Lesson Title: The Effects of the El Niño-Southern Oscillation on Ocean Currents

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Grade Level: Middle School Earth Science or Life Science

Type of Lesson: STEM

Objectives: 1) Understand what causes ocean currents, 2) Understand how ocean currents change in El Niño and La Niña years due to the El Niño-Southern Oscillation, and 3) Understand how these changes affect the ocean animals and humans.

Background Information: It will help if the students have an understanding about what causes currents. They need a background in food webs and water cycles.

References:

Tyus, Harold M. Unpublished. Ecology and Conservation of Fishes.
Developed/Writer O'Donnell, Carol. 2000. National Science Resources Center: Catastrophic Events Student Guide and Source Book. Carolina Biological Supply Company, United States of America.

Lesson Vocabulary: Ocean Current, Upwelling, El Niño-Southern Oscillation, Peruvian Anchoveta

Materials Required:

For each group-Large World Maps and Anchoveta Worksheet for every 2-4 students, 2 beakers of room temperature water, 2 eye droppers.

For each student-Safety goggles, 1 flexible drinking straw.

For the class-1 bottle of chilled water with purple dye, 1 bottle of warm water with purple dye.

Preparation: 1) Get together the ocean currents gear, 2) Cut out Anchoveta Worksheet and laminate cut-outs if you want to use them more than once, and 3) Get world maps together and laminate if you want to use them in the future.

Safety Information: The dye can stain. Eye protection should be worn with the purple dye.

Engagement: Tell the students that the rivers of the world wash nutrients into the ocean. Ask them: What happens to these nutrients? Brainstorm in groups of 2-4 for 1-2 minutes and then list possibilities together.

Answer: Although algae and organisms use some of the nutrients once they reach the ocean, a large amount of the nutrients sink to the bottom of the ocean where they are inaccessible to most ocean dwelling organisms.

Exploration: Create an *ocean current*. Make sure the two beakers of water are the same temperature. Have each group collect one eye dropper full of hot dye and one eye dropper full of cold dye. Have one student in each group slowly release 10 drops of hot dye, 1 drop at a time, into one of the beakers of water. Do the same with the cold dye and the other beaker of water. What observations did the students make? Why do you think this happened? Have a member of each group use the straw to gently blow across both beakers of water. The other members should watch the purple solution very carefully. What happened to the solution when air blew across the water's surface. Discuss your observations. Clean up.

How would you define a current?

Answer: Students should notice that currents move not around-in-a-circle like a drain but from the top of the ocean to the bottom of the ocean. An ocean current occurs when the ocean water moves in a definite direction. They can respond to changes in heat, wind, salinity (saltiness), land masses acting as barriers, and the rotation of the earth.

What happened when you blew across the top? What would happen to the nutrients that are down at the bottom of the ocean?

Answer: The nutrients would travel from the bottom of the ocean to the top. This is called an *upwelling*-when cold, nutrient-laden ocean water is brought from the deep to the surface.

What will happen to the plants and animals at the top of the ocean if an upwelling occurs around them?

Answer: The increase in food will allow the plankton that feed on them to increase their populations and animals, like fish that eat the plankton will also expand their population.

Create an ocean current using any wind cut-out, any upwelling cut-out, any plankton cut-out, and any anchoveta cut-out. Walk around and make sure everyone has been able to make an ocean current.

Explanation: Ask students whether they have ever heard about the El Niño-Southern Oscillation, El Niño years or La Niña years and what do they know about them?
Answer: The *El Niño-Southern Oscillation (ENSO)* is a phenomenon describing the change in the ocean current between Australia and South America compared to "normal" years. In a normal year (occurs about 50% of the time) a wind of medium strength blows across the Pacific Ocean from east to west (from South America toward Australia) and creates a medium upwelling. What is the wind current and upwelling near Peru going to look like if this occurring? Have students create on their own world maps a "normal" current in the southern Pacific Ocean.

