Plant phenology is the transition of plants through various phenophases, or observable stages of their life cycle that have a defined starting and ending point. Plant phenology has many critical applications, including the management of invasive species and forest pests; predictions of human health-related events , such as allergies and mosquito season; optimization of when to plant, fertilize, and harvest crops; understanding the timing of ecosystem processes, such as carbon-cycling; and assessment of the vulnerability of species, populations, and ecological communities to ongoing climate change (USA NPN). When the transition of phenophases begins to happen earlier or later than average, then allergies will have an effect at different times due to the unusual timing of flowering, farmers won’t know when to apply fertilizers and pesticides and when to plant to avoid frosts, and the phenology of the varying tropic levels of animals won’t be in sync with plant development anymore (USA NPN). Without plant phenophases occurring around the same time each year, catastrophic effects throughout the food chain may follow.

Forces that affect plant phenology include temperature, timing and duration of pest infestations and disease outbreaks, water fluxes, nutrient budgets, carbon dynamics, and food availability. One of the most obvious factors in relation to climate change is changing temperature. With extreme high temperatures during the reproductive stages of plants, pollen viability, fertilization, and grain or fruit formation will be affected (Hatfield, Prueger 2015). For non-perennial crops, faster development due to rising temperatures results in shorter life cycle resulting in smaller plants, shorter reproductive duration, and lower yield potential (Hatfield, Prueger 2015). Perennial crops seem to have a more complex relationship to temperature than non-perennial crops do, and climate change will affect the chilling requirements of these plants that produce fruit or nuts (Hatfield, Prueger 2015).

Along with temperature as a factor of phenological change, accumulated growing degree days are also important to look at. Growing degree days are the number of degrees the average daily temperature exceeds a base temperature, or the temperature below which the organism will remain developmentally inactive. For many plants, there is a specific number of growing degree days that must be accumulated to trigger a change in phenological status, such as budburst in plants. This minimum number of GDDs for a change in phenophase is referred to as a plant’s growing degree threshold. If a growing degree threshold for a phenological transition is known for a particular organism, it is possible to investigate how soon that transition is likely to be reached by calculating aggregated growing degree days over the course of a season.

By studying the phenology of deciduous broadleaf trees, a perennial plant, within several NEON domains throughout the United States and viewing their green-up along with the temperatures through a season, the broader impacts of climate changes or land use change can be investigated. Deciduous trees are among the USA-NPN regional species list to monitor due to their dominance in their habitat, their conservation value, association with health issues such as allergens, and their importance to ecosystem services such as food supply. According to the EPA, two phenology derived variables as climate change indicators are length of the growing season of plants and leaf and bloom dates. By using data collected by NEON, deciduous tree leaf growth throughout time at a field site within one season will be graphed along with the temperature over the season, so that the implications of climate change can be explored. The accumulated growing degree days for the sites will also be displayed so that the changes in phenophases can be compared to the heat accumulation at the site, further allowing for the exploration of plant phenology and its relation to climate change.

References:

USA NPN National Phenology Network. *Why Phenology? | USA National Phenology Network* Available at: https://www.usanpn.org/about/why-phenology. (Accessed: 21st June 2019)

Hatfield, J. L. & Prueger, J. H. Temperature extremes: Effect on plant growth and development. *Weather and Climate Extremes* **10,** 4–10 (2015).