CIPS and CIPSANON: What's new and what's coming…

GMUG
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CIPSANON 4.4 Objectives

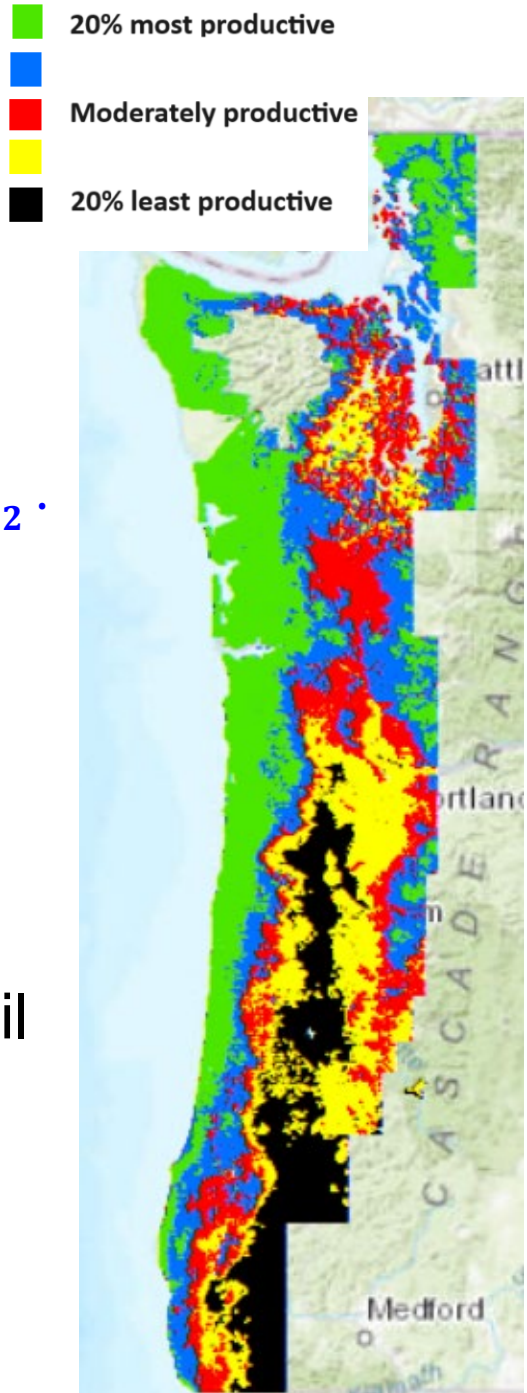
- **Incorporate site-specific variables**
  - Climate NA (monthly, seasonal, annual climate variables)
  - NRCS soils variables (texture, rock content, WHC, depth, chemistry (pH, CEC) at 3 depths (0.5 m, 1.0 m, total)
  - Topographic (slope, aspect, elevation, TPI, TWI)
- **Emphasize operational plantations**
  - Addressed through dataset changes, regression weights

CIPSANON 4.4: Equations with site specificity

- Static veg cover
- Dynamic veg cover
- Diameter increment
- Height increment
- Mortality
- Static height to crown base
- Crown recession

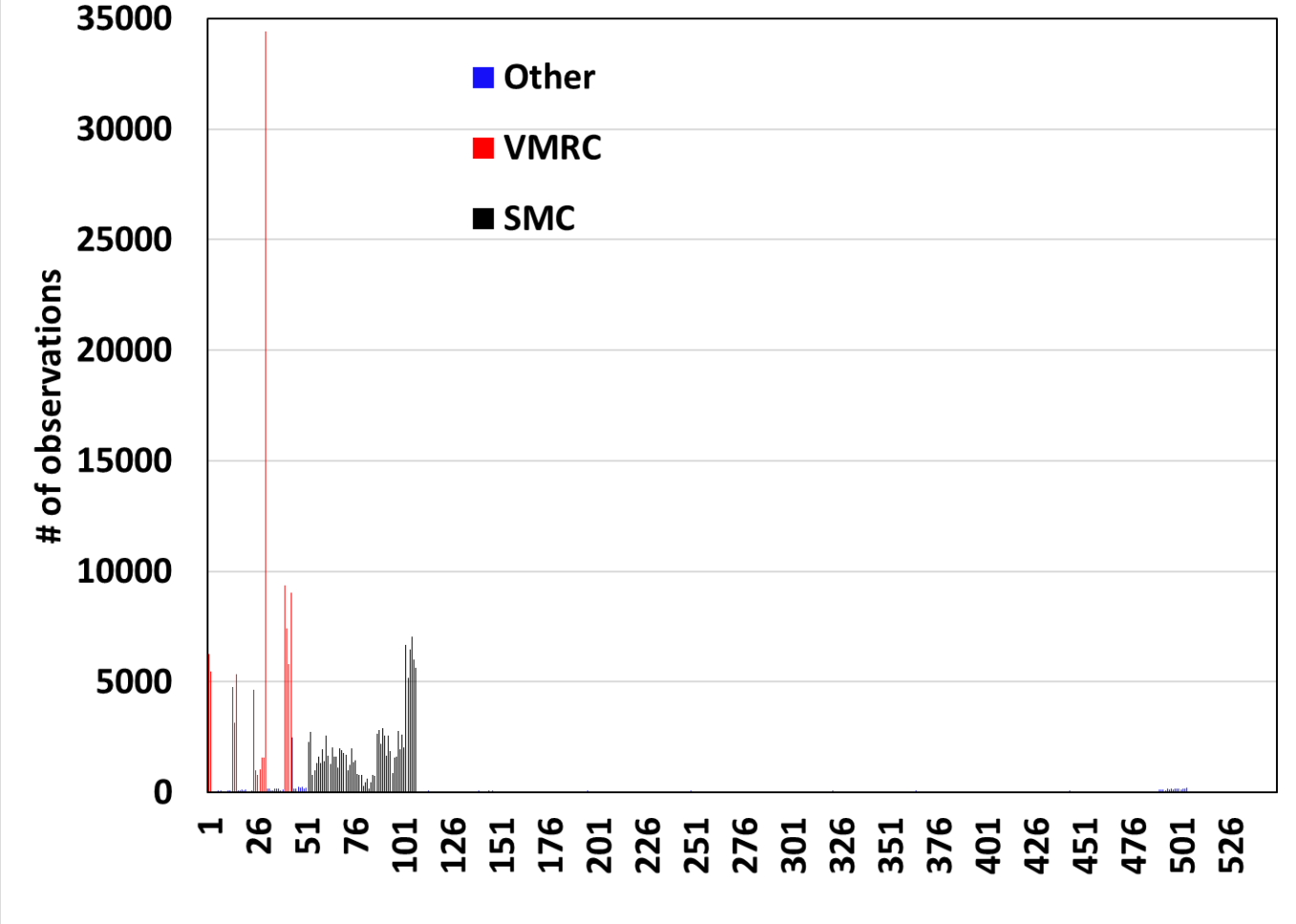
Diameter increment

- $DG = ((a_1) \cdot ((DBH + 0.1)^{a2})) \cdot exp(a_3 \cdot \left(\frac{DBH}{100}\right)^3) \cdot exp((a_4 \cdot log(CR)) \cdot exp((a_5 \cdot log(SI_{50})) \cdot exp((a_6) \cdot BA^{0.5}) \cdot exp(a_7 \cdot BAL)/(log(DBH + 2)))) \cdot (\boldsymbol{exp}((-\boldsymbol{exp}(-\mathbf{1.01946} + -\mathbf{0.98131} \cdot \boldsymbol{HT}) \cdot \boldsymbol{VEGCOV}^{\mathbf{0.5}}))) \cdot \boldsymbol{exp}(\boldsymbol{a_9} \cdot \boldsymbol{WHC_{50}} + \boldsymbol{exp}(\boldsymbol{a_9} \cdot \boldsymbol{TAVE\_SM}^{-1}) + \boldsymbol{a_{10}} \cdot \boldsymbol{TMIN_{SP}} + \boldsymbol{a_{11}} \cdot \boldsymbol{PPT_{SM}} + \boldsymbol{a_{12}} \cdot \boldsymbol{PPT_{SM}^2})$
- **Addition of site-specific variables decreases MSE from 0.2913 to 0.2798**
- **Map shows quintiles of relative diameter production, *independent of SI***
  - Water holding capacity in top 50 cm of soil
  - Average summer temperature
  - Minimum spring temperature
  - Summer precipitation



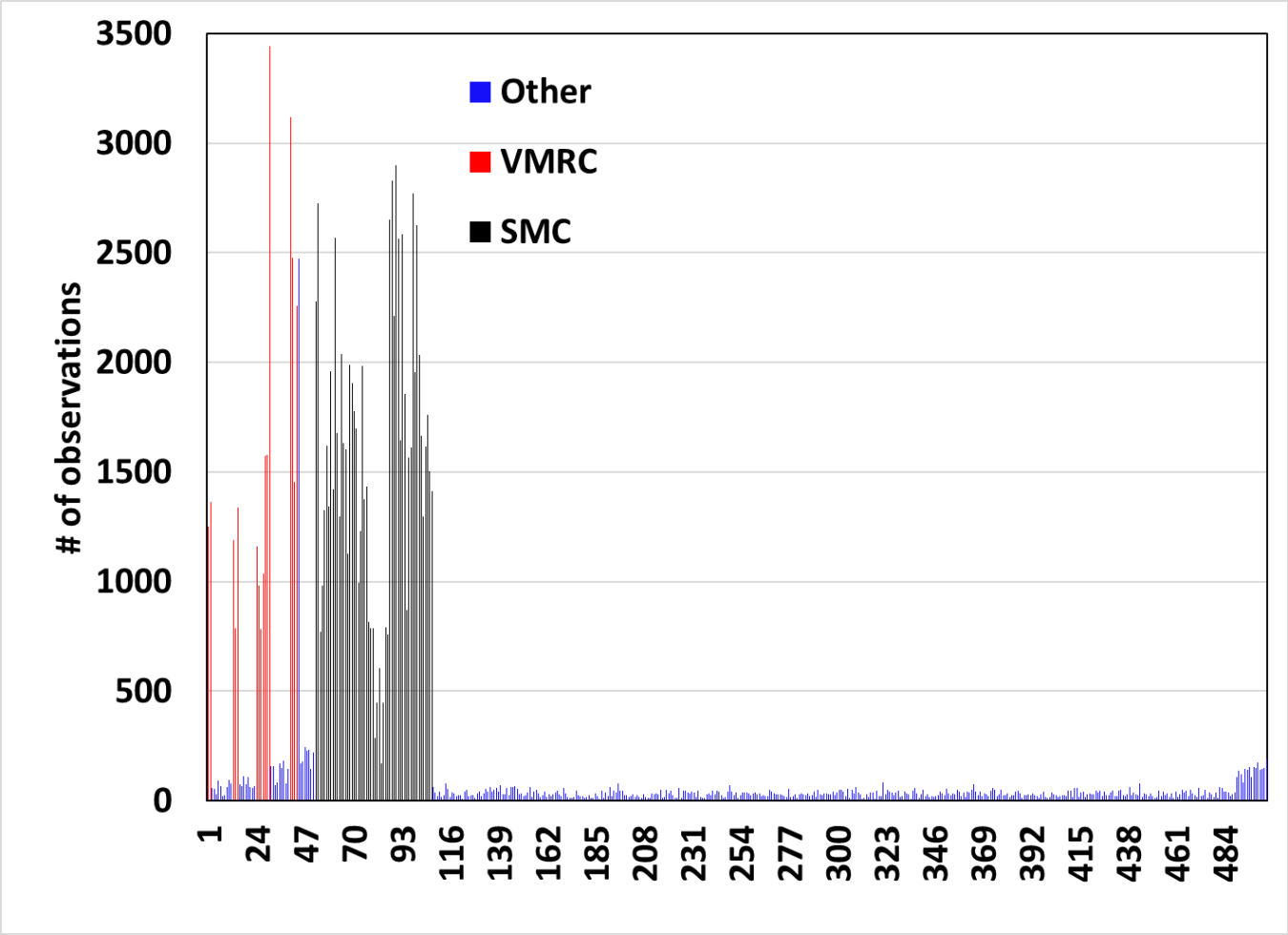
Fitting the new equations

- **Observations/site heavily weighted toward original young plantation data**
  - We want more emphasis on operational data
  - We want shared emphasis among sites



