Table 1. Comparisons of variables between early sampling periods (1942-1961) and later sampling periods (2012-2020).Variables include mean estimates of first-flowering day (FFD) by species and three environmental variables: Spring temperature (Feb, Mar, April), Snow pack in mid-march and Total snow.



Table 2. Statistical summary of standardized regression coefficients for indirect effects for reduced model. Number of asterisks indicate level of significance for p-value: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001.

|  |  |  |
| --- | --- | --- |
| Species | Indirect effects of TSNOW on FFD mediated by SPDX | Indirect effects of ST on FFD mediated by SPDX |
| *Anemone patens* | -0.040 | 0.010 |
| *Ranunculus rhomboides* | -0.049 | 0.048 |
| *Caltha palustris* | 0.248 | -0.085 |
| *Cerastium arvense* | 0.168 | -0.035 |
| *Ranunculus abortivus* | 0.553\*\*\* | -0.197\* |
| *Lithospermum canescens* | -0.107 | 0.068 |
| *Oxalis violacea* | 0.059 | -0.016 |
| *Trillium cernuum* | 0.297 | -0.061 |
| *Sisyrinchium angustifolium* | 0.222 | -0.046 |
| *Lithospermum incisum* | -0.166 | 0.034 |
| *Pedicularis canadensis* | 0.359\* | -0.097 |
| *Zizia aurea* | 0.277\* | -0.105 |
| *Vicia americana* | 0.012 | -0.008 |
| *Cypripedium candidum* | -0.524\*\* | 0.193 |
| *Achillea millefolium* | 0.065 | -0.003 |
| *Anemone canadensis* | 0.002 | -0.001 |
| *Oxytropis lambertii* | -0.514\*\*\* | 0.067 |
| *Penstemon grandifloras* | 0.148 | -0.096 |
| *Rosa arkansana* | 0.342\* | -0.126 |
| *Penstemon gracilis* | 0.033 | -0.014 |
| *Zigadenus elegans* | 0.201 | -0.06 |
| *Amorpha canescens* | -0.548\*\* | 0.088 |
| *Campanula rotundifolia* | -0.146 | 0.049 |
| *Oenothera nuttallii* | 0.224 | -0.182 |

Table 3. Goodness of fit values for each model. An asterisk indicates a good fit (Χ2 p-value > 0.05 and CFI > 0.95).

|  |  |  |
| --- | --- | --- |
| Species | p-value for Χ2 test | CFI |
| *Anemone patens* | 0.001 | 0.777 |
| *Ranunculus rhomboides* | 0.234\* | 0.981\* |
| *Caltha palustris* | 0.014 | 0.913 |
| *Cerastium arvense* | 0.653\* | 1\* |
| *Ranunculus abortivus* | 0 | 0.679 |
| *Lithospermum canescens* | 0.012 | 0.899 |
| *Oxalis violacea* | 0.069\* | 0.904 |
| *Trillium cernuum* | 0.528\* | 1\* |
| *Sisyrinchium angustifolium* | 0.01 | 0.836 |
| *Lithospermum incisum* | 0.302\* | 0.998\* |
| *Pedicularis canadensis* | 0.656\* | 1\* |
| *Zizia aurea* | 0.264\* | 0.996\* |
| *Vicia americana* | 0.361\* | 1\* |
| *Cypripedium candidum* | 0.736\* | 1\* |
| *Achillea millefolium* | 0.008 | 0.828 |
| *Anemone canadensis* | 0.348\* | 1\* |
| *Oxytropis lambertii* | 0.744\* | 1\* |
| *Penstemon grandifloras* | 0.546\* | 1\* |
| *Rosa arkansana* | 0.013 | 0.897 |
| *Penstemon gracilis* | 0.308\* | 0.999\* |
| *Zigadenus elegans* | 0.156\* | 0.962\* |
| *Amorpha canescens* | 0.004 | 0.662 |
| *Campanula rotundifolia* | 0.042 | 0.927 |
| *Oenothera nuttallii* | 0.684\* | 1\* |

**Figure Legends**

Figure 1. Average monthly snowfall and rainfall in Fargo, North Dakota for the years of this study (1942-1961; 2012-2020).

