WRAP-UP

To wrap-up the investigation, bring your students together for a group discussion to help them understand why and how they achieved their results. It is important to share results so that everyone has a clear picture of what happened. To help you facilitate the discussion, review the explanation in "The Why and The How" using the Group Discussion questions as a guide.

GROUP DISCUSSION
Explain to students that scientists learn from each other through discussion, and they build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their experiments, students will now come together as a group to share their results and make conclusions about the investigations they've conducted. Have students record their final results and the explanation in their journals. Ask students:

- What were the results from each group for the salt wedge investigation? Are there any differences? What might explain these differences?

Answer: how fast each student poured the water, the angle of the baking dish, etc.

- Do you think this was a good model of a salt-wedge estuary? What objects could be added to this model?
- What were the results from the freshwater plant investigation?
- What did you learn about water from this investigation?

The "Why" and The "How"
Stratification occurs when waters of different densities form layers in an estuary. Density is how much material is packed into a certain amount of space. Seawater has high amounts of salt, making it denser than freshwater, so it sinks below freshwater in an estuary. There is very little salt in freshwater lakes, rivers and streams. Freshwater and saltwater can mix in an estuary, forming a layer of brackish water.

Salt wedge estuaries occur when the mouth of a river flows directly into seawater. When this happens, freshwater from the rivers pushes against the saltwater flowing in from the ocean, resulting in wedge-shaped layers of water of different salinities. In the salt wedge model, the denser layer of saltwater flows below the less dense layer of freshwater. The Hudson River is an example of a salt wedge estuary.

Plants and animals are affected by changing salinity levels in their habitats. Each estuarine plant and animal must adjust to changes in salinity or they may not survive. When aquatic organisms are not able to control the amount of salt in their bodies, they become vulnerable to predators, competition from other species, sickness and death. Exposure to saltwater can cause freshwater organisms to become dehydrated (lose water from their cells), a process called plasmolysis. Freshwater plants such as Elodea are not salt-tolerant and cannot grow in saltwater environments.

aerial photo of saltwater intrusion into freshwater

Curriculum Match-Up

- Repeat the salt wedge experiment using smaller amounts of salt. What is the smallest amount of salt that will form a wedge?
- List some of the ways that humans rely on estuaries.
- Research and compare plants from saltwater and freshwater environments. How are they similar? Different? Cut open the stems and leaves of the plants and examine them using a microscope or magnifying lens.
- Research estuarine organisms. Write a "name poem" using the names of plants and animals that live in the estuary. Each letter of an organism's name serves as the first letter for each line of the poem. For example, C - R - A - B:
  Can walk sideways
  Really small
  Algae it eats
  Bottom dweller

References:
http://oceanservice.noaa.gov/education/kits/estuaries/media/
http://www.bbep.org/
http://www.delawareestuary.org/
http://www.ozestuaries.org/indicators/salinity.jsp
http://omp.gso.uri.edu/doee/science/descript/saltwedg.htm
http://www.saltwedge.org/
http://www.estuaries.gov/welcome.html
http://www.noaa.gov
Wikipedia Commons

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Estuaries

Learning Objectives

Students will:

1. Explain what an estuary is and its important role in the environment.
2. Build a model of a salt wedge estuary.
3. Examine how salinity affects aquatic plants.

Vocabulary Ventures

aquatic
brackish
current
ecologist
estuary
freshwater
marine
plasmolysis
salinity
salt-tolerant
salt wedge
saltwater
stratification

An estuary is a body of water that is created when freshwater from rivers and streams flows into the saltwater of an ocean. Estuaries are partially surrounded by land. They provide shelter to unique plants and animals that have adjusted to waters that are ***brackish*** – a mixture of **freshwater** draining from land and rivers and **saltwater** from the ocean.

Hudson River Estuary

Estuaries vary in their levels of **salinity** – the amount of dissolved salts. Areas of an estuary closest to its freshwater source generally have a lower concentration of salt, while waters nearest the ocean have a much higher concentration of salt. The salinity of estuaries changes depending on the seasonal climate, wind and water currents. Salinity levels are highest in estuaries during the summer months when there is less rainfall. During the winter and spring months, salinity levels are lower because there is more freshwater draining into the estuary diluting the amount of salt in the water.

Ecologists and other scientists study estuaries for a number of reasons. Estuaries provide habitats, or homes, for very diverse wildlife and have unique water movements called **currents** and **tides**. Tides create ocean currents that move saltwater in and out of the estuary, mixing freshwater and seawater. Scientists identify the different types of estuaries based on how their water circulates, or moves, and the way the layers of salt and freshwater are formed. As water moves in an estuary, it carries tiny organisms, circulates nutrients and oxygen, and transports sediment and waste. Plants and animals that are able to grow in salt-rich habitats such as estuaries are called **salt-tolerant.** These organisms have adapted to saltwater environments.

Estuaries in the New York/ New Jersey region include the Hudson River Estuary, Barnegat Bay (Little Egg Harbor Estuary) and the Delaware Estuary.

