

## Great Bear Rainforest Activity Plan

# What environmental changes are taking place in the Great Bear Rainforest that result from global human activity?

In this activity, students investigate the process of ocean acidification and design an experiment to explore how it may be affecting the marine areas of the Great Bear Rainforest.

## Learning Objectives

Students will:

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest
- Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world
- Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative)
- Contribute to finding solutions to problems at a local and/or global level through inquiry
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence
- Formulate physical or mental theoretical models to describe a phenomenon
- Investigate the impacts of ocean acidification on traditional Indigenous food sources
- Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information
- Examine, over the course of this activity:

### **Chemistry 12 Learning Standards:**

- » relative strength of acids and bases in solution
- » weak acids and weak bases
- » hydrolysis of ions in salt solutions
- » applications of acid-base reactions
- » saturated solutions and solubility product ( $K_{sp}$ )

### **Environmental Science 12 Learning Standards:**

- » water quality parameters and bioindicators
- » availability and water use impacts

## **Preparing for the Activity Plan**

- Read the background information and preview the videos and websites.
- Gather materials for the dissolved carbon dioxide demonstration.

### **Materials**

- computer and projector
- student computers / tablets/ devices
- access to the Internet
- beakers, tap water, bromothymol blue indicator, straws

## **Background Information and Resources**

In addition to global warming, another result of increasing levels of atmospheric carbon dioxide is ocean acidification. Ocean acidification has widespread ecological effects. One observable effect is the lowering of the amount of carbonate available for use by marine organisms that build shells and skeletons.

### **Videos**

#### **Acidifying Waters Corrode Northwest Shellfish (6:07)**

This video gives a direct example of the effect of ocean acidification, on pacific oysters.

[https://www.youtube.com/watch?v=x7Mpl9dZijk&feature=emb\\_title](https://www.youtube.com/watch?v=x7Mpl9dZijk&feature=emb_title)

#### **A Wall Worth Building: Making Clam Habitat Great Again (3:55)**

This video features the restoration of the traditional Indigenous clam gardens.

[https://www.youtube.com/watch?time\\_continue=1&v=22Nytmxw2Z8&feature=emb\\_logo](https://www.youtube.com/watch?time_continue=1&v=22Nytmxw2Z8&feature=emb_logo)

### **The Acid Test—Ocean Today (3:16)**

This link goes to the video and website that introduced the concept of ocean acidification from a global perspective.

<https://oceantoday.noaa.gov/theacidtest/welcome.html>

### **Coastal Guardian Watchman (11:56)**

This video shows how First Nations are actively protecting and preserving the resources of the Great Bear Rainforest.

[https://www.youtube.com/watch?time\\_continue=608&v=TZXqStE2llc&feature=emb\\_logo](https://www.youtube.com/watch?time_continue=608&v=TZXqStE2llc&feature=emb_logo)

### **National Ocean Service: What is Ocean Acidification? (1:04)**

This video gives a quick overview of the general process of ocean acidification. It shows graphically how the increase of atmospheric carbon dioxide is lowering the pH of the world's oceans. In addition to the video, this website provides a succinct description of ocean acidification.

<https://oceanservice.noaa.gov/facts/acidification.html>

### **Great Bear Wild—Dispatches from a Northern Rainforest (5:34)**

This video beautifully depicts the ocean of the Great Bear Rainforest. It stresses the importance of protecting this area from fossil fuel exploration and transport.

<https://vimeo.com/108089318>

## **Informational Websites**

### **A Swell to Quell the Dissolution of Shell**

This blog by Josh Silberg documents five ways the Hakai organization is monitoring ocean acidification along British Columbia's coast.

<https://www.hakai.org/blog/swell-to-quell-dissolution-shell/>

### **Effect of Carbonate Chemistry Alteration on the Early Embryonic Development of the Pacific Oyster (*Crassostrea gigas*)**

This PLOS article by Gazeau et. al (2011) is complex, but the abstract has a lot of information.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0023010>

### **Frontiers in Marine Science: Marine CO<sub>2</sub> Patterns in the North Salish Sea**

This is an academic article on marine carbon dioxide levels.

<https://www.frontiersin.org/articles/10.3389/fmars.2018.00536/full>

### **Hakai Magazine: A Scheme to End the World's Worst Acid Trip**

This article by Rebecca Boyle explores the idea of reversing ocean acidification with alkaline injections.

