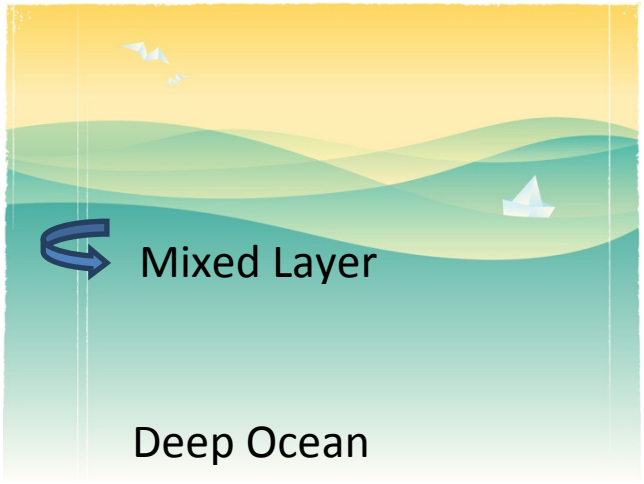
Teacher Edition

Density and Stratification

Grade:
Grades 6-8

Delaware State Science Standard:
Science Standard 2 - Materials and Their Properties
Strand: Mixtures and Solutions

Approximate Time Required to Complete the Project: less than 1 hour



Background Information: The temperature and salinity of water affects its density and the way it interacts with other water masses. Water with lower salinity or higher temperature is less dense and will float on top of water with high salinity or lower temperature. The layered water is "stratified" and the interface between layers may act as a barrier to prevent organisms from traveling between layers. Stratification also acts to prevent mixing between layers, resulting in a surface layer that is typically well mixed while the bottom layer is more resistant to mixing. In this experiment, you will examine the interaction between cold salt water (high salinity, low temperature) and warm fresh water (low salinity, high temperature).

Preparation:

If you have access to an aquarium, you may want to do this project as a demonstration. (Alternatively, if you do not have aquaria, see the 1st youtube.com video below for other ways to do this project.) For this project, you will need to prepare a 2-liter soda bottle with a small hole in the bottom (about the size of a pencil eraser.) Prepare the cold salt water ahead of time and keep in the refrigerator until use.

Fun facts:

- *Seawater contains about 35 g of salt per 1000 g of water. If the water from all of the oceans was evaporated, the salt would be enough to cover all of the continents to a depth of 1.5 meters.*
- *Organisms living in water tend to maintain the same salinity within their bodies as in the surrounding water. If you put a saltwater fish into freshwater, they will die and visa versa. Species that live in estuaries, and are exposed to both fresh*

and salt water, are better able to tolerate changes in salinity, or move up and down in the water column to stay within a narrow salinity range.

Materials and Equipment:

- Glass/plastic tank(s) or tub with clear sides
- Empty 2-liter bottle (e.g. soda / pop bottle) with small hole cut in bottom
- Cold, saturated salt water
- Very warm, fresh water
- Food coloring
- Duct tape
- Ruler (optional)
- Colored pencils

Methods:

1. Add warm fresh water to the tank to form a layer 8-10 cm (3-4 in) thick. Add some red food coloring to the water and mix thoroughly.
2. Add some food coloring (blue preferred) to the cold salt water. Cover the hole in the bottom of the soda bottle with duct tape and fill the bottle with the blue water. Place the bottle upright into the tank. Remove the duct tape from the hole at the bottom, allowing the salty water to slowly enter the bottom of the tank until a second layer 3-4 inches thick appears. Make sure the bottle cap is off of the bottle.
3. When you have added the salt water remove the bottle very slowly to minimize mixing. Let the tank sit without touching it for two minutes to stabilize. Avoid knocking the table to prevent mixing the layers.
4. Slowly lift one end of the tank until the water level almost reaches the top of the tank. Support the end of the tank with books.
5. Slowly and carefully set down the tank. Look closely at the waves between the fresh and salty water.
6. Let the tank settle until the water has formed layers again. With your hand, brush the surface layer of water in one direction (away from the edge of the tank) continuously for about 1 minute and skim water from the surface using a plastic cup.

Analysis:

The water forms layers because the densities between the water masses are different due to temperature and salinity. Density is a function of mass (or weight):

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

The same way that disturbed sediment will form layers based on weight (for example, larger sand particles will form the bottom layer), water masses will form layers based on weight. The temperature and amount of salt in water determines its density. Cold, salty

water has more mass per volume, therefore greater density, and will sink to the bottom. These dynamics are important, for example:

1. In estuaries, fresh water from rivers and creeks meets salt water from the ocean. The fresh water tends to float above the salt water until it is mixed by wind or water currents. The stratification of fresh water and salt water affects the way organisms and sediments are distributed.

2. Changes in water density in the ocean contribute to the formation of ocean currents that can impact weather patterns. As water becomes warmer, it is less salty and will rise to the surface. Cold salty water will then move in to fill the void left by the warm water. This movement creates a current, or "thermohaline" circulation, that moves a river of water throughout the world's oceans.

Questions:

1. Which layer is less dense?

   Warm, fresh water is less dense than cold, salt water and so it floats above it until mixing occurs.

2. Based on your observations, (a) how would you expect an influx of fresh water from a heavy rainstorm to affect life in a salt-water environment like the Delaware Estuary? (b) would you expect life at the bottom to be more or less affected by an influx of fresh water compared to life at the surface? (c) would it matter if the bottom was in a shallow area or in deep water? Why?

   a) *Fresh water would be harmful to many salt water species.*

   b) *Because fresh water floats on top of salt water, organisms at the bottom might not be affected.*

   c) *Shallow areas are more likely to be mixed and will be different than deep areas, where fresh water is less likely to affect life at the bottom.*

3. Repeat this experiment using less water and compare the results to your answer for part c in Question 2. How are the results similar or different to what you expected?

   Student answers will vary depending on how they answered the previous question. Answers should reflect a better understanding of the difference that water depth makes with stratification.

4. Would you expect to see organisms that can't tolerate both fresh and salt water a) in shallow areas? b) in deep areas? Why?

   a) *no, because they may be exposed to both fresh and salt water*

   b) *yes, because in very deep water, fresh water is less likely to reach the bottom.*

Extra Reading:
http://centerforoceansolutions.org/climate/impacts/ocean-warming/water-column-stratafi/
http://geography.about.com/od/physicalgeography/a/oceancurrents.htm
Online videos:
http://www.youtube.com/watch?v=4_TQCiOQkio&feature=related
http://www.youtube.com/watch?v=C5hTZSh1GtQ
http://www.youtube.com/watch?v=PCOL8kUtufg&feature=related