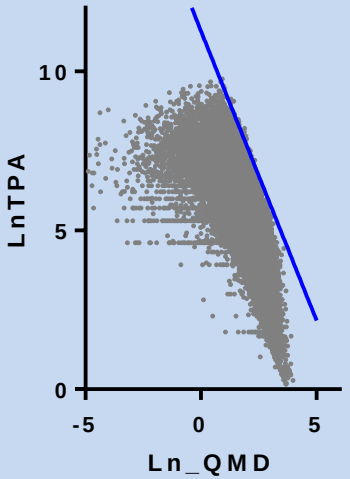
Defining Mixed Species Maximum Density

Technical Advisory Meeting

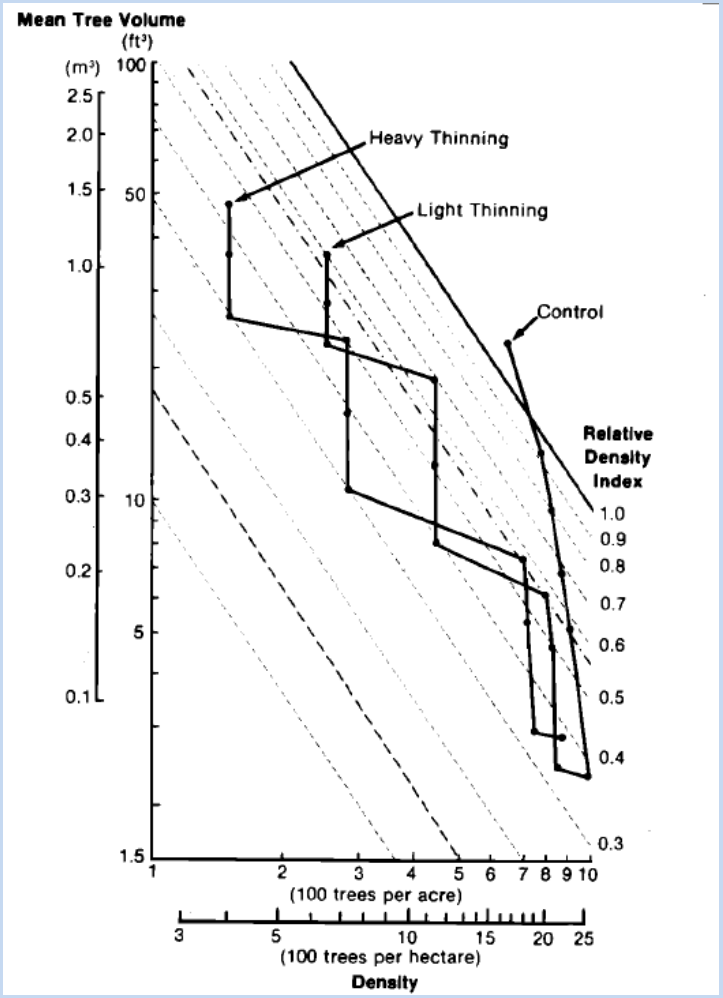
Spokane, WA

25 June 2014



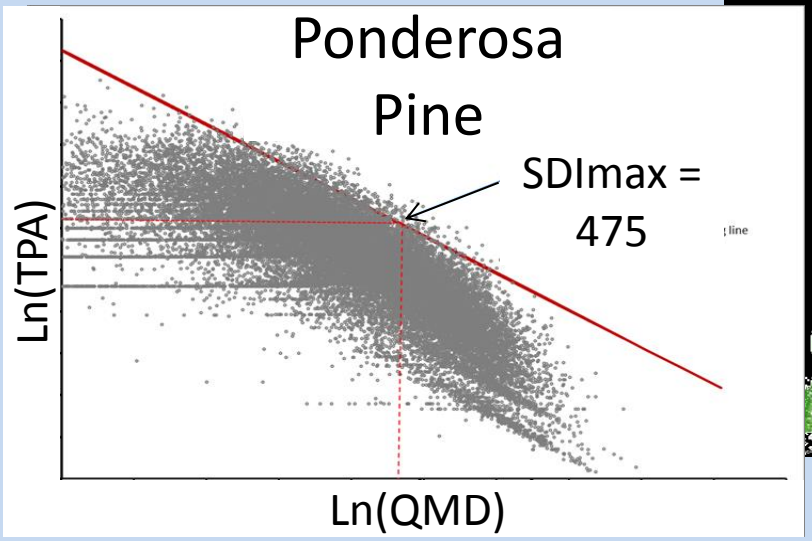
The utility of the ‘normal’ stand as a reference

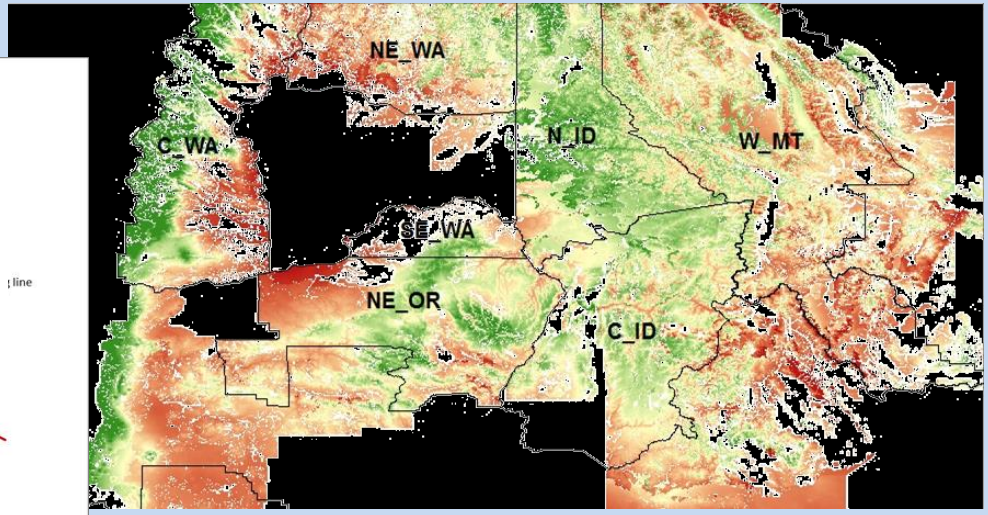
- Thinning meets numerous objectives:
  - improved economic value
  - Increased resistance to wildfire, drought, pests and disease
- Thinning is prescribed based on a maximum reference density
- Typically define maximum density for single species



