



### Purpose:

To utilize the USA National Phenology Network's Spring Indices to measure the impact of weather on the biotic environment.

### Grade or level

- High School or Undergraduate Course in Conservation or Ecology

### Time

- 30-minute in class lecture
- Two homework assignments

### Learning Outcomes

1. Describe the Spring Indices and list the type of biological events it is designed to predict
2. Summarize the reason for use of cloned lilacs to study local onset of spring
3. Locate the Spring Indices maps and the Visualization Tool on the USA National Phenology Network webpage.
4. Utilize the Visualization Tool to view observational data stored in the National Phenology Database
5. Utilize the Visualization Tool to compare peak phenophases between years
6. Utilize the Visualization tool to view the overlap in phenophase events of multiple species

### Background Information

This activity can be used as a supplement in a course designed to demonstrate climate change impacts on biotic species or a course designed to study the natural history of species in a given range.

Prior to presenting this lesson the instructor should familiarize themselves with the USA-NPN's Visualization Tool ([usanpn.org/data/visualizations](https://usanpn.org/data/visualizations)) and First Leaf and First Bloom maps (Spring Index Maps; [usanpn.org/data/maps](https://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](https://usanpn.org/nn/species_search)). In this 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. Included with this assignment is an editable student page where the instructor may edit the range and species to be explored.

## In-class presentation

Utilize the accompanying slide deck with notes for the in-class presentation. The slide deck can be found on the following webpage:

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.

### *Visualizing modeled and observational phenology data*

Demo of how to access the Spring Indices maps 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.

## Homework Assignments

- A. How did the First Leaf Index this year compare to a long-term average for the Tucson basin? Was the First Leaf Index earlier or later this year than the long-term average? How does the difference between this year and the long-term average for Tucson compare to other parts of the country? Include a map to support your answers (use the Print Screen function on your computer) and provide a caption for your map.

### **Instructions:**

1. Open the USA-NPN's Visualization Tool, available at [www.usanpn.org/data/visualizations](http://www.usanpn.org/data/visualizations). If you need assistance with the tool, use the ? icon on the right hand side of the tool. *This help section contains video tutorials that will walk you through how to use the tool.*
  2. Click on the Gridded Menu icon on the left-hand side of the page.
  3. Use the drop-down menus to select the appropriate layers. For more information about the Spring Indices, visit this page: [www.usanpn.org/data/spring\\_indices](http://www.usanpn.org/data/spring_indices).
- B. Explore the overlap in the phenology of two different species in a single year. Write a paragraph (50-100 words) that explains why you selected your species, what you found out about their overlap, and the

implications of your findings. 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](http://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](http://www.usanpn.org/nn/leaderboard-plants)) and animals ([www.usanpn.org/nn/leaderboard-animals](http://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 [www.usanpn.org/data/visualizations](http://www.usanpn.org/data/visualizations). If you need assistance with the tool, use the ? icon on the right hand side of the tool. This help section contains video tutorials that will walk you through how to use the tool.
2. Click on the Filter Menu icon on the left-hand side of the page.
3. Use the filters to select your years and species of interest.
4. Once you have applied the filters to the map, create an Activity Curve, found under the Visualizations Menu on the left-hand side of the page.

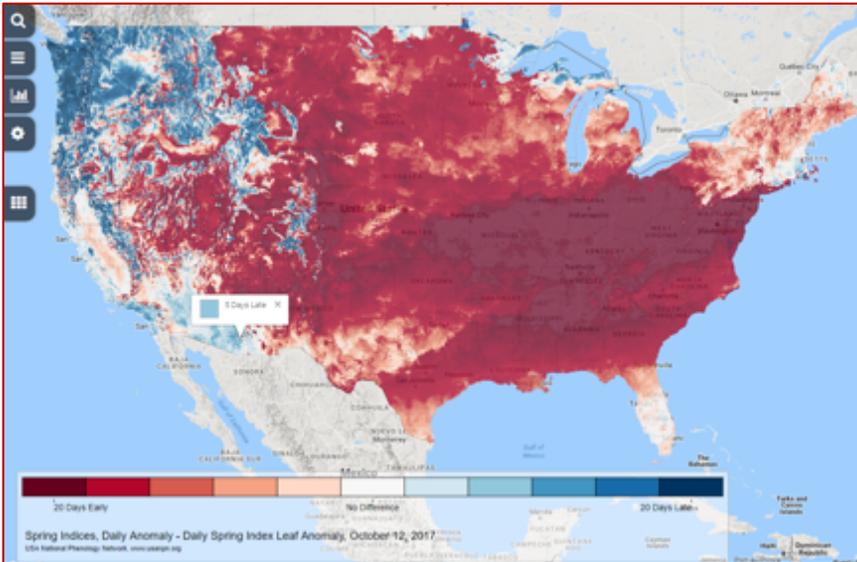
### Assignment A Answers

According to the Spring Indices, Daily Anomaly for the Spring Leaf Index for 2017, Tucson met the requirements for spring five days earlier in 2017 than the long-term average of 1981-2010.

**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 2-4 weeks earlier than average. Parts of the west coast of the US were 2-3 weeks 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.



**Figure 1.** The USA National Phenology Network’s Spring Leaf Index Anomaly for 2017. Dark red colors indicate that spring arrived 2-3 weeks earlier in 2017 than the long-term average (1981-2010). Dark blue colors indicate that spring arrived 2-3 weeks later in 2017 than the long-term average. In Tucson, spring arrived five days late.

**Rubric (12 points total):**

- 2 points: Gave a number of days for the difference between 2017 and the long-term average for the Tucson basin and stated whether it was earlier or later than the long-term average.
- 2 points: Compared the daily anomaly in Tucson to another location in the country.
- 2 points: Stated why the First Leaf Index might be less relevant in the Southwest 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 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.

### 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.