Flowering phenology response to climate warming in the Pacific Northwest

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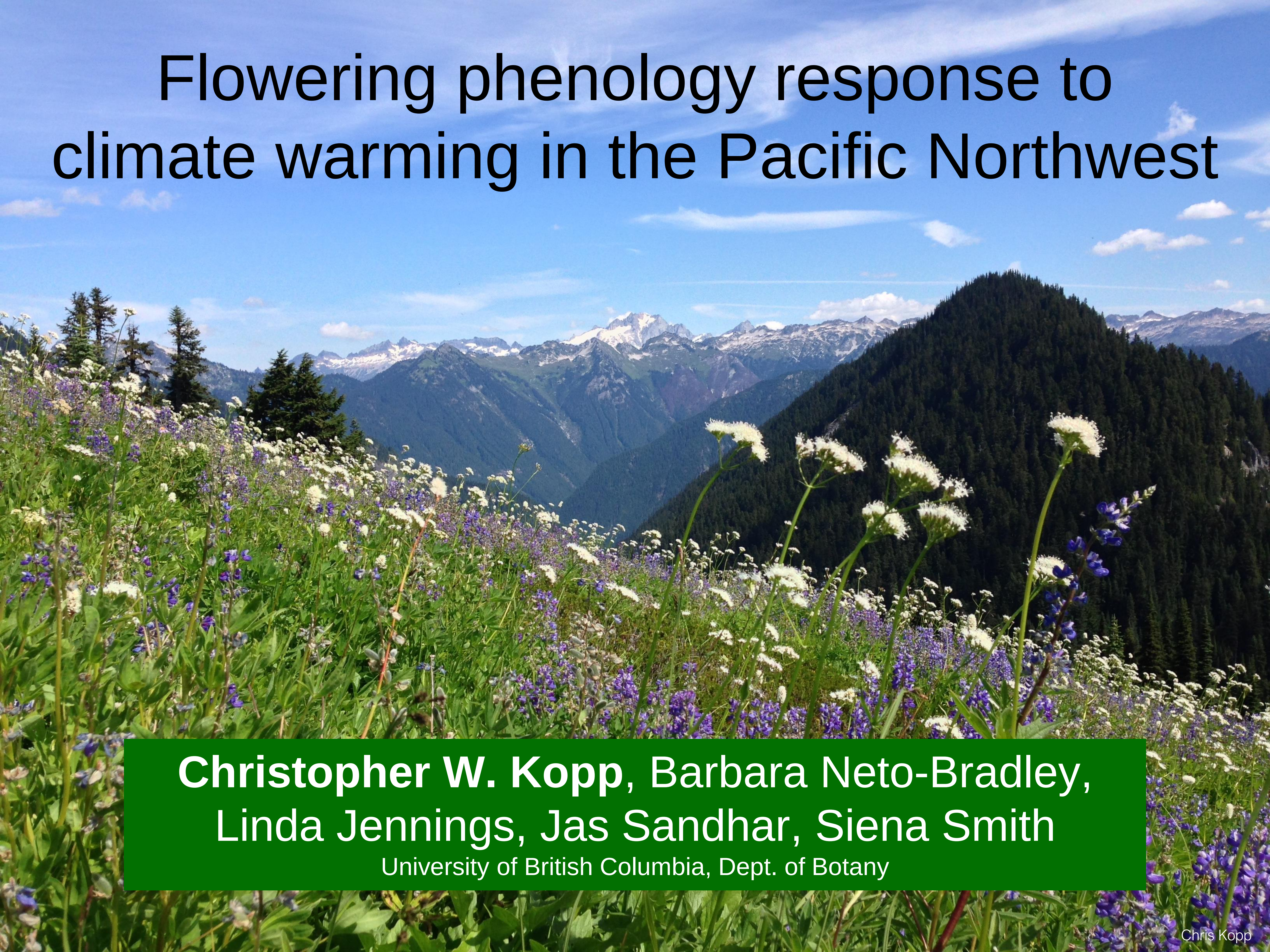
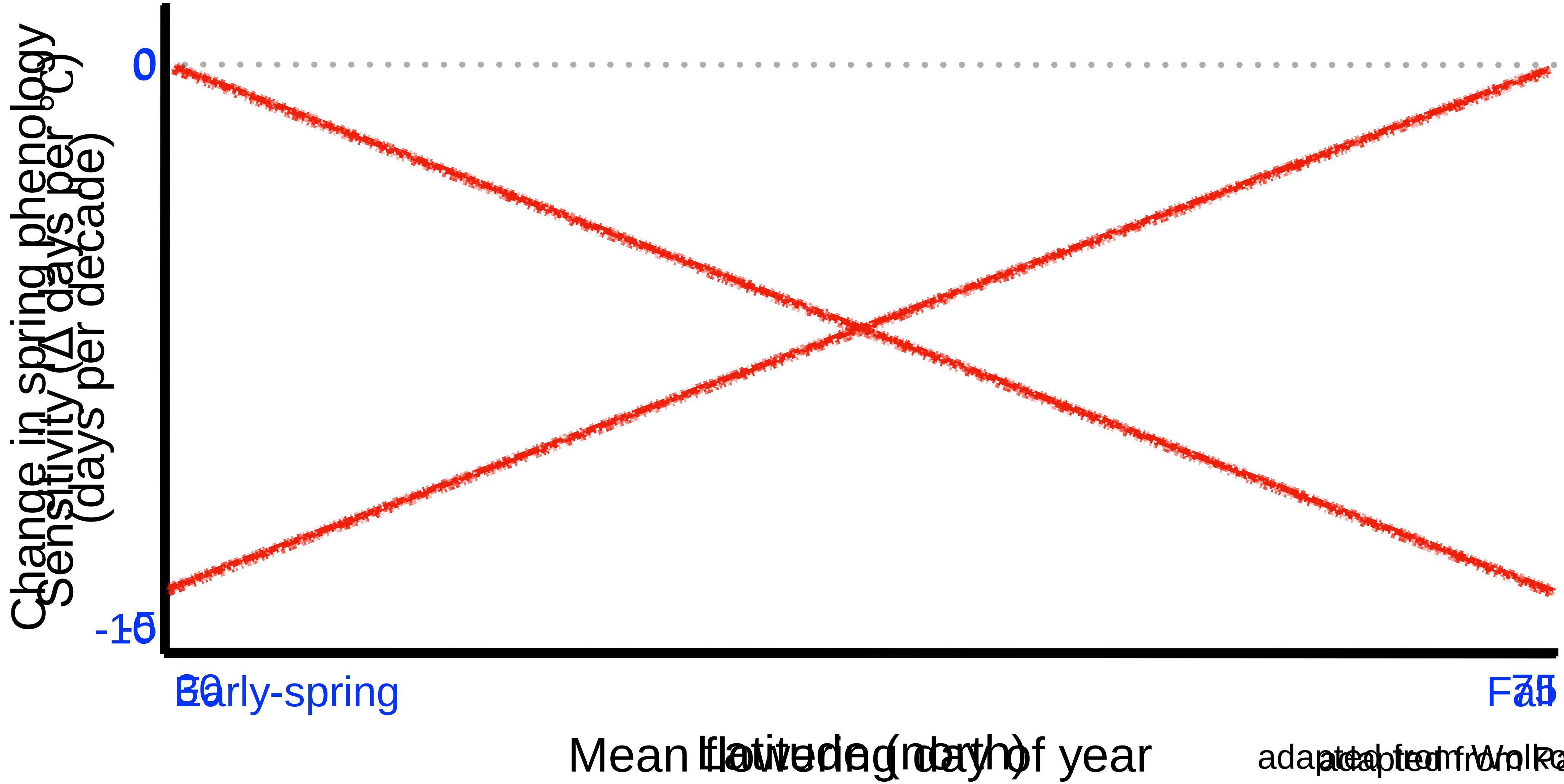


