand the natural world, science is also a process. It is how we come to understand the natural world through curiosity, exploration, and the use of our senses.

The core science skills you will find in these activities are observation, measuring, classifying, analyzing, predicting, and communicating. If you are looking carefully in your own backyard for birds and insects, testing to see what materials float or sink in water, or trying to construct the perfect parachute for an action figure, then you are doing science.

The activities in this book are designed to stand on their own, without much knowledge of the content. While some basic knowledge is helpful, we provide context and some background information in this manual. We have also tried to include resources for learning more, especially the Aquarium’s own Teacher Resource Center. We hope we can support you so that when a young person asks you a question and you don’t know the answer, you can always say, “I don’t know. Let’s find out together!”

Why science activities in after-school?
We live in an increasingly complex human-made environment and the skills of observation, reasoning, and problem solving are necessary to navigate this world in an efficient way. School-age children in particular are under pressure to do well in an ever-increasing number of different subjects and disciplines. The core science skills of observing, analyzing, and problem solving are applicable to a much wider range of subjects. Reading comprehension requires close observation and careful analysis; math involves analyzing numbers and their relationships. More complex disciplines that tend to be regarded only in later grades like government and citizenship require group problem solving and strong communication skills. All of these have their roots in basic science skills.

Furthermore, it is important to consider doing science activities in out-of-school time because there is less science being done during the school day. We also hope that without the pressure of grades and high-stakes testing, the anxiety that young students feel about science may be lessened. We hope that by leading students in activities that are fun, you can engage students who may not see themselves adept or interested in science, and help support all students’ developing science skills by feeding young learners’ innate curiosity.

While the focus of the activities in this book is science, we also provide many arts and crafts, movement activities, and games. With each of these we have tried to provide suggestions for how you can add ocean content. We hope that the suggestions here help you think through how you might add an ocean theme to a favorite game of tag or a go-to craft that you already do. These crafts and movement activities also provide opportunities for your students to observe, communicate, and stretch those science and literacy muscles! What do they notice while they’re coloring and cutting their hermit crab model? Can they remember what movements are associated with specific animals in the “Coastal Movement” activity? Remember that just letting students talk to each other and use their own problem-solving skills to work through a challenge can be a valuable experience for young learners!

A note about ages
While the activities in this book give a suggested age, most of them can be done with a fairly wide range. We generally provide only a lower limit to suggest which students might be too young for a particular concept or skill, but encourage you to try these activities out with younger or older students. Because the skills involved in these activities are important for all young learners (and even adults!) many of them can be facilitated in ways that can engage much younger or older students than you might think at first glance. We have tried to include notes about how to modify the activities for your group. Some of the activities have skills noted under the age range; this is to provide guidance about what skills are critical parts of the activity, like cutting with scissors or reading.
Additional background information or suggestions for further activities

While we have tried our best to include sufficient background information, extensions, and modifications for all the activities in this book, we know that some educators may want more. If a particular activity or lesson is a huge hit with your students, keep the momentum going! We encourage you to think creatively about what you might be able to do next with similar materials or ideas, but remember that the staff at the Aquarium is also a resource for you. If you are interested in finding some books that you can read to increase your background knowledge, books to read with your students, or additional activities and materials that might work into a unit or theme week, do not hesitate to get in touch with our Teacher Resource Center (TRC). The staff in our TRC are experts at helping educators support their students and have a collection of books, videos, artifacts, and activities that are free to loan. Contact them by email at TRC@neaq.org or by phone at 617-973-6590.

How Science Connects to Literacy

Science Skills
- Observing
- Classifying
- Comparing
- Drawing a conclusion
- Making a prediction
- Posing questions
- Finding cause and effect
- Activating prior knowledge
- Making an explanation from evidence

Literacy Skills
Science Explorations
**Science Explorations**

**Animal Pairs**

**Duration**
5 to 20 minutes

**Group Size**
Up to 30

**Ages**
5 and older

**Concepts/Skills Developed**
Close observation/attention to detail, problem solving

**Suggested Materials**
Two copies, or more, of each image provided

**What to Do**

1. Provide each student with one image. Try to distribute them such that there are at least two copies of each image. If you have a bigger group, you could have more than two for some of the images. If there are an odd number of students, the facilitator can also have an image.

2. Tell the students that they need to find their match. If students are not noticing the subtle differences between some of the images at first, you can guide them with questions like “Are you sure that one is your match?” or tell them “Look a little closer.”

If students are getting stuck, you can coach them to look at specific body parts.

For younger students, stick with just the more obvious images (like the minnows) rather than the more challenging ones. With a group that is mixed ages, you could have the older students supporting younger ones.

**Debrief**

Once everyone has successfully found their partner, you can ask them how they felt during the activity. What skills did they have to rely on? How did you determine when you had the exact match? What assumptions did you make when you started looking for a match? Did those assumptions have to change?

**Extensions/Variations**

Use this activity as a get-to-know-you activity. Once students have found their match, have each student exchange a fun fact, share a hidden talent, talk about favorite animals, colors or other favorites, or use other prompt questions. When everyone has found their match, have students introduce their partner.
Science Explorations
Animal Pairs
Science Explorations
Animal Pairs
**Science Explorations**

**Back-to-Back Drawing**

**Duration**
45 to 60 minutes

**Group Size**
Any. In order to debrief with everyone, this activity is best for groups of 25 people or fewer.

**Ages**
6 and older

**Concepts/Skills Developed**
Communication, understanding differences in communication styles

**Suggested Materials**
- Clipboards
- Blank paper
- Pencils
- Drawing templates (paper with line drawings)—These can be specific things: house, flower, snowman, etc., or can be more abstract sets of shapes. Use simpler drawings with younger children and challenge older students with more complex images.

**What to Do**
1. Divide the group into pairs. If you have an odd number of students, the facilitator can pair up with the last student.
2. Each pair sits back-to-back (or just so the students cannot see each other’s paper).
3. Give each person a clipboard. Give one person the blank paper and the other the template with the line drawing.
4. Tell the group that it is the job of the person with the line drawing to get the partner to draw a duplicate of the drawing without looking at the drawing.
5. After they are done, the partners compare the template with what was drawn.

**Variations**
- **No Questions**
  The first time through the exercise the student that is drawing is not allowed to speak or ask clarifying questions to the direction giver. Go through the activity a second time, allowing the student that is drawing to ask questions during the activity.
- **Different Templates**
  Have the group perform the activity more than once, with different templates. The second time, the drawer is allowed to ask only yes/no questions. The third time, the drawer can ask any question she likes.
- **Face-to-Face**
  Allow each pair to sit face-to-face. The direction giver is not allowed to speak nor to show the template; she must get the drawer to recreate the template using only visual cues.
- **One Direction-Giver**
  In a large group setting, one person could be the direction giver; all the rest are drawers. No one else is allowed to speak as they try to draw the shape the direction giver is describing. Afterward, have everyone compare their drawings.
Debrief

• What was it like to give directions? How was it different when the drawer could ask questions from when s/he could not?
• What was it like to receive directions?
• What was it like not being allowed to ask questions?
• Once you could ask questions, did that make the job easier? Why?
• Why are the pictures different, when everyone heard the same message?

Extensions

To give this activity a marine theme, borrow some artifacts like shells, molts, and a coral skeleton from the Aquarium’s Teacher Resource Center. Instead of using the line drawings have students describe these artifacts to each other. Have students imagine that they are research scientists in a submersible. The scientist holding the artifact pretends she has spotted a new species, but the other scientist can’t turn to look at it so she must describe it. Encourage students not to say what the animal is, but rather use descriptions and analogies. Remember that no one has ever seen this species before! Consider making a list of prohibited words like shell, claw, etc.

Try this activity with everyday household objects like pencils, mugs, notebooks, soup cans, or apples. Again, make sure students understand that they should not simply say what the object is, but rather describe the object and its parts in detail.

Adapted from “Submersible Mystery” from the Aquarium’s Closer Look Kit and Back to Back Drawing from Teampedia.net. Line drawings reproduced with permission from Portal to The Public Network / Pacific Science Center.
Examples of simple line drawings:
**Science Explorations**  
**Build a Tidepool**

**Duration**  
30 to 45 minutes or ongoing

**Group Size**  
20 to 30

**Ages**  
5 to 8 years

**Concepts/Skills Developed**  
Knowledge of tidepool animals that are found in Massachusetts

**Suggested Materials**  
The templates provided, colored pencils

**What to Do**  
Distribute sheets with the blank tidepool image to each student. Alternatively, you can allow them to color the tidepool onto a blank page. Distribute the animal icons, have students color and then paste them into their tidepools. If you want to use this as a wrap-up activity for a tidepool lesson, you could give students multiple animals all at once.

