How do trees know when to flower?

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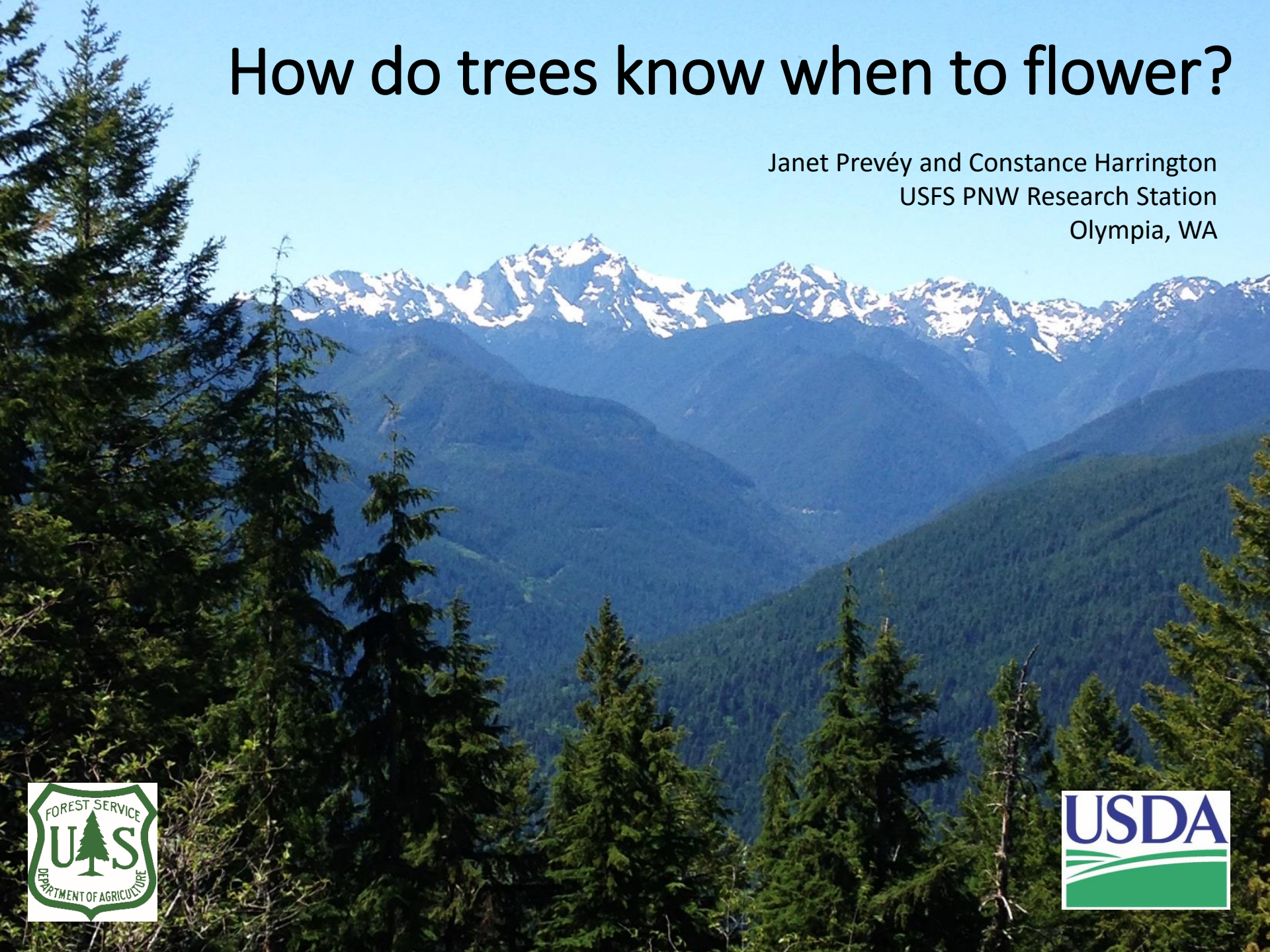
Olympia, WA



Timing of flowering is important…..

- Tree phenology is **fascinating** – it is one of the primary ways plants are adapted to their environment

- Flowering phenology can influence outcrossing rates, and success of seed crops

- With changes in weather from year to year - and changes in climate over longer timescales - we see changes in phenology

Timing of flowering is important…..

- Previous work with other tree species shows that **temperature strongly controls phenology**

- However, we lack information on how temperature and other cues determine the timing of reproductive events in Douglas-fir and western redcedar

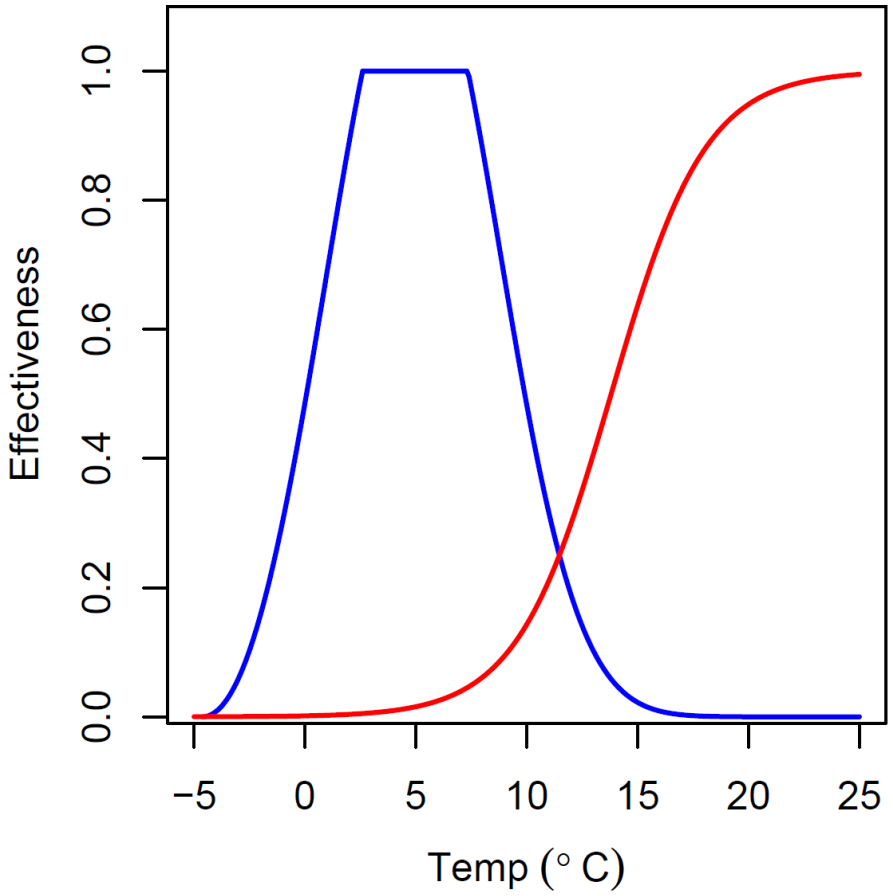
- If we can develop models of flowering, we can better predict **when** it will occur in the future…..

Research Questions

- Can we accurately model the date of flowering of **Douglas-fir** and **western redcedar** using environmental data?

- Does the relationship between environmental factors and flowering date differ between **species** or between trees from different regions?

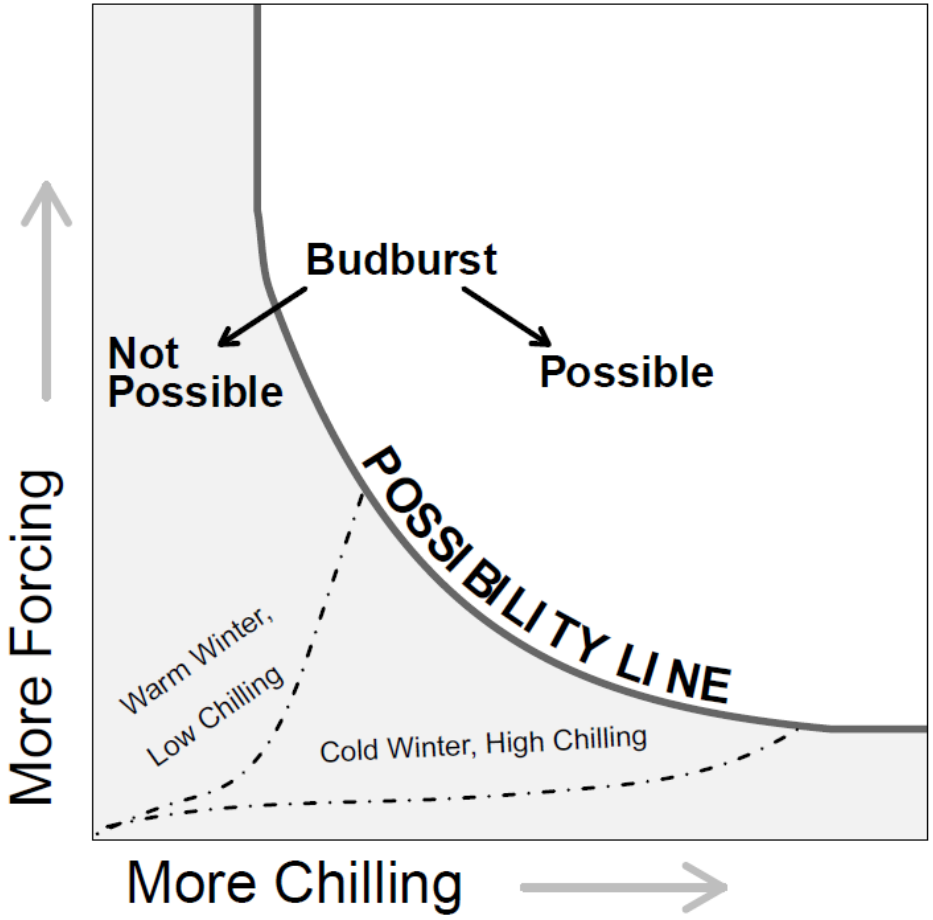
Previous research: Chilling and Forcing Requirements for vegetative budburst of Douglas-fir



