Continuing Project

Assessing and mapping regional variation in potential site carrying capacity

CAFS 19.75

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Justification

- Understocked stands underutilize site resources and will not reach maximum potential productivity
- Overstocked stands are slow to develop and susceptible to wildfire, drought and insect outbreaks due to competition for limited resources.
- To date, forest carrying capacity research is regionalized, utilizes multiple modeling approaches, and not universally available spatially across the US …...

Objectives

1) Synthesize a nationwide forest inventory database from publicly available data and from CAFS members,

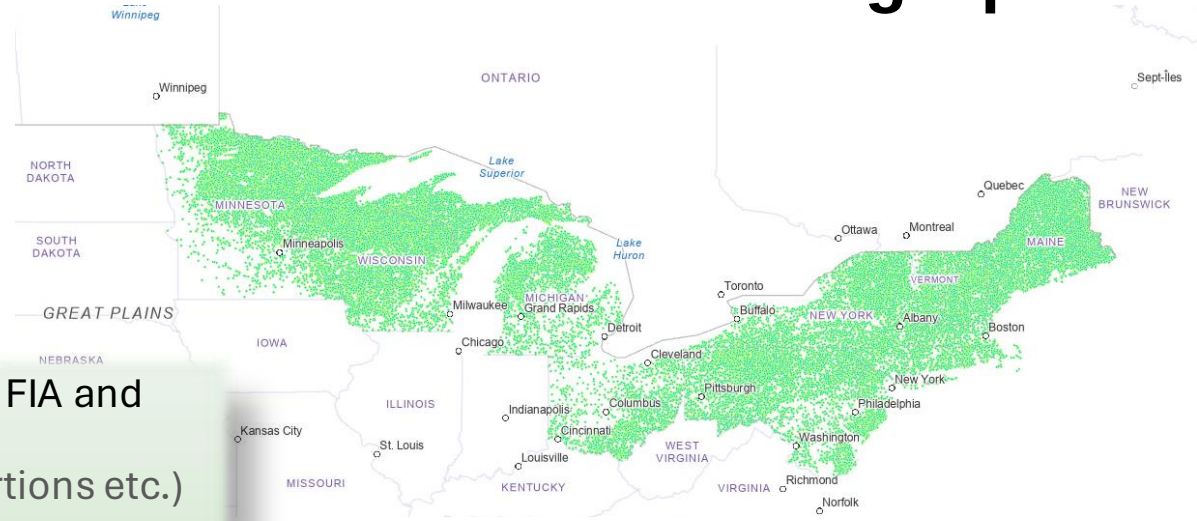
2) Standardize maximum carrying capacity modeling, and

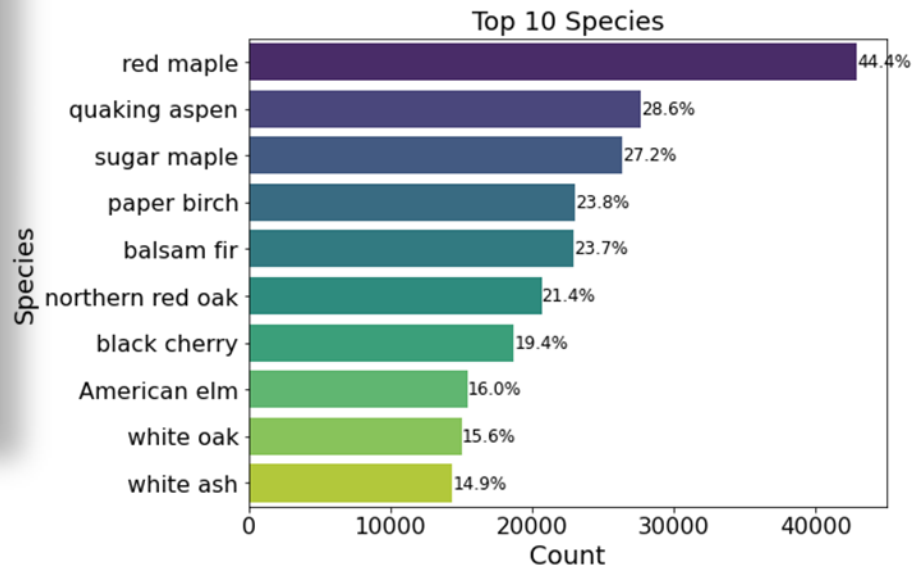
3) Create efficiencies for multi-regional forest management organizations by providing consistent, species-site-silviculturally sensitive, wall-to-wall spatial models of SDImax for commercial species of the United States.

Methods – NE US Modeling Update

Data

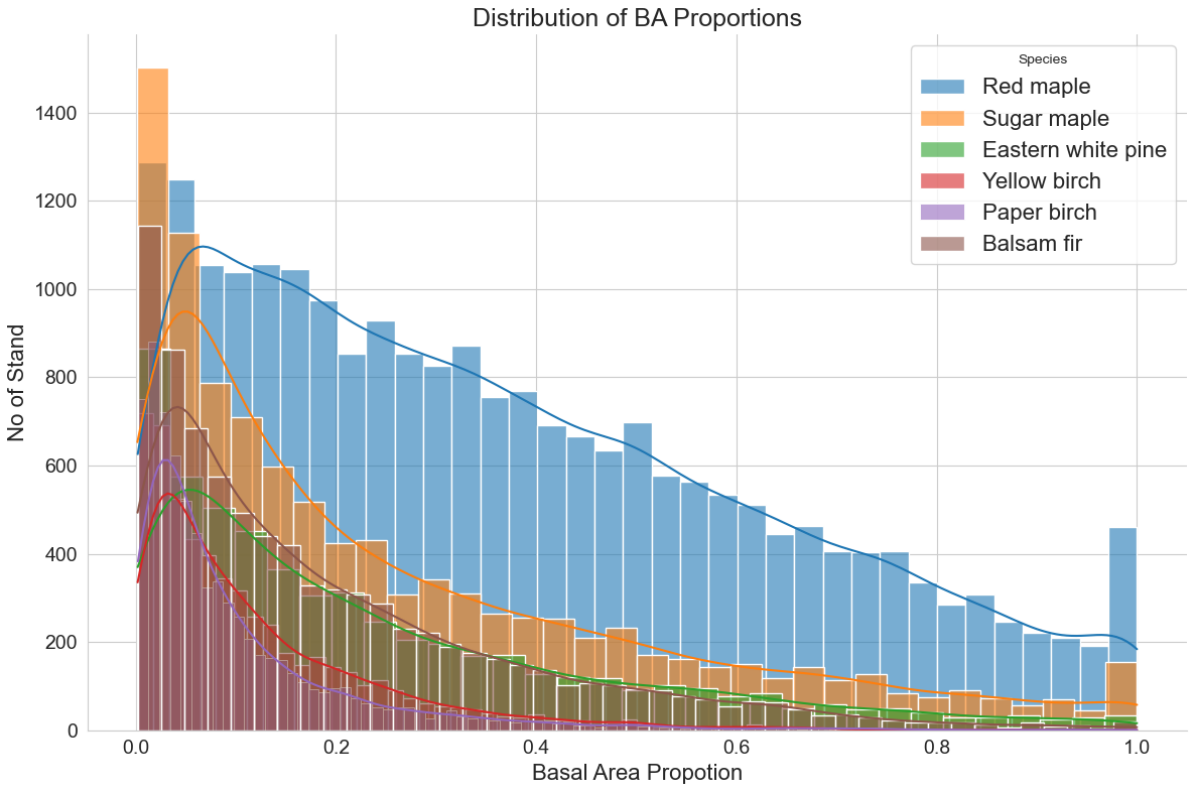
- 31,275 plots/stands info from FIA and Industry (TPA, QMD, Species BA proportions etc.)
- Forest Type, Eco-region
- Topography extraction from 30m DEM (e.g., Slope, Aspect, Topographic wetness index, Solar radiation)
- ClimateNA (Annual, Month, Season)
- Geology and Soil layer (SGMC & gSSURGO geodatabase)