Phenology and Warming

- Global climate warming (Socker 2013) corresponds to shifting phonologies across many organisms during the past century
  - Spring phenologies have advanced 2.3 days per decade (Parmesan & Yohe 2003)

Plant Responses

- Shifts depend on temporal and geographic positions
  - Greater advances at high latitudes
  - Earlier flowering species more sensitive to warming



adapted from Wolkovich et al. 2012

adapted from Parmesan 2007

Herbarium specimens

- Can be used to examine flowering phenology (via collection date of flowering specimens) over <u>long periods of time and broad geographic gradients</u>
  - For broad geographic scales it is important to pair collection data with climate data

Phenology in the Pacific Northwest

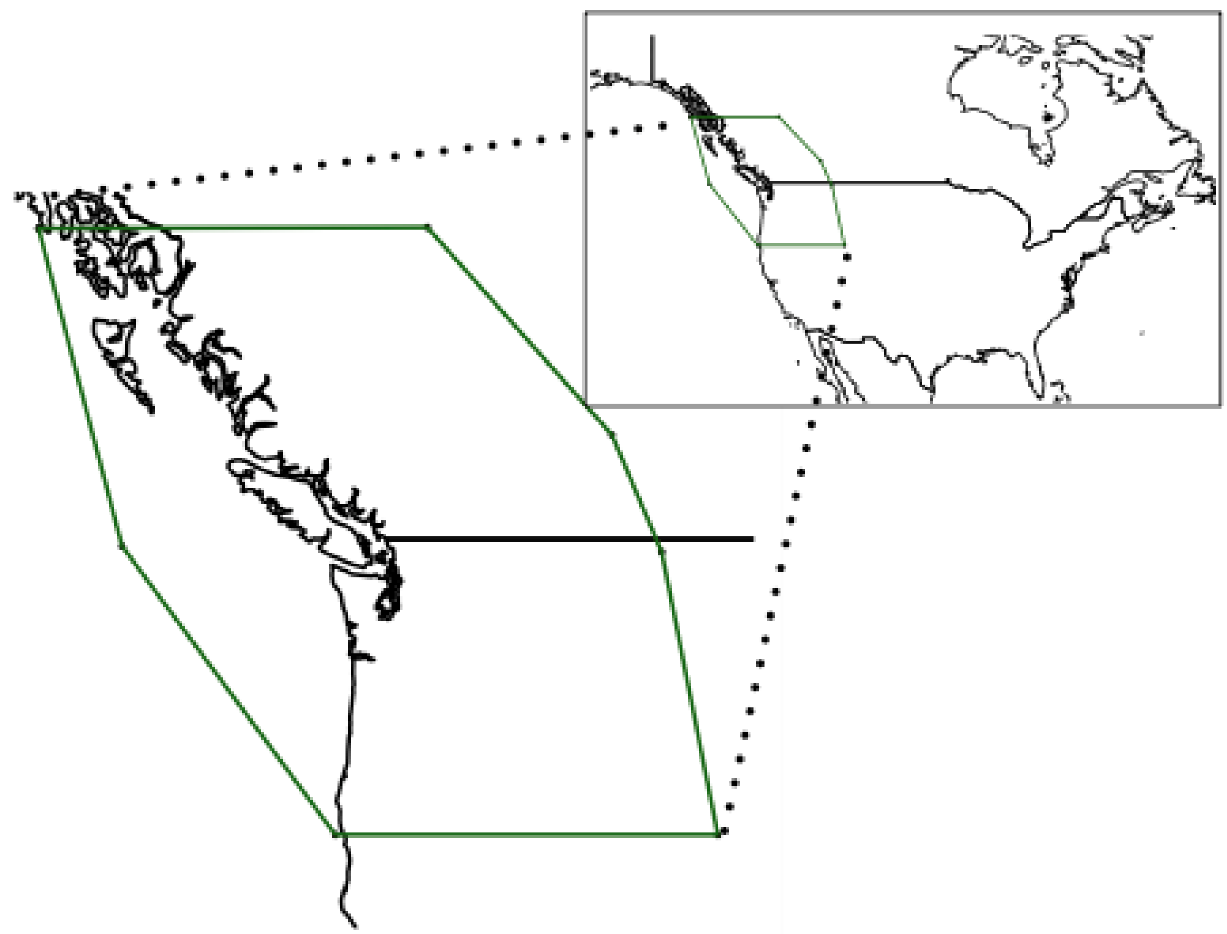
- In this study we investigated if species found in the Pacific Northwest (PNW) have flowering phenologies that are sensitive to climate warming

Hypotheses

- Day of collection (proxy for flowering phenology) of species across the Pacific Northwest is sensitive to spring temperatures
  - i.e. warmer springs → earlier collection dates
- Sensitivity will vary depending on flowering date and geographic range position (elevation, latitude and longitude)

Methods: Target species

- 1901-2015 collection dates and locations for herbs and shrubs were gathered from the Consortium of Pacific Northwest Herbaria
  - Targeted species have conspicuous flowers
  - At least 100 flowering specimens per species



Consortium of Pacific Northwest Herbaria

Providing access to specimen data and digital resources from herbaria throughout Pacific Northwest North America

Methods: Climate data

- Climate data from ClimateNA_MAP (Wang et al. 2016):
  - collection location
  - year of collection
  - 1960-1990 means for that location