ºC	ºF
0	32
5	41
10	50
15	59
20	68

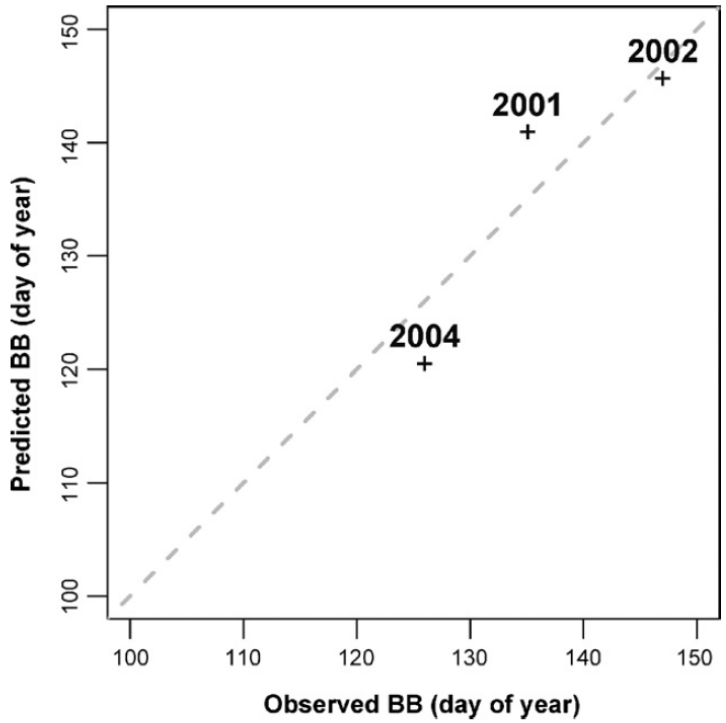
Cumulative cold and warm temperatures determine budburst timing and growth initiation of Douglas Fir

(Harrington *et al.* 2010, Ford *et al.* 2016)



Both **chilling** and **forcing** temperatures influence budburst timing – and many combinations can result in budburst

These models allow for predictions of vegetative budburst based on temperature data



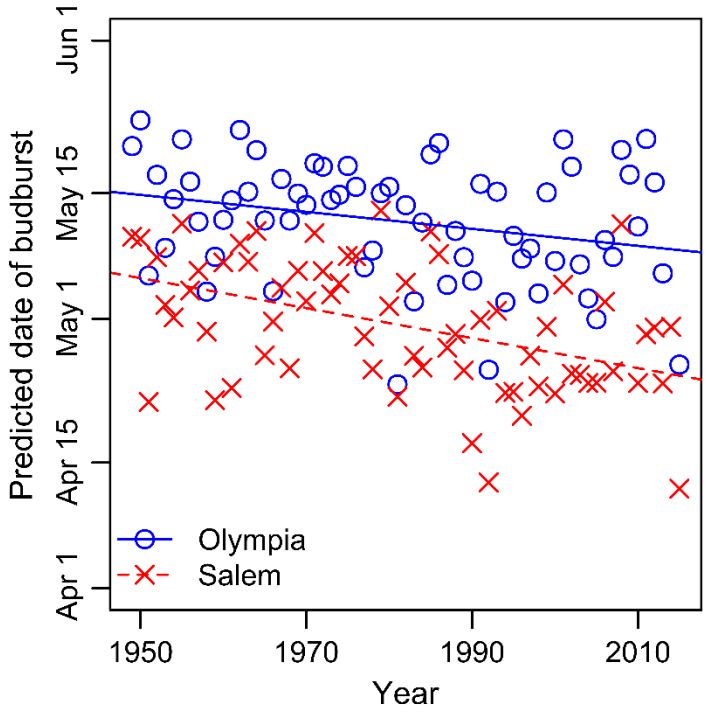
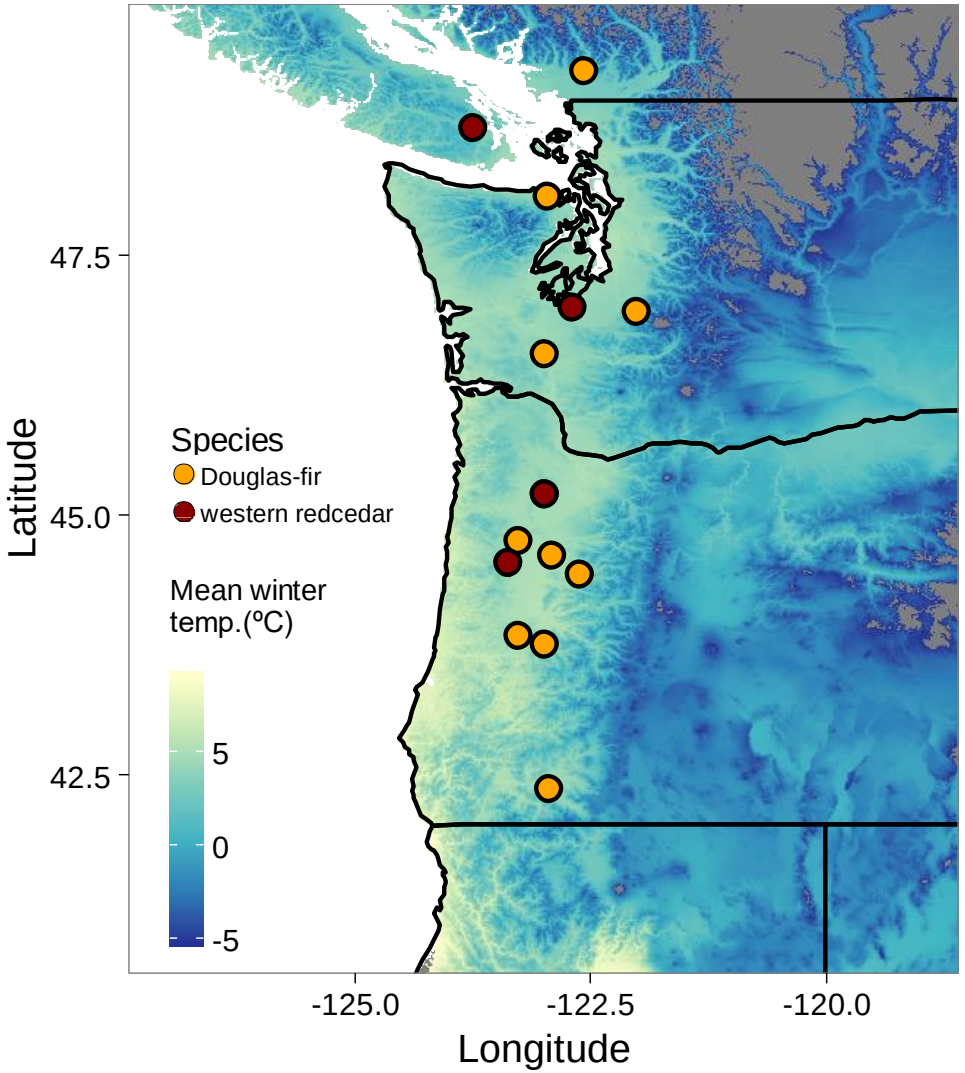


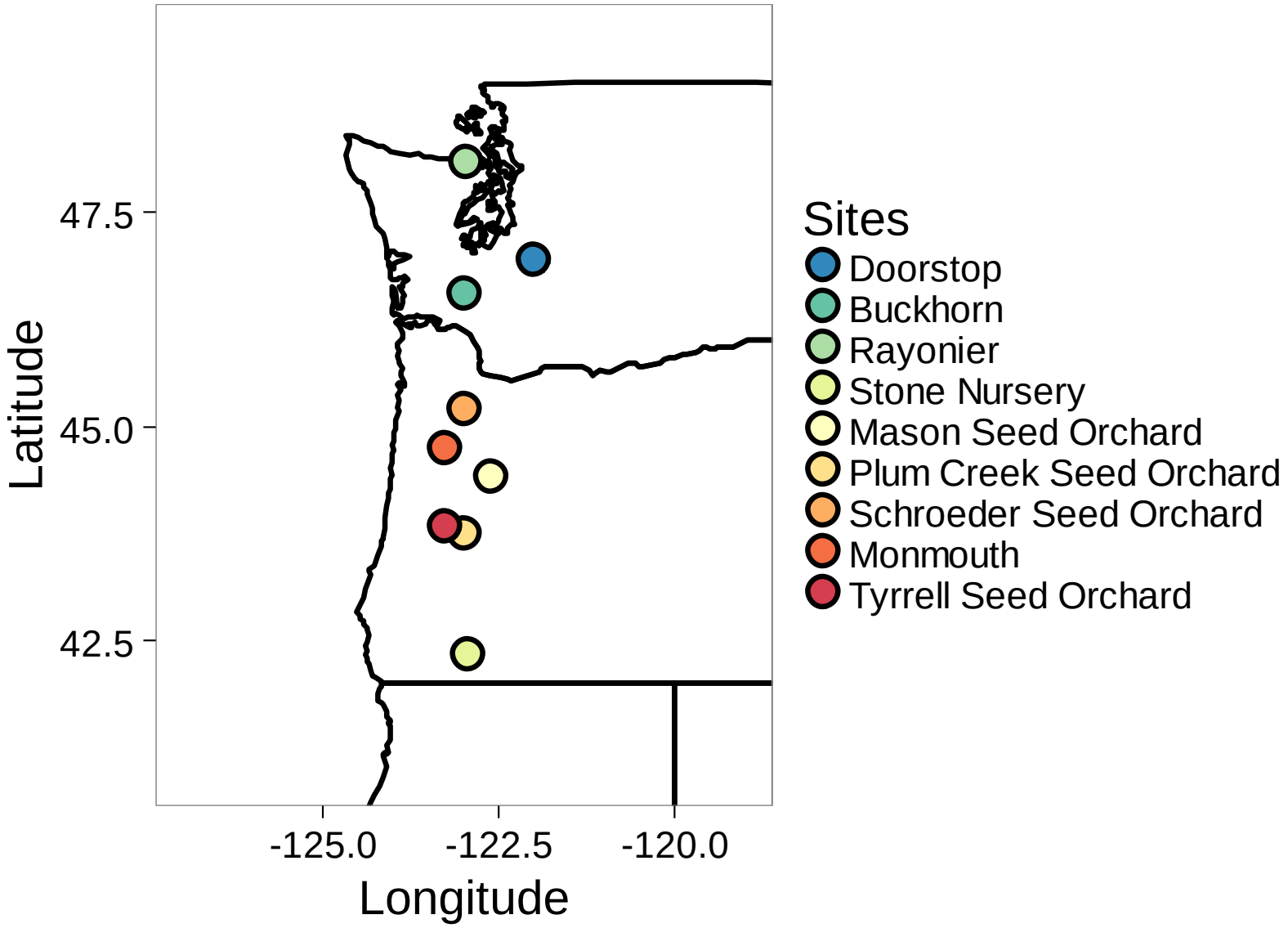
Fig. 8. Application of the possibility-line approach to prediction of date of budburst for 2001, 2002, and 2004 at Fall River, WA. The dotted line shows the 1:1 relationship between observed and predicted dates.

