

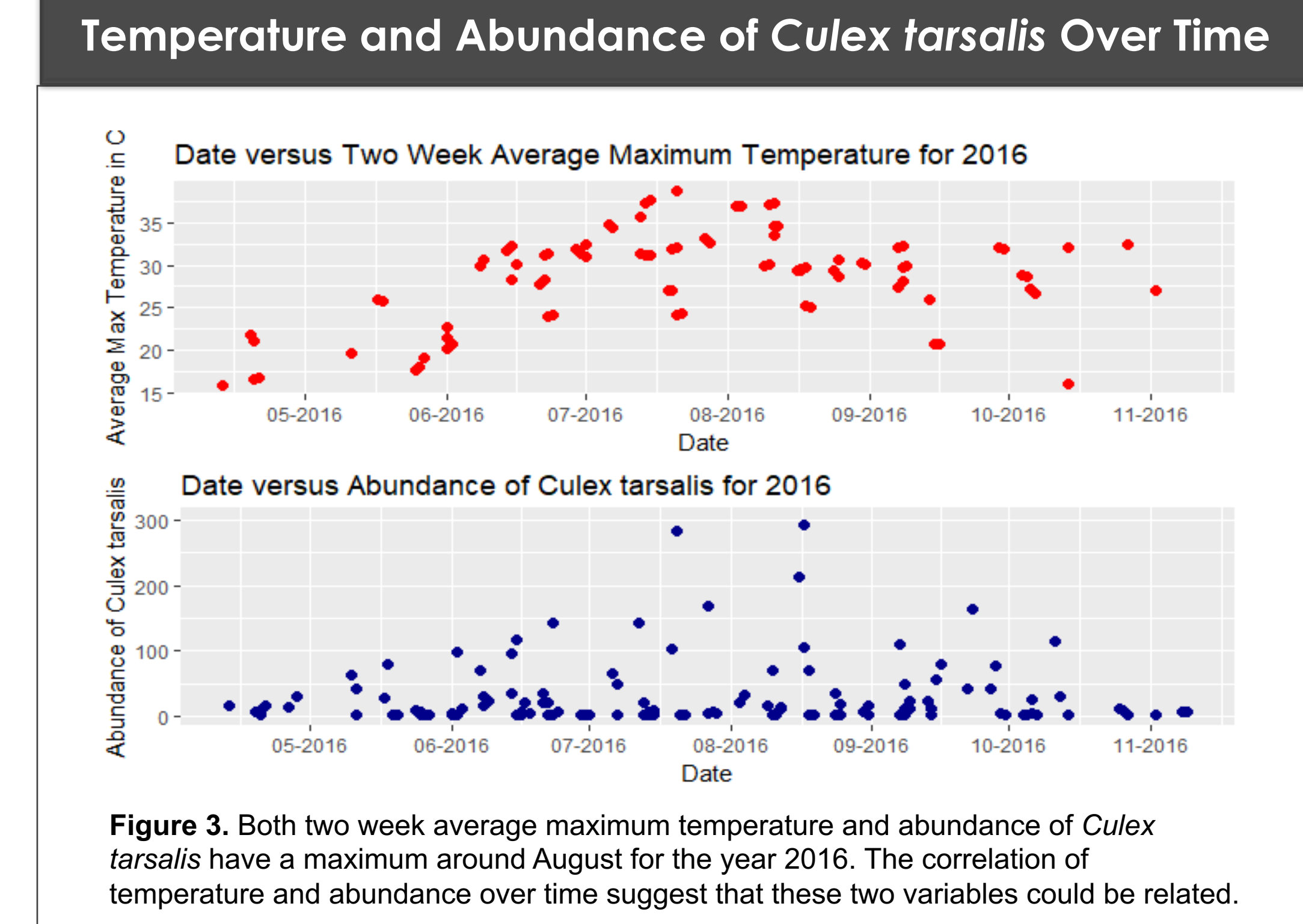
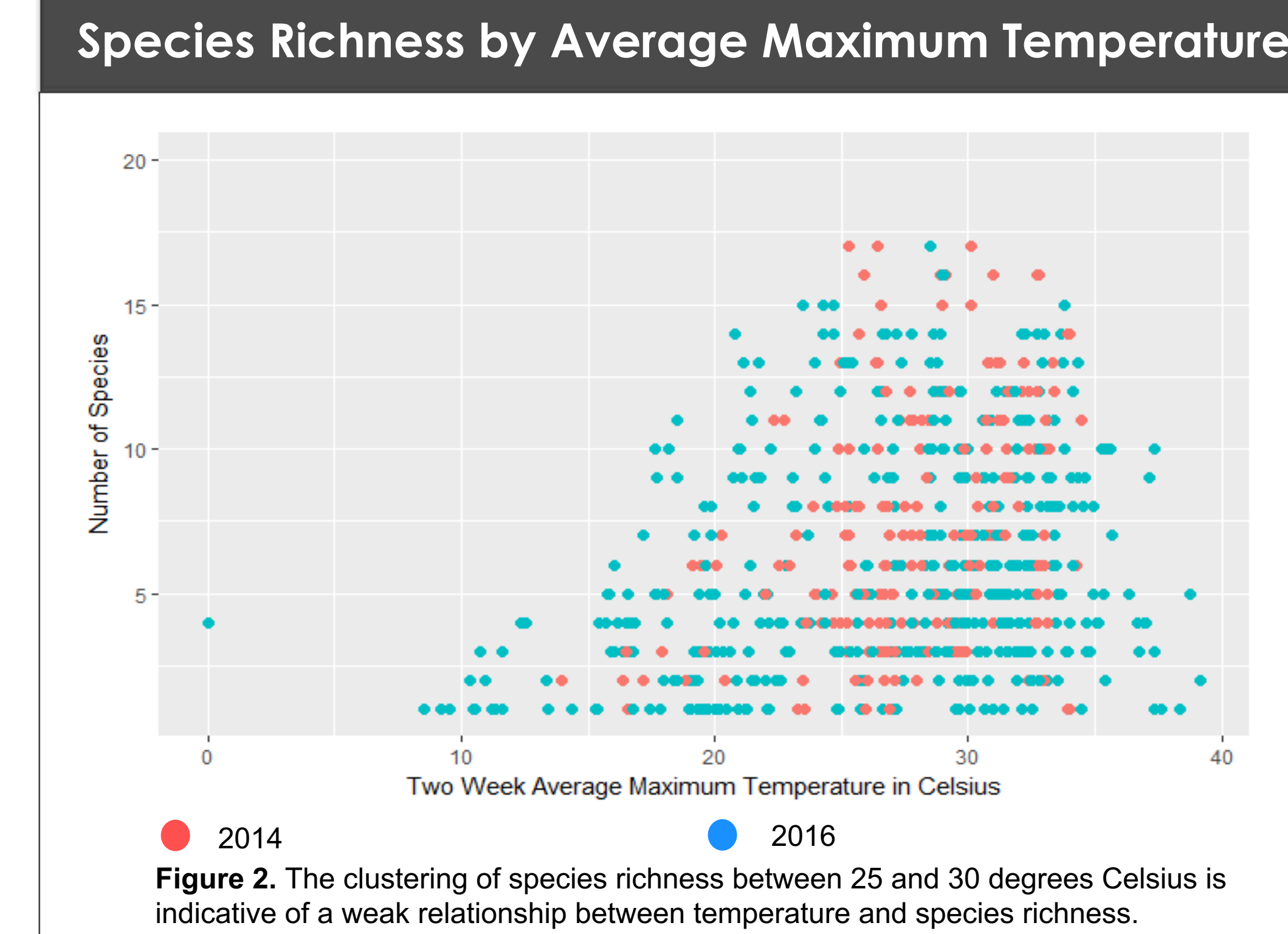
