Workshop 4: Species Distribution Model

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Objectives

The primary objectives of this analysis is to build a species distribution model for the provided data of observations of the saguaro cactus in the southeastern United States and northwestern Mexico.

Methods

Site Information

Saguaro cactus, *Carnegiea gigantea*

The study species is the saguaro cactus, *Carnegiea gigantea*, which is native to the southeastern United States and northwestern Mexico. The plant is specially adapted to the dry, hot environment of this portion of the world by retaining large quantities of water during the few annual rainstorms and slowly using this water throughout the year. The cactus reproduces via flower blossoms and fruits, and can live to be about 150 years old.

Species image obtained from https://en.wikipedia.org/wiki/Saguaro (https://en.wikipedia.org/wiki/Saguaro) Data set and species distribution model tutorial obtained from https://jcoliver.github.io/learn-r/011-species-distribution-models.html (https://jcoliver.github.io/learn-r/011-species-distribution-models.html)

Statistical Analysis

Five R packages were loaded and used to analyse the data: sp, raster, maptools, rgdal and dismo.

Saguaro cactus GPS coordinates were uploaded to Rstudio and plotted on a base map of the southwestern United States and northwestern Mexico. Bioclimate data was downloaded and restricted to the pertaining geographical area of the base map. Pseudo-data points were calculated to allow the model to account for both presence and

absence of the cactus. The observation points and pseudo-data points were randomly sampled into either a training group for building the model or a testing group for testing the validity of the created model. The created model was used to determine a threshold through the “spec_sens” sensitivity for presence data for the saguaro cactus, and the model was reconfigured based on this threshold to determine the areas of highest likelihood that the cactus could be found. This range was plotted along with the original presence points on the base map.

Results

No data table outputs were generated for this analysis. A total of 400 presence points and 400 pseudo-absence points were used to build and test the model.

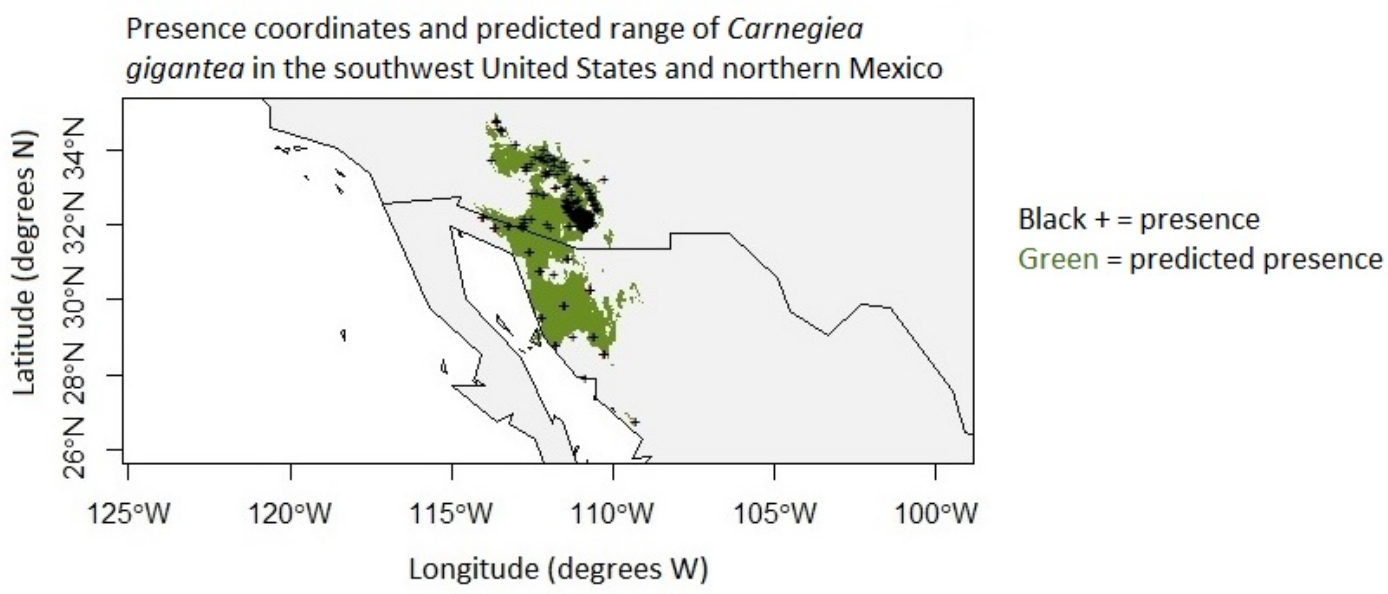

Figure 1. Plot of presence and absence data for saguaro cactus in the southeastern United States and northern Mexico

From the species distribution model, the minimun threshold for saguaro cactus presence was 0.009275. Once the model was reconfigured with similarity values above the threshold, presence and absence data from the model were able to be plotted on the base map of the United States and Mexico (Figure 1).The original data points were plotted as black crosses, the predicted presence range is colored green, and the absence points were given no coloration.

Discussion

The saguaro cactus is known to have an incredibly limited home range, relegated only to the the southeastern portion of Arizona and the northwestern portion of Mexico, though some plants have also been seen to extend into the outskirts of California (https://en.wikipedia.org/wiki/Saguaro (https://en.wikipedia.org/wiki/Saguaro)). One of the main limits to the cactus’ range extension is elevation; the plant is not adapted to withstand low temperatures, so higher elevations do not provide ideal habitat. This limited range is seen in the distribution model for this analysis; the presence data points plotted for the cactus seem to outline the predicted range generated by the model, suggesting that the cactus has reached its range limits in the area (Figure 1). The saguaro cactus is a keystone species, meaning it provides vital resources and habitat for organisms in the area and would be highly detrimental

for these organisms if the cactus populations were to be negatively affected (https://en.wikipedia.org/wiki/Saguaro (https://en.wikipedia.org/wiki/Saguaro)). Because the cactus is reletaged to such a small home range, it is vital to protect its habitat in order to ensure the proliferation of many other species in the area.