You might also use this as a crafting activity as you talk about different tidepool animals across several weeks. Each time you learn about a new animal, you can have the students add that animal to their tidepool.

It is often helpful for this kind of activity to make an example version yourself so that students have a good understanding of what the craft should look like.
Science Explorations
Build a Tidepool
**Duration**
10 to 20 minutes

**Group Size**
10 to 25 students

**Ages**
5 and older (skills required: cutting with scissors)

**Concepts/Skills Developed**
Sea star anatomy, comparative anatomy (how different animals’ bodies are similar or different), anatomy of a familiar animal that is very different from a human

**Suggested Materials**
Provide each student with the reproducible echinomorph template (one for each student), a blank sheet of paper (one sheet for each student), scissors, and stapler. Optional: Rubber band and pencils for sea cucumber

**Background Information**
The family of animals known as echinoderms is a group of animals that includes sea stars, urchins, sand dollars, and sea cucumbers. Echinoderm means “spiny skin” and most of these animals are rough or spiny. They also share a type of symmetry called “radial symmetry” which means that it can be folded along multiple lines. Think of a circle; no matter where you fold it, the circle will be the same on each side. Most sea stars and other echinoderms have five lines of symmetry.

This activity will show students how the body plans of these different types of echinoderms are similar by taking a sea star shape and folding it into the body plans for the other types.

**What to Do**
1. Make a double-paper star.
   a. Lay the star template on a blank page.
   b. Keep the pages together and as even as possible as you cut along the dotted lines.
   c. Staple the two pieces together with one staple at the end of each point.

   The circles represent tube feet, the sticky feet sea stars use to move. When you lay your star on a table, the tube feet should be on the bottom. A live sea star can tell if it is upside down, and bend to get hold with its tube feet and turn over.

2. Make the star into an urchin.
   If you fold the arms of the star up and join them at the top, you’ve changed the star into a sea urchin. Notice that the tube feet are on top now, as well as on the bottom. If you ever have the chance to see a live urchin, you will see long tube feet “waving” all over the animal’s body. The tube feet and five-part symmetry tells you the star and urchin are related, even though they may not appear similar at first glance.
3. Flatten the urchin into a sand dollar.
   There's not much difference between a sea urchin and a sand dollar. Just squash your urchin to make it flat. Sand dollars have spines too, but they are tiny and feel more like fur than spines. When you find the dried out skeleton or “test” of a sand dollar, you can see the five-part symmetry.

4. Making the cucumber is a stretch.
   Now you'll see why we made the sea star with two pieces of paper. If you pull the star apart, you'll change it into the sea cucumber. Optionally you can use a pencil to add tube feet to the other end and a rubber band to help the cucumber keep its shape.

**Extensions**
While younger students may not grasp the details of the science, that’s OK! If you can show them pictures of each type of animal, sea stars, urchins, sand dollars, and sea cucumbers, they can still have fun folding their echinomorph into different shapes. Young students may not exactly grasp that the different folds show that there is a common plan across all echinoderms, but you can still walk them through the folds and ask them what they notice about how each kind of animal is similar or different.

*Sketches and activity by Bob DeWeese.*
Star Template:
**Science Explorations**

**Fish Shapes**

**Duration**
45 minutes

**Group Size**
Up to 30

**Ages**
5 and older

**Concepts/Skills Developed**
Fish anatomy, comparative anatomy (how animals' bodies are similar and different), making a model

**Suggested Materials**
- A white board or chalkboard and something to write with
- Fish body, mouth, and tail templates, pre-cut out
- Materials to decorate/color their fish (markers, colored pencils, or crayons)
- Glue

**What to Do**
1. Ask students what kinds of body parts a fish has. As they name them, begin to draw a fish on the white board/chalk board.
2. Depending on your comfort and the students’ age and knowledge level, you can label specific fins. See the diagrams that accompany this activity.
3. Once you have all the parts labeled you can tell students that they are going to make their own fish.
4. Get them to think about: where their fish lives, what their fish eats, how their fish moves (is it fast, slow, shallow water, deep water), and other aspects that might be important to designing their fish. Again, the background information provided with this activity will help you think about what might be important.
5. Hand out fish part outlines to the students.
6. Have students glue their fish together when they are finished decorating.
7. If you have extra time, you can have students name their fish, and a few volunteers can present their creations to the rest of the group.

**Extensions/Variations**
Older students can do their own cutting, which saves some prep time. With very young students (5 to 6 years old) keep it simple! They will always impress you with how much they know, though.

**Background Information**

**Fish Vocabulary:**

**Lateral line** – The lateral line is a unique sensory system found only in fish. It consists of a series of vibration-sensitive hairs linked to the nervous system, protected within pores that form one or more rows along each side of the fish. It helps a fish avoid obstacles and predators. You can see the lateral line as a faint stripe running along each side of a fish’s body.

**Fins** – Fins help fish move and provide swimming stability. In most fish, paired fins are used for starting and stopping. Medial fins, like the anal and dorsal fins, act like the keel of a boat enhancing stability. In many species, the caudal fin or tail fin provides most forward movement and controls direction. Of course, there are always exceptions. See if you can spot them.

**Gills** – Fish breathe through gills. Oxygen-rich water enters the mouth, crosses the gills, where oxygen and carbon dioxide are exchanged, and exits the gill slits. Gill covers protect delicate gill filaments.
Fish Diagram:
Fish Body Template:
Fish Mouth Template:
Fish Tail Template:
**Science Explorations**

**Hermit Crab Activity**

**Duration**
20 minutes

**Group Size**
Works best with 15 or fewer (instructor cutting the “hole” in the shells can be hard with a larger group).

**Ages/Skills**
7 and older (cutting skill required)

**Concepts/Skills Developed**
Knowledge of hermit crab anatomy and behavior

**Suggested Materials**
- Hermit crab templates provided
- Scissors
- Markers, crayons, or colored pencils
- Card stock

**What to Do**

Have students color and cut out shells and hermit crabs. Be ready to cut the dotted line on the hermit crab’s shell with an open scissor or X-acto knife. Students can then move the hermit crabs from shell to shell, simulating the way that hermit crabs move into a larger shell as they grow. You can explain to students that hermit crabs live in old snail shells. When a hermit crab grows too big for its shell, it has to find a bigger one. It uses its antennae to feel inside a new shell to see if it is the right size. Point out the four claws along the hermit crab’s tail that it uses to hold its shell on its back.

**Extensions/Variations:**

Read *Is This a House for Hermit Crab* by Megan McDonald or *A House for Hermit Crab* by Eric Carle with the students. Contact the Aquarium’s Teacher Resource Center to borrow either or both!
**Hide-a-Fish**

**Duration**
About 20 minutes

**Group Size**
Up to 25

**Ages**
6 and older (cutting skill required, or you can prep templates yourself)

**Concepts/Skills Developed**
Understanding adaptations, understanding camouflage

**Suggested Materials**
- The template for this activity
- Tape
- Scissors
- Coloring materials, such as crayons or colored pencils
- Books with images of camouflaged animals (check your local library or the Aquarium’s Teacher Resource Center)

**What to Do**

1. Ask students if they know what the word **camouflage** means. Try to have one or more students in your group explain the concept. Ask students why animals have camouflage. If you are working with older students (starting at about age 8), you can introduce the term **adaptation**. Tell the group that camouflage is one of many adaptations that some animals have that helps protect them from their potential predators.

   Ask students if they know of any examples of animals with camouflage. While they list them, you can show images in books or pulled from the internet to help illustrate how they appear.

2. Explain to students that they are going to make fish that camouflage in the classroom space. Hand out templates to each student and have coloring materials ready. Have each student pick out a place in the room to camouflage their fish. They should color in the fish so that it blends in with that part of the room. Encourage students to stay in the place where their fish is camouflaged or periodically check to see if the colors and patterns are working to camouflage it. Students can then tape their fish in place.

3. Have the class take a “nature walk” in the space and try to find as many of the hidden fish as possible. Feel free to leave some of the hidden fish hanging in your space if permitted so that future students, staff, and parents can have the experience of being surprised by them!
Science Explorations
Horseshoe Crab
Anatomy Craft

Duration
20 minutes without extensions

Ages/Skills
7 and older (cutting skill required)

Concepts/Skills Developed
Knowledge of horseshoe crab anatomy and behavior

Suggested Materials
- Horseshoe crab patterns (provided)
- Scissors
- Markers or crayons
- Glue sticks

This activity works best with thicker paper or light cardstock

What To Do
1. Have students color their horseshoe crab.
2. Cut out the helmet. Make sure to cut out the dotted triangles on each side of the helmet.
3. Put glue on the x marked near the triangle that was cut out and glue the two sides together in order to make the helmet 3-D.
4. Cut out the abdomen and glue the tab marked with an x to the underside of the helmet.
5. Cut out the tail and glue the tab marked with an x to the underside of the abdomen.
6. Cut out the book gills and glue them to the underside of the abdomen.
7. Cut out the mouth and legs, and glue them to the underside of the helmet.