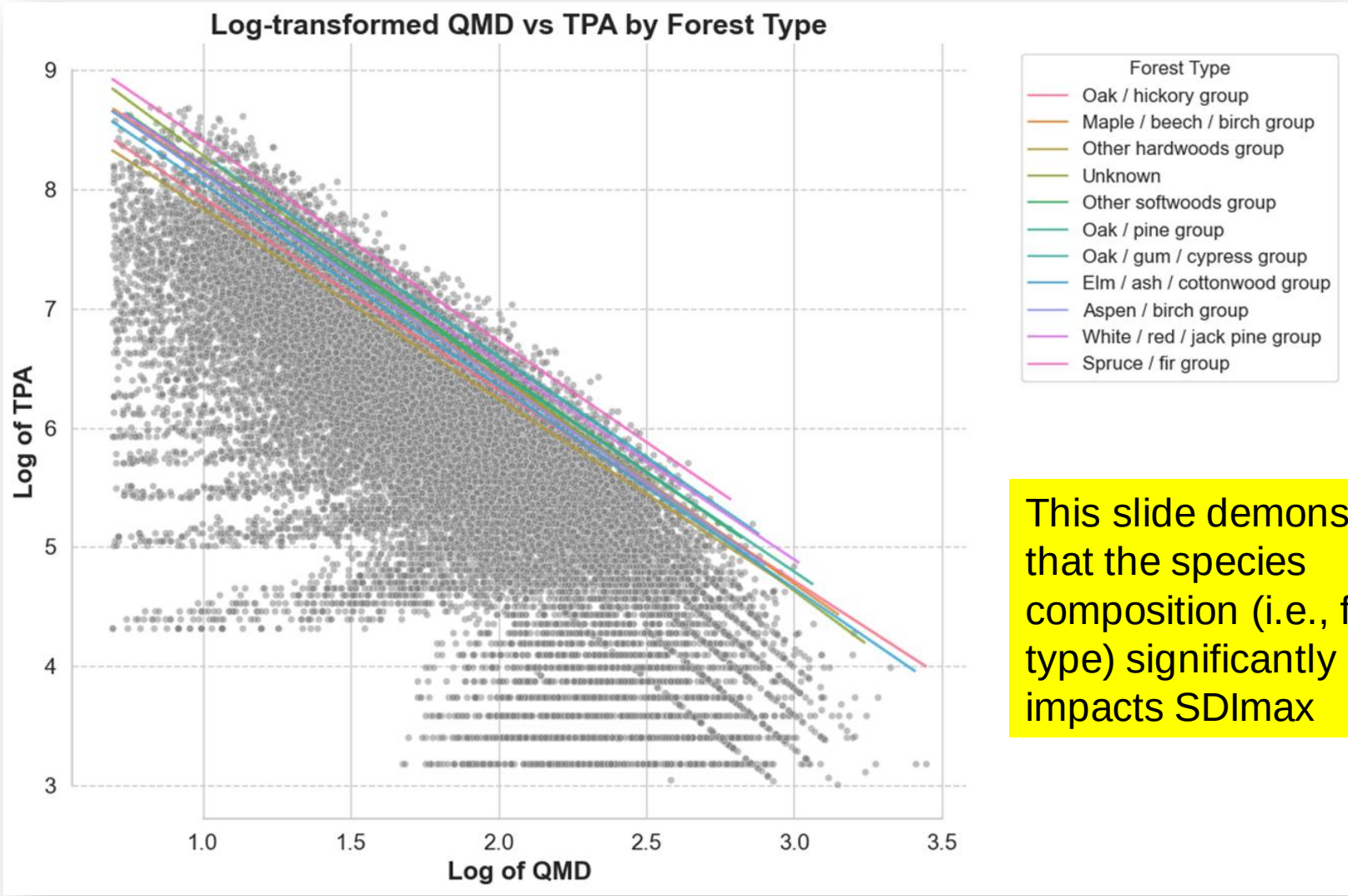


Methods – NE US Modeling Update

- Based on feedback from CAFS members, four hardwood and two softwood species were selected for SDImax modeling
  - Red/Sugar maple, Paper/Yellow birch, E. White pine, Balsam fir
  - Widespread and predominant in most stands
- Despite dominant presence, species purity rarely present
- Basis for use of forest types used in prior SDImax modeling

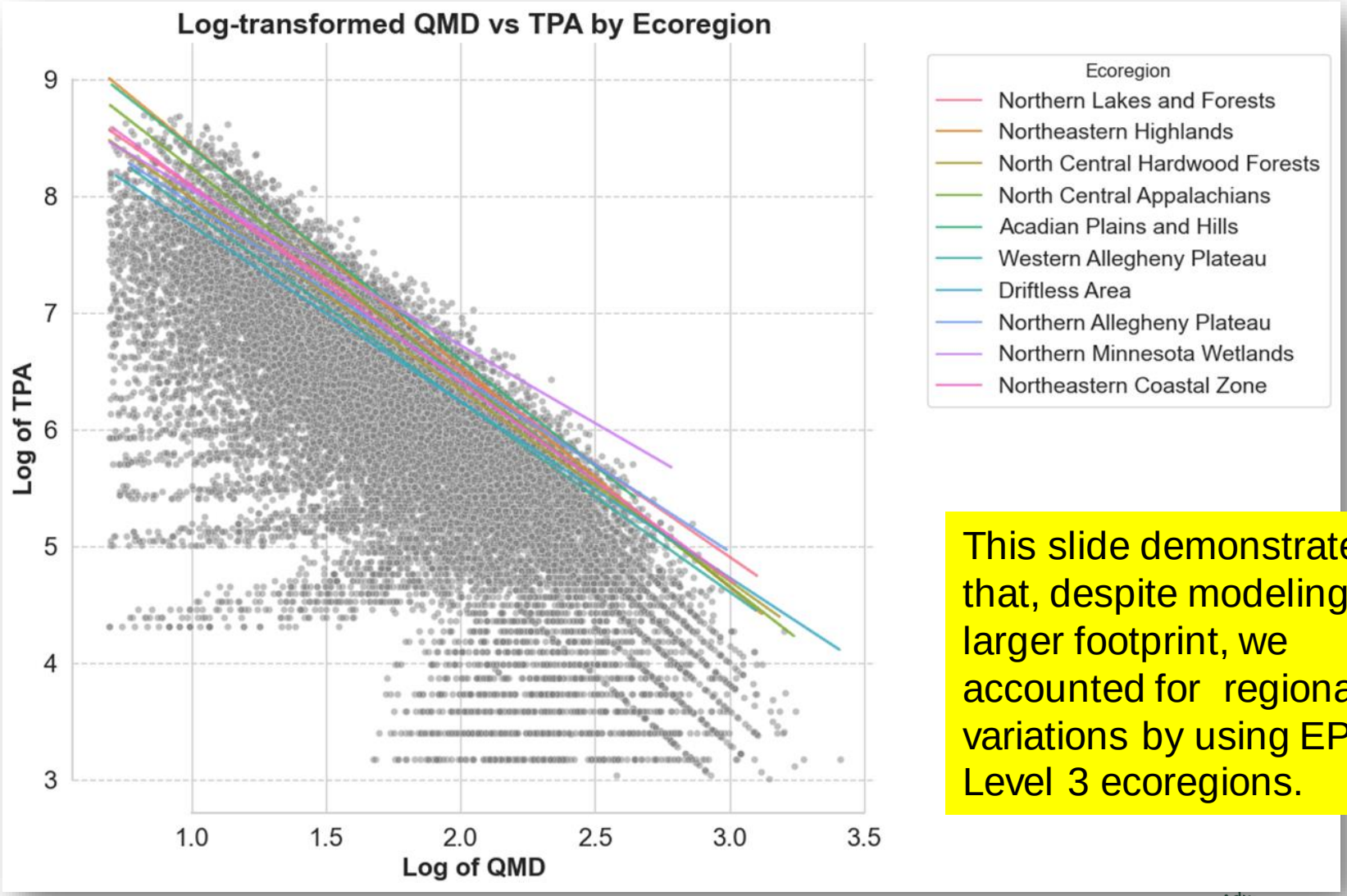


Methods – NE US Modeling Update



This slide demonstrates that the species composition (i.e., forest type) significantly impacts SDImax

Methods – NE US Modeling Update



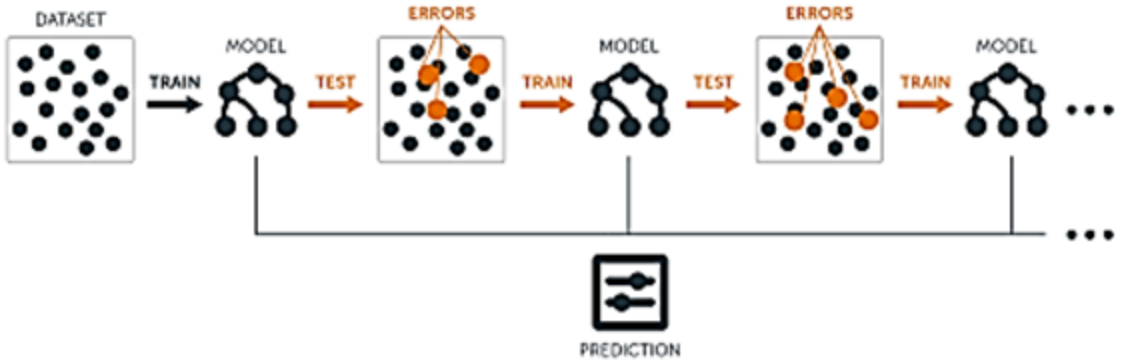
This slide demonstrates that, despite modeling a larger footprint, we accounted for regional variations by using EPA Level 3 ecoregions.

