Lesson 1 - The Curious Case of Michigan's Cherries

Time Needed	50 minutes
Materials/Prep	1. Teacher Slides (slide 1) a. Ensure ability to play audio clips from computer. 2. Student Lesson 1 Part 1 Worksheet (printed, optional- students can answer questions in their notebooks/ on paper). 3. KWL Worksheet a. See KWL (Know-Want to Know-Learned) overview for teachers here. a. Provide opportunities throughout the lesson for students to make entries in each column of the worksheet. 4. Lesson 1 Part 2 Worksheet & Homework #1 (printed) 5. Table 1 Handout 6. Table 2 Handout 7. Julian Day Calendar Handout 8. Have students sit in groups 9. Optional: Graph Paper - For more graphing practice (and if time allows) students could graph the data from tables 1 and 2 before seeing and discussing the completed Graphs 1 & 2.
Student Learning Outcomes	Students will be able to: 1. Understand the importance of cherries to Michigan's economy. 2. Understand and analyze historical phenology data on blooming date. 3. Understand and explain how changes in temperature can influence cherry phenology and crop success.
Additional Resources	If students first need an introduction or refresher on climate change, Lesson 2 from the middle school unit "Climate Change and Michigan Forests" may be helpful: "Connections to Climate Change".

Next Generation Science Standards

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Importance of Michigan Cherries

1. **Introduce/discuss Michigan agriculture: Ask students, *"Did you know that Michigan is famous for agriculture? Do you know what kinds of crops Michigan is most famous for? Do you have a favorite food that is grown in Michigan or a memory related to Michigan fruits or vegetables?"***

   a. Discuss student answers. Students may talk about cherries and cherry festivals, apples, peaches, grapes, blueberries, corn, trips to Traverse City, apple picking, pumpkin patches, local farms, farmers markets, their home garden, etc.

2. **Play short 1 minute Pure Michigan audio clip: "Michigan Agriculture" and ask students, *"Did you learn anything new from this video? Did anything surprise you?"***

   a. Audio clip mentions that there are 200 varieties of foods grown in Michigan, 10 million acres of farms, $90 billion contribution by ag. to state economy, employing 1 million people.

   b. Discuss student answers and add that Michigan has the 2nd greatest crop diversity in the U.S. (Michigan grows a greater number of diverse crops than any state except California).

3. **Introduce and discuss importance of Michigan cherries: Show slide 5 of Michigan cherries/cherry products/ festival. (Ideally, bring some real cherries in to class for students to snack on!) Ask students, *"What do you know about the importance of cherries to Michigan? Where are they grown? Have you ever had one? Have you heard of the National Cherry Festival?"*** Take student answers and add

these facts to their knowledge:

   a. Michigan is the country's #1 producer of tart cherries! 75% of America's tart cherries are grown in Michigan, particularly Northern Michigan. Michigan's cherry industry is a $72 million industry. (Citation: Michigan. gov)

   b. If you have you ever had a cherry pie, frozen cherries or dried cherries, then it is likely that you've eaten Michigan tart cherries!

   c. Traverse City area: Allowing students a quick moment to reflect on personal experiences of Traverse City/the cherries/cherry festival might help them positively associate with the topic at hand.

4. **Discuss: *"Given the importance of cherries to Michigan's economy, how might Michigan be affected when the cherry crop is damaged? Have you heard of or remembered years when Michigan had a cherry shortage?"***

   a. Get student ideas (students will likely mention farmers, the economy, or even simply not being able to enjoy cherries, or having to pay much more for cherries).

The Michigan Cherry Dilemma

1. **Introduce real-world cherry tree dilemma: *"Let's listen to this news story about an issue facing Michigan's cherry tree farmers. Pay particular attention to what happened in 2012."*** Play beginning of NPR radio clip, "Fruit Growers Try Tricking Mother Nature to Prevent Crop Damage." (~1 minute).

   a. We recommend starting at :23 second mark (because the intro gives too much info away) with "Fruit growers in Northern Michigan grow..." and

stopping at 1:16 (before they get into more detail about WHY the cherries bloomed early-- we want students to brainstorm this themselves first).

b. Transcript of this part of the story: *"Fruit growers in Northern Michigan grow apples, peaches and wine grapes. But the biggest crop here is tart cherries. More than half of Ken Engle's 140 acre farm is planted with what he calls "sour cherries." These trees are the most vulnerable just before their white blossoms unfold, at the so-called "water bud" stage. "What causes the damage is that on a cold night, the moisture that's in the blossom will actually freeze. It will break the cell wall, and then the blossom is killed." (Ken Engle) In 2002, a cold snap hit when trees were in that stage and destroyed almost the entire tart cherry crop here. Cherries were wiped out again in 2012, along with most other fruits, because the blossoms came out more than a month early. "Everything was frozen here because we had trees literally with less fruit on them than we normally leave after we've shaken them."* (Ken Engle)

c. Note to teachers about 2002: 2002 was not a particularly warm year (as you will see in graph on slide 11). However, there was a bad frost when the cherries were budding, and the buds were damaged before they could bloom.