Current locations with reproductive phenology data

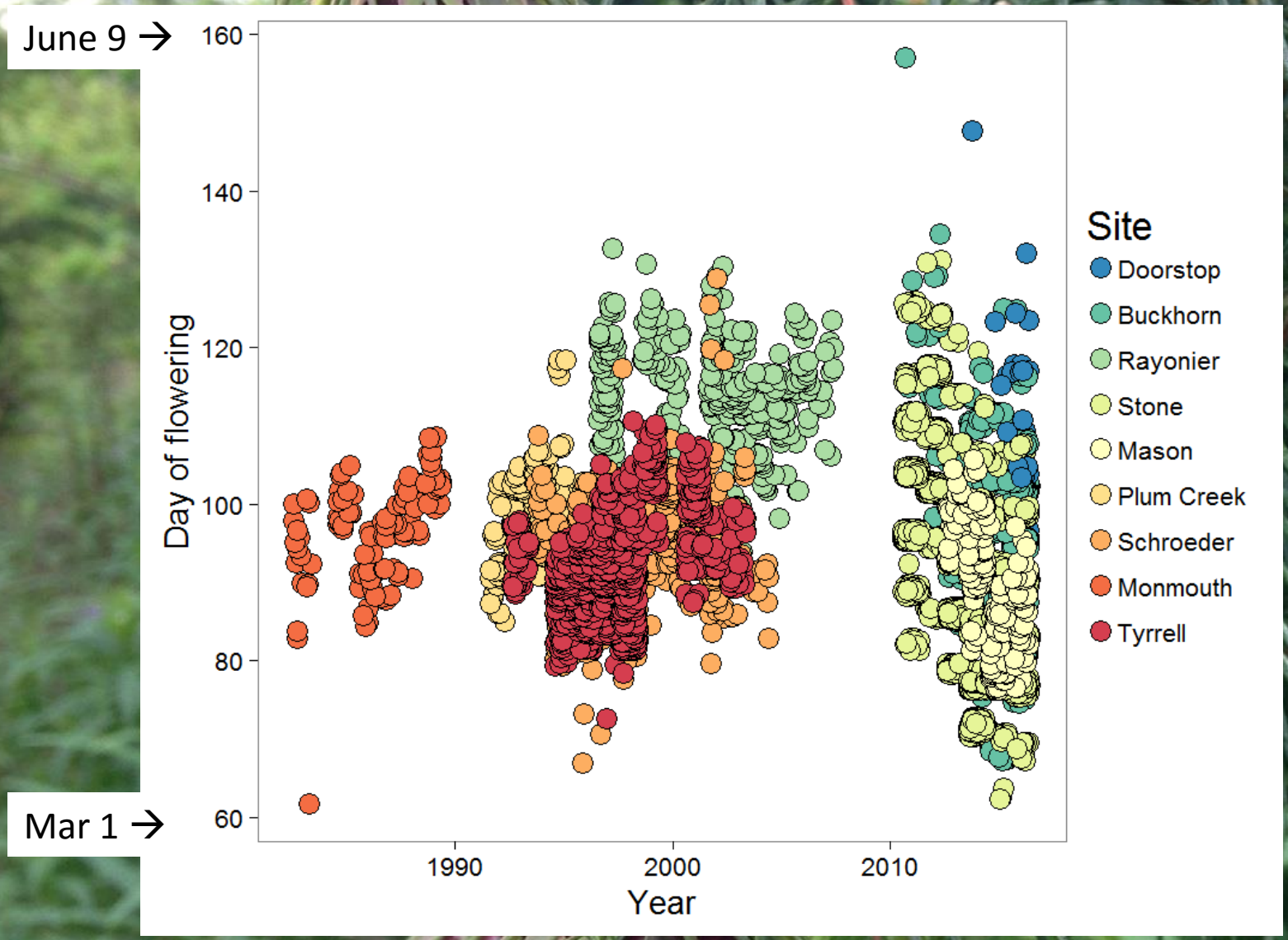


- Crossing or flowering dates from trees at 14 sites
- 1-10 years of data per site
- 9 locations from operational seed orchards