Modeling Approach

Methods – NE US Modeling Update

- **Data Cleaning – Model Sensitivity:**

Missing expansion factors, at least 10 TPA, QMD at least 2-inch, questionable & missing data removed

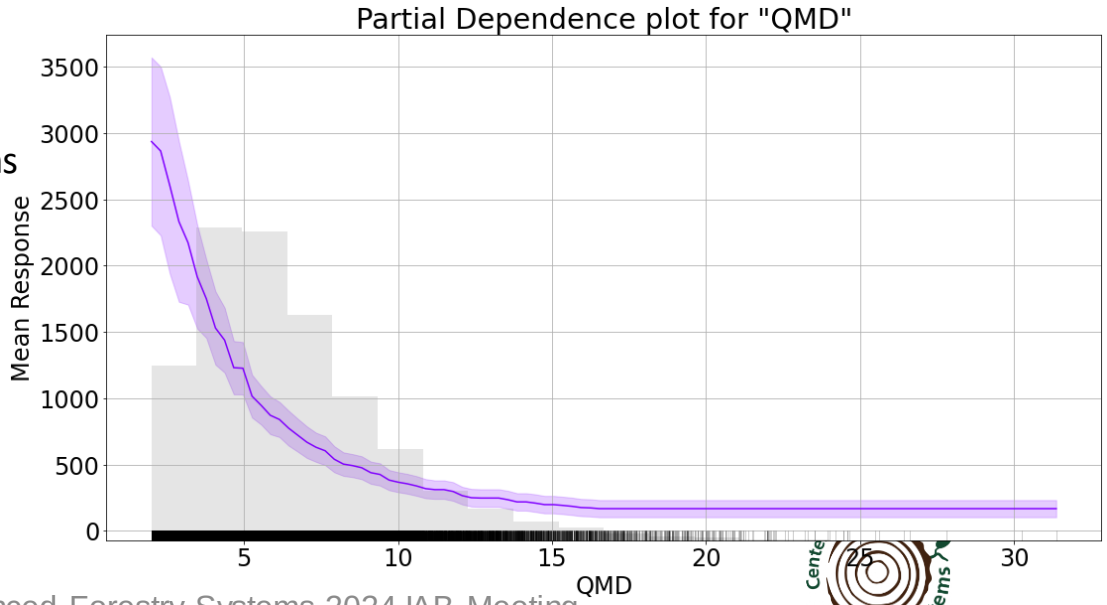


- **Variable Selection:**

Based on Minimum Redundancy Maximum Relevance (MRMR) algorithms

- **Fitting Quantile GBM:**

The quantile GBM model minimizes deviations between predicted and observed quantiles, ensuring robust estimations at the 95th percentile of the size-density relation.



Model Summary:

Major Findings - NE US

Quantile regression loss function can predict a specified percentile

Quantile

$$f = \begin{cases} w \times QuantileAlpha \times (y - f) & \text{for } y > f \\ w \times (1 - QuantileAlpha) \times (f - y) & \text{for } y \leq f \end{cases}$$

Where:

- y is a true response
- f is a predicted response
- w is weight

distribution = "quantile", quantile_alpha =.95

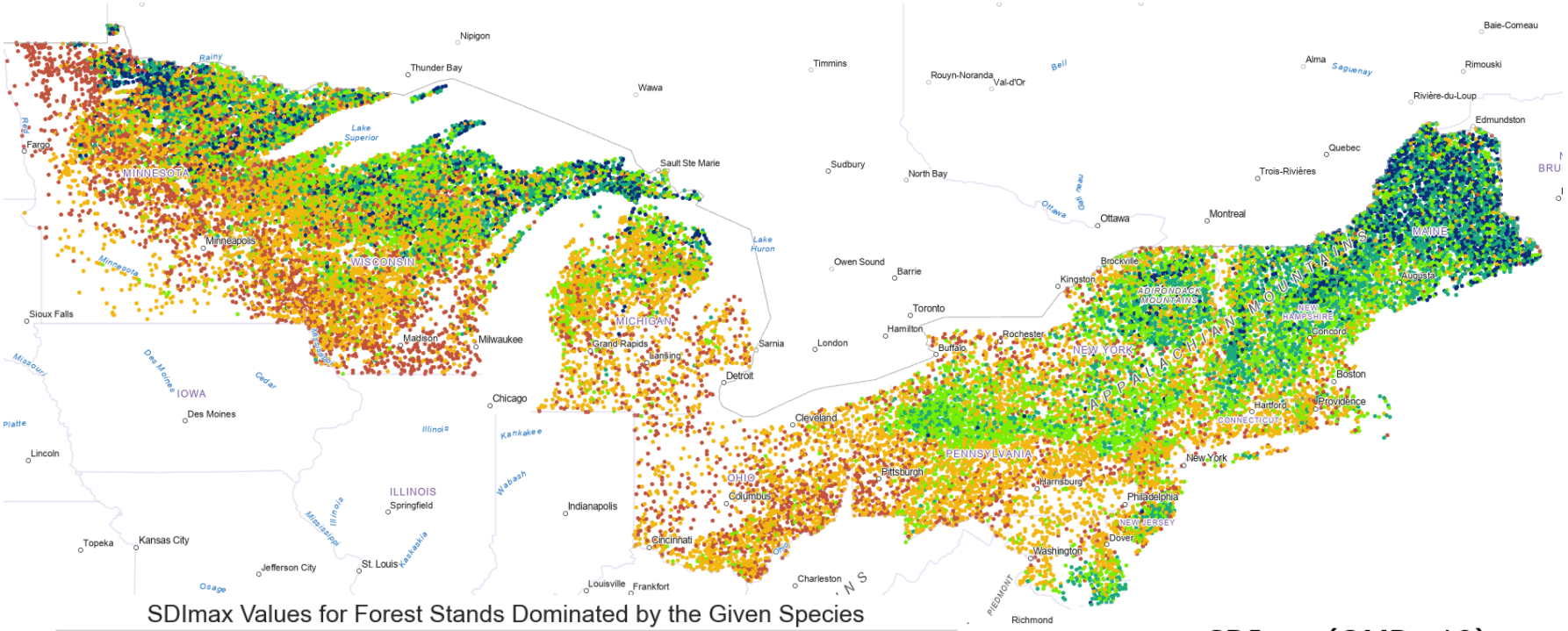
number_of_trees	number_of_internal_trees	model_size_in_bytes	min_depth	max_depth	mean_depth	min_leaves	max_leaves	mean_leaves
78	78	30855	5	5	5	15	32	26.3797

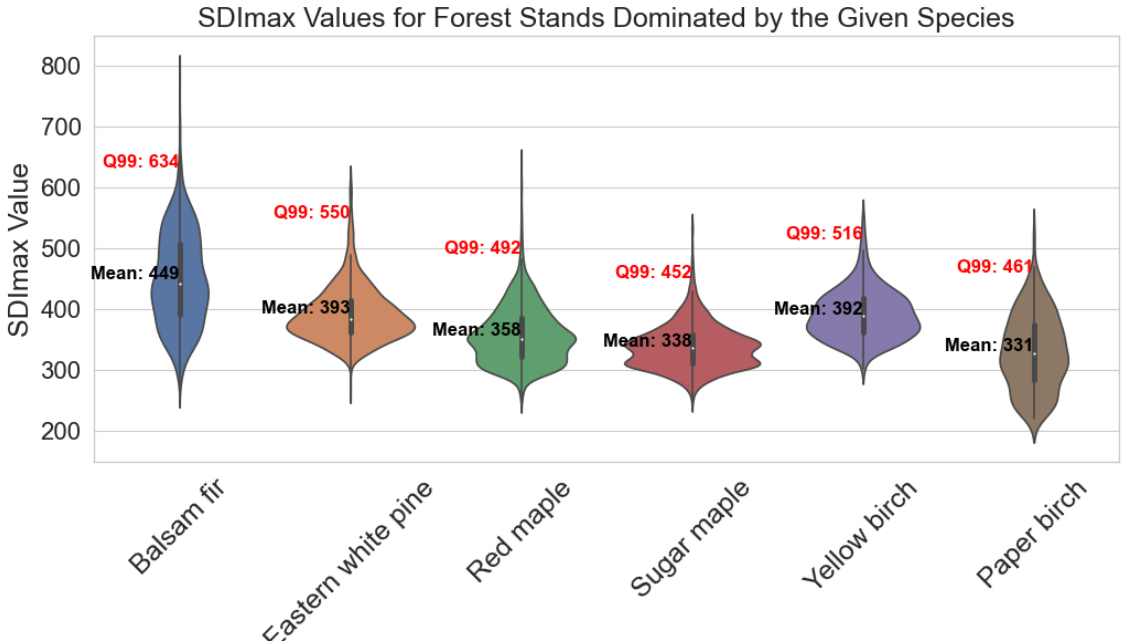
Consistent pinball loss (~28) in training and cross-validation signifies robust quantile estimation.

