NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Ocean Acidification: The Evidence

Students watch a video to identify and describe the effects of ocean acidification in detail. Next, they examine a graphical representation of ocean acidification data, summarizing the linear trends they see. Finally, students calculate the slope of these lines to quantitatively compare and contrast the strength and direction of these trends.

GRADES

6 - 8

SUBJECTS

Biology, Ecology, Earth Science, Climatology, Oceanography

CONTENTS

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OVERVIEW

Students watch a video to identify and describe the effects of ocean acidification in detail. Next, they examine a graphical representation of ocean acidification data, summarizing the linear trends they see. Finally, students calculate the slope of these lines to quantitatively compare and contrast the strength and direction of these trends.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/ocean-acidification-evidence/

In collaboration with

educurious
learning that connects

DIRECTIONS

This activity is part of the Climate Change Challenge unit.

1. Show a video and prompt students to identify and describe in detail the effects of ocean acidification.

- Ask students to revisit their *Ocean Impacts* handout from the *Oceanic Impacts* activity. Solicit volunteers to name the three important impacts of climate change on the world's oceans:
    - Warmer oceans
    - Rising sea levels
    - Ocean acidification
- Focusing on ocean acidification, prompt students to brainstorm as a class all of the marine organisms that they think might be affected by these impacts.
- Project a video about the impact of ocean acidification on wildlife and ask volunteers to compare and contrast what they learned with the class brainstorm.
- Assign students to add any new information on the causes and consequences of ocean acidification to Part 1: Causes and Part 2: Consequences of the *Ocean Impacts*handout.

2. Model and support students as they read and summarize linear trends using a graphical representation.

- Project the *NOAA Hawaii Carbon Dioxide Time-Series* graph onto a writable surface (whiteboard or chart paper) and distribute copies to students, prompting them to identify the aspect of this data representation that they have seen before.
- The Keeling Curve analyzed during Lesson 1: *Carbon Concerns* appears in red on this chart.
- Distribute the *Ocean Acidification Trends* handout.
- Using an I Do, We Do, You Do format, support students as they complete Part A of the handout:
    - Draw a trend line on the graph that passes through the data for the red line: Atmospheric Carbon Dioxide. (This is the Keeling Curve, with which students are already familiar.)
    - Complete the first row of this chart for the red line, "thinking out loud" as students observe your choices. Note that the trend summary can be created formulaically, using the information in the y-axis, Trend direction, and y-axis columns:
        - Variable & Identifier: red line = Atmospheric CO_2

    - Y-axis (units): CO_2 (ppm)
    - Trend Direction (increase/decrease): *Increase*
    - X-axis (units): *Time (years)*
    - Trend Summary: *Carbon dioxide concentration has been increasing in the years since 1958.*

  - Then use volunteers' contributions to complete the second row of this chart for the green line: Seawater pCO_2. This line represents a measure of the amount of carbon dioxide in ocean water.
  - Finally, assign students in pairs to complete the final row of the chart for the blue line: Seawater pH.

- In a Think-Pair-Share, prompt students to compare the three trends that they have examined, asking:

  - *Do all three trends occur in the same direction?*
  - *Which trend seems the strongest, and how do you know?*
  - *How can we use math to determine which trend is strongest?*
  - Students' answers to these questions will help you gauge their prior knowledge of trends and slope, in preparation for the next step

3. Direct students to assess current rates of change in ocean acidification by analyzing current trends.

- Use an I Do, We Do, You Do format to find the slope (m) of each line in the *NOAA Hawaii Carbon Dioxide Time-Series* graph, using Part B of the *Ocean Acidification Trends* handout (see *Tip*) to track your calculations.
- Direct students to compare the values of m (which will differ slightly depending on which points were chosen) with the three lines on the chart, asking:

  - *What is the difference between a positive and a negative slope?* (A positive slope shows an increasing trend over time; a negative slope shows a decreasing trend over time.)
  - *What is the difference between a small value for slope and a large value?* (The larger the slope, the steeper the line.)
  - *Which of these variables is changing most quickly over time?* (Whichever variable has the steepest slope is changing the most quickly, regardless of whether the slope is positive or negative. This is likely the Keeling Curve (red line) in students' calculations;

the amount of carbon dioxide in the atmosphere typically changes faster than the other variables that it affects.)
    - *How do these findings connect back to ocean acidification?* (This data tells us that the ocean is indeed getting more acidic (pH is dropping) as carbon dioxide concentrations are rising.)

