Continuing Project

Using predictive analytics to decompose site index

CAFS.20.83

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Justification

1. Preliminary inquiries demonstrate that the trees captured in Top Height calculations are on the photosynthetic frontier for a given stand. The heights of dominant trees are a good indirect measure of site productivity.

2. Site index curves are constructed using historic data; where each dimension varied within historic ranges. Observed site will be at odd with predictions for sites as data fall (increasingly) outside of historic ranges.

3. Density confounds on observed site index: Top height is related positively with planting density early in stand development; with the relationship possibly turning negative later in stand development. The utility of site index predictions decreases as stand age increases; the highest utility is at planting in order to make decisions that most affect future stand development.

4. Site index is a required input for many growth & yield models; including those used by SMC membership. Unless & until a replacement is coded, site index will need to be evaluated. This is reflected by CAFS IAB membership placing high priority on improved parameterization of growth & yield models.

Hypotheses or Objectives

1. Observed site index is a function of both static attributes (e.g. elevation, latitude, soil composition), dynamic stand measurements (e.g. basal area, mean diameter), and regional attributes that measure within historic ranges (e.g. temperature, precipitation).

2. Machine-learning techniques exist to both identify sufficiently influential individuals among myriad bio/geo/climatic predictors, and to reduce the computational burden through dimension reduction. Generally, these techniques are applied under supervision, rather than autonomous.

3. Objective is to build a direct model of site quality that captures the effect of interactions between multiple independent variables in the form of top-height: a dynamic measure that substitutes directly as site index in applications.

Methods

Summary of DF data sources and critical values

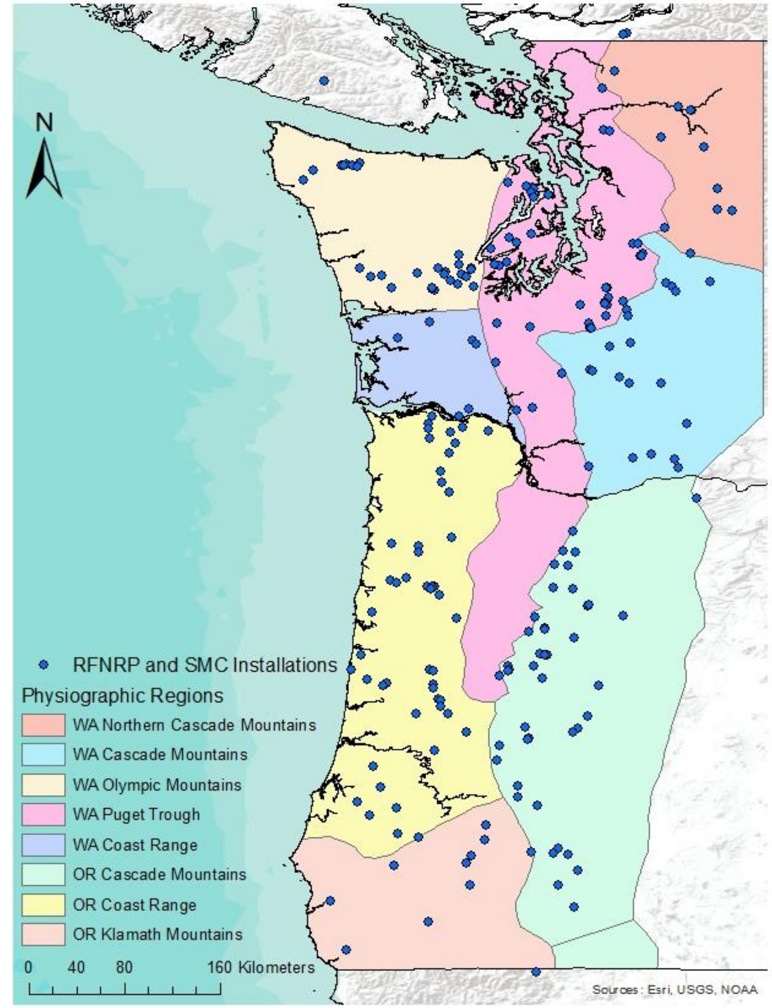
Project	Description	Plots	BH.Age	Top.Ht
RFNRP I	Unthinned natural	~~89~~	39	100
RFNRP II	Thinned natural	~~39~~	34	50
RFNRP III	Young, thinned, low-site	~~22~~	28	71
RFNRP IV	PCT, low-stocked planted	~~26~~	35	98
SMC I	Multiple thinnings of young	91 +75	19	61
SMC II	Thinning middle aged	12	31	87
SMC III	Planted spacing trials	127 +132	11	36

