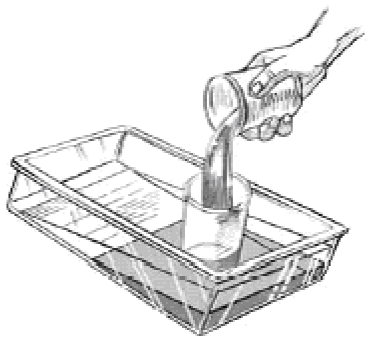
Grade 8 Activity

The Edge of the Wedge



Fresh water out, salt water in – the turn of the tides in coastal estuaries makes for a mixing adventure.

Concepts

- In tidal estuaries, fresh water behaves differently from salt water due to differences in density of the waters.
- This difference in density is the engine that drives tidal wedges.

Objectives

Students will:

- Demonstrate why fresh water will stay at the surface while salt water will travel up a river along the bottom in a wedge because of density differences.
- Describe the characteristics of water in an estuary, from salty ocean water, to brackish, to fresh water.

Duration

One-half to one hour.

Method

Students experiment with a hands-on model and complete a worksheet, followed by a whole class discussion.

California Science Content Standards

8. Density and Buoyancy

All objects observe a buoyant force when immersed in a fluid. As a basis for understanding this concept:

8.a. Students know density is mass per unit volume.

8.d. Students know how to predict whether an object will float or sink.

Background

An estuary is a semi enclosed part of the ocean where fresh water from land mixes with seawater. Historically, because of ease of transport by water, cities have been located on rivers and estuaries; seven of the ten largest U.S. cities are on large estuaries. San Francisco Bay is one of the smaller major estuaries at 1,190 square kilometers (459 square miles). The Chesapeake Bay system is the largest in the U.S. covering over 12,000 square kilometers (4,633 square miles). Estuaries are rich in nutrients that support large phytoplankton populations, which in turn provide food for zooplankton, fish, benthic organisms, and birds. Estuaries play a major role in the productivity of the coastal ocean, serving as home, nursery, and breeding ground for many species.

Estuaries act as a two-way street for water movement, where fresh water flows from the river into the estuary and spreads out as a layer over the denser salt water, while the salt water comes in with the tides. Fresh water moves generally seaward in the surface layer, and the two layers are separated by a horizontal pycnocline zone, which is a zone where water density changes noticeably with increasing depth as a result of changes in either salinity or temperature: low density surface water cannot readily move downward through the pycnocline zone. Friction occurs between the seaward-moving surface layer of fresh water and the salt water below it, causing currents that drag salt water from below and incorporate it into the surface layer. Because of the upward movement of salt water into the surface layer, the salinity of the surface layer increases in a seaward direction. The subsurface salt water in an estuary forms a wedge with its thin end pointed upstream. This is an idealized version – depending on the flow of the river and the time of the year, an estuary may be only moderately stratified. In general, the greater the flow of the river, the greater the degree of stratification, such as the lower Mississippi River or the Columbia River during flood stages.

Activity

1. Earlier in the day, prepare or have students prepare a salt water solution: add 35 grams of sea salt (regular salt has additives) to one liter of warm water, or approximately 1.2 ounces (2 scant tablespoons) of salt to 1 quart of warm water. Mix thoroughly until all salt is dissolved. Tint the salt water with food coloring (red makes a dramatic statement). Allow water to come to room temperature. To make a brackish mixture, halve the amount of salt (however, the zonation will not be quite as dramatic).

2. Divide class into groups of three or four to a model. Hand out worksheets and model materials to students. Go over the worksheets and answer questions. Be sure they understand the experimental procedure before they begin.

Materials

Photocopy of "Edge of the Wedge Lab" worksheet, one for each student.

For each group of 3-4 students:

1. Large, clear waterproof box or deep pan, such as a 9" x 13" baking dish
2. Tap water
3. One quart room temperature salt water (see activity description for directions on how to prepare; sea salt and food coloring are needed)
4. White paper
5. Paper cup
6. Small stones or pebbles

Preparation

Collect materials, photocopy worksheet, prepare area for a possibly wet model (not necessarily, but spills may occur), mix salt water.