Fitting the new equations

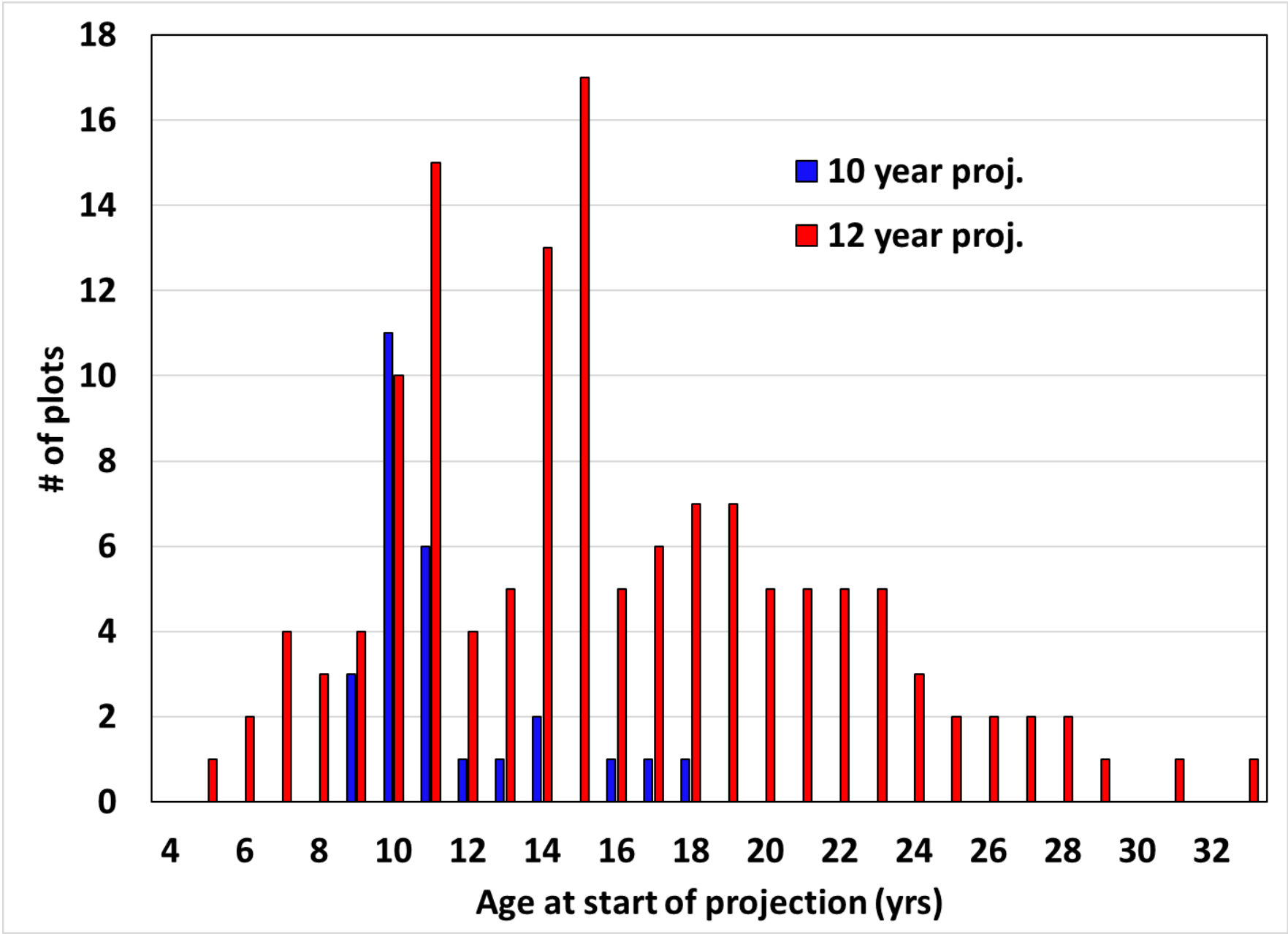
- **Reweighting the dataset for similar observations/period**
  - Original VMRC/MM weighted by 1/#blocks
  - FR weighted by 0.1
  - SMC type 4 weighted by 0.25



Pseudo-validation

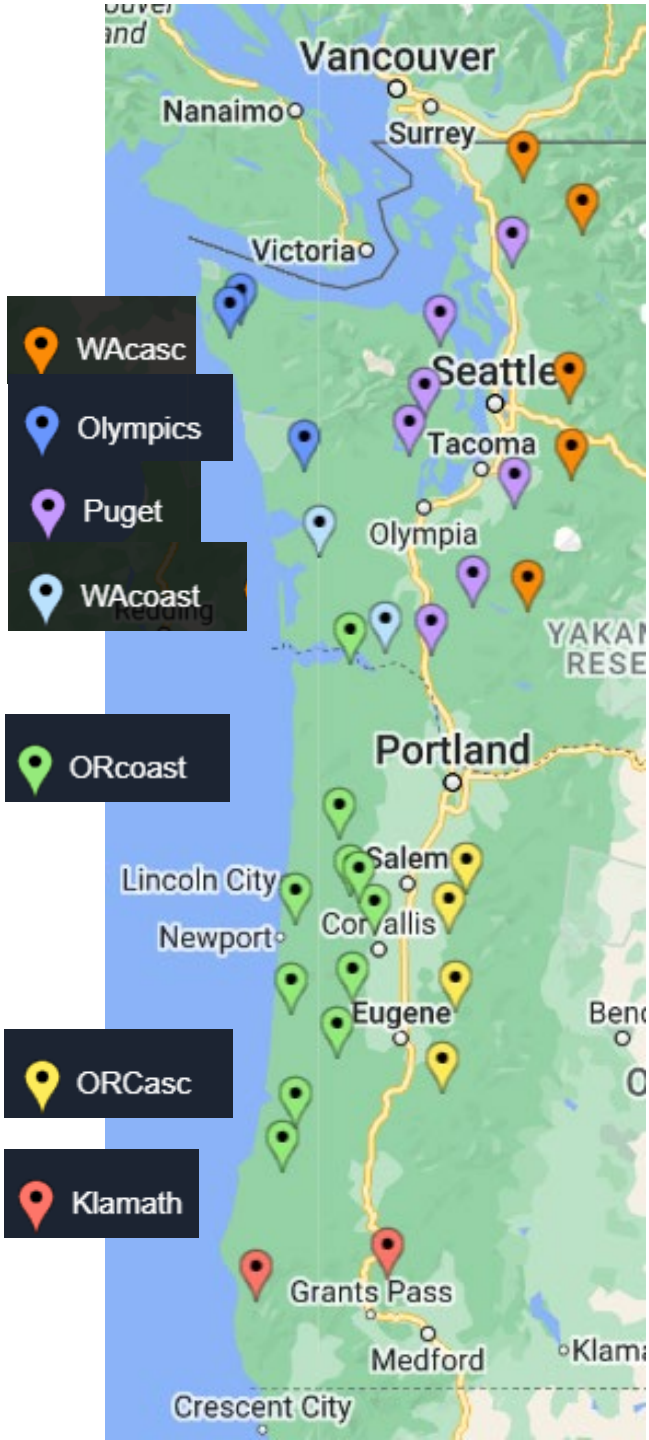
- **Used subset of SMC type 1 and type 3 installations**
  - Data from each SMC installation used for model fitting
  - Used multiple 10-12 year periods from each site
  - Treelists were projected with multiple combinations of equations
    - Multiple DBH equations: using different combinations of SS variables
    - 2 height equations: Height increment with 2-yrs of indicators; height increment with 3-yrs of indicators
    - 2 HCB equations: Static HCB; Hybrid dHCB
    - 2 mort equations: Mortality equation without site-specific variables in post-CC equation; mortality equation with site-specific variables in post-CC equation