Progress on single species density models

- Modeled SDImax for 4 species in the INW: DF, GF, PP, WL
- Based on IFTNC Database
- Developed Predictive layers
- Target species proportion always remains in models predicting maximum stand density

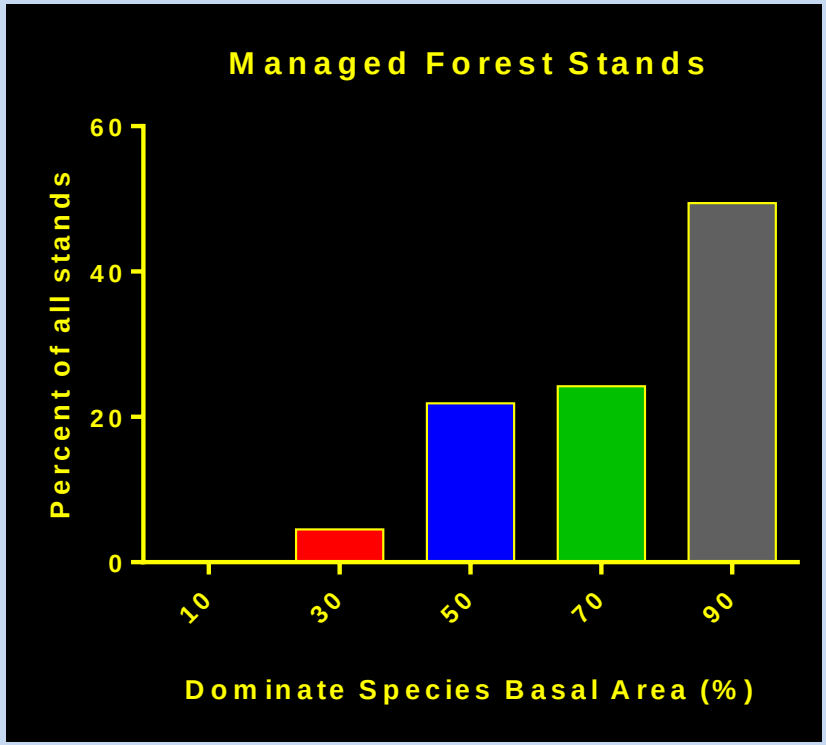




$$Ln(TPA) = b_0 + b_1 \cdot Ln(QMD) + b_{2i} \cdot RockType_i + b_3 \cdot Ln(ADI) + b_4 \cdot Ln(Elevation) + b_5 \cdot Ln(Prop.\ BA) + b_6 \cdot Ln(Prop.\ BA) \cdot Ln(QMD)$$