Extensions
Read Crab Moon by Ruth Horowitz with the students. You can do this before the activity and then have them decide if they want to make a male or female horseshoe crab.
Female Horseshoe Crab

- Tail (Telson)
- Helmet
- Abdomen
- Book Gills
- Legs
- Legs
Science Explorations
Hot and Cold Water Currents

Adapted from GEMS Ocean Science Sequences 3-5, copyright The Regents of the University of California

Duration
25 minutes

Group Size
Best for a classroom-size group of 30 or fewer and limited by the number of tubs. You’ll want to be able to get a group of students comfortably around a tub where everyone can see, so group size depends on the number and size of the tubs you have access to.

Ages
6 and older (Students will need to draw and preferably label their worksheets individually. If you want to run this activity with younger students be prepared to assist with labeling and recording.)

Concepts/Skills Developed
Predicting, close observation, recording, how water moves, temperature

Suggested Materials
• One clear plastic tub per approximately 5 to 6 students (or several if working in smaller groups)
• Blue ice cubes (colored with food or water coloring, prepared at least the night before)
• Red water (colored with food or water coloring)
• Glass beaker(s) or jar(s) for the hot water
• A hot plate with pot, electric kettle, or other way to warm water
• Tongs/hot mitt or some way to move the hot containers
• Worksheets
• Red and blue markers

What to Do
1. Distribute one set of worksheets to each student.
2. Fill clear tub (or more than one tub, if you have students working in smaller groups) with room temperature water.
3. Have blue ice cubes ready.
4. Heat water, transfer it to a beaker, and color it red.
5. Have students brainstorm how they think cold water and warm water will move. What do they know about hot and cold air? Will water be similar or different?
6. Introduce the model, telling students that they will be adding ice and hot water to the model and they will be predicting how the different temperature water will move. Have students predict what will happen with the cold water.
7. Introduce the ice, allow students time to observe and draw what they see.
8. Next, have students predict what will happen with the hot water.
9. Introduce the hot water in the jar by picking up the whole container and adding it to the larger container. Again, have students observe and record what they see by drawing on the worksheets.
10. Discuss what students saw and why they think it happened.

Extensions/Variations
Temperature plays a large part in regulating the ocean’s currents. How can you connect what they saw to the ocean? If you think it would be something your group would be interested in, you can easily find maps online of both world current patterns and temperatures across the ocean. How do they think the animals that live in the ocean are affected by these currents?
1. Predict and then draw where the blue, cold water from the ice will travel:

<table>
<thead>
<tr>
<th>Top View</th>
<th>Side View</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Draw where the blue, cold water from the ice actually traveled:

<table>
<thead>
<tr>
<th>Top View</th>
<th>Side View</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Predict and then draw where the red, hot water will travel:

<table>
<thead>
<tr>
<th>Top View</th>
<th>Side View</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
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</table>

2. Draw where the red, hot water actually traveled:

<table>
<thead>
<tr>
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<th>Side View</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Science Explorations

How to Make a Movement Cube

A movement cube is a large die made from cardboard with images of different animals on each face. Along with the image there are short instructions to move like the different animals on each face. Students (or facilitator) can throw the die and students move like that animal. A movement cube is a great time filler and gross-motor movement activity.

Duration
Varies by number of cubes and group size. About half an hour for one cube.

Group Size
About four students per cube.

Suggested Materials
• A large piece of cardboard or pre-constructed cardboard cube
• The images in this activity
• Packing tape
• Hot glue, Gorilla glue, or strong tape
• Contact paper or other clear, durable plastic sheets to cover each face of the die

What to Do
1. Draw this pattern onto your cardboard. The squares should be approximately 12 x 12 inches. You can also print, enlarge, and trace this pattern onto your cardboard.

2. Fold your cardboard into a cube. Glue tabs together to begin securing into a cube shape.
3. Print images from this document. Glue or tape them, one onto each face.
4. Cover each face with thin protective plastic, tape edges with packing tape to continue securing everything into place.
5. You can also make your own images, or have students draw their own. The ones provided are just a suggestion.
6. Label the images with the accompanying action:
   • Fish: Swim Like a Fish
   • Crab: Crawl Like a Crab
   • Penguin: Walk Like a Penguin
   • Snail: Hide Like a Snail
   • Jelly: Jiggle Like a Jelly
   • Dolphin: Jump Like a Dolphin

Extensions/Variations
Come up with your own animals and corresponding movements. Have each team of about four students come up with their own cubes before they make them.
Science Explorations

How to Make a Movement Cube
Science Explorations
How to Make a Movement Cube
Science Explorations
How to Make a Movement Cube
How to Make a Size Reel

A size reel is a length of string or other material that shows how large a certain animal is. They can be fun to compare to the students’ size. (Example: After you make the size reel, figure out how many students it takes to get up to the size of that animal.) They can also be a great way to visually compare the sizes of different animals.

Duration
Varies based on group size and which size reel and how many size reels used

Group Size
Any. This activity can work well for a single student as well as a group. Either have a team of students make one of the larger ones together or have each student make their own and then compare and contrast their animal sizes.

Ages
5 and older. (Skills required: Students will need to measure and cut. For the larger size reels, students will need to coordinate how they will measure the length using a ruler or a measuring tape that may not be long enough to cover the entire reel. While this can be challenging, it is a great exercise in planning, coordinating, and problem solving.)

Concepts/Skills Developed
Measurement, problem solving, comparing and contrasting

Suggested Materials
- A length of yarn, twine, string, or any similar material that can be unrolled and cut
- Scissors
- A tape measure or another method of measuring
- Known lengths of the animals that you are interested in measuring

What to Do
1. Hold the end of the tape measure at one end of the yarn or twine.
2. Begin unrolling until you have reached the length of the animal.
3. Then cut! That’s it.

To get students fully involved you can have them do pretty much all the work. Coach and encourage them when they need it, but try to stay as hands off as you can.

Here are some guiding questions to keep in mind as you make multiple size reels with your students:
Which animal is the biggest? Which is the smallest? Can we order them from biggest to smallest? Which ones are bigger than us? Smaller than us? How many kids (or hands) fit into each animal?

Here are some examples of animals you can make size reels for:

<table>
<thead>
<tr>
<th>Very Large Animals</th>
<th>Well-Known Animals</th>
<th>Very Small Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lion’s mane jelly: 120 feet</td>
<td>Leatherback sea turtle: 7 feet</td>
<td>Krill: Up to 6 inches</td>
</tr>
<tr>
<td>Blue whale: 100 feet</td>
<td>Orca/killer whale: 26 feet</td>
<td>Dwarf lantern shark: 6 inches</td>
</tr>
<tr>
<td>Saltwater crocodile: 15 feet</td>
<td>Cod: 3.3 feet</td>
<td>Clownfish: 4 inches</td>
</tr>
<tr>
<td>Giant squid: 60 feet</td>
<td>Emperor penguin: 3.6 feet</td>
<td>Pygmy seahorse: 0.51 inches</td>
</tr>
<tr>
<td>Whale shark: 42 feet</td>
<td>Lobster: Up to 3.9 feet</td>
<td></td>
</tr>
</tbody>
</table>

Extensions/Variations
Have students draw the animal or create a life-size drawing as a team! Encourage students to come up with their own animals to make size reels for. Collect various size reels over time so students can continue to compare and contrast them. If you have space, you could consider hanging them on a wall so students can see them next to each other regularly.
Science Explorations
Invent an Invertebrate

Duration
45 minutes

Group Size
Up to 30

Ages
7 and older (possible for younger, see variations and extensions)

Concepts/Skills Developed
Adaptations, comparative anatomy (how animals’ bodies are similar and different)

Suggested Materials
• Copies of the What Is It? worksheet
• Arts and crafts materials such as pipe cleaners, toothpicks, foam packing, colored paper, fabric, staplers, tape, Q-tips, craft sticks, rubber bands, yarn, tubes, egg cartons, etc.