Key Predictors

QMD	Eco region	ADI	soc20_50
ABBA_BAprop	Elevation	PAS_sp	soc0_5
ACRU_BAprop	Forest type	CMI_wt	aws0_5
BEPA_BAprop	Topographic wetness index	MSP	aws100_150
PIST_BAprop	sin_Aspect	DD_0_at	depreslay
BEAL2_BAprop	cos_Aspect	RH_at	
ACSA3_BAprop	tS_sA	DD18_at	
other_hard BAprop	tS_cA		
other_soft Baprop			
Dominant Species			

SDImax estimates with Species and Forest type info.





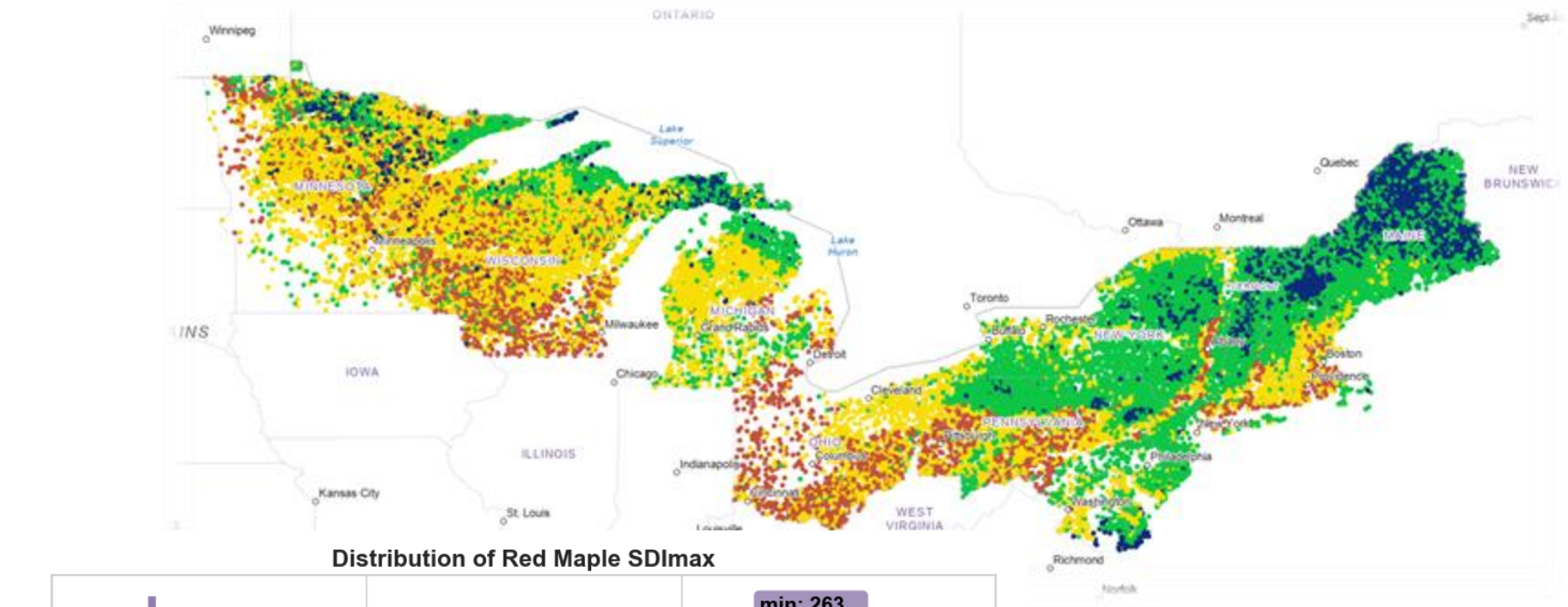
SDImax(QMD=10)

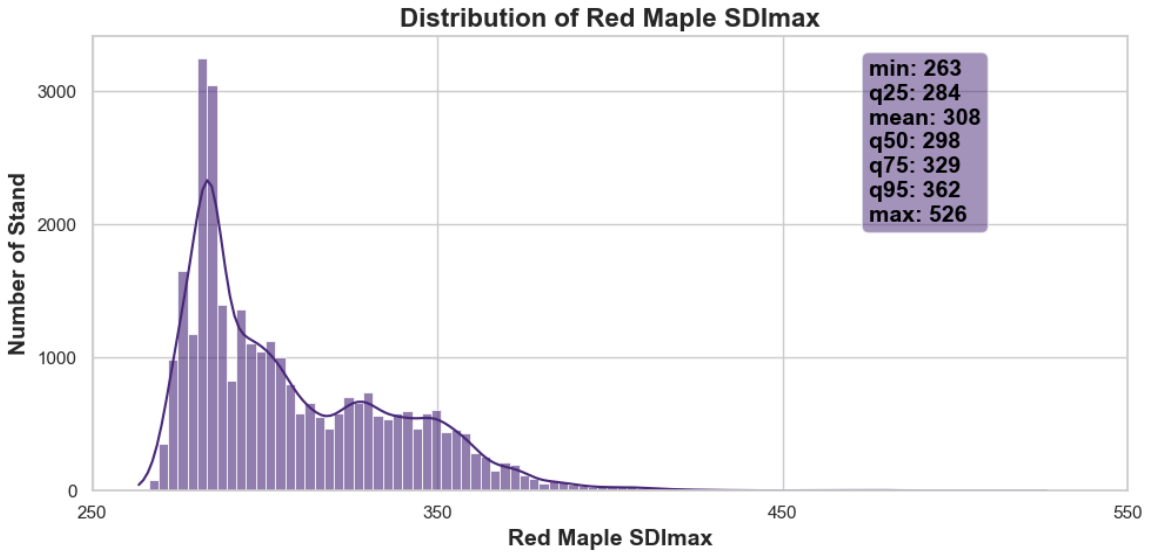
- <300
- 300-350
- 350-400
- 400-500
- >500