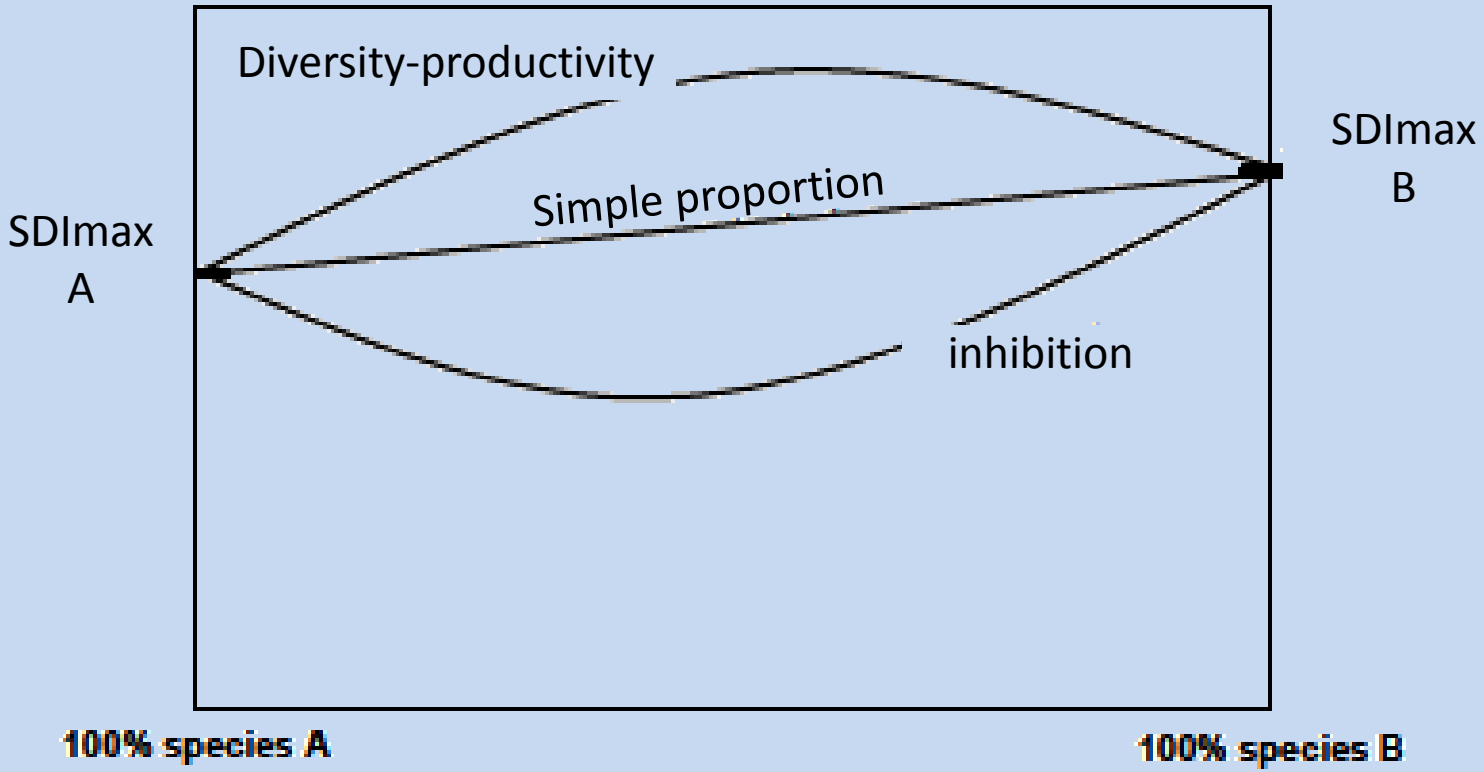
The challenge of mixed species stands

- Mixed species stands are typical in the intermountain region
- Maximum density for mixed stands is difficult to define.
- But still necessary for management



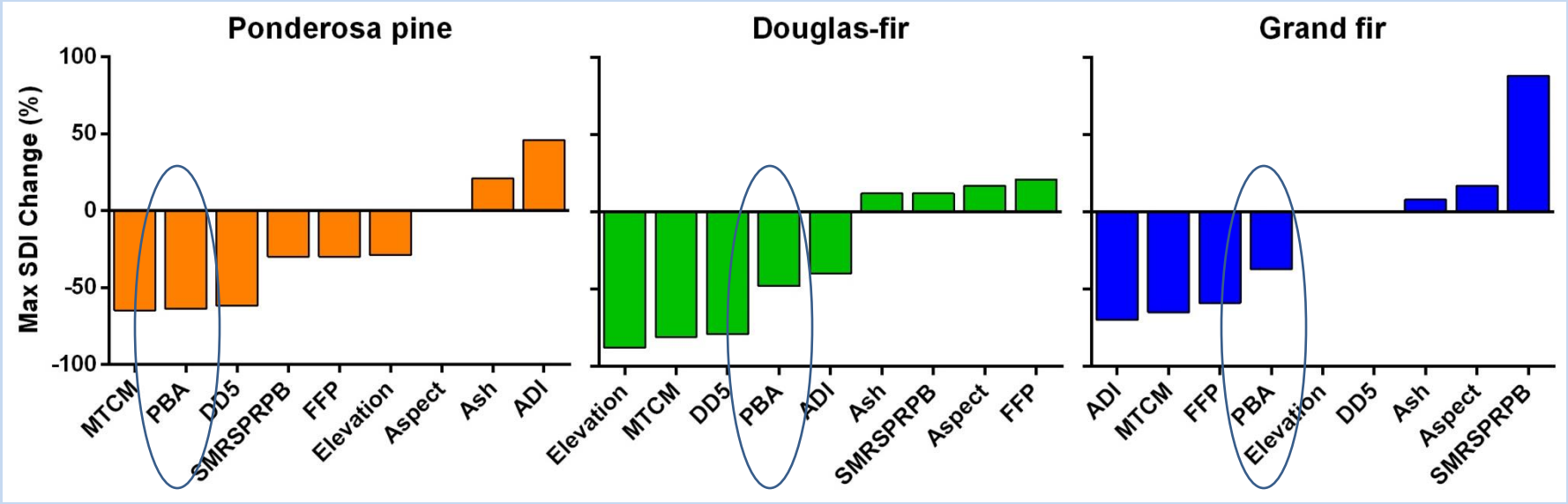
Previous approaches to mixed-stand SDImax

- Weighted sums
- Lowest component
- Two-species conceptual model
- Difficult to model SDImax for all possible combinations



Proportion of the basal area (PBA) is always an important factor in single species models

