Oyster Larvae Catastrophe

What caused the oyster larvae die off, and what can we do?

Overview

Ocean acidification is negatively affecting marine organisms that make their shells of calcium carbonate, such as oysters, clams, and pteropods. To investigate the phenomenon of an observed oyster larvae die off, students explore the cause, impacts, and potential solutions for ocean acidification.

Learning Goals

Students will learn the following:

- *Ocean acidification is the decrease in ocean pH that results from human activities that release excess CO2 into the atmosphere. The CO2 in the atmosphere is absorbed by the ocean and changes ocean chemistry.*
- *The change in ocean pH makes it difficult for marine organisms like oysters to build their shells.*
- *Humans can address the problem of ocean acidification by reducing the amount of CO2 released into the atmosphere.*

Introduction

Humans are releasing carbon into the atmosphere as CO_2, a by-product of burning fossil fuels, and the amount is increasing over time. This increase in atmospheric CO_2 causes more CO_2 to dissolve in the ocean. This increase in CO_2 in the ocean causes the ocean to become more acidic due to chemical changes in the ocean. This increase in acidity interferes with their ability to make shells (of calcium carbonate).

In this unit, students use current data and their knowledge of the carbon cycle to understand the effects of ocean acidification. They also learn about ways they can be stewards of the ocean and take action in their community.

Image: Oregon Sea Grant

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Grade Level

6-8

Anchoring Phenomenon
Oyster Larvae Catastrophe

Driving Question
What caused the oyster larvae die off, and what can we do?

Image: CSIRO Marine Research, CC BY 3.0

Standards

Next Generation Science Standards
LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Common Core Math Standards
7.RP.A.2
7.RP.A.2.A

Learning Objectives

Students will be able to:

1. *Construct an argument supported by empirical evidence that increased atmospheric carbon dioxide, due to increased fossil fuel emissions, leads to ocean acidification.*
2. *Recognize and graph changes in ocean pH over time.*
3. *Describe how oysters are affected by ocean acidification.*
4. *Identify potential solutions for the problem of ocean acidification.*

Image: Oregon Sea Grant

The anchoring phenomenon of this lesson centers around an observed die off of oyster larvae at a shellfish hatchery in Oregon. Students begin the lesson wondering what happened to cause the die off. As the lesson unfolds, they learn that the problem is the result of ocean acidification (OA) which is caused by an excess of CO_2 in the atmosphere. In order to understand OA, the instructor uses demonstrations, hands on activity stations, videos, and infographics. The students learn about the anthropogenic causes of OA, how ocean pH is changing, and the effects OA has on the ability of marine organisms to build their shells. Students reflect on what they learn by creating a poster that shows what the community can do to reduce CO_2 emissions into the atmosphere.

Essential Questions

- *What is ocean acidification and what causes it?*
- *What is pH and how is it measured?*
- *How do changes in seawater pH affect oyster larvae?*
- *What can people do to address ocean acidification?*

Definition

Ocean acidification *is "the change in ocean chemistry due to increasing amounts of anthropogenic carbon dioxide (CO_2) in the atmosphere."*

- *Erickson and Crews, 2019*

Vocabulary

hatchery
anthropogenic
fossil fuel
carbon
pH
pH indicator

OA Background Resources

- *Oregon OA Story map*
- *OA Graphics*
- *Changing Ocean Chemistry*

Image: Oregon Sea Grant

Image: Oregon Sea Grant

Lesson Procedure

ENGAGE

Introduce the anchoring phenomenon as a 'mystery' presented to students. Begin by showing the students 5:40-6:05 of the video *Ocean Acidification: Changing Waters.* In this clip they will see an oyster farmer explaining a die-off of oyster larvae.

Activity: Think-Pair Share
Engage the students in paired dialogue focused on the following questions: What happened here? What is the problem? What should we (humans) do next?

Next, show a short (0:29) time lapse video of a pteropod shell dissolving*. (See side panel *Avoiding Misconceptions*)

Activity: Class Demonstrations
To provide students with the foundational concepts necessary to understand the underlying problem for the larvae die off, the instructor will conduct demonstrations for the whole class while the students use a worksheet to record notes about what they observe. Demonstrations illustrate concepts pertaining to carbon dioxide (CO_2) and pH and will eventually help the students understand the problem of ocean acidification.

EXPLORE

Activity: Task Cards
Teacher instructions: To structure the activities in this and subsequent sections, see the *Task Cards*. The steps in the task cards are arranged in the 5E model, outline the flow of learning activities, and also serve as assignments for group work.

*Activity: pH Stations** (See side panel *Avoiding Misconceptions*)
To learn more about pH, students explore hands on activities at lab stations and record their data in a worksheet. Stations include:

- Test water samples with pH paper (local ocean water, tap water, estuary water). Continue this activity using common household acids and bases: vinegar, ammonia, etc.
- Put drops of HCl acid on oyster shells. Students will notice that the rapid fizzing will occur.
- Groups will get a chicken egg, they will put the egg in a cup of vinegar, CO_2 bubbles will immediately form on the shell. After sitting overnight, the eggs will have no shells. Explain that a chicken egg shell and an oyster shell are made of the same chemical: *calcium carbonate*

LESSON RESOURCES

Videos:
- *Ocean Acidification: Changing Waters*
- *Effects of OA on Pteropod Shells*
- *OA Solutions, part two*

Class Demonstrations:
- *Class Demo Descriptions*
- *Student worksheet*


Image: Bill Johnson

Vocabulary:
acidic
basic
pH scale
carbon dioxide gas
carbonic acid

Lesson Flow / Group Work
Task cards

pH Stations
- *Station set-up*
- *Student worksheet*

**Avoiding Misconceptions*
- *See Changing Ocean Chemistry, p. 17-18*


Image: Bill Johnson

Activity: Connecting OA to the Oyster Die Off

Return to the original video *Ocean Acidification: Changing Waters*, and this time watch from the beginning to about time 6:52. After watching the clip, follow up with a class discussion during which the teacher presents questions:

- How does the CO2 get into the ocean water?
- What does this do to the pH of the ocean?
- What is happening to the shells of the oyster larvae? How does that affect them?
- What do you think could be done next?

