What determines Trillium flowering in the absence of deer?

Department of Biology, Queen's University
Faith Hines and Kira Henders in the Grogan Lab

Introduction

White Trillium (*Trillium grandiflorum*), Ontario's official flower, is found in the understory of many deciduous forests throughout Eastern North America[1]. White tailed deer, also common in this region, are heavy consumers of Trillium flowers and underlying leaves, resulting in severely reduced flowering in subsequent years[2]. But what are the dynamics of Trillium flowering in areas where deer are absent or excluded?

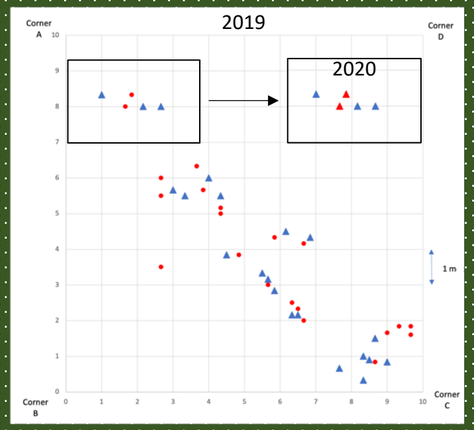
Research Questions:

In the absence of deer:

1. Are Trillium flowering numbers consistent among years?
2. Is the spatial pattern of Trillium flowering consistent among years?
3. Could Trillium total leaf area determine its capacity to flower, or conversely is there an investment trade-off between leaf area and flowering?

Methods

Flowering Trillium frequencies have been collected at various spatial and temporal scales since 2019 at Pangman Tract, a mature mixed-hardwood forest at the Queen's University Biological Station. The site contains ten 100 m^2 plots of similar species composition and terrain, half of which have been fenced to exclude deer since 2007. Trillium total leaf area of flowering and non-flowering plants in a deer exclosure, and in a deer-accessible plot (where all Trillium were non-flowering) was estimated based on leaf length and maximum width measurements.



Pangman Tract map illustrating the initially selected flowering and non-flowering Trillium plants (flagged blue and red respectively) along the diagonal of exclosure plot H in 2019, and in the inset (top right) some of the changes observed in 2020

Flowering Blue
Non-Flowering Blue
Flowering Red
Non-Flowering Red

Flagged Trillium in exclosure plot H – blue indicates flowering at least in 2019, red indicates non-flowering at least in 2019

One of 5 replicate deer exclosure plots at Pangman Tract, Opinicon Road

Results

1. Even in the absence of deer, overall flowering Trillium numbers across exclosure plot H fluctuated among years

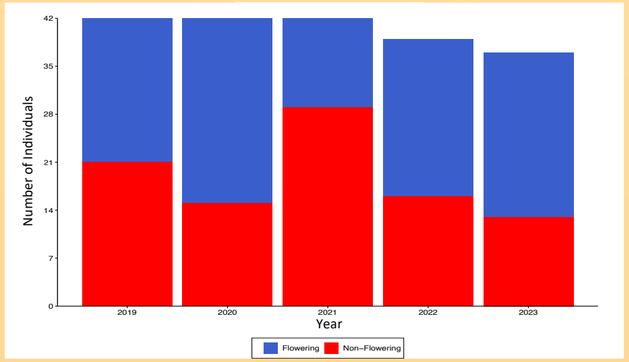


Figure 1: Count of subsequent annual flowering (blue) and non-flowering (red) Trillium in deer exclosure plot H, based on a selection of 21 flowering and 21 non-flowering plants in 2019

2. Even in the absence of deer, flowering of individual Trillium plants was not consistent between years

Figure 2. Annual flowering patterns in subsequent years for a selection of 21 flowering (blue) and 21 non-flowering (red) Trillium plants in 2019

3. Even in the absence of deer, flowering Trillium plants have significantly larger total leaf area than non-flowering plants.

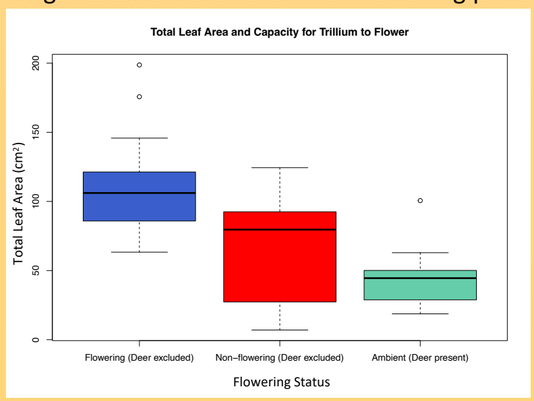
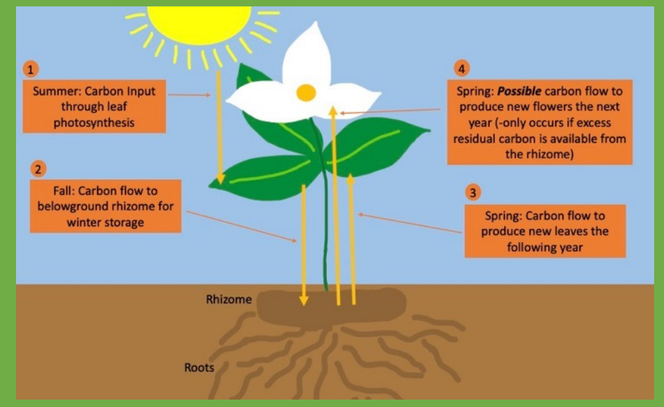


Figure 3: Total Trillium leaf area in flowering (blue) and non-flowering (red) plants within a deer exclosure (n=24 and 13 respectively), and also in a deer-accessible control plot (green) (n=21)



Seasonal dynamics of carbon flow within Trillium that determine the capacity for flowering in the subsequent year.

Conclusions

1. Even when deer were excluded completely by a fence, overall frequencies of flowering Trillium fluctuated across the next four years. This suggests that drivers other than deer browsing may influence Trillium flowering patterns.
2. Since spatial patterns of individual Trillium plant flowering varied among years (with only ~33% flowering every year), this suggests that it may take a certain number of years of non-flowering growth before most plants have the capacity to flower again.
3. The total leaf area results suggest that even in the absence of deer, carbon investment in flowering can occur only after a certain threshold in leaf area production is exceeded.

Our data from the Pangman deer exclosure and ambient control plots provide important insights into conservation efforts to promote Trillium flowering across Eastern North America, that may also apply to other flowering species. Moreover, our results suggest that using the number of flowering Trillium in an area as an estimation of deer population densities may be less accurate than previously thought[3].

References and Acknowledgements

[1] Knight, T. M., Caswell, H., & Kalisz, S. (2009). Population growth rate of a common understory herb decreases non-linearly across a gradient of deer herbivory. *Forest Ecology and Management*, *257*(3), 1095–1103. https://doi.org/10.1016/j.foreco.2008.11.018.
[2] Knight, T. M. (2004). The Effects of Herbivory and Pollen Limitation on a Declining Population of Trillium grandiflorum. *Ecological Applications*, *14*(3), 915–928. https://doi.org/10.1890/03-5048.
[3] Koh, S., Bazely, D. R., Tanentzap, A. J., Voigt, D. R., & Da Silva, E. (2010). Trillium grandiflorum height is an indicator of white-tailed deer density at local and regional scales. *Forest Ecology and Management*, *259*(8), 1472–1479. https://doi.org/10.1016/j.foreco.2010.01.021.

Special thanks to Kelly Balfour, Dominic Wood, Sarah Gordon and all the previous students who have collected Trillium data.