IAB Meeting

Center for Advanced Forestry Systems

SDImax estimates for 100% Red Maple

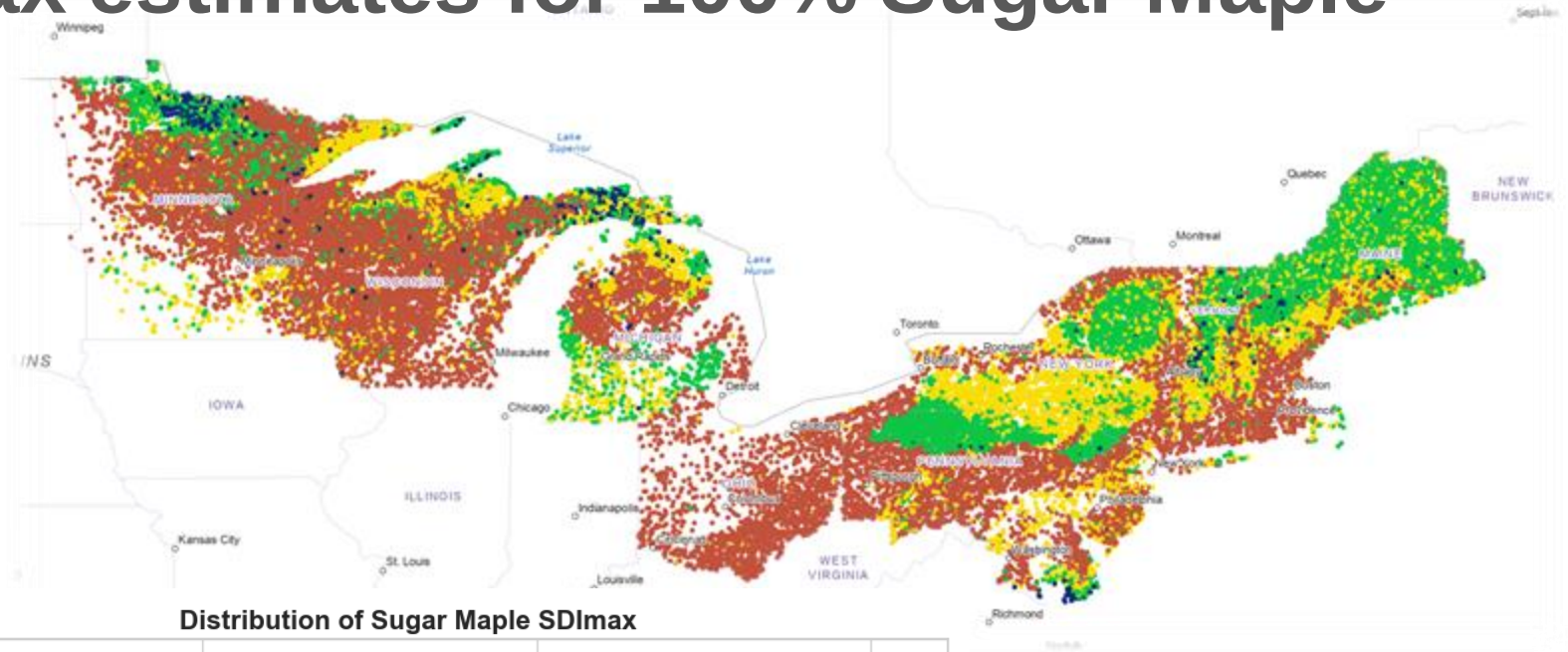


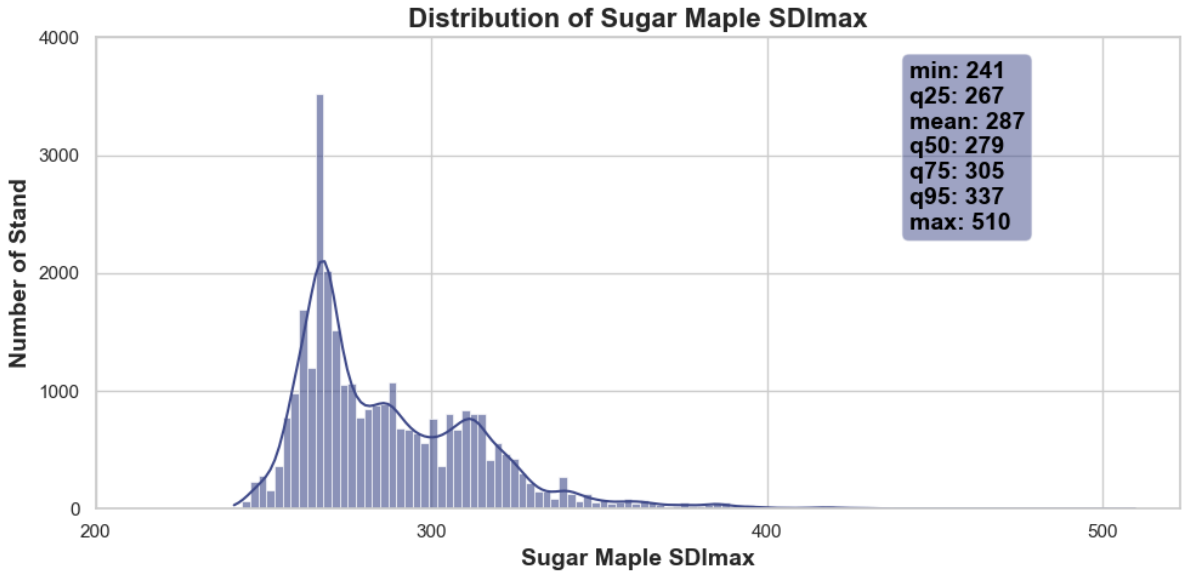


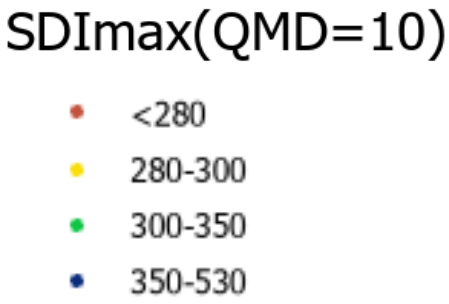
SDImax(QMD=10)