Centre for Forest Conservation Genetics
•CFCG•

ClimateNA_MAP

-- An Interactive Platform for Visualization and Data Access

Wang et al. 2016

Methods: Determining responses

- Sensitivity to temperature

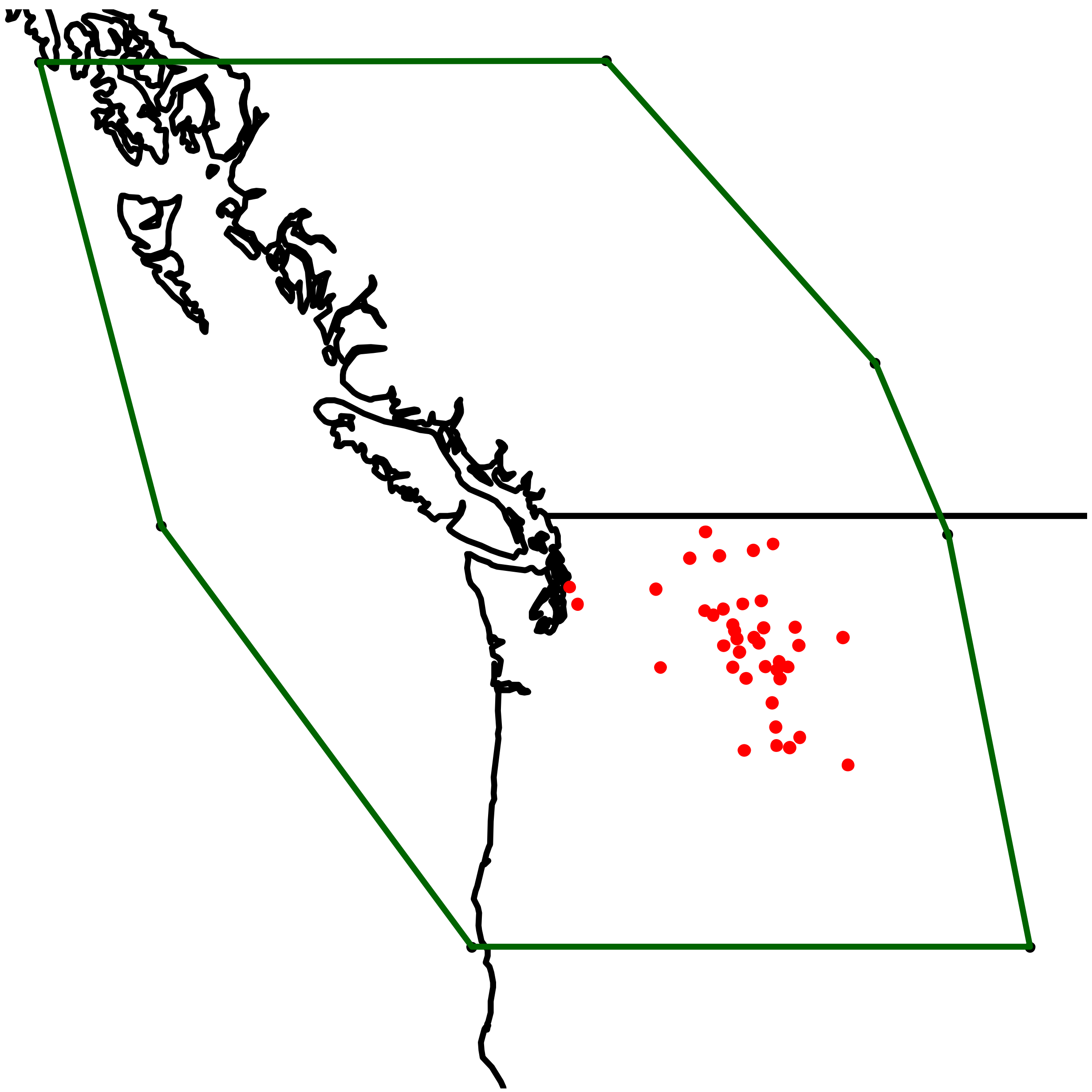
	mean spring temp. at collection location
−	mean 1960-1990 spring temp.
	Temp. anomaly

  - spring: three months preceding mean species collection date
- Use linear regression (day of year vs. anomaly) to determine species' sensitivity to temperature

