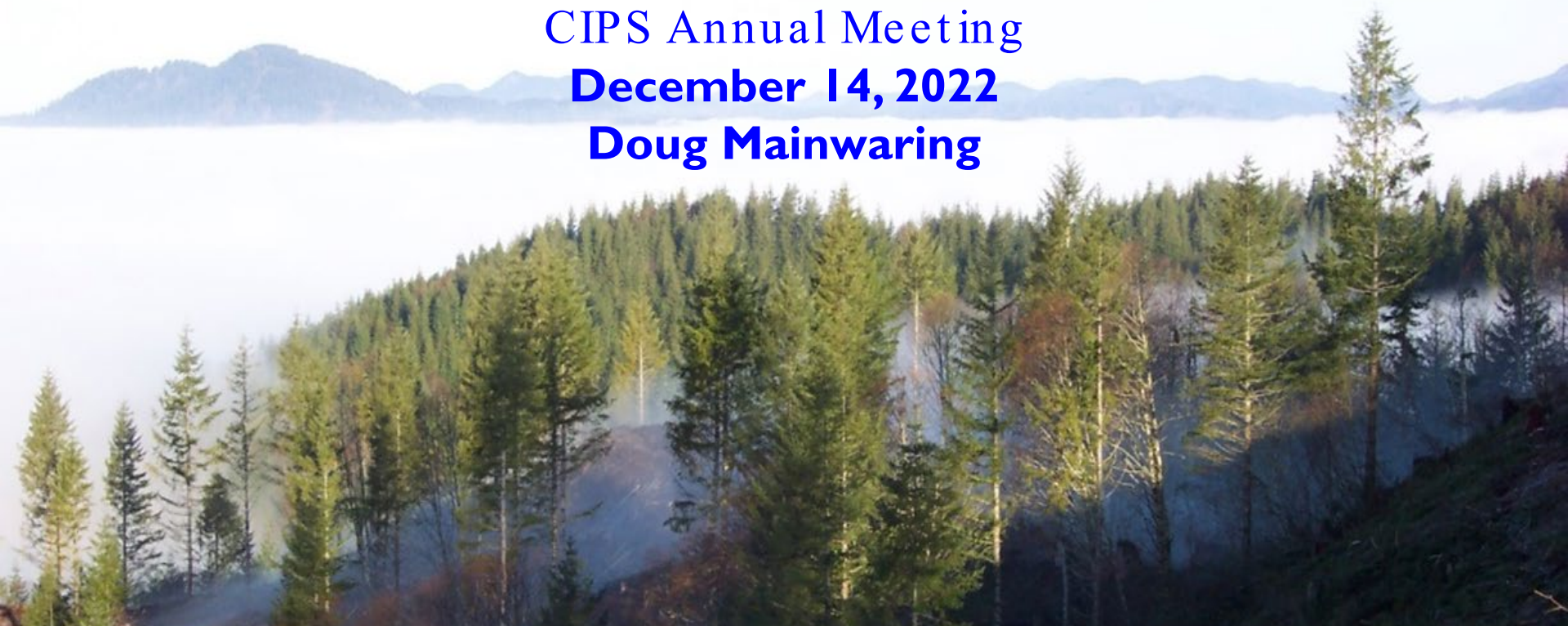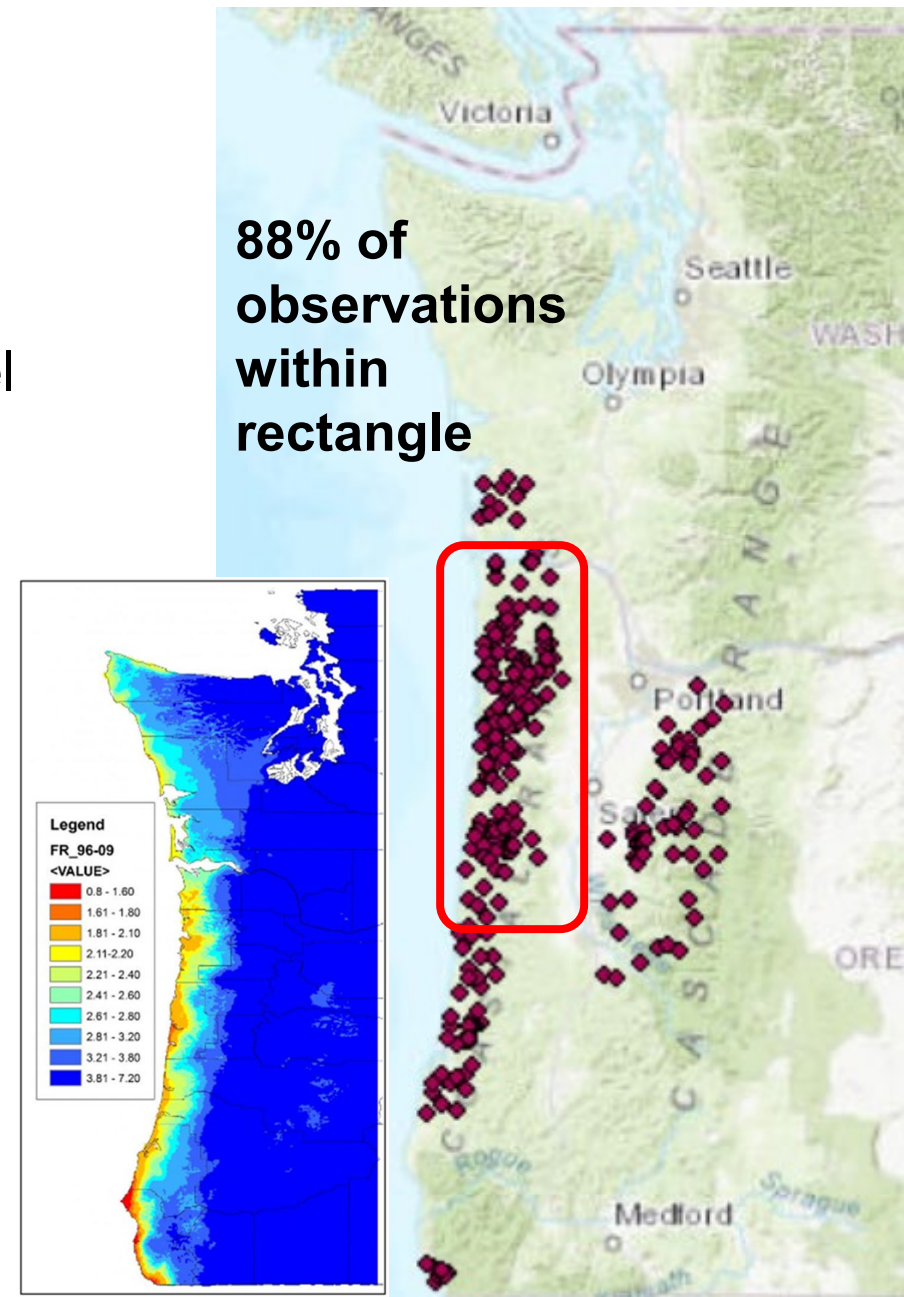# CIPS Annual Meeting: Progress reports

CIPS Annual Meeting
December 14, 2022
Doug Mainwaring

Remote estimate of DF foliage retention…why?

