

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☒ | ☐ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☐ | ☒ | The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ | A description of all covariates tested |
| ☐ | ☒ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☐ | ☒ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☒ | ☐ | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☐ | ☒ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☐ | ☒ | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	We used the website Nanonets to extract text from PDFs of tables from Hough (1861), and Excel and Google Sheets to manage extracted test. We used R and dplyr to manage data.
Data analysis	We used R and associated packages dplyr, lmer4, lmerTest, car, sf, sjPlot, ggplot2, phenesse, phyr and core R functions to perform analyses and create figure.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Historical phenology data (1851-1859) and contemporary phenometric estimates are available in a Zenodo repository (<https://doi.org/10.5281/zenodo.11248026>). All code used for generating phenometrics and environmental summary variables are in a github repository (<https://github.com/robgur/PhenoVelocity>).

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	na
Population characteristics	na
Recruitment	na
Ethics oversight	na

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	We utilized data from historical and contemporary observations of phenology to test a model framework that focuses on rate of spring warming, temperature context, and plant species thermal requirements. We calculated onset phenometrics from both historical and contemporary data and then fit models using the above variables plus latitude and other confounding variables to test the model framework.
Research sample	We used historical and contemporary observations of phenology onset utilizing compiled data from 1851-1859 and National Phenology Network and iNaturalist data from the present.
Sampling strategy	We thinned data in the present to area where we had the densest data in the historical dataset and had ample data (1000s of individual speciesXyearXregion replicates) for fitting models.
Data collection	We collected data from platforms that provide individual reports of plants either in flower or with breaking leaf buds or expanding leaves from USA-NPN or scored presence of leaves from iNaturalist and used compiled data on onset from historical sources.
Timing and spatial scale	We had two time periods in the same region of the Eastern USA: 1851-1859 and 2010-2023.
Data exclusions	We filtered phenometrics in the present that were more than 50km from any historical phenometrics as a way to better align historical and contemporary onset metrics spatially.
Reproducibility	We have provided the exact data frames (as .csvs) and code needed to reproduce the results fully as part of a data and code availability practices.
Randomization	Our model testing framework did not rely on randomizations since this work is not trial-based but looking at historical and contemporary trends.
Blinding	We are not performing a trial-based study but a set of statistical tests to test hypothesis about change dynamics over space and time.

Did the study involve field work? ☐ Yes ☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging