The Appalachian Trail as a Mega-Transect:
Using iNaturalist to Study Plant Phenology

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Introduction

- The **Appalachian Trail (A.T.) corridor** spans 2,190 miles, 14 states, 12° latitude, and nearly 2,000 m elevation → ideal **"mega-transect"** for monitoring phenological change
- **Phenology** = timing of seasonal biological events, such as leaf-out, flowering, and fruiting in plants
- **Climate change** drives shifts in phenological timing → cascading effects on species interactions, migration, and resilience
- **Plants** may be experiencing shifts in first bloom due to climate change → can serve as **bioindicators**, assessing condition of environment and identifying shifts over time
- Traditional long-term monitoring is limited by logistics, esp. in mountains → **citizen science via iNaturalist** overcomes spatial and temporal gaps

Study Objectives:

1. Community science-based study of spring wildflower phenology across A.T. Corridor
2. Outreach to facilitate community science and communicate research results
3. Integrate results to track wildflower climate sensitivity across spatial scales, identify bioindicators for climate change, and present to conservation partners to aid management decisions

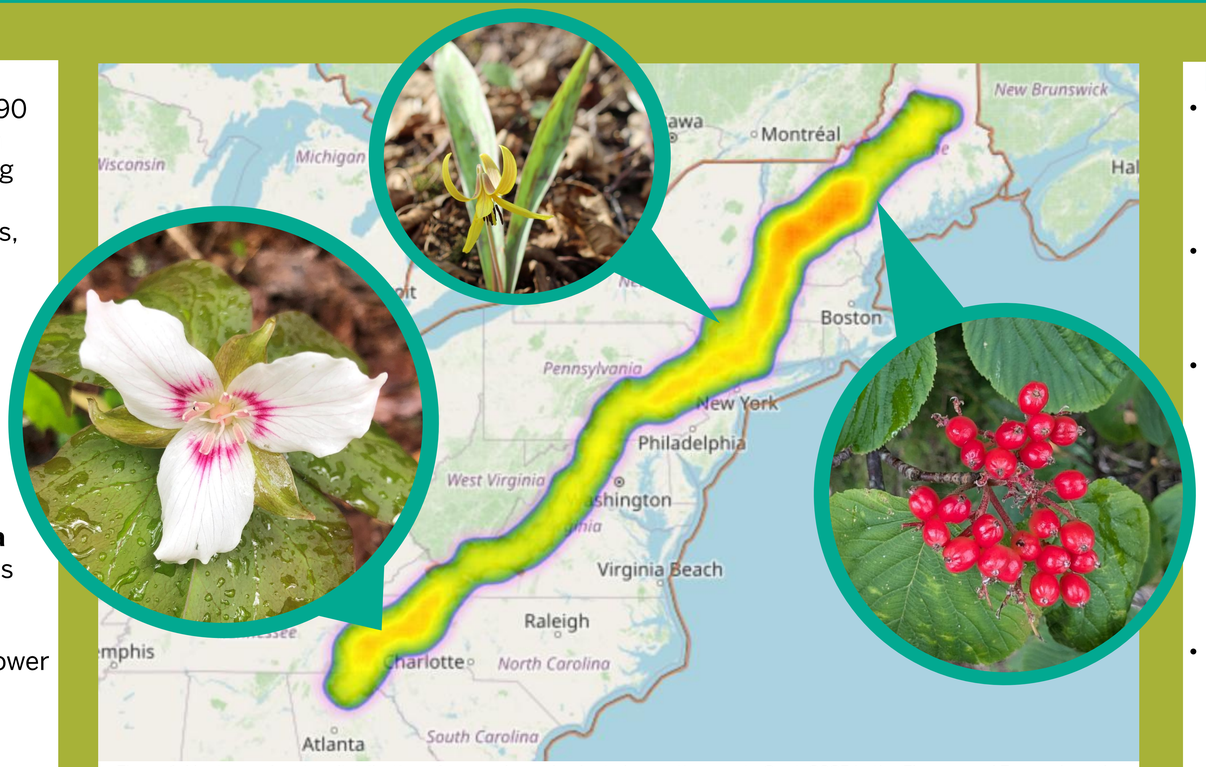


Figure 1. Heatmap showing distribution of research-grade plant observations up to Sept. 2025 in the *Flowers and Fauna along the Appalachian Trail Corridor* iNaturalist project. Callouts show photos from individual observations of 3 of our target species: painted trillium (left), trout lily (middle), hobblebush (right). Credit respectively to observers Curtis Hansen, Trix Neirnberger, and Jason Hill.

Citizen science via iNaturalist is a powerful tool for large-scale, long-term phenology monitoring.