Dataset for Pseudo-validation



Results from Pseudo-validation

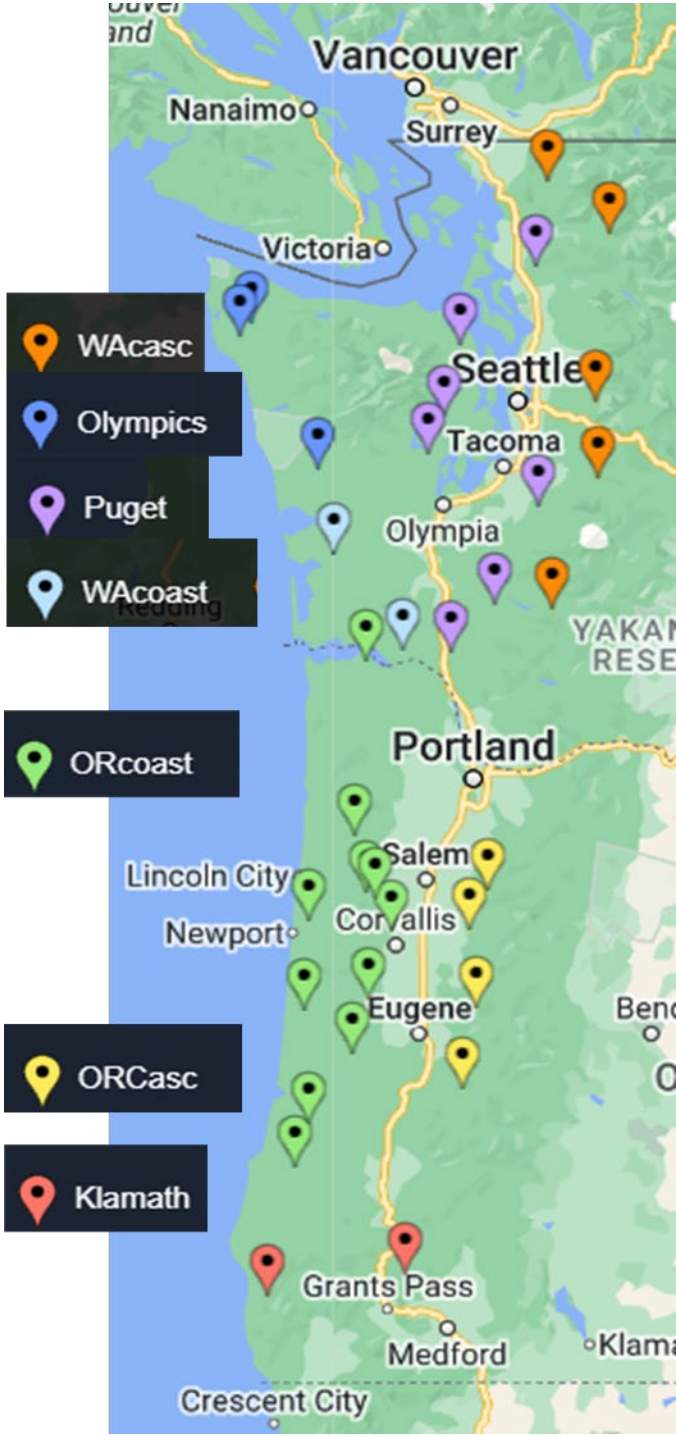
- **Used portion of diameter increment dataset**
  - Subset of SMC type 1 and type 3
  - non-Canadian measurements (due to lack of soils data)
- **Categorized results by SMC zones**
- **Presented results in binary:**
  - 1 if site-specific (CIPSANON 4.4) fit is better than non site-specific (CIPSANON 4.3); otherwise 0



Pseudo-validation

- Selection based on best fit for regions with environmental conditions furthest from the average

	Possible	Without WHC_{50}	General WHC_{50}
Klamath	30	26	27
OR_Cascades	80	41	43
OR_Coast	225	113	110
Olympics	55	32	35
Puget_Sound	120	73	75
WA_Cascades	145	82	72
WA_Coast	45	21	21
Total	**700**	**388**	**383**
Klamath		0.867	0.9
OR_Cascades		0.513	0.538
OR_Coast		0.502	0.489
Olympics		0.582	0.636
Puget_Sound		0.608	0.625
WA_Cascades		0.566	0.497
WA_Coast		0.467	0.467
Total		**0.554**	**0.547**

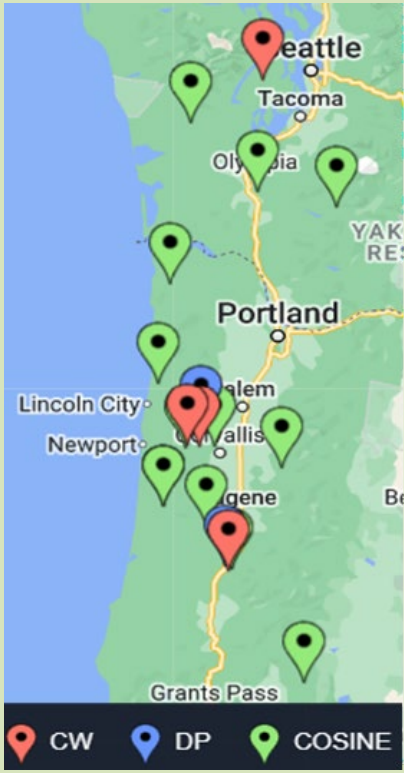


Replace site index with environmental variables?

- Hybrid CIPSANON with SI in DBH inc. equation: MSE = 0.5294
- Hybrid CIPSANON without SI in DBH inc. equation: MSE = 0.5619
- Projected SMC treelists with each set of equations
- Gray: Hybrid CIPSANON with SI in Dbh inc. equation
- Red: Hybrid CIPSANON without SI in DBH inc. equation
- Low SI: overpredicted
- High SI: underpredicted

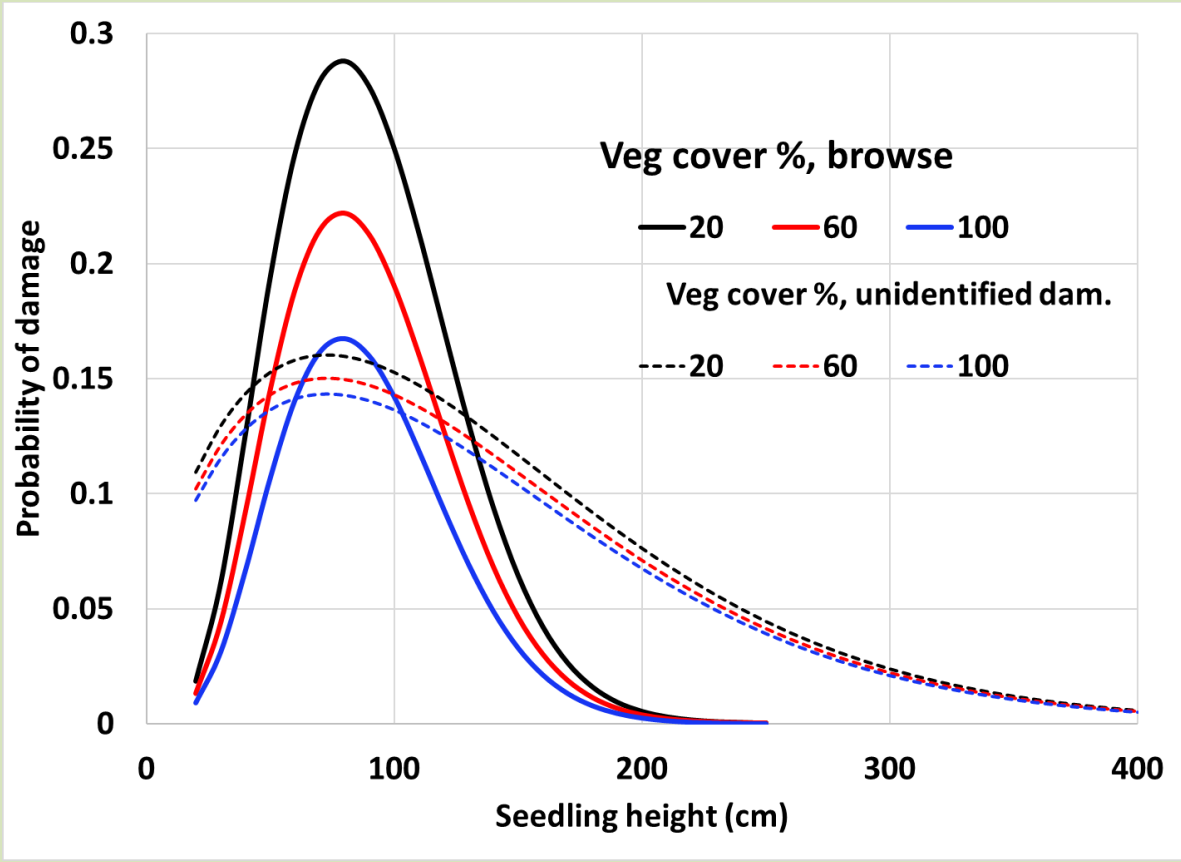
Browse within young plantations

- Juvenile height increment in CIPSANON is currently based on a function of relative height (CCH), which has almost no influence at this age.
- Model simulations do not generate typical annual changes in size rank during plantation development.
- Uranga's dissertation addressed this shortcoming by developing a methodology for adding variation to height increment in the first 5 years of plantation growth.
- Browse and other damage impart natural variation, and may be worth simulating
- COSINE and other data from unfenced plantations provide a dataset for estimating browse probability



Probability of browse or other damage

- Probability related to seedling height and % cover of competing vegetation
- Greater browse with reduced veg cover
- Browsed trees had 42.6% of htgr of unbrowsed
- Other damaged trees had 51.0% of htgr of undamaged

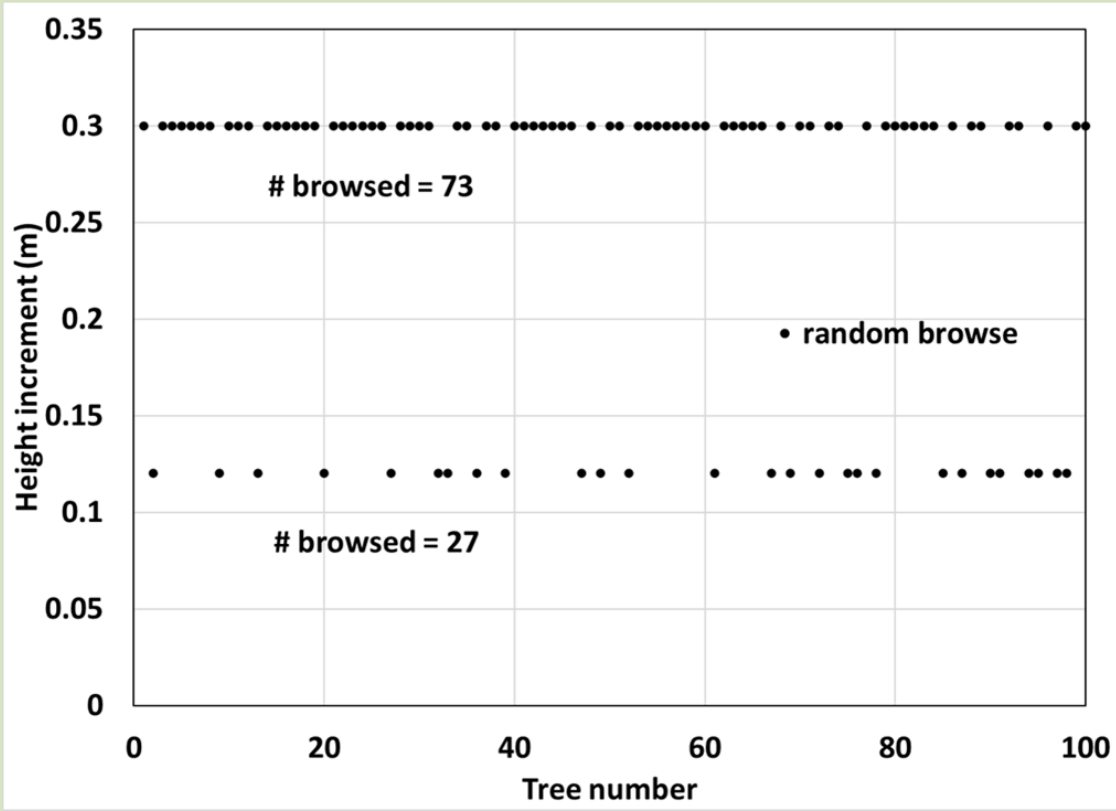


How to simulate browse within young plantations

- Simulate browse using random assignment
  - Probability of browse would be compared to a random number. If random number is smaller than probability of browse, tree is "browsed". The effect would be:

