

El Niño: A Current Case Study

Key Concepts

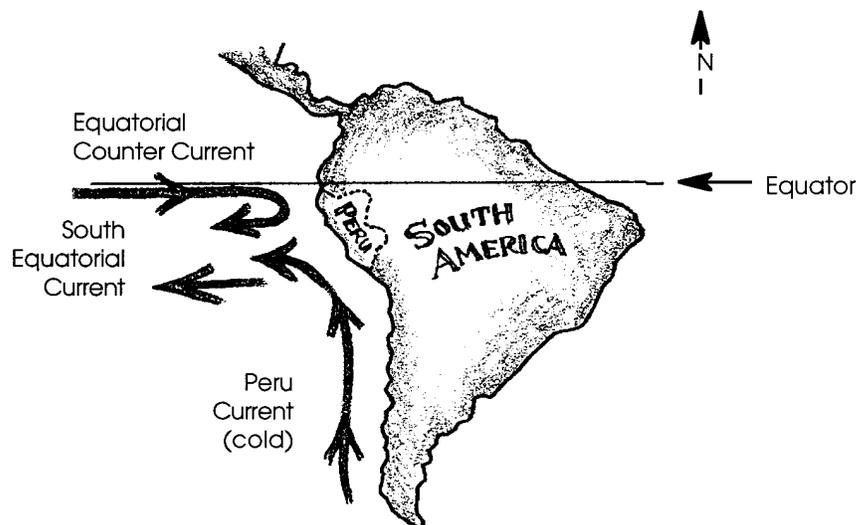
1. Currents are large-scale water movements in the sea.
2. Currents affect living organisms by influencing food supply, water temperature and weather patterns.



Background

Normal wind and current patterns in the Pacific Ocean create a flow of water near the equator that moves from the coast of the Americas toward the west. (See illustration, below). In the southern hemisphere, this current is called the South Equatorial Current. The winds that blow along this route are called the Trade Winds. (There is a North Equatorial Current in the northern hemisphere and it flows in the same direction: toward the west.) In a normal pattern, cold, nutrient-rich water from the Antarctic flows up along the coast of South America and is called the Peru current. The Peru current joins the South Equatorial Current near the equator and flows west across the Pacific.

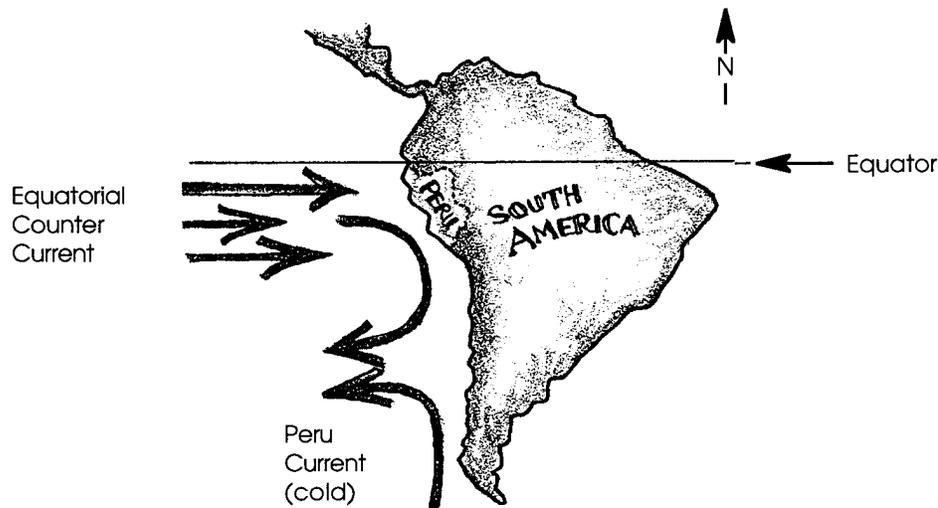
Normal Currents



Every few years this pattern of wind and currents changes. For some reason that is not well understood, the Trade Winds die down and become weak. The westward-flowing equatorial current slows and is pushed aside by

the equatorial counter-current running in the opposite direction. This means that lots of warm, nutrient-poor water moves east along the equator from the western Pacific. This warmer water reaches the coast of South America, pushing the Peru current further south.

El Niño Currents



Many organisms cannot tolerate warmer water. Plankton die from lack of nutrients in the warm water. Fish, such as anchovies, that feed on plankton, scatter to find food somewhere else. The food chain is disrupted by this change in ocean currents.

