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

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

**SP-3: Future Species Distribution Models and Hypothesis Evaluation**

**- Assignment -**

**- Example -**

Student Name

**I. Butterfly Forecast Model:** *Papilio cresphontes*



**Figure 1.** Species distribution model (SDM) for *Papilio cresphontes* for forecast (2070) climate conditions. SDM generated in R using research grade observation data collected from iNaturalist on 2018-02-01. Green area in the map represents the projected distribution of *P. cresphontes*.

Evaluation of model: Compared to the model for current conditions, the range of *Papilio cresphontes* is predicted to expand slightly to the north and contract significantly from the southern portion of its range.

**II. Host Plant Forecast Model:** *Zanthoxylum americanum*



**Figure 2**. Species distribution model (SDM) for *Zanthoxylum americanum* for forecast (2070) climate conditions. SDM generated in R using research grade observation data collected from iNaturalist on 2018-02-01. Green area represents the projected current distribution of *Z. americanum*.

Evaluation of model: The range of *Zanthoxylum americanum* is predicted to expand north to reach the border of the USA and Canada and contract out of the southern plains states (Texas, Oklahoma, and Kansas).

**III. Model Comparison of Forecast Distribution Overlap:** *Papilio cresphontes* & *Zanthoxylum americanum*



*Figure 3*. Species distribution models (SDMs) for *Papilio cresphontes* (pink), *Zanthoxylum americanum* (green), and area of overlap (red) for forecast (2070) climate conditions. *Papilio cresphontes* occupies 80.25% of the range of *Z. americanum* in this model. SDM generated in R.

Evaluation of the model: Compared to the present-day SDM, the percentage overlap does not change by much. However, the distribution of both the butterfly and the host-plant are predicted to contract and move northward. This means that the area of overlap between the butterfly and host-plant now occupies more of the overall range of the butterfly and host plant compared to present-day.

**IV. Hypothesis for effects of climate change on this plant-insect interaction.**

If the climate continues to warm, *Papilio cresphontes* will expand into northern Iowa and Minnesota, where its larval host plant, *Zanthoxylum americanum* currently exists.

**V. Evaluation of Climate Change Hypothesis**

Based on the comparison of the models for current and forecast climate conditions, both *Papilio cresphontes* and *Zanthoxylum americanum* are predicted to move their respective distributions northward in support of the hypothesis. *Papilio cresphontes* is predicted to move north into the northern Great Plains (northern Iowa and Minnesota), although not as far north and west as *Z. americanum* is predicted to expand. Even though increased climate temperature may allow *P. cresphontes* to expand its distribution northward, *Z. americanum* appears to be able to tolerate colder temperatures than *P. cresphontes* can survive in.