Results: Our dataset

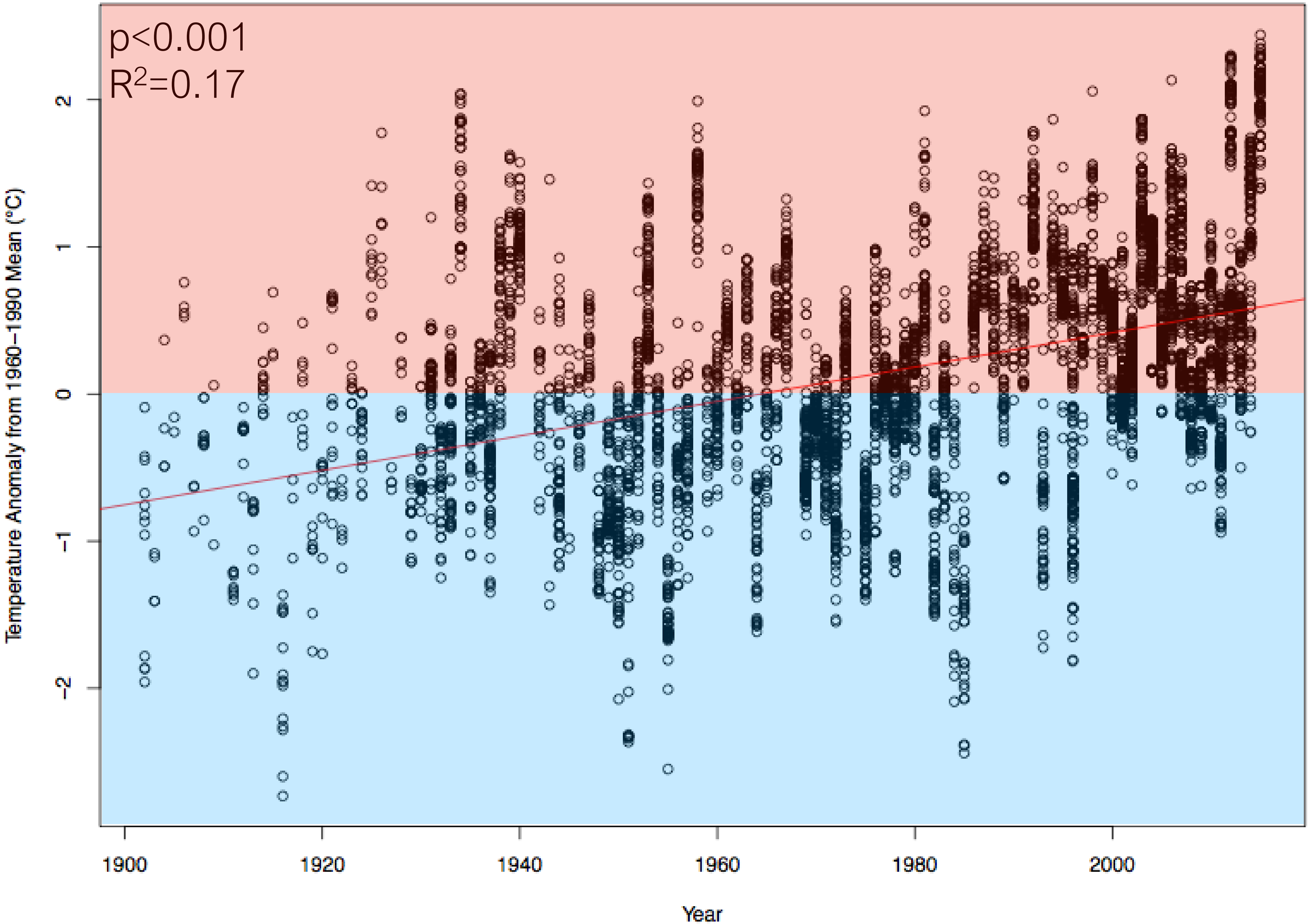
- 8,540 specimens
  - 39 species
  - Mean collection dates
    - May 21 to August 12