Because this event often happens during the Christmas season, the people of South America have named it “El Niño”, or “the child”. El Niño is devastating to the fishing industry of coastal countries such as Peru.

El Niño also affects weather patterns. Movements of large pools of warm water along the equator affect the atmosphere over the entire South Pacific. Warmer tropical waters bring rain. Rainfall that normally would drop on Southeast Asia and Australia is brought to the central Pacific and the coast of the Americas. These changes in weather patterns can be devastating, causing severe droughts in areas of Indonesia and Australia that depend on high annual rainfall for agriculture. Conversely, in the normally dry areas along the coast of the Americas severe flooding and storm damage can be the result of heavy rainfall.

Materials

For each student:

- “El Niño: A Current Case Study” activity pages

Teaching Hints

“El Niño: A Current Case Study” introduces your students to the effect of currents on global systems and human activities. Duplicate the activity pages. One set is recommended per student. “El Niño: A Current Case Study” is best performed by individual students as an in-class or homework assignment. You may elect to have your students meet in small groups to discuss their answers before you provide the answers to the text questions during a general class discussion. As always, use the approach that will work best with your particular class.

Key Words

current - large-scale movement of ocean waters

density - mass per unit volume of a substance. More dense seawater tends to sink, less dense seawater tends to rise in the ocean.

El Niño - weather related change in oceanic wind and current patterns

gyres - large circular ocean currents caused by wind and rotation of the earth

hydrometer - instrument used to measure density or specific gravity of a liquid

nutrients - essential minerals for life: similar to “vitamins”

salinity - measure of the quantity of dissolved salts in seawater

upwelling - process by which water rises from a lower depth: usually bringing nutrients with it

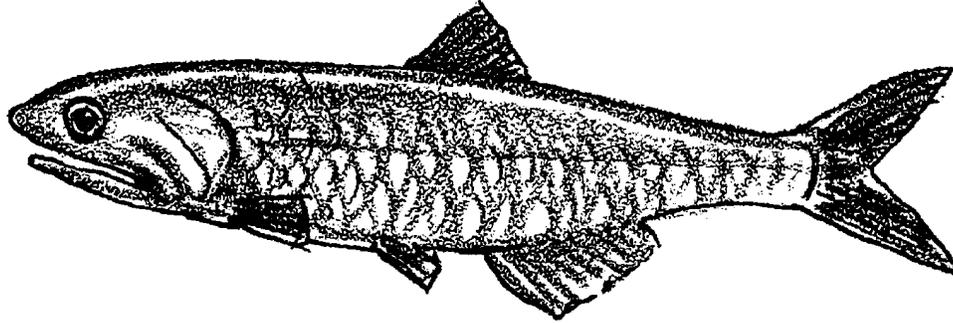
veer - a tendency to bend in one direction

Answer Key

1. El Niño is a weather-related change in ocean currents. El Niño brings more rain to the coasts of North and South America, while causing reduced rainfall in Australia and Southeast Asia.
2. El Niño causes a drastic drop in anchovy catches due to a decrease in upwelling of nutrient-rich deep ocean water. Less nutrient-rich water means less plankton. Less plankton means less food for fish that eat plankton like the anchovy.

3. The water in the Peru Current is very cold and rich in nutrients, while that in the Equatorial Counter Current is warm and nutrient-poor.
4. Three major industries dependent upon the Peru Current are:
 - a. fishing
 - b. fertilizer
 - c. tourism.
5. During El Niño, the Peru Current is pushed north/south. (The correct answer is underlined.)
6. One factor which helps cause the decrease in water density seen when El Niño arrives is the increase in surface water temperature. In “Heat It Up” your students were acquainted with the effect of temperature on water density.
7. The “Callao Painter” is caused by hydrogen sulfide gas released by the break-down of dead animals and plants.
8. The impact on each of the three industries impacted follows:
 - a. fishing - fish move farther from coast and fish catch drops
 - b. fertilizer - sea birds follow the fish, so fertilizer production stops
 - c. tourism - the smell of decaying organisms discourages tourists.
9. El Niño results in higher chicken prices because fishmeal made from Peruvian anchovies is used in chicken feed. A reduction in anchovies causes an increase in the price of chicken feed. The price increase is passed on from the farmer to the consumer and is reflected in higher prices for the chicken in your market.