    Ht. inc. of a browsed tree · ($Htg_{browsed,\ av.}/Htg_{unbrowsed,\ av.}$)

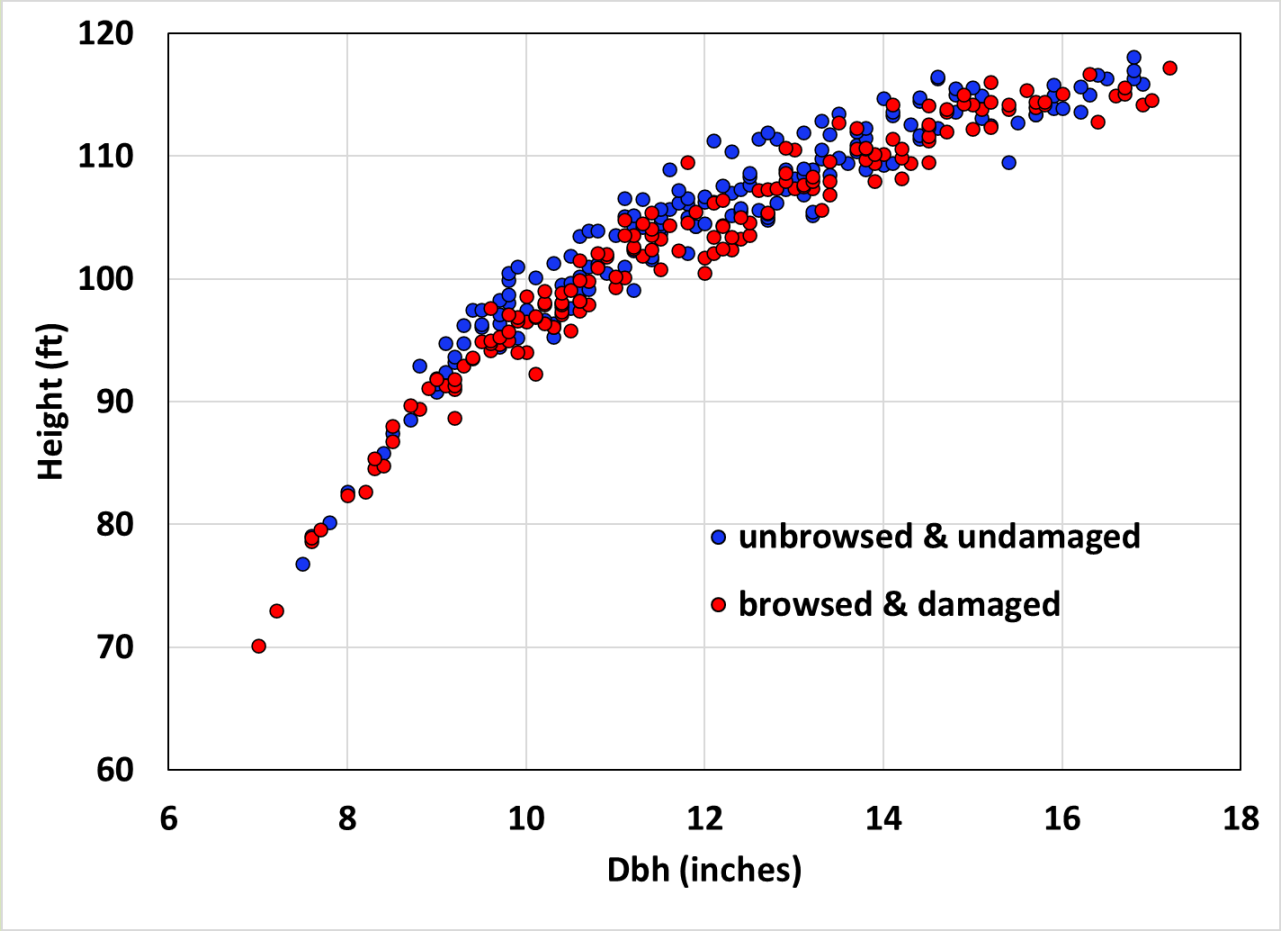
- Assume a plantation in its second year
  - 100 tree sample
  - Unbrowsed height increment of 0.3 m
  - Probability of browse = 30%
  - Increment of browsed =42.6% of unbrowsed



Long term effect of browse within CIPSANON

- Simulated same treelist:
  1) With browse and damage
  2) Without browse or damage

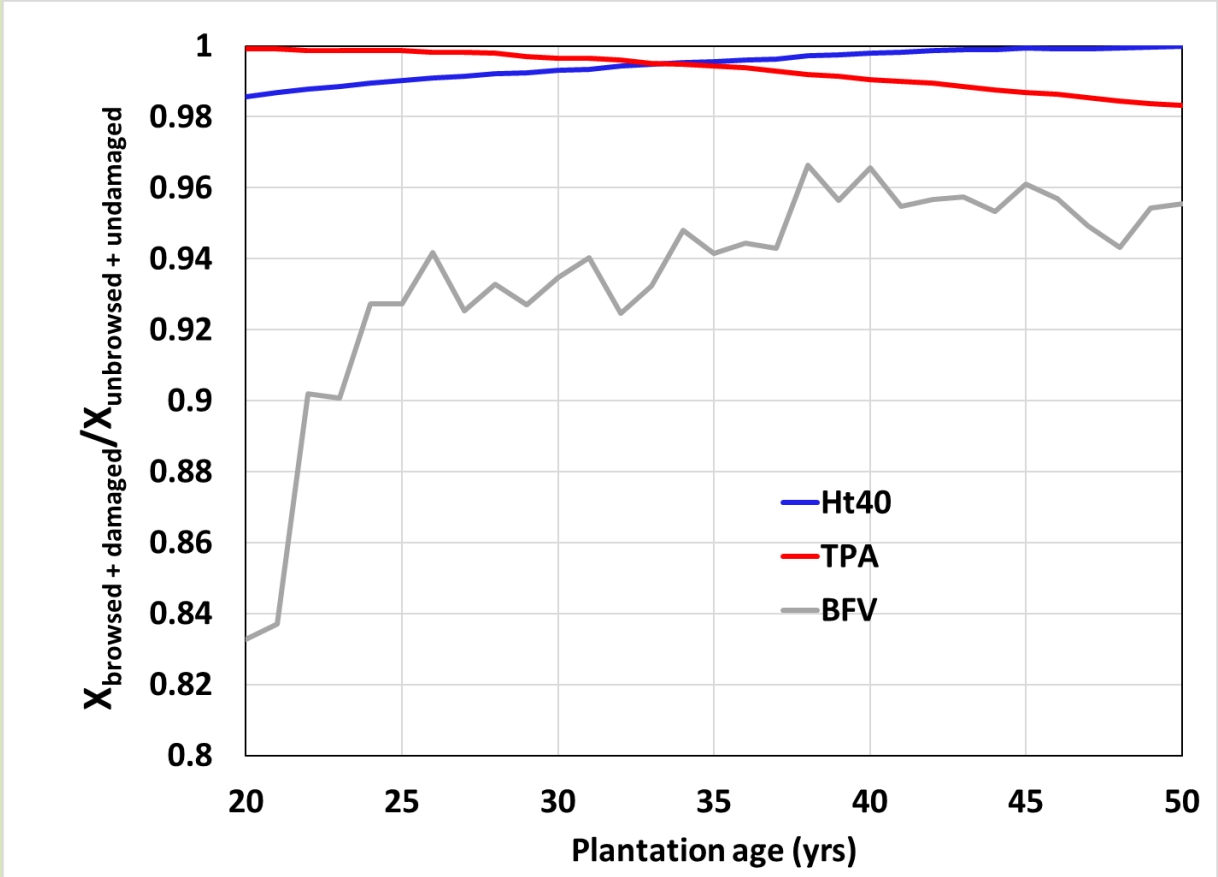
- Graph shows output: Height vs. DBH at age 40



Long term effect of browse within CIPSANON

- Simulated same treelist:
  1) With browse and damage
  2) Without browse or damage
- Graph shows ratio of 1) to 2)

- TPA decreases over time with browse due to greater differentiation
- Ht40 recovers over time due to use of GEA in height increment routine
- Volume remains depressed due to greater differentiation



Alternative accounting for select genetics

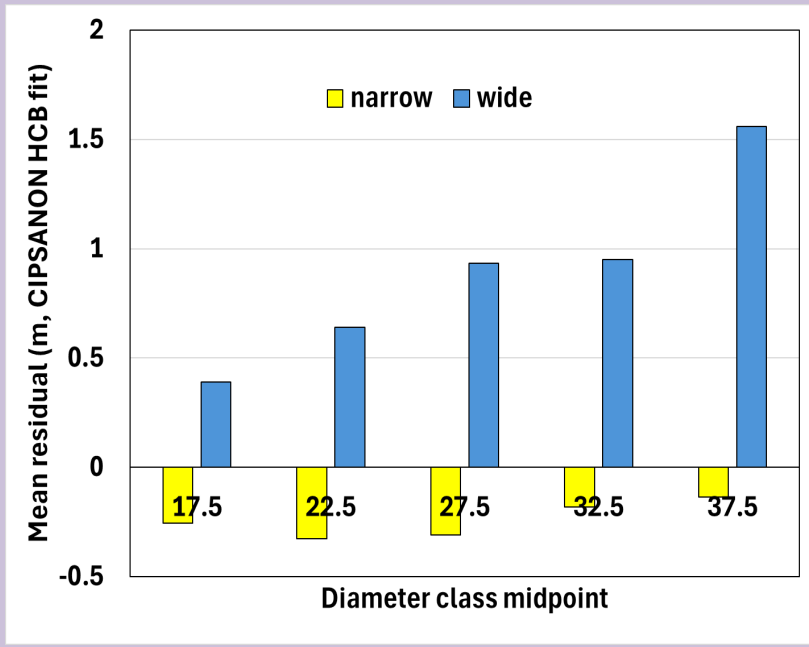
- Current genetics multipliers assign an elevated height or diameter growth rate to standard equations based on results from progeny tests or realized gain trials

- Improved performance of genetically select trees has been associated with specific crown morphological traits.
  - High leaf area density
  - Short branches, narrow crowns

- Tying improved growth of select trees to specific crown traits would provide an improved means of predicting the benefits of deploying specific select families

