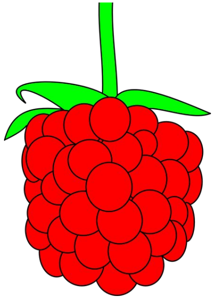
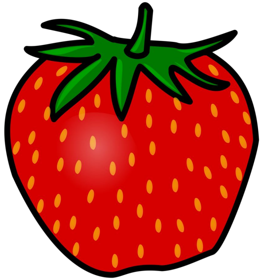
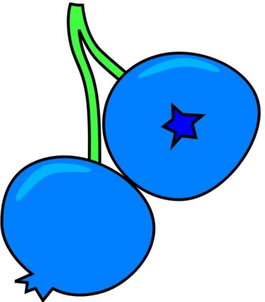
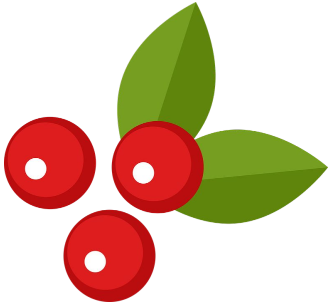


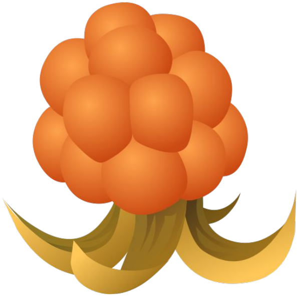


Turn & Talk:
What’s your favorite berry?

And what makes it taste the best?

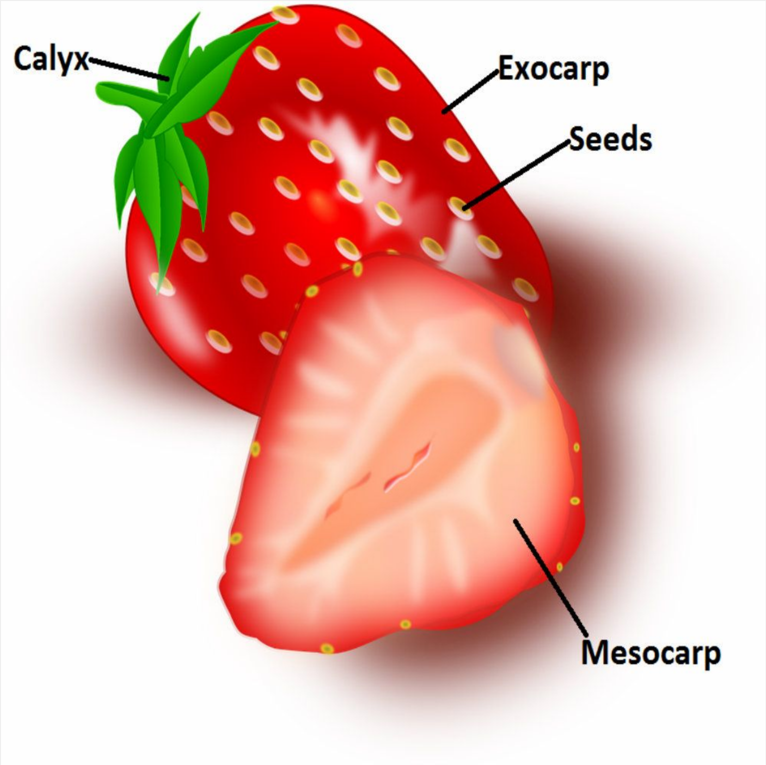






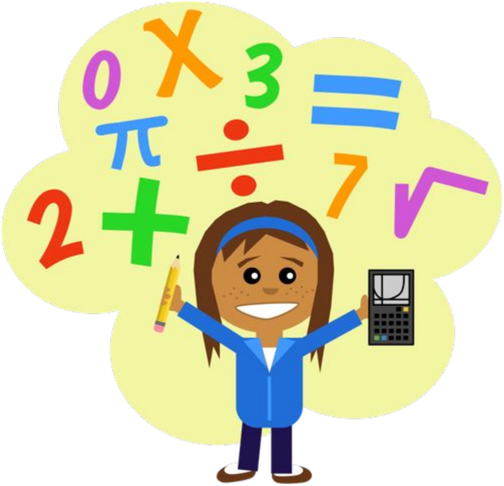
What makes up a berry?

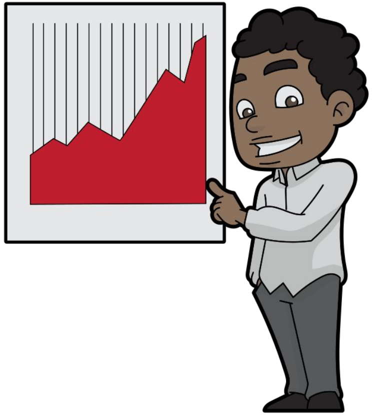
- Sugar
- Water
- Other Organic Materials (Seeds, etc.)



Objectives: Students will be able to…

- Analyze berry data by
    - Analyzing a graph of Berry Weights
    - Calculating the percentage of water in a berry species
    - Creating and analyzing a graph displaying class calculated data





What do you think of when you think of “The Arctic” or “Alaska”?

Atigun Pass cuts through the snowy mountains of the Brooks Range on the Dalton Highway, Alaska.

A group of hikers from Toolik Field Station walk through a green field along the Atigun River, Alaska.

What food do you think grows in the Arctic?

Photos by Elizabeth Backman (PolarTREC 2021), Courtesy of ARCUS

Berries in the Arctic:
An important food source for animals and people alike!

Liza Backman (R) and Sarah Ansbro (L) harvest berries at Chandalar Shelf, Dalton Highway, AK.
Photo by Jeremy May, Courtesy of Elizabeth Backman (PolarTREC 2021), Courtesy of ARCUS

What types of berries are there?

- The arctic is home to several different berry species!
- The five berry species that we will be focusing on are:
    - *Empetrum nigrum (EN)*
    - *Arctous alpina (AA)*
    - *Vaccinium uliginosum (VU)*
    - *Vaccinium vitis-idaea (VVI)*
    - *Rubus chamaemorus (RC)*

