How does environmental context influence the leaf phenology of tree species in Maritime Canada?

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Feedback Lab

Hemiboreal Leaf Phenology Monitoring: Acadian Phenocam Network

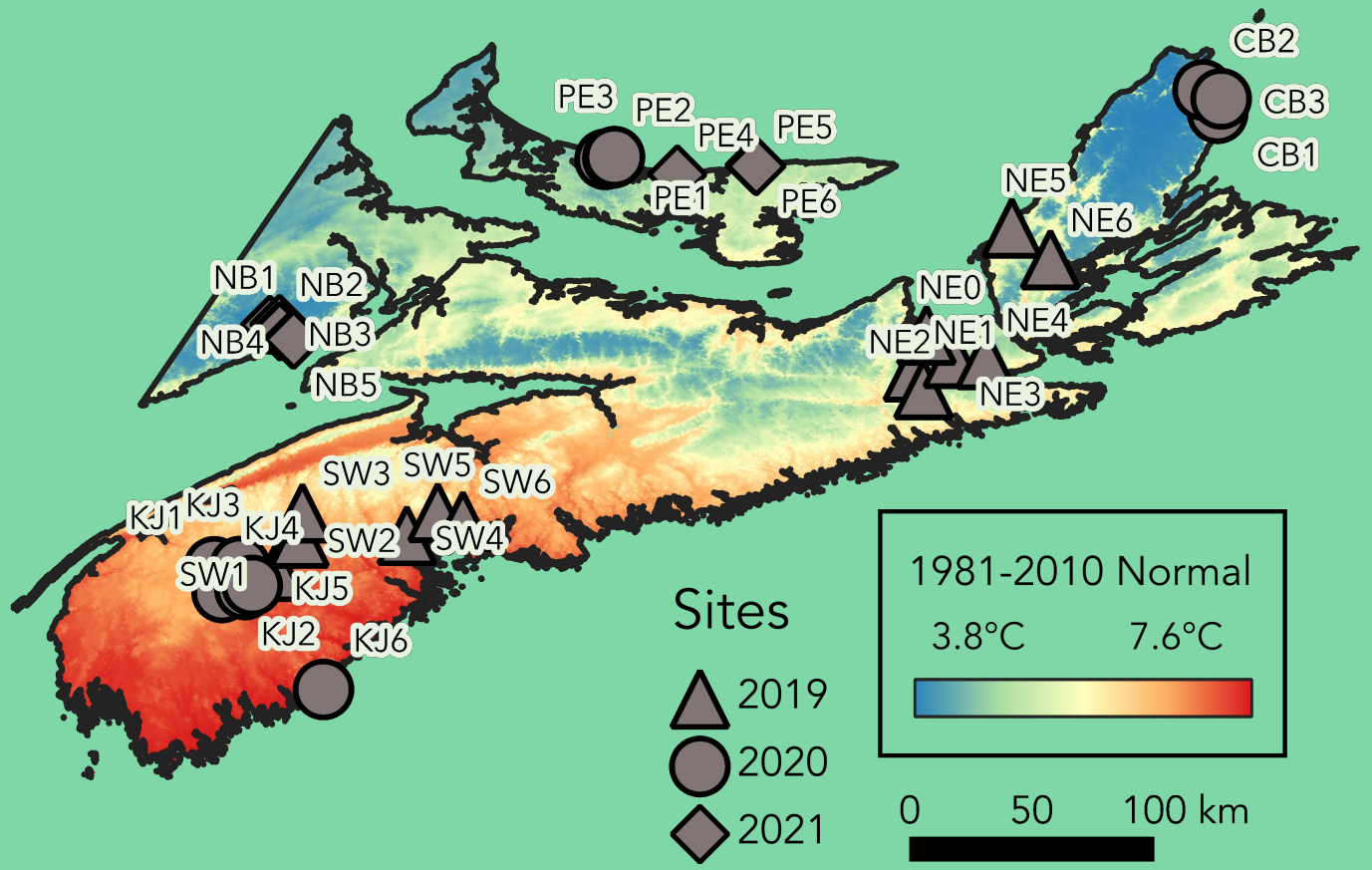
- Hemiboreal forest encompasses the biogeographical range limits of boreal and temperate forest
- To better understand the projected effects of climate change on hemiboreal tree species in the Canadian Maritimes, we first need to examine the influence of environmental context
- To this end we established a network of phenocams across the Maritimes