- Improve prediction of SNC levels for better inventory projection and stand valuation

- In 2011, the SNCC produced a model predicting DF foliage retention from climate variables based on sampling conducted from 1998-2009 (88% of observations were between Newport and Astoria)

- Foliage retention models

  - Coop and Stone (2008)
 - Latta et al. (2010)
  - Zhao et al. (2011)

88% of observations within rectangle

Legend
FR_96-09
<VALUE>

■	0.8 - 1.60
■	1.61 - 1.80
■	1.81 - 2.10
■	2.11-2.20
■	2.21 - 2.40
■	2.41 - 2.60
■	2.61 - 2.80
■	2.81 - 3.20
■	3.21 - 3.80
■	3.81 - 7.20

Dataset

- *Sources*
  - Growth Impact study (1998-2008)
  - Precommercial thinning study (1998-2008)
  - Commercial thinning study (2002-2007)
  - Southern Oregon/Southern WA transects (2009)
  - Cascade Transects (2001-2003)
  - Beyond N study (2008)
  - SNC Research Plot network (2013-2020)
  - WaDNR transects (2011-2021)
  - Cascade Transects (2017-2020)
  - BC Ministry of Forests (2017-2019)

Remote estimate of Douglas-fir foliage retention

- Objective:
- Estimate stand-level Douglas-fir foliage retention from numerous variables:
  - Climate (ClimateNA)
  - Soils (NRCS)
  - Topographic (DEM-based slope, aspect, TPI, TWI)

- Produce rasters for significant variables

- Introduce version of ORGANON that can estimate Douglas-fir foliage retention for specific latitude-longitude (using raster-extracted values) and project stand(s) with current SNC modifiers

● Post 2012
● Pre 2010
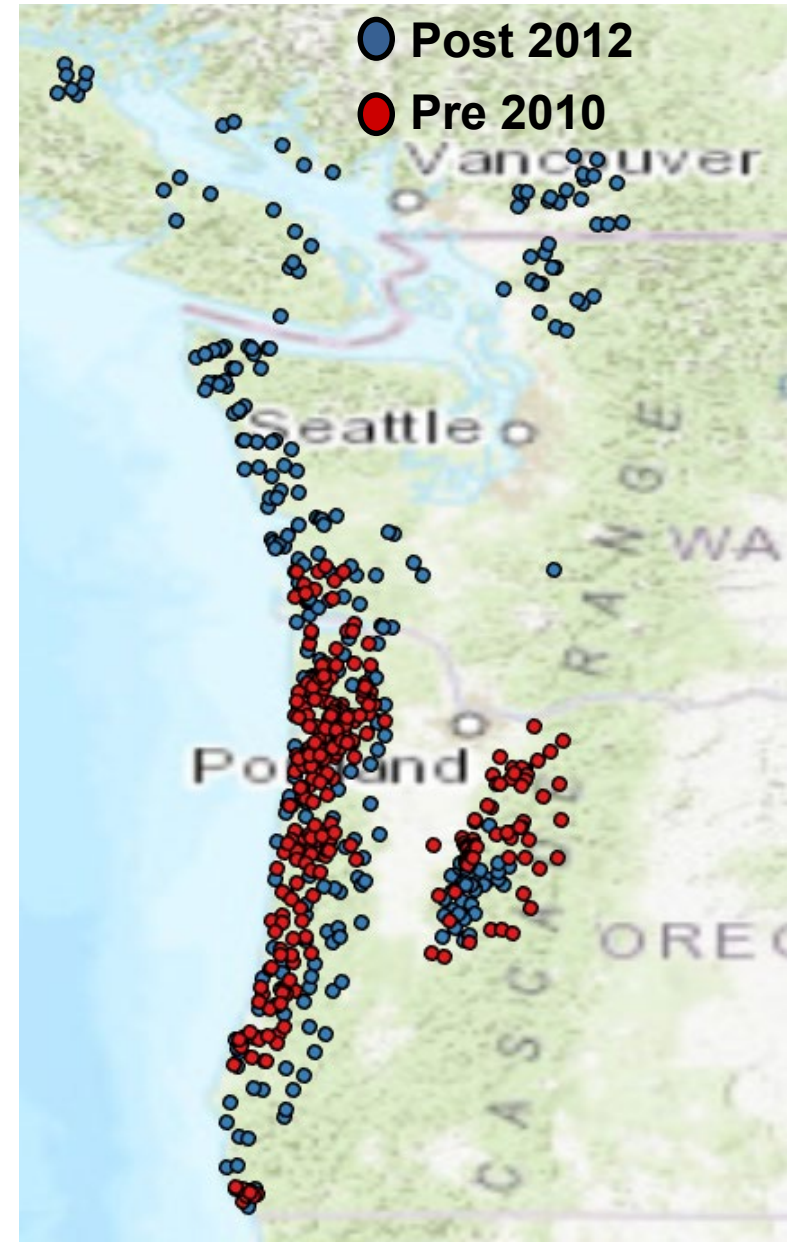
Dataset

- *Details*
  - Subsampled from datasets to ensure some independence of observations

Year	Year Sampled	Foliage retention < 2 yrs	Foliage retention >2 yrs
1998			
1999			
2000			
2001			
2002			
2003			
2004			
2005			
2006			
2007			
2008			

  - Foliage retention (FR) based on a 4-year maximum, so discarded observations where FR exceeded 4 yrs

Independent variables

- ***Climate***
  - Obtained from ClimateNA 7.20 for individual years, lagged by four years per observation. Obs. in year X based on climate in years $X-2$, $X-3$, $X-4$
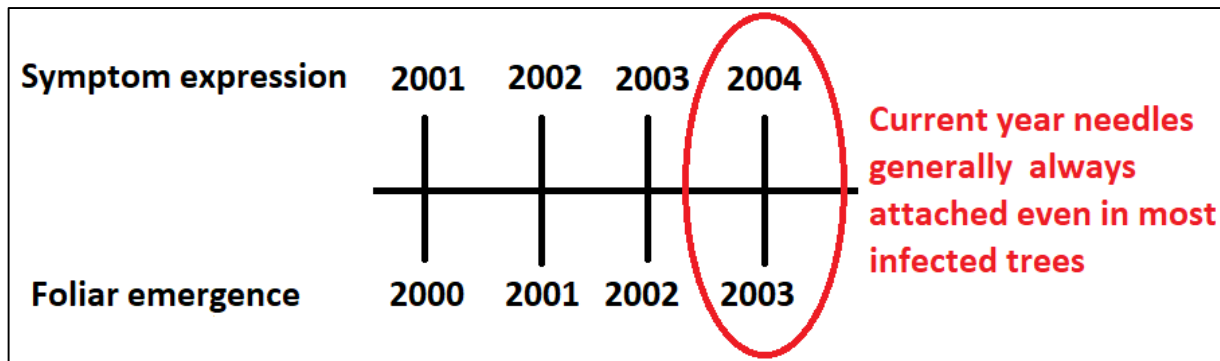
- ***Soils***
  - Based on chemical and physical properties of NRCS soil mapunits

- ***Topography***
  - 30m DEM produced within Google Earth Engine
  - DEM used within RSAGA to produce rasters for slope, aspect, topographic position index (TPI).