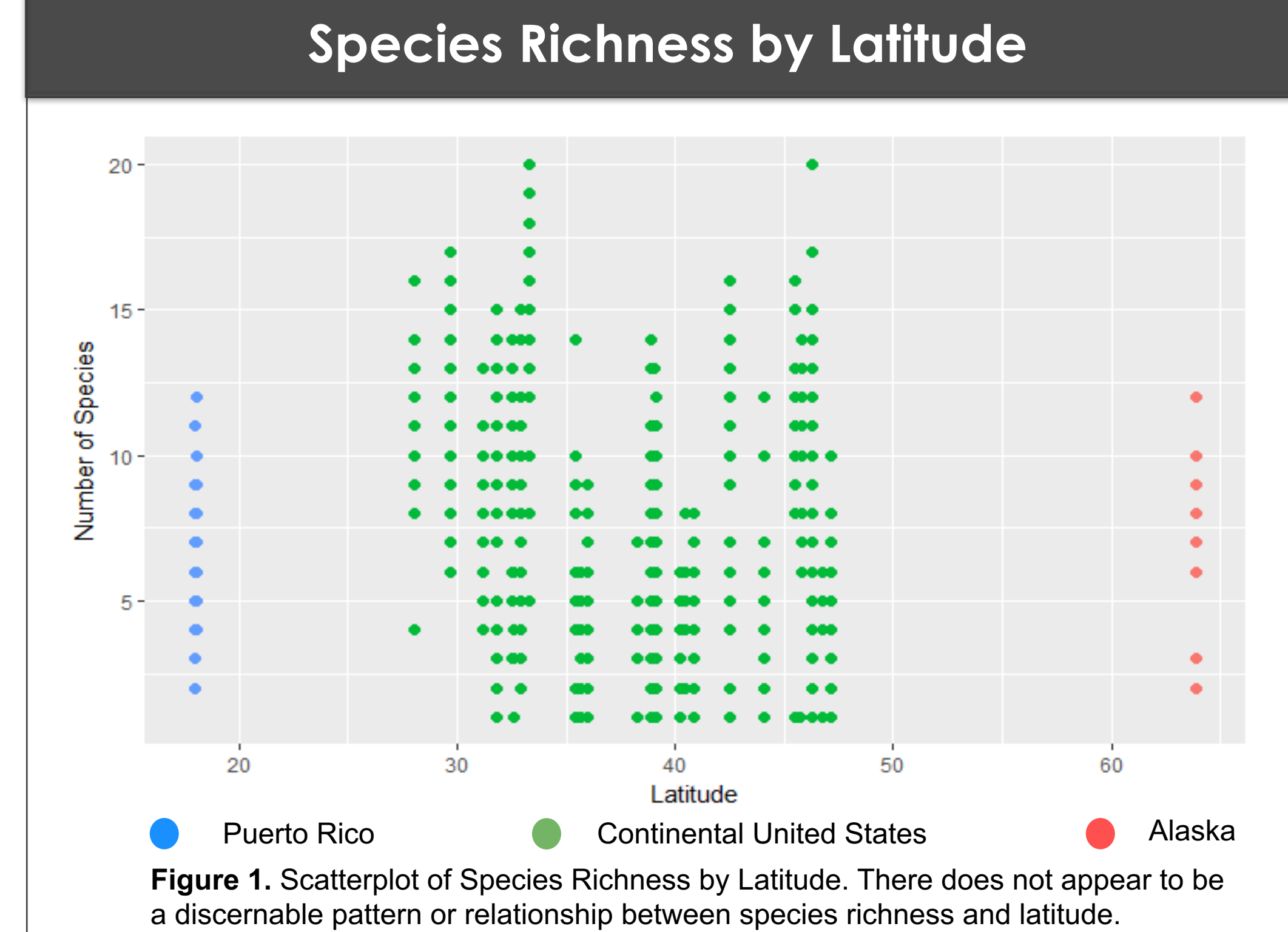
Methods of Exploring Spatial Patterns and Mapping NEON Mosquito Data in R