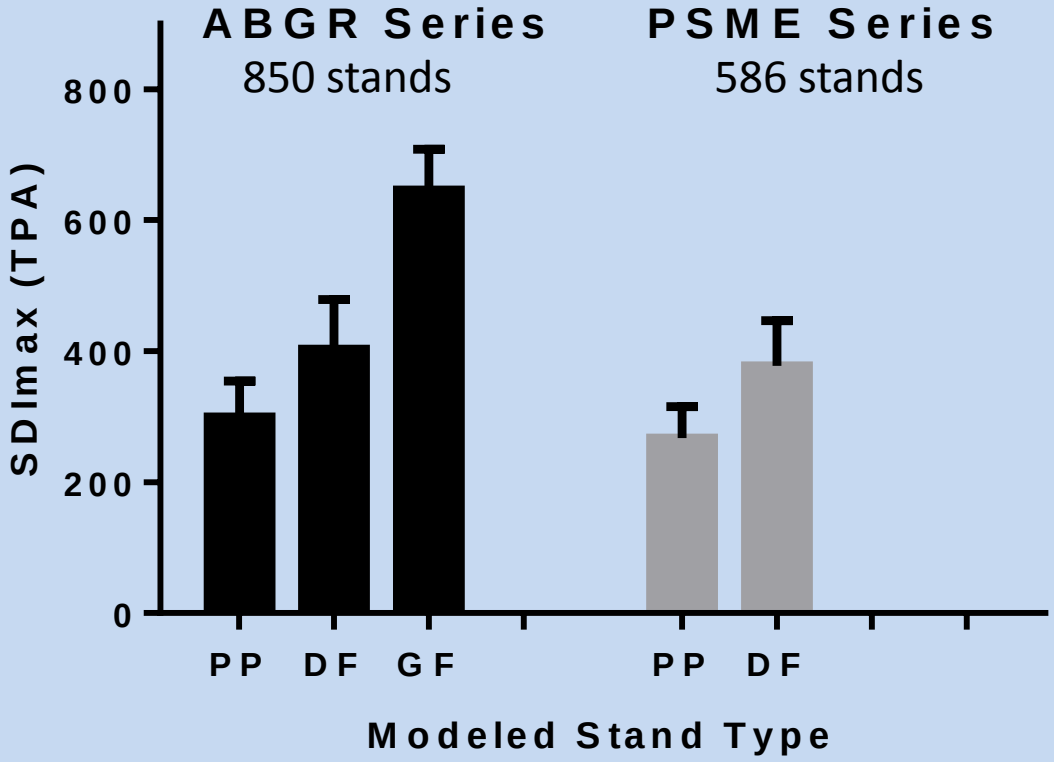
Shifts in Density by Factor



By subtraction, the PBA of other species in stand have equal and opposite impact

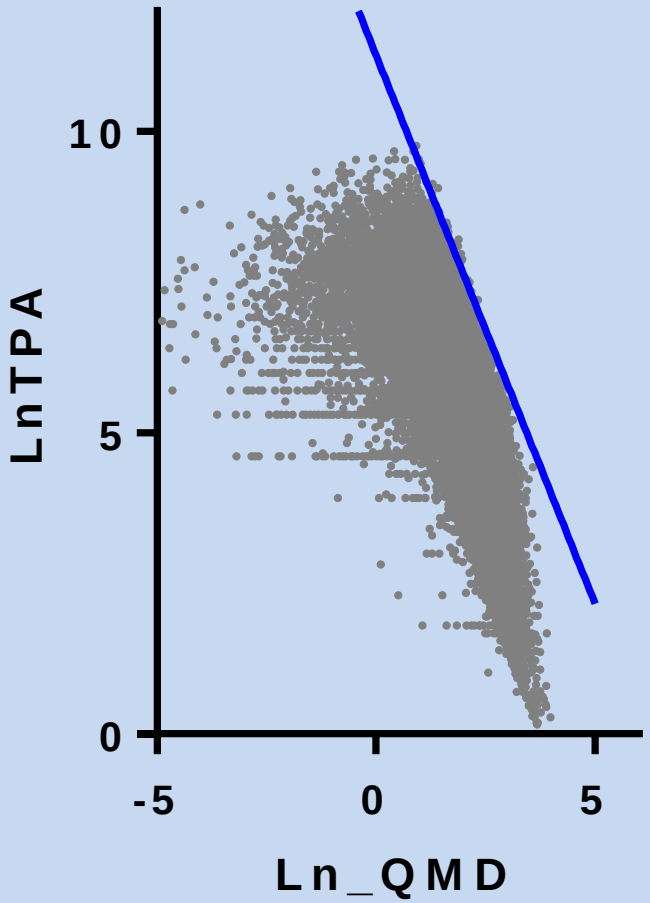
Successional climax species have the greatest stocking potential

- Single species models predict greater SDImax for the climax species than others



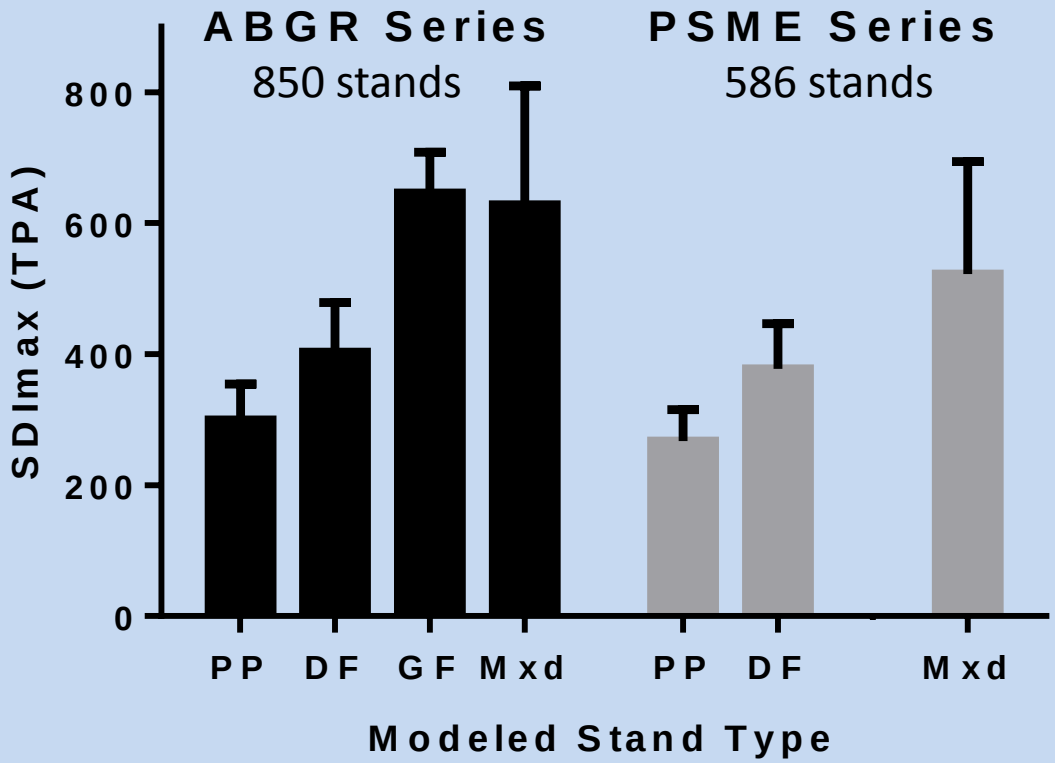
IFTNC Mixed Species Model

- Remove species filters
- Predict maximum density based on the entire IFTNC database
- Used as reference to compare single species models