Task! Can you find…

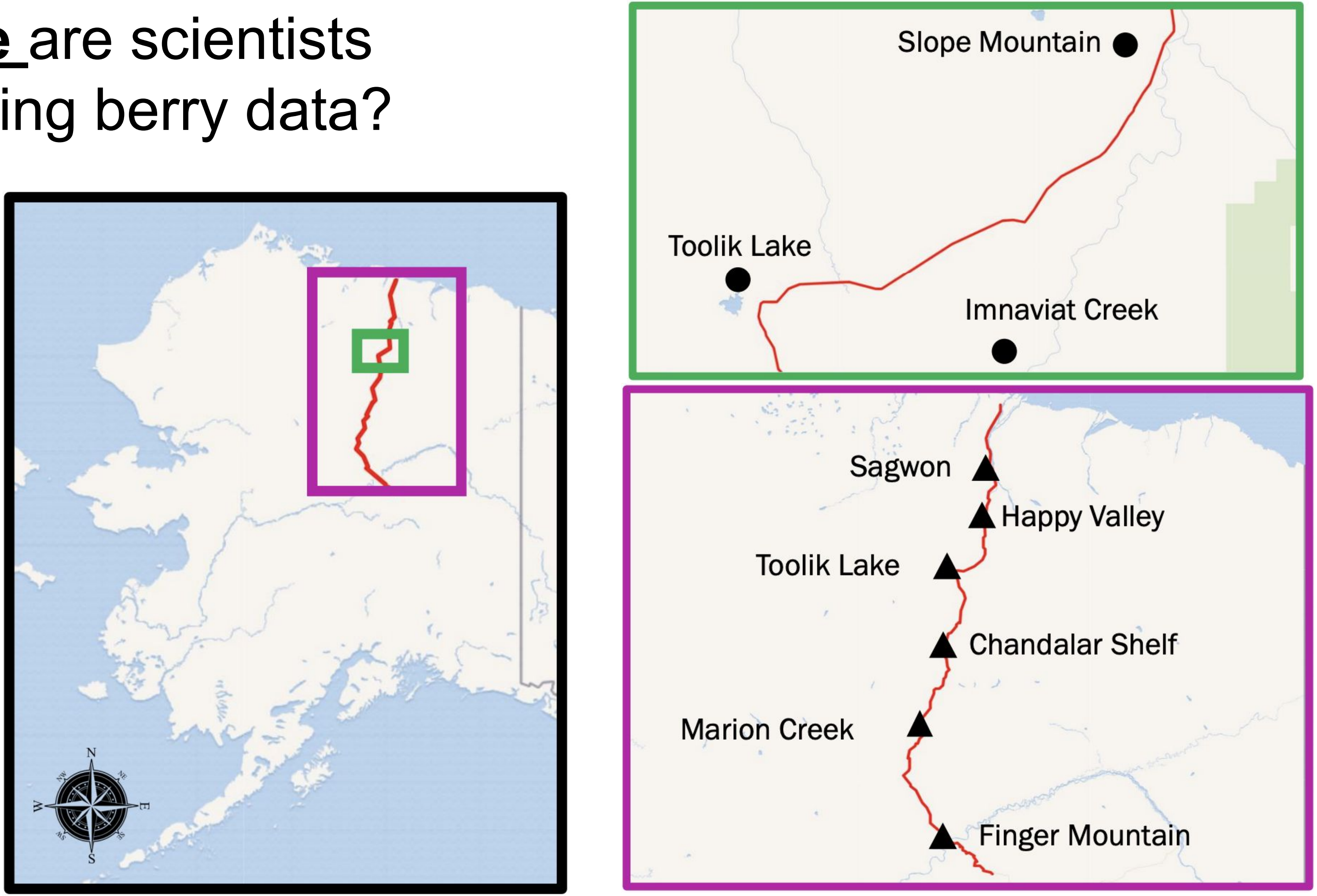
1. The Iñupiaq (native) name of these 5 species?
2. The common name of these 5 species?
3. One use for each species?

Need help? Click Here!

Big Question:
How is climate change affecting berry growth and nutritional value?

Let’s talk data collection!

Where are scientists collecting berry data?

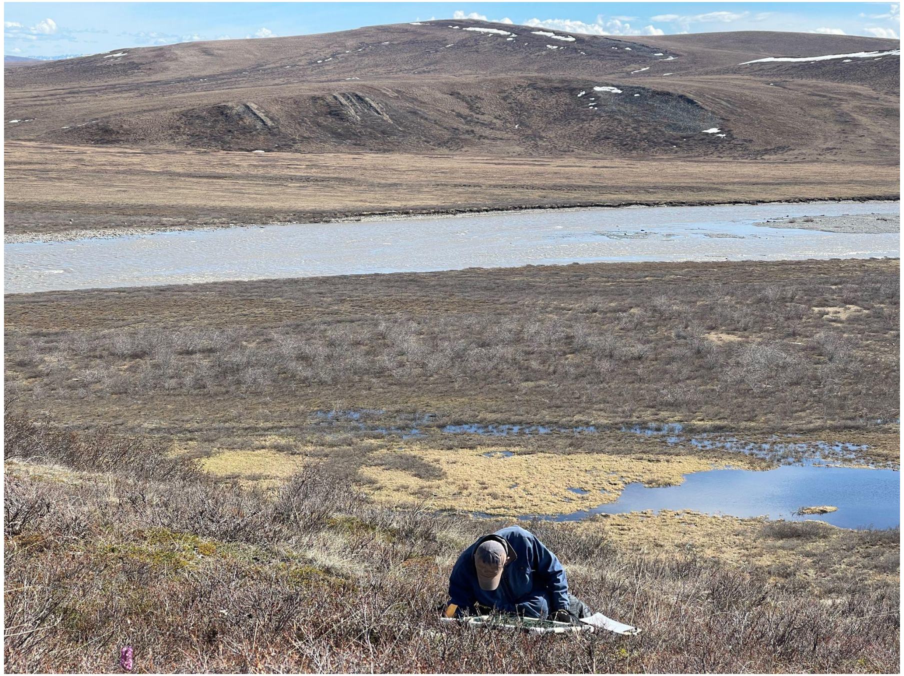


How often do scientists collect berry data?

- At most sites, Berry Monitoring is completed once in the "spring" (June) and once in the "fall" (August).
  - For three sites (Toolik, Imnavait Creek, and Slope Mountain), data has been collected since 2016
  - For all other sites, data has been collected since 2021

- In 2021, ***weekly*** data collection for the Imnavait Creek location began and ran for approximately 9 weeks
  - This data collection process was slightly different than what will be presented, but follows a similar concept.

How do scientists collect berry data?



Jeremy May counts berries on a slope near the Sagavanirktok River. Dalton Highway, Alaska.

Photo by Elizabeth Backman (PolarTREC 2021), Courtesy of ARCUS

In the field…

- First, a random area is selected
- Berries in that location are **counted** and **harvested**
- Berries are **separated by species** and **stored for further analysis**
- This happens 12x **per location**

How do scientists collect berry data?