El Niño: A Current Case Study



Anchovy

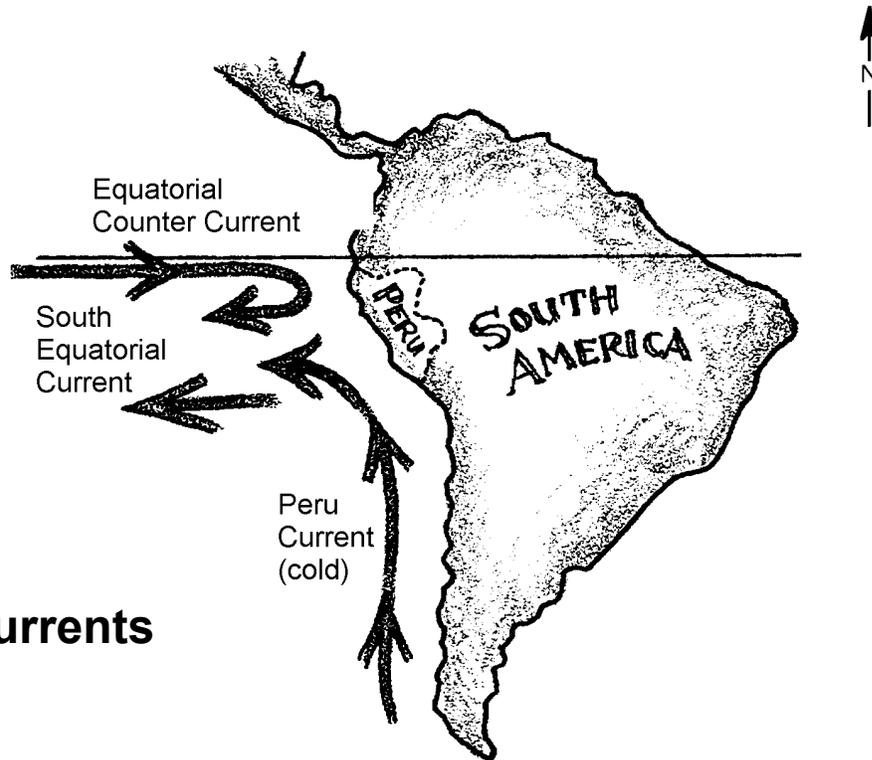
El Niño. They call it “The Child”, because it traditionally begins around Christmas time. But El Niño brings no joy. When it comes, millions of small fish called anchovy disappear. Other fishes, birds, and marine mammals die. The economy of Peru suffers a severe setback.

El Niño is a weather-related change in ocean currents. It can cause Peru’s annual anchovy catch to drop from over 10 million metric tons per year to less than 2 million metric tons per year. How can currents play such a major role in economic disaster?

1. What is El Niño?

2. What effect does El Niño have on anchovy catches?

In normal years, the west coast of South America is washed by the cold Peru Current which collides with the weak Equatorial Counter Current near the equator. The Equatorial Counter Current is easily pushed aside and with the Peru Current forms the South Equatorial Current. The map below shows the location of normal year currents.



Map 1
Normal Currents

The water in these two currents is very different. The water of the Equatorial Counter Current has traveled twice across the wide Pacific Ocean. The water has been stripped of nutrients and is very warm. In contrast the water of the Peru Current is the result of cold Antarctic waters and upwelling waters from along the coast of South America. This water is rich in nutrients, and so cold that Antarctic birds are found living in it as far north as the equator.

