Cumulative Photoperiod Days to Predict Cherry Blossom Blooms

Predicting the bloom day of a plant has been an area of interest for the last three hundred years. It is especially relevant today for event organizers of cherry blossom viewings. In order to plan these events, organizers need to know when the cherry blossoms will bloom. A standard rule of thumb is Quetlet's law, the law of flowering plants, which indicates that after a certain threshold of cumulative growing degree days, plants will bloom. Quetlet used temperature which has much variability from year to year especially with the effects of climate change. According to the Environmental Protection Agency (EPA) there are factors which affect phenological events such as temperature, light, rainfall, and humidity. With this, I propose using the cumulative sum of daylight hours instead because of the importance of photoperiod on bloom dates, the direct correlation of sunlight to temperature, and most importantly that daylight hours vary less from day to day.

The primary motivation for using sunlight was to find an indicator that was correlated to temperature, but not as noisy and unpredictable as temperature. As can be seen from the example in figure 1, there is a high dependence on the temperature of the last few days. More specifically, if there is a day closer to the typical bloom date that is low, it will impact reaching the threshold, but may not necessarily throw off the bloom date by that much. This variability and unpredictably in temperature led to the need for a more reliable source of prediction. Photoperiod does just that and is actually correlated to temperature, so it fits nicely into this technique.

Quetlet's GDD threshold was originally derived from his idea to apply physics formulas to the bloom prediction problem and is the average of the cumulative squared sum of temperature up to the bloom date for each year. In the case of photoperiod, the historical cherry bloom data was used to take the average sum of photoperiod for previous years and used as the threshold. In order to predict the day of year for the bloom dates, the photoperiod was summed for each day and once the threshold was reached the predicted day of the year was reported. Interestingly, the findings indicated that the threshold for photoperiod had an error of about seven days which preforms just as well as Quetlet's growing degree days also having an error of about seven days. This indicates that Quetlet's idea for a threshold at which plants have been exposed to a certain amount of heat also applies to the other phenological indicators.

In conclusion, the other phenological indicators can also be used in the same fashion as growing degree days with similar preformance. An interesting possibility for future work is to test if this also applies to indicators like cumulative rainfall. However, it is likely that photoperiod was the best indicator to use for it's lower variability. Using weather indicators are highly variable and not easily predictable year to year. The cumulative photoperiod performance is also widely applicable to other flowering plants as well. Overall, this robust prediction method is a failsafe way to predict cherry blossom tree blooms.

Appendix

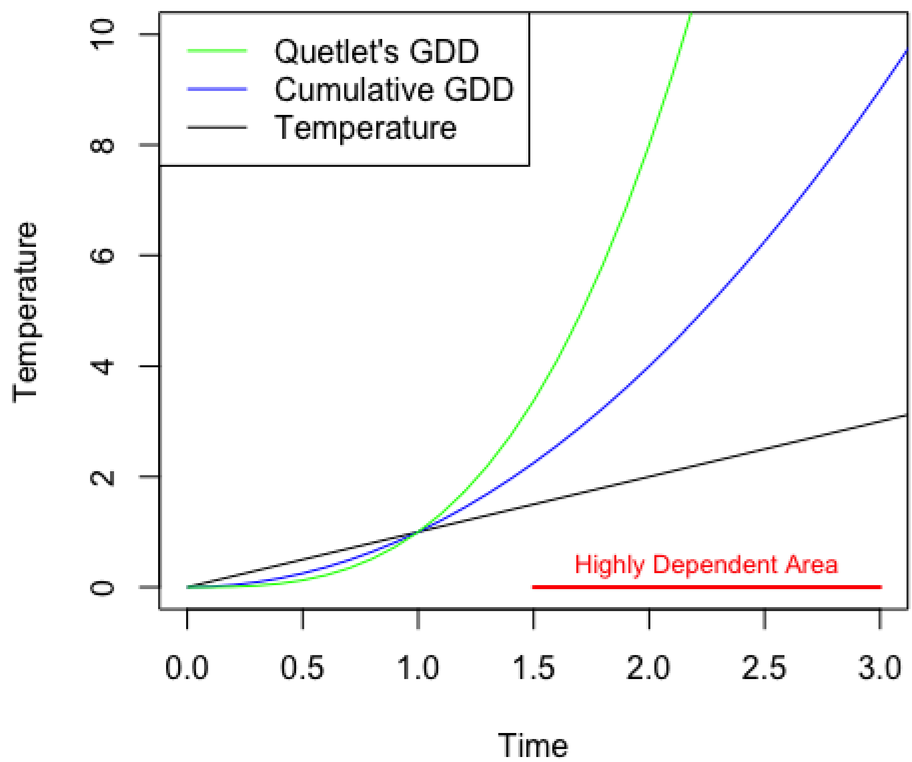

Figure 1. Graph showing an example of the accumulation of temperature and the highly dependent area

References

Auerbach, Jonathan. "A Demonstration of the Law of the Flowering Plants." *Real World Data Science*, 13 Apr. 2023, realworlddatascience.net/ideas/tutorials/posts/2023/04/13/flowers.html.

"Climate Change Indicators: Leaf and Bloom Dates." *EPA*, Environmental Protection Agency, 21 July 2023, www.epa.gov/climate-indicators/climate-change-indicators-leaf-and-bloom-dates#:~:text=4-,Background,light%2C%20rainfall%2C%20and%20humidity.