Background Information
This activity helps students understand the concept of adaptations. All organisms have adaptations to meet the challenges of the habitat in which they live. In this activity, students will create an imagined animal but should create one with adaptations for a rocky coast habitat. Animals’ adaptations are anything on their body or any behaviors they exhibit that help them get food, water, that help them to protect themselves and survive in their habitats.

What to Do
Imagine what it would be like to live on the rocky coast, exposed to the crashing waves—it certainly would be a challenge! To meet the challenges posed by their habitats, animals have evolved adaptations.

Have the class brainstorm a list of the challenges an organism living in a rocky coast habitat would face. While developing this list, you may want to note those challenges faced by organisms living in any habitat, and which are specific to the rocky coast. Some of the challenges included on your list might be:
• Getting food—all habitats
• Avoiding being eaten—all habitats
• Avoiding being crushed by waves—rocky and sand coast habitats
• Avoiding being washed away by waves—rocky and sandy coast habitats
• Getting oxygen, and/or carbon dioxide—all habitats
• Staying wet at low tide—all intertidal habitats

Every animal living in the rocky coast habitat must have adaptations to help it meet each of these environmental needs—but different animals solve these problems in different ways. For example, camouflage is one adaptation to avoid being eaten. A thick shell is another possibility. A barnacle’s adaptations for collecting food are its net-like legs, while an extrudable stomach and suction tube feet help a sea star solve the problem of finding a meal.

The Challenge
Explain that everyone will be inventing and building a brand new, never before seen, rocky coast organism. They can make their organism look however they want, act however they want, make an animal or a plant or some combination, and use any of the materials provided. However, every organism must have adaptations that will let it live in the very challenging habitat of the rocky coast. In designing their organism, students should think about adaptations to meet each of the environmental challenges listed by the class.

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Alternatively, you can make the activity more simple by having students design adaptations for only some of the challenges listed. A good selection is: getting food, avoiding predators, and holding on to the rocks.

If you have studied several coastal habitats, you can make the activity harder by having the class brainstorm a list of environmental challenges including challenges for each coastal habitat: sandy beach, rocky coast, and salt marsh. Have each student pick a coastal habitat, and then design and build an animal adapted to that habitat.

**Debrief**
Have students draw their creation in the top box of the *What Is It?* worksheet, and answer the worksheet questions. In addition, it is fun to have everyone present their animal to the class, and explain their animal’s adaptations. Students will be excited and proud of their inventions.

Discuss the idea of adaptations. You may want to develop a chart showing the different adaptations displayed by the new organisms. Did all the organisms meet the challenges in the same way?

**Extensions/Variations**
While students won’t fully understand the concept of adaptations until they are a little older (around age 7 they will be able to fully process the concepts in this activity), younger students will still enjoy the process of creating their own ocean creature. It’s a great idea to try to present the challenge in a similar way to younger students, but don’t necessarily expect them to make an animal that’s best suited to the rocky coast habitat. Younger students (and possibly older students) may have some wild ideas they want to add to their animals and that’s OK.

With older students, if they have made one creature, challenge them to choose a new habitat and create an animal with adaptations that work for that one.

If you don’t have access to crafting materials, you can always rely on the worksheet and have the students draw their inventions. Try creating a mural of the rocky coast on butcher paper and have students tape or glue their drawings onto the scene to create a rocky coast inhabited by the classroom’s creations.

For other resources to help you and your students learn about the rocky coast and adaptations that help animals survive there, contact the Aquarium’s Teacher Resource Center.
Draw your organism here:

I am called a:  

Here is a picture of my food:  

My habitat is:  

I was discovered by a scientist named:  

I get my food by:  

Other adaptations I have are:  
To avoid being eaten →
Investigating the Unknown: Mystery Bag and Black Box

Duration
30 to 60 minutes

Group Size
Up to 30 students

Ages
5 and older

Concepts/Skills Developed
Observation, constructing an argument from evidence, planning and carrying out investigations

Suggested Materials
One per group of 2 to 4 students:
- Brown paper lunch bags
- Black boxes or opaque containers (sealable and hard)—you should not be able to see through the boxes or be able to change the shape, i.e. a black hard plastic box, a jewelry box, an opaque pill bottle, etc.
- A selection of materials with different textures, shapes, smells, and sounds (see below for more ideas)
- Staples, tape, pencils
- Mystery Bag and Black Box student worksheet

What to Do

Pre-Class Preparation:
1. Fill each paper bag with an assortment of materials of different:
   a. Textures and shapes: rice, macaroni, balloons, sand or Crisco in a plastic baggie, dried beans, dice, etc.
   b. Smells: cotton ball with lemon extract, coffee beans, spices, etc.
   c. Sounds: bells, snack bag, cellophane wrap, etc.
2. Seal each bag with a piece of tape.
3. Fill each black box with one item. Since students will not be able feel anything inside the box, it’s best to use something that has weight and can be heard moving in the box (i.e. a marble, dice, etc.).
4. Seal the box tightly and very well with tape.

Directions:
1. Divide students into groups of 2 to 4.
2. Distribute a worksheet to each student.
3. Provide each group with a brown paper bag and direct students to complete the left part of the worksheet. Reiterate that they must use their senses to investigate but that they cannot open the bag.
4. After 10 minutes of investigation with the paper bag, discuss predictions and which senses were used to explore the bag.
5. Next give each group a black box and direct students to fill out the right side of the worksheet.
6. After a couple of minutes with the black box, discuss predictions and which senses were used to explore the box. Compare it to the paper bag exploration.
7. Instruct groups that they can now open up the brown bag. As a class, discuss whether predictions were correct, whether there were any surprises, etc.

8. Inform students that they cannot open the black box. Explain that the black box represents an area of science that is not easily explored. As a class, try to come up with areas of science that are comparable to the black box (i.e. the deep sea, space, etc.).

Debrief
Ask which additional tools would have been helpful in this exploration? How do scientists learn more about those areas of science that are not easily explored? This is a great opportunity to introduce the idea of using models to study certain topics. For example, models were developed to explain our solar system, DNA, anatomy, etc. See Foss Models and Designs for more ideas.

Extensions/Variations
To use this activity as an introduction to a new topic of study, include items relevant to the topic in the brown paper bag. For example, if you are beginning a unit on ocean ecosystems, one bag can include sand to represent the seashore while another can include Crisco to represent animals with blubber in the polar region.

- As an extension, ask students to create a model to investigate the contents of the black box even further. Provide them with different objects that they can test to make better predictions about what is in the black box. You may provide them with preset items or allow them to come up with a list of objects that they would like to test.
- For an example of how this activity was used in a classroom, see the Mystery Box Marvels article.
- For very young students and/or students who are not confident writers, it is OK to modify or omit the worksheets. Perhaps staff can take dictation. Another way to run this activity could be to have each group talk to each other about what they think is in their bag, then report out what they thought and what they ultimately found. You can emphasize that communication and sharing are integral parts of the scientific method.
- For older students, challenge them to make mystery bags and/or black boxes in an attempt to stump other students.
Use your senses to explore what is in the mystery bag and black box, without opening them.

- Record your observations.
- Write a few words or sentences to tell what you observe.
- Draw what you think some of the objects might look like.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Mystery Bag</th>
<th>Black Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How would you test your predictions?

<table>
<thead>
<tr>
<th>Observations</th>
<th>Mystery Bag</th>
<th>Black Box</th>
</tr>
</thead>
</table>
Make a Mud Snail

Duration
20 to 30 minutes

Group Size
Up to 30 students

Ages
6 and older (cutting required)

Concepts/Skills Developed
Observation/attention to details, snail anatomy

Suggested Materials
• Make a Mud Snail puzzle template
• Scissors
• Colored pencils
• Glue
• Construction paper

What to Do
1. Distribute a sheet with mud snail puzzle template to each student.
2. Instruct the students to cut out each of the puzzle pieces along the solid lines.
3. Have the students arrange the puzzle pieces to form a picture of a mud snail.
4. Then have them glue each piece in place on a sheet of construction paper or drawing paper and let it dry.
5. Finally, they can color the snail and label its body parts.

Background Information
Mud snails live along the mud banks and in the tidal creeks of salt marshes, as well as in other coastal areas. Like many snails, mud snails need to stay moist. So when the tide goes out, they often follow the water and crawl into pools. If a mud snail does get left high and dry and starts to get too hot or too dry, it can burrow down into the surface of the mud to stay moist and cool until the tide returns. Here is a look at the parts of a mud snail:

Shell — A mud snail’s shell can be a little more than one inch (2.5 cm) long and is usually light brown to black. The shell, like the shell of other snails, is the mud snail’s shelter and helps protect it from drying out as well as from some predators. The mud snail can pull its entire body into its shell.

