Regional Class Research Vessel

Oregon State University

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

Timeframe
60-90 minutes

Target Audience
Grades 9th- 12th

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

Contact:
SMILE Program
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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

Oregon Department of Fish and Wildlife (ODFW) biologists are concerned that pteropods, a zooplankton and one of the Ocean's best snack foods, is becoming scarcer. Salmon biologists have also taken note as pteropods make up an important component of the salmon's diet. They are also worried that a reduction in the number of pteropods may have adverse effects for many industries important to the Oregon economy. ODFW biologists have been studying the cause of this decline in pteropod populations, but they have not

identified the underlining cause. They have tasked your class with helping to determine the cause of the pteropod decline.

ODFW has set up a controlled experiment and has contacted your students for help! Your students are a team of biologists and are in charge of making a claim of what is happening to the pteropods, supporting that claim with evidence, and developing a hypothesis on what affect this may have on salmon populations in the future. ODFW has recreated water conditions at three simulated sites (1918: Pre-Industrial, 2018: Present day, and 2118: 100 years in the future) that each contain a population of 100 pteropods.

Students must recognize and identify patterns within the population of pteropods they are studying, analyze those patterns, and then create a claim about what is happening to the pteropods population. Their teams will then be tasked with presenting that claim to 'ODFW' based on evidence that they collected. Your class will take on the role of ODFW. Students will present to their classmates, while those in the role of ODFW will listen to the presenters and ask questions.

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. In addition to labeling the time period at every site, label each site with the following factors: Temperature, Dissolved Oxygen, Salinity, and pH. Following the *High School Teacher Station Data Chart* below. Temperature, dissolved oxygen, and salinity are similar for each site while pH will vary. The pH of the ocean is decreasing due to excess CO2 being dissolved in the ocean. Do not mention pH or other factors to students, the intent of the lesson is for students to recognize these patterns based on the changes in pH.
3. Cut out each individual pteropod found on the *Pteropod Cutout Sheets*. Use the *High School Teacher Station Data Charts* to know how many pteropods types to put at each station.

Next Generation Science Standards

PERFORMANCE EXPECTATIONS:

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

DISCIPLINARY CORE IDEAS:

ESS2.D: Weather and Climate
ESS3.D: Global Climate Change

SCIENCE AND ENGINEERING PRACTICES:

Analyzing and Interpreting Data
Using Mathematics and Computational Thinking

CROSSCUTTING CONCEPTS:

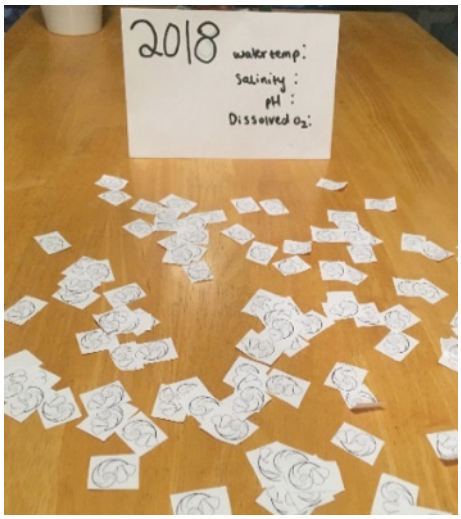
Cause and Effect
Systems and System Models

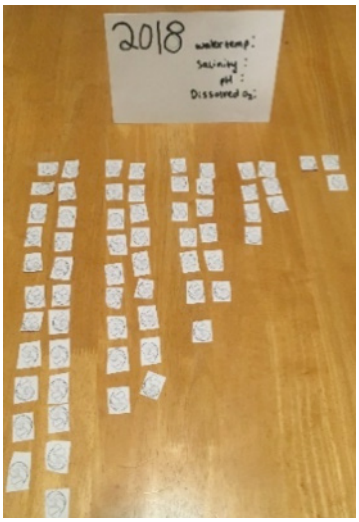
High School Teacher Station Data

Sites	No Dissolution	Minor Dissolution	Type I	Type II	Type III	Temp °C	Dissolved O2 (mg/L)	Salinity ppt (parts per thousand)	pH
1918	80	17	2	1	0	11.25	659	34	8.25
2018	72	19	5	2	2	11.5	658	34	8.1
2118	17	22	19	20	22	11.53	659	34	7.7

Use this chart to set up pteropods and environmental factors at three separate stations: 1918, 2018, and 2118. At each station, create a sign with the station date, and label each factor with a sharpie.

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.