Results

Foliage Retention =

$$4 \cdot (1 - \exp(a_0 + a_1 \cdot RH_{0607} + a_2 \cdot TMAX_{12} + a_3 \cdot PPT_{05}$$
$$+ a_4 \cdot slope \cdot \cos(aspect) + a_5 \cdot slope \cdot \sin(aspect)$$
$$+ a_6 \cdot MA400^{0.5} + a_7 \cdot TPI + a_8 \cdot CEC^{0.5}))$$

Where

RH_{0607} is average June and July relative humidity (%)

$TMAX_{12}$ is average maximum December temp (º C)

PPT_{05} is average May precipitation (mm)

  ·All climate variables are averages of 2,3,4 year lags
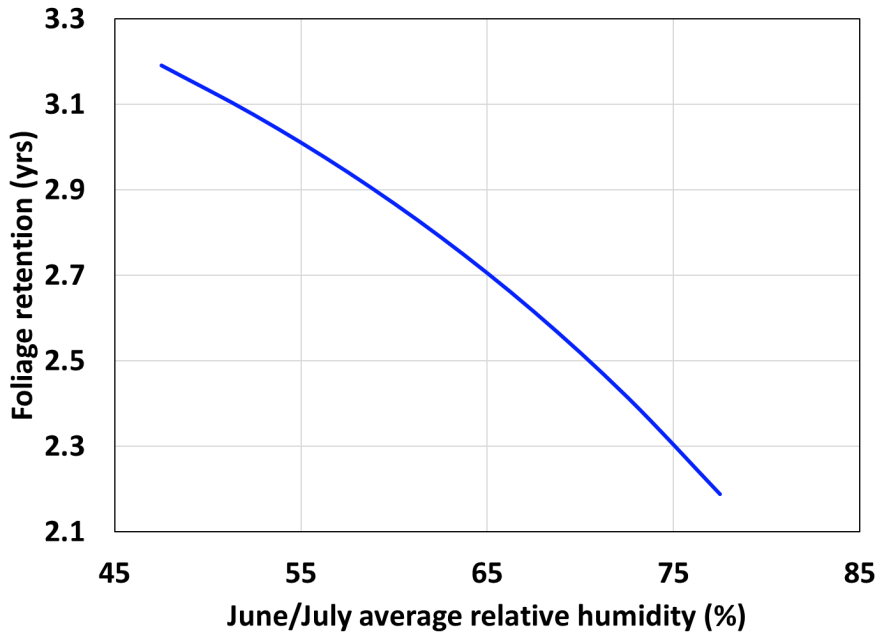
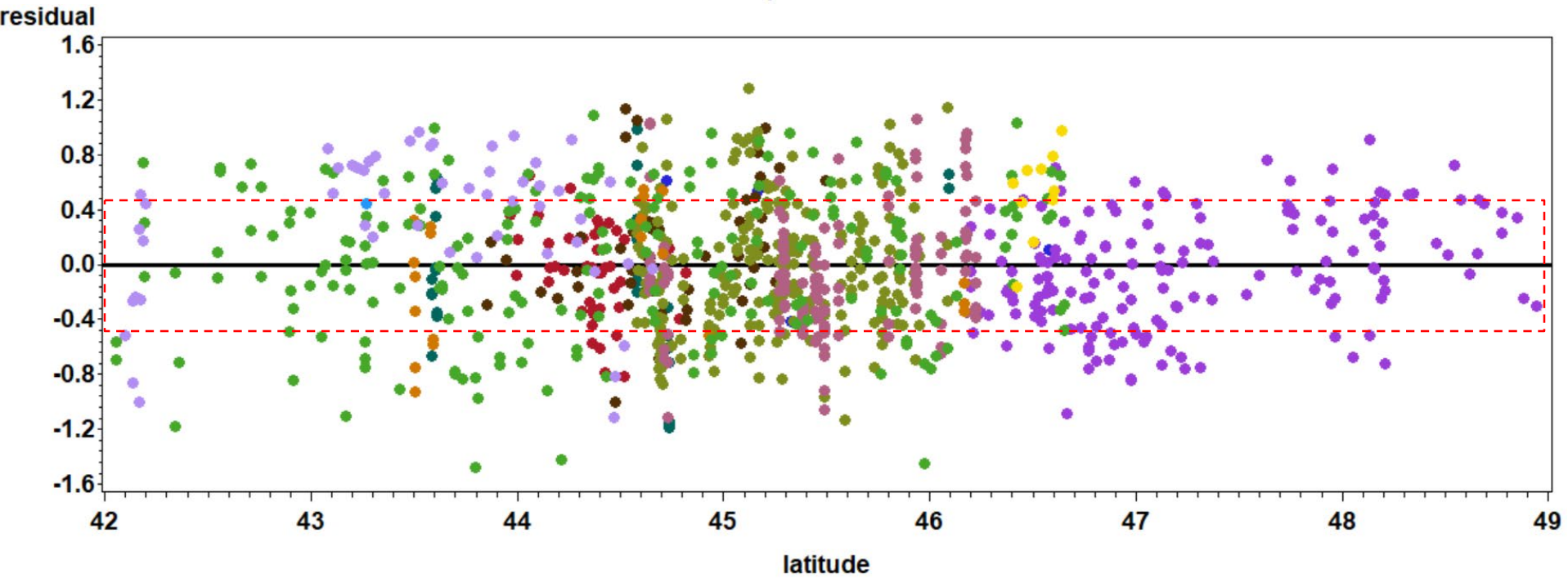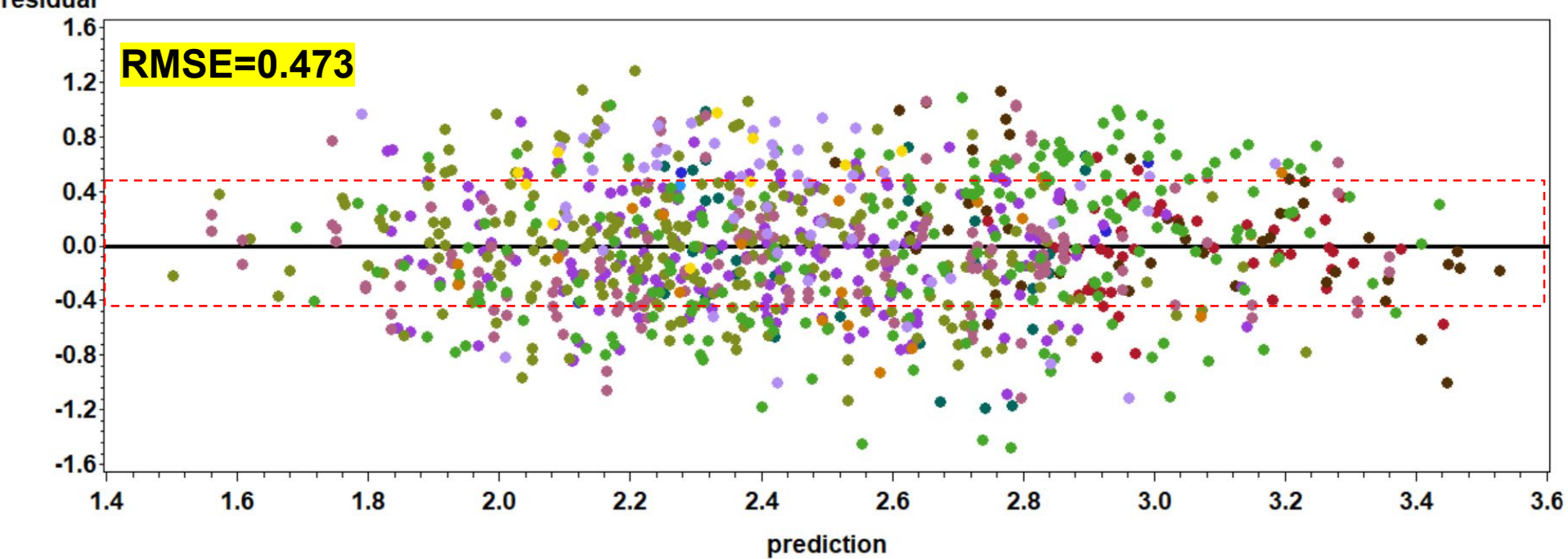Slope and aspect are in radians