Back at the lab…

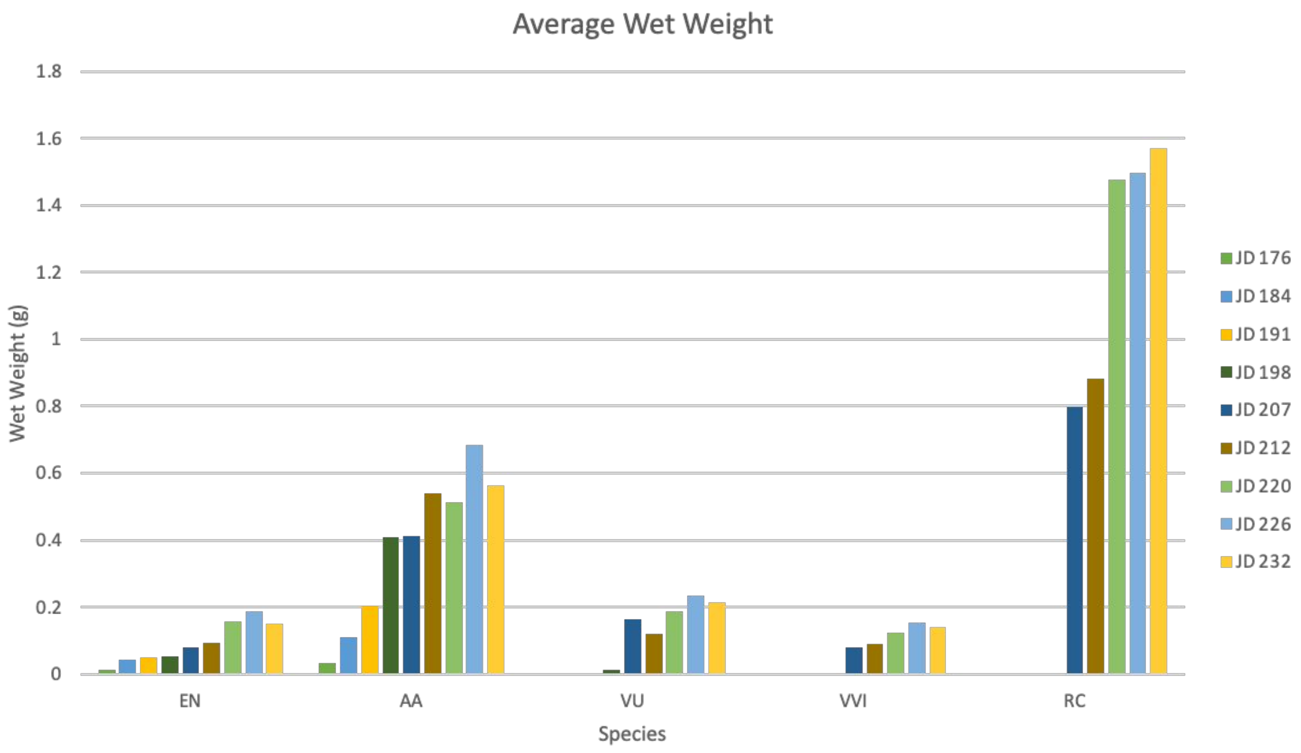
- Berries are re-counted by species
- Berries are massed
    - “Fresh/Wet Mass”
- Berries are dried out in a dehydrator
- Berries are weighed again
    - “Dry Mass”
- Berries are sent to another lab with proper equipment for more analysis
    - Sugar Content
    - Organic Content

Liza Backman (L) and Sarah Ansbro (R) weigh and measure berries harvested for the annual spring berry survey. Toolik Field Station, Alaska.

Photo by Jeremy May (PolarTREC 2021), Courtesy of ARCUS

Berry Data

Task 2: Analyzing a Graph



Trend: Berries are getting bigger over time

- Question: Why are they getting bigger?
  - More specific question: What part of the berry is changing as they get bigger?
    - Water content?
    - Sugar content?
    - Something else?

Think About It… Think back to the methods we discussed earlier, which of these variables do you think we monitored the most closely during the season? Why? (*Hint: Which did we do in the lab?)*

Finding water content

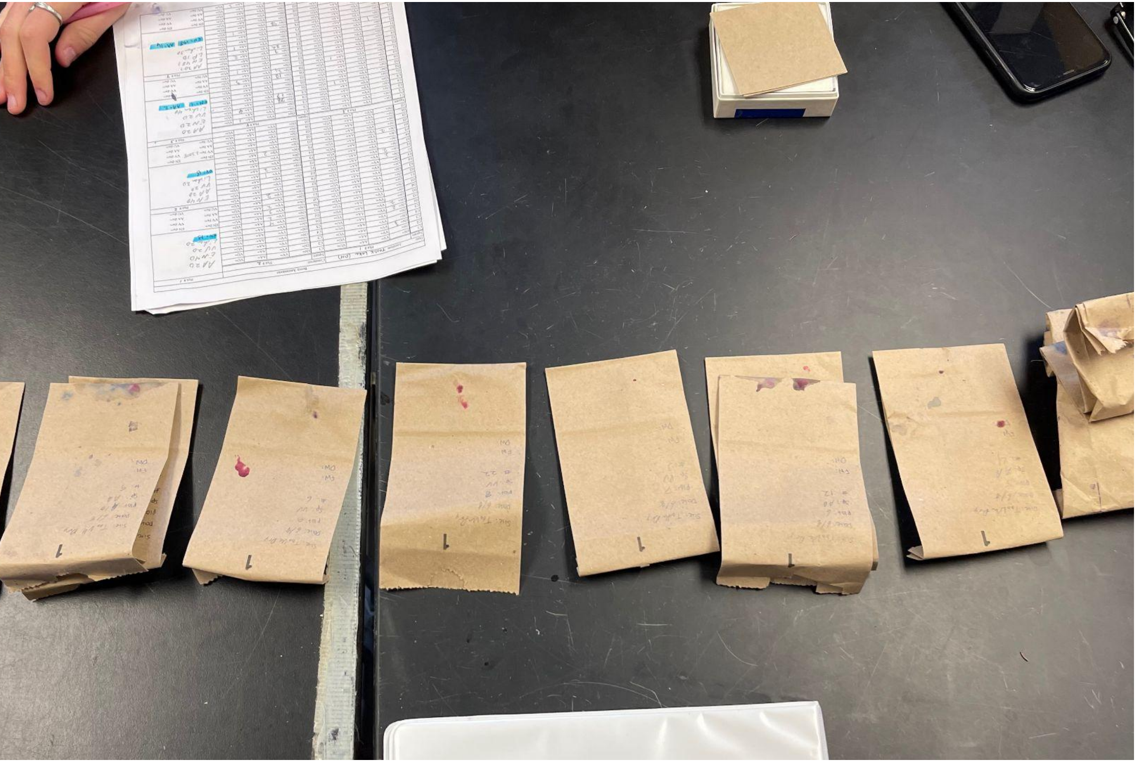
Procedure

1. Mass fresh berry (containing water)
2. Dry berry using a dehydrator
3. Mass dry berry (without water)

Task 3: Methods to Math!

On page 2 of your worksheet, you will be using the above procedure to help you analyze sample data and figure out how scientists process raw data.

After harvesting berries for the annual spring berry survey, they are recounted and massed. Later, the berries will be dried and then massed again to determine water loss. Toolik Field Station, Alaska. Photo by Elizabeth Backman (PolarTREC 2021), Courtesy of ARCUS



Sarah Ansbro recounts berries collected during the annual spring berry survey. Toolik Field Station, Alaska. Photo by Elizabeth Backman (PolarTREC 2021), Courtesy of ARCUS

How much data??

