What can a Lilac Tell us about National Climate Change?


Photo Credit: RichardBH

Grade Levels
Undergraduate

Overview
Students will use the Spring Index Maps and USA-NPN Visualization tool to explore the timing of spring between their location and other areas of the country. They will also explore the overlap of phenology between two species in a single year.

Background
The Extended Spring Indices are mathematical models that predict the "start of spring" (timing of leaf out or bloom for species active in early spring) at a particular location. These models were constructed using historical ground-based observations of the timing of first leaf and first bloom in a cloned lilac cultivar and two cloned honeysuckle cultivars. These species were selected because they are among the first woody plants to leaf out and bloom in the springtime and are common across much of the country.

Real-world Connection
The First Leaf and First Bloom Indices are synthetic measures of these early season events in plants, based on recent temperature conditions. These models allow us to track the progression of spring onset across the country.

Citizen Science Connection
This activity can be completed with or without a *Nature's Notebook* account. Completing it with an account can provide an opportunity to teach students about the importance of citizen science, and how their contributions help us to better understand the word around us.

Estimated Time
60 minutes

Learning Objectives
Participants will be able to:

- Describe the Spring Indices and list the type of biological events they are designed to predict
- Summarize the reason for use of cloned lilacs to study local onset of spring
- Locate the spring indices maps and the Visualization tool on the USA-NPN web page
- Utilize the Visualization Tool to view observational data stored in the National Phenology Database
- Utilize the Visualization Tool to compare peak phenophases between years
- Utilize the Visualization Tool to view the overlap in pheophase events of multiple species

Conducting the Activity

Materials
Resources needed

- A computer with internet access is required for this activity
- Prior to presenting this lesson the instructor should familiarize themselves with the USA-NPN's Visualization Tool (usanpn.org/data/visualizations) and First Leaf and First Bloom maps (Spring Index Maps; usanpn.org/data/maps). Both tools have accompanying technical documentation on the website, including tutorial videos and info sheets.
- The instructor should also identify a study range and at least two species of interest for student to explore, found on the *Nature's Notebook* Plant and Animal list (usanpn.org/nn/species_search). For example the Tucson Basin was chosen for exploration of the Spring Anomaly and the Northern red oak and Blue Jay were chosen to demonstrate the species phenophase overlap in the Activity Curve. The Activity Curves are designed to display phenological information such as resource availability in an ecosystem. Pages 3&4 of this document are an editable student page where the instructor may edit the range and species to be explored.

Engage
Connect to prior knowledge

- Utilize the accompanying slide deck with notes for the in-class presentation. The slide deck can be found on the following link:
  https://www.usanpn.org/files/education/usanpn_lilacs_climate_change_slides_0.pptx
  The outline of the presentation is as follows:
  - Measuring the impact of climate change on a landscape scale
    We've seen many reports in recent years on record breaking temperatures and weather events locally and nationally. But what does this mean for plants and animals? What is the best way to measure the impact of weather on the biotic environment?
  - The USA-NPN's Spring Indices
    Explanation of how the Spring Indices (Si-x) were created, what kind of biological events it predicts.
  - Visualization modeled and observational phenology data
    Demo of how to to access the Spring Indices map in the USA-NPN Visualization tool. We can also use the USA-NPN Visualization Tool to look at the observational data on phenology. We can look at how the timing, peak in life cycle events, or phenophases, compares between years, or look at overlap in life cycle events of multiple species.

RESOURCES Adapted from:

What can Lilacs Tell us About National Climate Change?

By: USA-NPN

NOTES ON ACTIVITY

Conducting the Activity

Explore

Hands-on learning

Give students the 2-page worksheet found at the end of this pdf. They can complete this assignment either in-class or at home.

Explain

Listening and communicating understanding

- Reflection: After the assignment is completed discuss what species they chose and why. What did they learn from this assignment? What is the value of long-term phenology data when studying the impacts of climate change?