Results and Reflection

1. In a whole class discussion, students share their hypotheses, observations, and conclusions with the class.

2. Conduct a whole class discussion on tidal wedges and density differences in salt water and fresh water.

Conclusions

Density differences between salt water and fresh water create stratification within the water column.

Extensions and Applications

1. How would tides influence the tidal wedge process?
2. Would the tidal influence be stronger in a fast flowing or slow flowing river?
3. Students may conduct research on a large California river that enters into the ocean. Does it have a strong tidal wedge? What types of organisms live there, and how have they adapted to the changing salinities? Have the dynamics changed over the years? What has contributed to the changes?

Additional Resources

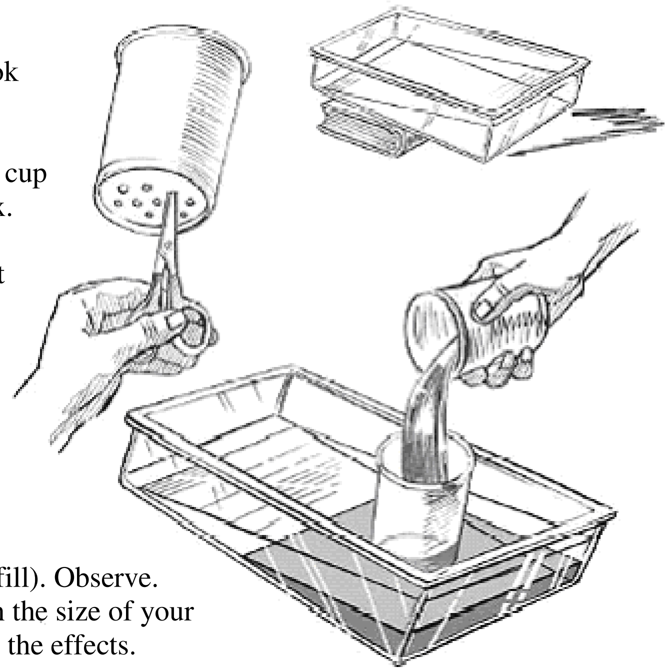
Estuary: www.darter.ocps.net/classrom/klenk/Estuary

National Audubon Society Guide to Marine Mammals of the World. Knopf, 2002. ISBN: 0375411410

Exploring Habitat Series (8 titles) Coastal Habitats. Gareth Stevens Audio, 2002. ISBN: 0836872525

America's Wetland: Louisiana's Vanishing Coast Louisiana State University Press, 2005. ISBN: 0807131156

Edge of the Wedge Lab



A. Make the salt water wedge model

1. Place one end of the clear box or pan on a small block or book about 1 inch high.

2. Make several tiny holes in the bottom of the cup. Weight the cup with small stones and place at the lower (deeper) end of the box.

3. Pour room temperature tap water into the box until it is about ½ inch from the top of the pan. Wait for about 3 minutes to allow the water to settle.

4. While waiting for the water to settle, take a moment to write a hypothesis about what will happen when you add the colored salt water to the cup.

5. Taking turns in your group, slowly and gently pour the room temperature salt eater into the cup a little at a time (do not overfill). Observe. You do not need to use the entire quart of water – depending on the size of your pan only half may work. Only use enough to be able to observe the effects.

6. After you have added the salt water, get down low and look at the pan from the side (instead of from the top). Draw a diagram of what you see. Next, write down a description of what you observe, and conclude why it is happening. Think about what the model represents and where this phenomenon would occur in nature.

B. Experimental Process

1. **Hypothesis:** What will happen when you add the salt water to the cup in the model?

2. **Method:** Describe only **how** you added the salt water to the cup in the model. Include any possible variables (e.g., the rate at which you poured in the water, the angle of the pan, etc.)

3. **Results:** Describe only **what you observed** in the model when you added the salt water to the cup. On the back of this page, draw a diagram to help explain what you saw. Do not write about your hypothesis here; save your ideas for the analysis.

4. **Analysis:** Using as few words as possible, **explain your results**. Is your hypothesis supported or not supported by your observed results?

5. **Discussion:** Here is the chance to be more creative. Discuss what you would do differently next time you conduct this experiment. Do you think this was a good model? How could the model be improved? How could the model better show what happens in nature? Use the back of the page for your answer.