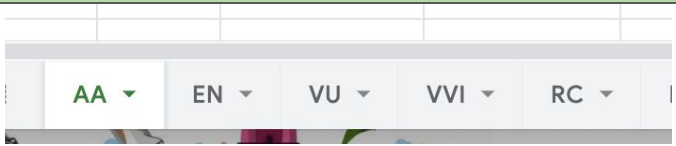
- The data we will be looking at is coming was taken **weekly (over 9 weeks)** at one location
- For each berry species (5 total), roughly 20 samples were collected each week.
- 5*20*9 = 900 specimens were analyzed… That's a LOT OF DATA!
- Luckily, we're going to take a look at only the average of the 20 samples for each day

Task #4: Processing and Analyzing Data

You and your group will be assigned one species that you're in charge of. For all data associated with that species, you will need to:

1. Calculate the Mass of H_2O
2. Calculate the % Composition of H_2O
3. Record the data you and your peers collect on your species' tab on the class spreadsheet IN THE YELLOW BOXES ONLY

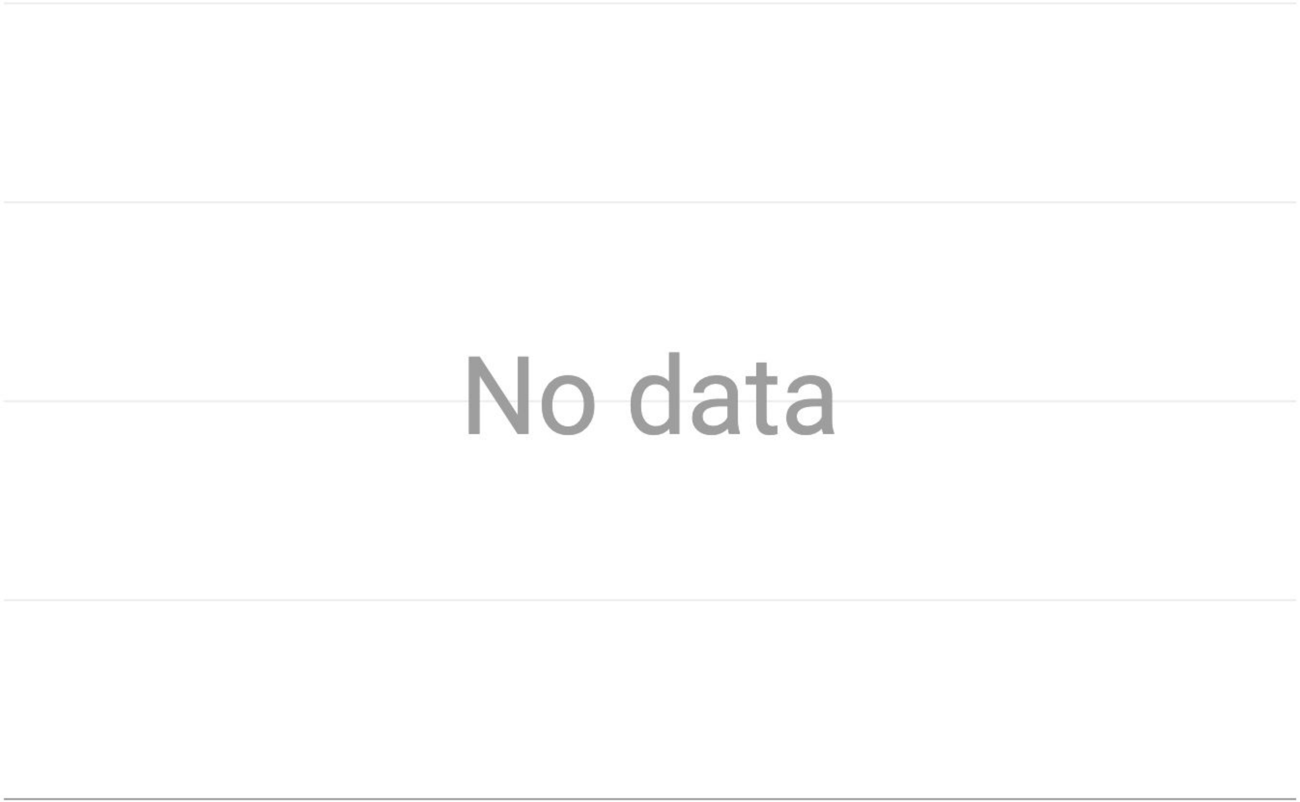
FOUND AT BOTTOM OF SPREADSHEET



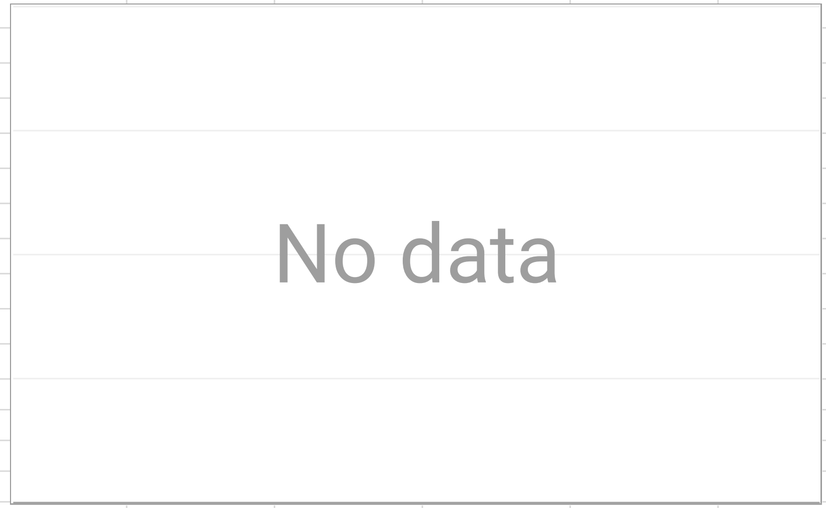
Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
0.0342	0.0049		
0.1105	0.0140		
0.2031	0.0273		
0.4081	0.0550		

4. Use the graph that is created to answer the analysis questions on your worksheet

Our Class Graph



Data for Arctuous Alpina					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
176	AA	0.0342	0.0049		
184	AA	0.1105	0.0140		
191	AA	0.2031	0.0273		
198	AA	0.4081	0.0550		
207	AA	0.4109	0.0582		
212	AA	0.5412	0.0880		
220	AA	0.51158	0.076465		
226	AA	0.68314	0.09231		
232	AA	0.564905	0.07945		



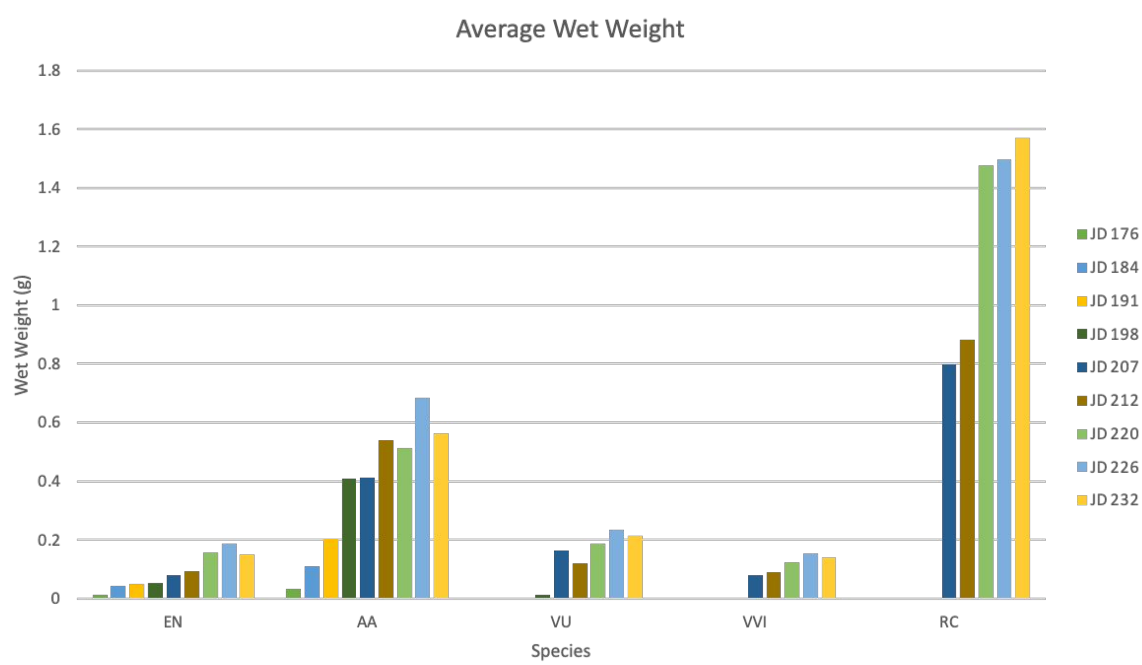
Name: ______________________________ Date: ____________________

