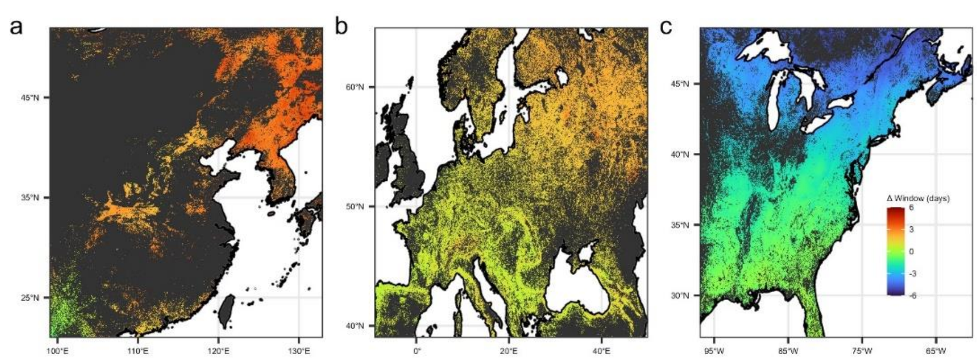
My research program centers around gaining a better understanding of how plants in temperate forests respond to climate change at the individual, population, and community levels. I focus on how climate change affects biotic interactions between plants and pollinators, mycorrhizal fungi, and other plant competitors. I incorporate information from historical datasets (especially herbarium collections) as well as field experiments and greenhouse and growth chamber studies. I am uniquely able to link pattern to process through physiological mechanisms that I identify, thus providing the basis for better projections of how temperate forest communities will respond to anthropogenic change. In my research program at Eastern Tennessee State University, I will continue to explore the following topics:

(1: Phenological Escape) In previous research, I found that understory plant species will experience changing access to light due to differences in phenological sensitivity with cooccurring canopy tree species. Access to early spring light is critically important for the growth, survival, and reproduction of understory plant species, which rely on this resource to assimilate 50-100% of their annual carbon budgets prior to the canopy closing above them (a strategy known as phenological escape; Lee & Ibáñez, 2021b). I found that North American spring ephemeral wildflowers will experience reduced access to spring light (Lee et al., 2022), although wildflowers in Europe and Asia will be less negatively affected (Fig. 1). In contrast, I found that deciduous tree seedlings will improve access to spring light availability in warmer springs, leading to projected improved availability to assimilate carbon by the end of the century (Lee & Ibáñez, 2021a). I then linked these phenological trends to physiological measurements that I and my colleagues collected to better predict changes in plant performance under future climates.

An important takeaway from this research is that species interactions will fundamentally alter how organisms respond to climate change, meaning that accounting for these interactions is important to improving predictions of how forests will fare under more extreme and stressful conditions. My lab will continue to address unanswered questions pertaining to phenological escape: How does forest canopy type (e.g., mixed-deciduous vs deciduous) affect understory plant access to light and performance? How do established relationships with growth, survival, and reproduction translate to population-level persistence and community-level coexistence? Which species are most vulnerable to climate change via reduced access to light and how can we best prioritize species conservation in the future? I will fund this research through NSF grants (both full DEB grants and climate change-specific grants such as the recent Organismal Response to Climate Change grants).



◄ Fig. 1: *I found that spring ephemeral wildflowers will experience reduced access to spring light in eastern N. America (panel c, blue), but will experience either no change (b) or improved access (c) in Europe and Asia, respectively.*

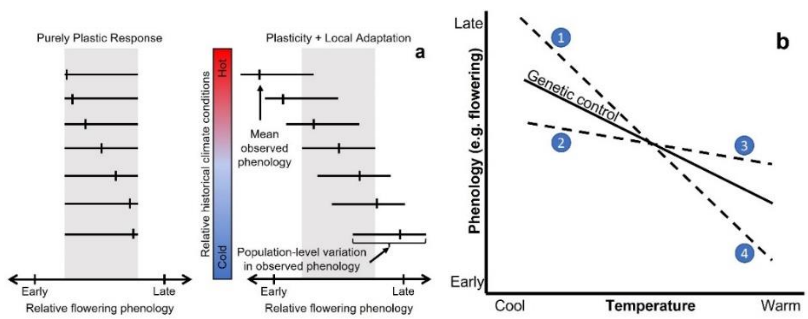
(**2: Dioecious phenological mismatch**) Recent research found that dioecious plant species (those that have male and female flowers on separate individuals) may respond differently in their phenology to warmer spring temperatures. **If male and female plants experience different shifts in flowering time in response to the same environmental conditions, this could reduce the period of flowering period overlap and compromise the reproductive success of these**

obligate out-crossers. I explored the potential for this phenological mismatch using Asian (Yang et al., 2022) and North American (ongoing, see UTK Hesler research fellowship) herbarium collections.

My lab will build off the historical trends established in these studies and use field experiments to explore how changes in the overlap of flowering period will affect dioecious plant reproductive success. We will establish bagging experiments to exclude pollinators from female flowers to artificially shorten flowering period overlap and quantify changes in fruit size, seed set, and germination success. We will continue working with entomologists to identify pollinator communities associated with dioecious plants and explore the possibility of plant-pollinator phenological mismatch. Lastly, we will use matrix population models to explore how and whether projected change in reproduction and recruitment affect population-level persistence. I will apply for NSF DEB funding to study *Lindera benzoin* (a common shrub) as a model system. I will also apply to USDA and DOE grants to extend this work to economically important tree species used for lumber production.

(**3: Plasticity vs. adaptation**) My lab will explore the relative contributions of phenotypic plasticity and local adaptation to regional and continental variation in expressed phenology. **The relative influence of these two mechanisms in cueing plant phenology to climate change is important because it has major implications for whether and how quickly plants will be able to respond to changes in environmental conditions** (Fig. 2a). If plasticity outweighs adaptation to local climate conditions, plants may be constrained in their ability to track future climate extremes.

Fig. 2: *(a) Relative contributions of phenotypic plasticity and local adaptation to expressed phenology may differently constrain population-level responses to shifting environmental conditions. (b) I will evaluate these relationships by comparing long-term phenological sensitivity in cloned populations to locally adapted plants in herbarium collections.*



Weather stations in Korea and Japan have collected observational phenology data on cloned plants for more than a century. Leveraging previous collaborations with colleagues in these countries and using these datasets (Pearse et al., 2022), I will compare genetically-controlled phenological sensitivity to phenological sensitivity estimated from herbarium collections amassed across similar spatiotemporal extents. I will for patterns of strong phenotypic plasticity (no deviation from genetic control in Fig. 2b), beneficial local adaptation (Fig. 2b line 1-4), and negative maladaptation (Fig. 2b line 2-3).

The unifying theme throughout my research program is a focus on how plants respond to climate change and on the implications of these responses on population, community, and ecosystem-level processes. More information on my other work, including my research on plant-fungal interactions, can be found on my website at https://benrlee.com. For more information about current and future research grants (including draft proposals when available), please visit https://benrlee.com/grants.