Crown width and recession

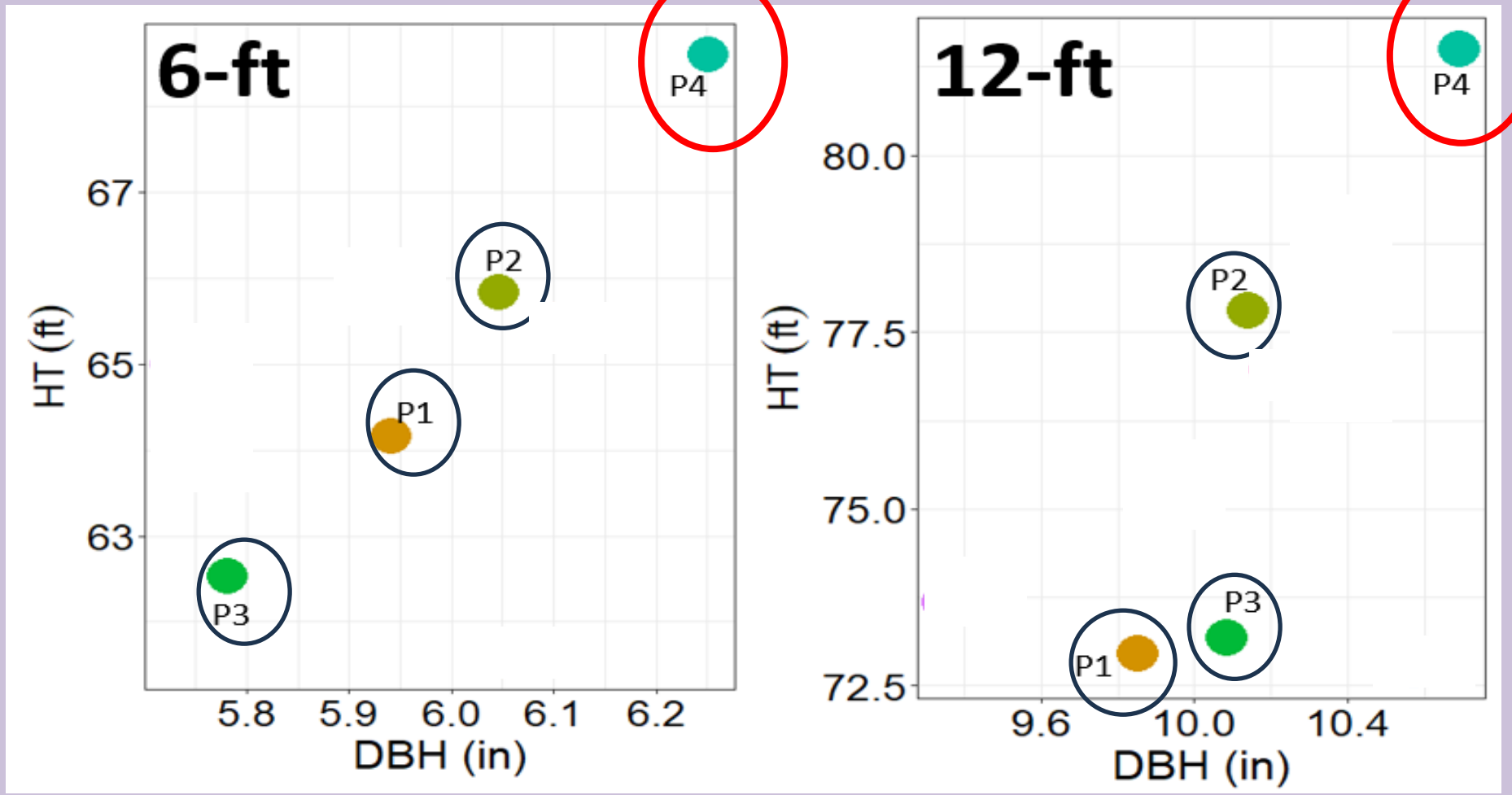
- SMC crown width measurements on open grown trees makes possible estimation of site-dependent MCW
- Significant random site effect **s** within a MCW mixed model ***(a+(b+s)*dbh+(c)*dbh^2)*** can be used to identify sites with narrow and wide crowns
- Max crown width of Douglas-fir is correlated with environmental variables
- Sites with contrasting crown widths show diverging quality of crown base estimates as crowns recede
- Wide crown sites implied to have greater recession than is currently predicted
- Better fit for narrow crowns consistent with current southern-Oregon MCW equation within CIPSANON



Mixing traits are good when we're talking about dogs, but what about trees?

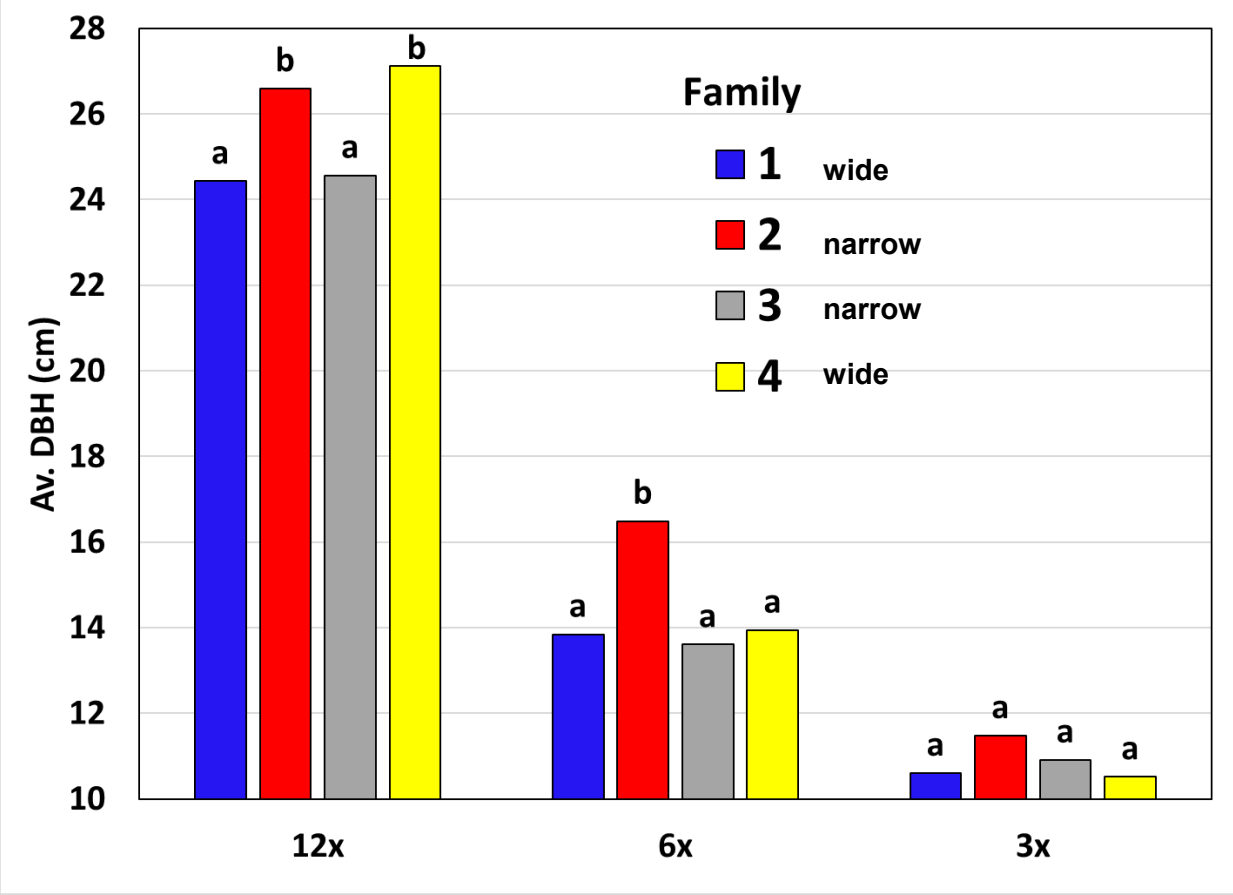
Performance in pure family plantings

- Comparison of families 1, 2, 3, and 4 at the family deployment study
- Grown as pure families, at 25 years of age, family 4 (wide crown) consistently has the largest average diameter and height



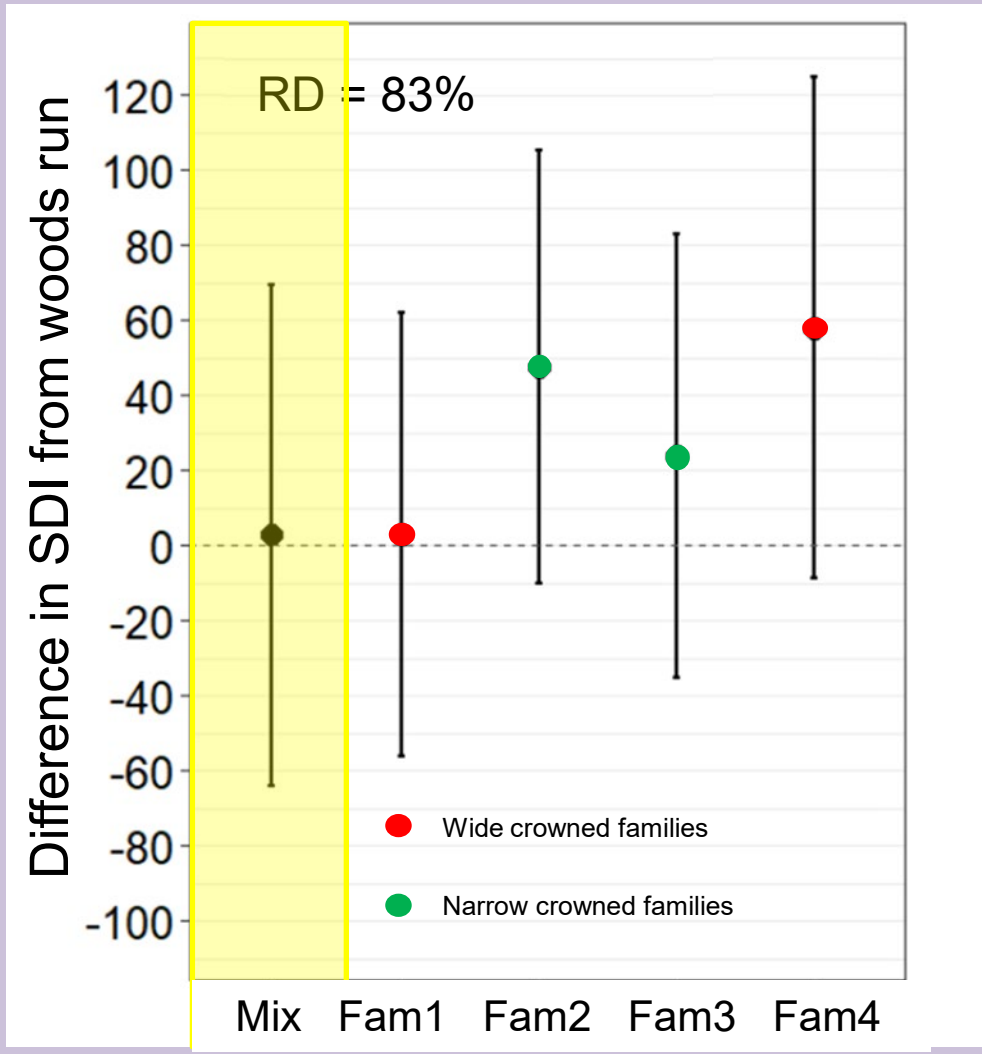
Performance in mixed family plantings

- Comparison of families 1, 2, 3, and 4 at the family deployment study
- Graph compares average DBH of families 1-4 when grown in a mixture.
- At wide spacing (12x), family four maintains a relative size advantage
- At narrow spacing (6x), family 2 (narrow crown) outperforms all others