Time Needed to Conduct Investigation
This investigation has three parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 25 minutes
Student journaling/group reflection: 10 - 15 minutes
5 minutes each day afterwards for 7 – 14 days
Total estimated time: 50 - 55 minutes

Investigation: Exploring Estuaries

Materials

For groups of three
Student journals and writing tools

Part 1
- 9 oz clear cup
- Measuring spoons
- Kosher salt or sea salt, 2 tablespoons
- Magnifying lens or microscope
- Microscope slide or clear plate
- Plastic stirrer or spoon
- ½ liter bottle of water
- Eyedropper or medicine dropper

Part 2
- Large clear plastic tub or Pyrex baking dish, (9 x 13)
- Ruler
- Tap water, 1 liter (room temperature)
- ½ liter bottle of saltwater solution (½ liter of water & 6 tablespoons of salt)
- Food coloring (blue, red or green)
- Paper cup, 3 oz or 5 oz
- Small marbles, stones or pebbles
- Pencil or pen with a pointed tip or other object with a sharp point
- Book or wooden block, at least 1-inch in width

Part 3
- Salt
- Four Elodea or other freshwater plant or fresh celery (all cut the same length)
- Magnifying lens
- Ruler (cm)
- Four 1000 mL graduated cylinders or 1-liter clear plastic bottles
- Four Test tubes or small jars
- Permanent marker
- Masking Tape
- Dechlorinated tap or spring water
- Measuring spoons

TIP
De-chlorinate the water by letting it sit in an open container for 24 hours to allow the chemicals to evaporate.

Part 1
Salt and Water

GET READY!
Tell students they will dissolve salt crystals in water to observe their effects on water. Remind students to use the journal to document their predictions, observations and findings.

OBSERVE
Invite students to take a pinch of salt and examine it using the magnifying lens or microscope. Have students share the following observations with their partners or groups:
- How would you describe what you see?
- Sketch your observations in your student journal.

PROCEDURE
1. Have students fill the cup with 100mL (about 3 ½ oz) of water.
2. Next, have them pour 1 tablespoon of salt into the cup and stir the solution until all of the salt dissolves.
3. Using the eyedropper, have students place one drop of the saltwater solution on a microscope slide or onto the clear plate.
4. Invite students to use their magnifying lenses or microscopes to examine a drop of the saltwater solution on the microscope slide.

Ask students to share their observations of the saltwater solution:
- How would you describe what you see?
- What happened to the salt when you mixed it into the water?

Part 2
Making a Salt Wedge

Tell students they will now make their own model of a salt wedge estuary. Salt wedge estuaries occur when the mouth of a river flows directly into seawater.

PROCEDURE
1. Have students place a small wooden block or book securely under one end of the baking dish, raising it approximately one inch from the table.
2. Next, have students make several tiny holes in the bottom of the cup using the tip of a pencil or a pair of pointed-tip scissors.
3. Drop marbles, small stones or pebbles into the cup and place the cup into the lower end of the baking dish.
4. Now, have students pour a liter of the room temperature tap water into the pan until it is about ½ inch from the top of the pan.
5. Allow the water to settle.
6. Have students add several drops of food coloring to the ½ liter saltwater solution, making it a dark color.

PREDICT
Tell students they will now add the saltwater solution to the tap water. Ask students to make a prediction about what will happen and record the prediction in their journals. Ask students:
- What do you think will happen when you pour the saltwater solution into the freshwater?

OBSERVE
Next, have students slowly pour the saltwater solution into the cup of marbles, being careful not to overfill the cup. Ask students to make observations as the water settles in the baking dish. Have students get at the table level and look at the pan from the side.
- What do you observe happening?
- Diagram what you see in your journal.
- Was your prediction correct? Why or why not?
- How do you think this activity relates to estuaries?

Answer: As river water flows into seawater, it pushes against the denser saltwater, creating wedge-shaped layers of water.

salt wedge set-up

Part 3
Plant Dehydration

Ask students what it means to be "salt-tolerant". Salt-tolerant organisms can live in habitats with high levels of salts. These organisms have special adaptations or abilities that enable them to absorb water from soils and marine water. Invite students to hypothesize why some organisms are salt-tolerant while others are not. Tell students they will investigate the effects of saltwater on freshwater plants.

TIP
Trim the plants from the top if they are not equal in length.

PROCEDURE
First, students should make their saltwater solutions:
1. Ask students to fill each graduated cylinder or soda bottle with 1000 mL (about 4 cups) of water and label the containers "1 Tbsp", "2 Tbsp", "3 Tbsp", and "no salt" using the masking tape and marker.
2. Have students measure 1 tablespoon of salt and pour the salt into container #1.
3. Next, students should measure 2 tablespoons of salt and pour the salt into container #2.
4. Students should measure 3 tablespoons of salt and pour the salt into container #3.
   NOTE: No salt will be added to container #4.
5. Have students use a long-handled spoon or stirrer to dissolve the salt in each container of water.

OBSERVE
Have students examine the freshwater plants and share the following observations:
- What is the color of the plants? The texture? Shape?
- What other characteristics describe the plants?
- Do these plants appear to be healthy? Why do you think so?

PREDICT
Invite students to predict what will happen when freshwater plants are added to saltwater. Have them document their predictions in their journals.

Have students place one plant into each of the containers labeled #1, #2, #3 and #4.
Ask students:
- Why is there one container with no salt?
- Why is it important to have this control in an experiment?

Answer: To ensure that we're only measuring changes caused by the amount of salt added to the water.

Students should observe the plants over the next several days and document their observations in the chart in their student journals. Place the plants in an area where they will not be disturbed. Do not place plants directly on or near a heat source.