MA400 is meters of elevation above 400 m elevation

TPI is topographic position index

CEC is soil cation exchange capacity

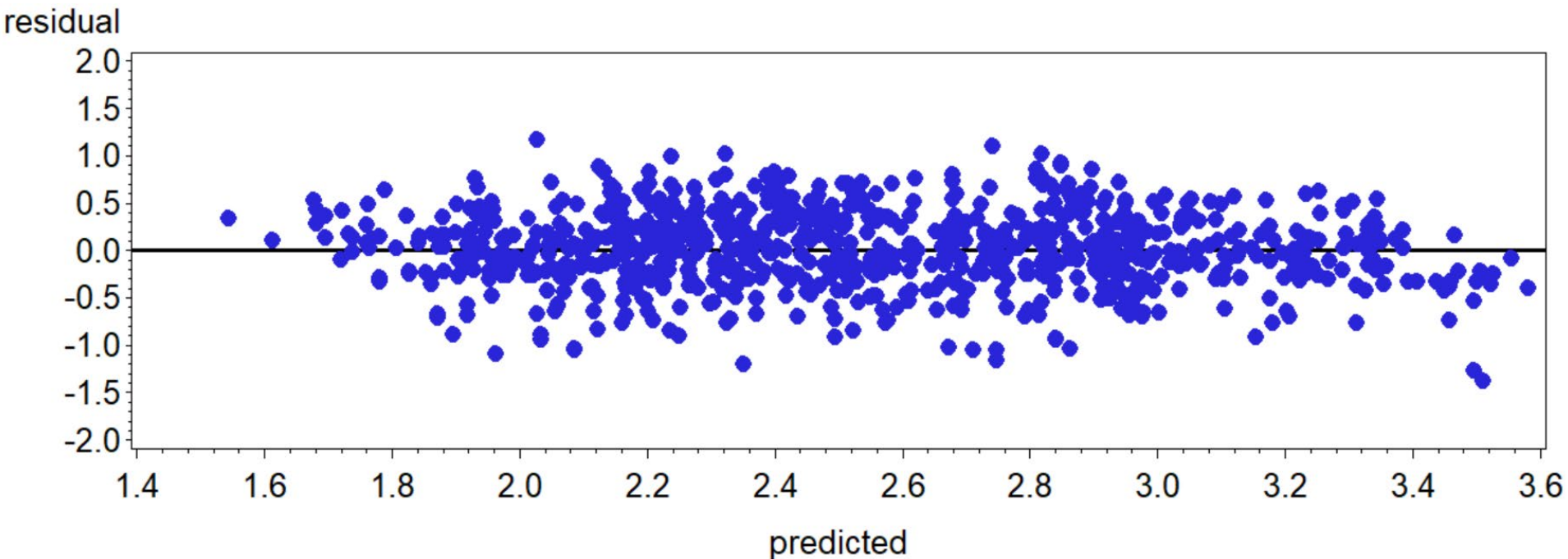# Results, with all other variables held at dataset mean