- <280
- 280-300
- 300-350
- 350-530

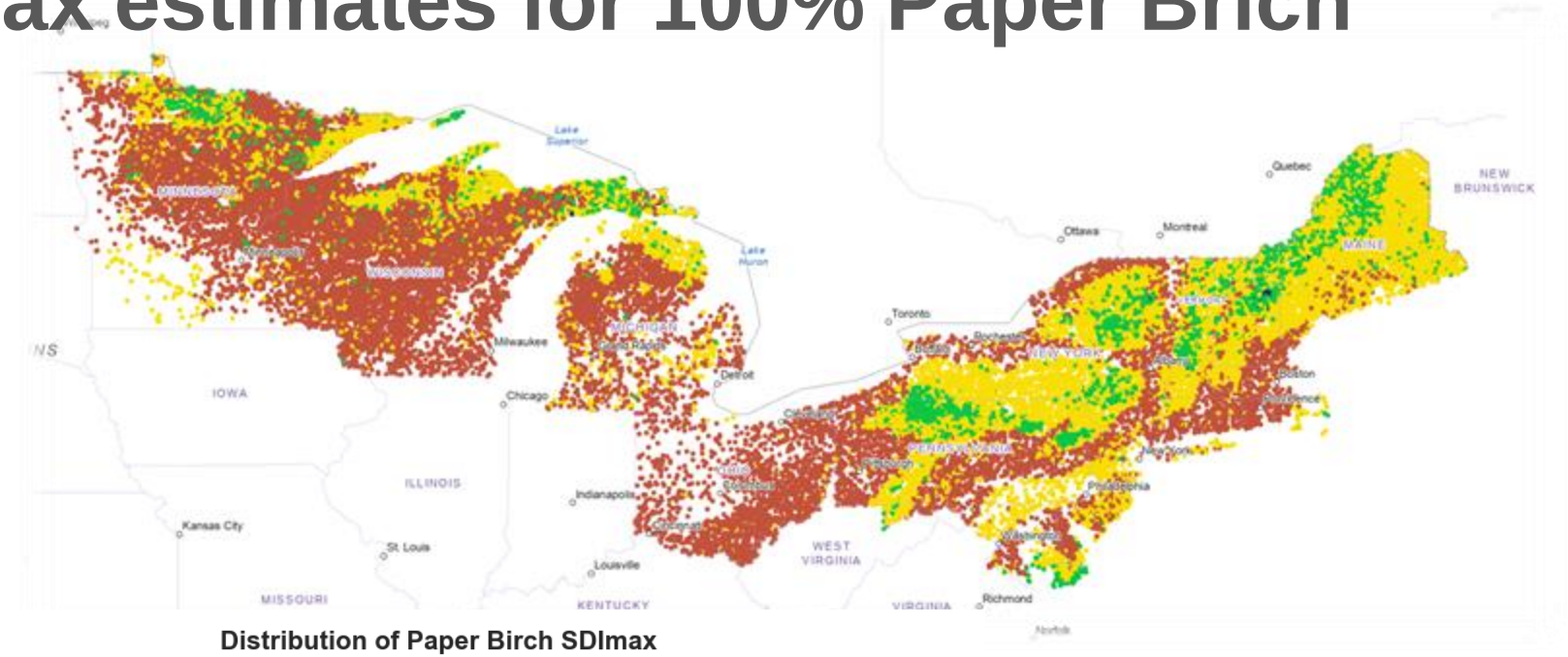
SDImax estimates for 100% Sugar Maple

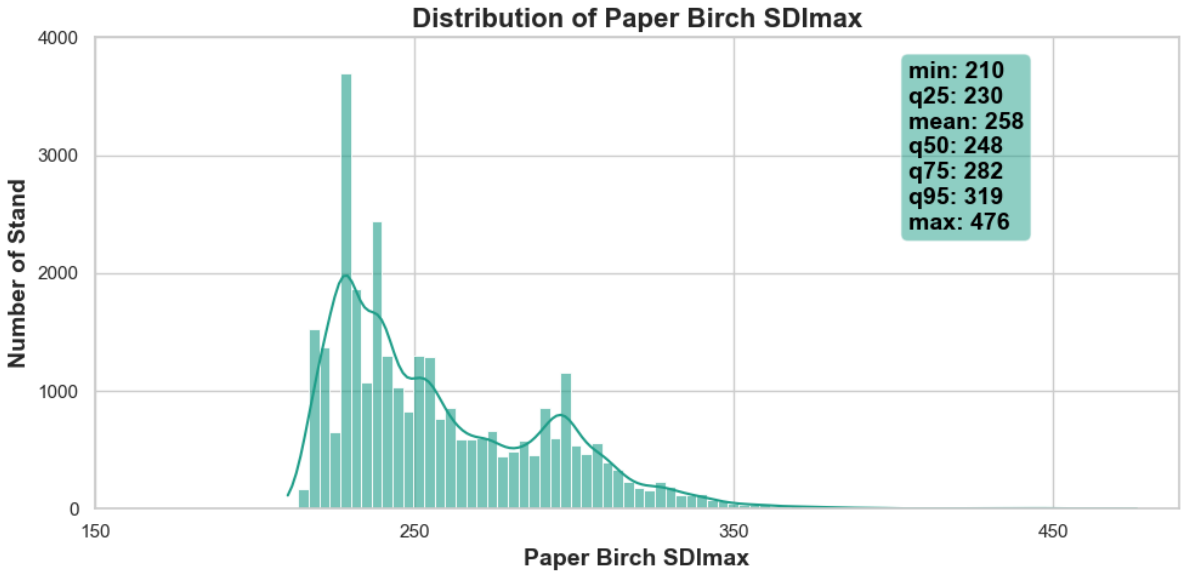


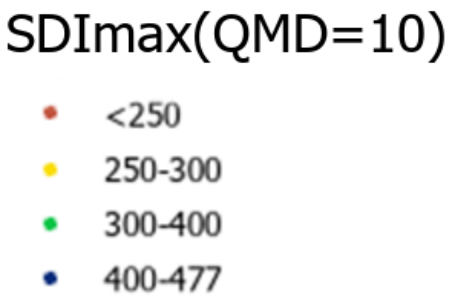




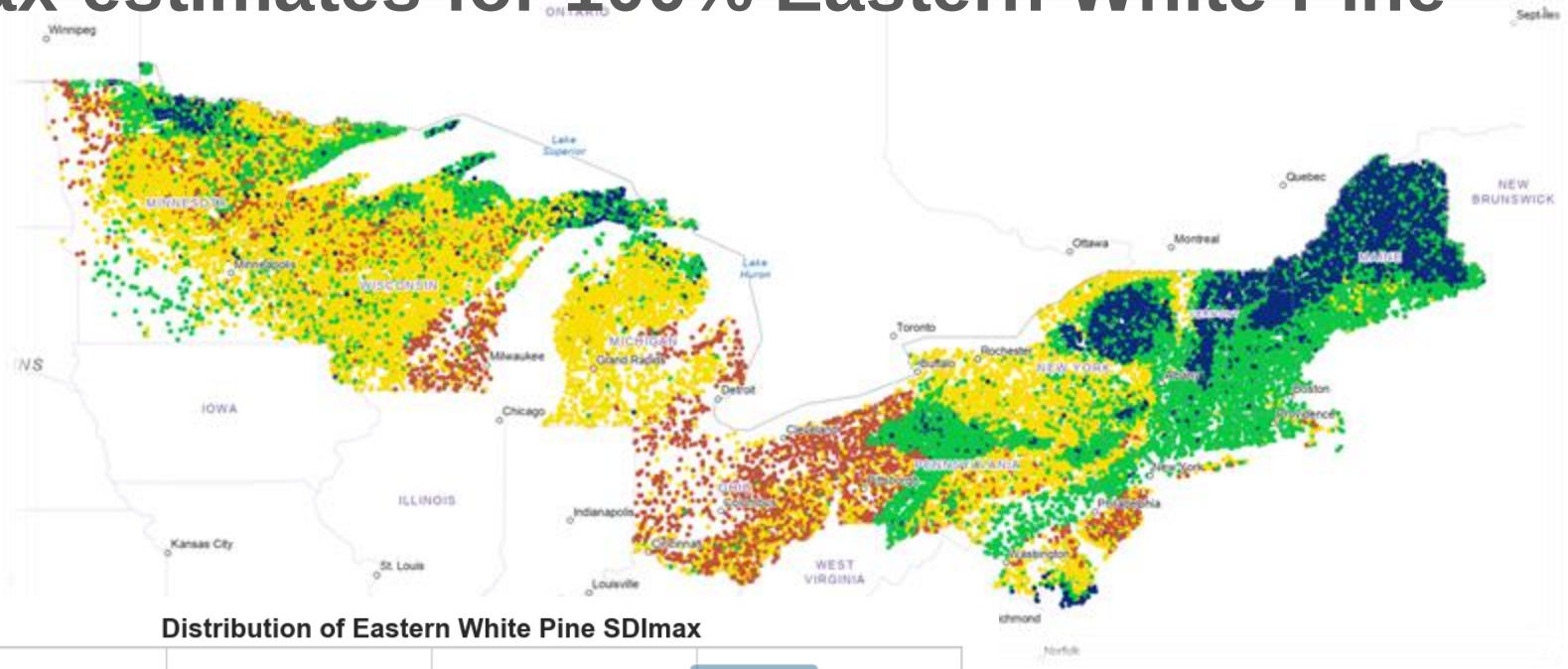
SDImax estimates for 100% Paper Brich

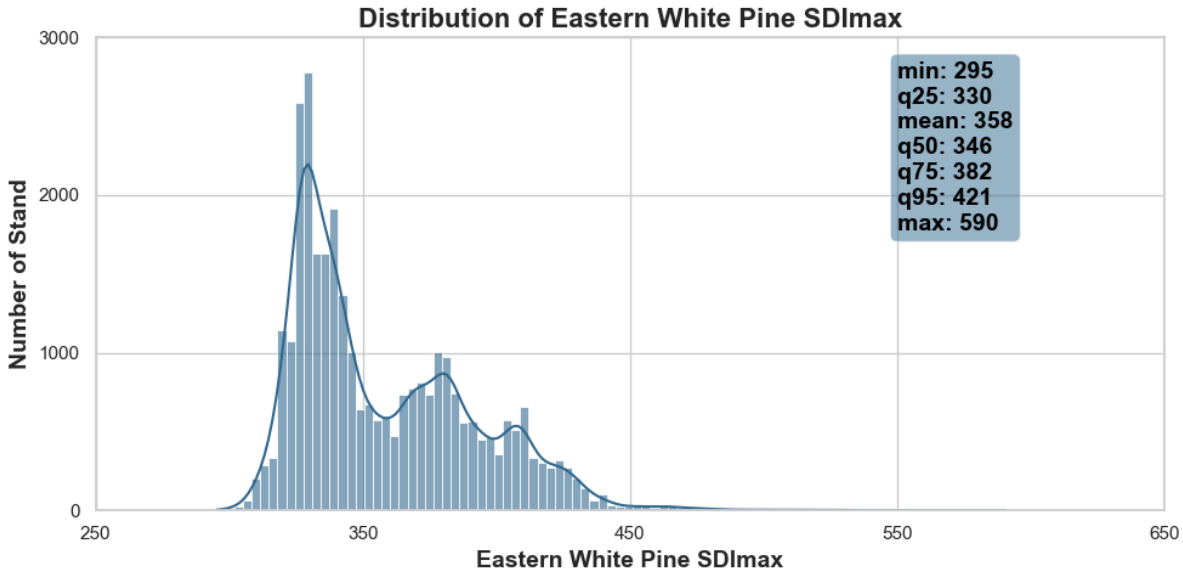


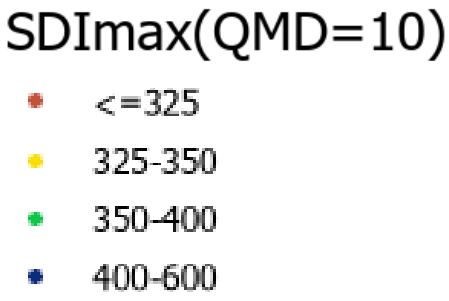




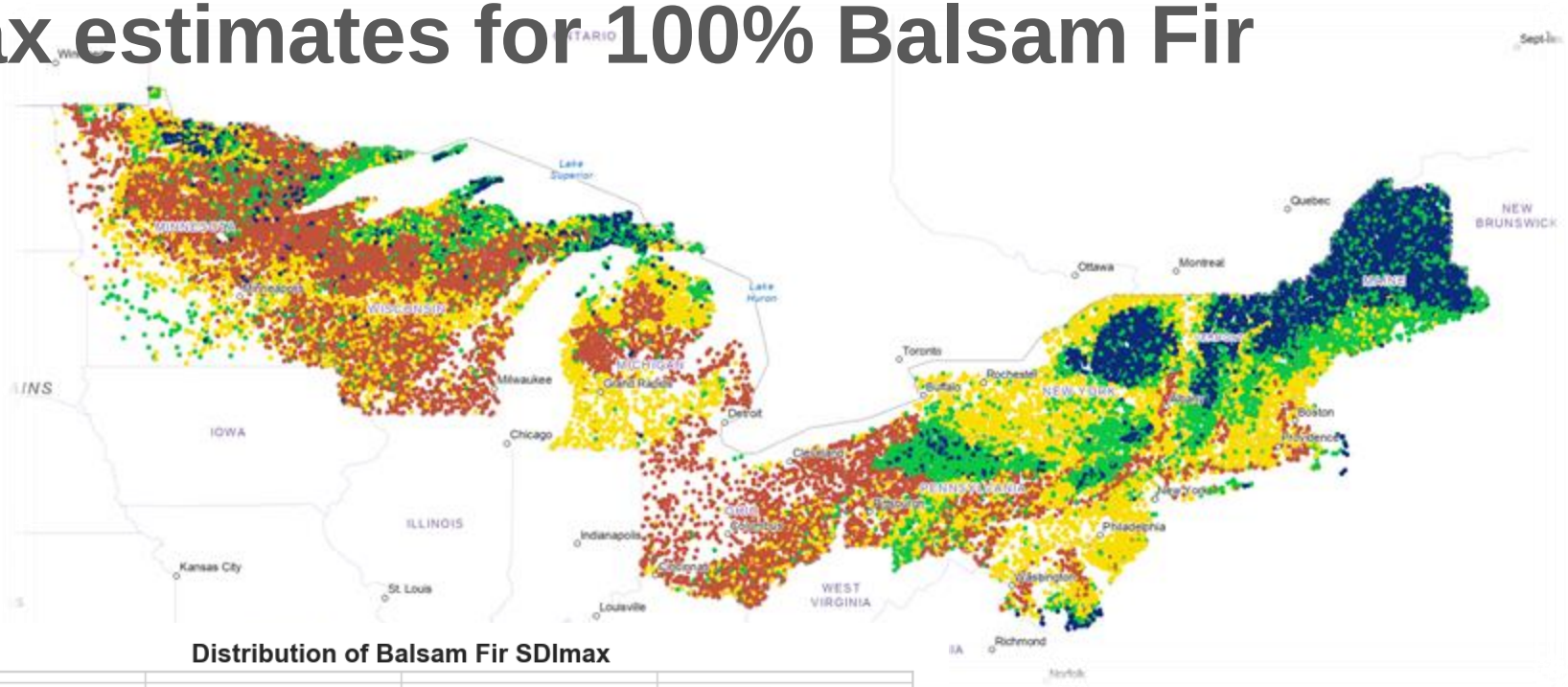
SDImax estimates for 100% Eastern White Pine