Objective

- Here we explore the influence of environmental context on leaf phenology in the 2021 growing season for hemiboreal tree species in the Canadian Maritimes:
  - Distance to the nearest coast
  - Elevation
  - Latitude & Longitude (proximity to warm Gulf Stream & cold Labrador Current)
  - Annual average air temperature
- We also examined the influence of differing site conditions:
  - Well drained forest sites
  - Poorly drained wetland sites
  - Situation along a lakeshore
  - Coastal sites with stunted vegetation

Acadian Phenocam Network

- 33 phenocams established over 2019-2021, coverage of 0.5-3 growing seasons as of 2022



- Phenocam station infrastructure:

Solar-powered cellular time-lapse trail camera

6-m tall aluminum telescoping

- Four site classes based upon local vegetation and conditions: forest (21), lakeshore (4), wetland (5), & coastal (3)
- Examined phenology response to drivers with multiple linear regression models with standardized drivers prior to regression

Environment Canada, 2021; McKenney et al., 2013; Price et al., 2011

Phenology Extraction Process

Imagery Timeseries for Each Stable FOV

Delineate and Classify Regions of Interest (ROIs) Corresponding to Distinguishable Individuals & Reference Panel

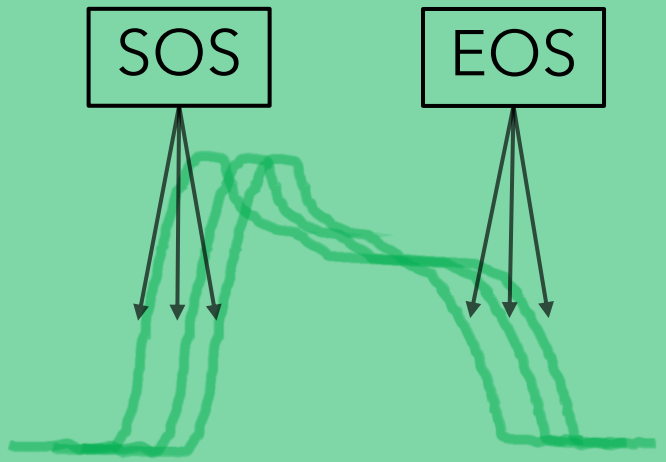
Verify Species Identifications in Field

$$Gcc = \frac{G}{(G + R + B)}$$

G, R, B: Mean Green, Red, & Blue Colour Channel Intensity

Calculate Green Chromatic Coordinate (GCC) for each ROI, Normalize by Reference Panel & Filter by 3-day Median

Visual Validation Following Peltoniemi et Al. (2018): R^2 = 0.78 Leaf Emergence & 0.74 Senescence. Extensive Ranges for Senescence.