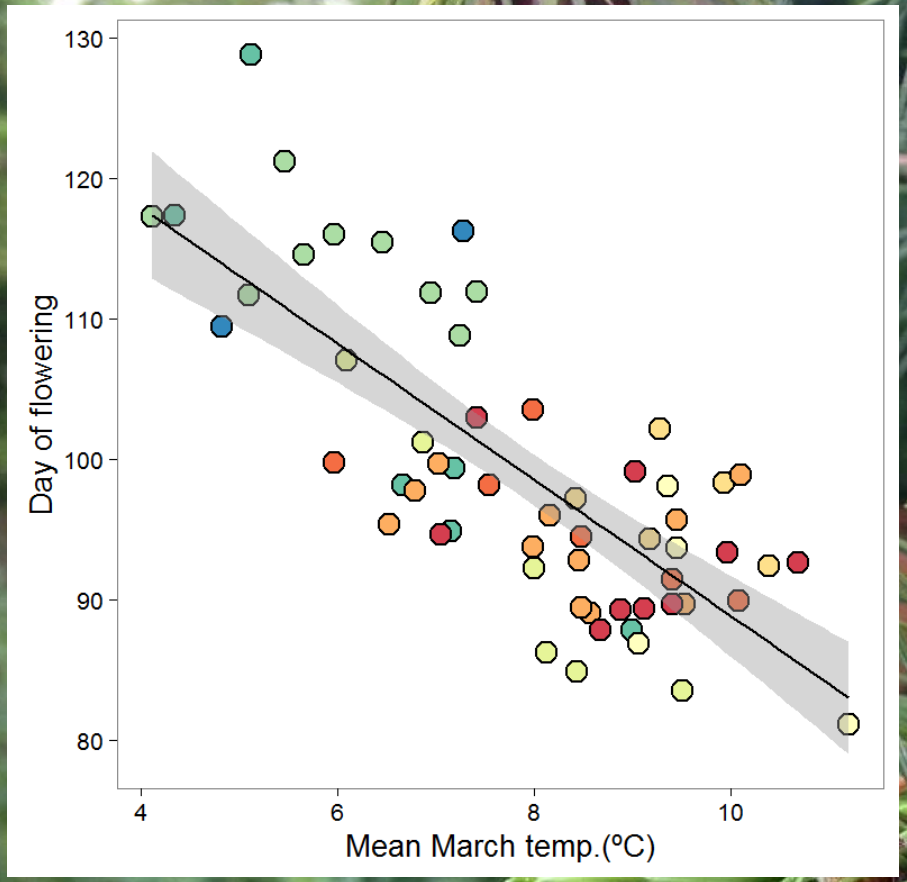
Preliminary Results – Douglas-fir

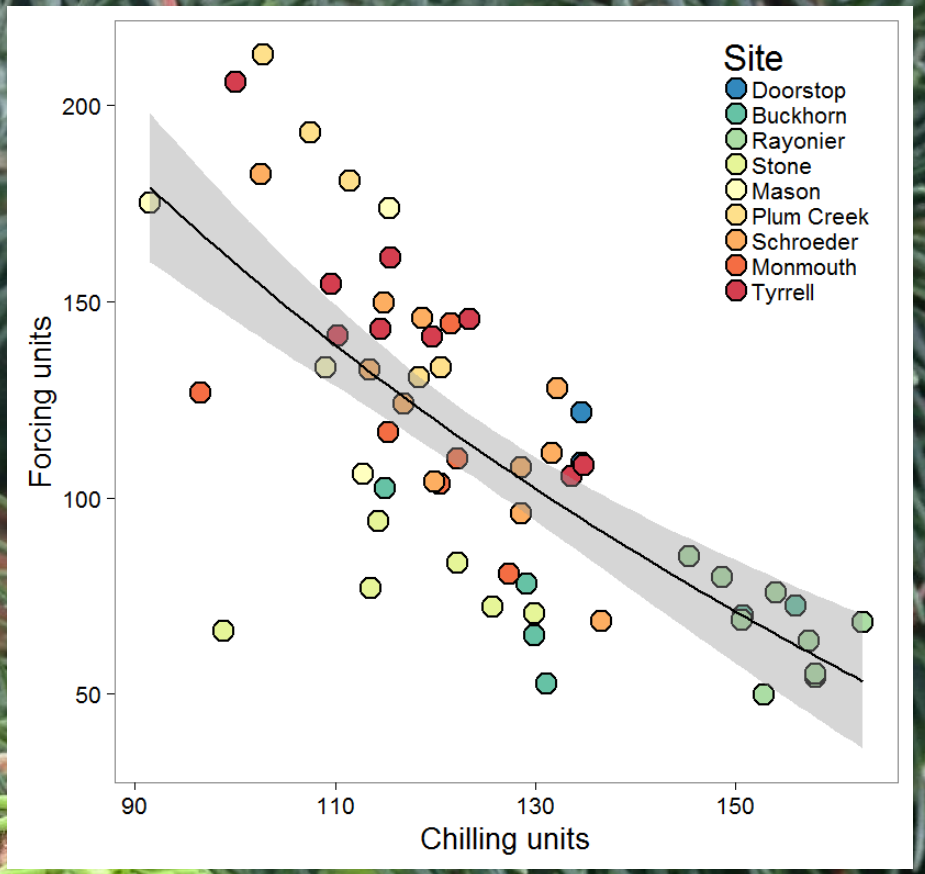


Preliminary Results – Douglas-fir



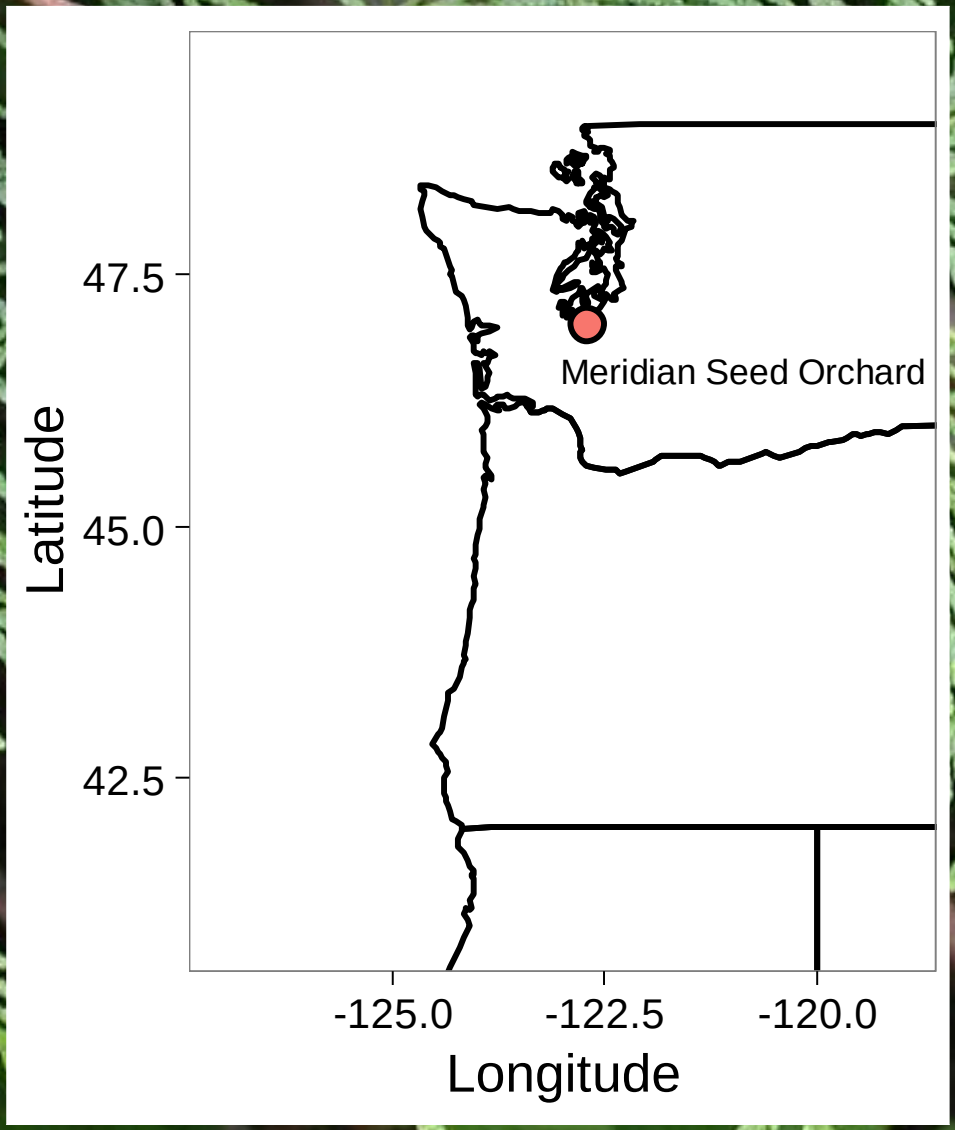
Preliminary Results – Douglas-fir

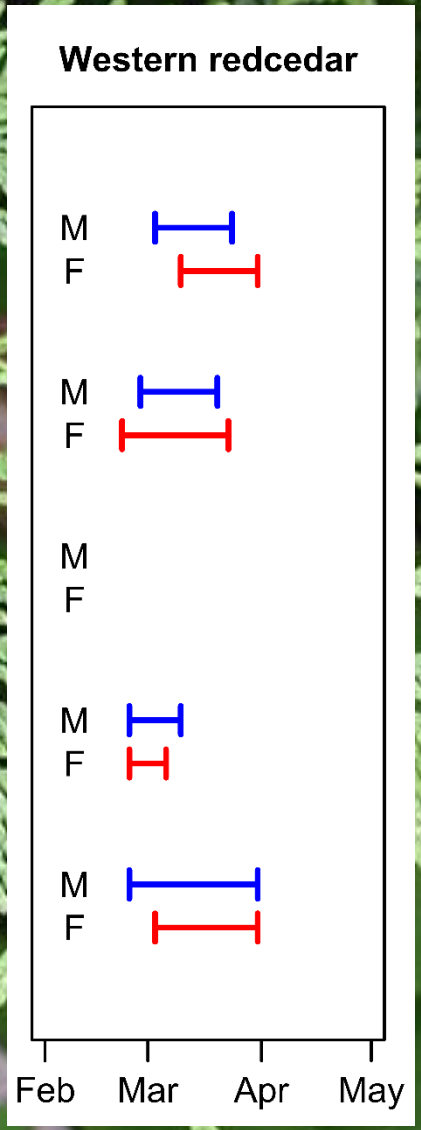




Preliminary evidence that both chilling and forcing temperatures help determine date of flowering of Douglas-fir……..

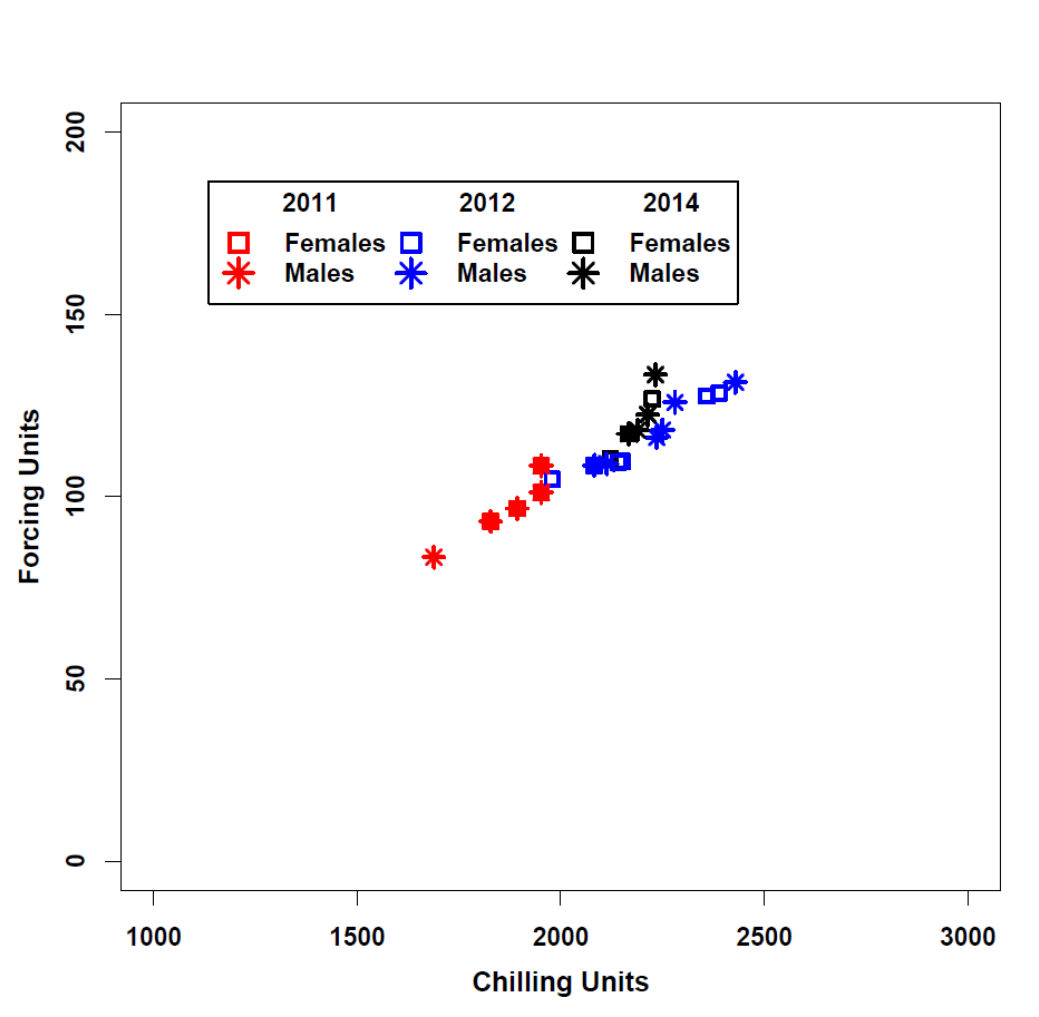
Preliminary Results – western redcedar





Slichter 2005

Preliminary Results – western redcedar



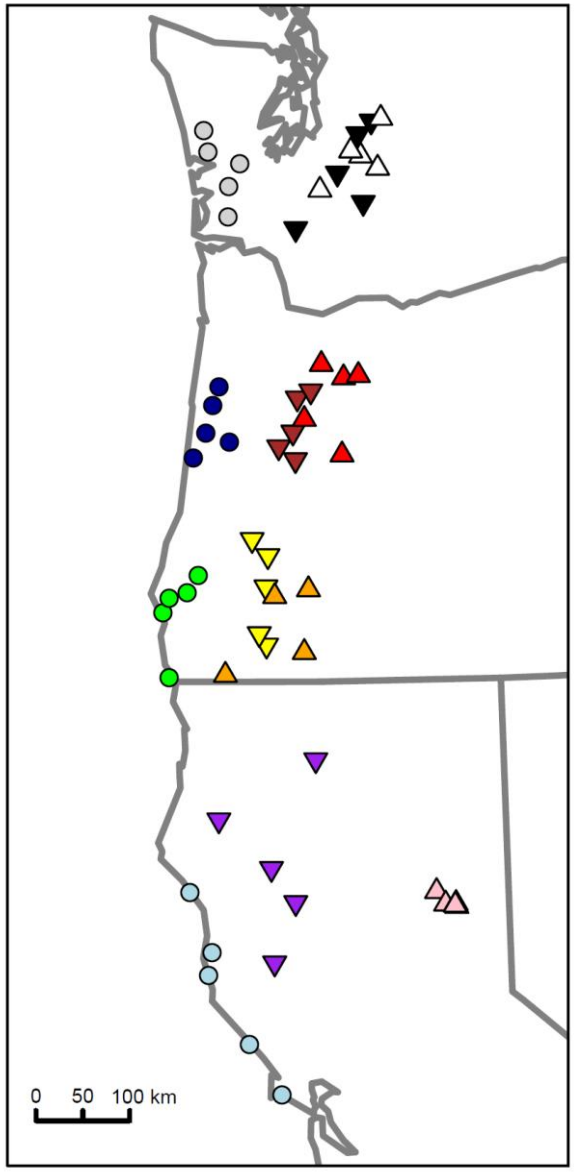
Chilling temperatures may not be as important for redcedar?