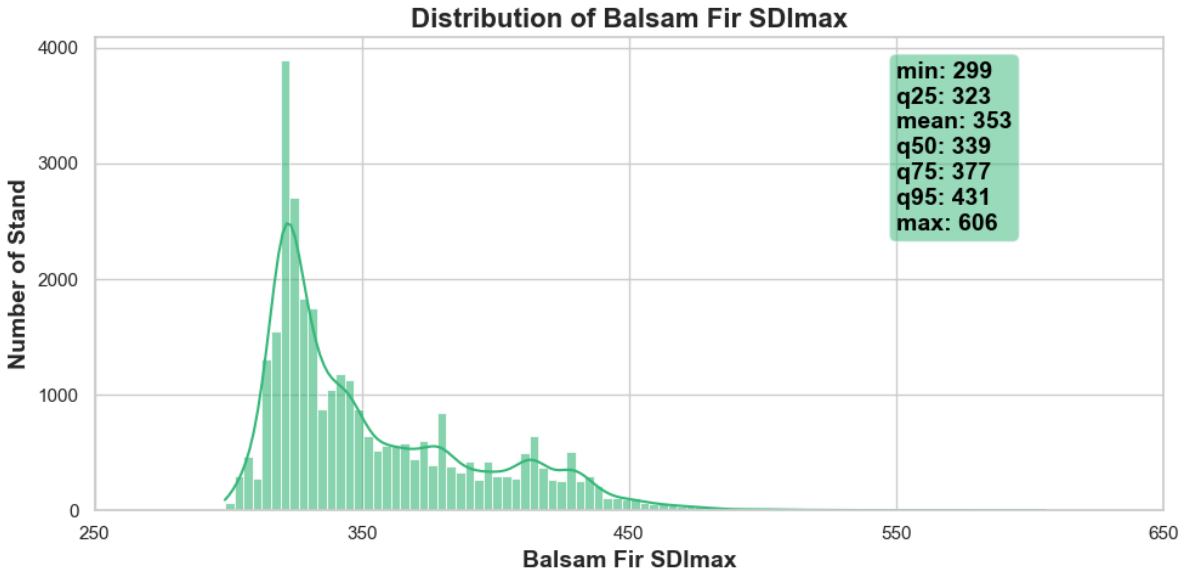






SDImax estimates for 100% Balsam Fir

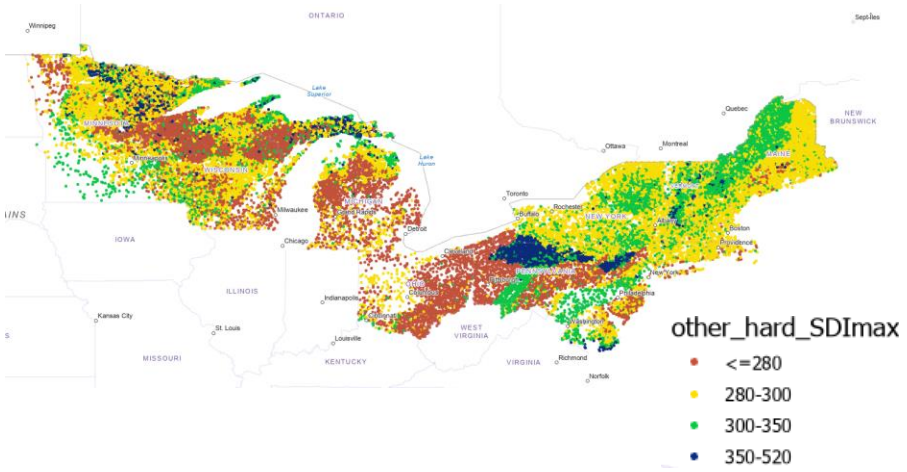


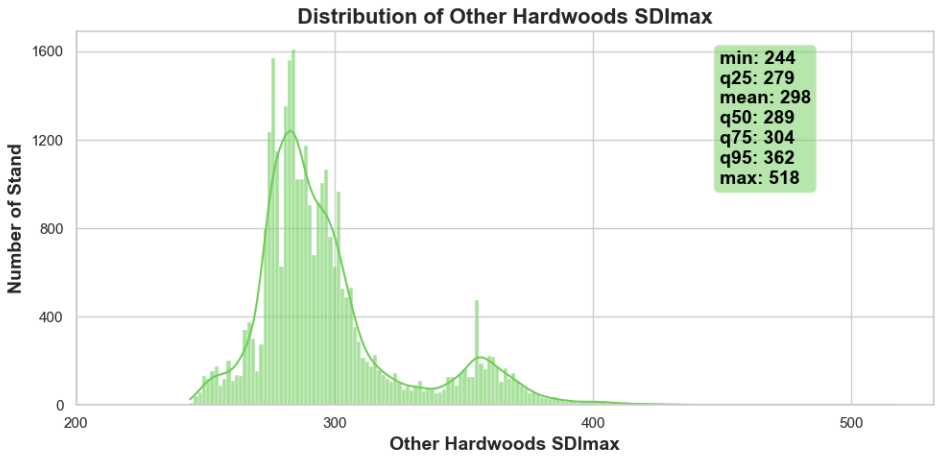


SDImax(QMD=10)

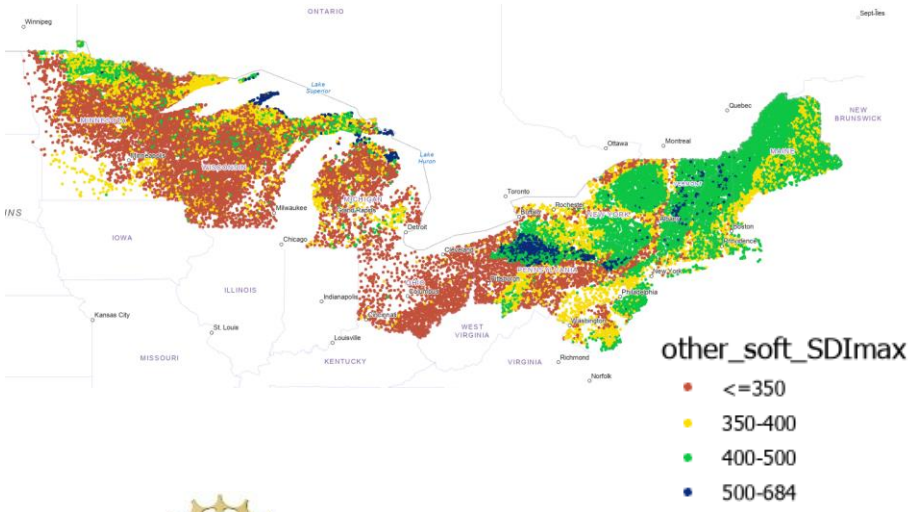
- <=325
- 325-350
- 350-400
- 400-600

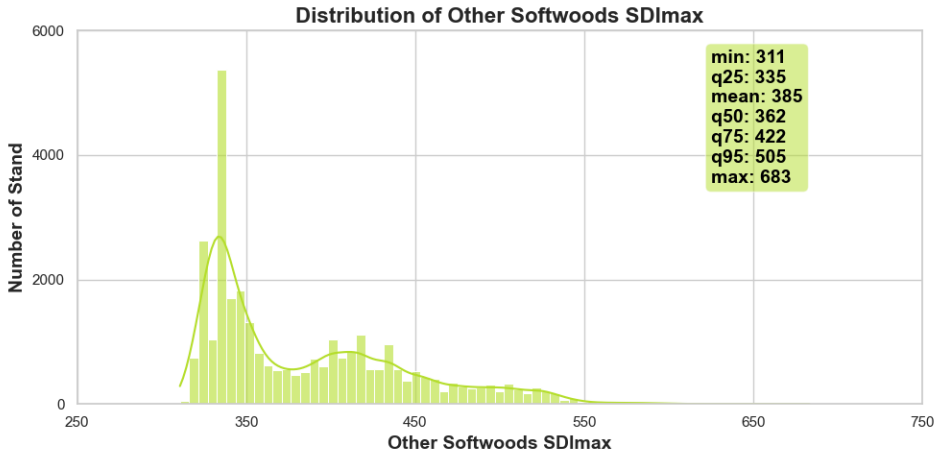
SDImax estimates for 100% Other Hardwoods