Oперculum — The operculum is a horny disk that rides on the back of a mud snail’s foot. When a mud snail pulls its body into its shell, the operculum comes last, shutting like a door to seal the mud snail inside. When closed, the operculum helps protect a mud snail from some predators and from drying out.

Foot — Mud snails glide from place to place along a single foot. (A snail’s foot is the fleshy part of the body that helps the animal move.) As snails move along the mud, the foot produces a special slime that makes the gliding easier. Chemicals in this slime can be “read” by other snails and thus aid in communication among individuals.

Proboscis — At the tip of this trunklike tube are the mud snail’s teeth and mouth. The mud snail uses its teeth to scrape algae and other food from the surface of the mud and to scrape flesh from the bodies of dead animals that it finds. As the food is scraped off it goes into the mud snail’s mouth.
**Siphon** — Mud snails’ siphons draw water into their bodies and around their gills, which absorb oxygen and give off carbon dioxide. The water pulled in by the siphon also circulates through a special organ inside the snail’s body. The organ can detect chemicals in the water. (Chemicals in the water help a mud snail find food and detect predators. They also aid in communication among individuals.)

**Tentacles** — A mud snail uses its two tentacles to feel things in front of it and detect chemicals in the water.

**Eyes** — The two tiny eyes near the bases of a mud snail’s tentacles can’t see images the way human eyes do. Instead they detect differences in the amount of light.
Science Explorations
Make a Mud Snail
Science Explorations
Making Observations

Duration
30 to 40 minutes (can be longer with extensions)

Group Size
Best with 10 to 20 students

Ages
5 and older

Concepts/Skills Developed
Observing, using different senses, recording, understanding how different people notice different things or see things differently

Suggested Materials
• Natural artifacts such as shells, stones, sticks, leaves, etc.
• Manmade objects that have small details can be substituted, such as buttons, marbles, small toys, etc.
• Blank paper and pencils or colored pencils to draw

What to Do
1. Introduce the word: observe. Observing is like looking, but with our brains turned on. When you observe something you look closely and really think about what you’re looking at. Tell the students that you are going to be observing just like scientists.

2. Tell the students that you want them to take 1 to 2 minutes to pick out something in the room that they don’t think anyone else would notice. Have them quietly observe that object. Go around and let the students share their observations and see how closely everyone was observing. Did anyone pick out the same object?

3. Now tell students that we are going to use a different sense to observe. We will be using hearing to observe different sounds in the space. Have them close their eyes and listen for 1 to 2 minutes. Now, again, go around and have them report one sound that stood out to them or one sound they think other students might have missed.

4. Now we are all going to individually select an object to observe closely. Hand students the blank paper, drawing materials, and one object. Encourage students to pay attention to different features like color, texture, etc. For older students you can hand out more than one object and challenge them to draw more than one object, possibly to scale.

For an additional challenge with older students, have them partner up and sit in chairs back to back. Have one student hold the object and the other hold the drawing materials. The student with the object should describe the object in as much detail as he/she can so that the other student can draw it with good detail. Encourage students not to say what the object is, but rather describe the shape, color, texture (so rather than say “it’s a marble” say “it’s round, it’s very smooth, it has a pattern that looks like this…” etc.)

Debrief
Discuss with the students what they noticed during each portion of the activity that they would not have without careful observation. Ask if any of the students can repeat in their own words the difference between observing and just looking.
Duration
Ongoing

Group Size
Any. One group can participate or have multiple groups add to the observations over time.

Ages
5 and older

Concepts/Skills Developed
Observing, recording, comparing and contrasting, how the natural world changes over time

Suggested Materials
• Chart paper or butcher paper
• Markers
• Collection containers/bug boxes
• Clipboards
• Pencils
• Binoculars (optional)
• Notebook or blank paper
• Field guides

What to Do
1. Hang butcher or chart paper in some fairly prominent, public area so that everyone will be able to see the recordings from time to time. This will be your chart for recording observations from students in your groups. Organize the chart by some period of time, whether it is by months or by seasons so that different periods can be compared. As students make observations, record them in the chart. Highlight observations of things across seasons: when do the leaves start changing color? What day was it? When do the leaves come off the trees? Is it the same for all the trees or is it different? What birds do you see? Are they the same through the year or are they different? What kinds of behaviors do you see in animals like squirrels? Are they the same all year or are they different?

2. There are two main ways to facilitate this. One way is to have students go outside and/or look out windows to make a few recordings each day. Is there anything particularly notable (such as the first color change on leaves of the year)?

The other way to facilitate observations is to lead a more formal expedition outside. Equip students with clipboard, paper, pencil, and other observation tools like the collection boxes, binoculars if you have them, and field guides. Encourage students to make notes, try to identify what they see, and draw in as much detail as they can. Once back inside you can lead a discussion about what they found and what might have been different from the last time. As you do this periodically through the year, you can add to your chart.

Even if there is not a lot of green space near where you are, can you lead a walk around the neighborhood? What trees, birds, insects, mammals, smaller plants, or even clouds can be seen? What is the weather like? Being as descriptive as possible is great. Instead of just snow, describe how hard is it snowing? Is it fluffy snow or heavy? How deep/how much snow fell? Is it also windy?
**Science Explorations**

**Personal Periwinkle**

**Duration**
20 minutes, longer with extensions

**Group Size**
Up to 30, depending on number of shells/other objects

**Ages**
5 and older

**Concepts/Skills Developed**
Close observation, recording, using specific language

**Suggested Materials**
- Periwinkle snail shells, one per student plus a few extras (shells may be borrowed from the New England Aquarium's Teacher Resource Center, this activity can also be done with other items such as buttons, marbles, paperclips, etc.)
- Pencils, colored markers, or crayons
- Personal Periwinkle worksheet

**What to Do**
1. Divide the class into groups of 5 to 10 students.
2. Distribute one snail shell to each student.
3. Instruct each student to examine his/her snail shell carefully for five minutes and record specific details about the specimen on the student worksheet.
4. Collect all the snail shells in each group and place them in the middle of the group; add a few new snail shells to the mix.
5. Have each student (staying within the group) pick out his/her own snail shell from the pile in the middle.

**Debrief**
- How did you distinguish your snail shell from all the others?
- Generate a list of the characteristics that students looked for when making visual observations (i.e. color, shape, texture, contrasting dark and light, relative size, length, width, weight, volume, relative size, patterns, symmetry, analogies: "looks like...").
- Emphasize that drawing is an observation tool—not about being a ‘good’ or ‘bad’ artist.
- What instruments could we use to extend our observations? For example: scale, hand lens, ruler, etc.

**Extensions/Variations:**
- After the discussion, instruct students to add to their observations if possible. Then, ask students to place shells back into a pile (staying within the same group). Now direct each student to pass his/her worksheet to the left. The task is to identify his/her classmate's periwinkle based on the notes. To minimize frustration, let students know that this is a challenge and that not everyone will succeed. This often takes everyone by surprise. Some students will find their partner's shell, others won't. After a few minutes of comparing shells and notes, this activity can lead to a discussion about (1) the difference between notes/observations for self vs. for another reader vs. for publication (report) and (2) how scientists make notes for themselves vs. field guides or other published work. This can then lead to guidelines for science journals. This extension works particularly well with older students, at least 8 to 9 years old.
• Ask student pairs to compare and contrast shells.
• With very young students (5 or younger) encourage them to get as much detail as they can in their drawings. Make sure to help young students with spelling if they need it.
• As previously mentioned, you can do this activity with other natural objects or even human-made objects. A collection of rocks, leaves, twigs, or any other natural objects you can easily find make great variations for this and still support young learners’ close observation skills. If you do not have access to any natural objects in great enough quantity you can substitute beads, buttons, marbles or any other small to medium size object you have that are similar but have enough details that can be distinguished. Get creative! Even something like pens/pencils, small scraps of construction paper, collage materials from a magazine or book or puzzle pieces can provide interesting details for young people to observe!
Write three observations about your periwinkle that make it special.

1. __________________________________________
   __________________________________________
   __________________________________________

2. __________________________________________
   __________________________________________
   __________________________________________

3. __________________________________________
   __________________________________________
   __________________________________________

Now draw your periwinkle. Include all the special details.
**Duration**
10-45 minutes depending on style and variations

**Group Size**
Classroom size, up to 30

**Ages**
7 and older (skills required: writing)

**Concepts/Skills Developed**
Close observation, constructing an argument from evidence, asking questions

**Suggested Materials**
- Worksheet provided in this activity
- Pencils or other writing implements
- Clipboards or other suitable writing surfaces

**What to Do**
In this activity students will observe some natural objects or scene and record their thoughts. If you do not have access to any natural or green space many man-made items can be substituted. Be creative with what you have students observe. A particularly rich picture book, a piece of art, set of common household or office objects, blocks, even just a classroom space can provide an opportunity to engage students’ observation skills. You can also use this activity to introduce a new unit, lesson, or line of inquiry you are taking with your students. If students become practiced with this way of processing, it will become easier for them over time.