Slichter 2005

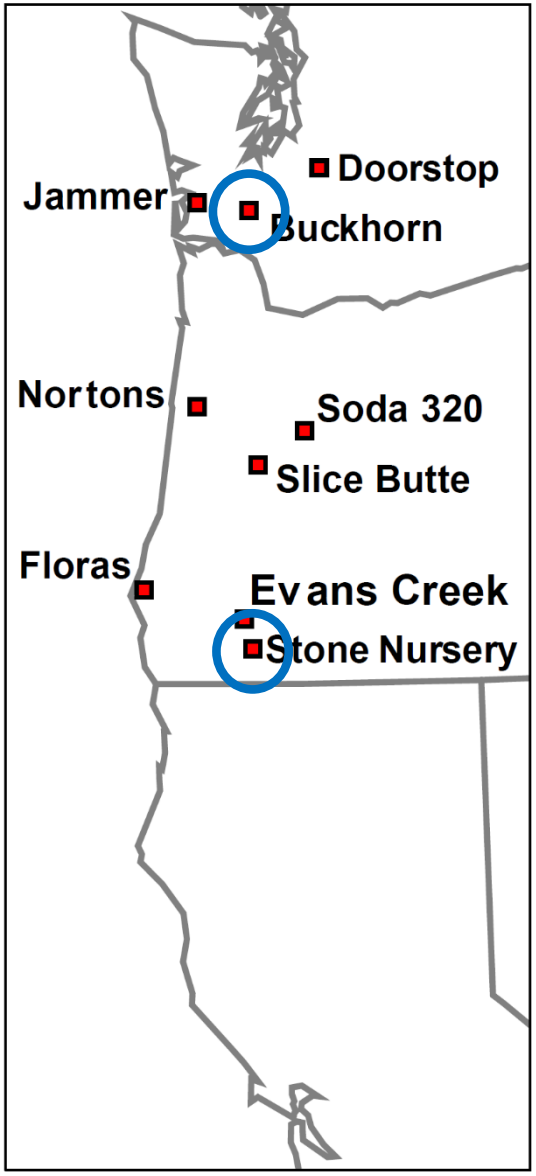
Douglas-Fir Seed Source Movement Trial

- Established 2009
- 60 populations from different regions
- 9 planting locations in diverse environments

