Ocean Acidification

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Background (taken in entirety from NOAA)

When carbon dioxide (CO_2) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals. These chemical reactions are termed "ocean acidification". Calcium carbonate minerals are the building blocks for the skeletons and shells of many marine organisms. In areas where most life now congregates in the ocean, the seawater is supersaturated with respect to calcium carbonate minerals, and there are abundant building blocks for calcifying organisms to build their skeletons and shells. However, continued ocean acidification will cause many parts of the ocean to become undersaturated with these minerals, which is likely to affect the ability of some organisms to produce and maintain their shells.

Since the beginning of the Industrial Revolution, the pH of surface ocean waters has fallen by 0.1 pH units. Since the pH scale is logarithmic, this change represents approximately a 30 percent increase in acidity. Future predictions indicate that the oceans will continue to absorb carbon dioxide and become even more acidic. Estimates of future carbon dioxide levels, based on business as usual emission scenarios, indicate that by the end of this century the surface waters of the ocean could be nearly 150 percent more acidic, resulting in a pH that the oceans haven't experienced for more than 20 million years.

Ocean acidification is expected to impact ocean species to varying degrees. Photosynthetic algae and seagrasses may benefit from higher CO_2 conditions in the ocean, as they require CO_2 to live just like plants on land. On the other hand, studies have shown that a more acidic environment has a dramatic effect on some calcifying species, including oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton. When shelled organisms are at risk, the entire food web may also be at risk. Today, more than a billion people worldwide rely on food from the ocean as their primary source of protein. Many jobs and economies in the U.S. and around the world depend on the fish and shellfish in our oceans.

Objectives

Students will be able to:

- Describe the impact of ocean acidification on marine organisms.
- Describe the process for how CO2 in the atmosphere makes the ocean more acidic.

Materials Needed

- Eggs
- Vinegar

- Cups
- Aquarium pH test kit
- Cups
- Straw
- Seashells

Safety Concerns

None.

Vocabulary

- Ocean acidification: Ocean acidification is the name given to the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of anthropogenic carbon dioxide (CO2) from the atmosphere. About 30–40% of the carbon dioxide released by humans into the atmosphere dissolves into the oceans, rivers and lakes.
- Acid: An acid is a chemical substance whose aqueous solutions are characterized by a sour taste, the ability to turn blue litmus red, and the ability to react with bases and certain metals (like calcium) to form salts. Acidity is measured in pH. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline. Pure water has a pH very close to 7.

Procedure

Time	Activity	Description	Supplies
10	Full group	1. Brainstorm about ocean acidification. a. What is it? b. How does it work? c. Where have you heard about it? 2. Definitions a. What's an acid? b. What's pH?	
5	Full group	Put an egg in a cup of vinegar. Students should closely observe, then discuss.	Eggs, Vinegar, Cups
10	Groups of 4	Give each group of 4 students a new egg and an egg soaked in vinegar overnight. What happened to the shell?	Eggs, Vinegar, Cups
5	Full group	1. Discuss. Were there any surprises? 2. Brainstorm: what has calcium carbonate shells in the ocean? Where do they live?	
20	Pairs	1. Put pH indicator in cup of water and blow into it with a straw until the color changes	Aquarium pH test kit, Cups, Straw,

		2. Grind up shells and mix them in until color changes	Shells
10	Group Discussion	Have students report their findings. Discuss: 1. How do the shells dissolving impact the pH? 2. How does this happen in real life? 3. Discuss how scientists figured this out.	

Additional Resources

Reputable

Climate Change Indicators in the United States | Environmental Protection Agency. URL [accessed Aug. 25, 2013]: http://www.epa.gov/climatechange/science/indicators/oceans/acidity.html

Ocean Acidification | Woods Hole Oceanographic Institute. URL [accessed Aug. 25, 2013]: https://www.whoi.edu/main/topic/ocean-acidification

What is Ocean Acidification | PMEL Carbon Program, National Oceanic and Atmospheric Administration. URL [accessed Aug. 25, 2013]: http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

Opinion / Newspaper

Ocean Acidification | National Geographic. URL [accessed Aug. 25, 2013]: http://ocean.nationalgeographic.com/ocean/critical-issues-ocean-acidification/

Ocean Acidification | Wikipedia. URL [accessed Aug. 25, 2013]: http://en.wikipedia.org/wiki/Ocean_acidification

Ocean Acidification: The Other CO2 Problem. | Natural Resources Defense Council. URL [accessed Aug. 25, 2013]: http://www.nrdc.org/oceans/acidification/

Ocean Acidification: The Other CO2 Problem. | Oceanacidification.net. URL [accessed Aug. 25, 2013]: http://oceanacidification.net/

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