

Phenological trends and climate change in Minnesota

After you complete this activity, you should be able to:

- formulate an answerable question from a given data set
- use basic Excel skills to locate and sort desired data
- analyze phenological data to determine trends

Introduction

Seasonal events, for example flowering, the return of migrating birds, and fruiting, happen at particular times of the year. Some of these events happen in relation to climate, while others are dependent on other factors. As the climate changes, the timing of some events may change in some species. This exercise will help you evaluate **how climate change has already affected species in Minnesota.**

The American elm (*Ulmus americana*) is a deciduous species and its range includes most of the eastern United States and a bit of southeast Canada. This elm is a hardy species and can grow to a considerable size. It grows well in urban areas, so it is common in many cities. Unfortunately, the species is also susceptible to Dutch elm disease and the tree populations can suffer from massive die offs. All these characteristics have led naturalists to be interested in this species, so we have lots of data about its phenophases.

Minnesota is in the northern part of the elm's range. As the climate changes, we may wonder how it is going to affect the elm. Potential questions we may ask include: Does climate change increase the occurrence of Dutch elm disease? Does it increase the rate of transpiration (water evaporation from the leaf)? Does it affect flowering date? Does it affect when leaves change their colors in the Fall? We can use the MN Phenological Network's database to determine which of these questions we can pursue and what the answers might be.

Activity A – Determine changes in flowering date for American elm in Ramsey Co, MN

1. **Open** the provided data sheet (“MNPN dataset_for students_sp21”).
2. Take a **look** at the data and see if you can determine how it is initially presented (e.g. what is listed earlier in the spreadsheet compared to later.). Additionally, **note** how many different entries (rows) are in the spreadsheet of just elm data.
3. What are some phenological events recorded for the elm?
4. After a long winter, people may be ready to think about spring and flowers, so let us concentrate on the phenological event of flowering date for American elm. We can now ask the question, **how does climate change affect the flowering date of American elm?**
5. It may still be tough to see a trend in the data as is it presented, so we can create a figure to help us visualize these data. Before we do that, we want to think about what location the flowering data came from. Do we want to use data from all over the state or just one county? For the elm we will just use Ramsey Co. records because we have a lot of data from that location.

6. **Open the worksheet with data** from only Ramsey Co. (not the Itasca Co. data) from 1941-1991.

7. What do you think the flower dates might look like over the 50 year span? **Sketch** out your predicted trend in Figure 1 below. Be sure to label your figure's axes.

(To draw in a Word program, look for an "insert" option and then select a draw/line/shape tool.)



Figure 1. Prediction of elm flowering date from 1941 -1991 in Ramsey Co, MN.



Figure 2. Actual elm flowering date from 1941 -1991 in Ramsey Co, MN.

8. Now **check** how close your prediction is to the real data. Go to the worksheet, "Year & Flower date". Highlight the data in your two columns and click on the "Insert" tab. To show the data, you will want to choose a scatterplot (in Excel, select "scatter" in the ribbon of tools at the top of the page; in G Sheets choose "Graph" then double click on the graph, select "set up" tab, then "scatter chart" in chart type). If you are using Excel, click on the gridlines of the chart and then hit delete to help focus on the data. In G Sheets, double click on the graph to open the Chart editor. Select the "Customize" tab, select "Gridlines and Ticks," and then toggle between vertical and horizontal dropdown to remove the gridlines. What kind of pattern do you see in the data?

9. One way to help visualize the data is to add a trendline (a line that represents the *overall* trend of the data) to your figure. **Add** a trend line to the graph (in Excel: find the layout or "add chart element" tools under the "chart tools" and "design" tab; in G Sheets double click on the graph, select "customize" tab, then "series" in the menu, then check the "trendline" box). Add a simple linear trendline.

Now, what kind of pattern do you see in the data and what does the pattern show? How would you quantify the trend (i.e. use approximate values to describe the trend)? Based on the data, over the last 50 years, has flowering happened earlier, later, or show no change in timing? How close was your prediction to the actual data?

Sketch the actual data trend on the graph above (Fig. 2, under step 9); if appropriate, you can also copy and paste your figure from your spreadsheet. Be sure to label your figure's axes.

10. As we look at the flowering date, what might be causing the change? **Identify** two ideas/hypotheses about what might be causing a change in this phenophase.

11. To investigate a relationship between climate and flowering date of American elm, we need climate data for Ramsey County from 1941-1991. Elm flowering dates range from mid-March through mid-May, so average temperature for March would be an appropriate period. For climate, it is good to gather data from at least a month. What do you think these data might look like? **Sketch** out your predicted trend in Figure 3 below. Be sure to label your figure's axes.



Figure 3. Prediction of average March temperature in Ramsey Co, MN from 1941-1991.



Figure 4. Actual average March temperature in Ramsey Co, MN from 1941-1991.

12. Now check how close your prediction about temperature matches the actual data. Click on the worksheet, "Temp". **Graph** the temperature data across time (1941-1991). To help focus on the data, delete gridlines. **Add** a trend line. How close was your prediction? **Sketch** the actual data trend in Figure 4 above; you can also copy and paste your figure from your spreadsheet. Be sure to label your figure's axes. If your prediction differs from the actual data, why might that be the case?

Citations:

Minnesota Department of Natural Resources (DNR). 2020. Minnesota Climate Trends. Accessed [7.10.2020]. Available: <https://arcgis.dnr.state.mn.us/ewr/climatetrends/>.

Minnesota Phenology Network (MNPn). 2020. Datasets. Accessed: [7.10.2020]. Available: <http://mnpn.usanpn.org>.