Evaluate

Summarize, check for understanding, assess

- Example answers are on pages 5&6 of this document

- Assignment A Rubric, 12 Points total:
  - 2 points: Gave a number of days for the difference between 2017 and the long-term average for your location, and stated whether it was earlier or later than the long-term average.
  - 2 points: Compared the daily anomaly in your location to another location in the country.
  - 2 points: Stated why the First Leaf Index might be less relevant in your region than in other parts of the country.
  - 2 points: Summary in 100 words or less of how the Spring Indices can be utilized to demonstrate the impacts of long-term changes in phenology. E.g. the Indices demonstrate the anomaly between the annual leaf and bloom time and the 30-year average, a frame of reference for describing how species are responding in any given year. This information provides details about potential impact to a species in it's range given prolonged exposure to a similar trend in warming though time.
  - 2 points: Included a map of the Spring Index Daily Anomaly for 2017.
  - 2 points: Included a caption for the map describing what the map displays.
- Assignment B Rubric, 8 points total:
  - 2 points: Explained why the two species were selected.
  - 2 points: Included a graph from the USA-NPN Visualization Tool that shows the relationship between two species in a single year.
  - 2 points: Interpreted the graph.
  - 2 points: Discussed the implications of the findings in 100 words or less.

Extend

Group projects, real world connections

Create an account with Nature's Notebook and have the students record data on plant or animal species found on your campus. Have the students explore the species that they monitor using the Spring Index and Visualization Tool. Discuss how citizen science projects are important for large-scale data collection.

Assignment

What can a lilac tell us about national climate change?

Assignment A (12 points):

Instructions:

1. Open the USA-NPN's Visualization Tool, available at https://data.usanpn.org/vis-tool/#/.
2. Click "See visualization" under"Where did spring arrive early this year?"
3. Under "Base Layer" You can lower the opacity to more easily see the map layer underneath.
4. To learn more about the Spring Index visit: www.usanpn.org/data/spring_indices.
5. Save an image (use the Print Screen function on your computer) of your map of the Spring Index Daily Anomaly and submit it with the answers to the discussion questions below.

Discussion Questions

A. How did the date of the First Leaf Index this year compare to the long-term average (Daily Anomaly) for Your location? Was the First Leaf Index earlier or later this year than the long-term average for Your location?

B. How does the difference between this year and the long-term average for Your location compare to other parts of the country? Why might the First Leaf Index be less relevant for ecosystems in the your region than in other, more temperate, parts of the country?

C. In 100 words or less summarize how the Spring Indices can be used to demonstrate the impact of a warming climate on a region's species.

D. Include a map to support your answers and provide a caption for your map that describes what your map shows.

Assignment B (8 points):

Explore the overlap in the phenology of two different species in a single year. Include a graph from the Visualization Tool to support your answers (use the download button on the visualization) and provide a caption for your graph.

Note: You can visit the Nature's Notebook *species list (www.usanpn.org/nn/species_search) to see which species are available and view the Leaderboards to see which plants (www.usanpn.org/nn/leaderboard-plants) and animals (www.usanpn.org/nn/leaderboard-animals) have the most data available. We recommend limiting your selection to the years 2012-2017 for the greatest amount of data.*

Instructions:

1. Open the USA-NPN's Visualization Tool, available at https://data.usanpn.org/vis-tool/#/ and click "Data Explorer" on the Left
2. Click on "Activity Curve" and then "Next."
3. You can choose to either create a polygon with a hand-drawn boundary or select a pre-defined boundary. Click "Next."
4. Choose the year, species, and phenophase class that you would like to visualize data for. Click "Add curve" to add an additional species and/or phenophase. After entering your curves, click "Next."
5. Save an image (use the Print Screen function on your computer) of your Activity Curve Graph and submit it with the answers to the discussion questions below.

Discussion Question

A: In 100 words or less describe the implications of the findings on the Activity Curvegraph. Explain why you selected your species, what you found out about their overlap, and the implications of your findings. What potential impacts might each species face in light of a warming climate? What might happen to the species?