<https://www.hakaimagazine.com/news/end-worlds-worst-acid-trip/>

### Meet the Burk-O-Later

This blog by Josh Silberg documents an instrument that records ocean acidification (pH and aragonite) all along North America's west coast.

<https://www.hakai.org/blog/meet-burke-o-lator/>

### PMEL Carbon Program (National Oceanic and Atmospheric Administration)

This website gives an overview of the chemistry of ocean acidification and its biological impacts.

<https://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>

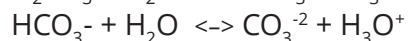
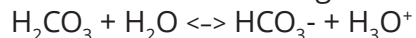
## Delivering the Activity Plan

### Access Prior Knowledge

- Ask students what they know about global warming. Most students will understand that global warming is at least partially caused by increasing levels of atmospheric carbon dioxide. Ask them what effect this has on the world's oceans. Discuss the concept of ocean acidification—generally speaking, this is an overall decrease in the pH of the ocean.
- Show [The Acid Test](#). After viewing, ask students if they know of any areas in British Columbia that would be at risk of ocean acidification.
- This would be a good time to show [Great Bear Wild—Dispatches from a Northern Rainforest](#). After viewing, ask students if they think the Great Bear Rainforest could be affected by ocean acidification.
- For further information, you might show these other two suggested videos:
  - » [What is ocean acidification?](#) by the National Ocean Service is a short and simple description of this phenomenon.
  - » [Acidifying Waters Corrode Northwest Shellfish](#) presents a direct example of the effect of ocean acidification.

### Inquire

- As the level of carbon dioxide gas increases in the atmosphere, so does the level of dissolved carbon dioxide. Ask students to determine what acid-base equilibria occur as a result (Chemistry 12). Some students will predict that carbonic acid is produced; others will need to be given that information.



## Experience

- In this dissolved carbon dioxide demonstration, students can observe firsthand how easily water absorbs carbon dioxide and how it subsequently lowers pH.
- Add a small amount of bromothymol blue indicator to a beaker of tap water; it should initially be green/blue (bromothymol blue is green at pH 7). Have students predict what will happen if they blow into the water with a straw.
- Have students blow into the water with a straw. Over time, the colour will change to yellow (or lighter green).

**Note:** It is important that students do not ingest the indicator, as it is harmful if swallowed.

- Ask students why they thought this occurred. (The carbon dioxide in their breath forms carbonic acid and subsequently lowers the pH of the solution, changing its colour.)

## Explore

- Now that they know what ocean acidification is, students can inquire further. It is thought that this lowering of pH is having and will have many effects on marine life. Have students create a hypothesis about ocean acidification and how it affects marine life in the Great Bear Rainforest.
- Have students work to design experiments that tests their hypotheses.
- Note that you can have students simply design their experiments or, if feasible and ethical, they could also carry out their experiments.
- Examples of topics that students could explore include the following:
  - » photosynthetic algae: explore the potential benefit of increased carbon dioxide
  - » shellfish/pteropod shell formation: design an experiment to determine the  $K_{sp}$  of aragonite (the carbonate component of shells), or design an experiment to determine the pH range that dissolved shells
  - » bioindicators: propose potential bioindicators that might be used to measure ocean acidification
  - » solutions: propose small- or large-scale solutions to reverse the impact of ocean acidification on the Great Bear Rainforest
  - » clam gardens: explore how traditional Indigenous clam gardens work and how the conditions in the gardens are ideal for clam growth

## Assess

- Did students formulate a testable hypothesis?
- Did students design a repeatable, ethical, and detailed experiment? Have they considered how their results could be interpreted?
- Did students demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest?
- How did students make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world?
- How did students collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative)?
- To what extent did students contribute to finding solutions to problems at a local and/or global level through inquiry?
- How did students apply knowledge of scientific concepts to draw conclusions that are consistent with evidence?
- How did students formulate physical or mental theoretical models to describe a phenomenon?
- Were students able to apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information?
- During their experimental design process, did students demonstrate an understanding of

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## Go Beyond

- Other possible inquiry topics students could explore include the following:
  - » How might ocean acidification impact other sea life in the Great Bear Rainforest (e.g., mammals)?
  - » Small organisms such as plankton could be the most affected by ocean acidification. As a major source of the Earth's oxygen, how could this put our oxygen supply at risk?
  - » In what ways does ocean acidification impact terrestrial plants and animals in the Great Bear Rainforest?
  - » How are First Nations protecting the Great Bear Rainforest from human activity? (See the video [Coastal Guardian Watchmen](#).)



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