Provide each student with a worksheet and describe the three prompts so everyone understands the activity.

Tell students that for the first prompt, this should be just what they see. What colors, shapes, textures, and other physical features do the students notice? The first part is just the objective facts.

The second part is about inferences. What do their observations tell them about the object or scene? This part asks them to essentially make an argument. The students are asked to record what they think and why they think that.

Finally have students record what they wonder. What questions do they have about what they have observed?
This is what I see....

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

I think ___________________________ because....

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

I wonder....

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
**Duration**
45 minutes

**Group Size**
Works well with a smaller group, 5 to 10 students. For larger groups, students should work in pairs or teams of three.

**Ages**
8 and older

**Concepts/Skills Developed**
Adaptations, planning, making models, designing solutions

**Suggested Materials**
To set up the lesson:
- Small plastic garbage bag
- 4 pounds of bird seed (rice may be substituted)
- Pillow case
- String

For each student of pair of students:
- One sheet of card stock (or two 5 x 8 index cards)
- Scissors
- Masking tape
- Copy of The Wave worksheet

**Background Information**
Animals and other living things that live on beaches and rocky shores have to have special adaptations for living under crashing waves. To help steer your students in a direction that will result in a successful design in this activity, here are a few examples of adaptations we see on our coast.

<table>
<thead>
<tr>
<th>Limpet shells are conical, and barnacle shells resemble pyramids. Both shapes distribute the force of breaking waves over a wide area.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mussels have a hydrodynamic shape that provides little resistance to water flow. The mussel shell also acts like a weather vane pointing into the wind; by rotating on its byssus (attachment) threads, a mussel presents the smallest possible surface area to the waves. Some animals like sponges grow flat when they are exposed to waves. In deep water, the same type of sponge may grow with many arms and projections. Flexible stems allow seaweed such as rockweed and kelp to be whipped around by waves without breaking. Woody plants would snap.</td>
</tr>
</tbody>
</table>

All things being equal, thick shells are stronger than thin ones, and small is better than big.
What to Do
Ask students if they have ever played in the waves at the beach. For humans, it may be a fun experience, but imagine being a tiny animal that lives under the crashing waves.

Explain to the class that they will be inventing and building rocky coast organisms using just paper and tape. Their organisms should be able to withstand the wave being dropped on them, just as rocky coast organisms must withstand breaking ocean waves. Drop the wave bag for effect. The students’ creations need not resemble real animals or plants.

The Challenge
Working in pairs, or as individuals, students should design and build their own structures from one sheet of card stock (or two 5 x 8 index cards), and tape. If you are using The Wave Worksheet, tell students to draw their organism on the worksheet and write down their predictions of what will happen to their organism when the wave is dropped on it.

Gather the class when all of the shapes are ready. Test each organism by dropping the wave bag directly on it from a height of four or five feet. Before dropping the bag, you can have each group talk about the adaptations of their organism and give their predictions of its fate. The group can then record the actual results on their worksheet.

Most students will probably develop fairly successful organisms. For contrast you may want to build a large cube or other card stock shape that you know will be crushed.

Debrief
Applying the Concepts
• Ask students if just any animal in the world could live in a tidepool. Why or why not? You may want to suggest specific animals to consider, such as sharks or whales.
• Discuss the results of the wave activity, and the different strategies students have developed. Compare the paper forms with adaptations of real rocky coast inhabitants.
• With the information from the first trials, students can try creating a second generation of paper organisms that incorporate the successful adaptations.
Draw your shape here:

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you think this shape will survive? Why or why not?
What adaptations does your organism have to keep it from being crushed by waves?

What happened when the wave was dropped on your shape? Why?
The Tragedy of the Commons is a theory that comes from economics that illustrates what can happen with a shared resource if individuals act only in their own self-interest and not with the whole group in mind. The original example comes from a hypothetical town green being used by many individuals to graze their cattle. In this activity, the concept of a shared resource is illustrated with students fishing a shared ocean, with edibles representing the shared resource of fish.

**Duration**
20 to 30 minutes, possibly longer depending on extensions and conversation afterward

**Group Size**
Best suited for classroom-size group, up to 30, but depending on setup and materials can include more.

**Ages**
7 and older

**Concepts/Skills Developed**
Close observation, constructing an argument from evidence, asking questions

**Suggested Materials**
- One lasagna tray (or similar container) for about 4 students
- Straws (one per student)
- Spoons (one per student)
- Bowls (one per student)
- Edibles: Goldfish, Swedish fish, chocolate chips, Cheerios (you may substitute whatever edibles you like based on student/your preference, availability, and allergies. It is important that they range in how desirable they are, however.)
- Cup or some other way for you to scoop edibles from the trays (optional)
- Trivia cards and a way to keep scores for different teams (white board, chalkboard, etc.) (optional)

**What to Do**
There are several optional additions to this activity. The procedure describes the most basic way of running this activity, and extensions are listed below.

Sit students at trays so everyone can reach into the tray. Hand out straws, spoons, and bowls.
Add edibles to each tray. Add the most Cheerios, fewer Goldfish than Cheerios, fewer Swedish fish than Goldfish and very few chocolate chips (or if substituting different edibles, the most of the least desirable food and the fewest of the most desirable food).

Explain to the students that they are fishers, the straw, spoon, and their hands represent their fishing gear, the bowl represents their boat, and the tray represents their section of the ocean that they are allowed to fish. They will be fishing for several seasons (5-6 is generally a good number, but don’t tell the students how many it will be). Each season will be 30 seconds long. They will have access to only the straw in the first season (which you have to use by sucking just enough to pull up on the edibles), then the spoon, and then their hands.

Begin the first season. After each season you will “restock” the oceans, adding edibles based on how many of each kind are left. So if there is a lot of one kind, they can easily “reproduce” and you will add a lot of that kind. If there are few, only a few new can reproduce. If there is only one, none can reproduce.
You may see some students beginning to understand after the second season that if they fish too much the populations will not come back. Some may only be concerned with how much they are getting. Don’t say too much until the end, when you can talk about what happened, especially if you see different results in different parts of the ocean. Try to pay attention to what is happening around the room. Are some groups developing regulations? Are some groups overfishing? Are there groups that don’t agree on how to best manage their ocean?

At the end, lead a discussion about what the students noticed, what they thought, and how the activity relates to real-world fisheries management. Below are some resources for you to start learning about fisheries management.

Allow students to eat the edibles during or after the activity at your discretion.

**Variation/Extensions**

One variation is instead of naturally allowing students to use different fishing methods in each season, you can have trivia questions between seasons that earn them points and have them “buy” access to different methods. If you don’t have trivia questions you want to use or don’t have time to develop your own, take the opportunity to practice math, vocabulary, literacy, or anything else that your students have been working on. Then, as an example, you can award 100 points for each question and have them spend 300 points on the spoon and 800 to be able to use their hands.

Another variation adds to the simulation by introducing events in between fishing seasons. You can choose an event randomly or decide which one you want to introduce between each season. They are as follows:

- Hurricane: normal reproduction, but scoop out a handful from each section of ocean.
- Migration event: scoop out a handful from the ocean on one end and add it to the ocean on the other.
- Invasive species: add a handful of shredded paper to one or more sections of ocean.
- Typical year: this is a normal fishing season.
- Boom year: a Marine Protected Area is formed that allows part of the population to stay protected and increases reproduction. Increase reproduction by about half.

**Optional Background Information**

Some background on fisheries regulations: [http://www.nmfs.noaa.gov/regulations.htm](http://www.nmfs.noaa.gov/regulations.htm)

**Science Explorations**

*Window to the Tidepool*

**Duration**
30 to 60 minutes, with extensions

**Group Size**
Best for groups up to 20, depending on materials

**Ages**
7 and older (requires cutting, painting, gluing, and other fine motor skills; may require adult preparation for younger students)

**Concepts/Skills Developed**
Reinforcing knowledge of tidepool animals local to Massachusetts

**Suggested Materials**
- Templates of tidepool animals
- Two paper plates per student
- A circle of clear or blue cellophane for each student
- Scissors
- Glue
- Markers and/or paint
- Masking tape

**What to Do**
Discuss what the tide is and how tidepools form with the students. Every day at most places on the coast, the tide rises and falls twice a day. As high tide recedes, especially in rocky parts of the coast, water is often left behind in pits in the rocks. These pools of water are known as tidepools. They are often home to a variety of marine life.