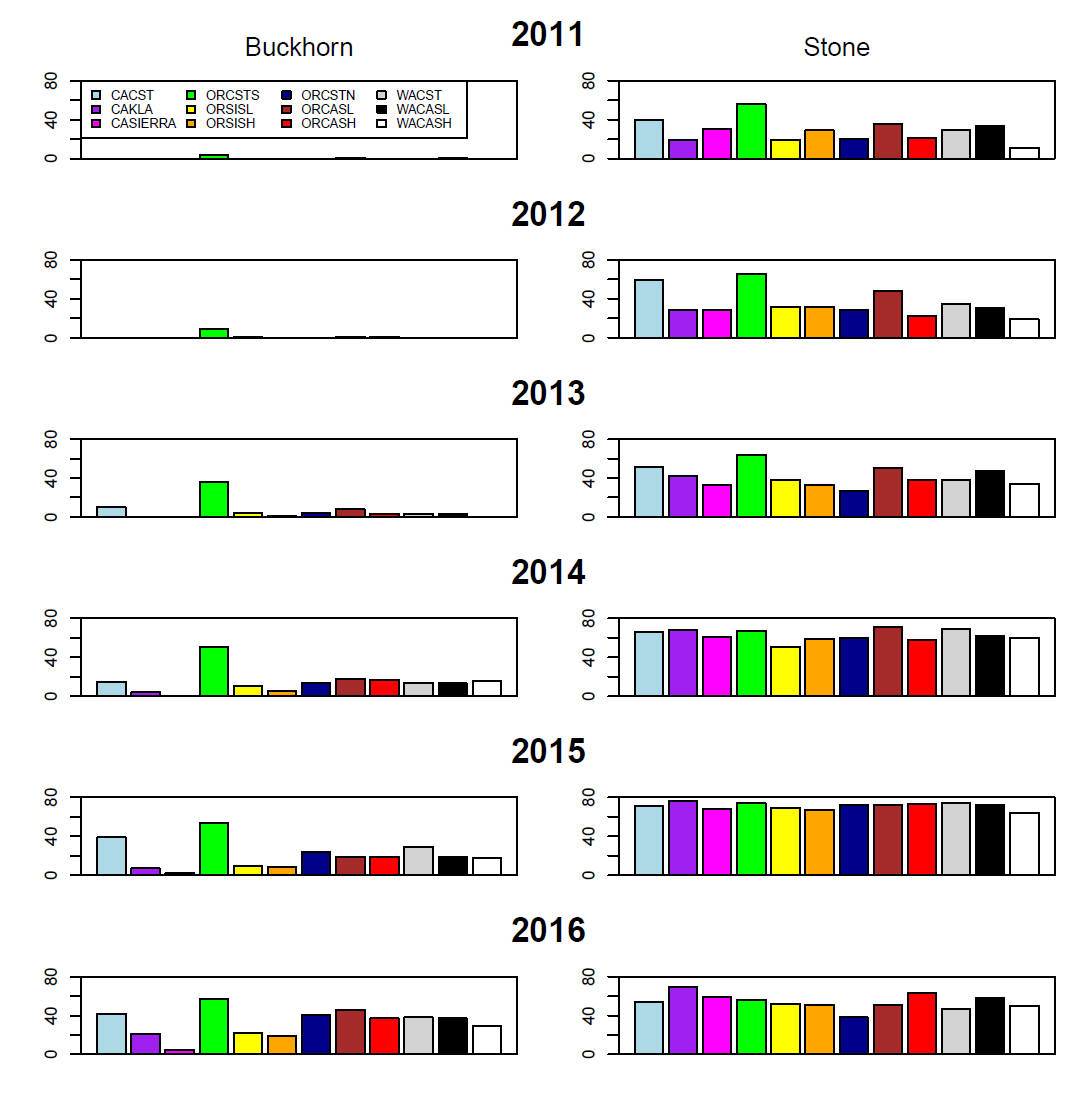
Populations



Planting Locations

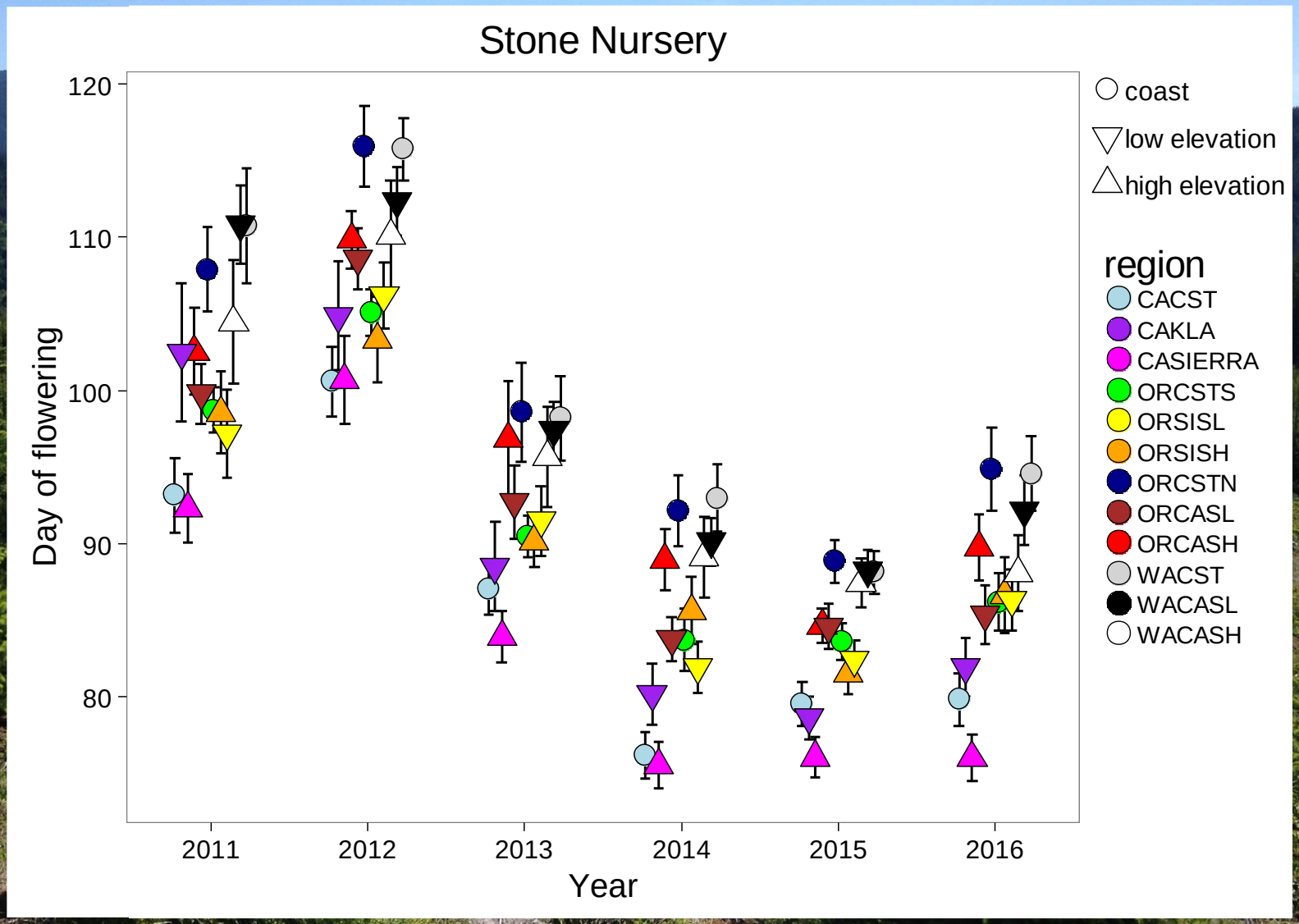


Preliminary results from the Seed Source Movement Trial…



Trees from some regions started flowering **before** others…

Preliminary results from the Seed Source Movement Trial…

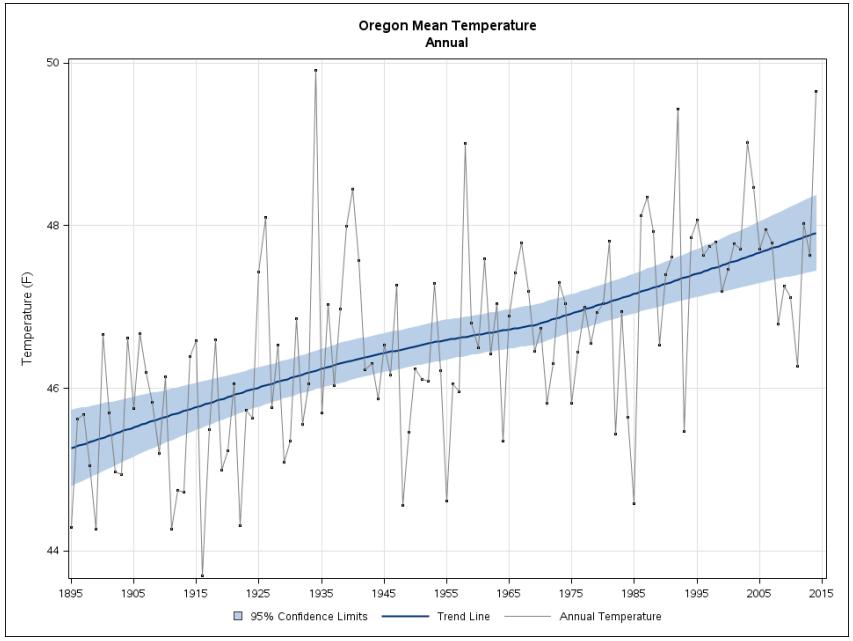


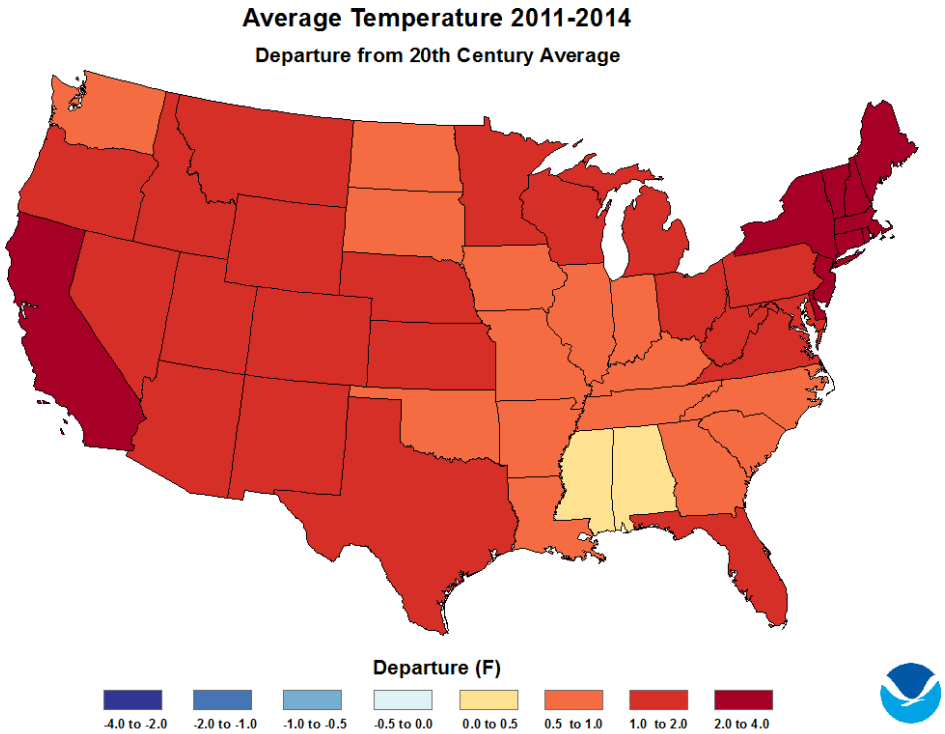
Trees from some regions **flower earlier** in the year.

Importance

- Climate change will affect when trees flower, and this will **influence the success** of pollination and seed development

- Understanding the **environmental cues** that determine timing of flowering will help us predict changes, and manage for more desirable/adaptable trees in the future





Want to help?

- Breeding, crossing, or pollen collection data for either Douglas-fir or Western red-cedar

- We are especially interested in **multiple years of data** on trees from different seed sources

- Local climate data (daily temperature and precipitation data)

- All data is **confidential**, we will not share genetic identity information with anyone!

Hobo weather station at a Seed Source Movement Trail site

Want to help?

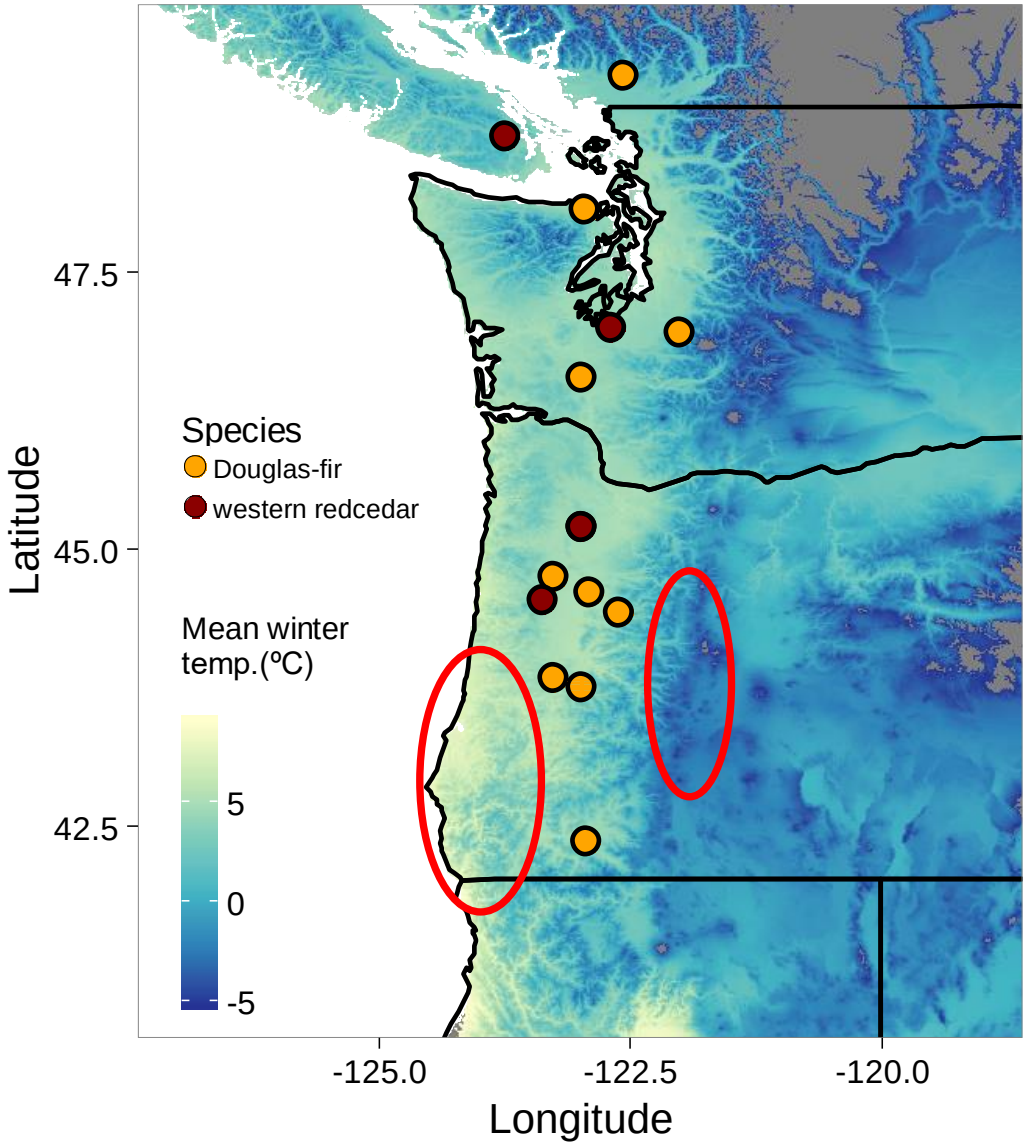
If you are willing to share data or have any questions, contact Janet:

jprevey@fs.fed.us

- Electronic **OR** paper data
- Should have minimal impact on you
- We could enter data and share back with **you**

Hobo weather station at a Seed Source Movement Trail site

We would also like data from orchards with different climates!



Thank you!