Arctic Berries

Task 1: Species of Interest. Fill in the table below for each of the five species of interest. You may want to use this website as a starting place for your research: https://bit.ly/3MNo5W4

Species Name	Iñupiaq Name	Common Name	One Use

Task 2: Analyzing a graph. Annotate the graph with your teacher!



1. What trend do you notice within each species?

2. What do you notice when you compare data across species?

Task 3: Methods to Math!

The following data table shows 5 samples of Empetrum Nigrum taken on the same day at the same location. This is only a portion of the full amount of data taken.

Julian Day	Species	Fresh Weight (g)	Dry Weight (g)	H_2O (g)	% H_2O
176	Empetrum nigrum	0.0202	0.0026	0.0176	87.13
176	Empetrum nigrum	0.0163	0.0026	0.0137	84.05
176	Empetrum nigrum	0.0183	0.0030		
176	Empetrum nigrum	0.0089	0.0018		

Use the data table above and the data collection method to answer the following questions:

1. What are the two **quantitative measurements** *(in other words, measurements that contain numbers)* collected in the initial method?

   ______________________ and ______________________

2. What mathematical operation (addition, subtraction, multiplication, or division) was done with the two measurements from question 1 to calculate the mass of water in each berry (H_2O (g))? Show your work for at least one row.

3. Write an equation to calculate the mass of the water. You must use two quantitative measurements from question one and the operation you chose in question two.

   Mass of Water =

4. Use your equation to fill in the mass of water column *H_2O (g)* for the bottom two rows.

5. The general equation to find a percentage is shown below

General % Equation

$$\% = \frac{Part}{Whole} \, x \, 100$$

% H_2O Equation

a. To find the percent of water, what data would we use as the "part"?

b. What data do we use as the "whole"? *Not sure? Test it!*

c. Rewrite the equation using the variables that you selected as the "part" and the "whole" in the box to the right.

6. Use your equation to fill in the percent water composition column *% H_2O* for the bottom two rows.

7. Think back to Task 2. Why might we want to use **percentages** when comparing water content instead of **mass**?

Task 4: Data Processing and Analysis

1. Your teacher will let you know what berry species your group is responsible for and will bring over your team's raw data.
    a. My group is in charge of the _________________________________ species
2. As a team, calculate the following for each Julian Day. Use the space below to show your work for at least **one** set of data.
    a. Mass of H_2O (g)
    b. % of H_2O
3. Under your teacher's direction, add your calculated data into the class spreadsheet. Make sure you are on the tab with your species and are only entering data into the YELLOW BOXES. The graph of your data should automatically populate. You will be using it to answer the following analysis question.

Analysis

1. Looking at the graph for your species…
    a. What patterns or trends do you see in your species graph?
    b. Does this surprise you? Why or Why not?
2. Now, click on the spreadsheet tab labelled "DO NOT EDIT: Full Class Data". (*Remember, tabs are found at the bottom in Google Sheets)*
    a. Is the pattern you found in your species the same across different species?
    b. Does this surprise you? Why or Why not?
3. Remember, our bigger question was what part of the berry was changing as the berry mass grew.
    a. Based on your graphs, did the water content of the berry increase over time?
    b. What does this imply about the part of the berry that is changing as they get bigger?

Name: ______________________________ Date: ____________________

Arctic Berries Check for Understanding

Directions: Use your skills to help fill in the following table. Show your work and/or make sure you reference the equations you are using to fill in the missing data.

Data for Rubus Chamaemorus					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	RC	0.6552	0.1010		
207	RC	0.3658	0.0625		
207	RC	0.4197	0.0630		

Name: ______________________________ Date: ____________________

Arctic Berries Check for Understanding

Directions: Use your skills to help fill in the following table. Show your work and/or make sure you reference the equations you are using to fill in the missing data.

Data for Rubus Chamaemorus					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	RC	0.6552	0.1010		
207	RC	0.3658	0.0625		
207	RC	0.4197	0.0630		

Name: ______________________________ Date: ____________________

Arctic Berries Check for Understanding

Data for Rubus Chamaemorus					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	RC	0.6552	0.1010		
207	RC	0.3658	0.0625		
207	RC	0.4197	0.0630		

1. Fill in the missing parts of the table above. Show your work or reference the equations that you used in the space given below.

2. Which berry species is represent in this set of data? How do you know?

3. Is the data above representing berries from multiple days or from the same day?. How do you know?

4. Describe any patterns or trends you see in % H_2O for this data set.

5. Why do we use % H_2O (as opposed to mass H_2O) when we are comparing data in this scenario?

6. **<u>Reflect</u>**: Fill in the table below to rate your understanding of the skills we learned during the berry lessons. (1 = I need help, 5 = I can teach it!)

Skill	Rating (Circle one!)
I can calculate mass of water and % of water in berry samples.	1 2 3 4 5
I can analyze graphs of berry data	1 2 3 4 5

Species Data: Cut each data table to give to each group of students

Data for Arctuous Alpina					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
176	AA	0.0342	0.0049		
184	AA	0.1105	0.0140		
191	AA	0.2031	0.0273		
198	AA	0.4081	0.0550		
207	AA	0.4109	0.0582		
212	AA	0.5412	0.0880		
220	AA	0.51158	0.076465		
226	AA	0.68314	0.09231		
232	AA	0.564905	0.07945		

Data for Empetrum Nigrum					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
176	EN	0.0128	0.0022		
184	EN	0.0442	0.0042		
191	EN	0.0512	0.0085		
198	EN	0.0520	0.0106		
207	EN	0.0804	0.0134		
212	EN	0.0920	0.0152		
220	EN	0.155675	0.02167		
226	EN	0.187455	0.02372		
232	EN	0.15104	0.0177		

Species Data: Cut each data table to give to each group of students

Data for Rubus Chamaemorus					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	RC	0.7995	0.1215		
212	RC	0.8823	0.1359		
220	RC	1.4766	0.2283		
226	RC	1.4955	0.2193		
232	RC	1.5719	0.2474		