3. How does the water in the Peru Current differ from that in the Equatorial Counter Current?

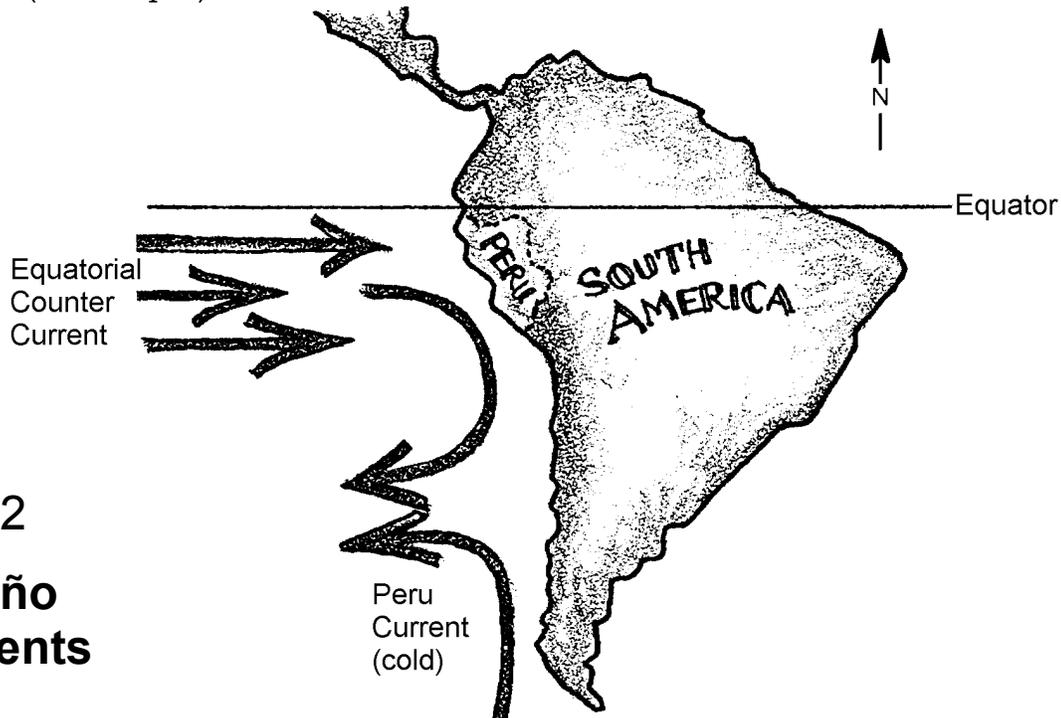
Three of the major industries in Peru are directly or indirectly dependent

upon the Peru Current. Although Peru is a small nation, it presently ranks third among all nations of the world in annual fish catch. The fish, which are abundant in the cold coastal waters, bring millions of sea birds which nest along the coast. Tons of resulting guano (bird waste) is processed and sold as fertilizer throughout the world. The fertilizer industry is the second major industry dependent upon the Peru Current. Finally, tourists are drawn to resorts along the Peruvian shores. The tourists provide the third major industry.

4. What are three major industries dependent upon the Peru Current?

- a.
- b.
- c.

Now, once in every eleven years or so something happens to change global wind patterns in the Southern Hemisphere. Some scientists think this change may be related to the cycle of sunspots, but no conclusive link has yet been demonstrated. Whatever the reason, the weakened wind patterns have a disastrous influence on the normal movements of water in the oceans. The weakened winds cause a general weakening of the Peru Current. The weakened current is no longer able to push aside the Equatorial Counter Current which suddenly invades coastal areas of Peru, which are normally washed by the Peru Current (See Map 2). El Niño has arrived.



Map 2
**El Niño
Currents**

5. During El Niño, the Peru Current is pushed north/south. (Circle the correct

answer.)

When El Niño visits, the upwelling of coastal waters which brings colder, nutrient-rich deep water to the surface stops. Surface waters become warmer and salinity decreases. The results can be disastrous for marine and bird life as well as for the Peruvian fishing industry. Microscopic plants quickly use up all of the nutrients in the water. The anchovy disperse (swim in different directions). The millions of sea birds that feed on the anchovies disperse or die.

6. What is one factor which helps cause the decrease in water density seen when El Niño arrives?

Other fishes and marine mammals also die. Rotting fish, mammals and birds can cover local beaches. Hydrogen sulfide gas released by the breakdown of the dead animals and plants blackens the hulls of ships and boats in the area. The phenomenon is called the “Callao Painter” because it often occurs off the Peruvian port of Callao.

7. What causes the “Callao Painter”?

Consider the economic impact this change has on industries in Peru. The fish follow the cold water hundreds of miles from the coast. The fish catch drops. The sea birds follow the fish, so fertilizer production stops. Invading warm waters kill existing plants and animals. The stench of the dead organisms discourages the normal tourist trade. The economy of Peru collapses.

8. What is the impact of El Niño on the three major Peruvian industries that are affected?

a.

b.

c.

The story doesn't end here. Peru is the world's leading producer of fishmeal. The fishmeal is used in chicken and livestock feed. El Niño causes a drastic

drop in fishmeal production. The price of chicken feed skyrockets. The price of chickens in your market also skyrockets. Thus, changed ocean conditions off Peru result in higher costs for food to the consumer.

9. How does El Niño result in higher chicken prices?

“El Niño” current usually lasts only 8 to 12 months, but in that period of time it puts pressure on the world supply of protein and thereby drives up the price of everything from salmon to soy beans. How well you eat and how well we relate to our South American neighbors does depend on the flow of the Peru Current.