Topic: Ocean Acidification
Grade: 5th grade

The following lesson is designed as a 3-4 class mini unit focusing on the process of ocean acidification. Students have previously engaged in discussions about human created increases in atmospheric carbon dioxide but have yet to really dig into the massive impact climate change has on the ocean/hydrosphere. In this lesson students will use authentic data to develop models showing the connection between atmospheric changes and hydrosphere changes, specifically ocean acidification due to increases in ocean carbon dioxide. This lesson is a bridge between 5-PS-1 Matter and Its Interactions and 5-ESS-2 Earth's Systems.

## STEM Integration Justification

Providing authentic data is critical for students to understand the scientific principles and processes behind the changes that we are seeing in Earth's Spheres. The integration of mathematical practices allows students to look at real data and the patterns in that data that allow scientists to understand what is happening and why. Having students understand the variables that impact ocean health allows them to see that, yes the changes are bad and scary, but because we know the science processes in play there are great engineering opportunities to problem solve creative and useful solutions. Knowing the science and understanding the data provides the framework for student advocacy and activism. The connection between science, math, engineering, and technology (how we collect much of the data) is critical for students to understand what is happening, why it is happening, how change can happen, and how they have a voice and a role in the future of Earth's climate.

## Lesson Objectives

-Students will be able to work collaboratively to analysis and find patterns in line graphs with 2 variables
-Students will be able to see the connection between atmospheric carbon dioxide, ocean carbon dioxide, and ocean acid levels
-Students will understand that even a small change in ocean acid levels can have a large impact on ocean health and life
-Students will understand that scientists use data to answer questions about processes in the natural world
-Students will understand that even particles too small to see can have a large impact on the earth
-Students will begin to understand the spheres of the earth are interconnected
-Students will understand that human actions are impacting the health of the ocean

## Standards

NGSS:

**Performance Expectations**

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen
5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact

| Science and Engineering Practices | Disciplinary Core Ideas | Cross Cutting Concepts |
|---|---|---|
| Developing and Using Models<br>-Use models to describe phenomena | PS1.A<br>Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. | Scale, Proportion, and Quantity<br>-Natural objects exist from the very small to the immensely large. |
| Developing and Using Models<br>-Develop a model using an example to describe a scientific principle | ESS2.A<br>Earth's major systems are the geosphere, the hydrosphere, the atmosphere, and the biosphere. These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms. | Systems and System Models<br>-A system can be described in terms of its components and their interactions |

Ocean Literacy Principles
5 The ocean supports a great diversity of life and ecosystems
6 The ocean and humans are inextricably interconnected

Climate Literacy Principles
3 Life on Earth depends on, is shaped by, and affects climate.
5 Our understanding of the climate system is improved through observations, theoretical studies, and modeling
6 Human activities are impacting the climate system.
7 Climate change will have consequences for the earth system and human lives

Common Core State Standards for Mathematics
**MP.2** Reason abstractly and quantitatively. *(5-PS1-1)* (5-ESS2-1)
**MP.4** Model with mathematics. *(5-PS1-1) (5-ESS2-1)*

## 5E Lesson Model

**Engage:**
Students will be introduced to the biodiversity and beauty of ocean life by completing a NOAA Ocean Diversity Challenge which provides a beautiful artist rendition of 73 different species found in our ocean. Students are challenged to find as many as they can. After taking about 10 minutes to work on the challenge, students will be asked to share what they noticed and observed about biodiversity and will be asked to provide at least one difference and one similarity between species. Students should also have a space to post any questions that they have about ocean biodiversity and ocean health.

Posters of the different animals with a description of each should be posted around the classroom for the remainder of this lesson.

**Explore:**
Previous background knowledge - Students have completed a chemistry unit called Chemical Magic. In this unit, students investigated the properties of matter by dissolving everyday chemicals to make solutions and by exploring simple yet surprising chemical reactions. Through these investigations, students began to build conceptual models for the particulate nature of matter. Students should have a solid understanding that particles are too small to be seen (such as carbon dioxide particles) and that acids are highly reactive substances based on several labs exploring vinegar.

*Lesson #1: Looking at the data*
Students should work through the introduction and steps 1 and 2 of the following NOAA lesson looking at data collected in Hawaii exploring relationships between atmospheric and ocean carbon dioxide concentrations and ocean acidification. Copies of the data to analyze should be printed and handed to the students. While this lesson does not need much modification, a way to scaffold the lesson to ensure understanding is to work through the resource as a class. Students are asked to share their ideas about the questions provided in the lesson but were not required to write down their answers or to fill out a lab sheet. At the end of the class students completed an exit ticket.

*Lesson #2: Looking at the impact*
Students should work as teams to complete the following NOAA lab activity looking at the impact of vinegar on shells and other materials (chicken bones, clam shells, urchin tests, small abalone shells, other snail shells, piece of coral skeleton). In this two part lab activity students are first asked to work with pH paper to test different levels of acidity (water and vinegar) and how different materials are impacted by both. In the second part of the lab activity students are asked to repeat the test with tap water and carbonated water.
Students are asked to record initial predictions about what they think might happen in each test. Students should record 5 qualitative observations of the material tested before and after each test.

**Explain:**
- After completing both explore lessons, students should revisit the online NOAA resource and read through the background information provided in step 1 and 2.
- Each student should get two post it notes. Post it note #1 should be something that they learned and post it note #2 should be something that they still wonder.
- Post it notes should have a visible place in the classroom.
- In addition, here is a great NASA resource that is designed for elementary students so students should be able to look through the material relatively independently.
- Again, two post it notes should be provided for students to record one thing that they learned and one thing that they still wonder.
- A class discussion should allow for students to share their learns and wonders – this a great opportunity for the teacher/facilitator to address any misinformation or questions.

**Elaborate:**

- Provide each group of collaborative students with a new data set from the USEPA.
- Based on the new data set students should complete a See-Think-Wonder sheet, providing at least one thing that they notice, wonder, think, and still wonder.
- Groups should report out their findings to the class.
- After every group has shared, students should identify any patterns in the entire data set that they see.

**Evaluate:**
Student participation in small group discussions and class discussions
Completion of lesson #1 exit ticket
Completion of at least 5 qualitative observations about how the material changed in lesson #2
Completion of See-Think-Wonder chart

## Resources


National Oceanic and Atmospheric Administration an activity book. (n.d.). https://aambpubliccelebrating200.blob.core.windows.net/celebrating200prod/media/edufun/book/frontofbook.pdf

Common core state standards - national council of teachers of mathematics. (n.d.). https://www.nctm.org/ccssm/

*Home Page: Next generation science standards*. Home Page | Next Generation Science Standards. (n.d.). https://www.nextgenscience.org/

NASA. (n.d.). *Climate literacy: The essential principles of climate sciences*. NASA. https://gpm.nasa.gov/education/articles/climate-literacy-essential-principles-climate-sciences

Ocean Literacy - College of Exploration. (n.d.-b). https://www.coexploration.org/oceanliteracy/documents/OceanLitChart.pdf

*Story map series*. noaa.maps.arcgis.com. (n.d.). https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=adec7620009d439c85109ab9aa1ea227

Marine osteoporosis aquarius4 - .NET framework. (n.d.-a). https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/docs/20220603-marineos.pdf

NASA. (n.d.-b). *What is ocean acidification?*. NASA. https://climatekids.nasa.gov/acid-ocean/

Environmental Protection Agency. (n.d.). EPA. https://www.epa.gov/climate-indicators/climate-change-indicators-ocean-acidity