***Exploring how climate will impact plant-insect distributions***

***and interactions using open data and informatics***

**SP-2: Species Distribution Maps (SDMs) and Hypothesis**

**- Simplified Instructions -**

**Brief Summary:** Naturalists are engaging in biodiversity research more than ever. Web-based biodiversity records have been widely adopted, data science has become increasingly sophisticated, and biodiversity technologies have become mobile. In particular, the creation of massive online citizen science web platforms and smartphone applications has resulted in real-time biodiversity data collection across continental and global scales by citizen scientists. This data acquisition of the world’s biodiversity is the type of data needed for precision conservation. With these data, mapping and data science converge to tell the up-to-date narratives of each of Earth’s inhabitants and to signal when to intervene and how well our conservation efforts are helping. Here we will map species distributions of butterflies and an important host plant using iNaturalist open source data and basic data science tools such as R, R Studio, and Git. From these maps, we will make testable hypotheses about the effects of climate change on the distributions and interactions between this butterfly and its larval host.

**Learning Goals & Objectives:**

1. Use data science tools (Citizen science crowd sourced data, R programming language, GitHub collaborative web platform, data visualization) to study a butterfly-host plant interaction.
   1. Apply common research computing tools including RStudio and GitHub to visualize butterfly-host plant distributions
   2. Search, filter and download butterfly and host-plant distribution data from biodiversity citizen science web platforms, specifically iNaturalist
   3. Differentiate descriptive and predictive species distribution models Create maps for species distribution models using R from open source biodiversity data for hypothesis generation
   4. Develop a hypothesis regarding the effects of climate change on a plant-insect interaction 50 years from now

**Background References:** R and R Studio Intro for Macs <https://www.youtube.com/watch?v=cmj8Oi6PFe0>, <https://www.youtube.com/watch?v=bGBgjZd6YHw>

**How To Make a Species Observation Map:**

1. Find your taxa on iNaturalist (<https://www.inaturalist.org/taxa/>)
2. Print screen of species observation map
3. Crop as appropriate for Student Project 2 making sure to provide the link to the iNaturalist site and the date of data visualization

**How To Make a Species Distribution Map:**

*Installation*

1. Install R (<http://lib.stat.cmu.edu/R/CRAN/>), R studio (<https://www.rstudio.com/products/rstudio/> ), and Git (<https://git-scm.com/downloads>)
2. In RStudio, clone the Git repository at <https://github.com/jcoliver/biodiversity-sdm-lesson.git>
3. Install the following packages:
   1. raster
   2. sp
   3. dismo
   4. maptools

*Data Setup*

1. Download data for your butterfly species from iNaturalist as a CSV file, save it in the biodiversity-sdm-lesson/data folder as butterfly scientific name\_data (e.g. Adelpha\_eulalia\_data.csv)
2. Download data for your plant species from iNaturalist as a CSV file, save it in the biodiversity-sdm-lesson/data folder as plant scientific name\_data (e.g. Quercus\_gambelli\_data.csv)

*Running Analyses*

1. Copy the file run-sdm-pairwise.R and rename the copy <species>-sdm-pairwise.R, replacing <species> with the name of your butterfly. Use underscores instead of spaces; so for butterfly species *Adelpha eulalia*, the file name would be Adelpha\_eulalia-sdm-pairwise.R.
2. Open this new file (e.g. Adelpha\_eulalia-sdm-pairwise.R) and update the following values:
3. butterfly.data.file <- "data/BUTTERFLY\_DATA.csv" Change "BUTTERFLY\_DATA.csv" so it matches the file of butterfly data you saved above (e.g. Adelpha\_eulalia\_data.csv)
4. plant.data.file <- "data/PLANT\_DATA.csv" Change "PLANT\_DATA.csv" so it matches the file of plant data you saved above (e.g. Quercus\_gambelli\_data.csv)
5. Save the file with these updates

3. Run the analyses by typing the following command in the **Console**: source(file = "scripts/<species>-sdm-pairwise.R"), replacing <species> with your butterfly or plant species name (e.g. scripts/Adelpha\_eulalia-sdm-pairwise.R)

**Next Steps:** Use your maps to complete **SP-2 Assignment: Species Distribution Maps and Hypothesis** to report your findings and develop testable hypotheses on how climate change may affect your butterfly species distribution.