2. **"Think-Pair-Share" (Slide 9):**

   Ask students, *"What was this radio clip about? What happened to the cherry trees in 2012 and why did this happen? Had you heard about this happening?"* (Students think about this question individually ("think"), then

discuss in their groups or pairs ("pair"), then share with entire class as teacher writes key points on the board ("share") and helps students fill in their knowledge as necessary.)

   a. **What happened (in short):** Cherry trees bloomed earlier in the spring, which made them susceptible to spring frost. The frost damaged nearly the entire crop. (As spring approaches and temperatures get warmer, these warmer temperatures signal to the tree that it is time for its flowers to bloom. If it gets warm very early in the spring and the flowers bloom before the last frost, then those flowers will get damaged by the frost.)

   b. **Additional notes for teachers:**

      i. Early blooming may not be a problem in and of itself, but it is a problem because it means the early blooming flowers are at greater risk of spring frosts. The later they bloom in the spring, there is less risk of another frost event.

      ii. The damage from frost is even more serious if the flowers are already very developed. They are most hardy during the winter when they are fully dormant. However, as they begin to swell and expand into blossoms, they become less resistant to injury from frost. In other words, a frost event that occurs immediately after bud burst will not have as serious of consequences as one which happens after the flower has developed for a few weeks. (Citation: MSU)

   c. **Other answers:** Students might also say that it could it also be something else (day length, precipitation, etc). These could indeed influence

cherry tree growth, but in this case, bloom date is strongly influenced by temperature.

i. *Example:* Day length does not greatly change from year to year, so it cannot explain a CHANGE in the bloom date. Additionally, day length is more relevant in the fall: as the days become shorter it signals plants that winter is coming and they start getting ready for it (leaf fall and other physiological changes to avoid freezing).

Examining Bloom Date data

1. **Examine Data Table 1: Explain Julian Days/Date of Year (DOY) format to students.** *"Scientists often use a date format called "Julian Days," also known as the ordinal number or "Day of Year" (DOY) format. This is a continuous count of days starting at January 1. So, for example, Jan. 1 is the number 1 in Julian or DOY format. February 4 is the number 35. Note that the numbers are slightly different in leap years."*

   a. You can print this Julian Day Calendar handout for students to reference (we did not include all 12 months on the handout, only those that are relevant to this unit). This will enable them to find or confirm the Julian Day equivalent of a given date, such as July 20, 1989. We will use this date format to calculate and graph phenology data.

   b. **Ask students to work <u>in groups</u> to examine Data Table 1 (Handout)**

      i. *What do they notice about the data? Do they see any trends? Anything different about 2012? If so, what might explain these*

differences? *What format could we put this data into to better analyze it?* Help students realize that graphing the data could make it easier to visualize the trends.

      ii. Optional: Students can graph the data from Table 1 on graph paper before teacher shows them Graph 1 on the slides.

2. **Show and discuss Graph 1 - <u>Year vs. Bloom Date:</u>** *"The problem we first heard about through the radio story was that cherries bloomed early in 2012, destroying the crop. We looked at the data set, but how can our graphs help us understand this information even better? What does this graph tell us?"*

   a. *What is the x axis showing? What is the y axis showing? What are the units?*

      i. Discuss how it is common practice to put the independent variable on the X axis, dependent on the Y axis.

   b. *What is the range of variability in blooming date?* (From earliest date to latest date)

   c. *What is the overall trend? (Blooming earlier or later?) Is it steep or fairly flat? What does this mean?*

      i. Students could note that the dots start closer together and become more spread out in later years.

   d. *What do you notice about the 2012 dot?*

   e. *How is this graph useful to us? Does the data agree with the radio story saying that blooming dates are getting earlier?*

      i. Helps us see if there is a trend over time in when the cherry blossoms bloom.

What factors could influence Bloom Date?

1. **Research in groups & with textbooks:** Have students brainstorm together and use their textbooks to review/research what factors could be influencing when cherries blossom.

   a. Help them with prompts - *What signals other fruit trees to blossom? Or what kinds of things influence or trigger other annual plant and animal events?*

   b. Encourage students to look outside for ideas if space/time allows.

   c. You can use the next slid to help students.

   d. Regroup to have students share their ideas & explain why they came up with the answers that they did. Write student ideas on the board.