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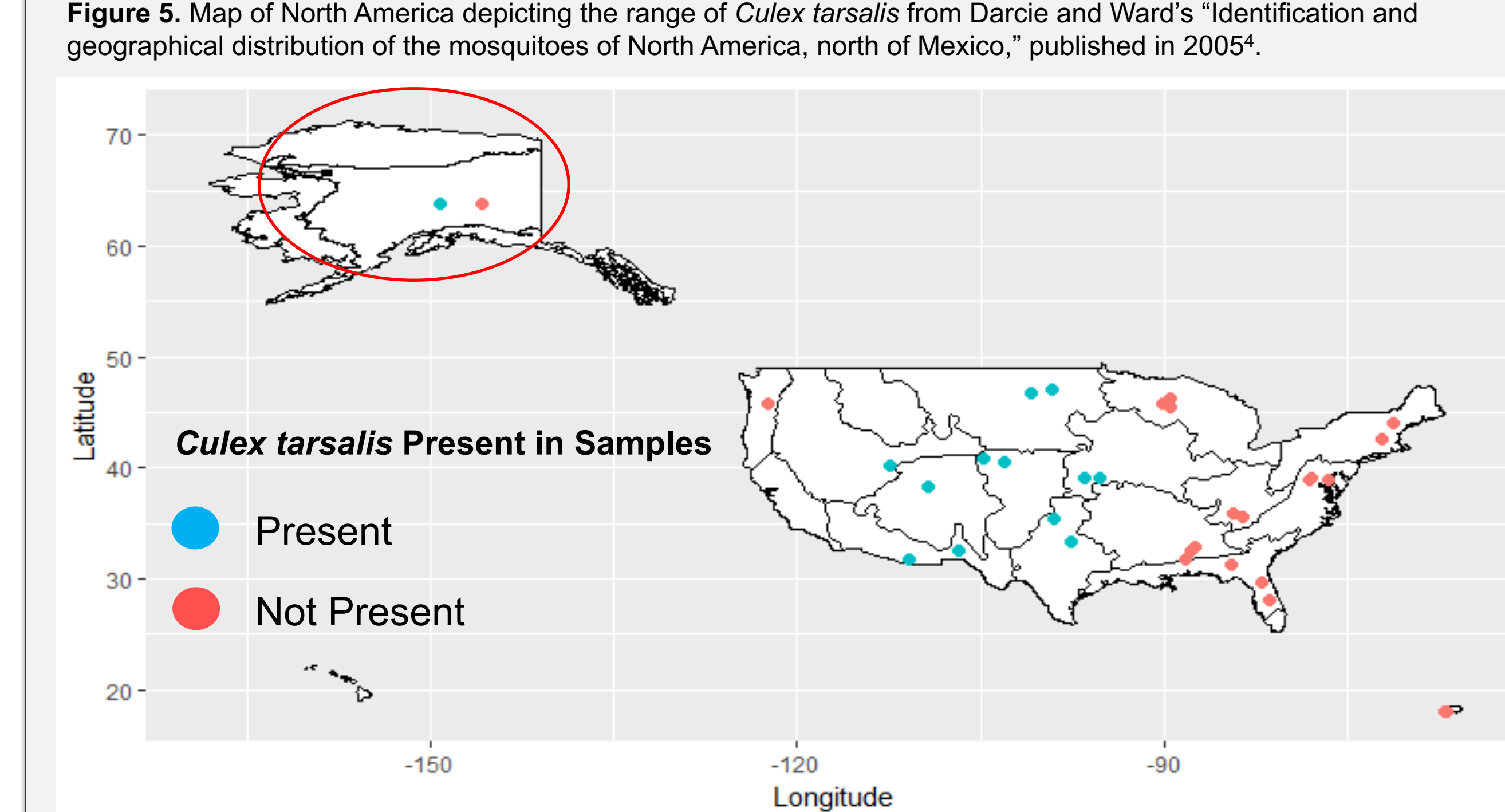
Creating a Tutorial for NEON Mosquito Data