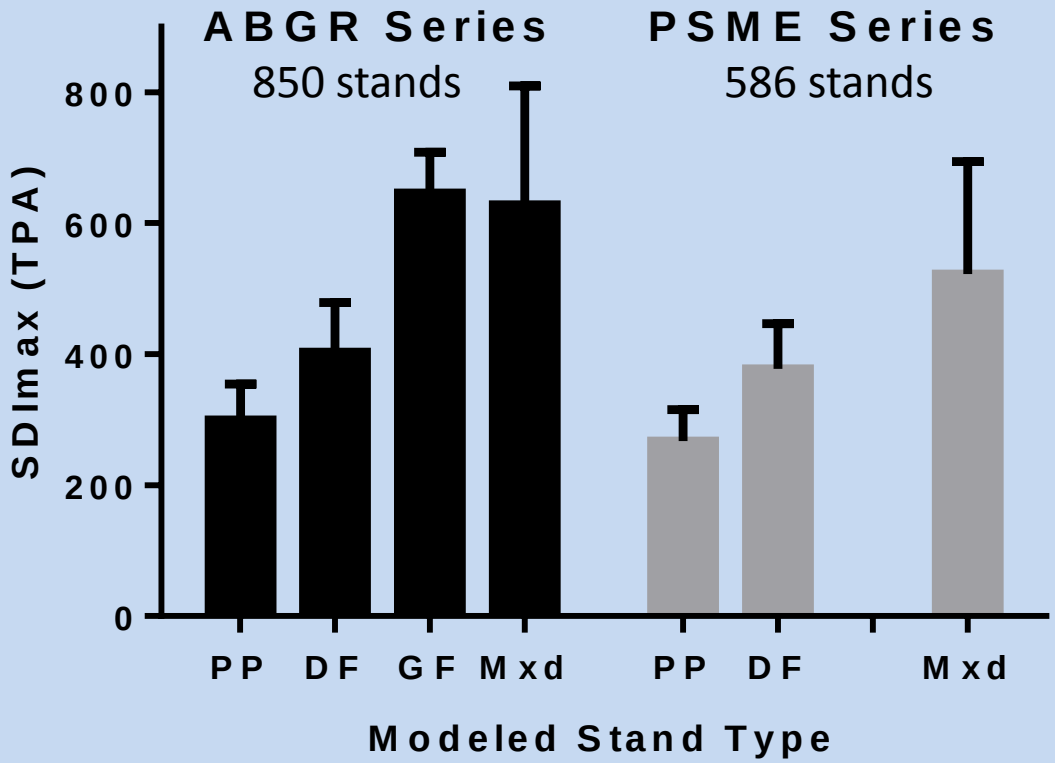
Mixed stand likely have higher carrying capacity than pure stands

- More likely on PSME series than on ABGR series
- Predicted SDImax for mixed stands is more variable than for pure stands



Site quality effect are not greater than species effects

- Predicted SDImax for pine and Douglas-fir are similar on either veg series
- Yet there are strong species differences
- Variation in mixed stands is probably due to species mix rather than site variation



How do we determine SDImax for mixed stands?

- The all-species mixed stand model
  - is a lumped average
  - suggests individual species are important
- How to separate species in the mixed stand model?
  - Wood specific gravity approach
  - Multiple regression approach