Methods

- **Platform:** iNaturalist project *Flowers and Fauna along the Appalachian Trail Corridor* (est. 2018).
- **Target Species (8):** *Arisaema triphyllum, Clintonia borealis, Erythronium americanum, Maianthemum canadense, Sanguinaria canadensis, Trillium erectum, Trillium undulatum, Viburnum lantanoides.*
- **Outreach:** trainings, pocket guides, activity booklets, in-person tabling
- **Data Curation:** observations must be (1) research-grade (≥ 2 IDs), (2) geo and date tagged, (3) within A.T. corridor, and (4) positional accuracy ≤250 m.
- **Analysis:**
  - Flowering phenophase timing vs. elevation, latitude, and longitude
    - Tested against Hopkins' Bioclimatic Law
    - Flowering curves generated to compare species and regions

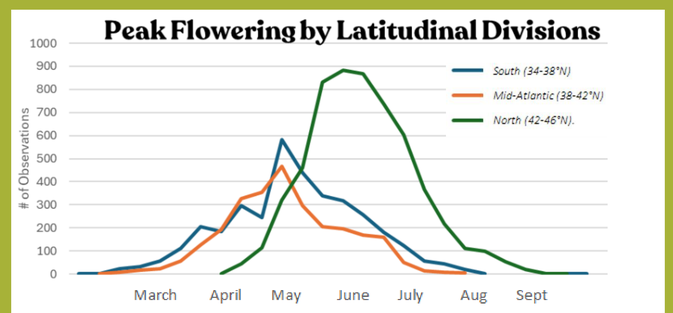


Figure 2. Flowering curve showing number of observations by month for 8 target species until July 2024, separated by latitude. Peak flowering is shifted ~25 days later when comparing the Northern (42-46°N latitude) to the Mid-Atlantic (38-42°N latitude) and Southern (34-38°N latitude) regions.

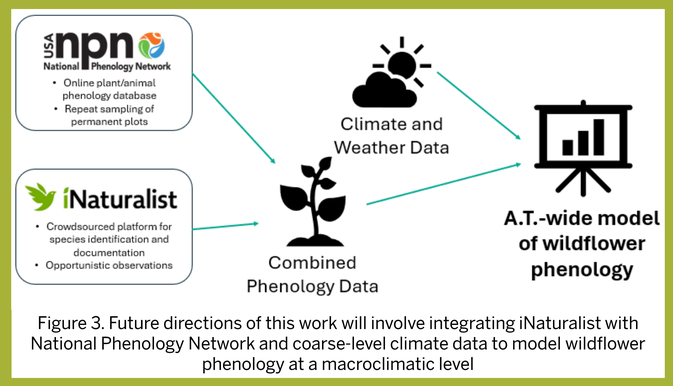
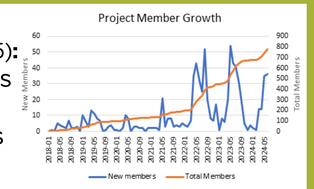


Figure 3. Future directions of this work will involve integrating iNaturalist with National Phenology Network and coarse-level climate data to model wildflower phenology at a macroclimatic level

Results

- **Participation** (as of Sept. 2025):
  - 67,000+ total observations since 2018
  - 10,000+ unique observers
  - 999 project members



- **Outreach:** 2024 outreach reached 1,068 people (+214% vs. 2023).
  - Distribution: Tabling (966), Presentations (76), Webinars (26)
- **Phenology Patterns**:
  - Shifts in phenology aligned with directions predicted by Hopkins' Bioclimatic Law, though magnitudes differed
  - Tourville et al. 2024 results show spring phenology advances with warming for understory forbs (~6 days °C^{-1}) and canopy trees (~3 days °C^{-1}), with the strongest sensitivity in the mid-Atlantic (~10 days °C^{-1}) and an expanded spring phenological window in the northern region (~2.7 days °C^{-1})
- **Regional Differences:**
  - Elevational relationships were strongest in Northern and Southern A.T., while Mid-Atlantic results were more variable
  - Flowering peak occurred ~25 days later in the North vs. South/Mid-Atlantic (Figure 2)
- **Biases:**
  - 52% of observations in flowering phase (showy flowers attract observers).
  - Stronger representation in the White Mountains (NH), Green Mountains (VT), and Blue Ridge (VA/NC); data gaps in PA and southern VA.

Discussion & What's Next

The project demonstrates that woodland flowering species can serve as **reliable bioindicators of climate change**, with flowering times shifting predictably along elevational and latitudinal gradients. Regional variability may be attributed to limited elevational gradients and sampling gaps in the Mid-Atlantic, highlighting both ecological complexity and the importance of filling data gaps through **targeted outreach and curation**.

In 2025, the project focus will be on curating the potentially tens of thousands of suitable observations into the project, focusing on expanding representation of spring wildflowers in terms of both functional and phylogenetic diversity. In addition, by sustaining participation in the project and integrating iNaturalist records with National Phenology Network data, we hope to create a **robust, multi-source monitoring framework**. This combined approach will enable stronger detection of climate-driven phenological shifts, while **engaging thousands of community scientists** in **biodiversity conservation** across one of North America's most **iconic landscapes.**

Acknowledgements

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Tourville, Jordon C., Georgia L. D. Murray, and Sarah J. Nelson. 2024. "Distinct Latitudinal Patterns of Shifting Spring Phenology across the Appalachian Trail Corridor." Ecology 105(10): e4403. https://doi.org/10.1002/ecy.4403