[1] RFNRP: Regional Forest Nutrition Research Project
[2] SMC: Stand Management Cooperative
[3] Obs: Average number of observations across Plots within Project
[4] BH.Age: Median breast-height age value among observations
[5] Top.Ht: Median top-height among observations

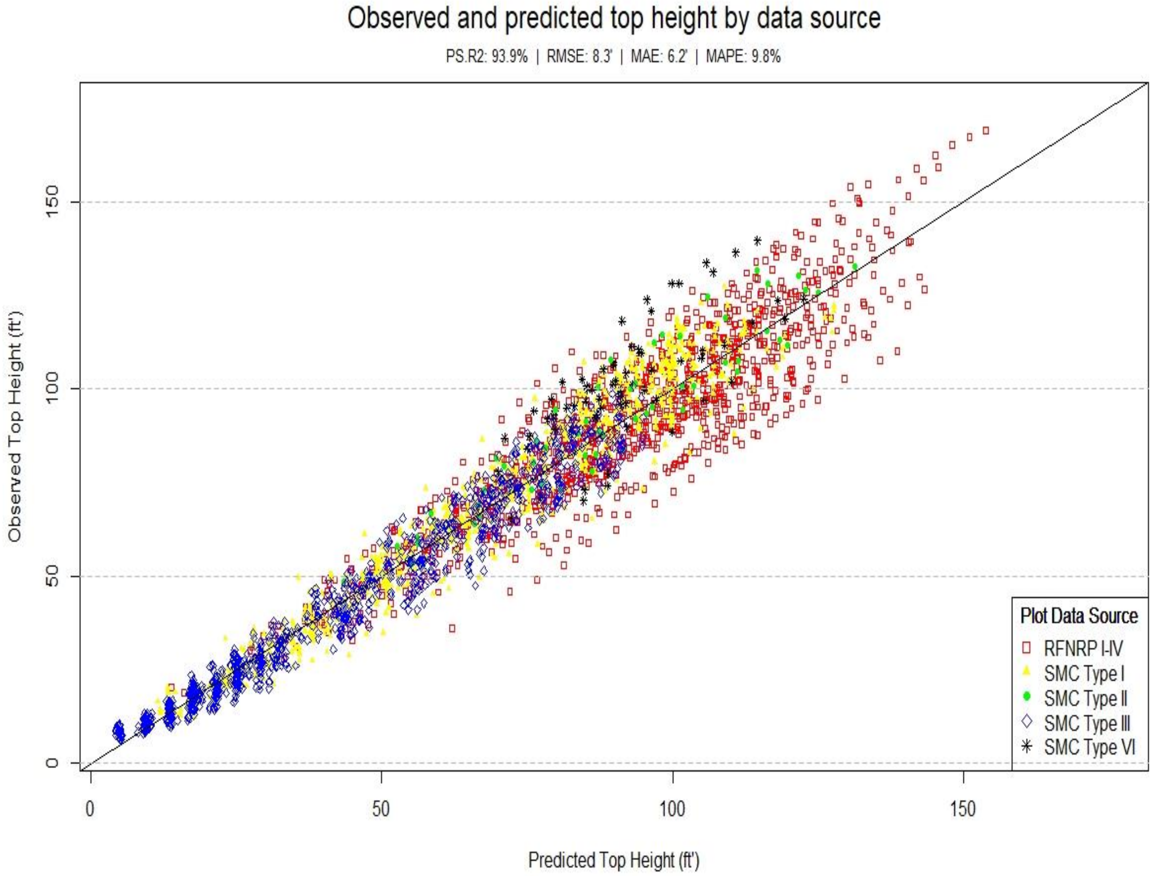
Year 1: Model comparison & selection;
pure MW parameter prediction

Year 2: Simultaneous fit of parameters on
MW with fixed asymptote

Current: Augment fit data, challenge assumptions;
simultaneous fit on CR including asymptote.