SDImax is related to wood density

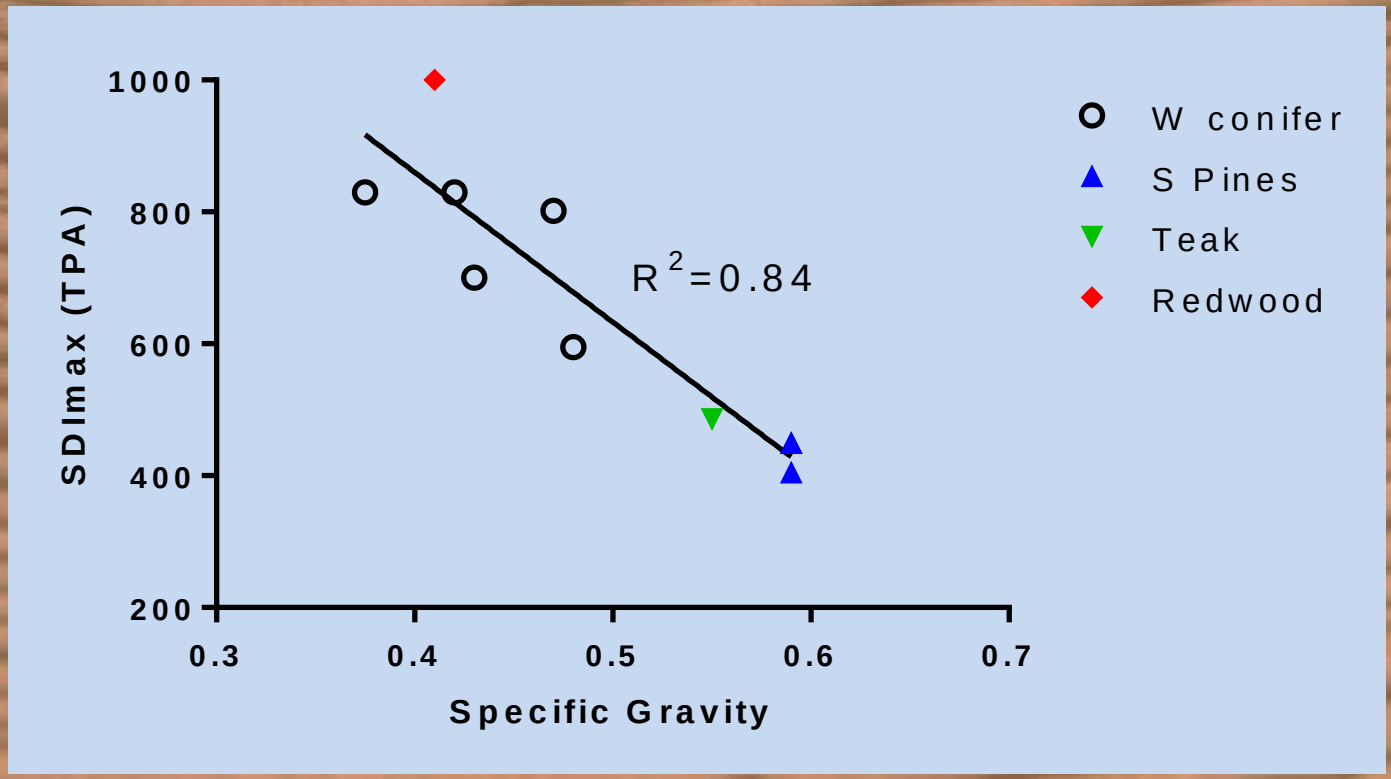
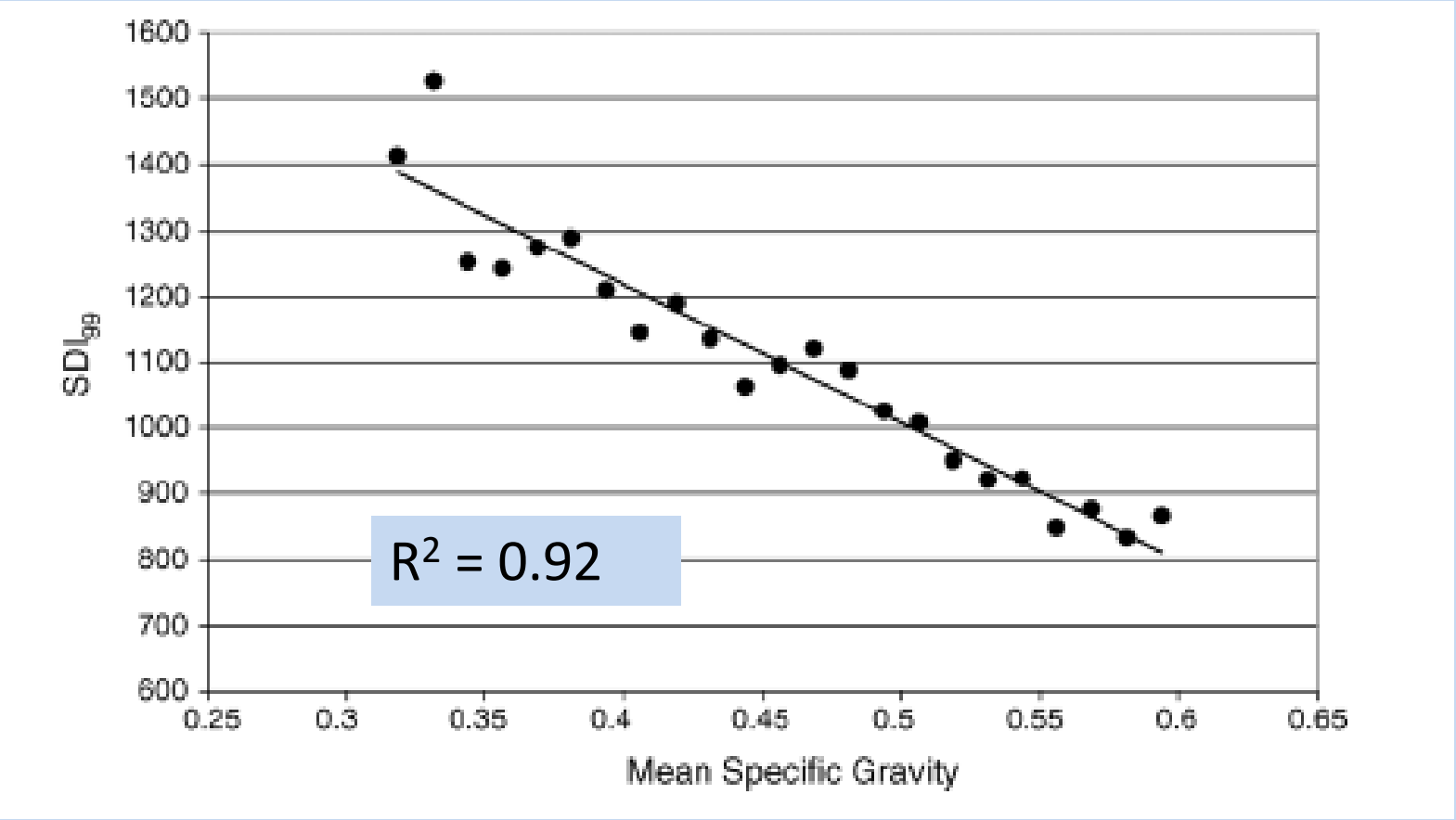