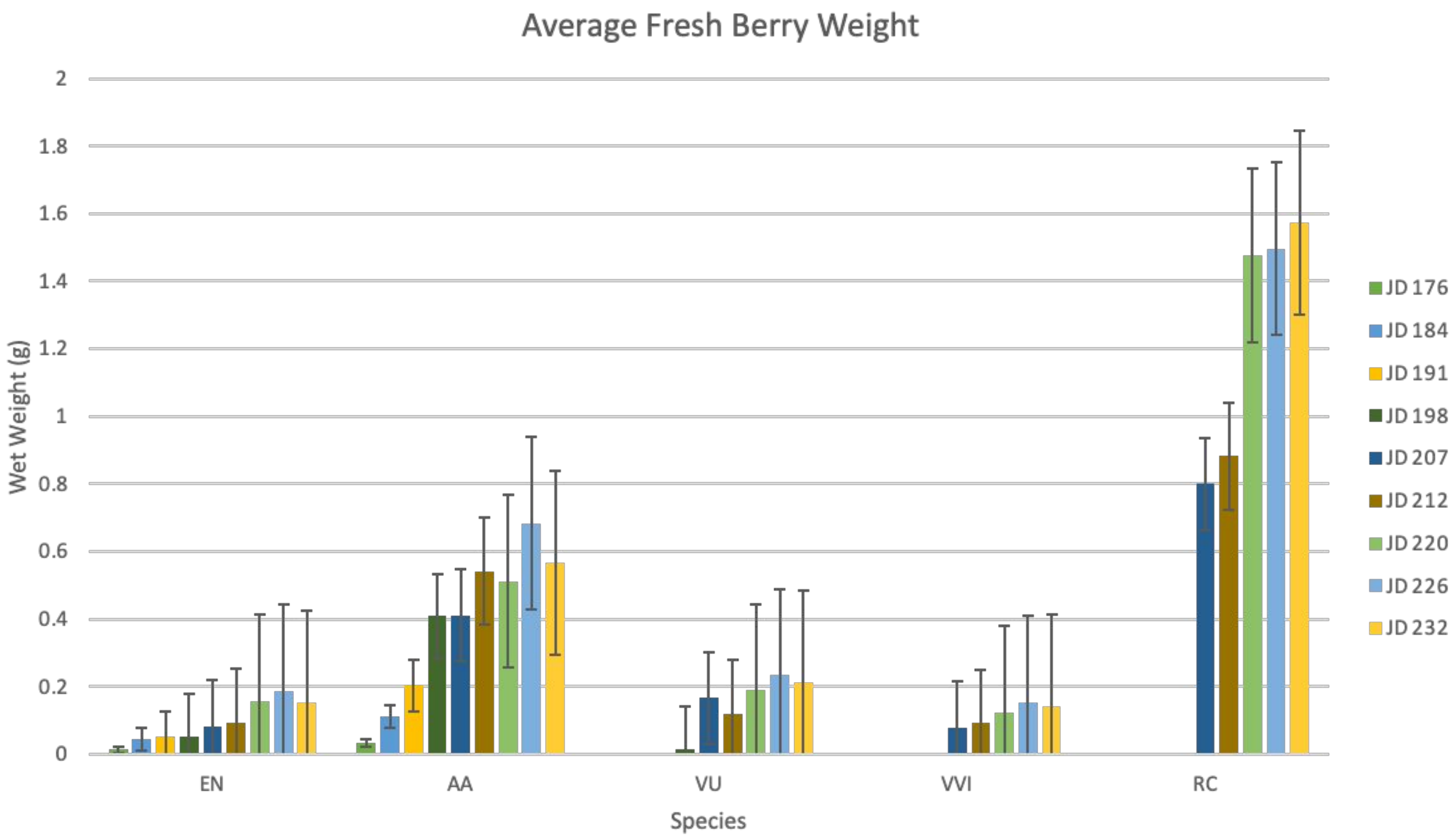
Data for Vaccinium vitis-idaea					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	VVI	0.0791	0.0097		
212	VVI	0.0909	0.0122		
220	VVI	0.1231	0.0163		
226	VVI	0.1530	0.0224		
232	VVI	0.1416	0.0199		

Data for Vaccinium uliginosum					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
198	VU	0.0141	0.0032		
207	VU	0.1653	0.0167		
212	VU	0.1200	0.0130		
220	VU	0.1888	0.0173		
226	VU	0.2331	0.0208		
232	VU	0.2127	0.0190		

Task 1: Species of Interest. Fill in the table below for each of the five species of interest. You may want to use this website as a starting place for your research: https://bit.ly/3MNo5W4

Species Name	Iñupiaq Name	Common Name	One Use

Task 2: Analyzing a graph. Annotate the graph with your teacher!



Use the graph from slide 2 to answer the following.

What trend do you notice within each species?

What do you notice when you compare data across species?

Task 3: Methods to Math!

The following data table shows 5 samples of *Empetrum nigrum* taken on the same day at the same location. This is only a portion of the full amount of data taken. Use this data to answer questions on the following slides.

Julian Day	Species	Fresh Weight (g)	Dry Weight (g)	H_2O (g)	% H_2O
176	Empetrum nigrum	0.0202	0.0026	0.0176	87.13
176	Empetrum nigrum	0.0163	0.0026	0.0137	84.05
176	Empetrum nigrum	0.0183	0.0030		
176	Empetrum nigrum	0.0089	0.0018		

Use the data table on the previous slide and the data collection method your teacher shared to answer the following questions:

What are the two **quantitative measurements** *(in other words, measurements that contain numbers)* collected in the initial method?

What mathematical operation (addition, subtraction, multiplication, or division) was done with the two measurements from question 1 to calculate the mass of water?

Use the data table on Slide 4 and the data collection method your teacher shared to answer the following questions:

Write an equation to calculate the mass of the water. You must use two quantitative measurements from question one and the operation you chose on the previous slide.

Mass of water =

Use your equation to fill in the mass of water column H_2O (g) for the bottom two rows on Slide 4.

Use the data table on Slide 4 and the data collection method your teacher shared to answer the following questions:

The general equation to find a percentage is shown below

General % Equation

$$\% = \frac{Part}{Whole} x\,100$$

% H_2O Equation

To find the percent of water, what data would we use as the "part"?

What data do we use as the "whole"? *Not sure? Test it!*

Rewrite the equation using the variables that you selected as the "part" and the "whole" in the box to the right.

Use your equation to fill in the percent water composition column (% H_2O) for the bottom two rows.

Use the data table on Slide 4 and the data collection method your teacher shared to answer the following questions:

Think back to Task 2. Why might we want to use percentages when comparing water content instead of mass?

Reflect.

How confident do you feel (on a scale of 1-5, 1 meaning you need some extra help, 5 meaning you can teach the class) with calculating % H_2O content? Why?

Task 4: Data Processing and Analysis

Your teacher will tell you and your group which berry species you are in charge of processing for the next few slides.

Note: you only need to complete ONE of the next few slides.

My group is processing the species…

Click on your group's species ID below to take you to your data table!

AA	EN	VU	VVI	RC

Complete the following table for Arctuous alpina.

Data for Arctuous alpina					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
176	AA	0.0342	0.0049		
184	AA	0.1105	0.0140		
191	AA	0.2031	0.0273		
198	AA	0.4081	0.0550		
207	AA	0.4109	0.0582		
212	AA	0.5412	0.0880		
220	AA	0.51158	0.076465		
226	AA	0.68314	0.09231		
232	AA	0.564905	0.07945		

Click here when finished!

