

ABSTRACT

Herbarium specimens along with field observations from *Nature's Notebook*, an online citizen science database, were used to access flowering dates of black cherry and red maple trees. The year, date and state (in the United States) were separated into northeast, southeast, southwest, midwest and western regions. The West region's first flowering dates generally became later in contrast to the other regions. In the Northeastern regions, the red maple had the most consistent flowering dates for both databases. Despite the fact that a large database was used, there was still insufficient data for some areas, which made it difficult to narrow the regions down even further to examine smaller regions by themselves.

INTRODUCTION

Plants have reacted to the warming climate by adapting their life cycles. One important change that has occurred is that plants are flowering and leafing out earlier than usual. The leaf out time of the plants determines the survival of other organisms (Polgar 2011). With the increasingly early flowering dates, bees do not appear in time for pollination. Without pollination the trees will be unable to reproduce and bees will lose their food source.

Botanical gardens are home to herbarium specimens that can be used to conduct research projects about climate change. Housing preserved sections of a plant species from various times throughout history, it is possible to observe and compare plant behavior today and previously (Primack 2009). Data for herbarium specimens can be collected by observing the dried plants for the targeted phenological event.

Nature's Notebook is a plant and animal phenology observation program of the USA National Phenology Network. This program utilizes volunteers known as citizen scientists to collect large amounts of data over a large area in a short amount of time.

In this study, flowering dates from all over the United States were collected for analysis.

MATERIALS & METHODS

◆ Herbarium specimens from Steere Herbarium and field observations from *Nature's Notebook* were utilized.



Red Maple Herbarium Specimen

http://www.ibiblio.org/botnet/flora/images/Acer_rubrum003.jpg

- ◆ Dates and location were recorded as long as flowers were present in specimen/data entry.
- ◆ First flowering dates for each year used only.
- ◆ Data was organized into regions before plotted on a scatter graph.
- ◆ Uniform Y-axis were used to make analysis easier.

Herbarium specimens and field observations show changes in first flowering dates for *Prunus serotina* and *Acer rubrum* within US regions

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RESULTS



Figure 1: Flowers: On the left, *Acer rubrum* flowers are shown while on the right *Prunus serotina* flowers are displayed. Data within this research study was collected based on whether or not these flowers were present.

https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcQikPpKcLF5Hj-pSM78px2s_OMI-dyCf8BRg39AVVwRFxvcdw3Zb-BEDQ

<http://news.s3.amazonaws.com/taxon-images-1000s/1000/Rosaceae/prunus-serotina-14-cameron-d.jpg>

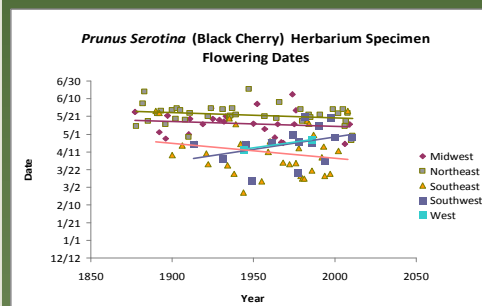


Figure 2: *Prunus serotina* Herbarium Specimen Flowering Dates: Trend lines are drawn for each region for comparison. The Northeast and Midwest lines; Southwest and West lines are parallel to each other while the Southeast line is drawn in a steeper negative slope.

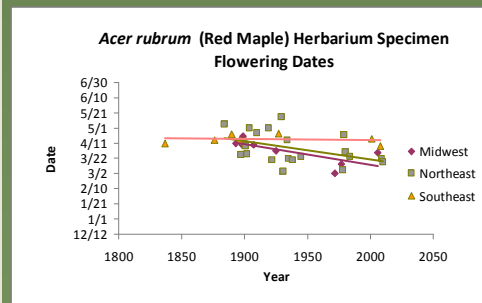


Figure 4: *Acer rubrum* Herbarium Specimen Flowering Dates: Trend lines are drawn for each region for comparison. The Midwest and Northeast trend lines are almost identical in a negative slope while the Southeast line is mostly straight.

