HOLDEN
FORESTS &
GARDENS

# Understanding Phenological Asynchrony

Phenology is the study of timing and cyclical patterns of natural events. You can observe many phenological events quite easily, like the first snowfall or the first bloom on a plant in a given year. The phenology associated with organisms entering different phases of their life cycle or beginning seasonal changes to their daily routine is determined by environmental cues. Two common types of environmental cues used by organisms include photoperiod and temperature. Photoperiod is the change of day length across the seasons and does not change much from year to year. Temperature is more variable, generally increasing more rapidly than it has in the past due to climate change, but also changing differently in different habitats. Therefore, organisms that use different cues or spend time in different areas (during migration) may experience changes to their phenological events in different ways. Many organisms depend upon the availability of other organisms to provide essential resources, like food and shelter. The differences in phenological responses to different cues among different organisms could cause **phenological asynchrony** (i.e., phenology mismatch), where the peak of demand for a resource does not coincide with the availability of that resource. What could be the effects of this phenological asynchrony?

The figure on the following page is from a paper (Mayor et al. 2017) that explored possible phenological asynchrony between the time when migrating birds arrive to their breeding areas and when "green-up" occurs there. "Green-up" represents when vegetation (like leaves) starts to emerge on plants, which is a good predictor of insect food availability (since most insects depend upon vegetation for food and survival). Circles represent the average values and the error bars above and below the circles show the variability in the average (generally, average values are not significantly different from values overlapping error bars). Asterisks indicate statistically significant differences between arrival and green-up. Symbols along the x-axis represent the habitat location of breeding grounds for each bird species listed.

In the top panel (A), the rate of change shows whether bird arrival or green-up changed to be earlier (negative values below the zero line) or later (positive values above the zero line) across the 12 years of data collection. Birds that show average arrival to breeding grounds (in orange) that don't overlap with average green-up (in green) may experience some degree of phenological asynchrony that affect their breeding performance.

In the bottom panel (B), the rate of change shows whether phenological interval (the difference between bird arrival and green-up) were negative (where birds arrive after green-up occurred) or positive (where birds arrive before green-up occurs).

Examine the figure on the next page. Make notes on the figure based on the information provided above to help you interpret the data. Answer questions below the figure to demonstrate understanding.
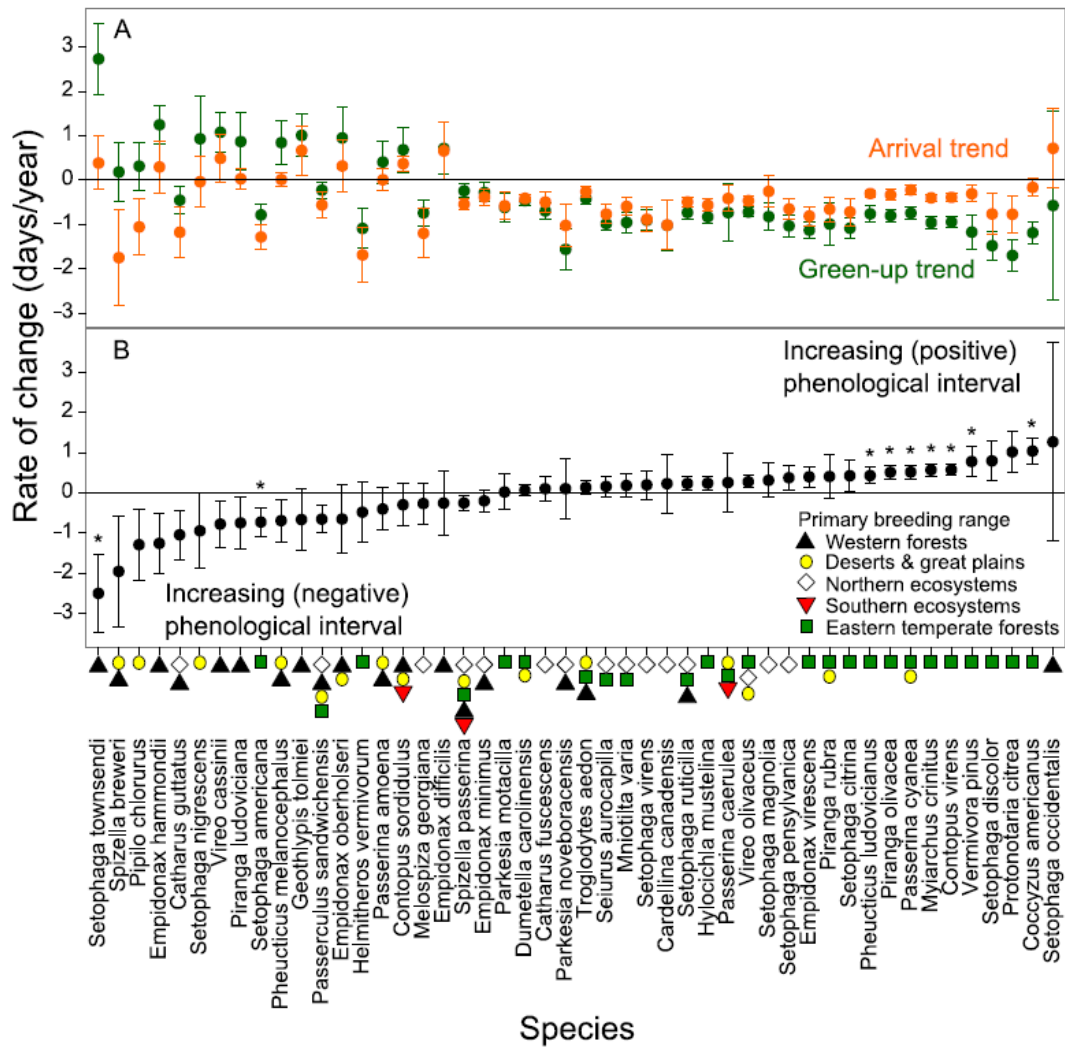
1. Identify three dependent variables: _____

2. Identify two independent variables: _____

3. **Circle** any data points that show a trend of birds arriving at their breeding grounds AFTER green-up has occurred. How many birds fall into this category? _____ Name a bird species in this category.

4. **Box** any data points that show a trend of birds arriving at their breeding grounds BEFORE green-up has occurred. How many birds fall into this category? _____ Name a bird species in this category.

5. What **habitat locations** tend to be associated with birds that are arriving at their breeding grounds BEFORE green-up has occurred?

6. What **habitat locations** tend to be associated with birds that are arriving at their breeding grounds AFTER green-up has occurred?

7. Explain why you think bird breeding performance can be affected by arriving before or after green-up and indicate which you think could be more detrimental for the birds.