RMSE=0.473
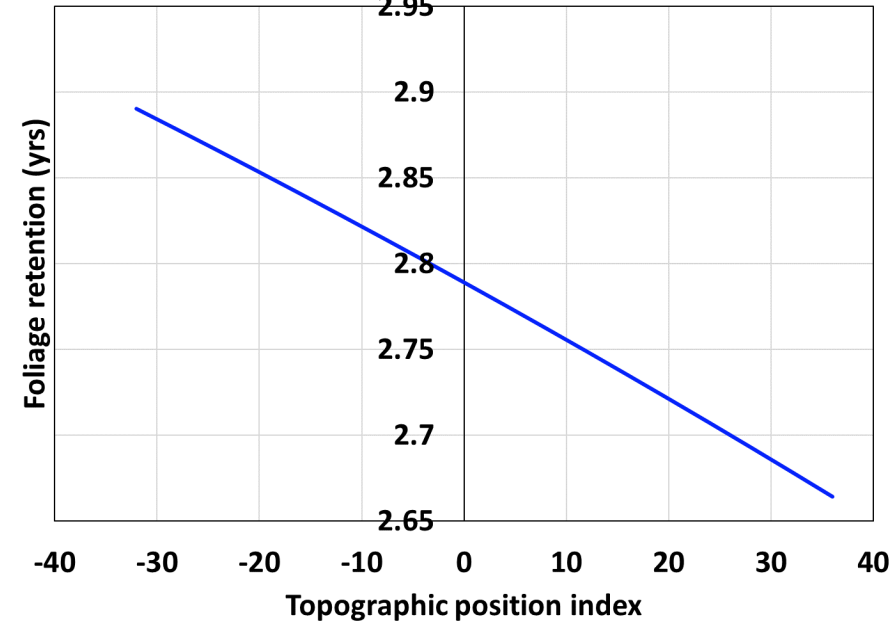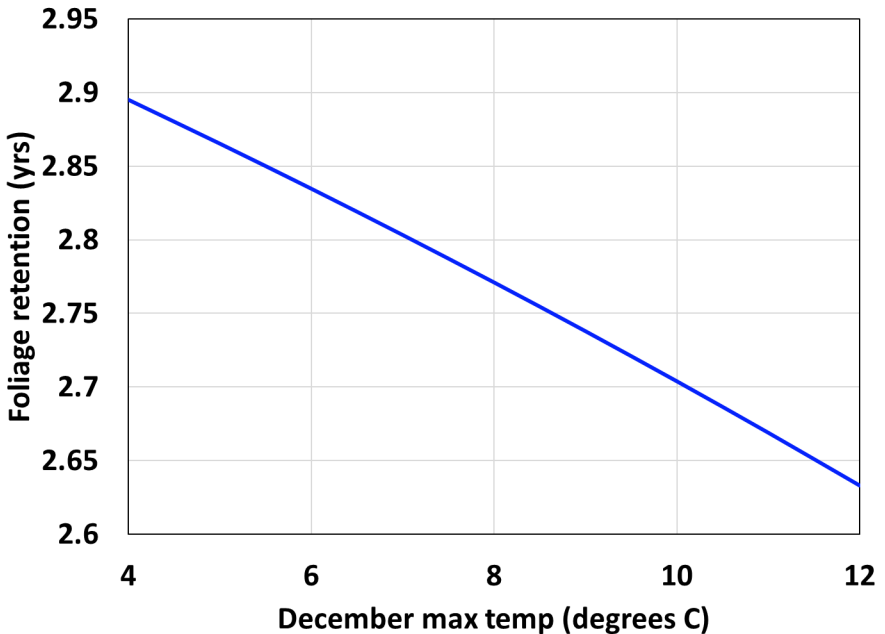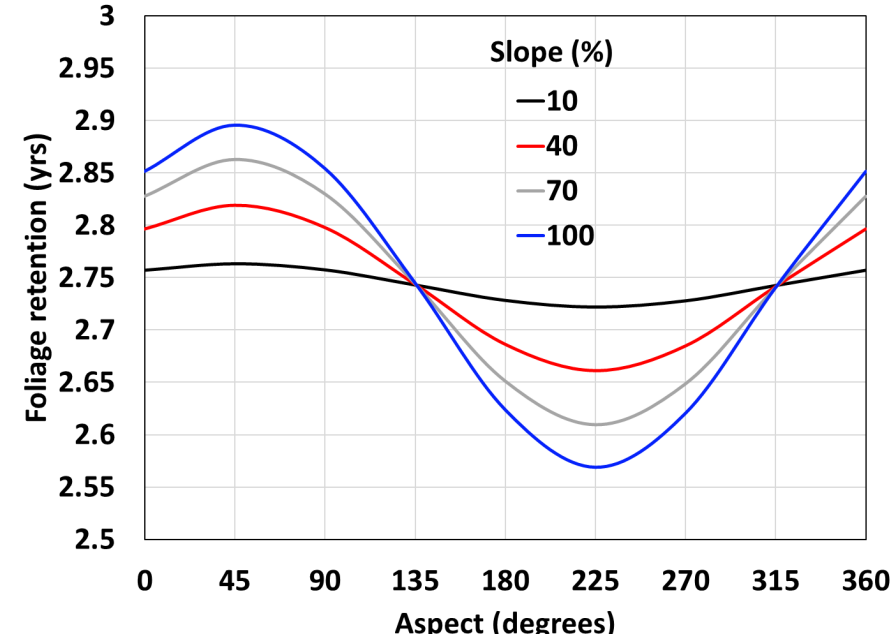
| study | BN | CASCT | CT | Casc | DNR | GIS | Menasha | PCT | RCT | RPN | SOT | WT |

Validation results

- Final MSE=0.222; Final Zhao et al. MSE = 0.25

- 824 observations not used in the model fitting were used to validate the model: predicted residuals below

- Mean residual = 0.023 years

Other topographical significance?