Complete the following table for Empetrum nigrum.

Data for Empetrum nigrum					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
176	EN	0.0128	0.0022		
184	EN	0.0442	0.0042		
191	EN	0.0512	0.0085		
198	EN	0.0520	0.0106		
207	EN	0.0804	0.0134		
212	EN	0.0920	0.0152		
220	EN	0.155675	0.02167		
226	EN	0.187455	0.02372		
232	EN	0.15104	0.0177		

Click here when finished!

Complete the following table for Vaccinium uliginosum

Data for Vaccinium uliginosum					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
198	VU	0.0141	0.0032		
207	VU	0.1653	0.0167		
212	VU	0.1200	0.0130		
220	VU	0.1888	0.0173		
226	VU	0.2331	0.0208		
232	VU	0.2127	0.0190		

Click here when finished!

Complete the following table for Vaccinium vitis-idaea

Data for Vaccinium vitis-idaea					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	VVI	0.0791	0.0097		
212	VVI	0.0909	0.0122		
220	VVI	0.1231	0.0163		
226	VVI	0.1530	0.0224		
232	VVI	0.1416	0.0199		

Click here when finished!

Complete the following table for Rubus chamaemorus

Data for Rubus chamaemorus					
Julian Day	Species ID	Fresh Weight (g)	Dry Weight (g)	H2O (g)	% H2O
207	RC	0.7995	0.1215		
212	RC	0.8823	0.1359		
220	RC	1.4766	0.2283		
226	RC	1.4955	0.2193		
232	RC	1.5719	0.2474		

Click here when finished!

Under your teacher's direction, add your calculated data into the class spreadsheet. Make sure you are on the tab with your species and are only entering data into the YELLOW BOXES. The graph of your data should automatically populate. You will be using it to answer the following analysis questions.

Looking at the graph **for your species…**

What patterns or trends do you see in your species graph?

Does this surprise you? Why or Why not?

Now, click on the spreadsheet tab labelled “DO NOT EDIT: Full Class Data”.
(Remember, tabs are found at the bottom in Google Sheets)

Is the pattern you found in your species the same across different species?

Does this surprise you? Why or Why not?

Remember, our bigger question was what part of the berry was changing as the berry mass grew.

Based on your graphs, did the water content of the berry increase over time?

What does this imply about the part of the berry that is changing as they get bigger?

Overview
This content has been created with the intent for the teacher to develop it to best suit their classroom setting. In its most basic form, students are asked to analyze wet and dry berry data to determine how water content changes (or doesn't) for several berry species over the course of one season.

This lesson has multiple stages or sections within it that could be developed into stand alone lessons. Curriculum Writer (CW) Notes and Teacher Notes have been added in to identify those areas with explanations on how they could be expanded. Because of the comment above, this content is written to take approximately two 45 minute days, but it very well could stretch into roughly four to five 45-minute periods.

Standards
- **NGSS**
  - DCI
    - LS1.C: Organization for Matter and Energy Flow in Organisms
    - PS1.A: Structure and Properties of Matter
  - SEP
    - Analyzing and Interpreting Data
    - Using Mathematics and Computational Thinking
  - CCC
    - Scale, Proportion, and Quantity
- **Polar Literacy Principles**
  - Principle #4: The polar regions have productive food webs.
  - Principle #5: The poles are experiencing the effects of climate change at an accelerating rate.
  - Principle #6: Humans are a part of the polar system. The arctic has a rich cultural history and diversity of indigenous peoples.
- **Common Core Math Standards**
  - CCSS.MATH.CONTENT.HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
  - CCSS.MATH.CONTENT.HSS.IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
  - CCSS.MATH.CONTENT.6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

Objectives
- Analyze berry data by
  - Analyzing a graph of Berry Weights
  - Calculating the percentage of water in a berry species
  - Creating and analyzing a graph displaying class calculated data

Materials

- Teacher Slides (used for both in person and virtual)

- For **IN PERSON INSTRUCTION**:
  - Worksheet
    - Check For Understanding
    - Group Data Sets (pre-cut out by teacher)
  - Access to a classroom shared spreadsheet
    - Either assigned through google classroom or made available so that students can upload their data

- For **VIRTUAL INSTRUCTION:**
  - Individual Student Work Slides (where students will record their answer)
    - These are best assigned through google classroom with the “Make a Copy for each student” feature
  - A classroom shared spreadsheet
    - This is best assigned through google classroom with the “Students can edit file” feature

Procedure

- **Introduction/Do-Now/Warm Up:**
  - What’s your favorite berry? And Why?
    - *Teacher Note: The goal of this warm up is to get students to think about what’s in a berry and, in particular, trying to get them to intuitively realize that berries are mostly sugar and water. Student comments like “this berry is really juicy” or “it tastes sweet” correspond to these data points*
  - Wrap Up: What’s in a berry?
    - *CW Note: In its raw form, this tiny mini-lesson only identifies the compositional pieces of a berry that are focused on for the data (in other words, sugar and water). For a biology class, it may be prudent to spend time on what defines a berry botanically as many of the berries students may identify in the do-now are not considered berries in the botanical world (such as raspberries and blackberries).*
  - Overview/Objective Slide *(Optional)*

- **Eliciting student ideas:**
  - Ask students to share their thoughts around the following questions:
    - What do you think of when you think about the Arctic? Or “Alaska”?
    - What food do you think grows in Alaska?
      - *Teacher Notes: The purpose of these slides is to get students to recognize the importance of studying berries as a food source for Alaskans and animals in Alaska*
      - *CW Note: These slides may be skipped for timing purposes*

- **Providing the Broader Context:**
  - Use student ideas to help review the importance of berries as a food source in the arctic both for humans and animals (which then humans eat as well)
  - Remind students that this is why studying berries (in general) is an important topic
    - *CW Note: This can be an opportunity to provide broader context around food options for residents in Alaska (and particularly the arctic) and engage students in thinking about food deserts: what they are as well as the groups of people that are most often harmed by food deserts*

- **Task #1: Types of Berries**
  - Share with students that although the arctic is home to many, many different berry species, there are only five berry species that we will be focusing on and analyzing in the days to come. Have students record the berry species names
  - Student Task: Students are tasked with using the ITEX-AON website (through Grand Valley State University) to identify the Iñupiaq (native) name, the common name, and a use of each species of interest (5 in total).
    - *Teacher's Note: The website is designed so that the berry's common name is shown along with an image of the berry. To get more information about the berries, they must click on the image.*
  - *CW Note: for Biology teachers, this Task may be an opportunity to review the parts of scientific naming and the classification system (Particularly focusing on comparing Vaccinium uliginosum (VU) and Vaccinium vitis-idaea (VVI), which are both part of the same genus). This may also lead to discussion of a bigger understanding on how the different berries are related to one another (or not related to one another) and/or are related to berries that are more geographically familiar to your students.*
  - *CW Note: If you have shorter class periods, or younger students, this may be a good "stopping place" before going into the more data-heavy sections of the lesson(s). As an extension/assessment of their work for Task 1, you might have students share a reflection on what they learned and/or list the species name, Iñupiaq (native) name, the common name, and a use for one of the berries listed on the website that is not one of the five species being researched.*

