



Mystery of the Disappearing Pteropods: Dude Where's My Shell

Timeframe

60-90 minutes

Target Audience

Grades 6th- 8th

Suggested Materials

- Three tabletop stations
- Paper
- Scissors
- Graphing paper
- Pencils and colored pencils
- Sharpie marker

Description

In this activity, the students will explore the topic of climate change by engaging in an experiment in which they will observe the estimated condition of pteropod shells collected from different time periods (past, present, and future). They will be able to collect data on the number of pteropods that have been affected by ocean acidification, as well as their different levels of shell dissolution. Students will then contrast their observations to estimate shell dissolution in the past, present, and future ocean. The students will analyze their data from their assigned experiment and determine the correlation between ocean acidification and the higher rates of shell dissolution. Students will then create an argument for or against ocean acidification effect on pteropod shells.

Learning Objectives & Outcomes

- Recognize patterns
- Data collection and data analysis
- Argument from evidence

Using This Lesson

The activity in this lesson will be done in small groups. The background information has been written so it can be used as reading material for students. Key terms are defined at the end of the lesson. Questions and charts are provided to promote discussion and critical thinking. See the resource page for links to documents that support this lesson.

Background Information/Scenario

One of the ocean's best snack foods is becoming scarcer due to environmental changes and salmon population. Scientists are concerned! Oregon Department of Fish and Wildlife is worried that a loss of pteropods may have adverse effects for many industries in Oregon. However, they are unsure of the cause of the declines in pteropod populations and what it means for future Salmon populations.

Contact:

SMILE Program

smileprogram@oregonstate.edu

<http://smile.oregonstate.edu/>

ODFW has set up a controlled experiment and has contacted your students for help! Your students are a team of oceanographers and are in charge of determining what is happening to the pteropods, why it is happening, and if it will be detrimental to the future Salmon industry. ODFW has recreated water conditions at three simulated sites (the past 1918, present, and 100 years in the future) that each contain a population of pteropods.

Students must recognize and identify patterns, graph those patterns, and then create a claim about what is happening to the pteropods population. Their teams will then be tasked with presenting a claim to ODFW based on evidence that they collected.

Set Up

1. Create three table top stations. Label one station 1918, another 2018, and the last 2118. Each of these stations represents pteropods populations in a simulated experiment. 1918 has similar ocean conditions of the ocean 100 years ago, while 2118 simulates the water conditions we might expect to see 100 years in the future.
2. Label each station with the time period (as followed by the *Middle School Teacher Site Data Chart* below). In addition to labeling the time period at every site, label each site with the pH factor. This can be found on the Teacher Site Data Chart. The pH will decrease over time to represent the potential change of hydrogen at each time period. Do not mention pH or other factors to students, as you should aim for students to recognize patterns based on the trend of decreasing pH.
3. Cut out each individual pteropod found on the Pteropod Cutout Sheets. Use the *Middle School Teacher Site Data Charts* to know how many pteropods types to put at each station.

Middle School Teacher Station Data

Sites	No Dissolution	Minor Dissolution	Type I	Type II	Type III	pH
1918	80	17	2	1	0	8.25
2018	72	19	5	2	2	8.1
2118	55	22	9	8	6	7.7

Next Generation Science Standards

PERFORMANCE EXPECTATIONS:

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

DISCIPLINARY CORE IDEAS:

ESS3.C: Human Impacts on Earth Systems

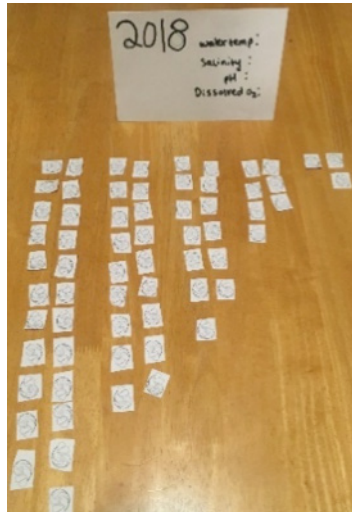
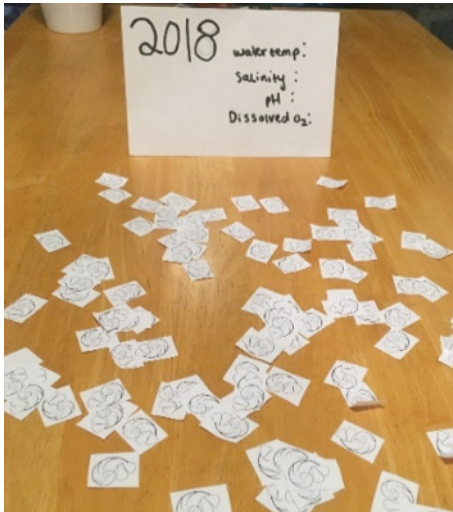
SCIENCE AND ENGINEERING PRACTICES:

Constructing Explanations and Designing Solutions

CROSSCUTTING CONCEPTS:

Cause and Effect

Station Example








Stations should contain a mixed pile of 100 pteropod cutouts. Students will then organize the cutouts into five piles based on their dissolution type.

