Budburst Data Activity: When do Lilacs Flower?

Overview: This activity aims to build student data literacy skills by facilitating student exploration of an authentic phenology dataset from Budburst (budburst.org), a nationwide citizen science program whose participants collect data on the timing of seasonal changes in plants (phenology) to inform climate science. In this activity, students will use a series of graphs to explore inter- and intra-annual variability in the timing of flowering in common lilacs. They will generate ideas about how both natural and methodological factors could drive this variability. Finally, they will perform an exercise that guides them to form new research questions based on the graphs they've viewed.

Grade Levels: 9-12, college

Estimated Time: 45 – 60 minutes

Materials: Supply students with hard copies or digital versions of lilac phenology graphs (see Lilac Single Year Plots and Lilac Decade Plot PDFs) and student discussion questions for each section. Also provide them with the description of lilac graphs.

Standards: This lesson can be used to build towards the standards listed in the table below. The emphasis is on science practices (NGSS) and competencies (Vision and Change).

NGSS	**Vision and Change**
Performance Expectations - HS-LS2-6 *Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.* Science and Engineering Practices - Asking questions and defining problems - Analyzing and interpreting data - Obtaining, evaluating, and communicating information	Core Concepts - Systems Core Competencies - Apply the process of science - Use quantitative reasonin

Objectives: This activity was designed to help students become comfortable with real-world data sets. Many research programs such as Budburst rely on opportunistically collected field data, resulting in large, "messy" (patchy and variable) datasets. Instead of seeing these datasets as frustrating, this activity aims to help students approach them as opportunities to identify patterns, ask questions, think critically about study design, and launch future investigations.

By the end of this activity students will have practiced a variety of data literacy skills, primarily:

- Recognizing and describing variability in real-world datasets
- Describing visual patterns in data
- Generating new research questions based on data.

The activity can also be used as an opportunity to reinforce ecological concepts. Plant phenology is complex, influenced by numerous abiotic factors such as temperature, and tied to many important biological processes at different scales. Shifts in plant phenology can have widespread effects on larger ecosystems, impacting plant-pollinator interactions, seasonal migrations, and human activities. By exploring such topics, students can better understand the interconnectedness of living systems, human-environment interactions, and more.

Background Knowledge: Students should have a basic understanding of how abiotic factors (e.g. temperature, rain, and hours of daylight) can influence plant phenology. They can read about the connection between phenology, weather, and climate on the Budburst website: budburst.org/phenology.

*Note that although there is much focus in the literature on the connection between phenology and climate change, the data set here will NOT demonstrate this. A long-term data set (at least 30 years) is required to see an effect of climate change. Because the data shown here only span ten years, the focus of discussion should be around possible connections between phenology and abiotic factors such as location (e.g., latitude) and shorter-term (e.g. annual) fluctuations in weather, rather than climate change.

Activity Outline

Part A: Flowering Times for One Year

Instructions: Give each student a boxplot showing one year of data. (Graphs are available for the years 2011, 2012, 2014, 2015, 2017, and 2020 (See the Lilac Single Year Plots). In part B, you'll pair students with graphs showing data from different years together.

Have the students answer the following questions about their assigned boxplot:

1. Describe the data by answering the questions below.
    a. Estimate the following from your boxplot.
        i. Median
        Date _____ *Day of Year* _____

        ii. Minimum
        Date _____ *Day of Year* _____

        iii. Maximum
        Date _____ *Day of Year* _____

        iv. Sample Size _____

b. Describe the shape of your data. (Is the data clustered around a central point or is it more evenly spread out? Are there any apparent outliers?)

2. What factors might cause variability in recorded day of first flower? (i.e., Why do you think some observers are reporting earlier flowering times than others and vice versa?). List both factors related to plant biology AND factors related to research method/data collection protocols.

3. Multiple locations in North America hold annual week-long lilac festivals to celebrate spring.
   a. Based on your data, what dates would you suggest people hold a lilac festival? Remember that the festival can only last 7 days.

   b. How confident are you in your suggestion? Is there any information that would help you make a recommendation?

Part B: Flowering Times for Two Years

Instructions: Create pairs so that each student is matched with someone who looked at a different graph during Part A. Suggested pairings are: 2011 and 2017, 2012 and 2014, 2015 and 2020. For example, pair a student that looked at data from 2011 with one that looked at data from 2017. The pair will compare the 2011 and 2017 graphs by answering the questions below. Afterwards, come together to discuss as class.

Questions:

1. Compare and contrast the data from each year (Refer to your answers in Part A #1).

   a. What is different about your datasets? What factors might have caused your datasets to differ? (Again, think about factors related to plant biology and research method.)

   b. What is similar about your datasets? Why do you think these similarities exist?

2. Compare the suggestions you made about when to hold a lilac festival (Part A, #3). Why did each of you suggest the dates you did? Would you change your suggestion based on the additional data?

Part C: Flowering Times for a Decade

Instructions: In groups, have students examine the 10-year boxplot (Lilac Decade Plot PDF) and answer the questions below.

1. What do you notice in the graph? Is there a trend in flowering time across years or is there more variation year-to-year?

2. Do any years stick out? Are the lilacs flowering particularly early or late that year?

3. What questions do you have about this data? Generate as many questions about this graph and the data shown as you can in 3 minutes.

   Teaching Note: At this point, consider guiding your students through the question formulating technique by the 'Right Question Institute'. This technique is a structured way to form and improve questions. It involves brainstorming a list of questions, categorizing each one as either open-ended or close-ended, then changing an open-ended to a close-ended question and vice versa.

4. Choose one question that could guide future research on topics related to flowering times. Why did you choose this question? Will the answer help you understand a particular phenomenon or add new meaning to the data?

   Teaching Note: It can be helpful to direct students to focus on questions that are open-ended and testable in some way. As an extension, you can have them brainstorm ways they could address their question through data collection.