

ADD fig refs
to outline!

Have you tested for change in hysteresity
(veg-flor dates) in HF data over time
f/or w/ climate? You should!

concordance=TRUE

1. Phenology, the study of seasonal life cycle events, has long been studied, and recently drawn increasing scientific attention. Recent work is beginning to show that it is not only individual phenophases that are important, but also the relationship between them, even if they are seemingly disparate. (Examples: Phenology shifts can change life history ie winter to summer annual or others. But this work is really just beginning.)

} great!

} Good but be careful w/ examples

2. One phenological sequence that has attracted some attention is the flower leaf sequence (FLS). Why do some species flower before leaves while other produce leaves first?

← Add a little of your current intro on why to care (it's common...)

3. It has been suggested that flowering first, also known as hysteresity, proteranthly, or precocious flowering, may be an important mediator of reproductive or physiological functioning, and several hypotheses have emerged.

(a) Here are the hypotheses:

(b) Wind Pollination efficiency: This is the dominant temperate hypothesis. It has a corollary in the tropics: insect visibility.

(c) Hydration issues, the primary idea emerging from research in dry tropics.

(d) Several other hypotheses of hysteresity are actually just hypotheses for early flowering, ie. seed size, cold tolerance, others mentioned in "the paper". These would imply the FLS is a byproduct of differential selection regimes on leaves and flower.

(e) or phylogenetic conservatism.

(f) It is clear that climate change is altering phenology. This could alter FLS. If FLS is truly important, which we assume it is, alterations might be bad for plants, and we should know more about this.

} Feels out of place (maybe mv up after #2?)

4. Despite the rich theory behind it, there is limited, quality, empirical data about FLS.

(a) Why? Flowering and leafing are often observed separately, we don't have good phenological records.

(b) The best data are verbal description from guide books like "flowers before leaves" etc.

(c) Sadly, these verbal descriptions are incompatible with the quantitative phenology we use. (There are three major sources of uncertainty in these data, limiting their use in a meaningful way- 1] natural variation 2] Definitional ambiguity with the observer, and 3] ambiguity in researcher interpretation. Each of which we will discuss in detail below.)

① I think HERE you should mention why it matters to models/research then state your point of the paper.

Feels like starting a subsection to paper

SUBHEADER - Sources of uncertainty

5. Natural variation

① and. or, you could re-work the outline into a short intro then have a subsection on hypotheses before Sources of Variation. I think this would work better.

Somewhere around here (as reader) I am expecting the in this paper we do X

Feels like an impt.
Separat pt. under
nat. var. heading

(a) We do not have a great sense about the range of interannual variation, or interpopulation difference in FLS which could be really important. Perhaps species with short lag times in their FLS may switch between year, or life stages, or have different FLS across their range. None of this can be captured with the data sources we have— we don't know if "or" statements like "Flowers before or with leaves" reflect interannual variation, variation between individuals, branches or over a region or overlap?

(b) Why might there be variability? *Think more about this*? Different cues are more reliable for different phenophases, some year cues converges or diverges and the patterns respond.

(c) adaptive reasons?

(d) We don't know, but understanding this would be huge for actually testing hypotheses. You could ask questions like in years of more extreme FLS separation, do we see more pollination success, or are they droughtier?

(e) To get a baseline sense of this, we looked at a few species from Harvard forest again. And look there is considerable variation between trees and years.

(f) It is considerable. [FIGURE 2]

(g) We also don't know if differences between sources can be attributed to biological differences or definitional ones which we will discuss below.

Discuss
bud differences?

Is the distance
always a constant
thermal sum
given chill +
photo are
held constant

(Refs to Fie et al. 2015?)

Feels
out of
place

6. Ambiguity in definition

(a) What does an author mean when they say "flowers before leaves?". There are different ways to characterize this as we seem from other studies (cite some or talk about BBCH).

(b) Using Harvard forest data we demonstrate this matters. If an author means flower bud burst before leaf budburst you get a very different species list than flowers open before leaf expansion. [FIGURE OR TABLE 1] This could explain differences between sources, but does rule out there are biological differences mentioned above, and this ambiguity limits our ability to understand this trait across space and time and it makes it difficult to validate these descriptions with other phenological observation that specifically specify budburst, leafout etc.

7. Ambiguity in interpretation and modeling choices

(a) For modeling, these descriptions allow for the FLS to be characterized binary or at best, categorical approximations only, when in fact, it is a continuous trait. Where to draw the line between categories is up to researcher interpretation, and these choices could affect downstream analysis.

nice ✓

(b) These choices might be influenced by our bias. If I favor the wind pollination hypothesis, I would be biologically justified for choosing the more expansive definition, but if I think it hysternathy is a physiological constraint, a more conservative physiological definition would be appropriate.

Act. No one really wants to discuss bias (even if we should) so my brain up if you have strong evidence

8. Do these sources of error matter to how we understand FLS? We illustrate the implications of all of this uncertainty through modeling. We show the support for the various hypotheses is sensitive to ~~research~~ choices using our analysis from MTSV and Silvics.

(a) Look! The phylogenetic signal changes with our choices and between data sources [FIGURE 3 phylogeny figures]. This is also discussed in "the paper's" random forest supplement models. Not only that, we see that the result reinforces the model choices and data sources, i.e. the more expansive definition strengthens wind pollination effect [FIGURE 4].

(b) Our analysis shows that generally early flowering, pollination syndrome and seed characteristics are decent predictors of hysternathy, though the strength of these effects, and the phylogenetic signals, are sensitive to choices made during analysis that could be entangled in the three levels of data ambiguity discussed above.

(c) This makes it hard to conclusively favor a single hypothesis from the ones laid out at the beginning

(d) But that's okay, because it is likely hysternathy didn't evolve for a single function but may serve different functions for different life histories, biogeographic origins etc (Lizzie had a better way of saying this and some citations I think).

(e) What we can say right now is that there is good evidence that FLS and other phenological sequences are important beyond the phases they contain, and study of these patterns and the relationship between them should continue and be improved.

hmm. for genes look up FRIGIDA work by Shindler... For traits there should be examples....

9. We have a few suggestions for how this area of study should progress:

(a) More observation, so we can treat FLS as continuous rather than discrete variables. Do this over multiple years and locations

(b) Mechanism. We have to identify the variability in the cues

(c) View this in the context of the phenological cycle as a whole especially budset.

Underground tissues (geoxyletfree...) protect from frost at high elevations + fire elsewhere.

SUBHEADER -
~~how definitions of hysternathy~~
without ~~research~~ during
see email

Need to define structure next better / more

add a little structure
... if you had these data what would it change, & why does that matter?