Middle School Teacher Instructions

1. Show students Introductory PowerPoint and share the scenario with the class. The scenario can be found at the beginning of this lesson.
2. Separate students into groups of three. These groups will be their original 'home' groups.
3. Explain to students that there are 100 pteropods at each time period, and that they will need to separate the cutouts based on patterns they recognize in order to determine what is affecting the pteropods.

Pteropod Shell Dissolution Types and Descriptions

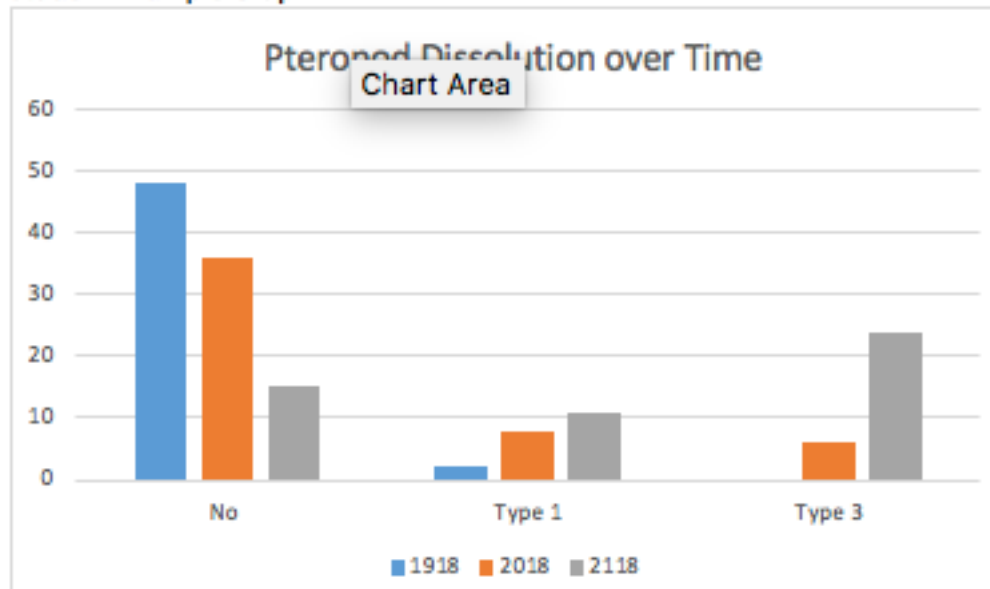
Types of Damage	Description/definition	Visual Representation
No Dissolution	No pores are visible on the surface of the shell.	
Minor Dissolution	7 or fewer small pores are visible on the surface of the shell.	
Type I Dissolution	More than 7 small pores are visible on the surface of the shell.	
Type II Dissolution	Larger areas of the shell surface are covered by dissolved patches. Many small and medium pores are visible on the shell.	
Type III Dissolution	Large gaps on the surface of the shell. The shell is starting to lose its structure due to damage.	

Use this chart in addition to the pteropod cutouts to determine pteropod shell dissolution types. This chart describes the five categories of dissolutions present at each station. Students will receive an empty dissolution chart to complete. You may share this with your students to familiarize them with the five types of dissolution, or ask your students to distinguish pteropod type without the help of the chart. Students will fill in missing information based on the five types of cutouts that they notice at their stations. Students will also categorize each type of damage by creating a sketch of the patterns they notice at their stations.

4. Give students the *Student Handout Sheet*. The student handout sheet includes guiding questions. Answers to the guided questions can be found separately in "Teaching Guiding Question Answers."