High 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. Give students an example pteropod population labeled 'Pteropod Population Sample' that contains each category of pteropods (separate from the three stations). You will need 1 per group. Here students will identify each category of dissolution and complete their empty *pteropod type chart* – familiarizing them with the pteropod dissolution categories before they are asked to collect data at their stations.
3. Explain to students that their 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?

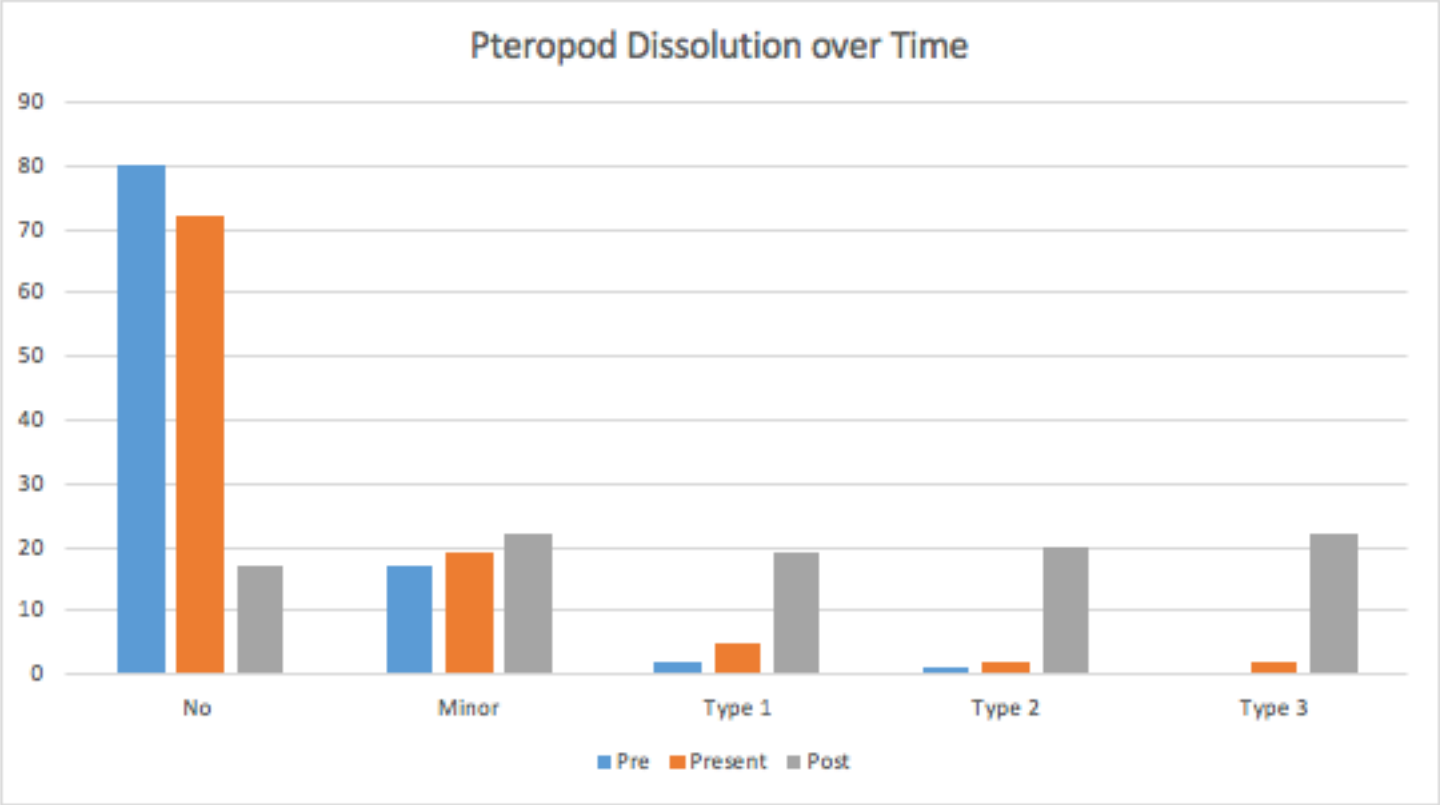
7. At each station have students divide pteropods cut outs into piles based on the conclusion that they came up with at their station groups. Students should come to the conclusion that pteropods should be separated by dissolution patterns. If students separate pteropods by something other than dissolution, students may have difficulty proceeding through the lesson. Note that students will not receive a complete 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 an empty *Dissolution Chart* and will be asked to separate pteropods by severity of damage. Students may organize pteropods cut outs by patterns that they recognize.
    b. Students should fill out the chart based on their findings, including drawing a sketch of each dissolution type.