2. **Discuss student answers about other examples of annual cycles:** Leaves changing colors in the fall, leaves emerging or "leafing out" in the spring, dandelions (different stages), snow crocus emerging in late winter, birds migrating, flower blooming, bears or squirrels hibernating, local squirrels preparing for winter, pollen in the spring.

   a. Reinforce ideas with a image of a simple annual cycle that students would be familiar with: flowering, leafing out, dispersing seeds, leaves falling.

3. **Discuss student ideas, incorporating Evidence & Reasoning:** Discuss student ideas. The slide list may encompass many of their ideas, but there may be others that students identified.

   a. Ask students to practice CLAIM - EVIDENCE - REASONING.

   i. *What is their claim? Evidence for that claim? Reasoning behind that claim?*

   b. Have students discuss what potential explanation they think might be strongest. Students do not have to agree.

   c. Ask students: *"What if it have to do with temperature? Would you expect temperatures to be getting warmer or cooler if cherries were blooming earlier? Why?"*

4. **Students brainstorm what evidence - observations, data, etc, they would need to support that hypothesis/claim.** Help students realize that if we have data about the temperatures in those same years, we could see if the temperature and bloom data have a relationship.

   a. Note for teachers: Students might also say that it could be something else other than temperature (day length, precipitation, etc). These could indeed influence cherry tree growth, but bloom date in this case is based on temperature.

   i. *Example:* Day length does not change from year to year, so it cannot explain a CHANGE in the bloom date. Additionally, day length is more relevant in the fall, not the spring: as the days become shorter it signals plants that winter is coming and they start getting ready for it (leaf fall and other physiological changes to avoid freezing).

Examining the hypothesis that Temperature influences Bloom Date

1. **Ask students to work in groups to examine Data Table 2 (Handout).**

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1. **Ask students to work in groups to examine Data Table 2 (Handout).**

   a. *"What do you notice about the data? Do you see any trends? Is there anything different about 2012? If so, what might explain these differences?"*

   b. *"What format could we put this data set into to better analyze it?"* Help students realize that graphing the data could make it easier to visualize the trends.

   c. Optional: Students can graph the data from Table 2 on graph paper before teacher shows them Graph 2 on the slides.

2. **Show and discuss Graph 2 - Year vs. Average March temperature** (on slide)**: *"We hypothesized that warmer temperatures might be leading to earlier bloom dates. Let's examine the data to see if it supports this claim."*** What is the x axis showing? What is the y axis showing? What are the units?

   a. What is the x axis showing? What is the y axis showing? What are the units?

   b. What is the variability in average March temperature? (coolest to warmest average March temp.)

   c. What is the overall trend? Are average March temperatures getting warmer or cooler? Is it steep or fairly flat? What does this mean?

   d. What do you notice about the 2012 dot?

   e. How is this graph useful to us?

      i. Helps us see if there is a trend over time in average spring temperatures getting warmer (or cooler).

   f. Note for teachers: We use average March temperature because March is the month that is always before blooming, no matter how early it is. If we use April or May sometimes blooming was before those dates, and thus we would be using temperatures taking place after blooming.

3. **Has Michigan gotten warmer?** Ask students to answer the question used the slide with the image entitled "Winter Mean Temperature Change"

   a. Note: Technically the first day of spring is March 20, so we might be interested in both the average winter and average spring temperatures. It is hard to find data as exact as how the average March temperature will change. In this case, both the average winter and average spring temperatures in NW Michigan have increased by around 3.5-4.2 degrees from 1950-2012. For simplicity, we have chosen to show the Winter temperature change rather than both winter and spring.

4. **What do these two graphs tell us?** Ask students (also on *Lesson 1 worksheet Part 2*): *"So what do these two graphs tell us? What trends do you see? Are there any years that stand out? (What about 2012?) Can you draw any conclusions from this graph? Would these graphs support our hypothesis that warmer temperatures lead to earlier bloom dates? Why or why not?*

   a. Students could note things like: the graphs are almost inverses of one another, dots start out closer together

and seem to spread out over time on each graph.

b. Students confirm that 2012 was a very warm March and that the bloom also occurred very early that year.

c. So it does seem like there might be a relationship between average March temperature and bloom date. Looks like perhaps when average March temperatures are warmer, the cherries bloom earlier, and when average March temperatures are cooler, the cherries bloom later.

5. **Rest of Class/Homework:** Found on Lesson 1 Worksheet Part 2

a. How else could we graph the data to better see the relationship between avg. March temperature and bloom date? If we plotted both sets of data on ONE graph, what would it look like?