1. Q1: Which cues are favored in more variable[[1]](#footnote-1) environments?

|  |  |  |
| --- | --- | --- |
|  | Low day-to-day variation | High day-to-day variation |
| High year-to-year variation | 1. Instantaneous measures favored 2. Cumulative measures should be okay 3. Photoperiod disfavored due to high year-to-year variation | 1. Extreme case is totally random, and should be neutral 2. Cumulative measures favored 3. Photoperiod disfavored due to high year-to-year variation 4. Instantaneous traits disfavored due to high day-to-day variation. |
| Low year-to-year variation | 1. In the extreme case, all cues should be informative (neutral case) | 1. Photoperiod should be favored 2. Cumulative measures should be okay 3. Instantaneous traits disfavored due to high day-to-day variation |

* 1. Year-to-year variation – (early+late) vs normal phenologies – if day-to-day variation is low, annual variation is informative about phenology, so cumulative temp and temp will be favored, while photoperiod will be disfavored. Cumulative precip may be informative of seasonal patterns, while instantaneous precip will be disfavored.
  2. Day-to-day variation – smooth vs rough variation – with very noisy variation, photoperiod and cumulative temp will be favored as a long-term approximation of season trends and a way to avoid false starts. Instantaneous temps and precip will be disfavored as too noisy.
  3. Spatial variation – Depends on the balance of inter-annual and intra-annual variation in the locations being compared. General prediction is that day-to-day variation creates seasonal noise, and will favor photoperiod and cumulative measures and disfavor instantaneous measures, while year-to-year variation is informative about phenological windows, and plastic phenotypes that are able to track this variation will be favored – so maybe cumulative temp will be most favored, but photoperiod will be disfavored.
  4. Simulated variation – we should be able to create histories that independently manipulate year-to-year variation independently of day-to-day variation.

1. Q2: Which cueing phenotypes are more resilient to climate change?
   1. Low year-to-year variation -> high year-to-year variation sequence: photoperiod will be depreciated, phenotypes that relied on photoperiod will be selected against. Flexible phenotypes that are able to track year-to-year variation will be favored.
   2. Late phenology -> early phenology sequence: if climate change is directional, phenotypes that can track change will be favored; however, if the rate of change is slow, photoperiod might be able to keep up.
   3. We could try a factorial experiment, manipulating year-to-year variation independently of mean phenology.
   4. Note: the climatic cues don’t have to change at all (or much) if phenology shifts directionally. But it may still depend on how reliable climatic cues are. Expect portion of parameter space to favor photoperiod in advancing phenology scenario if day to day variation is high (if advancement isn’t too fast)

1. Here, variability means phenological variability, e.g. (early+late) vs normal phenologies. [↑](#footnote-ref-1)