Pure vs. mixed: carrying capacity

- Graph compares pure family blocks (fams 1, 2 , 3 ,4) to mix of the same four families (6x6 spacing)
- Advantages in carrying capacity gained in pure family blocks may be lost when the same families are mixed
- Increased carrying capacity of a stand may depend on planting blocks of trees with similar crown traits



Alternative accounting for select genetics

- **We're currently conducting a CAFS-financed project looking into ideotypes**

- **Objectives**

  - From laser scan point data, develop an algorithm for identification of heritable crown morphological traits associated with enhanced growth rates (leaf area density, crown width)

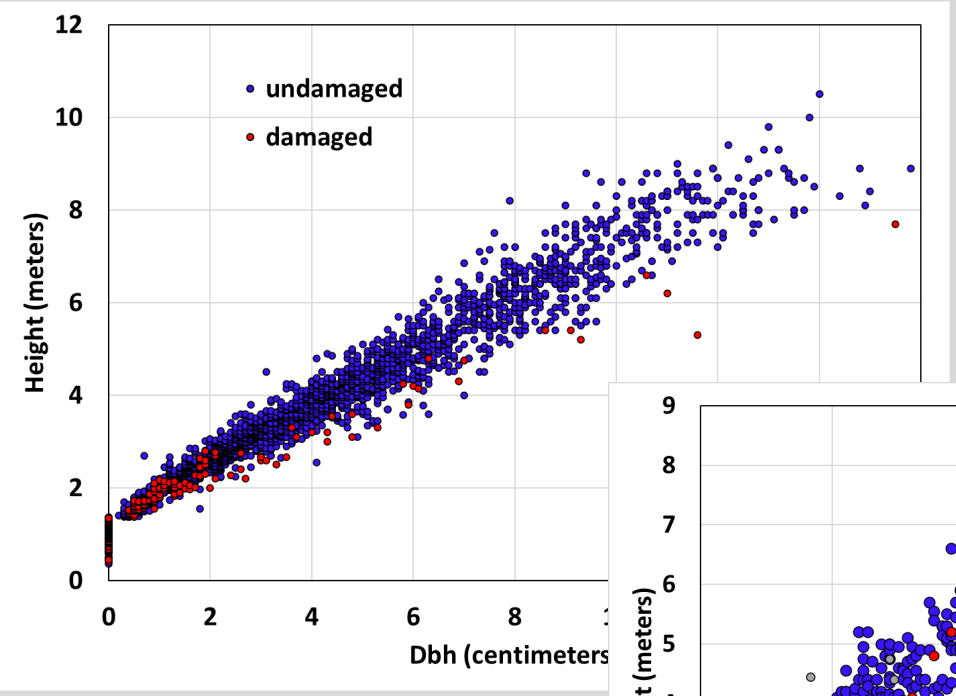
  - Using increment and allometric data from measurement of families representing contrasts in crown width and density, attempt to account for genetically-relevant crown morphological traits in pertinent growth model equations

Updated tree generator

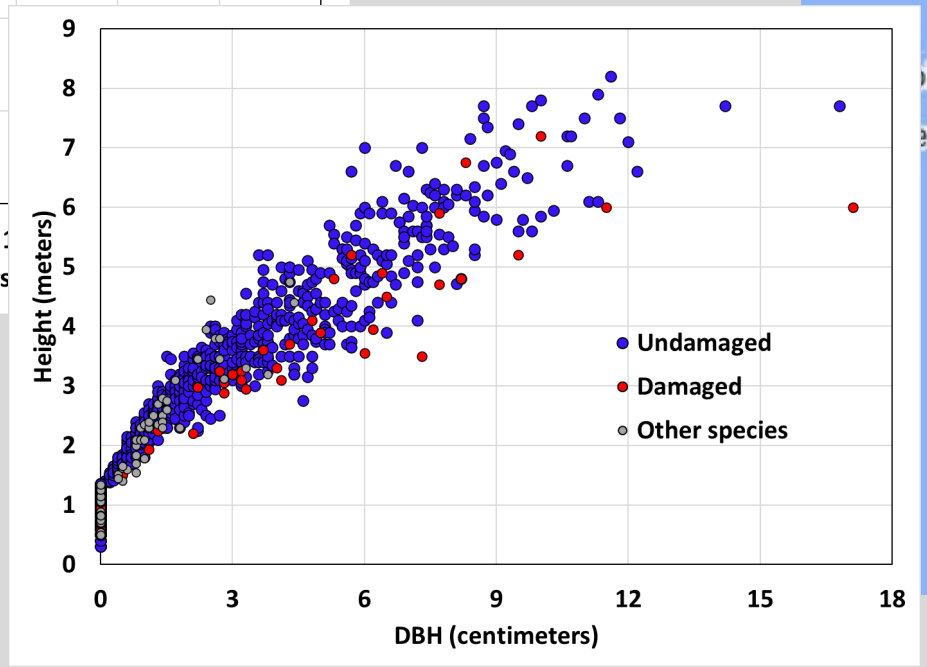
- **Objectives**
  - Produce an updated treelist generator based on height-diameter distributions found within operational plantations (DF, WH)
- **Methods**
  - Install (*semi-permanent*) plots within 3-10 year-old operational plantations on membership property
  - Tag trees; measure height and DBH of all trees on the plot
  - Fit equations predicting ht and dbh distributions (Weibull), HT:DBH relationship, and height variability
  - Covariates for equations include:
    - Plantation age
    - Site productivity
    - Vegetation management history
    - Environmental variables (climate, soils, topographic)

Updated tree generator

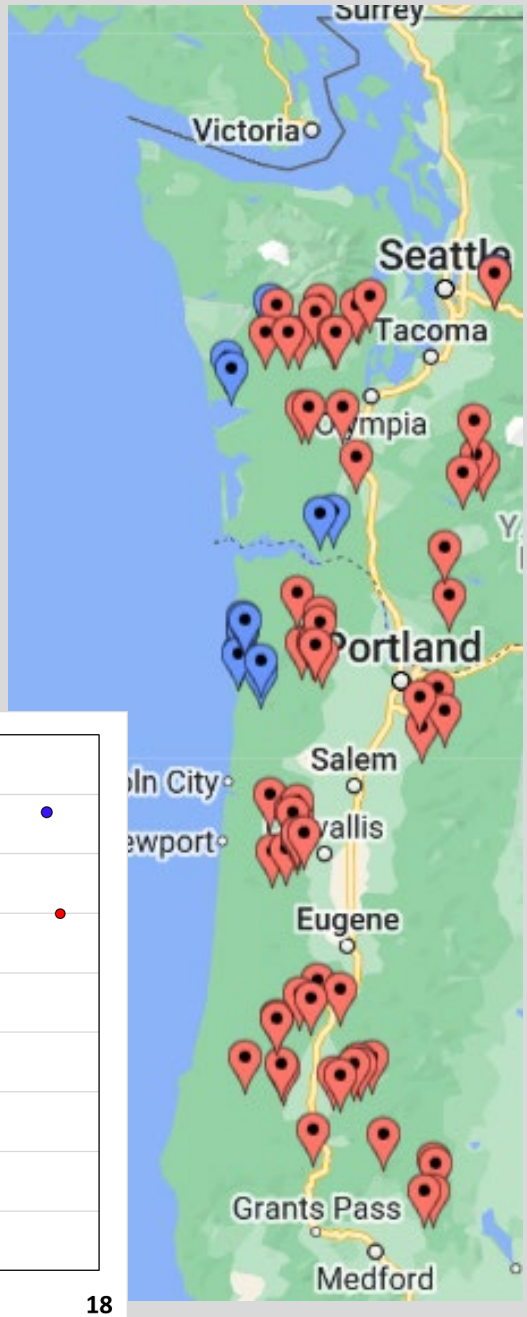
- **Locations**
  - Douglas-fir: 69 sites installed
  - Western hemlock: 16 sites installed