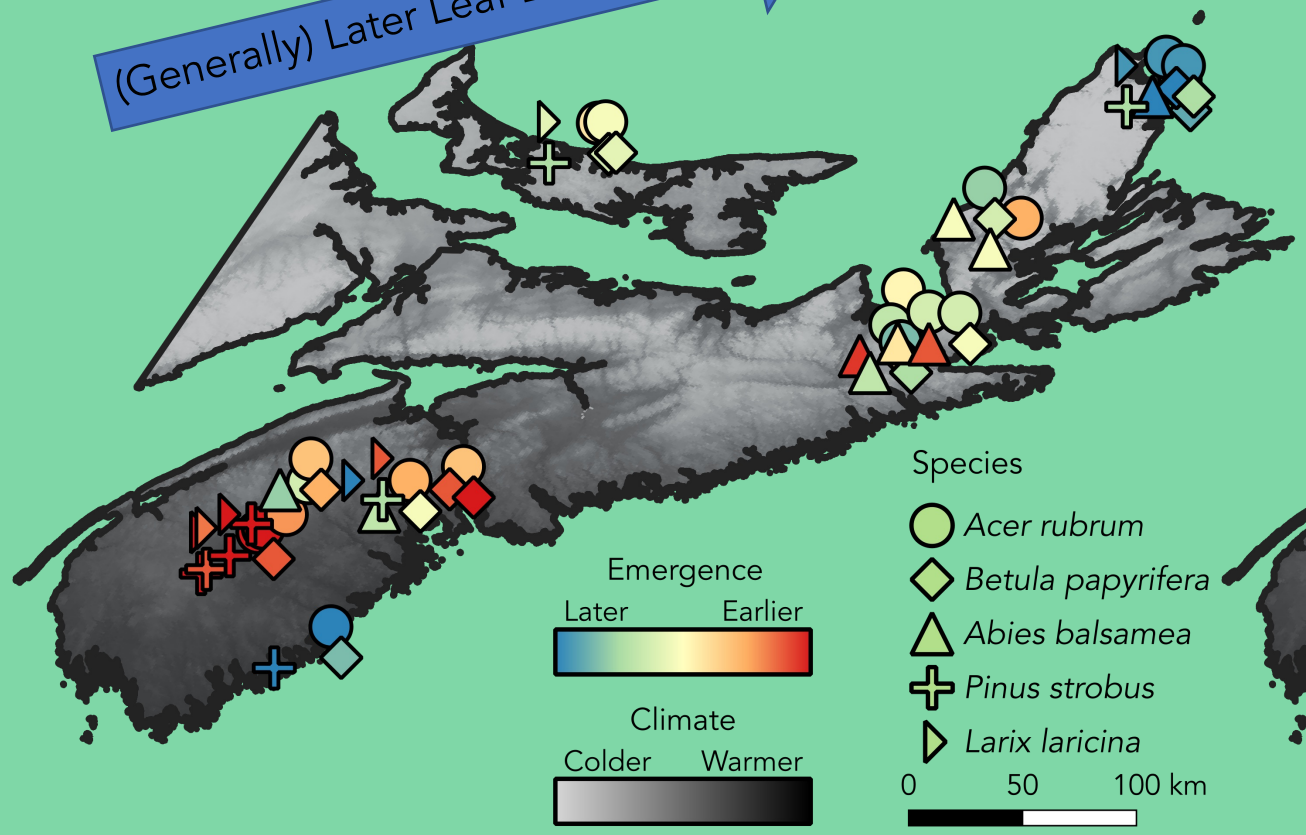


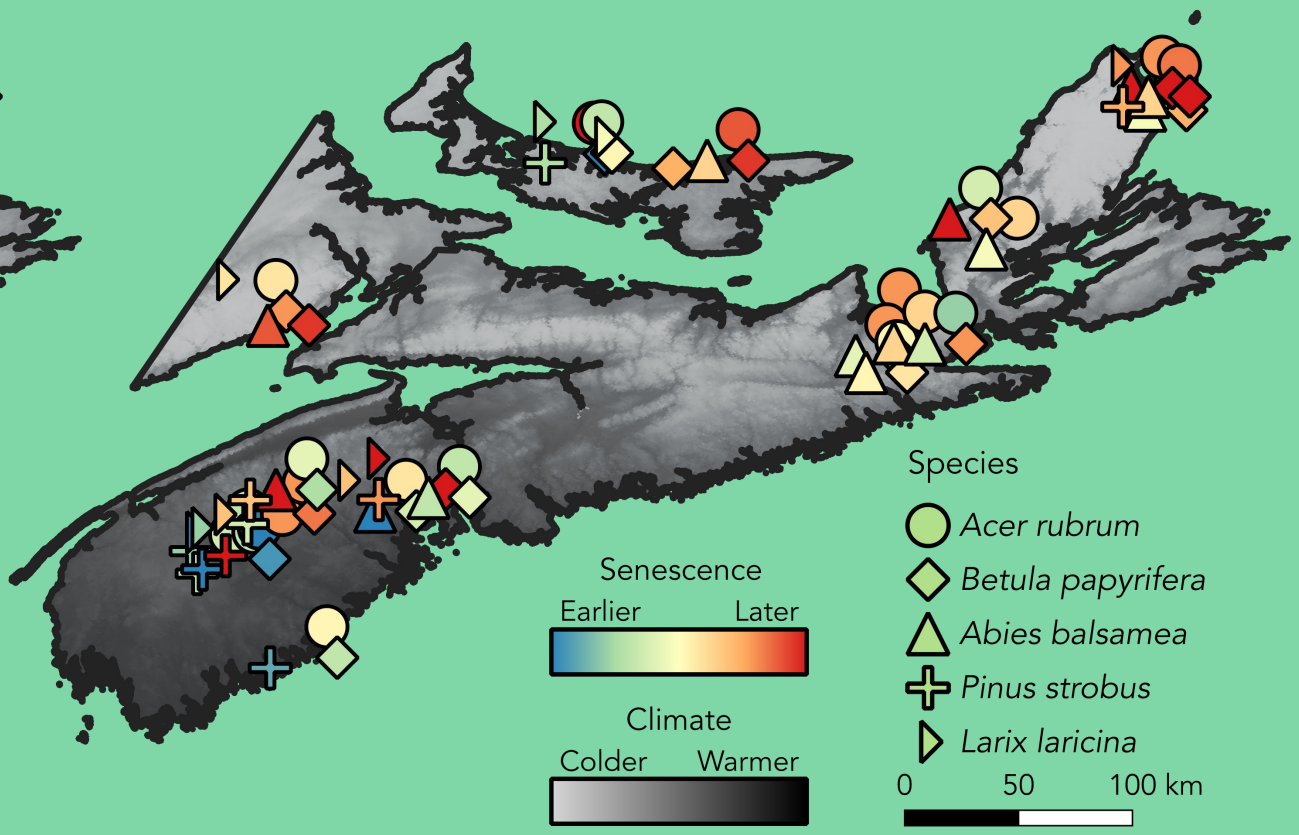
Extract Leaf Emergence & Senescence as Date of 50% Amplitude in Rising & Falling Portion of GCC Curve

Broad Spatial Patterns in 2021: Leaf Emergence & Senescence

Abies balsamea (balsam fir) spatial pattern distinct for both phenophases

(Generally) Later Leaf Emergence



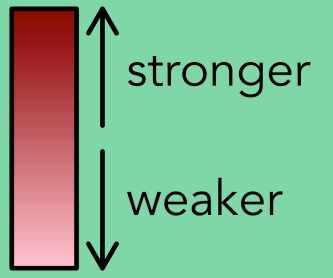


Northeastern and coastal sites tend to emerge later

Senescence patterns variable, though show possible dependence on spring

Response to Drivers: Multiple Linear Models for Leaf Emergence & Senescence in 2021

All drivers were standardized prior to regression for comparison of influence via absolute value of coefficients