Assignment A Answers

According to the Spring Indices, Daily Anomaly for the Spring Leaf Index for 2022, Tucson met the requirements for spring five days earlier in 2022 than the long-term average of 1991-2020.

> ***Note:*** *the legend should state Spring Indices, Daily Anomaly – Daily Spring Index Leaf Anomaly. The date on the legend is flexible but should be late enough in the year to have all of the pixels across the country filled in with color (around the end of May). The default date is the date on which the map is created.*

Spring arrived much earlier than the long-term average in other parts of the country than it arrived in Tucson – much of the Southeast, Mid-Atlantic, Great Plains, and Midwest were 20 days earlier than average. Parts of the west coast of the US were 20 days later than average.

> ***Note:*** *the students can choose which parts of the country to highlight. The number of days later than average may vary, depending on which pixel the student selected from within the Tucson basin.*

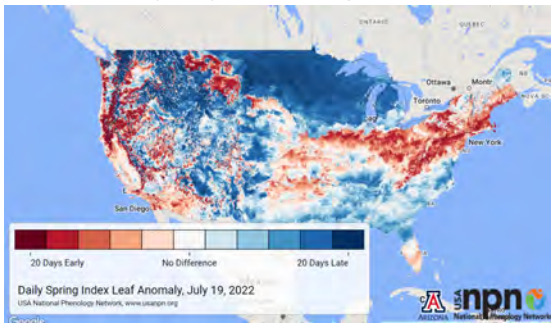

Figure1. The USA National Phenology Network's Spring Leaf Index Anomaly for 2022. Dark red colors indicate that spring arrived 20 days earlier in 2022 than the long-term average (1991-2020). Dark blue colors indicate that spring arrived 20 days later in 2020 than the long-term average. In Tucson, spring arrived two days late.

Assignment B Answers

Students should use the Activity Curves visualization on the USA-NPN's Visualization Tool to create a graph that shows the overlap for 2 species-phenophase combinations for a single year. Below is an example showing the proportion of yes records reported for ripe Northern red oak acorns and the total number of Blue Jays recorded exhibiting nut gathering behavior. Students should explain their selection of species, interpret their graph and discuss the implications of their findings.

Example:

We selected Northern red oak, a deciduous tree that is a dominant overstory tree in the eastern United States. Red oaks produce acorns which are an important food source of Blue Jays. We wanted to look at the overlap in when ripe acorns are available, and when Blue Jays are observed gathering the acorns.

In 2016, the peak in the proportion of yes records for Northern red oak ripe acorns occurred in early September. The peak in the number of Blue Jays gathering nuts occurred in mid-October, over a month after the peak in ripe acorn availability. It's possible that Blue Jays are waiting to gather oaks until they have fallen from the trees, which would occur after acorns have ripened. This graph represents the entire dataset of Northern red oak and Blue Jay observations from across the eastern US. Restricting the data to look at more local regions might reduce the environmental variability and provide a more accurate picture of the overlap between the life cycle events of these two species.

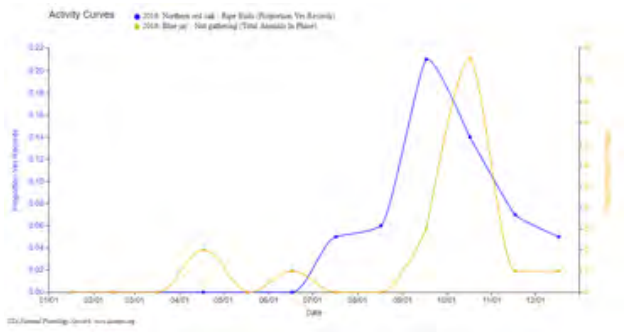

Figure 2. Activity Curve from the USA National Phenology Network's Visualization Tool, displaying the overlap in the proportion of yes records for ripe fruits of Northern red oak and total Blue Jays observed gathering nuts in 2016, summarized by month.