# Discussion

1. Across our four models—species' traits influenced the timing of budburst date in response to its three major cues
2. But the magnitude and consistently of trait effects across cues varied by trait and across species.

## Traits and phenology in forests

1. Gradients in budburst phenology were generally aligned with well known gradients in traits, spanning acquisitive to conservative growth strategies, but some deviations were found in relation to specific budburst cues.
   (a) We found early bb species = traits that allow them to grow quickly and benefit from high light availability in the early season open canopy—more photosynthetic potential and faster reproduction—beneficial for early succession spp, like *Alnus* (Fig. **??**)
   (b) But late budbursting species filled different trait space—traits that infer greater competitive abilities and slower growth—beneficial for late succession, canopy spp, such as *Quercus* (Fig. **??**)
   (c) This suggests the assembly of forest communities is driven by varying selective pressures, such as strong abiotic filters early in the growing season, and greater biotic pressures later in the season.
   (d) Including phenology in the trait framework allows us to tease apart underlying mechanisms shaping species temporal niche variation across communities
2. The traits whose cue responses deviated from our expectation also offer novel insights into the tradeoffs between traits and environmental cues
   (a) All traits included in this study are associated with many aspects of plant growth—adaptive for other reasons than those we predicted
   (b) We found short trees = strong responses to forcing—could prevent frost damage or xylem cavitation with false spring, Clemnets et al 1972, Marquis et al 2020, influence cambial meristem growth Lenz et al 2016
   (c) Similarly, greater forcing response of high SLA individuals could other attributes associated with SLA—relative growth rates, leaf longevity—and not photosynthetic potential
   (d) Highlights the complexity of determining drivers of spp trait profiles, but furthers our understanding of how traits could affect community dynamics under variable environments

## Phenology-trait relationships under future climates

3. Incorporating phenology into species trait syndromes, is necessary to infer how species are likely to respond to climate change.
   (a) Well documented that species phenologies are shifting with climate change—but still high degree of unexplained variation—our work suggests other traits are related to phenology cue responses as well
   (b) Our results suggest spp with acquisitive growth strategies = likely to facilitate adaption to future climates—not limited by chilling and photoperiod requirements and possess traits = faster growth and resource acquisition
   (c) Future climates could result in more stressful environments for conservative spp—constrained by chilling and photoperiod requirements—might experience greater levels of competition, while hotter summers = greater drought stress

   (d) In addition to altering the distribution of species temporal niche within a community, species trait syndromes have the potential to reshape spp assemblages and community dynamics.

4. Cascading impacts of species trait syndromes and temporal niche can determine the invasibility of forest communities

   (a) Invasive species = more sensitive to seasonal variation—greater ability to shift their phenologies (Wilsey et al., 2011; Fridley, 2012)

   (b) Also tend to bb early—possess the same traits that allow native species to track changes in temperature and fill vacant niche early in season

   (c) Includes traits like higher rates of leaf production and differences in wood anatomy = faster growth (Yin et al., 2016).

   (d) Knowing the association between phenology and other traits will allow us to better predict the vulnerability of forest communities to species invasions and mitigate their impacts.

## Trait response models capture important trait variability

1. Our study is one of the first to jointly model budburst phenological cues and timing with other trait relationships.

   (a) This approach allowed us to identify trends in phenological responses to cues based on species-level trait variation

   (b) Also accounting for the high degrees of uncertainty that arise from using varying datasets and individuals from across diverse forest communities.

   (c) While we were able to only include a small number of spp = a first step to identify general trends that scale across populations and species

   (d) Accurate predictions of individual trait-cue relationships requires data from finer scales—with trait and phenological data at the individual level within the same populations.

   (e) Our approach allows us to better address the complex interactions between traits that shape species temporal niche—contributing to a more holistic approach and potential to better forecast changes in species temporal niche under future climate change.