Table 2, Dean and Baldwin 1996 FEM 81:25

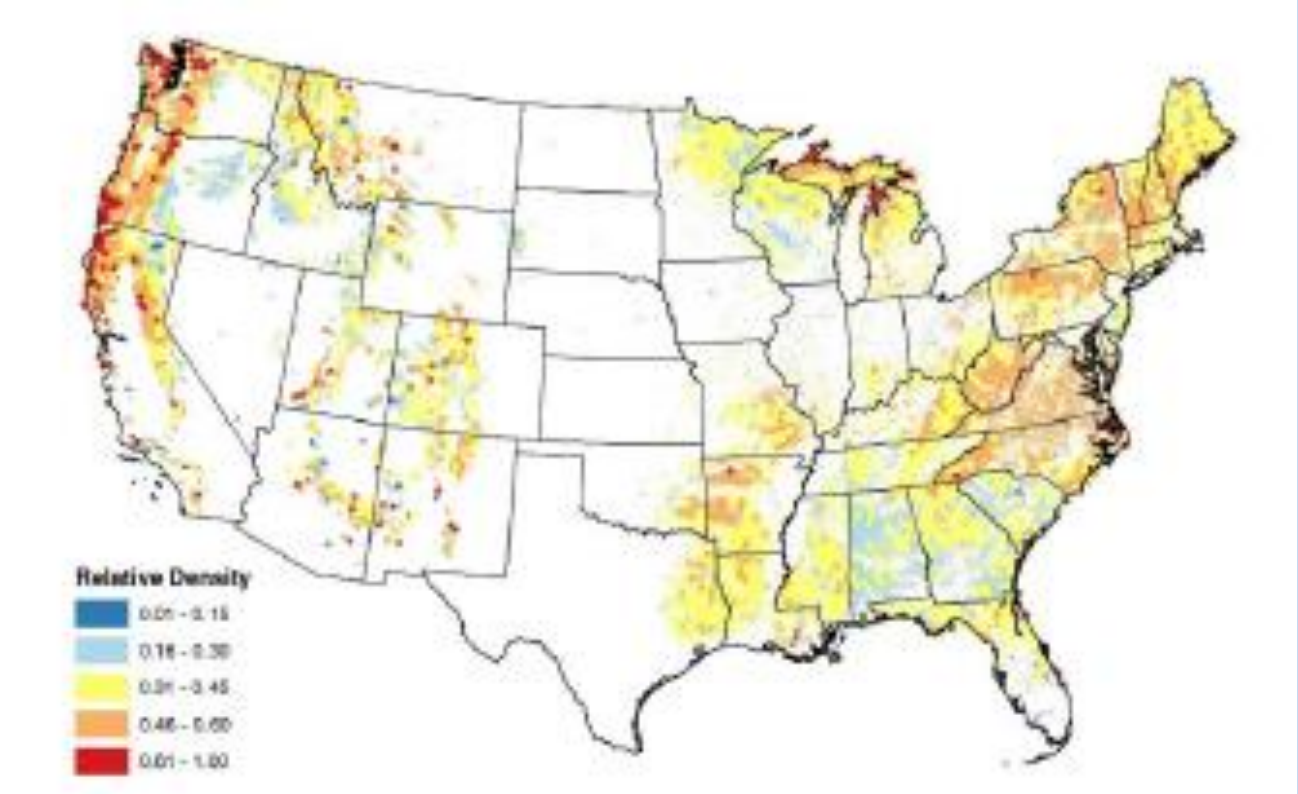
99th percentile of SDI for 26 specific gravity classes