DF

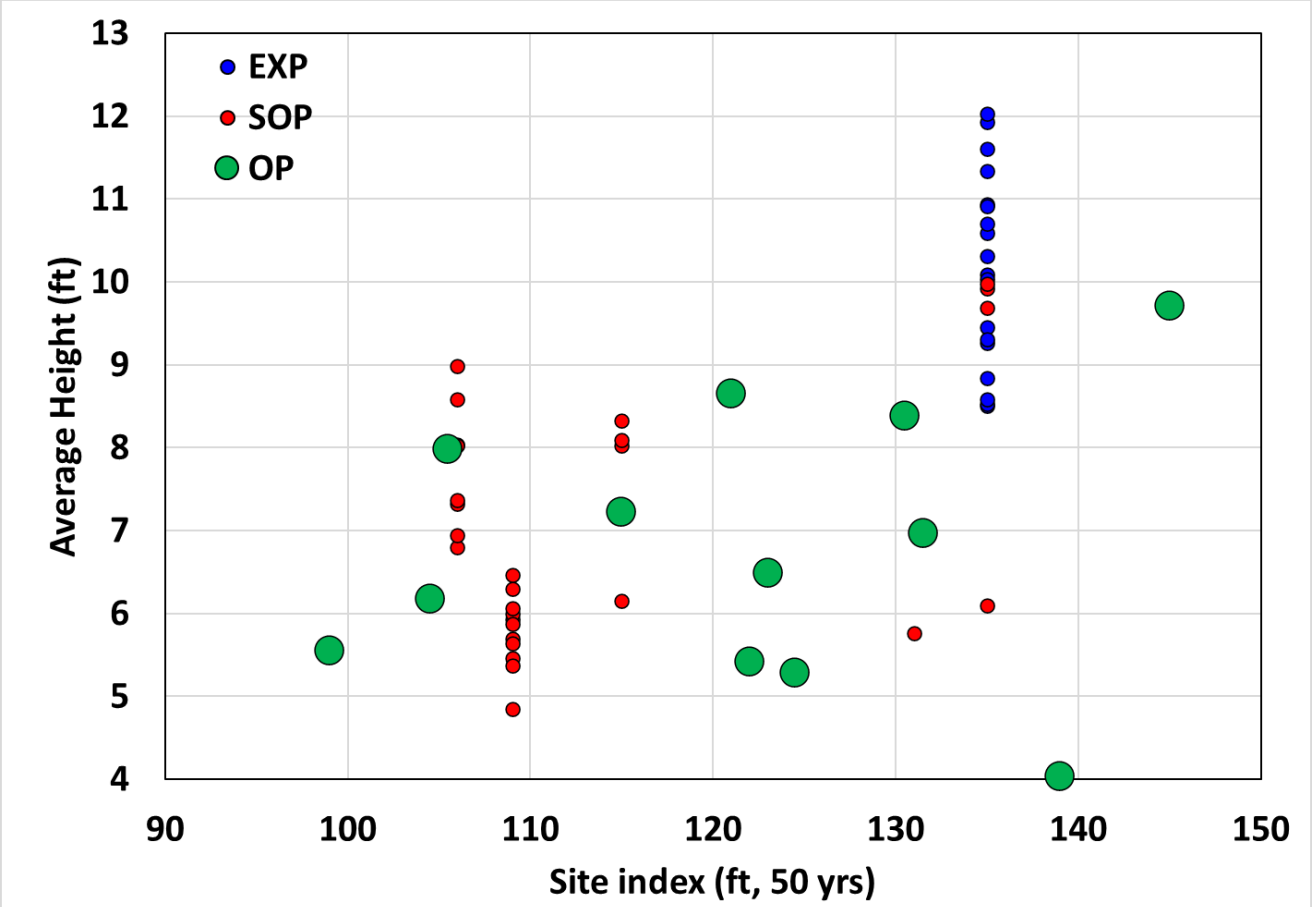


WH



Updated tree generator

- Treelist comparisons: Height, year 5
- Site prep and 1 release
- Speaks to poor SI values (?) and/or poor correlation between juvenile plantation development and site productivity



Updated tree generator

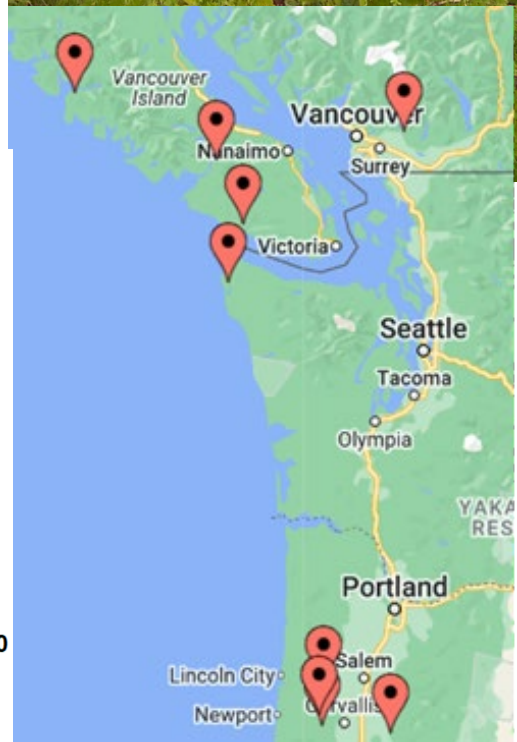
- **Benefits**
  - Geographically-distributed operational dataset for creation of an updated tree generator
  - Potential future validation dataset for juvenile component of CIPSANON *with remeasurement*
  - Optional data for future addition to CIPSANON *with remeasurement*
    - Addresses operational interest
    - Addresses site-specific interest
  - Dataset for updated production of stochastic variation of height increment *with remeasurement*
  - Provides additional browse data

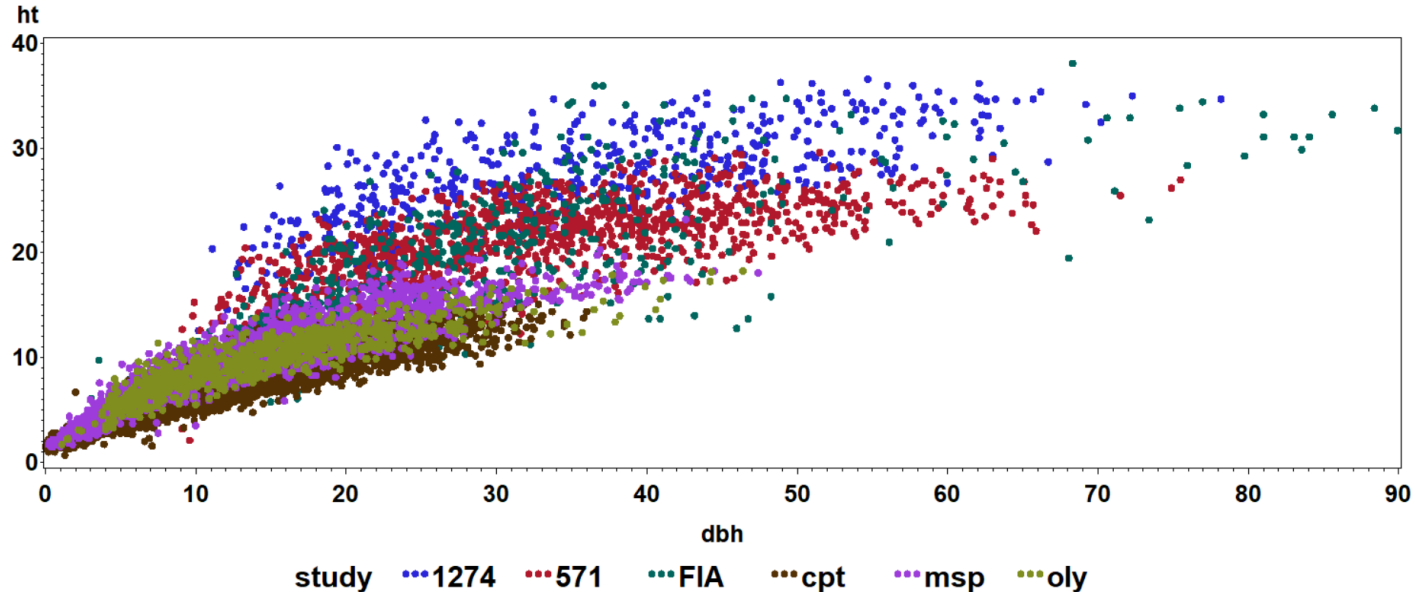
New addition…western redcedar

- **Current redcedar equations within CIPSANON are the same as those within ORGANON**
  - Based on 100 scattered and subordinate trees
  - Height increment is implied from applying height:diameter equations
  - Height increment of 15-40 year old pure redcedar stands was underpredicted by ~0.6 ft/yr
  - Diameter increment of 15-40 year old pure redcedar stands was underpredicted by 0.06”/yr

New addition…western redcedar

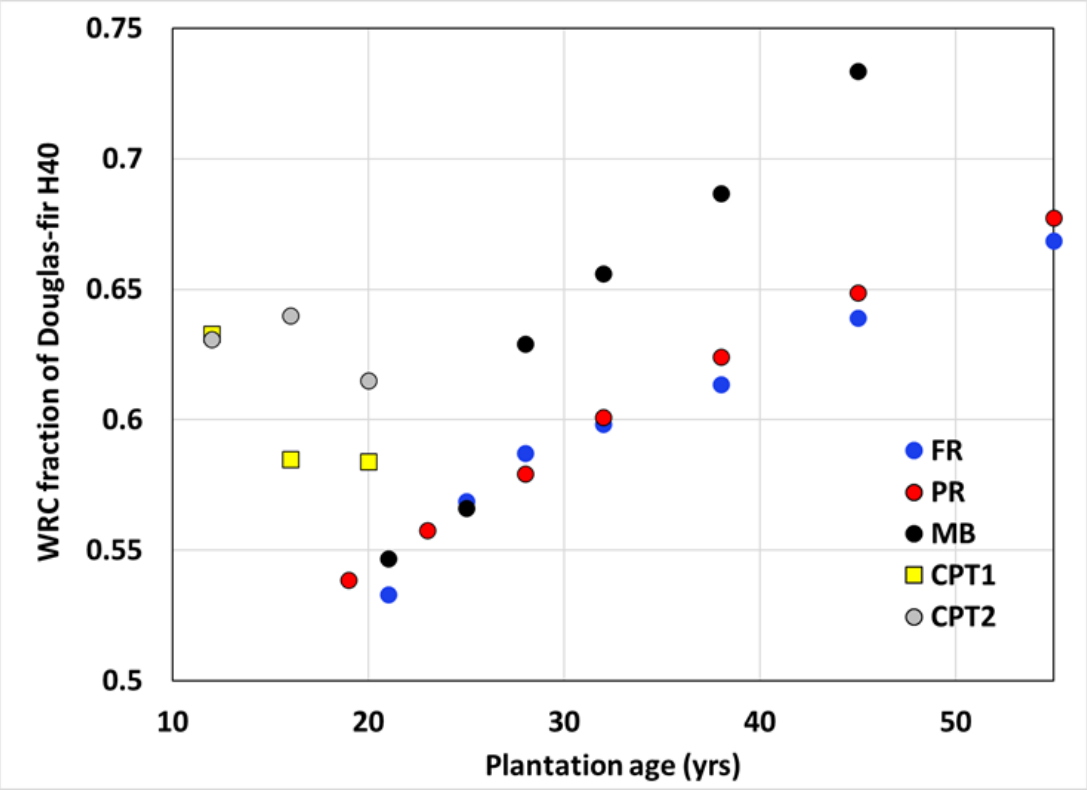
- **Equations for projecting even-aged WRC**
  - Dominant height prediction based on Kurucz (1978)
  - Diameter increment, height increment, HCB based on data from pure WRC plantations in western Oregon, Washington and BC
  - ~34,000 diameter increment observations
  - ~23,500 height increment observations
  - ~13,000 CR observations





