Continuing Project

Stand Response to Thinning:

Enhancing Response Prediction Through Modeling

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Justification

- Forecasting yield is a primary objective of forest managers
- Thinning a stand has a propensity to alter stand allometry
- Stand productivity:

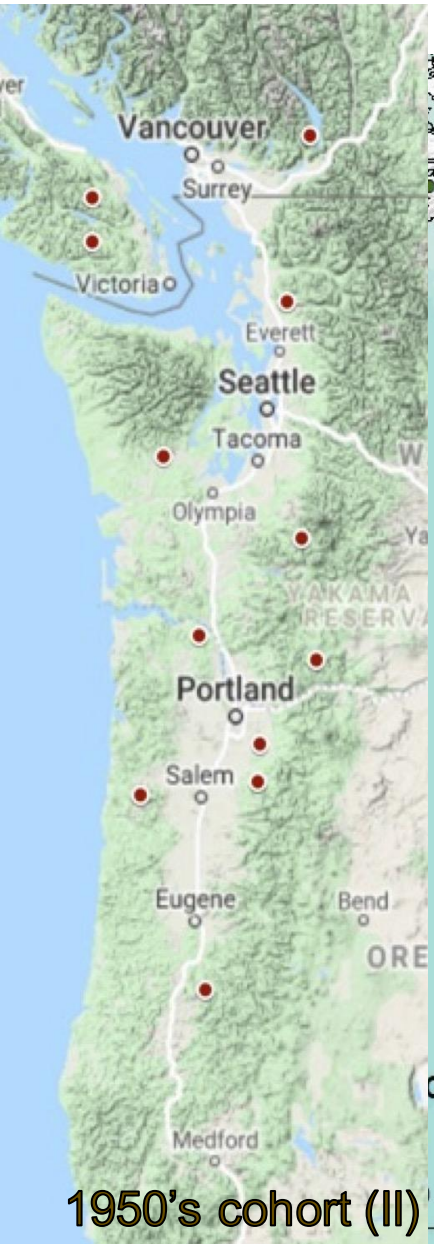
  Actual → *Realistic [Realizable?]* → *Potential*

