Acidic Oceans

Duration:
1 class

Objectives:
Students will:
- Create a carbon cycle diagram to illustrate oceanic processes
- Read a scientific paper, discuss, and expand ideas
- Revisit their carbon cycle diagram, then add and change the diagram to evaluate what they have learned

Vocabulary:
Acid
A fluid containing a high concentration of hydrogen ions (H^+), usually sour tasting
Base
A fluid that neutralizes an acid, has a high concentration of hydride ions (OH^-)
Coral
An invertebrate that builds its skeleton from calcium carbonate that we see as reef
pH
Measure of H^+ ions in a solution, a measure of acidity

British Columbia PLO's:
Science 6, 7, 8
English Language Arts 6, 7, 8
Visual Arts extension

Background:
In this activity students will evaluate their understanding of the carbon cycle in the oceans while reading different articles. This activity can follow the introductory lessons on climate change and is easily incorporated into a science or chemistry lesson. This activity can also be used as an extension into visual arts with the students illustrating their diagrams, which they have interpreted from a variety of readings

Carbon dioxide in the atmosphere and the oceans are exchanged at the surface layer between these two environments. When the concentration in the atmosphere increases, as it has over the last few centuries, the ocean takes in much of it, sequestering the CO_2 from the atmosphere. In this way, the oceans are moderating the amount of greenhouse gases in the atmosphere. Without the oceans, atmospheric CO_2 levels would be even higher.

Unfortunately, this process may cause long-term damage to marine ecosystems. As CO_2 is transferred to the ocean it lowers the pH and creates a more acidic environment, compromising the ability of mollusks, plankton, sea stars, corals and other animals to produce the shells they require to survive.

Currently, the average pH of the oceans is approximately 8.1, so you could say that a decrease in pH is actually making the oceans more neutral (7 is considered neutral). Unfortunately, the organisms that live in the oceans are accustomed to specific conditions and may not be able to adapt to a more acidic environment.

Materials:
- *Oceans News* article *Acidic Oceans* (class set)
- Ecological Society of America's media advisory *Ocean Acidification threatens cold-water ecosystems* (class set)
- World Science article *Acidifying oceans could trigger mass extinction, researcher warns* (class set)
- Blank carbon cycle diagrams
- Sample carbon cycle diagram
- Coloured pencils or pens

Procedure:
1. Display a blank carbon cycle on the overhead for the students to see. Ask them to consider how carbon moves around in different biomes.

2. Give the students a copy of the blank carbon cycle and have them brainstorm the locations of different carbon sources and sinks (this can be done individually or in groups). They are to indicate carbon sinks with a minus sign and carbon sources with a plus sign. They should write all their ideas down using only one colour.
3. Ask the students to put their diagrams aside, and as a class or as individuals read the *Ocean News* article *Acidic Oceans.*
4. Using a different colour, get the students to add new details to their carbon cycles that they may have learned about through the article.
5. Ask the students to read the Ecological Society of America's media advisory *Ocean Acidification threatens cold-water ecosystems* (http://www.esa.org/pao/newsroom/pressReleases2006/04032006.php).
6. Using a third colour, get the students to revisit their carbon cycles and make more additions.
7. The last reading is from the World Science site (www.world-science.net) *Pollution slowly turning oceans to acid: report.* (http://www.world-science.net/othernews/050701_acidfrm.htm)
8. Give the students a few minutes to make any changes they wish to add to their carbon cycle diagrams (they are not to re-draw them as the point of this exercise is to evaluate what they learned after each reading). Remind them to indicate with a – or + all the sinks and sources.
9. Ask the students to compare their altered and corrected diagram with the person/group beside them and discuss.
10. In partners or larger groups, have them combine their ideas to come up with a more comprehensive diagram. These additions and changes should be done on a separate piece of blank paper.
11. Write three to four of the discussion questions (see below) on the board for the students to consider. Have the students answer the discussion questions in small groups.
12. After answering the discussion questions, ask the students to trade their individual diagrams with a neighbour. Place the detailed carbon cycle sample on the overhead for everyone to see. Encourage the students to assess their partner's diagram by underlining all the correct phrases and concepts. Add any other sources, sinks and links that the class has made to the sample carbon cycle on the overhead for all to see. The sample is far from complete but will give them an idea of what can be included.
13. Discuss the students' answers and the different ideas the class came up with.
14. After conferring with their neighbours and the sample carbon cycle, ask the students to construct a final carbon diagram that they can keep in their notes. This can be done for homework if time is limited.
15. As a wrap up exercise, briefly discuss the three readings that were examined. Draw three columns on the board and ask the students to list differences and similarities. Compare and contrast tone, language used, length, intended audience, sources etc.

Discussion:

- What happens when CO_2 is in excess in the atmosphere?
- What would CO_2 levels in the atmosphere be like if the oceans covered a smaller area of the planet? Why?
- Make a list of organisms that will be directly affected by more acidic ocean waters. How will human populations be affected?
- Make a list of the organisms that will be indirectly affected by oceans with a lower pH. How will this affect you personally?

- How are the three different written pieces different from each other? Who are they targeted towards?

Extension and Resources:

- Evaluate and discuss the credibility and reliability of the different sources. As a class, create a list of reliable sources to find good scientific information. What are some clues that would suggest a particular article is a poor source of scientific information (too ideological, too many doomsday conclusions, etc.).
- ART - Have the students choose organisms that will be affected by more acidic ocean waters and illustrate what they may look like under those conditions. Students may use images from the *Acidic Oceans* article for ideas, as well as the source paper U. Riebesell *et al.*, *Nature* **407**, 364-368 (21 September, 2000)
- To further investigate the affects of pH levels on marine life, see the *Ocean News Plankton* lesson plan.
- Read the Ecological Society of America's media release *Ocean Acidification threatens cold-water ecosystem* (http://www.esa.org/pao/newsroom/pressReleases2006/04032006.php)
- Read J. Guinotte *et al.*, *Frontiers in Ecology and the Environment* **4**, 141-146 (2006).
- *Intertidal Stressors* is another *Ocean News* article and lesson plan that looks at how changes in pH will affect marine organisms.