If your students have not learned about tidepools previously, it’s a great idea to find some books with pictures of tidepools and the animals that live in them. You can always get in touch with the Aquarium’s Teacher Resource Center to borrow some books on the topic.

**Window to a Tidepool Activity**
1. Give each student two paper plates and instruct them to cut a circle out of the center of one of the plates. (You may want to do this part ahead of time depending on the age of your students.)
2. Have students paint or use markers to color each paper plate to look like the rocks of a tidepool.
3. Students will glue the circle of cellophane to the inside of the hole on the paper plate in order to form a window to the tidepool.
4. Using marking tape, students will tape the paper plates together on one edge in order to form a hinge so the tidepool can open and close.
5. Using the first handout, students can color in and cut out their periwinkle, hermit crab, and blue mussels and place them in their tidepool.
6. Students can color in and cut out both the top and bottom of the sea star and then glue the two halves together and place it in their tidepool.

**Extensions/Variations**
If you want to read with your students to develop their knowledge of tidepools and the living things you might find in them, we suggest *At Home in the Tide Pool* by Alexandra Wright, *The Seaside Switch* by Kathleen Kudlinski and *In One Tidepool* by Anthony Fredericks.

These books are great to read before this activity to help develop your students’ knowledge of tidepools, but could also be used afterward, depending on how you want your lesson to flow.
Science Explorations
Window to the Tidepool

Top

Bottom
Simple Experiments with Water
In this section you will find suggestions for how to explore water and its properties with your students. Very simple descriptions of the water properties involved are included, but if you want to know more before leading these experiments feel free to get in touch with us at the Aquarium’s Teacher Resource Center by emailing trc@neaq.org or calling 617-973-6590.

**Displacement, Sinking, Floating**

Especially for very young learners, simply experimenting with what happens when you drop objects into water is a valuable science experiment.

**Ages/Skills required**
4 years old and younger

**Suggested Materials**
- A container
- Water
- Objects of different sizes and densities

**What to Do**
Collect a variety of objects, some that will sink and some that will float. Encourage students to predict what will happen and allow them to experiment at their own pace.

In addition to floating and sinking, students can observe what is known as displacement. This is when the water level in a container rises when an object is submerged. Larger objects will displace more water because the volume of the object will be equal to the volume of water that is displaced. You can actually measure the volume of any object that will sink using this process (this is science that you can include for older students if you want, around the age of 9 they’ll begin to be ready to understand the concept of volume and how displacement can measure it).

Whether an object sinks or floats is related to a number of properties but one of the most important factors is the object’s density. Density is how much an object weighs compared to how big it is. If two objects are roughly the same size but one is heavier, the heavier object is denser and will be more likely to sink in water.

**Extensions**
Challenge students to experiment and construct an object that “flinks,” or hovers in the water neither floating nor sinking completely. Sealable containers like film canisters filled with objects like pennies or water work very well for this. Experiment with various crafting materials like clay, toothpicks, Styrofoam, tin foil, or straws.

**Oil and Water**

**Suggested Materials**
- Container
- Water
- Vegetable oil
- Water or food coloring

**What to Do**
Take a close look at how oil and water don’t mix! Allow students to experiment with this by coloring water and adding some oil to a sealable clear container like a glass jar. What happens when you shake the container vigorously? What happens over time?

Because molecules of water stick to other water molecules better than they stick to oil (and vice versa), they will not mix. Oil is a bit less dense than water and so it floats on top.
**Surface Tension**

Surface tension is created by what is known as cohesion. Water molecules stick to each other and so the surface of water can support a small amount of weight. Have you ever noticed insects walking on the surface of water? They can do this because the molecules that are stuck together are supporting them!

**Suggested Materials**

- Pennies
- Water
- Eye droppers
- Plastic or glass containers
- Paper clips

**What to Do**

Here are several suggestions for experimenting with cohesion, or surface tension:

**Penny Drops:**

Give each student or group a penny and an eye dropper as well as a small amount of water. Instruct them to carefully drop one drop of water at a time onto the surface of the penny. You will notice that the water will build up into a little dome rather than running right off the penny. Challenge students to see how many drops they can fit onto a single penny!

**Overfilled Glass:**

Similar to the penny drops, give students a nearly full glass of water. Instruct them to carefully add very small amounts of water at a time. As the glass nears being full, encourage them to continue even though they may think it will spill. You will observe the same thing as the penny; the water will actually form a small dome over the top of the glass as the surface tension holds it together over the top.

**Floating a Paperclip:**

Take a paperclip and place a small piece of paper towel under it. Holding the paper towel by the corners, carefully place both into a container of water. The paper towel should begin sinking as it absorbs water. If it is stuck to the surface gently poke it with a pencil and it should sink, leaving the paper clip floating on the surface. The same paperclip will sink if you drop it onto the surface. This, again, is due to the surface tension. Try placing a drop of soap onto the surface while the paperclip is sinking. This will break the surface tension and the paperclip will sink!

**Evaporation**

Water is always moving. Evaporation is the process of water molecules leaving the surface and becoming water vapor, which is water as a gas.

**Suggested Materials**

- Water
- Plate or other shallow container

**What to Do**

Experiment with how long it takes different amounts or different depths of water to evaporate simply by leaving some out in the classroom. Temperature and humidity of the space will also change how long it takes for the water to evaporate. What other factors do your students want to test out?
**Refraction**

Refraction is the process of light changing speeds as it goes from air to water or from water to air. This is what causes a straw to look broken when it is in a glass of water.

**Suggested Materials**
A clear container, pencil or straw, and a light source (a window on a sunny day will work well)

**What to Do**
Put the straw or pencil into a clear glass or container and have students observe. Students may have noticed this in a pool before.

Refraction can also create a rainbow! Put the clear container with water in it near a light source like a window on a bright sunny day. As light passes through the glass, you may see a rainbow forming on the surface it is resting on. This is because the different colors of light go in slightly different directions as they are refracted through the water.

**Making Huge Bubbles**

Not only are bubbles super fun, especially in the summer, they’re also a fascinating opportunity for science! Bubbles form because the ingredients in the mixture decrease the surface tension allowing the water molecules to form a sheet that stretches out into a bubble.

**Suggested Materials**
- Bubble mixture: 6 cups water, 0.5 cup dish detergent, 0.5 cup cornstarch, 1 tbsp baking powder, 1 tbsp glycerin
- Bubble tool: string or twine, straws, other bubble wands optional

**What to Do**
Have students experiment with making their own bubble making tools and challenge them to make the biggest bubbles they can.

**To make the bubble mixture:**
Dissolve the cornstarch into the water first, mixing well. Then slowly stir in the remaining ingredients.

**To make the tool:**
Run a length of string or twine through two straws and then tie the length together, leaving a couple inches of exposed string looped between the straws. The straws provide handles and some structure for the bubble tool. Dip the tool into your mixture and slowly drag through the air to make a giant bubble!
Introduction to Time Fillers and Field Games

The games and activities in this section are designed for times when you need something fun to do during a transition time or while waiting for students to assemble for a more structured project. Most of these activities are movement-based and many may look familiar. We have tried to include ideas about how you can tweak them with ocean-themed concepts if you are trying to reinforce other activities in this toolkit or if you’re running an ocean theme week.

**Tidal Wave**  
(ages 6 and older)

Set chairs in a wide circle, there should be one less chair than people. The group leader counts everyone off naming them orca, shark, seahorse, oyster, and barracuda. You can choose other animals instead, just make sure there are at least two people per name. One person is it and will stand in the middle of the circle while the rest of the players take a seat at the seats in the circle. It will call one of the animals, for instance orca, and all the orcas have to jump up and find a new, now vacant seat in the circle. It will also try to sit in a vacant seat. Whoever ends up without a chair is now it. If they call out Tidal Wave then everyone needs to jump up and find a new seat.

**Animal Charades**  
(ages 6 and older)

Pick someone who wants to act out an animal. You can decide in the beginning if they can use sounds. The child who guesses the correct animal will get a chance to act out an animal.

**All Aboard**  
(ages 9 and older)

Create a 2-foot-by-2-foot space using a piece of cardboard, wood, or just marking off an area on the floor with tape. Challenge all your participants to get on/in at the same time. You can modify the size of the area depending on the size of your group. To give it an ocean theme, you can have the board become a raft that the participants have to stay on for a certain amount of time (something less than 30 seconds is generally a good enough challenge).