Coefficients for drivers in models

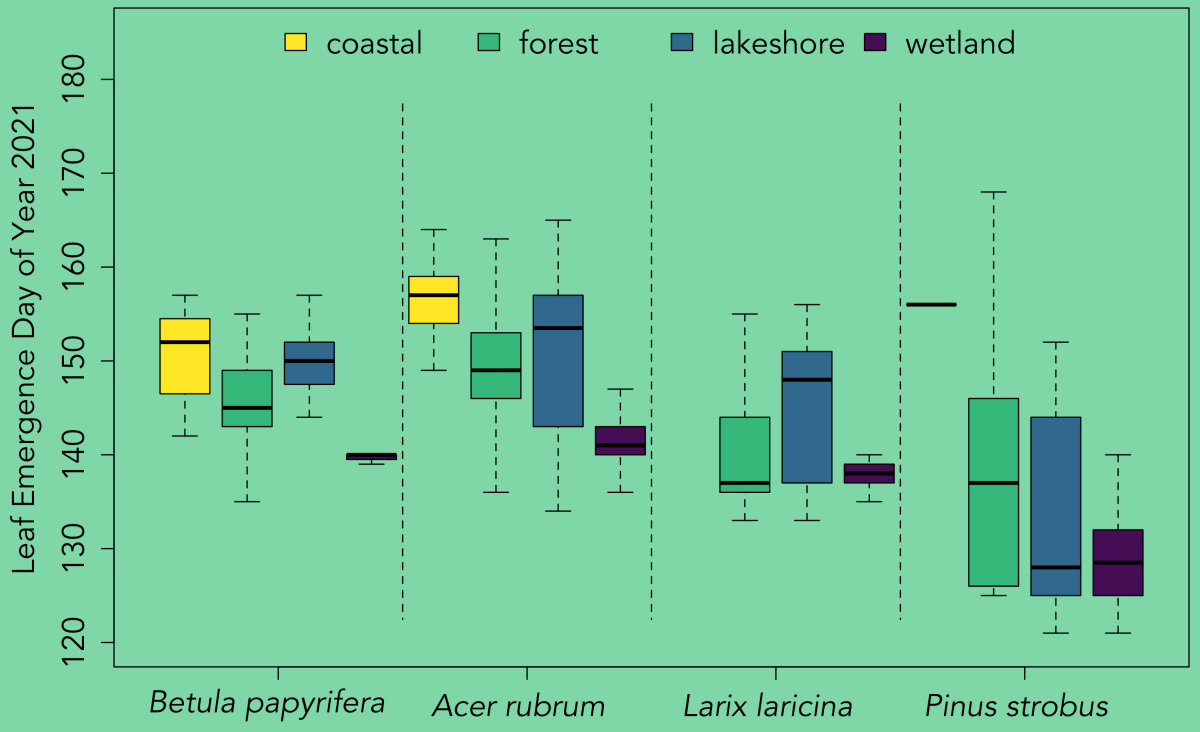
	Distance to Coast	Climate Normal	Elevation	Latitude	Longitude	Model Results
Acer rubrum	β = -3.4	β = -3.1	β = -0.9	β = -3.6	β = -2.2	R^2 = 0.53 p < 0.01
Betula papyrifera	β = -3.1	β = -3.1	β = -2.1	β = -3.4	β = -3.1	R^2 = 0.35 p < 0.01
Larix laricina	β = -7.6	β = 36.4	β = 2.6	β = 26.7	β = 6.6	R^2 = 0.83 p < 0.01
Pinus strobus	β = -18.5	β = 67.8	β = 18.8	β = 58.6	β = 24	R^2 = 0.63 p < 0.01
Abies balsamea	β = 5.9	β = -7.9	β = -7.3	β = 15.9	β = 20	R^2 = 0.05 p > 0.1

