Click on the worksheet labeled “Flowering data.” This worksheet provides data on the dates of flowering for six plant species collected throughout Ohio as well as temperature data and additional descriptive data (Calinger *et al*. 2013).

Look at the column headings: Species, Common Name, County, Year, Division, Temperature, and DOY. Species and Common Name specify the plant species of interest. Each row represents an individual observation for a given species. County and Division provide information on the county of observation and the NOAA Climate Division in which that county is found. Year simply indicates the year in which the observation was made.

Flowering dates are given in the “DOY” column. DOY stands for “day of year” and is the numeric day of year (day 1=Jan.1, Dec. 31=365, and so on) that the plant was flowering. Each flowering date is paired with a temperature specific to the individual plant’s location, year, and season of observation. This temperature (oC) is given in the Temperature column.

*1. Given these data, how will you assess phenological responsiveness (days/oC) for each species? Consider the following questions in your answer: What are your independent and dependent variables? What type of graph would be appropriate for your data? What statistical technique will you use to determine your phenological responsiveness value for each species?*

2. Based on your answer above, create a graph showing the relationship between flowering date (DOY) and temperature for each of the six species. Use these graphs and the appropriate statistics to determine phenological responsiveness values for each species and fill in the chart below.

|  |  |
| --- | --- |
| **Species** | **Flowering Shift (days/oC)** |
| *Carduus nutans* |  |
| *Castilleja coccinea* |  |
| *Cornus florida* |  |
| *Clematis virginiana* |  |
| *Aquilegia canadensis* |  |
| *Cypripedium acaule* |  |
| **Average Flowering Shift** |  |

*3. Do all species exhibit identical shifts in flowering time with an increase in temperature, or do some species advance/delay flowering more than others as temperature increases? Use specific species as examples in your answer.*

*4. Based on the average shift in flowering (*days/oC*) over all species, is flowering time in Ohio changing with warming temperatures? On average, how much would flowering shift with a 1oC or 2oC temperature increase?*

*5. Based on your flowering shift calculations for each species, will all species be equally well adapted to a warming Ohio climate? What impacts might this have on Ohio species diversity (we will consider species richness, or the total number of species in a given area, as our measure of species diversity)? Explain.*

*6. Compare the results from this study (Calinger et al. 2013) with the results of the study by Miller-Rushing and Primack (2008) of flowering times in Concord, MA. Did both projects use similar methods to assess temperature change? Phenological change? Has temperature changed in Concord at a similar rate to change in Ohio? Has temperature change affected flowing times in Concord as well?*