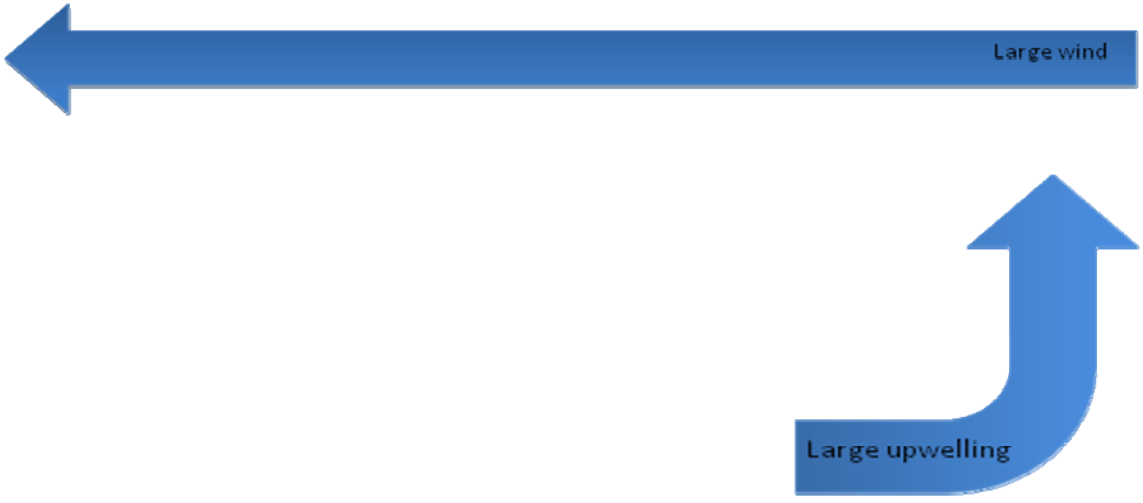
Answer:

In El Niño years (occurs about 30% of the time) the west winds are very weak and the easterly winds are very strong. This means the winds blow easterly (from Australia toward South America) although they are very weak. What is the wind current going to look like if this is occurring? What is the upwelling going to look like next to the Peruvian coast?

Answer:

In La Niña years (occurs about 20% of the time) the westerly wind (from South America toward North America) is very strong. What is the wind current and upwelling near Peru going to look like if this is occurring?

Answer:



Elaboration, Extension: Which one of these conditions will result in the highest plankton blooms off the coast of Peru? The lowest? What does this mean for the *Peruvian anchovetas* that feed on the plankton off the coast of Peru? Have a 1/3 of the groups create El Niño currents with the addition of plankton and Peruvian anchovetas cut-outs, another 1/3 do the same for La Niña years, and the last 1/3 do the same for a normal year. Have the different groups describe their systems to each other.

Answer: The highest plankton booms off the coast of Peru occur during La Niña years when the upwelling is strongest. This upwelling in turn causes the Peruvian anchovetas, a main predator of the plankton, to increase in population size. The El Niño years, with no upwelling off the coast of Peru, cause populations of plankton and their predators to plummet.

In the 1950s, humans discovered the Peruvian anchovetas as a fishery that could be taken advantage of and were taking 4 million tons of anchovetas from the 30 mi to 800 mi area where the upwelling occurs (1 million elephants worth of fish). By the 1970s, they were taking 12 million tons (3 million elephants worth of fish). Can we take the same number of fish from this area every year? Why or why not? Have the groups discuss the answer.

ANSWER: The fish populations rise and fall with the changing conditions of the ENSO. The population has crashed numerous times since the 1970s worse than if the population was simply responding to changes in upwelling since the population is also being affected by fishing. The fishery remains unstable.

How do you think this would affect animals that eat the anchoveta? Have the groups discuss the answer.

Answer: There are seabirds that eat the anchoveta and have done so for so long that their droppings have accumulated under their roosts in layers over 40m thick. The population of seabirds usually rise and fall with the availability of anchoveta but they have also suffered from the continued fishing for anchovetas even during El Niño years.

Evaluation: Throughout the lesson the students are being asked to create currents and food webs, which the teacher can over see and the teacher will be able to see whether the students are understanding the concepts. Any of these questions can be used as homework, a quiz or a test.

Wrap-up: Why is it important to understand ocean currents and the effects of the El Niño-Southern Oscillation on them?