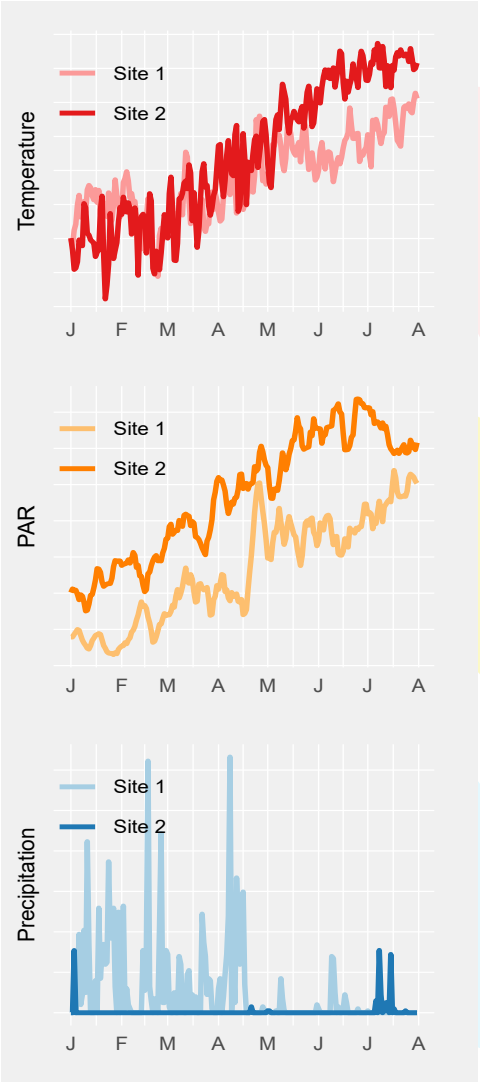
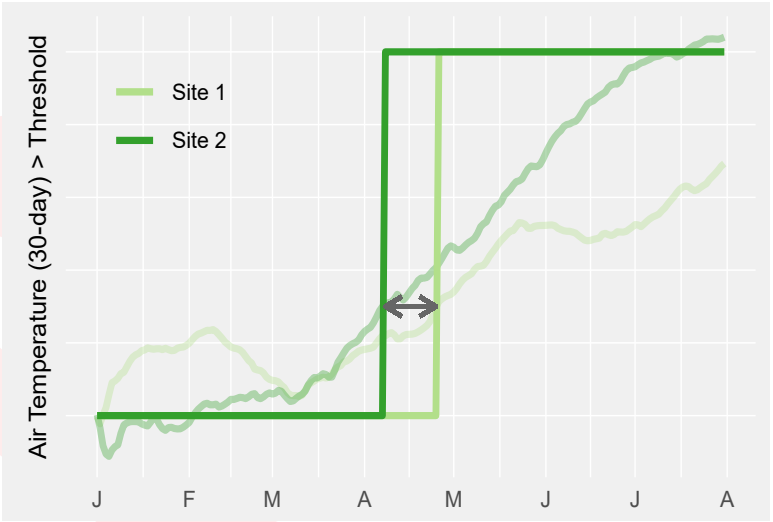
Multivariate Environment



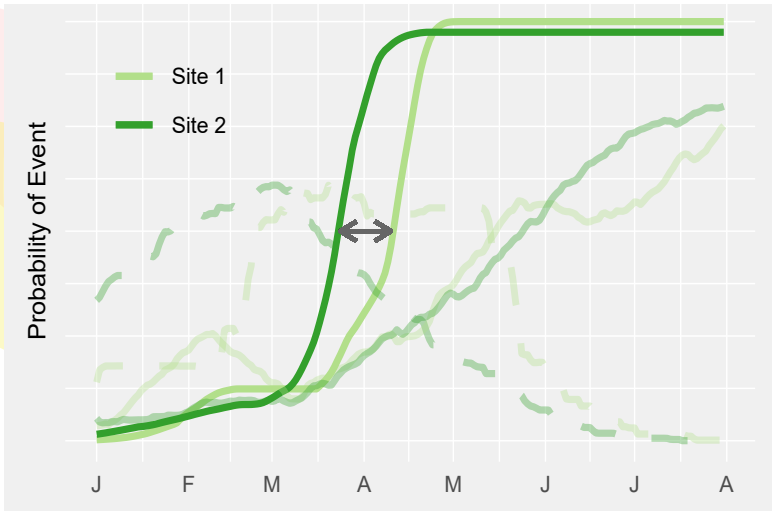


Measured Environmental Tracking

Ecologists often use simple measurements to estimate tracking. Here, a running average of 30-day air temperature is used to identify a threshold response, which is predicted to be earlier in Site 2.

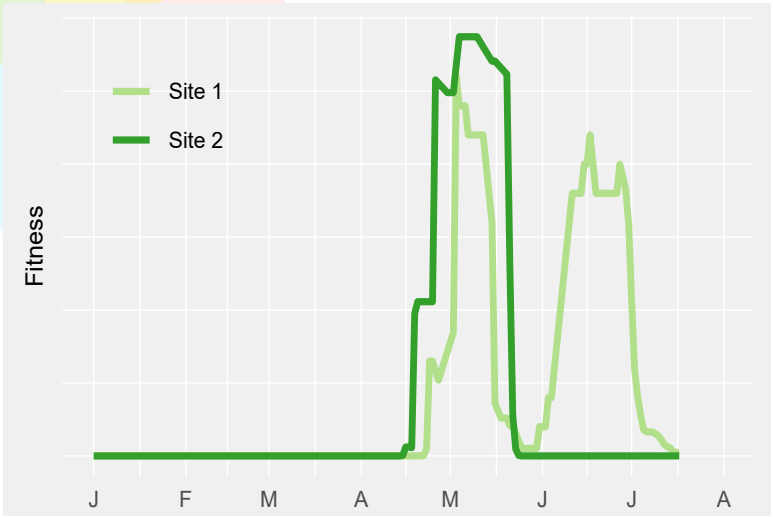
Environmental Tracking

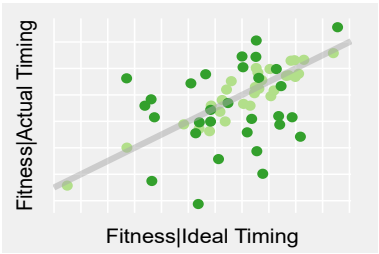
An organism's cue system may be a multivariate response to the environment. Here, the probability of a phenological event depends on accumulated heating and chilling hours



Fundamental Tracking

Ultimately, fitness is determined by the joint distribution of many environmental variables. Here, end-of-season fitness is a function of the timing a start-of-season life history event and the changing environment through the season. Fitness depends on growth—a function of temperature, light, and soil moisture—and survival—a function of early season frost and summer heat stress.





Cue Reliability

Of ultimate value to the organism—especially under a changing climate—is cue reliability. I.e., the correlation between fitness given the actual timing of a life history event and fitness given the ideal timing.