- Full dataset residual plot shows trends of unexplained bias
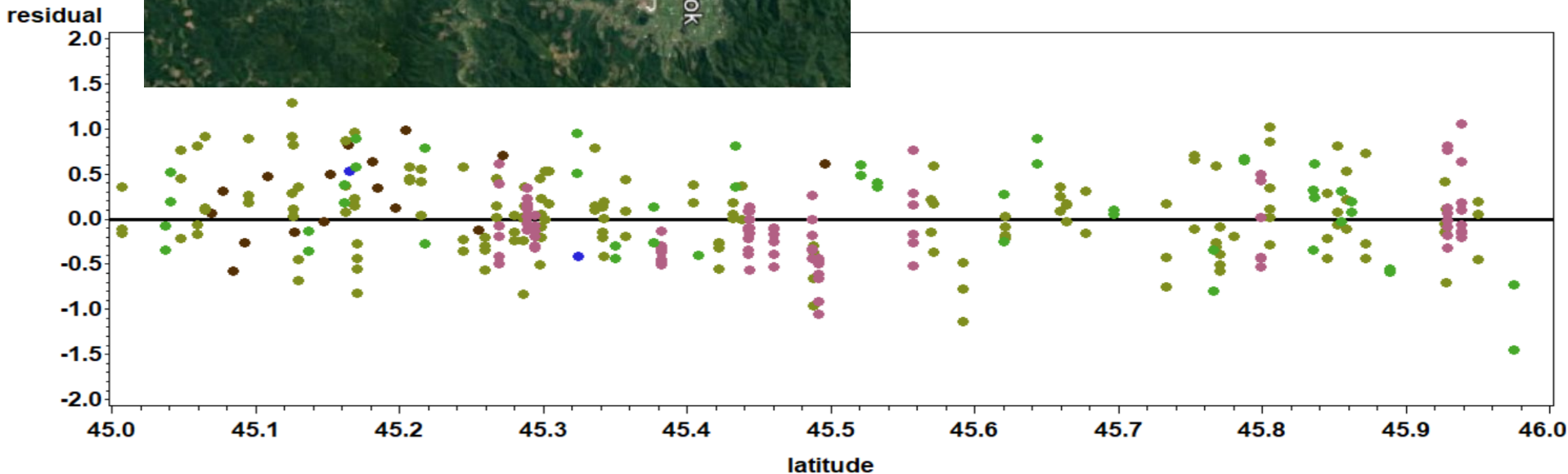- One such area is 45.1-45.5° N latitude
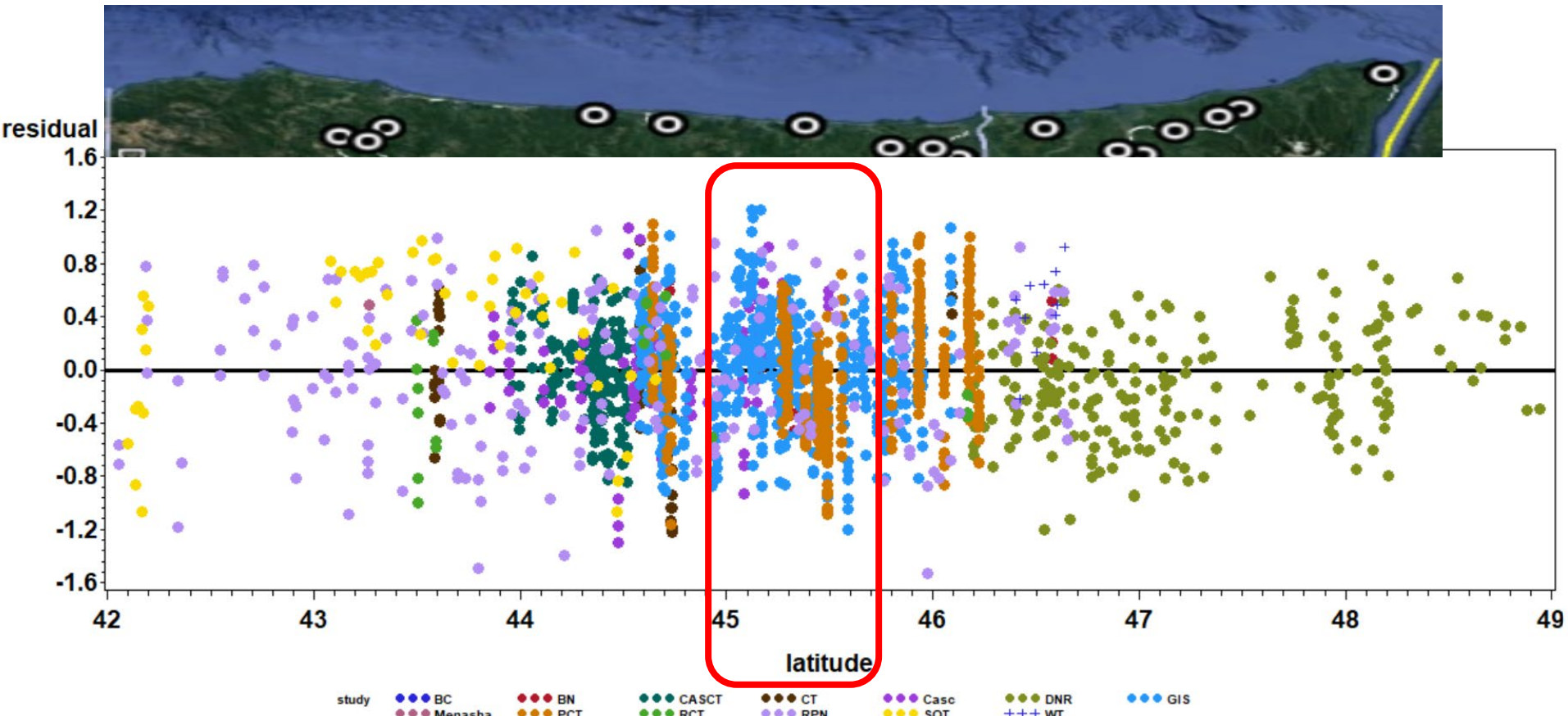
Other topographical significance?

- FR underestimates at 45.1°--perhaps due to barrier of Cascade Head?
- FR increasingly overestimated until 45.5°--perhaps due to interior access of marine environment from Nestucca drainage and Tillamook basin?

- Wind predictions relevant?

Estimated foliage retention

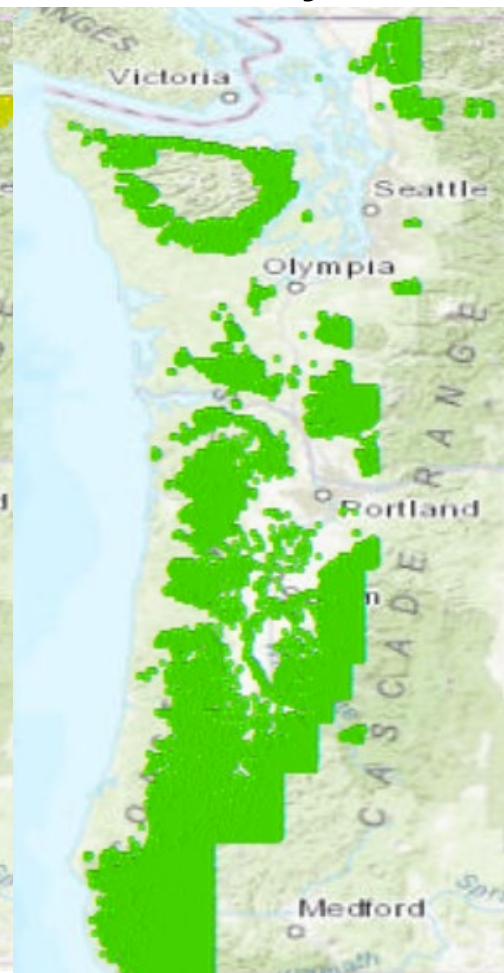- Estimated foliage retentions, based on a systematic grid

| FR < 2.0 yrs	FR = 2.0 - 2.5 yrs	FR = 2.5 - 3.0 yrs	FR > 3.0 yrs

Foliage retention estimated with Sentinel2

- Attempted correlation of SNC_RPN FR with Sentinel-2 satellite spectral wavelength bands

- Spectra collected during May 6, 2019

- FR= a_0 + $a_1 \cdot b5$ + $a_2 \cdot b7$ + $a_3 \cdot b8_A$

- Quality of fit and/or significance of specific bands dependent on timing of symptoms, spectral collection date, and location

Residual

R^2=0.49; RMSE=0.485

Predicted Value of fr
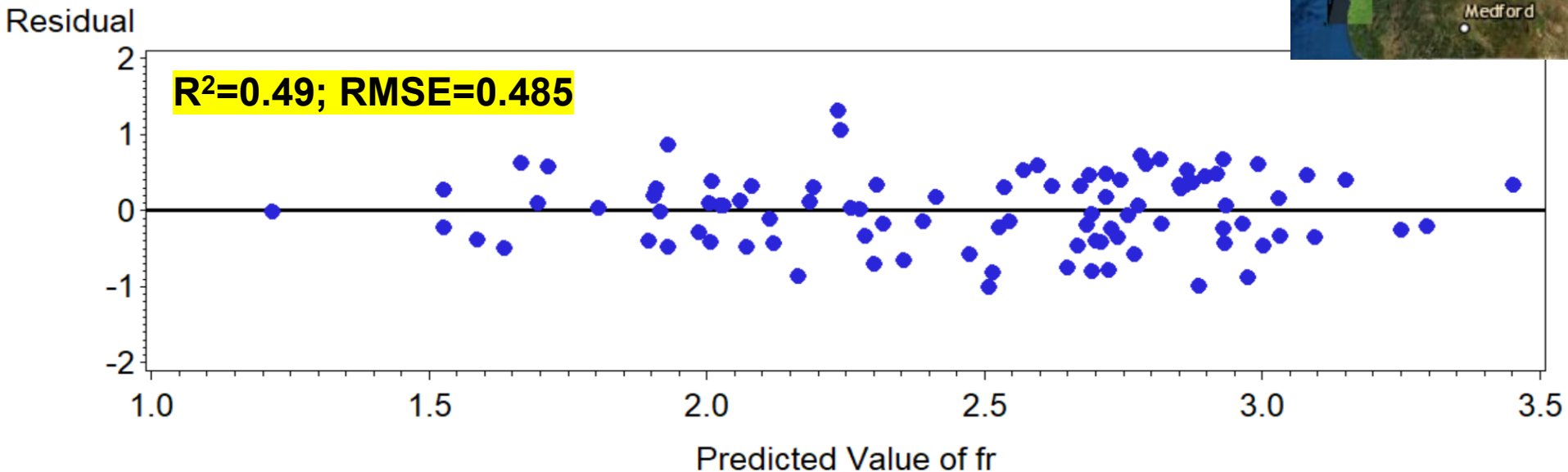
- The strength of the model is not the prediction of the lowest lows.

