**Mystery of the Disappearing Pteropods: Dude Where’s My Shell**

**High School Teacher Page**

**Teacher Materials**

* Three Tabletop Stations
* Paper
* Scissors
* Graphing Paper
* Pencils and Colored Pencils
* Sharpie Marker

**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 numbers 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.

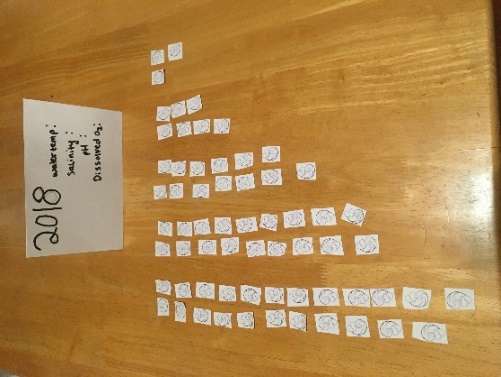
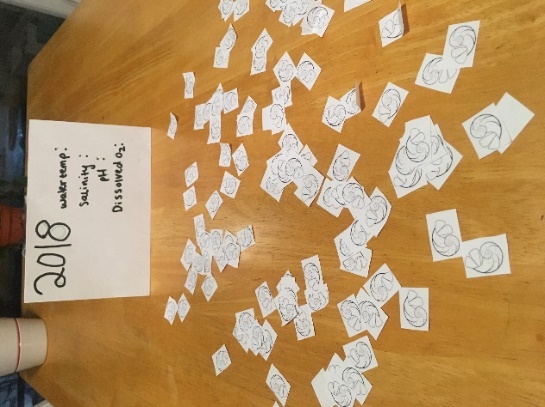
ODFW has set up a controlled experiment and has contacted your students for help! Your students are a team of biologists and are in charge of making a claim of what is happening to the pteropods, supporting that claim with evidence, and develop a hypothesis on what affect this may have on salmon populations in the future. ODFW has recreated water conditions at three simulated time periods (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 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.

**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 top of the High School Teacher Page.
2. Separate students into groups of 3. 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 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 | 10 or fewer small pores are visible on the surface of the shell. |  |
| Type I Dissolution | More than 10 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 5 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 5 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 5 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.

1. Give students the *Student Handout Sheet*. The student handout sheet includes guiding questions. Answers to the guided questions can be found separately in “Teacher Guiding Question Answers.”
2. 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.
3. Ask students to discuss the following question in their station groups
   1. What are ways that you can separate cutouts at each station?
4. 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.  
   1. 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.
   2. Students should fill out the chart based on their findings, including drawing a sketch of each dissolution type.
5. After separating the pteropod cut outs based on dissolution, ask students to create a chart and record their data at their perspective stations. A premade chart exists in the MS version of this lesson, if you would like to use one with your students.
6. 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. 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*.
7. Ask the following questions to the class after students have created graphs and had time to discuss some of their findings:
   1. What did your bar graph look like?
   2. What trends did you notice?
   3. Why do you think these trends are happening?

**Example Student Graph**

1. Have students finish their remaining guided questions.
2. 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.
3. 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.*
4. 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.

**High School Student Page**

**Student Materials**

* Desk Space
* Graphing Paper
* Pencils and Colored Pencils
* Paper

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.