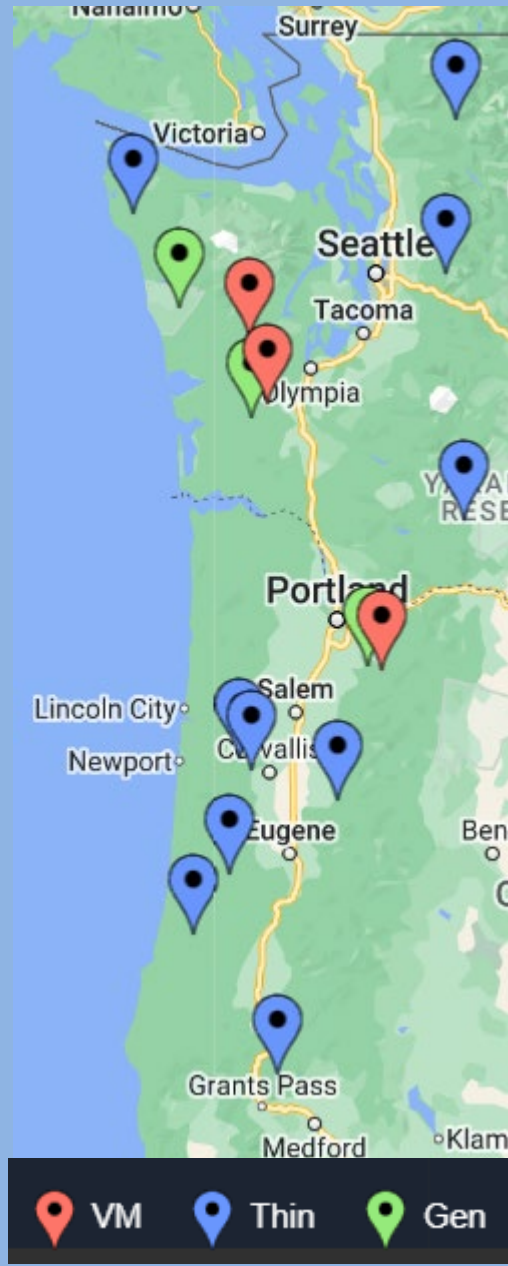
Redcedar site productivity

- **Five sites with numerous plots of pure Douglas-fir and pure western redcedar (3 in British Columbia, 2 in western Oregon)**
  - Dominant height of WRC between 0.65 and 0.75 of Douglas-fir at age 50 (British Columbia)
  - Dominant height of ***(fenced)*** WRC in western Oregon between 0.58 and 0.62 of Douglas-fir at age 20…greater than that in BC at same age



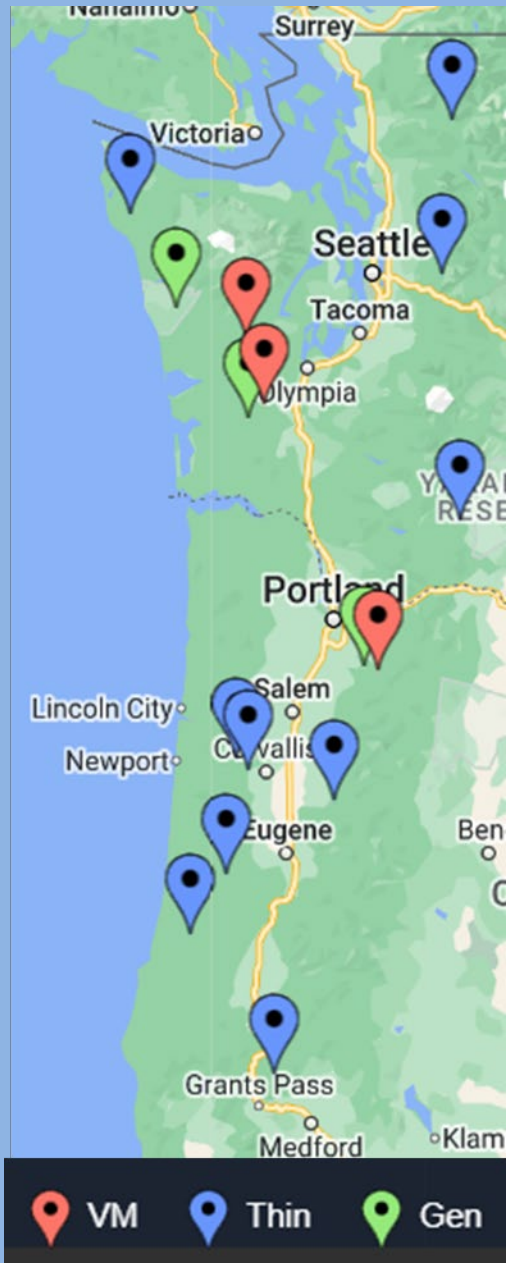
New field studies (winter 2024-2025)

- **CIPS members have voted to investigate the effects of silvicultural treatment on stem form**
  - We've done this work for N fertilization
  - Requested permission to use SMC type 1 and type 3 installations to look at the effect of thinning (rotation age stands)
  - Requested permission to use ECR, LTSP sites to look at the effect of vegetation management (early commercial entry age)
  - Requested permission to use SMC type IV, Realized gain trials to look at the effect of elite genetics (early commercial entry age)



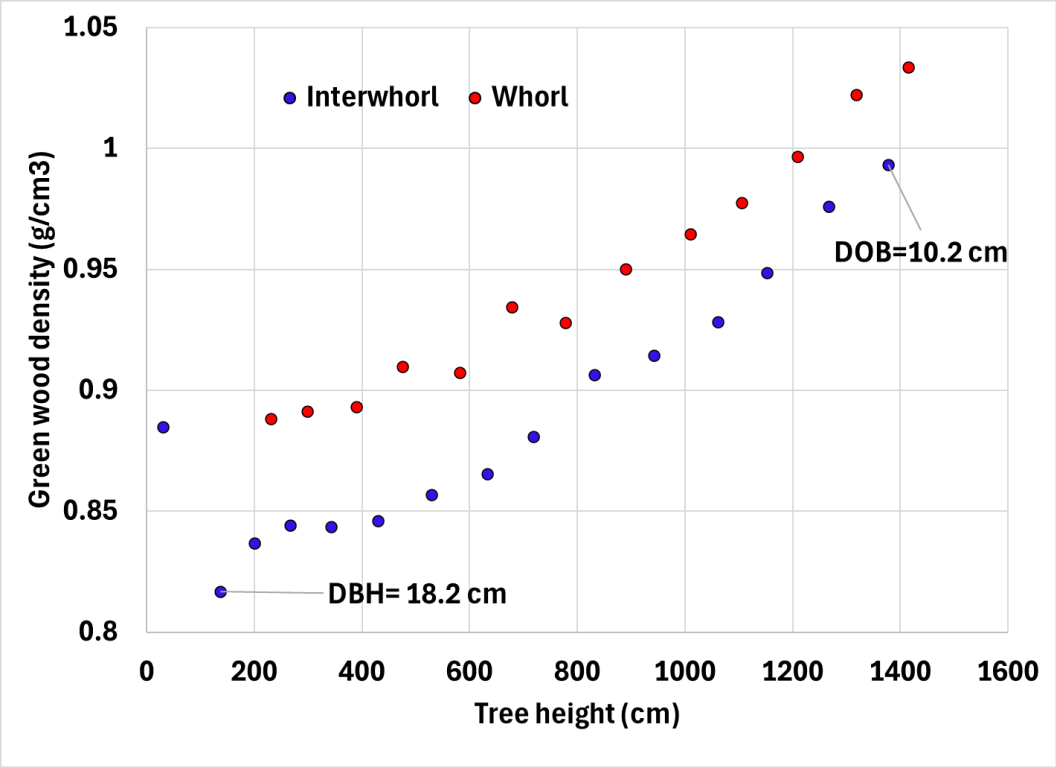
New field studies (winter 2024-2025)

- **Destructive sampling will provide opportunity for expanding other datasets**
  - **Destructive sampling possible on thinning sites, 1 genetic site, and 1 (and maybe 3) veg management sites**
  - **Crown profile measurements**
    - Current equation is based on MacDonald forest sampling
    - Proposed taper sampling sites provide geographic/environmental diversity
    - David Hann has expressed an interest in analyzing updated dataset
  - **Green wood density; bark thickness; carbon content?**
    - Augmentation of WTVWC data



Western Taper, Volume, and Weight Consortium (WTVWC)

- Collection of organizations interested in accumulating new dataset of Douglas-fir taper and weight measurements across the westside (200 trees)
- CIPS in discussions about handling the construction of the green vertical density profile equations and double bark thickness equations
- Sampling will include both whole-whorl bolts and interwhorl disks

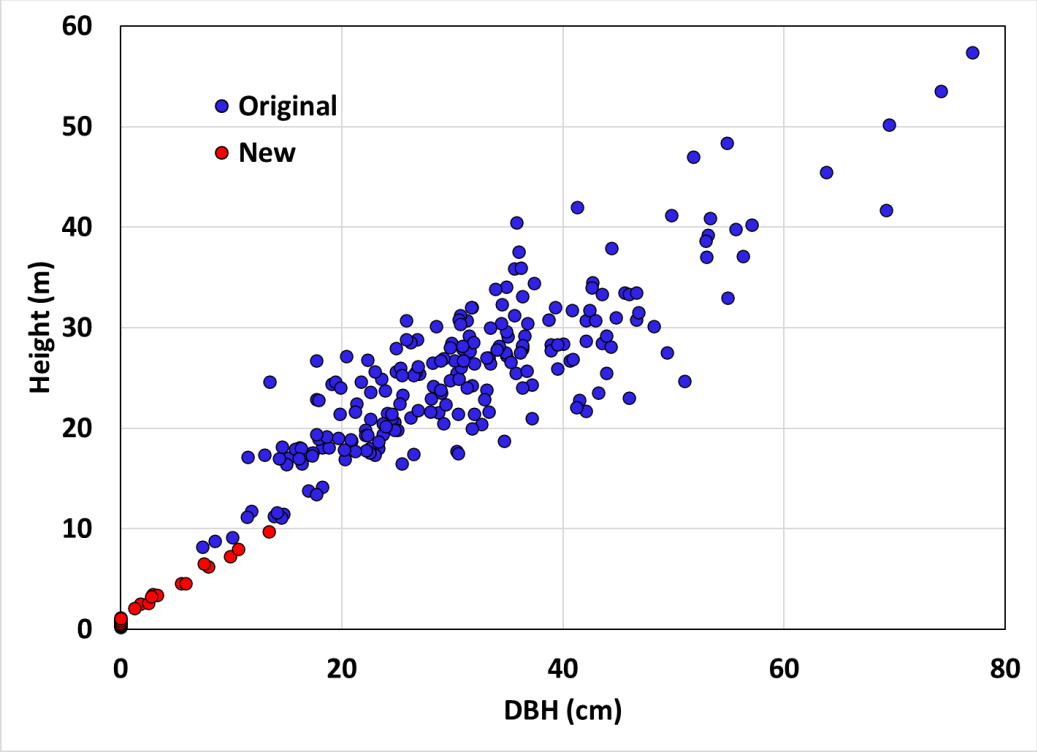


American Carbon registry, update

- ACR is a carbon crediting program
- ACR has developed peer-reviewed carbon accounting standard and methodologies
- FVS is currently the designated G&Y model for forestry-based carbon projects
- CIPS is pursuing acceptance of CIPSANON as a model for ACR carbon projects
  - Will require external peer review
  - Have spoken with independent biometricians about the conductance of an external peer review

American Carbon registry, tasks

- Update biomass fit
  - Added observations from 0-10 year-old Douglas-fir plantations
  - Add dead wood accounting using FVS source code




Questions?