- Large amount of noise means strength is not stand to stand comparative predictions

- It probably does a good job estimating average FR on a regional, landscape, or ownership scale, providing an opportunity for a broad accounting of Swiss needle cast on yields and/or finances.

Effect of SNC on juvenile growth

- Current SNC modifiers alter diameter and height increment

- Field observations of young SNC-infected plantations suggests that growth performance of small trees is not as impeded by disease

- Stands with the worst infections almost always retain at least 1 year of foliage.

- Wide latewood rings of even heavily infected stands attest to the contributory effect of 1 year old foliage.

- Hypothesis, untested: growth loss of young SNC-infected Douglas-fir is related to their proportion of 1-yr old foliage
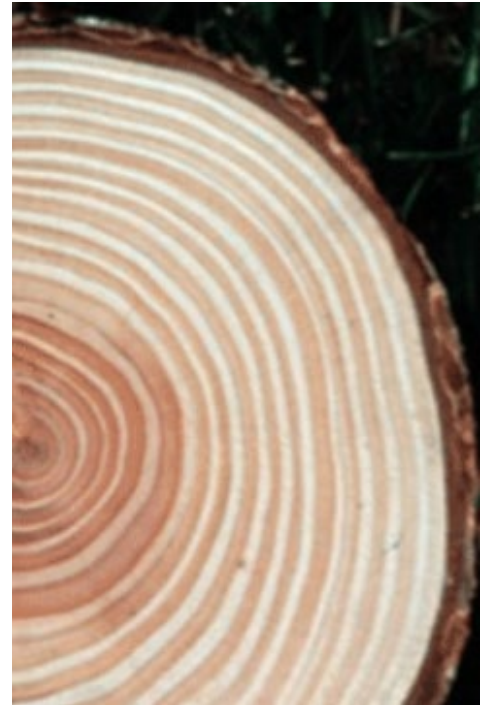
How do we predict 1 yr old foliage proportion?

- Data from NARA and a small side project provided data for predicting 1-yr old foliage proportion

- Live crown length was found to be the tree measure most correlated with 1-yr old foliage proportion

- Current SNC modifiers are appropriate for older trees from sampled population (10+ years) with a relatively steady foliage age distribution
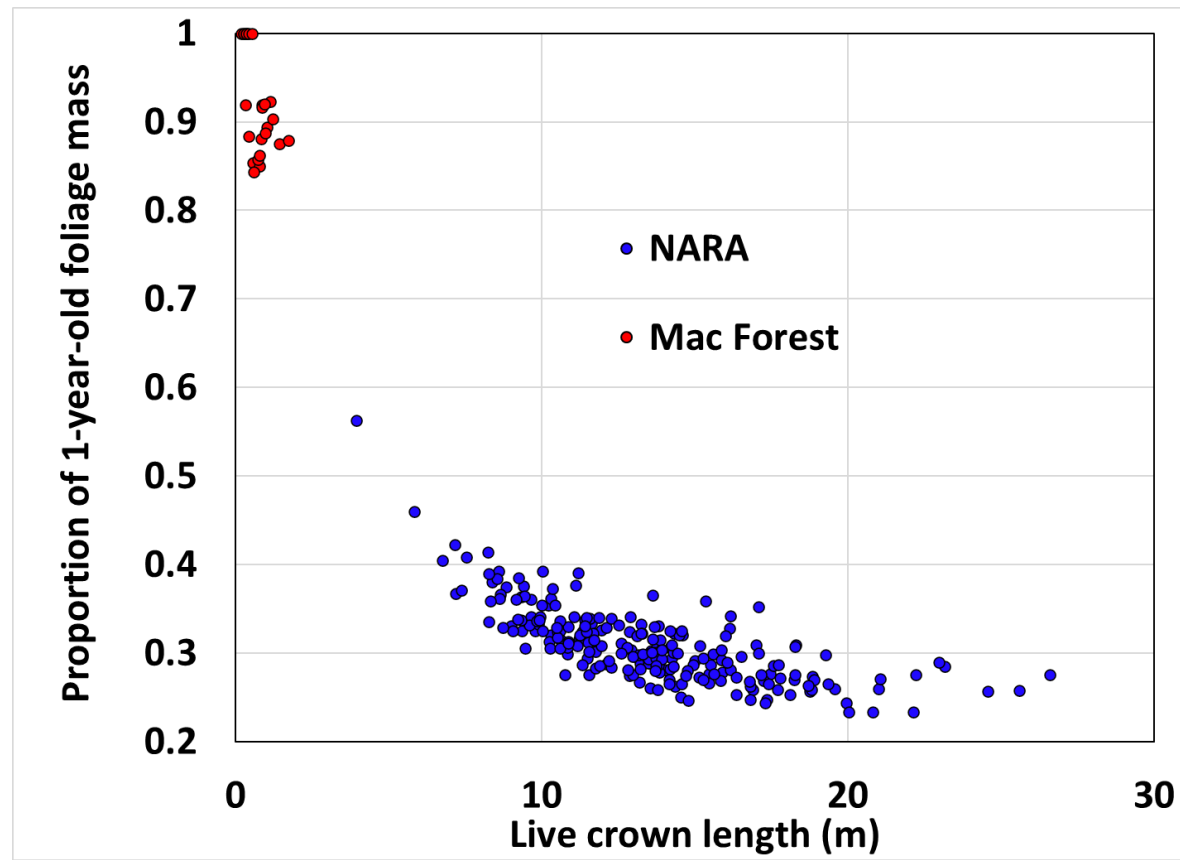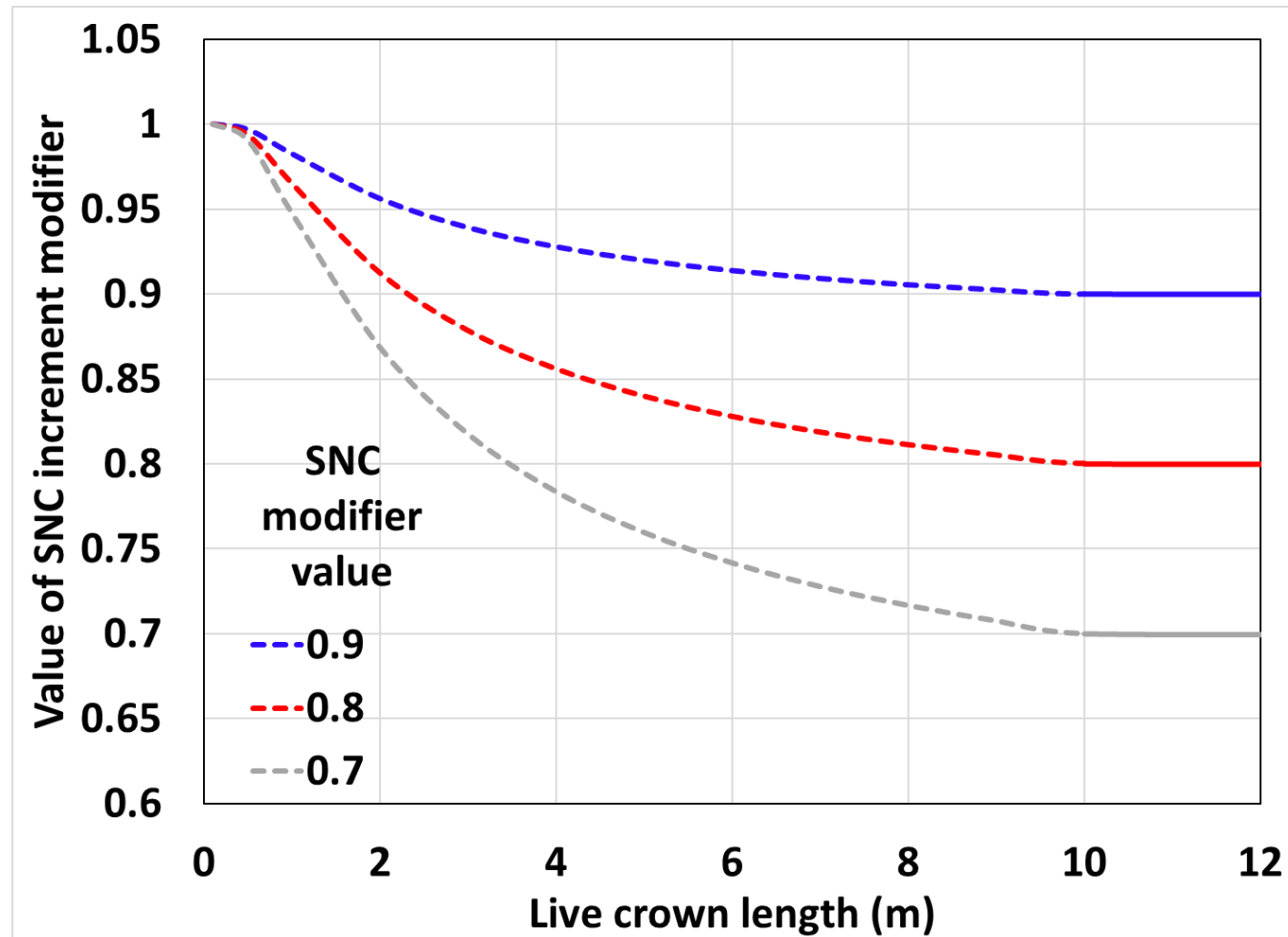
Adjusting SNC modifiers for juvenile trees