Background: The study of mosquitoes is important because of their roles as members of food chains, carriers for human diseases, and as a sentinel taxon for climate change¹. The National Ecological Observatory Network (NEON) will be collecting mosquito occurrence, identification, and pathogen data at 47 terrestrial sites over the next 30 years.

Project Goals: The aim of this research project is to develop and provide future data users with methods and examples of working with NEON mosquito data to facilitate data analysis and visualization using the R programming language. We present a general workflow for downloading, merging, and processing data from NEON's mosquito data product to explore and visualize species richness across all NEON sites. The tutorial includes examples of how to combine field observations with meteorological data to explore the relationship between mosquito species richness and temperature thresholds. The broad spatial distribution of NEON sites may enable early detection of mosquito species range expansion. We show how these data can be used to analyze the presence or absence of a single species, *Culex tarsalis*, across NEON sites.



Range of *Culex tarsalis*



NEON mosquito data indicates that the range of *Culex tarsalis* has expanded:

- Climate change will likely make more habitats suitable for *Culex tarsalis* now and in the future
- A comparison of the established range of *Culex tarsalis* (top) to NEON site where *Culex tarsalis* was present (bottom) reveal that this species has been found in habitats farther north from its typical range.
- Range expansion in response to environmental changes will likely become more commonplace and "climate change may broaden the range of some mosquito-borne pathogens and as a result expose new human populations to these disease-causing agents"⁵.

Picture of a Female *Culex tarsalis*



Figure 4. *Culex tarsalis* is an especially important species to study because their role as carriers of the West Nile Virus. Pictured here is a female *Culex tarsalis*.³

Acknowledgments

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References

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Lesson Outline

- Data Organization and Set Up**
 - Retrieve NEON Location Information
 - Use a function that calls NEON APIs to obtain location data
 - Merge trapping, identification, and sorting data frames
- Vignette One: Mosquito Species Richness**
 - Calculate Species Richness
 - Count the unique number of scientific names at each sampling site by using the 'ddply' function
 - Create Temperature and Degree Day Variables
 - Create a temperature lag function that calculates the average maximum temperature and number of days above 16° Celsius two weeks prior to sampling²
 - Apply the temperature lag function to a species richness data frame using the 'mapply' command
- Vignette Two: Abundance and Range of *Culex tarsalis***
 - Calculate Abundance
 - Create a subsample multiplier to estimate the number of individuals in each sample
 - Sum individual count from samples by site identification and date
 - Visualize *Culex tarsalis* Range
 - Download NEON domain shapefiles
 - Create indicator variable of *Culex tarsalis* native status and sampling presence
 - Use the 'ggplot2' package to visualize NEON domain map

For more information on project methods and access to code, please scan this QR code. To access NEON mosquito data, please visit data.neonscience.org/home