**Materials and Methods**

Study Area

The plants studied in this project included all herbaceous species in Colorado growing at altitudes greater than 3,200 meters. Alpine is generally considered to occur above 3,505 meters in Colorado, and as such this study area included subalpine and alpine plants up to the highest point, the summit of Mt. Elbert at 4,374 meters. The Rocky Mountains and continental divide run north to south through the middle of the state from Latitudes 30°N to 41°N.

Climate Data

Climate data was obtained from the Prism Climate Group (http://www.prism.oregonstate.edu/) and consisted of 2.5 arc-minute (4 KM2) gridded data sets of United States climate. The three climate variables studied included average annual maximum temperatures, average annual minimum temperatures, and average monthly precipitation from 1950 to 2011. Growing Degree Days were calculated from the minimum and maximum temperatures. These climate data were imported into QGIS v. 1.8.0.

Elevation data was obtained from the USGS Core Science Metadata Clearinghouse and consisted of a US Geologic Survey Digital Elevation Model with a pixel size of 90 square meters. Geographic areas with elevations above 3,200 meters in Colorado were extracted from the climate data by creating sample point centroids for each Prism Climate pixel, and using the point sampling tool in QGIS to sample the altitude digital elevation model to determine which centroids had elevations 3,200 meters or greater . 1279 sampling points were extracted using this process.

Finally, the same sampling points were used to sample the climate data from each of the three climate variables for every year from 1950 through 2011. These data were used to determine the average high temperature, average low temperature and average monthly precipitation for each year.

Herbarium Data

Herbarium data was collected from Seinet (<http://swbiodiversity.org/seinet/index.php>) and separately from the University of Colorado Herbarium. The University of Colorado Herbarium contains the largest number of herbarium specimens collected in Colorado, but does not participate in the Seinet program. Data sets were collected from both sources and were filtered to include only vouchers which had been recorded as “in flower”, “in fruit” or “bulblet” and had been collected at or above 3,200 meters. No attempt was made to identify the exact coordinates of the collections because so much of the data was collected before precise GPS technology existed. We relied on the collector’s estimate of the elevation to determine whether the collection fell within our elevation constraints.

The data was then refined as follows:

1. Records which did not record the exact date of collection were removed.

2. In years where there were multiple collections, only the species with the first date of collection was retained in the dataset. All collections with later dates of collection were removed. It is important to note that collections occurred between 3,200 and 4,374 meters, but no accommodations were made to account for bloom times by elevation.

3. Herbarium specimens collected outside of the study period of 1950 through 2011 were removed.

3. Herbarium specimens with flowering times recorded for less than ten years were removed in order to assure that a minimum level of statistical viability was attained.

(NOTE: actually, I don’t think we ever did this. May have been done in R, but I couldn’t find it). The lowest number of distinct years collected for a species was 7. 290 total species were found in the sample. 271 species had ten or more years of collection.

Matching Climate Data with Species Data

Regression analyses were performed in R (R x64 1.13.2) matching each species phenology date to the climate data in each year collected using the following variables

* Bloom date by average high temperature
* Bloom date by average low temperature
* Bloom date by Precipitation