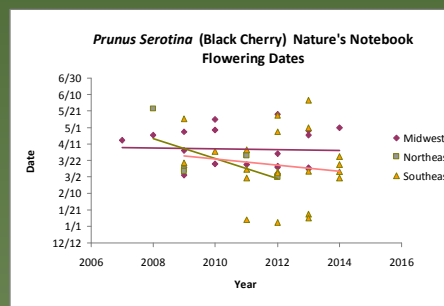


Figure 3: *Prunus serotina* Nature's Notebook Flowering Dates: Trend lines are drawn for each region for comparison. The Midwest is mostly straight while the Northeast and Southeast lines have steeper negative slopes.

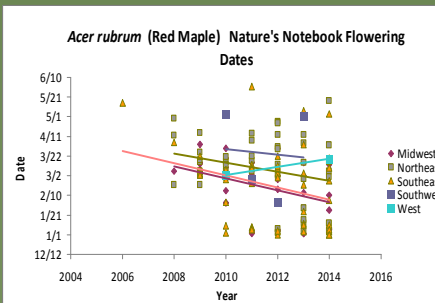


Figure 5: *Acer rubrum* Nature's Notebook Flowering Dates: Trend lines are drawn for each region for comparison. The Southwest and Northeast and Midwest trend lines are parallel in a steep negative slope. The Southeast line has a steeper slope than the trend se three lines just mentioned. The West line is the only line in the opposite direction with a positive slope.

DISCUSSION

Dataset ranges: The herbarium specimens in the Steere Herbarium ranges from the 1800s to the present while *Nature's Notebook* ranges from 2004 to the present. *Nature's Notebook* data have citizen scientists collecting data nearly every day, all over the United States. Therefore, *Nature's Notebook* data gives a wider range of data within a short time period while herbarium specimen data can show an overview of the flowering dates through a longer period of time.

Regional Patterns: The *Acer rubrum* Northeastern regions for both the herbarium specimens and *Nature's Notebook* graphs have the most consistent trend lines. For both, the flowering dates moved about half a month between the start and end of the data. However, *Prunus serotina* graphs did not show similar trend lines. Even though both species were observed in the same regions where environmental factors and temperature are similar, the changes in first flowering dates are erratic. This shows that there are differences in flowering rates not just on a continental level. (Ibáñez 2010). Overall, there may be flowering dates advancing but internally within regions, there are areas where flowering dates are becoming later and vice versa. An example is the Southeastern dates on the *Acer rubrum* Nature's Notebook data. Some data points are from Florida and Georgia and their temperatures are higher than the rest of the states in the South east region. These led to first flowering dates in January while the trend line was mostly within March.

Conclusion: Climate change has made a huge impact on trees. As can be seen, trees in all areas in the United States have been affected. Because of this, it is possible that the changes will affect the rest of the ecosystem. Ultimately, there may be sharp declines of necessary resources that will be hard to replace. Although the changing behavior of trees is a gradual process, it is not something to be dismissed lightly. With enough time, changes caused by these trees may directly affect humans.

CITATIONS

- Ibáñez, I., Primack, R. B., Miller-Rushing, A. J., Ellwood, E., Higuchi, H., Lee, S. D., ... & Silander, J. A. (2010). Forecasting phenology under global warming. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1555), 3247-3260.
- Polgar, C. A., & Primack, R. B. (2001). Leaf-out phenology of temperate woody plants: from trees to ecosystems. *New Phytologist*, 151(4), 926-941.
- Miller-Rushing, A. J., Inouye, D. W., & Primack, R. B. (2008). How well do first flowering dates measure plant responses to climate? The effects of population size and sampling frequency. *Journal of Ecology*, 96(6), 1289-1296.
- Nature's Notebook*. (n.d.). *USA National Phenology Network*. Retrieved August 27, 2014, from https://www.usanpn.org/natures_notebook
- Primack, R. B., & Miller-Rushing, A. J. (2009). The role of botanical gardens in climate change research *New Phytologist*, 182(2), 303-313.

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