- Decision space is clearly in zone between Actual and *Potential*

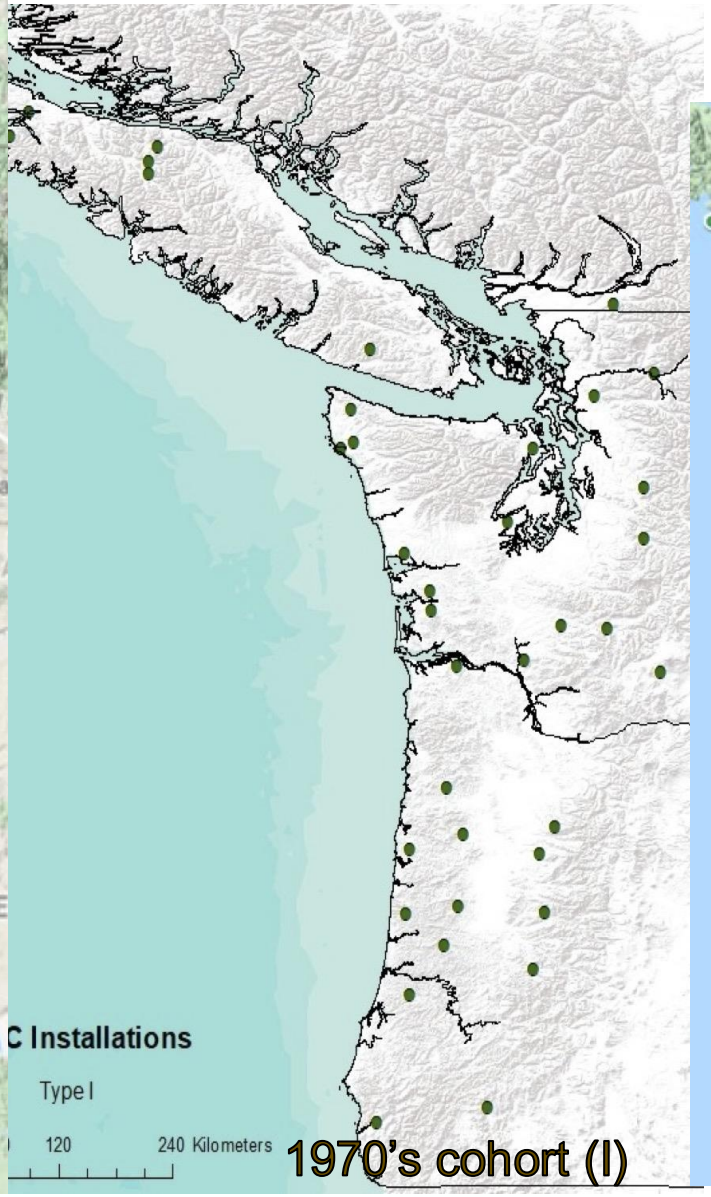
Objectives

- Refit the extant base stand yield model (untreated stands) within the SMC Plantation Yield Calculator (SMC-PYC) given another two full cycles of data collection, improved volume estimates, and updated physiographic region data
- Fit a survival model mortality to order to back-calculate planting density and calculate actual PCT intensity, also to derive QMD from TPA and BAA
- Incorporate Pre-commercial and Commercial Thinning effects using results of Cross & Turnblom (2020); where a thinning is defined by its timing (PCT = absolute, CT = relative) and intensity (proportion of stems removed)
- Benchmark fitted model against independent data set, adjust if necessary

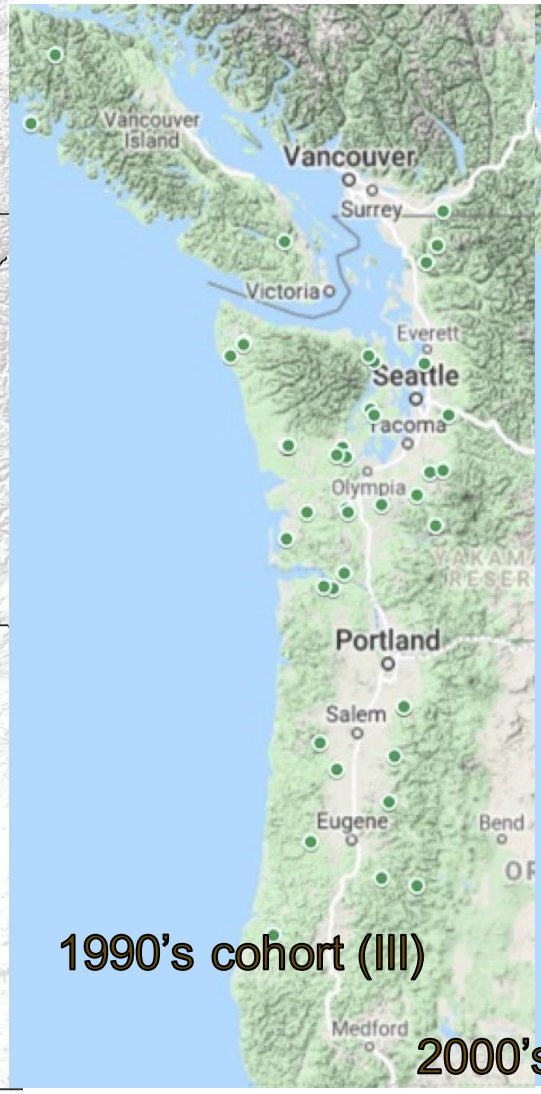
Methods



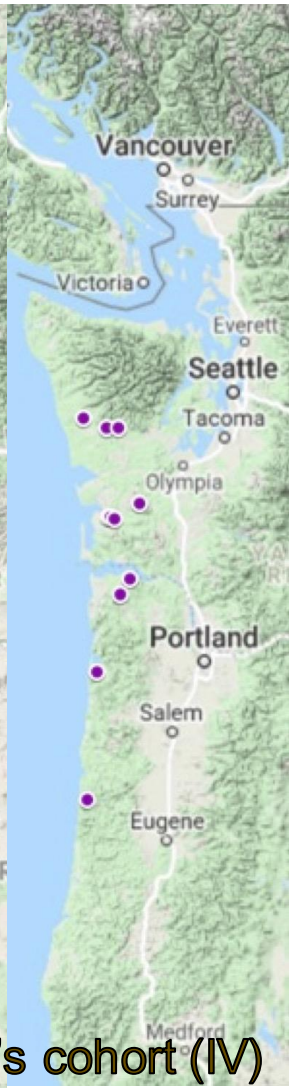
1950's cohort (II)



1970's cohort (I)



1990's cohort (III)



2000's cohort (IV)

Methods

- The base modeling framework selected for the Stand Management Cooperative-Plantation Yield Calculator (SMC-PYC) is the Richards (1959) function for its quasi-biologically interpretable parameters

- Use a standard algorithm for implementing weighted least squares to identify system parameters, coupled with a bootstrapping step to examine parameter distributions for eliminating those that are statistically not significant (0.05 error rate) [Objective 1]

