



Programa de Doctorado en **Biología Integrada**

Facultad de Biología, Universidad de Sevilla

Specialization Workshop

“Climate Change and Plant Phenology: specimen-based approaches for detecting and quantifying the effects of climate on flowering time”

Lead instructor: Visiting Professor Susan Mazer
Department of Ecology, Evolution and Marine Biology
University of California, Santa Barbara
Santa Barbara, California

Coordinators: Letícia Rodrigues Novaes, Juan Arroyo
Departamento de Biología Vegetal y Ecología, Universidad de Sevilla

Objectives: To hone students' skills in the quantitative detection, description, and interpretation of variation in flowering phenology within and among wild and naturalized angiosperm species in response to spatial and temporal variation in climate. Students will also gain experience in presenting and debating the motivation, methods, results, and conclusions of peer-reviewed papers on this topic.

This course is for graduate students who are interested in how wild and naturalized populations and species of angiosperms respond to climate change by altering the seasonal timing of their flowering. Millions of electronic records of herbarium specimen data are now available for the analysis and interpretation of the effects of spatial and temporal variation in climate on plant flowering times at a wide range of ecological scales. Examples of recent publications that have used herbarium-based specimen data to measure and to forecast the effects of past and future climate change on the seasonal flowering cycles of angiosperms appear in the Selected Bibliography below.

During each of five 3-hour meetings of this course, following an introductory lecture by Professor Mazer, participants will discuss peer-reviewed papers on plant phenology, and a small team of participating students will present the primary discoveries of each paper. Throughout this one-week intensive class, we will read and discuss recent papers and methods in ecology and evolution that focus on the effects of past and contemporary climate on the flowering times of wild plant species. Participating students will learn the methods and statistical approaches that ecologists and evolutionary biologists are currently using to detect how climate change has altered these seasonal cycles in the past and to predict how upcoming climate change will continue to alter them in the future.

Analytical program:

- Introduction to herbarium-specimens and their use in phenological research
- Application of linear regression to distinguish between plastic and adaptive responses of flowering time to local climatic conditions

- Review and evaluation of the quantitative methods used in the current literature to detect small- and large-scale responses to short-term and long-term changes in climatic conditions
- Ideas and hypotheses to guide future research

Selected References:

- Wolkovich, E. M., B. I. Cook, J. M. Allen, T. M. Crimmins, J. L. Betancourt, S. E. Travers, S. Pau, J. Regetz, T. J. Davies, N. J. B. Kraft, T. R. Ault, K. Bolmgren, S. J. Mazer, G. J. McCabe, B. J. McGill, C. Parmesan, N. Salamin, M. D. Schwartz, and E. E. Cleland. 2012. Experimental warming underestimates plant responses to climate warming. *Nature* 485: 494-497.
- Love, N. L. R., I. W. Park, and S. J. Mazer. 2019. A new phenological metric for use in pheno-climatic models: a case study using herbarium specimens of *Streptanthus tortuosus*. *Applications in Plant Sciences* 7: e11276.
- Love, N. R. and S. J. Mazer. 2021. Region-specific phenological sensitivities and rates of climate warming both contribute to divergent temporal shifts in flowering date throughout a species. *American Journal of Botany* 108: 1873-1888. <https://bsapubs-onlinelibrary-wiley-com.proxy.library.ucsb.edu:9443/doi/10.1002/ajb2.1748>
- Ramirez-Parada, T. H., I. W. Park, and S. J. Mazer. 2022. Herbarium specimens provide reliable estimates of phenological responses to climate at unparalleled taxonomic and spatiotemporal scales. *Ecography*. 10: e06173.
- Park, I. W., T. Ramirez-Parada, S. Record, C. Davis, A. M. Ellison, and S. J. Mazer. 2025. Herbarium data accurately predict the timing and duration of population-level flowering displays. *Ecography* 3: e06961. <https://doi.org/10.1111/ecog.06961>
- Ramirez-Parada, T. H., I. W. Park, S. Record, C. C. Davis, A. M. Ellison, and S. J. Mazer. 2024. Plasticity and not adaptation is the primary source of temperature-mediated variation in flowering phenology in North America. *Nature Ecology & Evolution* 8: 467-476. <https://doi.org/10.1038/s41559-023-02304-5>

Format:

Duration: 1 week

Total hours: 15

Language: English

Completion requirement: Confirmed attendance to all sessions signature by students

Dates: September 15-19, 2025. Monday to Friday, 9:30 - 12:30