Major Findings



Red: oldest age classes
smallest plot size
heights via clinometer
estimated planting density
acts on shape parameter

Blue: youngest age classes
larger plots
density-controls
known planting density
acts on rate parameter

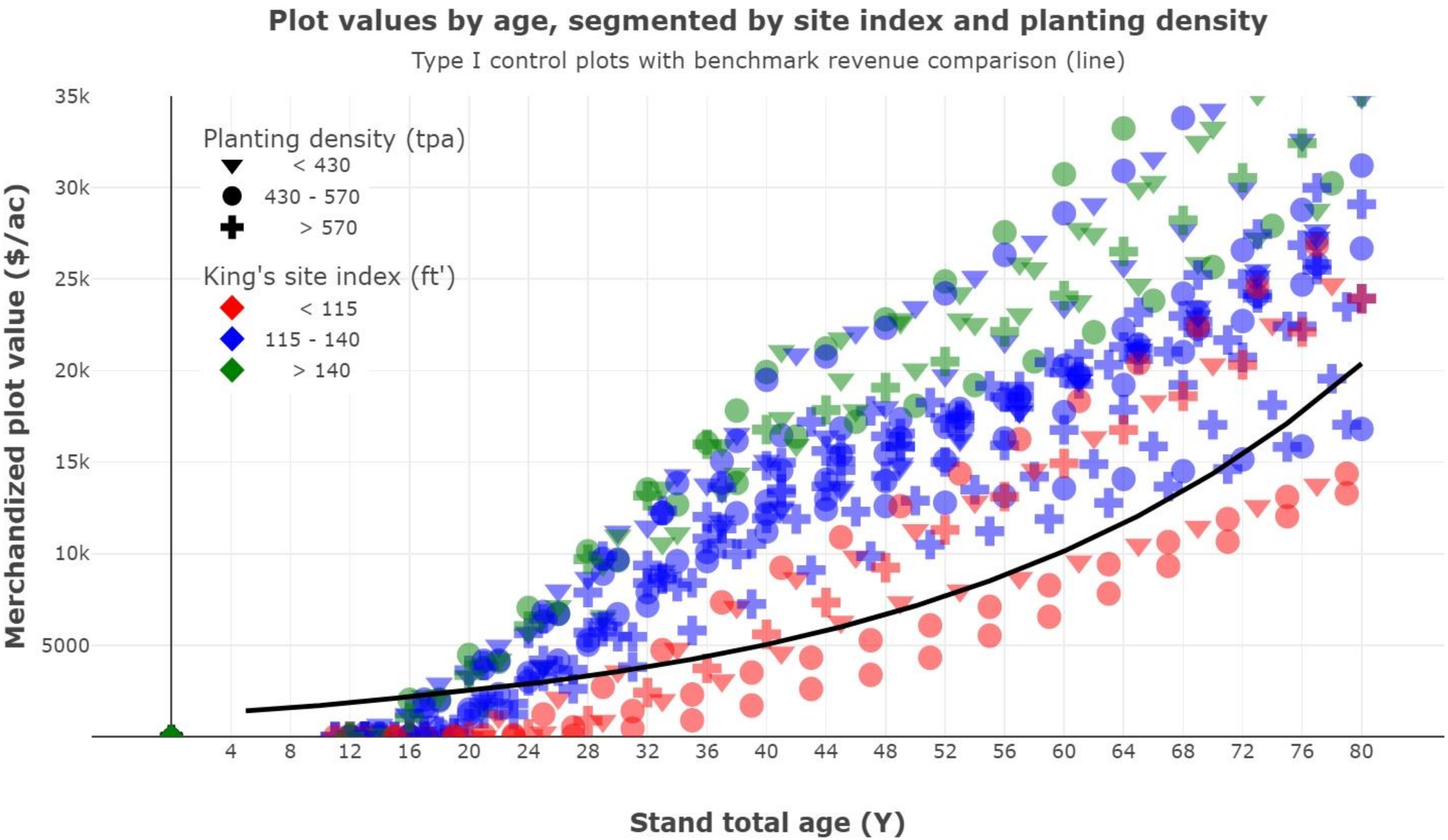
Yellow: spans age classes
largest plot size
site repetition at density
known-ish planting density
acts on both parameters

Deliverables

For SMC Members:
- Working Paper #9 detailing data and methods for application to internal data sets
- Integration into Plantation Yield Calculator (CAFS 20.82) for improved estimates
- Calibration code for FVS / FPS integration

For CAFS Members:
- Possible URL/API based calculator
- Mapping application unlikely unless GIS resources are pooled

Company Benefits



Recommendations

1. Transition from supervised machine-learning techniques to unsupervised (automated) will require standardization of bio/geo/climate data sets. At least in scale, but also in choice of native vs. derived[1] metrics.

2. Pooling of GIS resources to create unified data sets, both for within-region compatibility and for between-region comparisons.

[1] https://crsf.umaine.edu/wp-content/uploads/sites/214/2022/06/Brungard_DSM_CAFS_Jun22.pdf