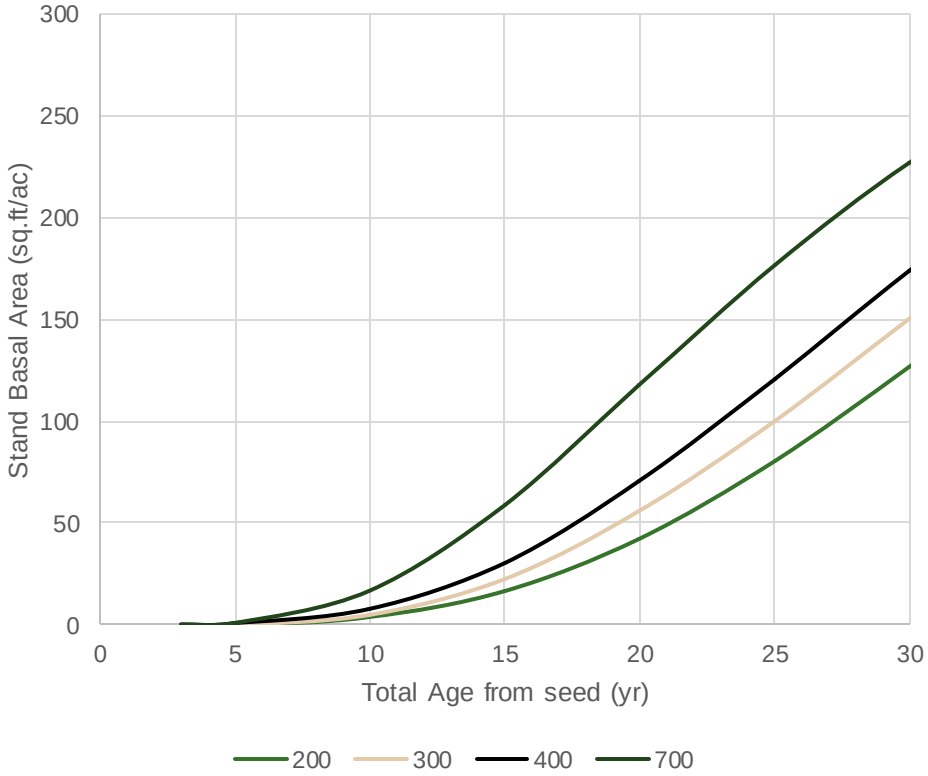
Methods

- Used spacing trial data (i.e. plant & grow) from SMC Type III installations and RFNRP low site spacing trial plots to create survival model [Objective 2]

- Augment the baseline model with silvicultural treatment variables, both pre-commercial thinning and commercial thinning. Pre-commercial thinning effects are to be applied to the current (non-linear) structure using ratios (treated:control) determined from a separate analysis conducted by Cross & Turnblom (2020) [Objective 3]

- Benchmark fitted model against independent data set, adjust if necessary [Objective 4]

Major Findings



Stand basal area (ft^2/ac) of the total stand over time in Douglas-fir Type III installations as affected by initial density (all other site variables at median values).

PAI and MAI for stand basal area (ft^2/ac/yr) of the total stand over time for 700 TPA starting density in Douglas-fir Type III installations (all other site variables at median values).

Major Findings

- The effects may differ slightly by volumetric unit, but overall the emerging climatic variables affecting yields are annual solar insolation; summer degree-days above 18°C; spring, autumn, winter Hogg's climate moisture index; autumn precipitation; minimum autumn temperature; spring relative humidity; and end of the frost-free period.

- A good fitted survival model has parameters with quasi-biological interpretations (site index, solar insolation); some parameters do not have a strict biological foundation; chief need is to differentiate between planting densities.

- Refined planting density estimates (survival @ 3y) remains a key to differentiating between treatment yields.

- Updated baseline models (those fitted prior to adding climate variables) are useful for comparison with the previous fits and are instrumental in debugging newly coded FORTRAN Nelder-Mead optimalization algorithm.

Deliverables

- Further updates on PYC modeling
  - Version 2.0 : Baseline Equations
  - Version 2.1 : Version 2.0 + PCT effect
  - Version 2.2 : Version 2.1 + CT effect
- Working Paper to be delivered to SMC membership detailing data, methods, and results
- User interface to yield model available to SMC membership (SMC-PYC v.2)