Record the ideas generated at the student brainstorm session to use later in the Evaluate section of the lesson.

EXPLAIN

Activity: Exploring OA Impacts

Watch the remainder of the video *Ocean Acidification: Changing Waters.* List additional impacts of OA, both those that seen now and those that are predicted for the future.

For additional information, explore the ArcGIS story board *Oregon: Ocean Acidification*.

Activity: Guest Speaker

Invite a marine science researcher to talk to the students about how ocean pH is measured. This could be in the form of a classroom visit or video. See the *task cards* for guidance about how to ask questions of the guest speaker.

Activity: Ideas for Field Experiences

- Take students on a field trip to visit a coastal monitoring site and participate in monitoring ocean pH.
- Visit a commercial operation affected by ocean acidification and hypoxia (OAH), such as a local oyster hatchery.
- See the *task cards* for guidance about how to ask questions of onsite speakers.

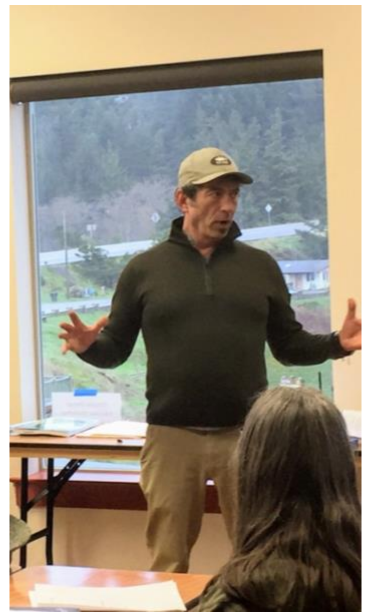
ELABORATE

In this section, students work in groups and use the prompts in the *task cards* to create a brochure that connects the problem of CO2 to OA and the resulting impacts on oyster larvae.

Students examine the Hawaii Carbon Dioxide Time Series graph to answer questions and create their own graphs of pH levels in the ocean over time.

Video:
- Ocean Acidification: Changing Waters

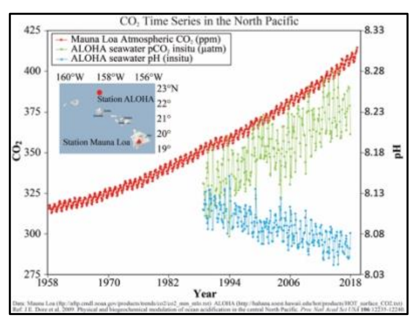
ArcGIS Story board
- Oregon: Ocean Acidification



Tom Calvanese at Port Orford Field Station
Image: Oregon Sea Grant

Field Experiences for Students
- Visit OSU's Port Orford Field Station
- Visit Whiskey Creek Shellfish Hatchery

Student Brochures
- Hawaii CO2 Time Series Graph
- Examples of student work



Hawaii Carbon Dioxide Time Series
Image: pmel.noaa.gov

In addition, students use the Claim, Evidence, Reasoning (CER) method to explain in their brochure what happened to the oyster larvae.

EVALUATE

Ultimate success of the unit will be seen in students' enthusiasm as they move to developing ideas to reduce CO2 in the oceans.

Students will work in groups and use the prompts in the *task cards* to create a solutions-focused poster entitled "Making a Difference". In the poster, the students will create displays showing their group's ideas for actions that could address the problem of ocean acidification. Student groups will present their displays to other groups, with time at the end for discussion and questions. Students will give positive evaluations of other groups' displays and presentations using a *Poster Evaluation Worksheet*.

Further study: Students compare their list of ideas for reducing CO2 emissions to *Project Drawdown*, a compiled source of solutions, followed by discussion of which approach might work best in their community.

Next Generation Science Standards

Performance Expectation:
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Science & Engineering Practice:
Engaging in argument from evidence

Disciplinary Core Ideas:
LS2.C: Ecosystem Dynamics, Functioning, and Resilience

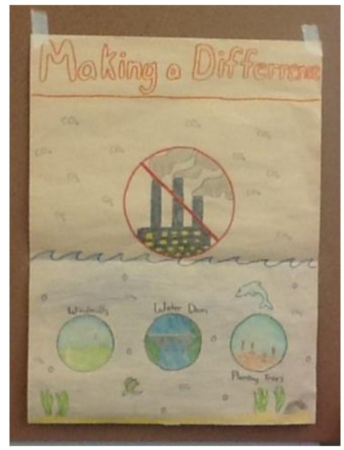
Crosscutting Concept:
Stability and Change

Math Practices:
Reason abstractly & quantitatively
Construct viable arguments and critique the reasoning of others

CC Math Standards:
CCSS.MATH.CONTENT.7.RP.A.2
Recognize and represent proportional relationships between quantities.
CCSS.MATH.CONTENT.7.RP.A.2.A
Decide whether two quantities are in a proportional relationship,

Student Posters
- *Poster Evaluation worksheet*
- *Examples of student work*
- *Project Drawdown website*

Additional OA Lessons for HS
Changing Ocean Chemistry



e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.

Acknowledgments

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See more lessons on the ORSEA webpage