Currents-Their Causes and Effects

by

George Linzee

A current is defined as a large mass of continuously moving oceanic water (Greene, 1998). Surface ocean currents are mainly wind-driven and occur in all of the world's oceans. Examples of large surface currents that move across vast expanses of ocean are the Gulf Stream, the North Atlantic Current, the California Current, the Atlantic South Equatorial Current, and the Westwind Drift. Associated with surface currents are counter-surface and underlying currents. Surface ocean currents are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere due to the Coriolis effect. The Coriolis effect holds that because the Earth is spinning, surface waters move in a clockwise direction in the Northern Hemisphere and in a counterclockwise direction in the Southern Hemisphere. The currents eventually come into contact with the continents which deflect them, creating giant oceanic current circles known as gyres.

Vertical and ocean-bottom currents are mainly driven by density differences caused by changes in temperature and salinity. Originating in polar regions, cold, salty waters sink to the ocean bottom and move toward the opposite poles where they again surface. Vertical upwelling currents can also be caused by winds "blowing off" a coastline. The displaced waters are then replaced by underlying bottom waters. Currents are important to marine life as they help to move food and nutrients, making them available for photosynthesis, metabolic requirements and/or consumption.

OBJECTIVES:

Students will be able to:

1. Define ocean currents and understand overall surface circulation.

2. Show the relationship between global air circulation and oceanic currents.

3. Explain how certain coastal and divergent wind patterns can cause upwelling.

4. Demonstrate thermohaline and density currents and explain their importance to bottom-water currents.

MATERIALS:

* Rectangular Pyrex® baking dish

* Small fans or hair dryers which can dispense cool air

* Blue, yellow, and red food coloring

* Wind map

ACTIVITY:

1. Introduction: Open class discussion with the question, "Why do the oceans move?" Make sure the class knows that you are not referring to waves, but actual, massive "rivers" of water moving in definite directions. Give some examples of currents. Discuss the effects of winds on currents.

2. Wind on Water Demo: Set up the Pyrex® dish with water, add red and blue food coloring to opposite ends of the dish and start blowing both hair dryers in opposite directions on opposing sides of the tray. After a gyre has appeared, start this process again. Use new water and dye; this time blow the fans in the same direction on opposite sides and watch as two currents and a counter current occur.

3. Map Exercises: On a world map, have the students draw the prevailing wind currents with black, thin arrows and the related ocean currents with thick, blue or red arrows, depending on the temperature. Have students label the major currents and discuss the Coriolis effect and its effect in causing currents to bend somewhat from the wind currents. As the students work, stress continents have a more dramatic effect on ocean currents than on air currents, causing the five ocean gyres. Also, indicate the different characteristics of eastern and western boundary currents, the Ekman spiral, and geostrophic currents.

4. Homework Question: How can winds create a vertical up-welling current? Give an

example of where it happens and how it affects marine life.

5. Homework Answer: Ekman transport is formed when a northern wind parallels a western coast in the northern hemisphere (California) or a southern wind parallels a western coast in the southern hemisphere (Peru). Winds blowing parallel to the coast

cause movement of surface water away from the coast and lift bottom water toward the surface. This is known as upwelling. Upwelling brings ample nutrients to the surface which support a wide variety of marine life.

6. Density Current Demo: Perform the density current demonstration in the "Moving Water" activity (insert link here).

7. Demo follow-up: Perform the thermohaline circulation demonstration in the "Moving Water" activity (insert link here)..

8. Evaporation Density Currents: The Mediterranean is a good example of currents in which evaporation is rapid and causes the more dense saltier water to sink, thereby driving bottom water from the Mediterranean and drawing surface waters from the Atlantic.

9. Homework Problem: If a bottom current were moving around the world at 0.5 miles per hour, calculate an estimate as to how long it would take to complete the trip. Refer to a world map for the distance and remember distance equals rate divided by time.

POSSIBLE EXTENSION: Research interesting facts behind the Atlantic Gyre and other ocean currents including information on explorers, submarine incidents, and yacht races which relied on that current.

TEACHER EVALUATION:

1. Each student map and homework would be evaluated.

2. Questions:

- In the Northern Hemisphere, do the ocean current gyres go clockwise or counterclock wise? Why?
- How are the processes of both freezing and evaporation similar in the way they both make sea water more dense?
- Why is the coast off Peru one of the most productive fishing areas in the world?

REFERENCES:

Garrison, Tom. 1995. *Essentials of Oceanography*. Belmont, CA. Wadsworth Publishing

Company.

Greene, Thomas F. 1998. *Marine Science*. New York, NY, AMSCO School Publications, Inc.