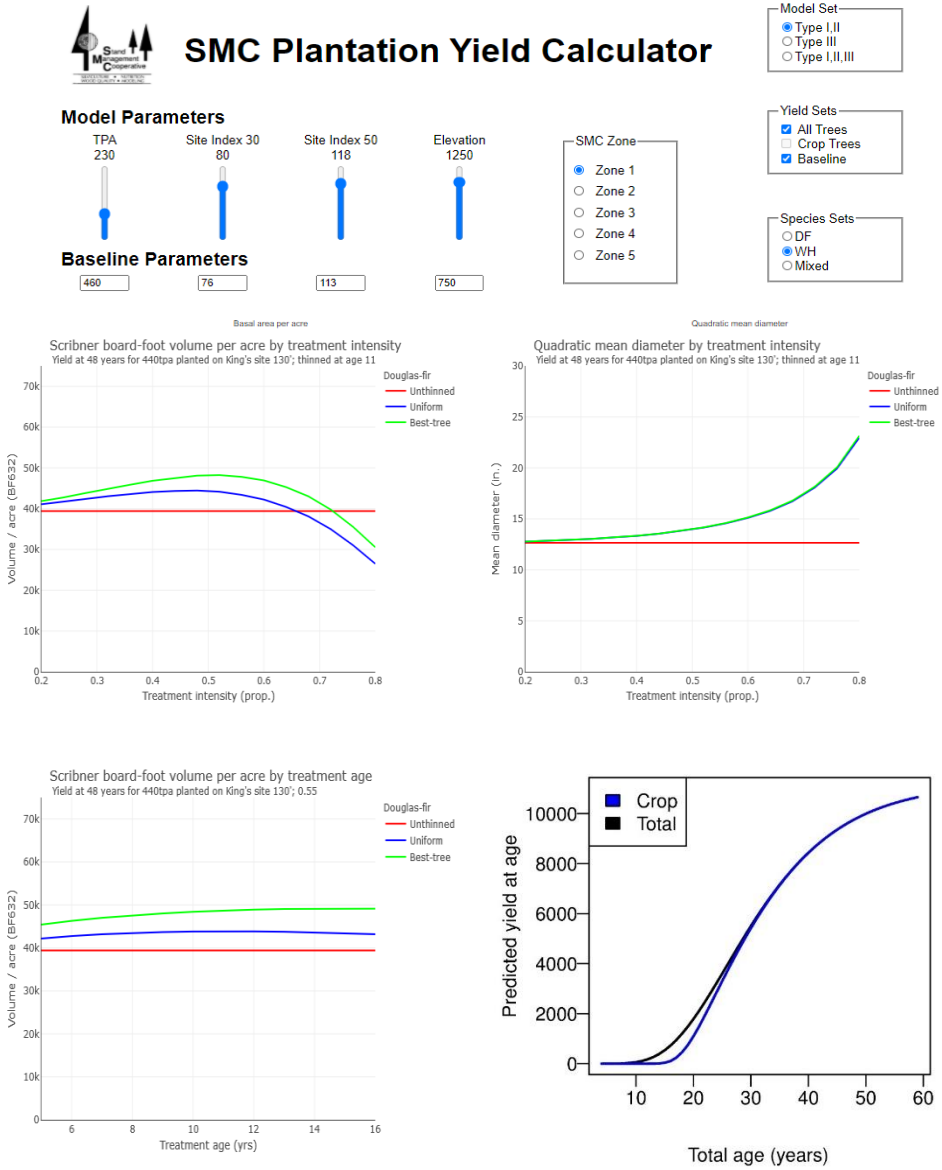
Basal Area (sq.ft./acre)

	Planted	Stems	Per	Acre		
AGE	100	300	500	700	900	
3	0.0	0.0	0.1	0.1	0.2	
5	0.1	0.3	0.6	1.2	2.0	
10	2.5	5.5	10.5	17.6	26.5	
15	12.3	23.9	40.7	60.7	82.2	
20	33.7	58.1	88.7	119.8	148.4	
25	67.2	104.0	144.1	179.2	206.8	
30	110.4	154.8	197.6	229.7	250.9	

QMD (inches)

	Planted	Stems	Per	Acre	
AGE	100	300	500	700	900
3	0.2	0.1	0.2	0.2	0.2
5	0.5	0.4	0.5	0.6	0.6
10	2.2	1.8	2.0	2.1	2.3
15	4.9	3.9	3.9	4.1	4.2
20	8.2	6.2	5.9	5.9	5.9
25	11.7	8.4	7.8	7.5	7.3
30	15.2	10.5	9.4	8.8	8.3

Company Benefits



- Project results would be a standardized framework for stand modeling
- Easier future calibrations of growth and yield prediction models given framework for model updates
- Mortality, Planting Density, QMD yield models can be applied directly to FVS to grow & generate tree lists that match yield metrics
- Improved forest planning and financial assessments

Recommendations

- Parameter prediction method is quite useful, particularly when parameters and their predictors are identified simultaneously
- "Winnowing" down the field of potential parameter predictor variables using principal components is very useful (especially when pool is large)
- Investigation of the mechanisms behind the differences in physiographic regions and their local climate effects is useful
- Keep opportunities for cross-region collaboration open

Summary

- Explicitly accounting for PCT effects required a lot of background work / new data assembly – PCT database now completed
- The PCT database was folded into the complete, well formatted PYC database
- Updated model fitting process underway to incorporate climate effects
- Independent data set has been identified for benchmarking