5. Ask each home group to send one student to the 1918 station, one student to the 2018 station, and the remaining student to the 2118 station.
6. Ask students to discuss the following question in their station groups.
 - a. What are ways that you can separate cutouts at each station?
7. At each station have students divide pteropods cut outs into piles based on the Dissolution Chart.
 - a. Students should be dividing 100 pteropods at each site into five categories: No Dissolution, Minor Dissolution, Type 1 Dissolution, Type 2 Dissolution, and Type 3 Dissolution. Students will receive a *Dissolution Chart* and will be asked to separate pteropods by severity of damage.
 - b. Students should fill out the visual representation of the dissolution chart by sketching an example of each pteropod type. Students can do this by sketching example pteropods at their stations.
8. After separating the pteropod cut outs based on dissolution, ask students to fill in a student data chart to record their data. The student data chart, once complete, will look exactly like the Teacher Station Data chart. See above.
9. While students are working at each station, ask the first two guided questions. Students will take this knowledge and apply it later to their home groups to help them create their claims. Each student in the class needs to complete the guided questions used later in their home groups, using data from all three sites (1918, 2018, and 2118), have students graph their pteropods numbers based on the dissolution type. See *Example Student Graph*.
10. Ask the following questions to the class after students have created graphs and had time to discuss some of their findings:
 - a. What did our bar graph look like?
 - b. What trends did you notice?
 - c. Why do you think these trends are happening?
11. Have students finish their remaining guided questions.

Student Example Graph



12. Give the students the *Student Handout Articles* (2) to read. If you have access to the Internet the students can also do Internet searches to find additional information.

13. In their home groups, ask students to construct a claim based on the evidence they collected and that of the readings using the *Claim and Evidence Chart*.

14. In their home groups, have students present their evidence and claim to 'ODFW'. Your class will take on the role of ODFW. Students will present to their classmates, while the rest of the class in the role of ODFW will listen to the presenters and ask questions.

What is happening to the pteropods in the ocean, and based on their evidence, why is it happening?

Using their claim and evidence have students make a hypothesis on how what is happening to pteropods will affect future salmon populations, industry in Oregon, and the Oregon economy.

This project is supported by the Regional Class Research Vessel Program in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University.

Resources

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

<https://ww2.kqed.org/quest/2014/02/25/pteropods-very-small-and-very-important/>

<http://rspb.royalsocietypublishing.org/content/281/1785/20140123>

http://www.noaanews.noaa.gov/stories2014/20140430_oceanacidification.html

<https://apps.seattletimes.com/reports/sea-change/2014/apr/30/pteropod-shells-dissolving/>

Middle School Student Page

One of the Ocean's best snack foods is becoming scarcer due to environmental changes and salmon population. Scientists are concerned! Oregon Department of Fish and Wildlife is worried that a loss of pteropods may have adverse effects for many industries in Oregon. However, they are unsure of the cause of the declines in pteropod populations and what it means for future Salmon populations.






ODFW has set up a controlled experiment and has contacted you for help! You are a team of oceanographers and are in charge of determining what is happening to the pteropods, why it is happening, and if it will be detrimental to the future Salmon industry. ODFW has recreated water conditions at three simulated sites (the past 1918, the present 2018, and 100 years in the future) that each contain a population of pteropods.

Instructions

1. Send one person from your group to the 1918 station, one person to the 2018 station, and one person to the 2118 station. Pteropods will be categorized into five types.
2. At your station, discuss with classmates how you should divide your pteropod samples. Once you have discussed with your classmates, separate your pteropod samples into five groups.
3. At your stations fill in the Pteropod Type Chart. The type chart includes an area for you to sketch the different pteropod types. To determine these, look at your organized pteropod samples and describe any patterns you recognize.