Janet Prevéy

jprevey@fs.fed.us

Chilling and forcing models

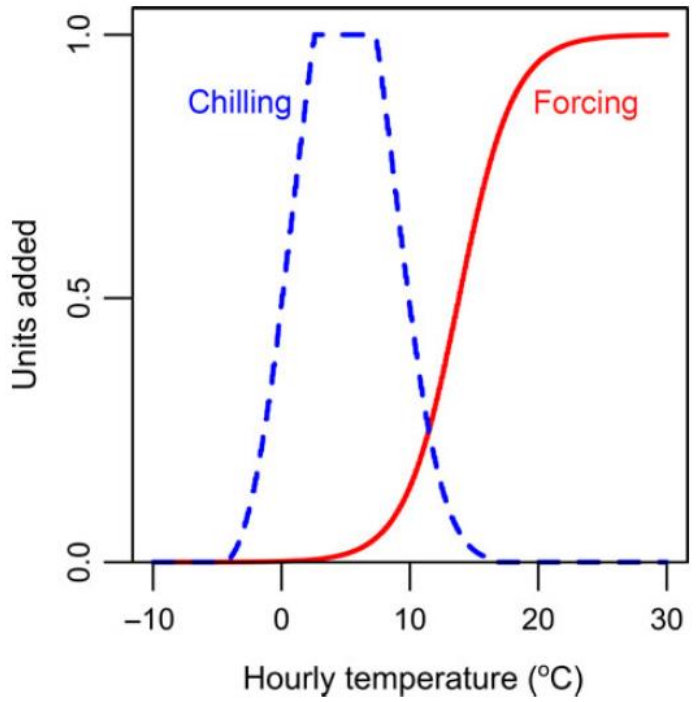
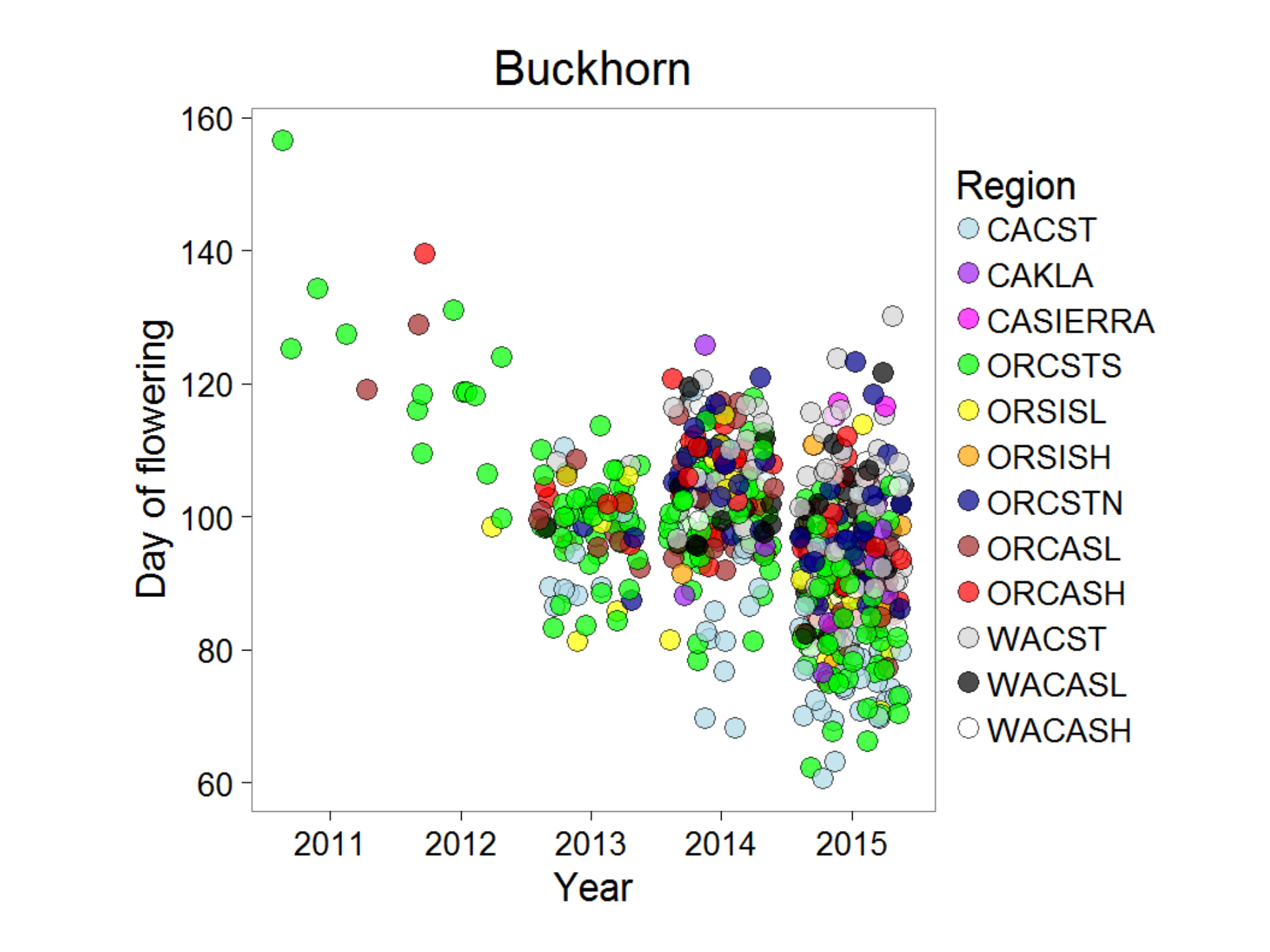


Fig. 2 The functions that depict how trees sense chilling and forcing (i.e., accumulate chilling/forcing units), based on hourly temperature from November 1 through growth initiation. See Harrington *et al.* (2010) for a description of function development.

$$CU = 3.13\left(\frac{T + 4.66}{10.93}\right)^{2.10} e^{-(T+4.66/10.93)^{3.10}}$$