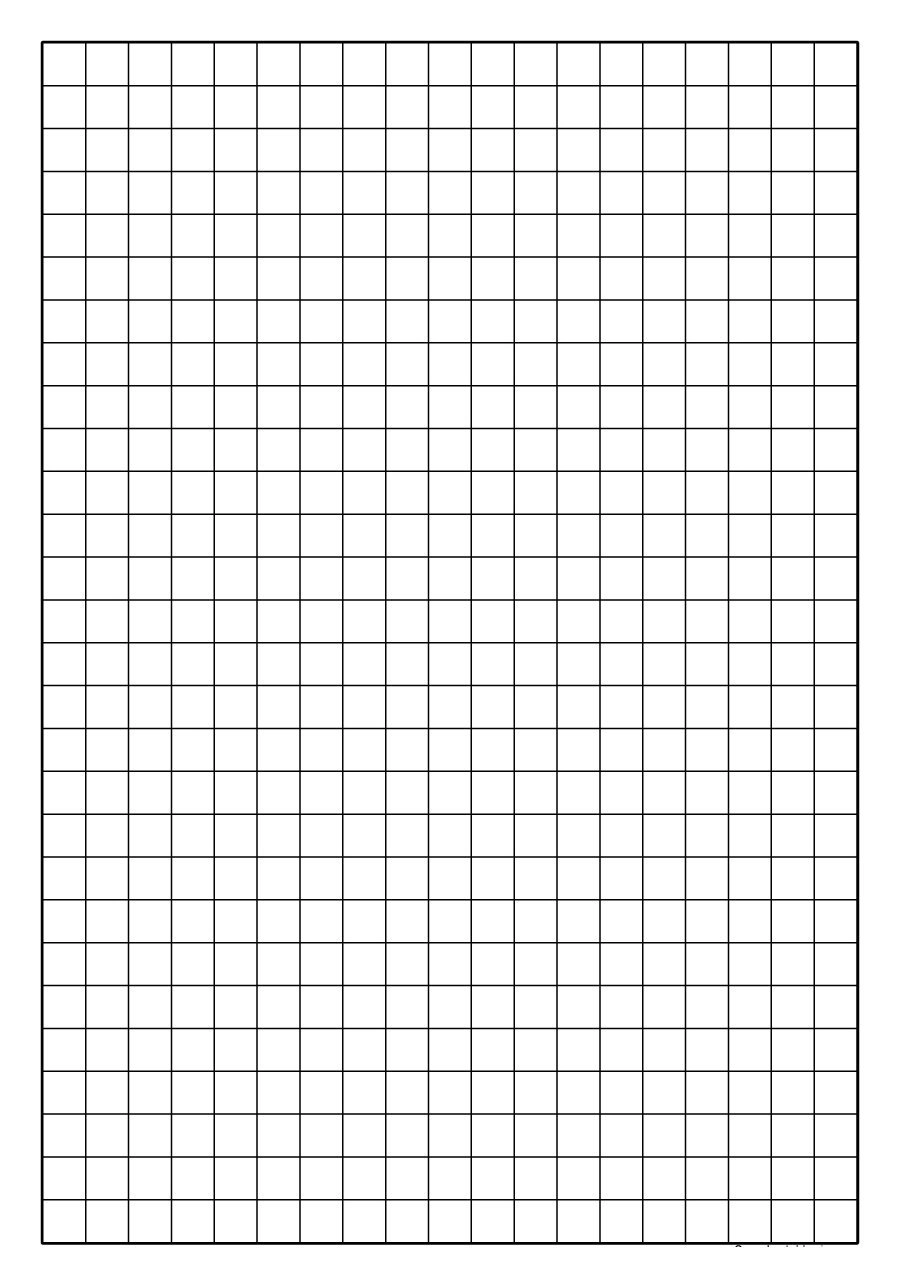
ODFW has set up a controlled experiment and has contacted you for help! You are a team of oceanographers and are in charge of determining what is happening to the pteropods, why it is happening, and if it will be detrimental to the future Salmon industry. ODFW has recreated water conditions at three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

1. Using your group’s 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 5 types.
3. 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 5 groups.

**Pteropod Type Chart**

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

1. At your station answer the first 2 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.
2. 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.



1. Rejoin your home group and complete the remaining questions.
2. In your home group, read the two articles:  
    Pteropods: The Beer Nuts of the Sea  
    Ocean Acidification: A Risky Shell Game
3. 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.

1. 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 2 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?