Mean Geographic range position



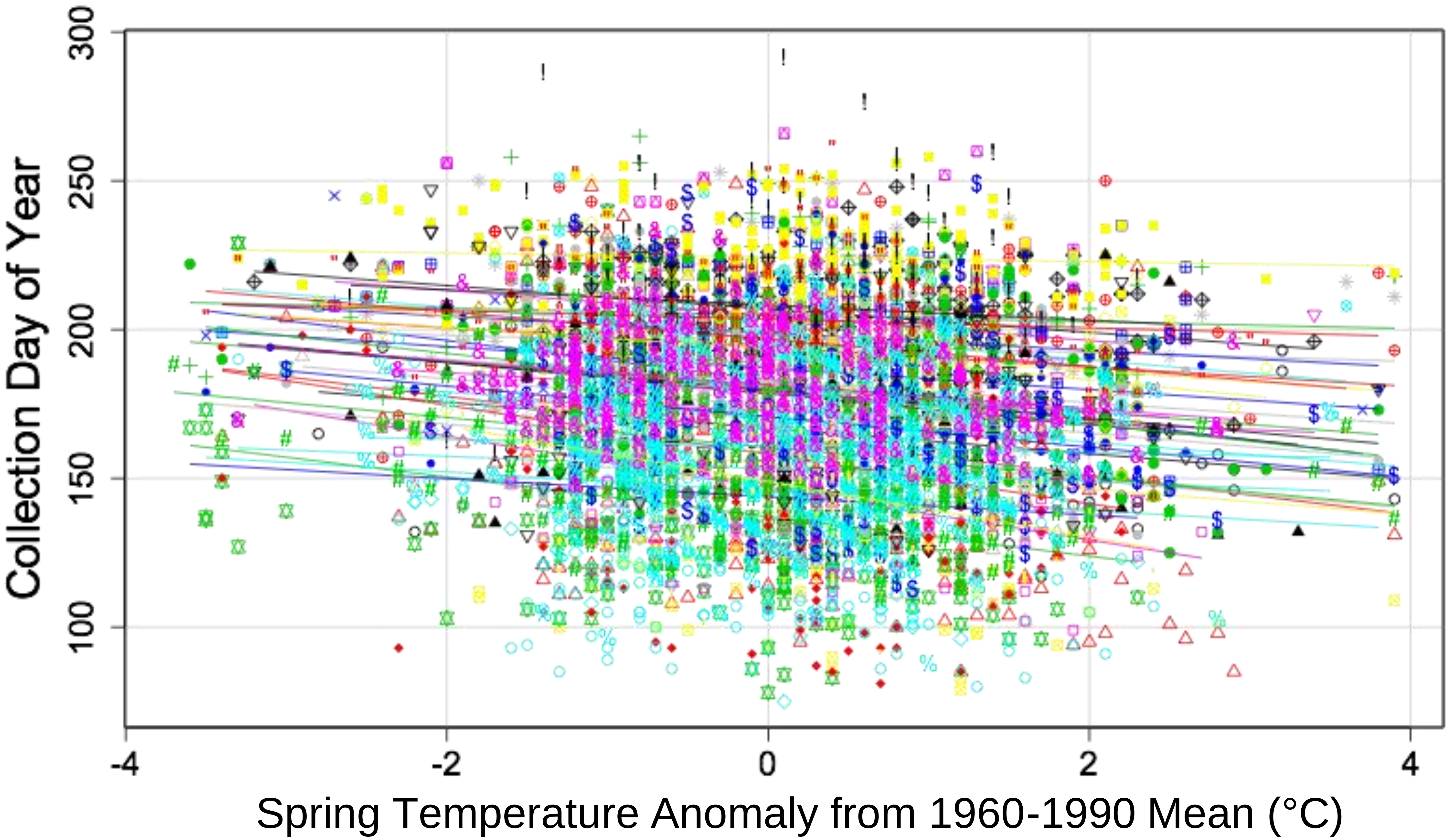
Results: Regional temperatures (1901-2015)