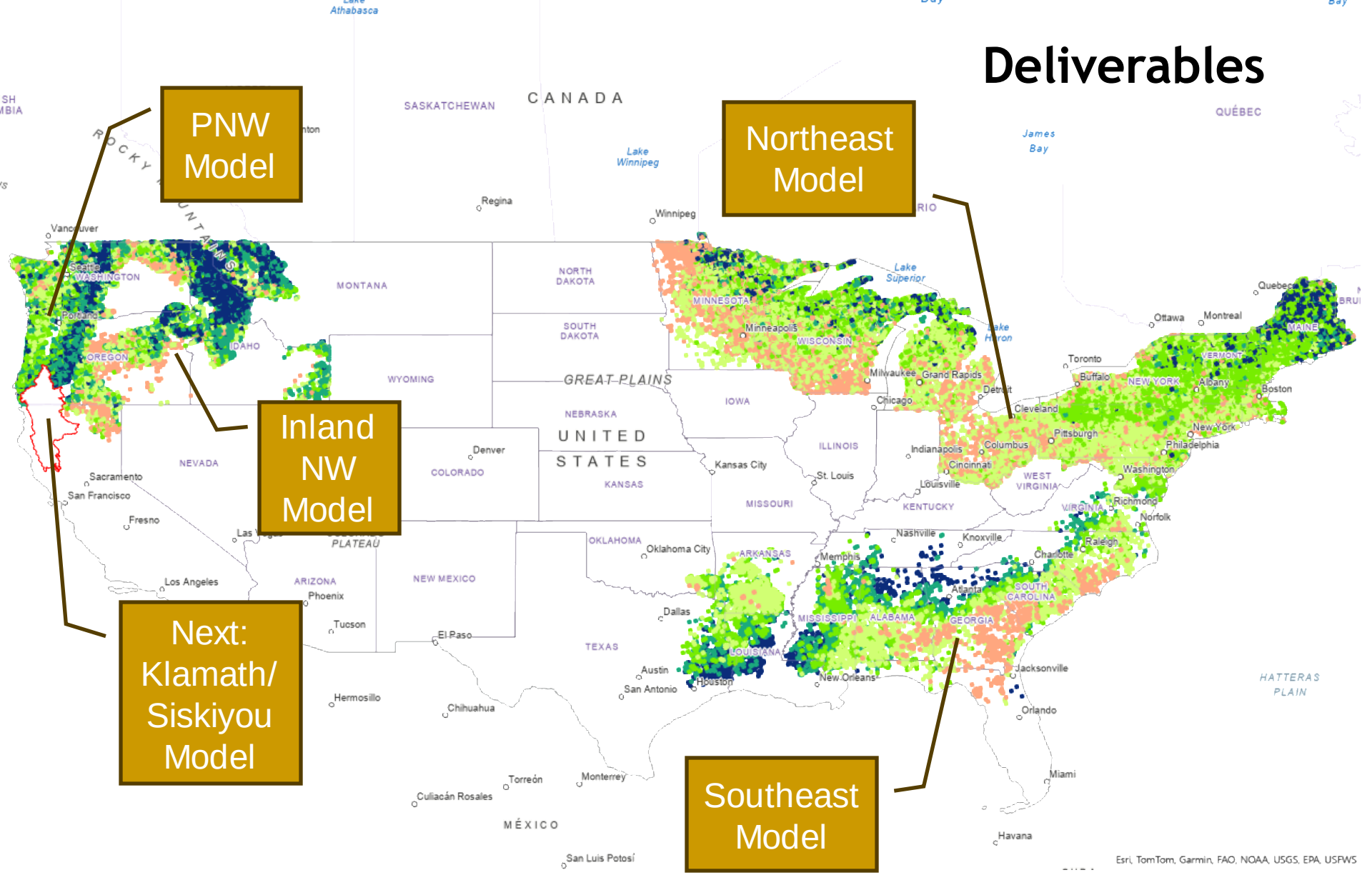


SDImax estimates for 100% Other Softwoods





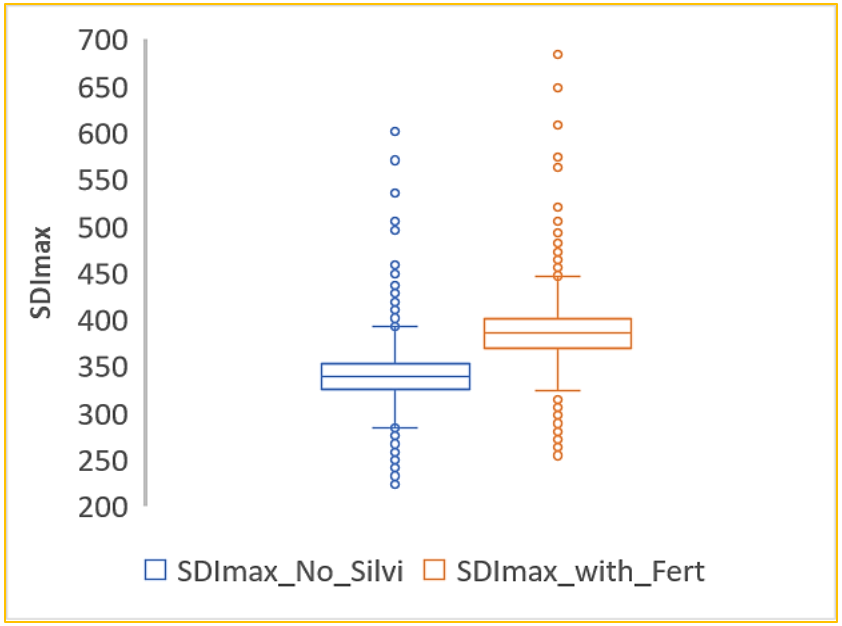
Deliverables



Regional model python script available for GIS integration

Company Benefits

- Understand key drivers of forest carrying capacity across the US
- Identification of optimal planting or thinning residual densities for a company management objective as a function of:
  - Species composition
  - Site resources
  - Silvicultural treatments (SE US only)
- Consistent methodology/platform for identifying and managing forest density across multi-regional land holdings



Recommendations

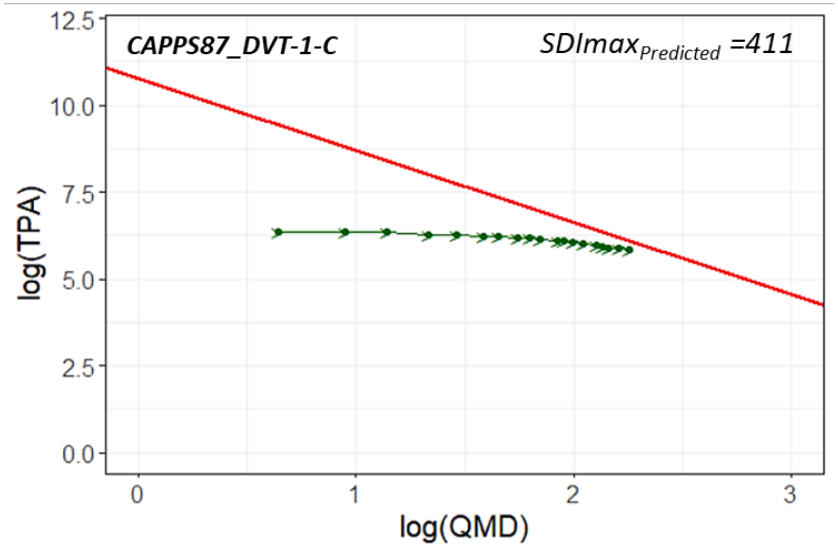
❑ CAFS members begin evaluating regional models, we need operational feedback

❑ Leverage existing inventory data and regional models to:

- Determine if model is correctly identifying self-thinning stands, or is under/over predicting SDImax

❑ Leverage CFI plots to identify growth trajectory (QMD/TPA) toward predicted SDImax

- Determine if trajectory under/over shoots predicted SDImax



Summary

❑ Next Steps

- Finalize loblolly pine model with most current FPC soils database
- Finalize northeast model with CAFS member input from this meeting
- Re-run PNW model using standardized methods used for INW, SE, NE
- Create Klamath/Siskiyou model
- Given time, evaluate additional species assemblages in SE
- Provide CAFS members with Python SDImax model script for operational feedback
- Continue building zero-coded web app for regional SDImax models
- Begin developing projected climate SDImax models