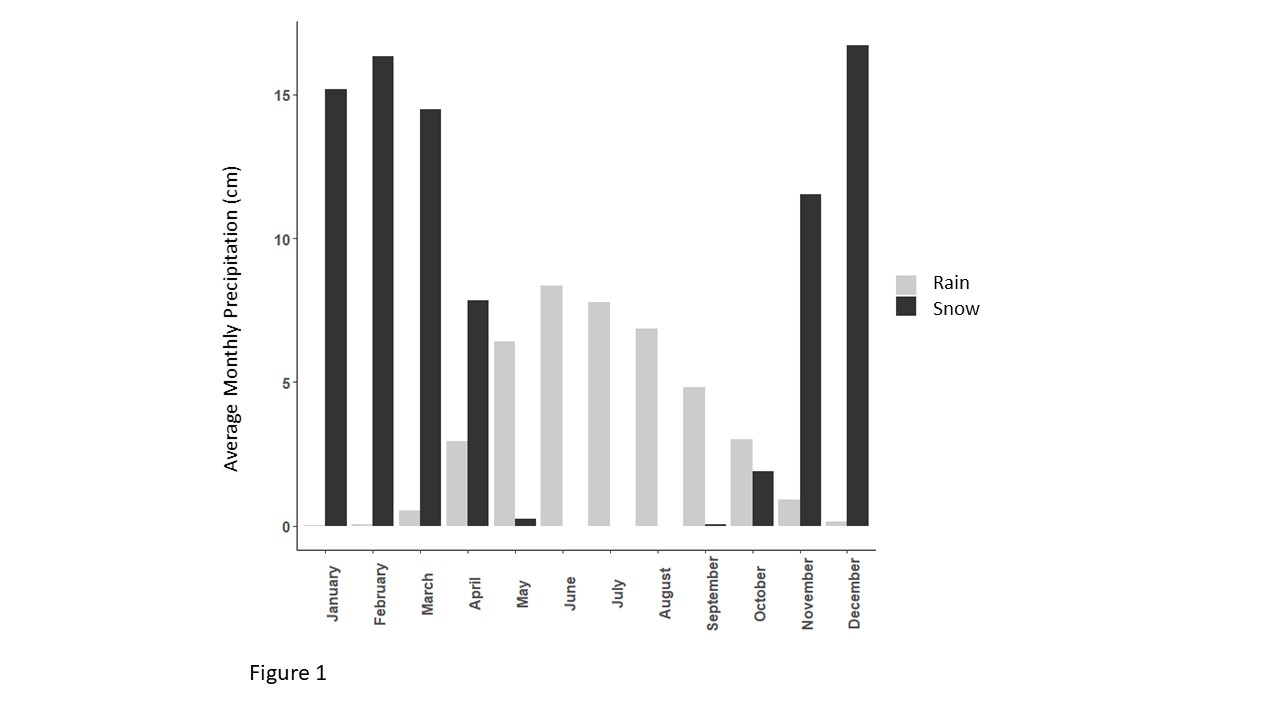
Figure 2. Correlation matrix showing strength of relationships among environmental variables: ST (spring temperature), TSNOW (total snowfall), SP15 (snowpack on March 15), DOBG (date of first bare ground). The magnitude of the correlation coefficient is proportional to the size of the circle; red indicates a negative relationship and blue indicates a positive relationship.

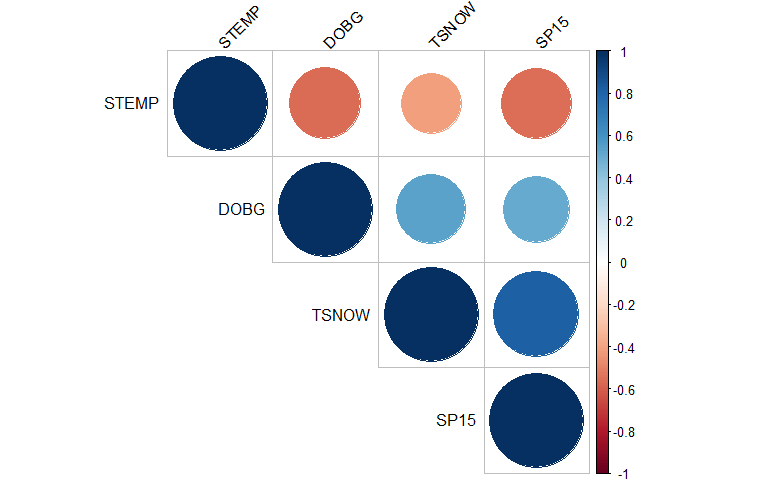
Figure 3. Full path diagram with ST (spring temperature), TSNOW (total snowfall), SPDX (snowpack on day X), DOBG (date of first bare ground), and FFD (first flowering day) (a) and reduced path diagram excluding DOBG (b). The reduced path diagram was used for the structural equation modeling.