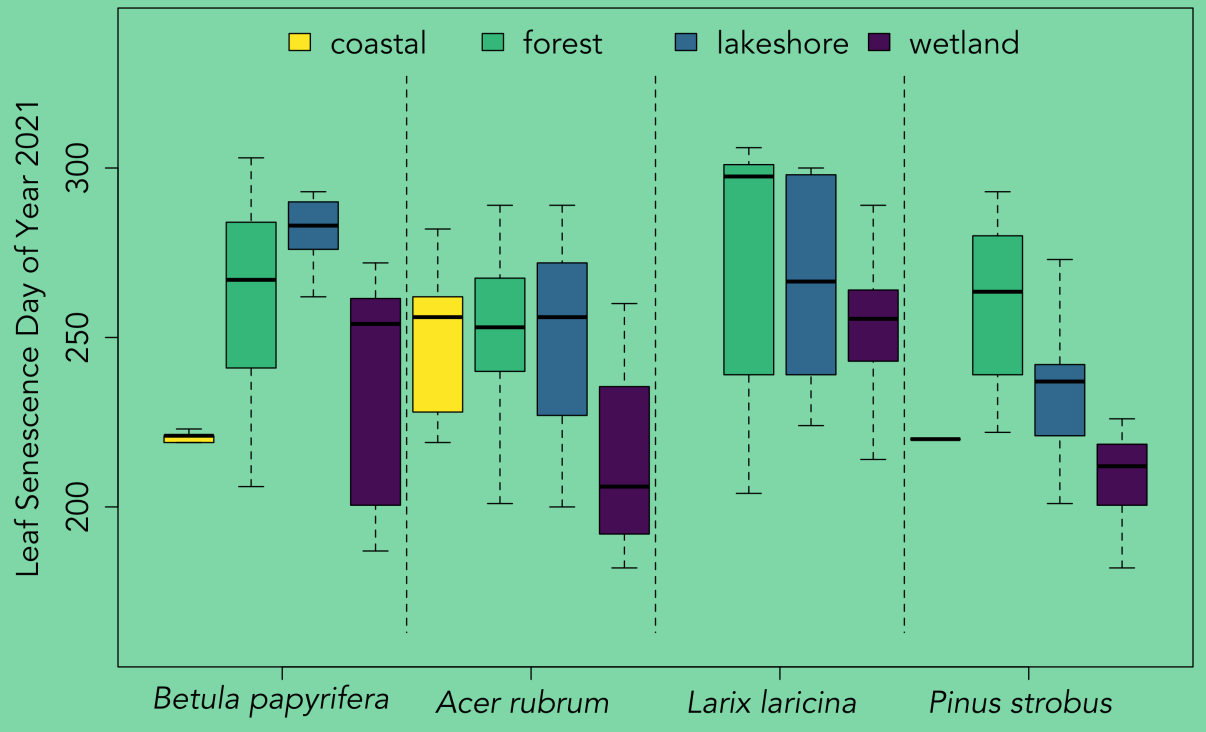
Climate normal & latitude influential for emergence

	Distance to Coast	Climate Normal	Elevation	Latitude	Longitude	Model Results
Acer rubrum	β = -6.9	β = -17.3	β = -12.3	β = -0.5	β = 1.8	R^2 = 0.37 p < 0.01
Betula papyrifera	β = -7	β = 3.8	β = 7.1	β = 12.2	β = -0.7	R^2 = 0.19 p < 0.01
Larix laricina	β = -21.2	β = -2.8	β = 7.3	β = -33.4	β = -26.3	R^2 = 0.3 p < 0.01
Pinus strobus	β = -1.5	β = -145.7	β = -17.9	β = -131.1	β = -64	R^2 = 0.59 p < 0.01
Abies balsamea	β = 13.5	β = -4.8	β = 10.9	β = 27.7	β = 19.6	R^2 = 0.23 p < 0.01

Senescence less clear, latitude prominent

Site Class Effects in 2021: Leaf Emergence & Senescence





Coastal sites emerge late & wetland sites emerge early relative to forest sites

Patterns are less clear for senescence, though wetland sites generally senesce early

Anomaly @ Site PE2 in 2021: Early Colouration

Early colouration by ~2 months may be due to legacy effects from Hurricane Dorian (2019)

Conclusion

- Most species showcased expected patterns for leaf emergence in response to climate normal and latitude
  - Drivers explained more variation in leaf emergence than senescence
  - Wetland conditions promote early emergence & senescence
- Patterns for *Abies balsamea* distinct from other species
- Future work:
  - More growing season observations and better representation of species across environmental gradients

References

- Environment & Climate Change Canada. (2021). Government of Canada. 1981-2010 Climate Normals.
- McKenney, D. W., Hutchinson, M. F., Papadopol, P., Lawrence, K., Pedlar, J., Campbell, K., Milewska, E., Hopkinson, R. F., & Price, D. (2013). Spatial climate models for Canada's forestry community. The Forestry Chronicle, 89, 659-663.
- Peltoniemi, M., Aurela, M., Böttcher, K., Kolari, P., Loehr, J., Hokkanen, T., & Arslan, A. N. (2018). Networked web-cameras monitor congruent seasonal development of birches with phenological field observations. Agricultural and forest meteorology, 249, 335-347.
- Price, D. T., McKenney, D. W., Joyce, L. A., Siltanen, R. M., Papadopol, P., & Lawrence, K. (2011). High-resolution interpolation of climate scenarios for Canada derived from general circulation model simulations. Edmonton, AB: Canadian Forest Service, Northern Forestry Centre.

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