- **Mini-Lesson: Collecting Berry Data**
  - Let students know that for the rest of the lesson(s), they will be using data collected by scientists in the Arctic that are trying to understand part of the bigger question "How is climate change affecting berry growth and nutritional value?"
  - Review the Collection Protocols (methods) slides with students
    - *Teacher's Notes: It is important to note the "How long" slide reviews a key vocabulary term (Julian Day) students will need to be able to do the following task*
    - ***Julian Day:*** a three digit number that represents the day of the year (Jan 1 = 001, Jan 2 = 002, … Dec 31 = 365)

- **<u>Task #2: Analyzing a Given Graph</u>**
    - Guide students through annotations of the parts of a graph. Below is a suggestion of items to identify and highlight for students:
        - Title of Graph
        - Title of X-Axis
            - Teacher Notes: Have students identify the species names from Task #1 based on the species ID
            - It may also be helpful to show how the "big graph" could be broken into smaller graphs for each individual species to help students see what data is attached to which species
        - Title of Y-Axis
        - The Key + Different Colors + What they mean?
            - Each color represents a different Julian Day
    - Students will then spend a few minutes working on the following two analysis questions:
        - What trend do you notice **<u>within</u>** each species?
        - What do you notice when you compare species?
- *CW Notes: It is important not to skip understanding the methods section because it provides the basis for understanding the mathematics that is done in order to process the data and is referenced in following tasks*
- *For student groups that have a good grasp of parts of a graph, this Task may be adjusted to be an independent review before moving on to Task #3. However, for students that struggle with graphing or if the focus for your course is more on the data processing side (and less on the graphing side), it may be simpler to lead students through the graph analysis section.*
- *CW Notes: For younger groups, or for shorter class periods, this may be another time to end the lesson before continuing the next day. An assessment for this day might be giving students a different graph (perhaps from a reference table), and asking them to annotate the parts of the graph and answer trend patterns.*

- **<u>Mini-Lesson: Initial Graph Summary</u>**
    - Summarize for students that the trend is that berries are "growing" in mass over the course of the season. Remind students that as scientists, we aren't always satisfied with just seeing the trend, we want to know more about it, which leads into the following "big question: Why are the berries getting bigger over the course of the season?
        - Because this question is fairly broad, we might want to distill it into a more simpler question first, such as "What part of the berry is growing? Sugar? Water? Something Else?"
    - Have students discuss the "Think About It" Question: Think back to the methods we discussed earlier, which of these variables do you think we monitored the most closely during the season? Why? (Hint: Which did we do in the lab?)
        - *Teacher Notes: this section might be done whole group or as a table talk*
        - *The goal here is to have students use the method to identify that the process of determining water content is fairly simple and it's much harder to figure out sugar content of berries*
    - Review with students the laboratory procedures needed to collect the data that will then be processed to determine water content.

        - *Teacher Notes: In their work on analyzing data, they will need to figure out the mathematical equation themselves. This is to help students develop their quantitative reasoning by recognizing that the methods done in the laboratory often mimic the mathematical equations used during processing.*

- **Task #3: Methods To Math**
    - The methods to math section is on page two of the worksheet, and would best be completed in groups of 3-4 students.
        - *Teacher Notes: Depending on their comfortability with mathematics, students may be hesitant to try to formalize their intuition. In my experiences, students intuitively can figure out "Oh, I'm subtracting!" but get caught up in writing the equation using words. Follow up might be giving them an outline verbally: "good! Subtraction! So what minus what?", at which point most students can say "fresh weight minus dry weight". Having them verbalize the equation first often helps them in writing it down.*
    - CW Note: This task mimics a POGIL (Process Oriented Guided Inquiry Learning) experience, in that it is designed to be used with self-managed groups. In these experiences, the teacher is seen as a facilitator of knowledge rather than the source of content. Since this particular experience is a little more math heavy, it is important to remind students that they can "play with" the numbers and test what they think is happening as a way to check if the equations they are coming up with are correct.

- **Task #4: Processing and Analyzing Data**
    - Share with students that now that we've figured out the math skills we need to process our data data and we've practiced our graph analyzing skills, we are going to process and analyze data on our own
    - Remind students that in science, there are often hundreds upon hundreds of data points (in this case too!). However, for ease, we're going to be looking at averages across several data points
        - *Teacher Note: I find that students often don't get to experience the "dull" or "repetitive" moments within science until they're older, and then it often comes as a shock to them. This experience (and the idea that there are LARGE AMOUNTS of data points that they have to process) is to help them get that experience of doing science as well*
    - Assign students into 5 groups based on the berry species and give each group its data set (either printed or on the shared spreadsheet).
        - *Teacher Notes: Some species have more data points/less data points. This can be used as a tool for differentiation–I might give a higher achieving group a species with more data points (like EN) and a struggling group a species with less data points (like RC).*
    - As students work through the first part of Task 4, they will be completing math calculations. When they are complete, have them submit their data into the YELLOW BOXES ONLY on their species' tab of the shared spreadsheet. The graphs are programmed to populate automatically as they enter their data.

        - *It is crucial not to edit the Full Class Data. This tab is programmed to automatically pull student's work from their individual spreadsheets and will populate automatically. If the Full Class Data tab is edited, the program may not run properly*
        - *Answer Key for the spreadsheet data is found on the "Individual Points" Tab, which can be hidden when sending to students*
    - Once student graphs are populated, students will complete the second half of Task 4 (Analysis)
        - CW Note: Task 4 could be expanded to having students graph their data (or the full class data) independently by hand. This would support students who struggle with basic graphing skills.
        - Another way to rearrange this activity for a class of students who are confident with their math skills might be to make groups of 5 students and have each student be in charge of a specific berry data set. In this setting, you would want to make copies of the spreadsheet (one for each group).

Assessment

- Two versions of assessment have been provided: a shorter version, which focuses only on the data processing, and a longer version, which re-asks students some of the key questions that arise during the work

Transferability

- For virtual learning, the worksheet has been made into student-facing editable google slides. Students work through the slides alongside you presenting over your presentation software of choice (Zoom, Google Meet, Teams, etc.)
    - *Teacher Notes: For student facing slides each "Task" has a different background. (Task #1 is pink, Task #3 is green, etc.) This will help you to orient students within the slides as you present (instead of needing to look for slide numbers).*
- If your curriculum requires students to understand how to use data logging/processing software (like the International Baccalaureate curriculum), this lesson could be used to teach students how to use Excel as a calculator and data processor (to create graphs). In this case, you would want to override the equations programmed into the sheet already.
- For a Chemistry Classroom, this set of tasks might be used to help students think about the process of chemical composition, formulas of hydrates, or both. Follow up lessons would have them apply parts of what they learned from Task #3.
- For an Earth Science Classroom, this set of tasks can be adjusted to help students focus on the various locations that data is taken (different latitudes and longitudes of the various sites). It may also be useful to use as an introduction or a think-piece on getting students to understand that there are multiple definitions of the seasons: Earth Scientists use the astrological settings of the Earth and the Sun, but Biologists (as well as most people) often use the term more colloquially to recognize weather/climate data and/or plant growing seasons

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