Student Materials

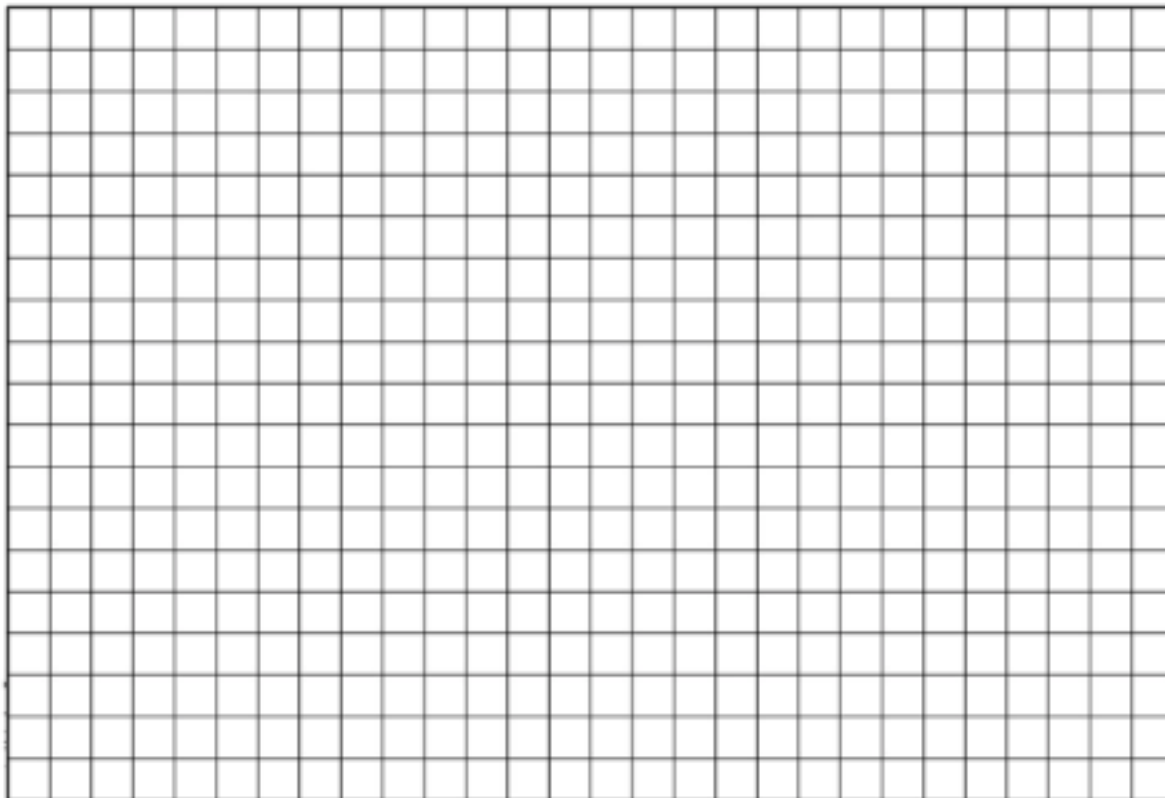
- Desk space
- Graphing paper
- Pencils and colored pencils
- Paper

Types of Damage	Description/definition	Visual Representation (sketch number of pores on empty pteropods)
No Dissolution	No pores are visible on the surface of the shell.	
Minor Dissolution	7 or fewer small pores are visible on the surface of the shell.	
Type I Dissolution	More than 7 small pores are visible on the surface of the shell.	
Type II Dissolution	Larger areas of the shell surface are covered by dissolved patches. Many small and medium pores are visible on the shell.	
Type III Dissolution	Large gaps on the surface of the shell. The shell is starting to lose its structure due to damage.	

4. At your station, record your data in the Pteropod Data Chart.

Sites	No Dissolution	Minor Dissolution	Type I	Type II	Type III	pH
1918						
2018						
2118						

5. In your home group, create a graph that compares each pteropod type at each station (1918, 2018, and 2118) in the space below or on a separate sheet of graphing paper. Use your collected data and group mates' data.



6. Rejoin your home group and complete the remaining questions.

7. In your home group, read the two articles:

Pteropods: The Beer Nuts of the Sea
Ocean Acidification: A Risky Shell Game

8. With your group, construct a claim based on evidence using the *Claim and Evidence Chart*. A description of how to use a Claim and Evidence Chart to create a scientific explanation can be found below.

Mystery of the Disappearing Pteropods: Dude Where's My Shell (MS)

Example

Description	Example
Claim: The answer or conclusion to the scientific question	<i>The Yankees are the best team in Major League Baseball.</i>
Evidence: Scientific Data that supports the claim	<i>The Yankees have won the World Series more than any other team in history.</i>
Reasoning: Explains why the evidence supports the claim, providing a logical connection between the evidence and claim	<i>The World Series is a championship to determine who is the best team in the major leagues. Because the Yankees have won this championship more times than any other team, they are the best team in Major League Baseball.</i>

Claim and Evidence Chart

CLAIM (The environmental impact on the pteropod shells is occurring because...)	EVIDENCE (List data that backs up your evidence and supports your claim)	REASONING (This evidence supports my claim because...)

Complete the Claim and Evidence Chart in your home group to construct a claim that will later be presented to ODFW.

9. With your original group, present your evidence and claim to ODFW! What is happening to the pteropods in the ocean, and based on your evidence, why is it happening?

Using your claim and evidence make a hypothesis on how what is happening to pteropods will affect future salmon populations, industry in Oregon, and the Oregon economy.

Questions

Answer with 2-3 full sentences

1. How did you decide to organize your pteropods? What do the spots on the pteropod shells represent?

2. Do you expect the data at the other two time periods to look similar to the data you collected at your station?

Explain your answer.

3. What time period had the greatest amount of severely affected pteropods? What trends do you see? What do you think shell dissolutions might look like at 2150?

4. Why do you think the rates of shell dissolution may vary at different time periods?

5. What would you conclude to be the main cause of pteropod dissolution?