Figure 4. Box plots of the first flowering day (FFD) of 19 plant species from the Bluestem Prairie reserve in Clay county, MN. Observations were made between 1942-1961 and 2012-2020. Box plots indicate distribution quartiles and standard error bars.

Figure 5. Simple linear regressions of first flowering day (day of year) as a function of snow pack on day X (cm) for each species with best-fit lines based on least-square estimates. Results for species are organized in order of flowering sequence over the season from early spring to late summer.

Figure 6. Path diagrams with standardized regression coefficient estimates labeled. Number of asterisks indicate level of significance for p-value: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001.

****

****

**Figure 2.**

![Diagram

Description automatically generated](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAA4cAAAIYCAIAAABRyA7jAAAACXBIWXMAABJ0AAASdAHeZh94AAAgAElEQVR4AQAIf/eAAf///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figure 3.

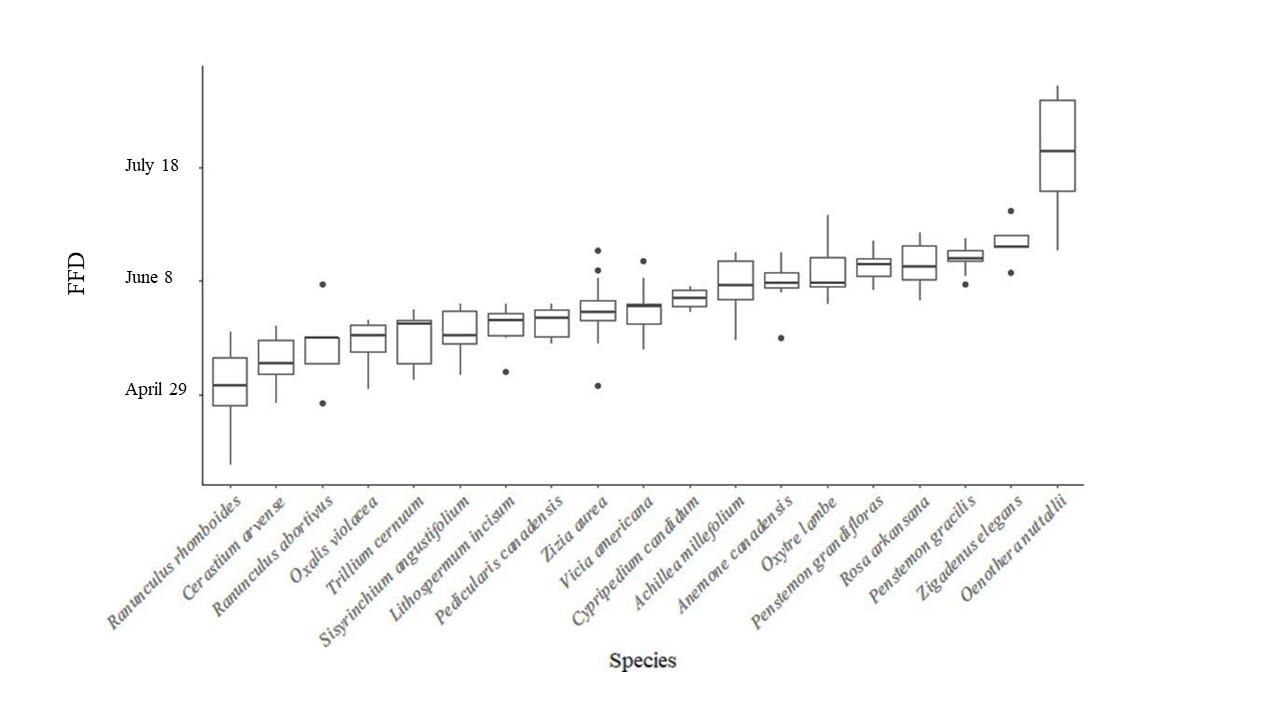


Figure 4.

A picture containing map

Description automatically generated

Figure 5.

Diagram, schematic

Description automatically generated

Figure 6.