- Seedlings with ~ 100% first year foliage are assumed to be unaffected by SNC

- A live crown length of 10 m and larger was arbitrarily chosen to represent trees appropriately adjusted by current SNC modifiers

- Trees sized between newly planted seedlings and those with a 10m CL are adjusted with a factor proportional to 1-yr foliage
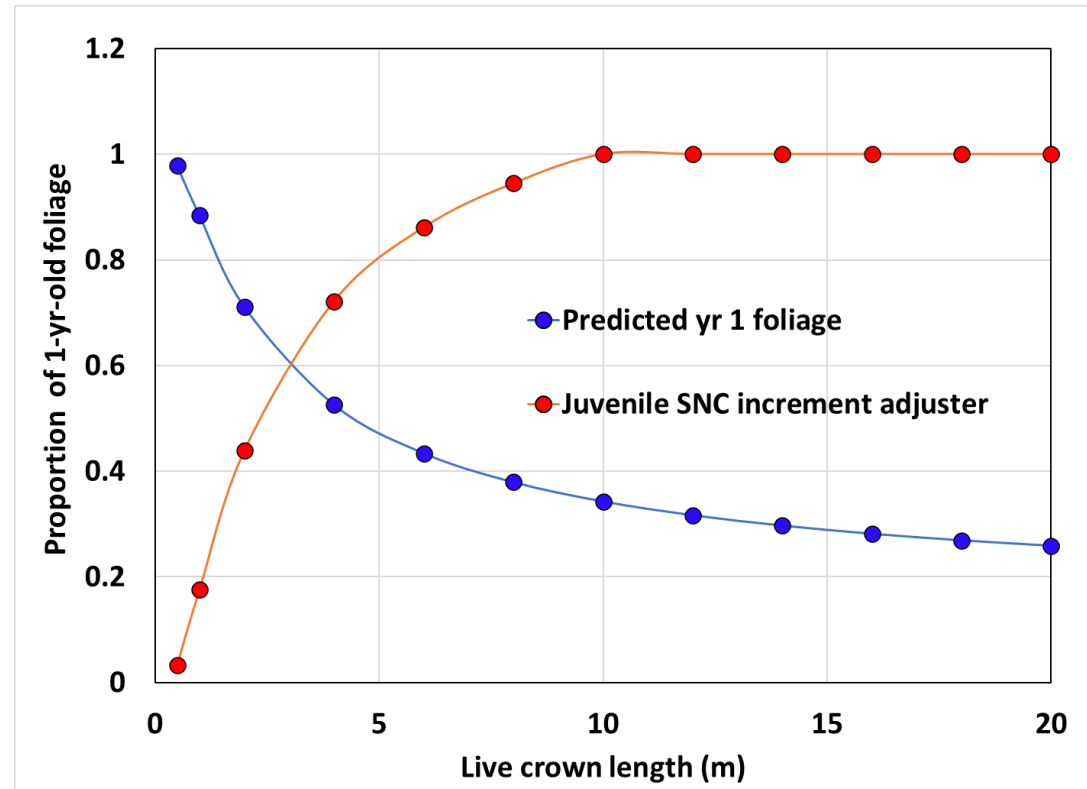
Conclusions

- The SNC modifier is adjusted for juvenile trees with CL<10 m

- This relationship is entirely conjectural, and is not backed up by the complications of measured data

Questions?