- Study region temperatures increased 0.1°C/decade



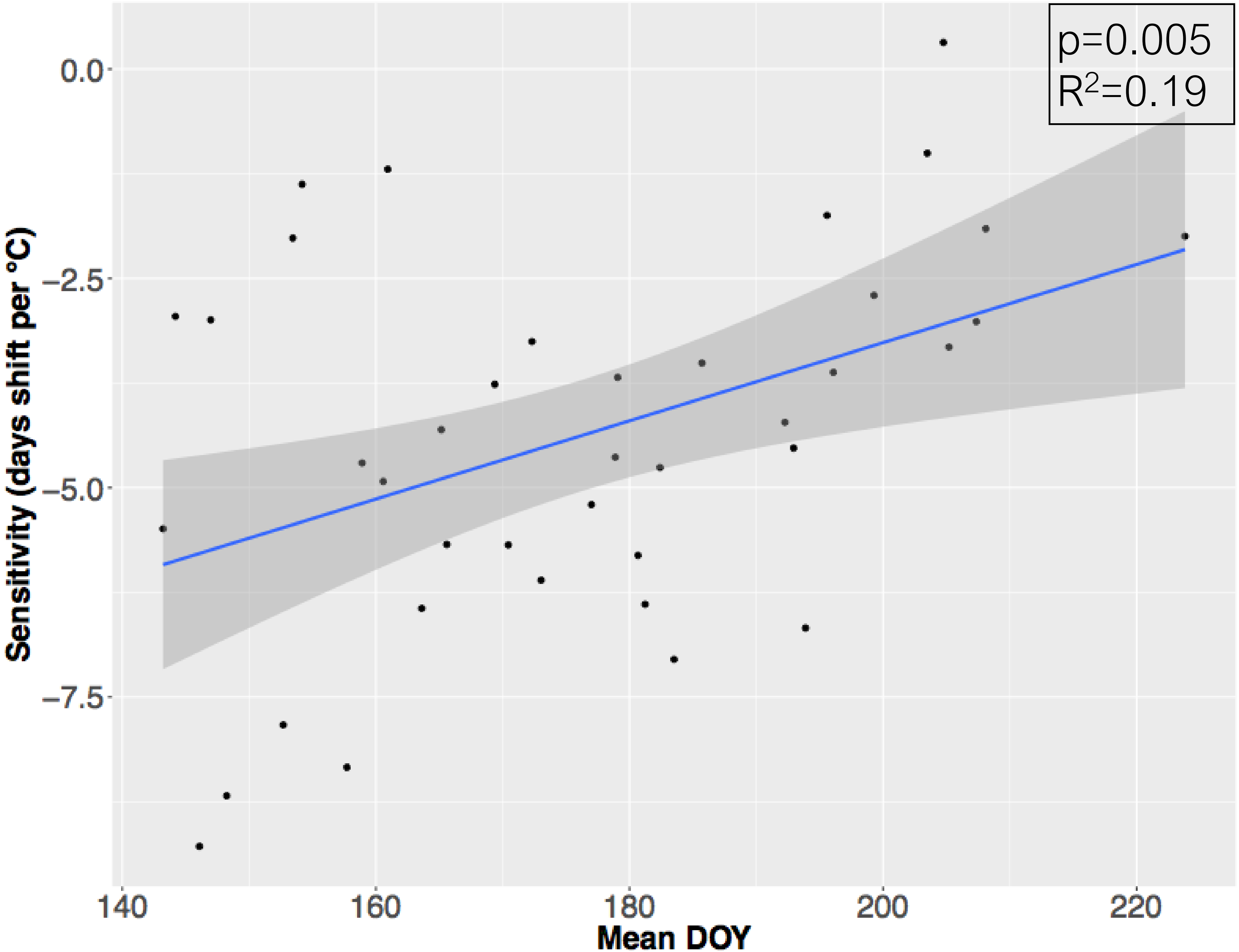
Results: Sensitivity to spring temperatures

- 28 out of 39 species are sensitive ($p<0.05$) to spring temperatures