$$FU = \frac{1}{1 + e^{-0.47T+6.49}}$$


Buckhorn
Day of flowering
160
140
120
100
80
60
2011
2012
2013
2014
2015
Year
Region
CACST
CAKLA
CASIERRA
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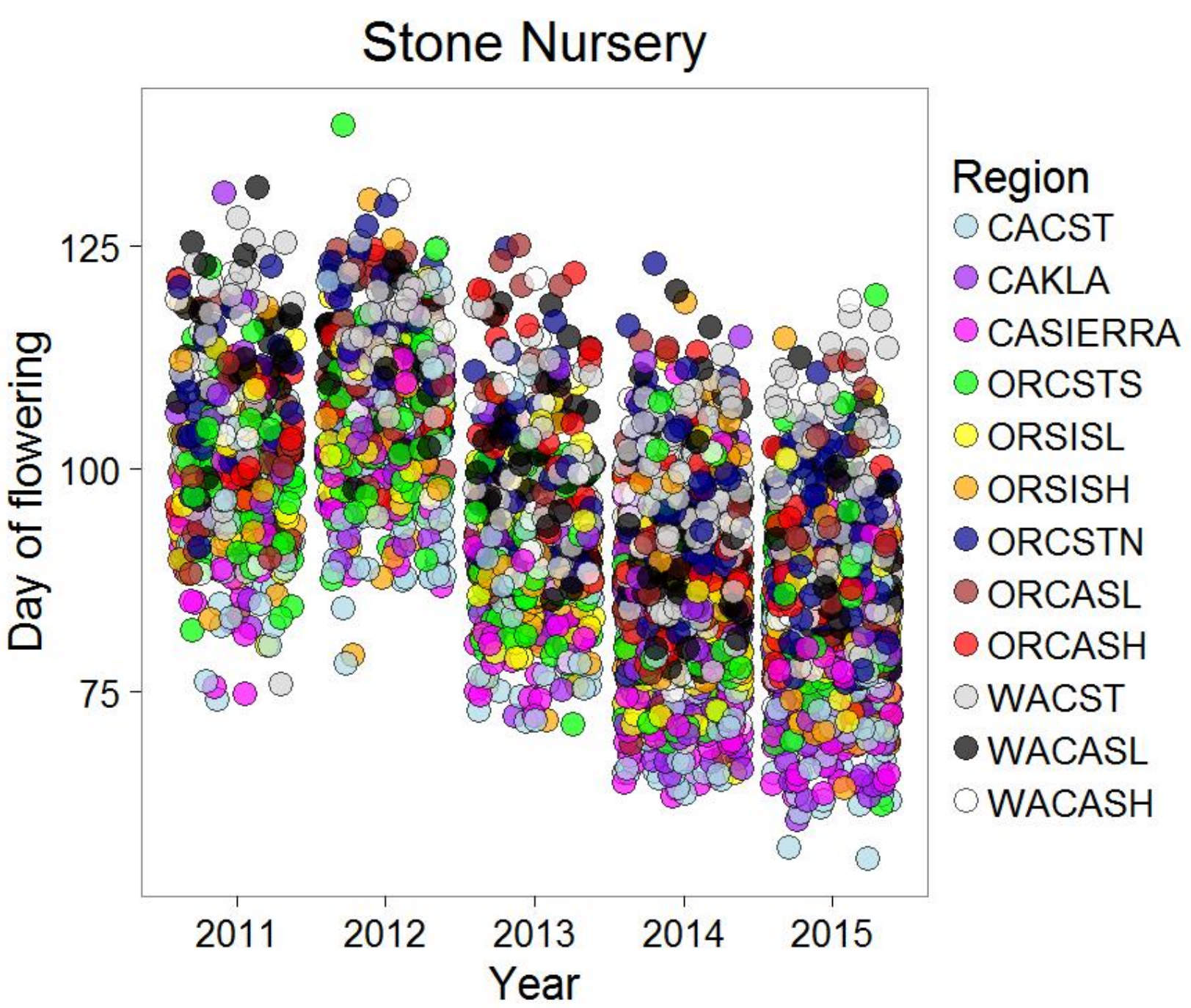
Stone Nursery
Day of flowering
125
100
75
2011
2012
2013
2014
2015
Year
Region
CACST
CAKLA
CASIERRA
ORCSTS
ORSISL
ORSISH
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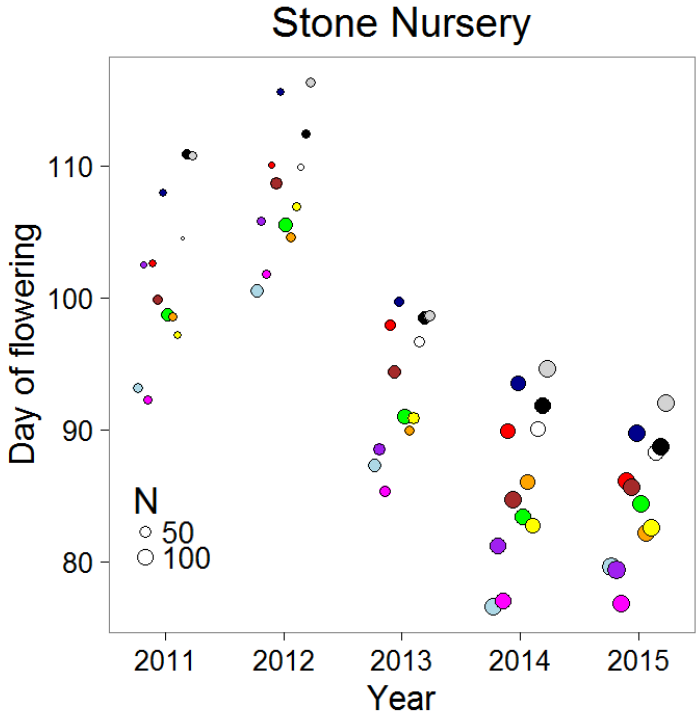
Stone Nursery
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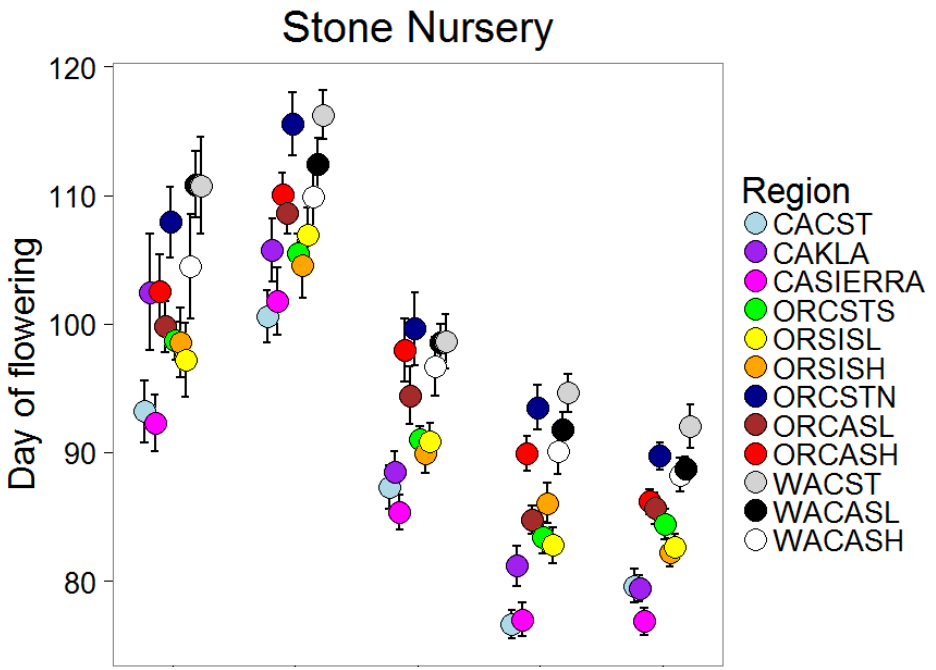
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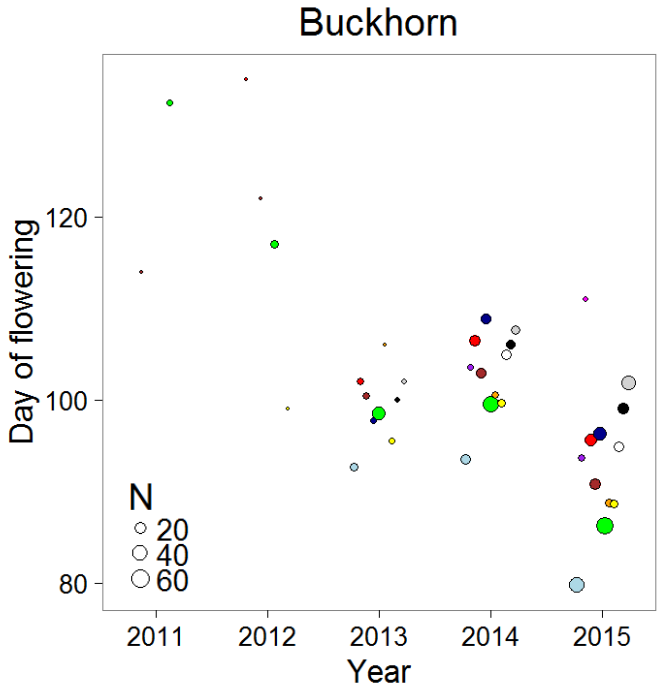
Buckhorn
Day of flowering
120
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80
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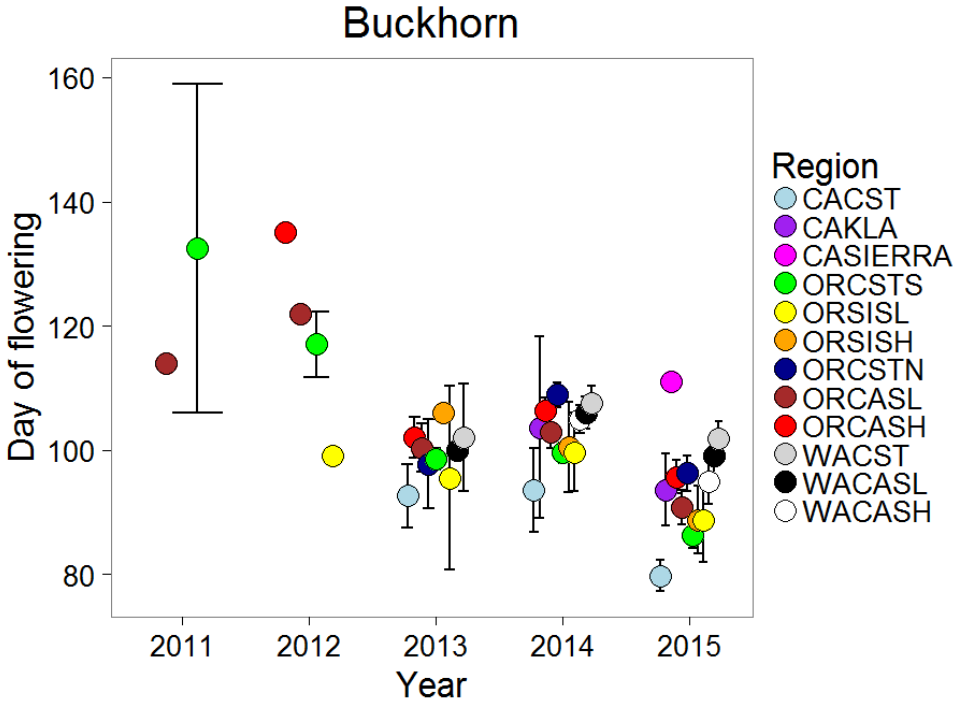
20
40
60
2011
2012
2013
2014
2015
Year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2011
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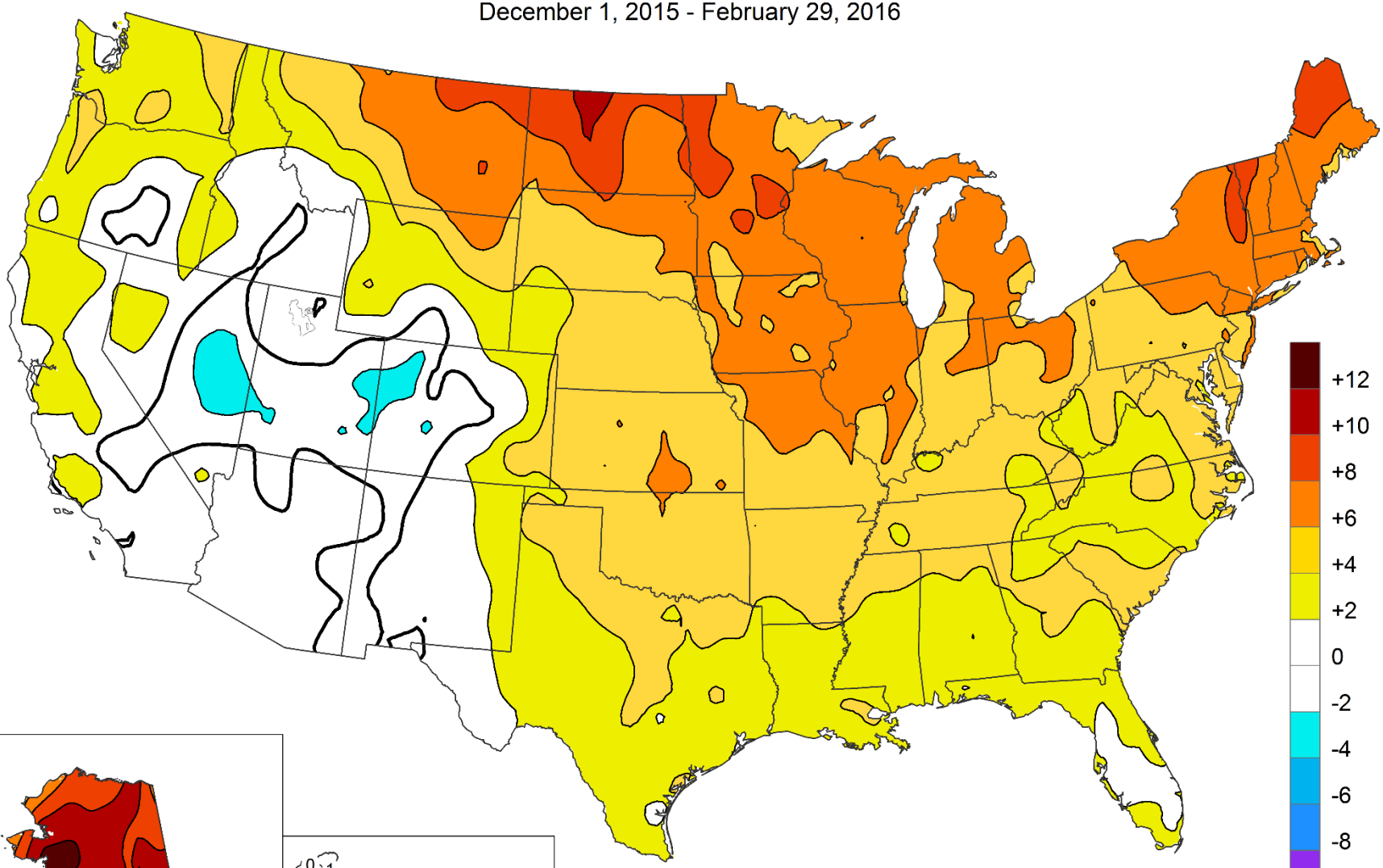
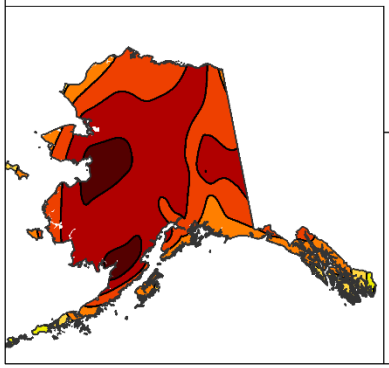
Year

Departure of Average Temperature from Normal (°F)

December 1, 2015 - February 29, 2016





CLIMATE PREDICTION CENTER, NOAA
Computer Generated Contours
Based on Preliminary Data

https://westernconifers.wordpress.com/douglas-fir/