Outstanding Oaks: *Quercus* Phenology at NEON Sites

Module Overview

Oaks (trees within the genus *Quercus*) live within a broad range of ecosystems in the United States, including semi-arid savannas in California, temperate deciduous forests in the northeast, and coastal scrublands in the southeast. Within these diverse ecosystems, different species within *Quercus* have adapted traits that are suited for each environment. One example of these adaptations are differences in the phenological timing of *Quercus* events, including leaf formation and growth, flowering, and leaf-fall.

This exercise is designed to visualize repeated phenology observations from the National Ecological Observatory Network (NEON) to examine similarities and differences among *Quercus* phenology at different sites. This exercise uses NEON site data from the San Joaquin Experimental Range (SJER) in California, the Ordway Swisher Biological Station (OSBS) in Florida, and the Harvard Forest (HARV) in Massachusetts.

Learning Objectives

1. Describe how differences in environmental conditions might lead to adaptations in *Quercus* phenology across a diverse set of ecosystems.
2. Construct hypotheses about how the timing of phenological events might vary across ecosystems in semi-arid California, the temperate Northeast, and Florida.
3. Illustrate patterns in *Quercus* phenology with long-term observations at three different field sites.
4. Compare similarities and differences among phenological timing within an individual site across many years, and among sites.

Instructions

1. This app will examine patterns in oak phenology at "phenophases" that describe important events during annual oak development. These include: Budbreak, Leaves present, Leaves falling, Breaking leaf buds, Open flowers, Increasing leaf size, Colored leaves. With your group, make a diagram that outlines the annual timing of these events.
2. Navigate to the oak phenology app at https://qubeshub.org/resources/neonoakpheno. Using the links to the NEON sites within the app, create a table that outlines differences in the sites that might impact the timing of the phenophases.

3. Choose one phenophase from the list above. Based on your investigations of the NEON sites and what we learned in class about the differences in climatology of California, Florida, and Massachusetts, make a hypothesis about how the location of the oak species might produce evolutionary adaptations in the annual timing of that phenophase. In addition to (or within) your hypothesis, identify and describe the mechanisms (*i.e.*, differences in the environment and the connection to the phenophase timing) that you expect to create differences in phenophase timing at the three sites.
4. Use the app to display data that tests your hypothesis. With the group, discuss why, or why not, the data confirm your hypothesis.