**Bag Toss**

The facilitator should have a supply of 5 to 10 beanbags or stuffed animals or other soft objects that can be tossed and caught by the participants. Stand in a circle and say the name of one of the participants, throwing a beanbag to them. They repeat this, throwing the beanbag while saying the name of another participant. Each participant should receive the beanbag once and then have the bag return to the facilitator. Once you have established a pattern, start another beanbag around the circle and then add new ones periodically. You can make it easy or more challenging by adding beanbags in quick succession. Challenge the group in other ways like going backwards, adding in random objects (just make sure nothing too hard/heavy is getting thrown!), etc.

Another challenge that can map an ocean theme onto this activity is having participants say their name and an ocean animal that begins with the same letter as their name around the circle. Challenge participants to think of an animal that no one else has said so that everyone has a unique animal. Now, instead of using names, use the chosen animals.

**Amoeba Tag**

Two people are it. They hold hands and try to tag other participants. Any person they catch joins the chain by linking hands. When another person is caught they can stay together or split into two and two, but they must split even numbers and can link together at will. This game is played until everyone is part of a group of at least two.
**Shark and Minnows**

Everyone begins the game as a fish and stands on one side of the playing field.

One person is chosen to be a shark; they will stand in the middle of the playing field. Play begins when the shark calls out, “Fishy, fishy, swim in my ocean!”

All players must run across the playing field trying to get to the other side without getting tagged by the shark. Anyone who is tagged must sit down where they are tagged. They now become the shark’s helpers/seaweed.

When the shark calls out “Fishy, fishy, swim in my ocean!” again, the players will try to run back to the other side. Anyone who runs within arm’s reach of the sitting players and gets tagged must sit down. The game continues until there is only one person left.

**Steal the Bacon**

Split the group evenly into two groups and sit them with their backs turned towards the center line, approximately 20 feet apart.

Assign numbers to each player on both sides from one to the final person. At the end, each team will have a number 1, 2, etc.

In the center place a ball, bandana, or other toy or object students can easily grab off the ground. When you call out a number, the goal is to be the first to reach the ball, and bring it back to your side without being tagged by the other person. If you make it back safely, your team scores a point, if you are tagged, the tagger gets a point for their team and the ball goes back in the middle, and a new number is called.

**Variations**

As the game goes on and the kids get smarter (try to wait for the other person to pick up the bacon so they can get the easy tag for the point, etc.) try to mix it up a little.

Call out a second and sometimes third number to get a few more kids out there to cause distractions.

You can also play it on a sand volleyball court and use a bacon that you can bury. Have the kids with their backs to the center so they can’t see where we put the bacon.

To make this more ocean-themed students can pretend to be lobsters, sharks, orcas, or some other ocean predator and the bacon is a prey item. Alternatively, just changing the name to steal the clam or steal the quahog gives you a little ocean content. One last idea is, instead of giving students numbers, assign each student an animal name (you still want to give both teams the same names) so instead of calling out numbers you call, “Periwinkles and crabs!” or “Urchins!” to steal the bacon.

**Perpetual Tag**

Everyone is it. If someone is tagged they kneel or sit down. (If two people tag each other at the same time they play rocks, paper, scissors to see who is the tagger.) People that are kneeling can be untagged and rejoin the game.

To give this an ocean theme, you could call it Plankton Tag. Plankton are the mostly tiny animals and plant-like creatures that float through ocean currents. While they are often food for bigger things, many plankton also eat each other. Students can pretend to be plankton floating in the current in this version of tag. If you want to learn more about plankton or plan a lesson about them, reach out to the Aquarium’s Teacher Resource Center by calling 617-973-6590 or emailing trc@neaq.org!
What to Do
Introduce each animal and the movement that goes with it to the students:
1. Heron: stand on one leg
2. Mud snail: antennae's out, pull in if another student gets close (or the instructor becomes a crab and students can pull antennae in when they get close)
3. Crab: crouch, claws out
4. Mussels: stick to the floor, fingers not quite touching
5. Fish: swim like a fish
6. Jelly: pulse like a jelly

Once students know what movement goes with each animal, you can hold up the pictures one at a time and have everyone do the corresponding movement.

If you don’t want to use all of the images, feel free to cut some number of them.
Activities and Games

Coastal Movement Activity
Activities and Games
Coastal Movement Activity
Coastal Movement Activity
Activities and Games
Coastal Movement Activity
Activities and Games

Coastal Movement Activity
**Group Size**
Best with two players

**Suggested Materials**
- Paper
- One marker, colored pencil, or crayon of a different color for each player

**What to Do**
1. Each player chooses a different color pencil or marker.
2. Each player thinks of an animal, but keeps it secret from the other player.
   - Both/all players will work on the same drawing, adding features of their chosen animal.
   - The object of the game is to guess the other player’s animal.
3. Decide which player goes first.
4. Each turn is a single stroke (no picking up your pencil/marker!)
5. After each stroke you guess what the other player’s animal is.
6. Once you guess what the other player’s animal is that player stops drawing.
7. The other player continues to draw until the other player guesses.
8. Then you name your animal! (Example: If one player was drawing a dolphin and the other was drawing a lobster you could name it a “dolphster.”)
Tidepool Hop

Suggested Materials
• Large tidepools to spread across the floor made from a material that will not slip. Blue “rug gripper” works great. You will need a number of tidepools equal or greater than the number of students.
• Optional: music you can start and stop, like musical chairs. You will be using your voice to give cues, but music can add to the fun!

What to Do
1. Explain to the students that during high tide, many different animals can be found swimming and moving all over the area. But as the tide goes out they begin to find low spots where the water will remain until the water level rises again.
2. Students will now become tidepool animals. They can be whatever they would like to be and decide how they will move through the area. But they have to be careful and remember to find a tidepool (show them the blue spots) when the tide goes out. They will know when the tide goes out because you will shout “Low Tide!” More than one child can be in the same tidepool and they have to at least have one part of their body touching the spot.
3. Once everyone is in their tidepool, one or more tidepools may dry up in the hot sun so you should take away some of the blue spots. If there are children on these spots they need to quickly find their way to another.
4. Once you shout “High Tide,” they can begin to move around again until you say “Low Tide” again.
5. In the end you will have one tidepool remaining. For younger children, plan on leaving a bigger one but challenge older children by leaving the smallest tidepool behind.

Extensions
If you find that students are hovering around tidepools in anticipation of low tide, you should add another element to the game. When you shout “Tidal Wave,” all the children have to move from one end of the space to another like they’ve been pushed by a huge wave. This may add a new level of chaos so you may need to instruct on how the wave pushes them, but it might also help in shaking things up a bit—especially if a wave comes right before low tide.

The facilitator may also choose to be a predator and chase the tidepool animals away from the tidepools. This is another way to get the children to move around during high tide and not hover by the tidepools.
The following pages are designed to be used as time-filling activities, for students who have finished another activity or as a choice if students are able to choose different activities to do. These pages are meant to be a substitute to just coloring. Coloring is relaxing and certainly an appropriate activity for after-school. These pages just add a little more to the coloring experience, engaging students’ brains in a way that reinforces learning done during the school day. These activity pages are particularly designed to help students strengthen observation, basic literacy skills, and basic math skills. If students are not following the written directions and simply coloring just gently point out what to do once or twice. But if some students just want to color, that’s perfectly fine!
Color the big one, circle the small one.
How Many Arms?

1

How Many Legs?

1 2

1 2
Tidepool Word Search

BARNACLE
CRAB
LOBSTER
SHELL
ANTENNA
SNAIL
TIDEPOOL
URCHIN
MUSSEL
OYSTER
SEASTAR
SEAWEED
# Tidepool Patterns

<table>
<thead>
<tr>
<th>Horseshoe Crab</th>
<th>Clam</th>
<th>Crab</th>
<th>Sea Star</th>
</tr>
</thead>
</table>

Look at the pattern in each row. Draw what comes next.

<table>
<thead>
<tr>
<th>Clam</th>
<th>Horseshoe Crab</th>
<th>Clam</th>
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<table>
<thead>
<tr>
<th>Crab</th>
<th>Sea Star</th>
<th>Clam</th>
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<table>
<thead>
<tr>
<th>Sea Star</th>
<th>Clam</th>
<th>Horseshoe Crab</th>
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Make your own pattern:
What will I look like when I grow up?

Draw a line from the babies on the left to their adult match on the right.

**Answer Key:**
- A = Sunfish
- B = Crab
- C = Swell Shark
- D = Cod
Number five animals that are over the seafloor and five animals that are under.