8. After separating the pteropod cut outs based on dissolution, ask students to create a chart and record their data at their respective stations. A premade chart exists in the MS version of this lesson, if you would like to use one with your students.

9. While students are working at each station, ask students to answer 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?

Example Student Graph



11. Have students finish their remaining guided questions.

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 informaiton.

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/

High 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.

Student Materials

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

Instructions

1. Using your groups pteropod sample, individually complete the *pteropod type chart* found below. 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.

2. 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.

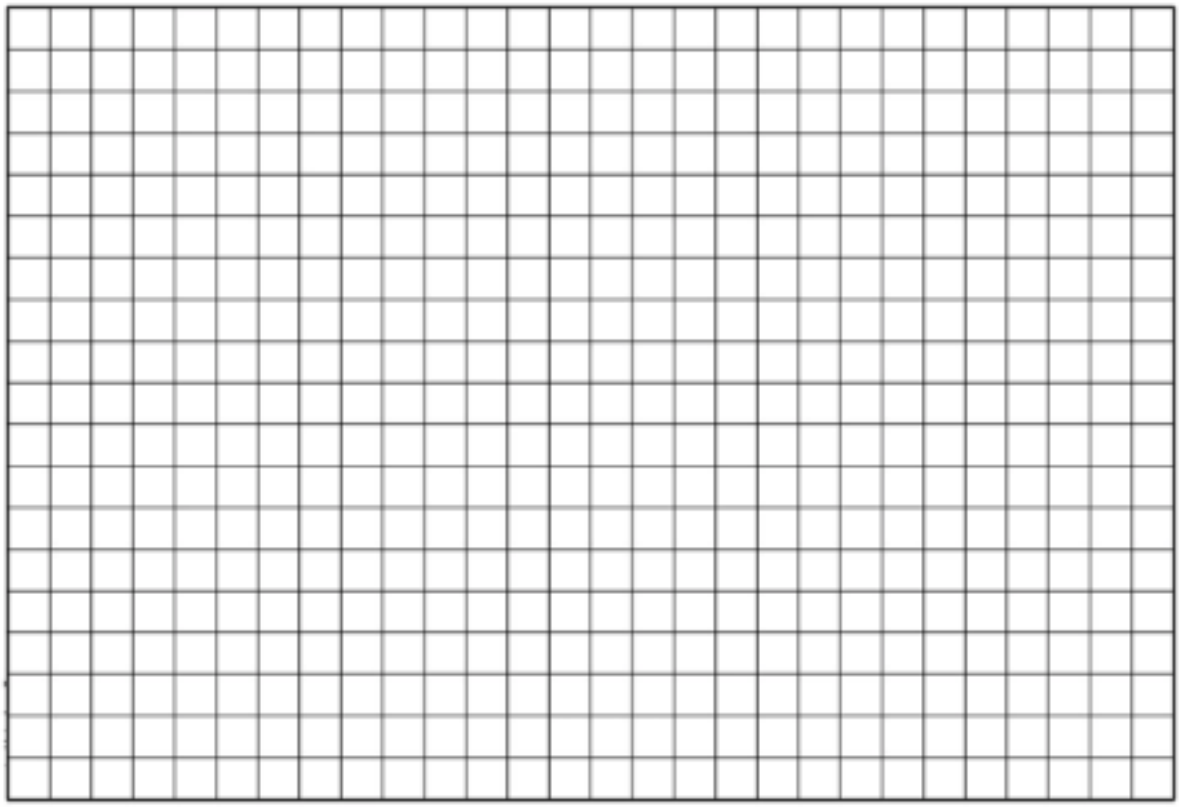
2. At your station, discuss with classmates how you should divide your pteropod samples. Once you have discussed with your classmates, separate your pteropod samples into five groups.

Pteropod Type Chart

Types of pteropods	Description/definition	Sketch of pteropod patterns
1.		
2.		
3.		
4.		
5.		

4. At your station answer the first two questions found below. You will answer the remaining questions in your home group. Develop a chart to collect the data at your station in the space provided below.

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.

Example

Description	**Example**
Claim: The answer or conclusion to the scientific question	*The Yankees are the best team in Major League Baseball.*
Evidence: Scientific Data that supports the claim	*The Yankees have won the World Series more than any other team in history.*
Reasoning: Explains why the evidence supports the claim, providing a logical connection between the evidence and claim	*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.*

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?