- Revisit the class *Know and Need to Know* chart, recording any new nuances in students' understanding of the impacts of ocean acidification.

Tip

Step 3: There are multiple ways to calculate slope; students may be familiar with particular methods. If it is necessary to walk students through this calculation, you can do so as follows:

- Choose an early point (Point 1) and later point (Point 2) at either end of the trend line and record their approximate x and y coordinates in the chart.
- Calculate the trend "rise" by subtracting the y-value of Point 1 from the y-value of Point 2 (y2-y1). Calculate the trend "run" by subtracting the x-value of Point 1 from the x-value of Point 2 (x2-x1). These calculations should be done by hand in this activity; in future activities within the lesson, students may move to digital calculation.
- Calculate the slope of the line by dividing the rise by the run (m).
- See below for examples of each of these observations and calculations:
    - **Variable & Identifier:** red line = Atmospheric CO_2
    - **Point 1:** (x1, y1): *(1958, 320)*
    - **Point 2:** (x2, y2): *(2018, 410)*
    - **Rise:** y2-y1: *410-320 =* ***90 ppm***
    - **Run:** x2-x1: *2018-1958 =* ***60 years***
    - **m slope rise/run:** *90/60 =* ***1.5 ppm/year***

Informal Assessment

Informally assess students' understanding of ocean acidification from the details they add to their *Ocean Impacts* handout after watching the video. Assess their ability to summarize linear trends verbally and calculate slope with the *Ocean Acidification Trends* handout.

Extending the Learning

Collaboration with students' math educators may help support and extend their learning as you work with linear trends and their equations in this lesson.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Climatology
- Oceanography

Learning Objectives

Students will:

- Describe the effects of ocean acidification in detail.
- Verbally summarize linear trends associated with ocean acidification.
- Calculate slope using graphical representations of ocean acidification.

Teaching Approach

- Project-based learning

Teaching Methods

- Lab procedures
- Modeling
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
  - Life and Career Skills
    - Flexibility and Adaptability
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Remembering
  - Understanding
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Using mathematics and computational thinking

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.7:**
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2: Cause and Effect:**
Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• **Crosscutting Concept 4:**
Systems and system models
• **Crosscutting Concept 7:**
Stability and change
• **MS-ESS3-2:**

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

• **Science and Engineering Practice 4:**
Analyzing and interpreting data

• **Science and Engineering Practice 5:**
Using mathematics and computational thinking

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Color printer, Monitor/screen, Projector, Speakers

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Large-group learning
- Small-group learning
- Small-group work

BACKGROUND & VOCABULARY

Background Information

Ocean acidification occurs when carbon dioxide in Earth's atmosphere becomes dissolved within the sea, combining with water to form carbonic acid. This change in pH will likely cause problems for some marine organisms with shells and skeletons: the changed conditions make creating and maintaining these structures more challenging. When organisms low on the food chain struggle to stay healthy because of ocean acidification, it affects all of the organisms higher up who rely on them for food, including humans!

Graphical representations help to communicate the messages of data in visual form. Different types of graphical representations, such as bar and line graphs, are suited for use with different types of data. Labels help an audience to interpret graphs. Typically, a graph should have a title, and each axis (x and y) should have a brief text description of the variable being measured.

Prior Knowledge

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Recommended Prior Activities

- Carbon All Around
- Circulation of the Seas
- Global Trends
- Heating Up
- Local Emissions
- Meteorological Models
- Now and Then
- Oceanic Impacts
- Our Greenhouse
- Plot It!
- Weather Interconnections
- Weather, Meet Climate

Vocabulary

Term	Part of Speech	Definition
carbon dioxide	*noun*	greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.
climate change	*noun*	gradual changes in all the interconnected weather elements on our planet.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.
Keeling curve	*adjective*	graph illustrating the amount of carbon dioxide (CO_2) in Earth’s atmosphere as measured at the Mauna Loa Observatory in Hawaii.

Term	Part of Speech	Definition
ocean acidification	*noun*	decrease in the ocean's pH levels, caused primarily by increased carbon dioxide. Ocean acidification threatens corals and shellfish.
pH	*noun*	measure of a substance's acid or basic composition. Distilled water is neutral, a 7 on the pH scale. Acids are below 7, and bases are above.
slope	*noun*	slant, either upward or downward, from a straight or flat path.

For Further Exploration

Instructional Content

- National Geographic: Resource Library: Collection: Climate Change
- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Catastrophic Weather Events
- National Geographic: Resource Library: Collection: Weather