  - Day of collection changed between +0.3 and -9.3 days per 1°C increase in spring temperature



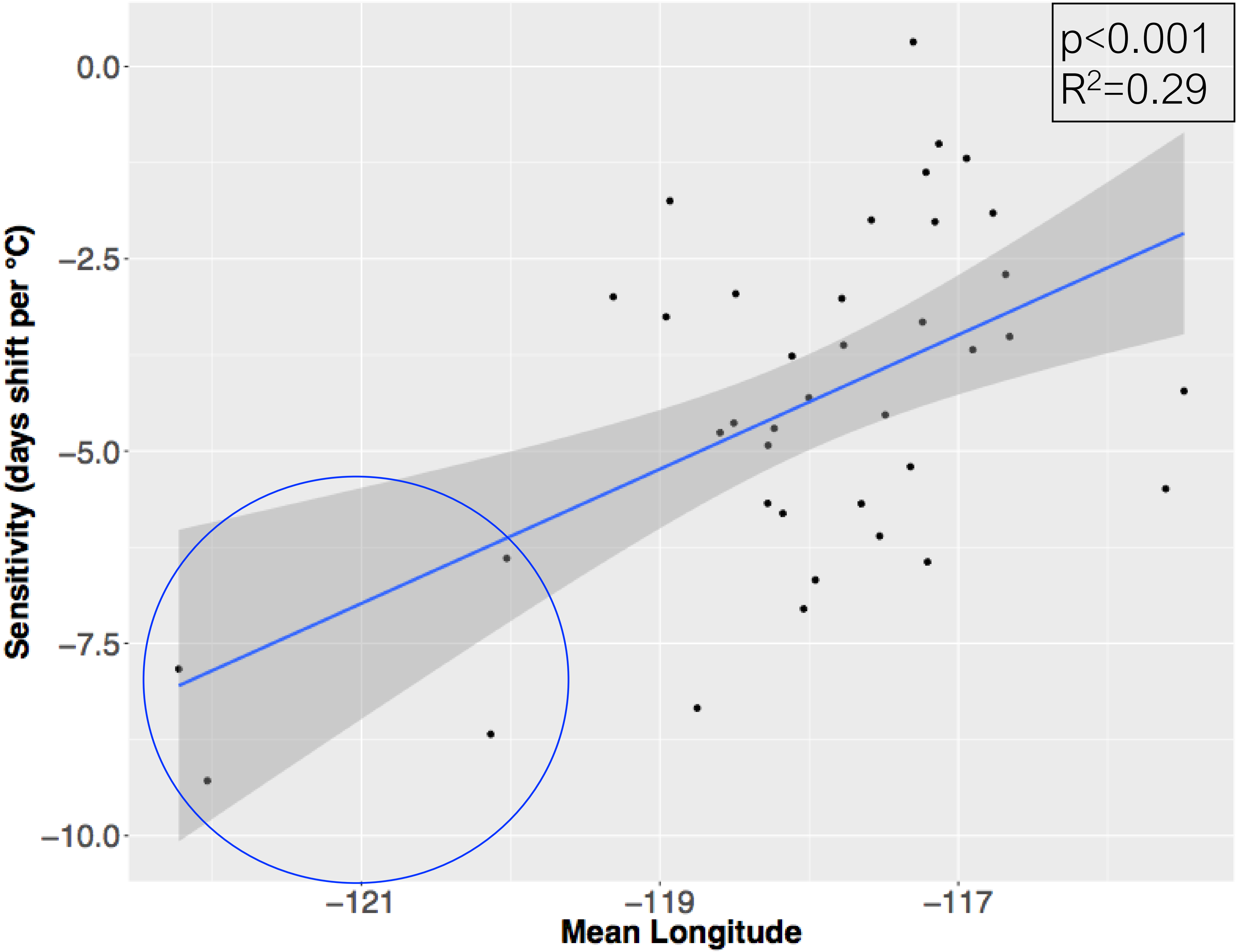
Early bloomers more sensitive to temperature

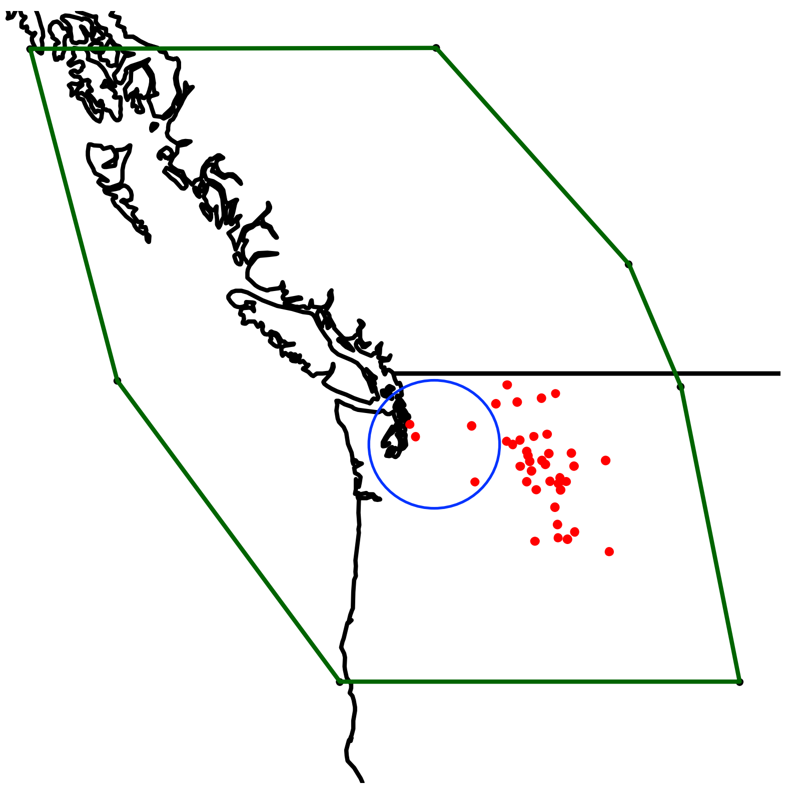
- Sensitivity to spring temperature decreases 1.4 days for every 30 day delay in mean flowering date



Coastal species more sensitive to temperature

- Sensitivity to spring temperature decreases 0.9 days per 1° longitude





Conclusions: Spring comes early to the coast

- Earlier flowering species are more sensitive to warming (Wolkovich et al. 2012)
- Spring "starts" earlier in the western part of the PNW
  - Species near the coast flower earlier and therefore are more sensitive to warming temperatures

Going forward

- Longitudinal gradients in coastal regions deserve more attention, especially concerning phenology and climate change
- With digitization, we can go bigger with more!


Questions?
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a place of mind
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Chris Kopp

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