119,235 FIA plots

Figure 3, Woodall et al 2005 FEM 216:367

Application of the specific gravity approach



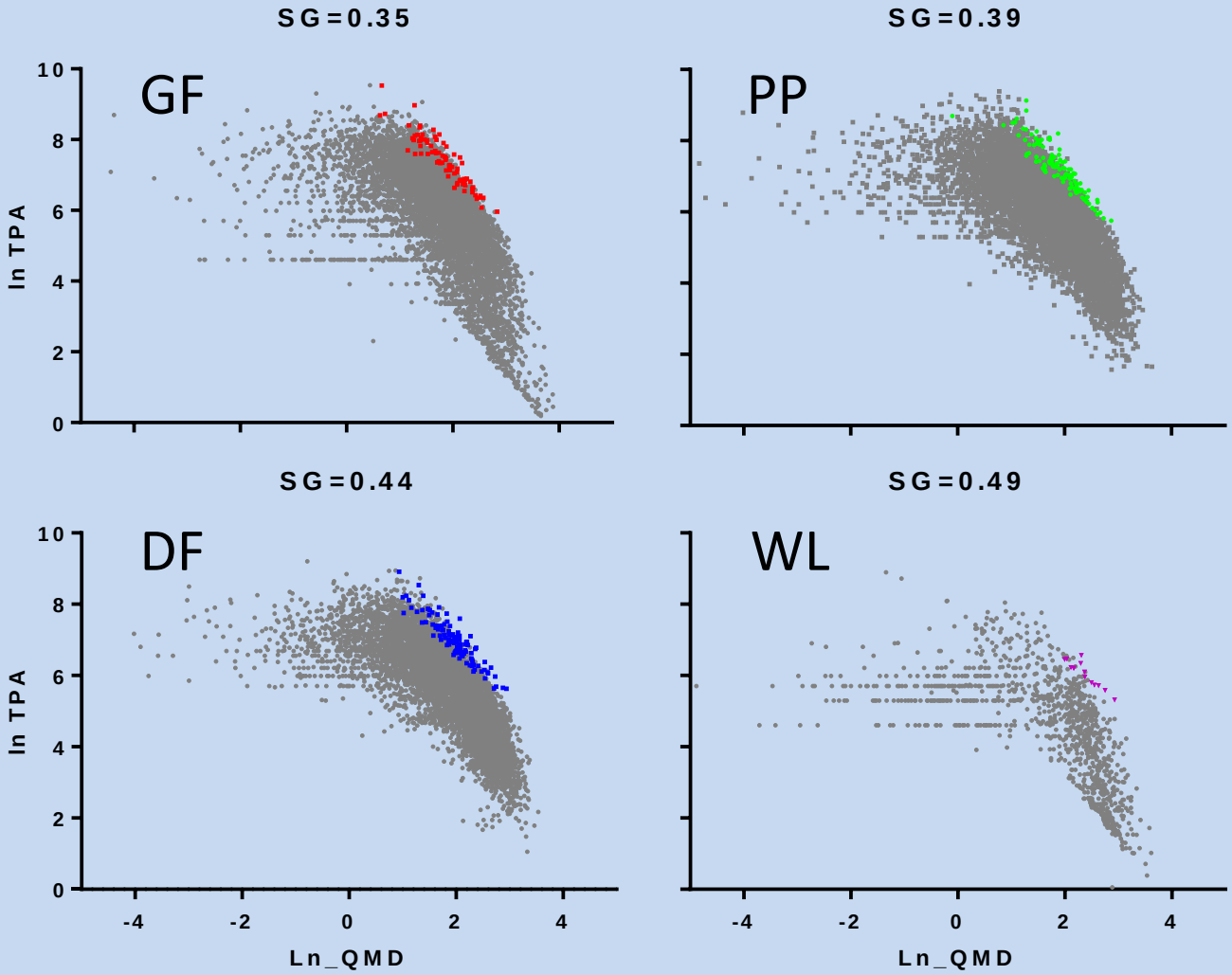
Relative Density
RD = SDI / SDImax

Where

SDImax = 3547 – 3927 SG_{mean}

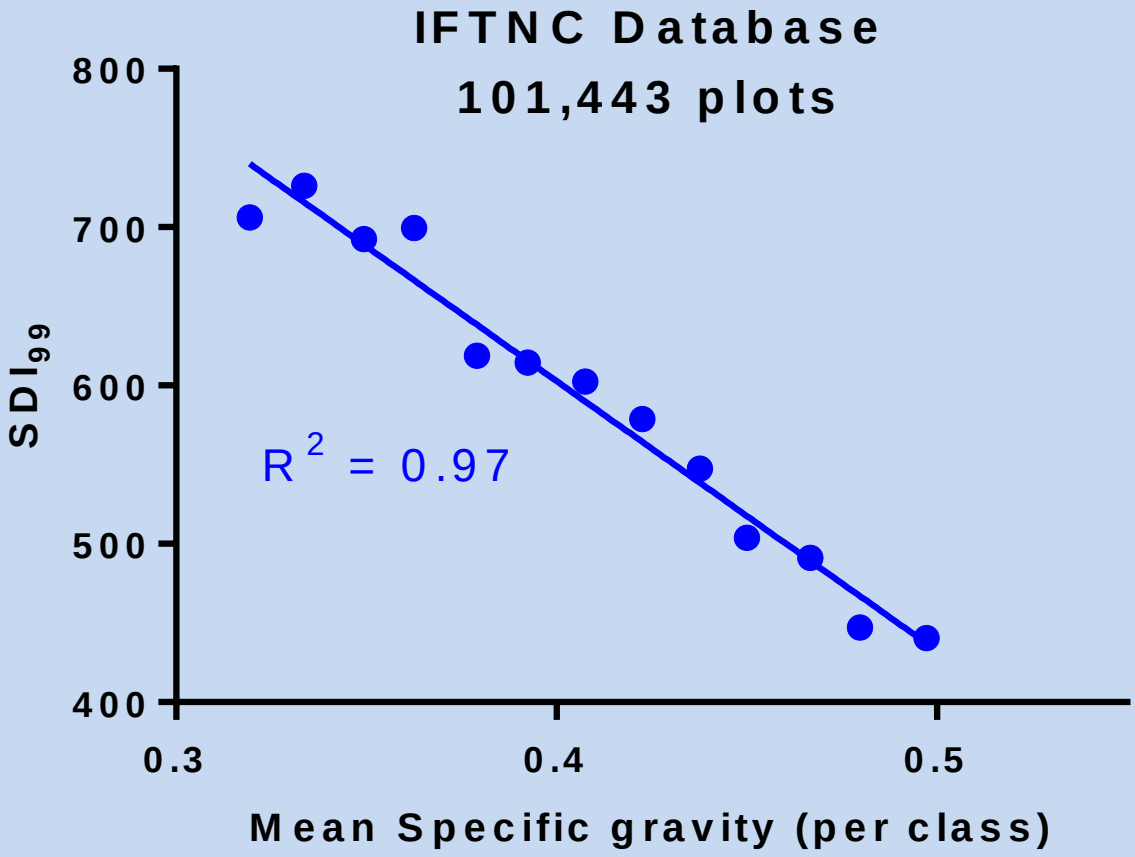
Woodall et al 2006 FEM 226:368

4 of 13 specific gravity classes represent individual species



Potential mixed-species model

99th percentile of SDI for 13 specific gravity classes



Stochastic Frontier Regression Model:

$$Ln(TPA) = \alpha + \beta_1 * Ln(QMD) + \beta_{2\text{-}i} * (Factors) + e$$

Proc QLIM in SAS

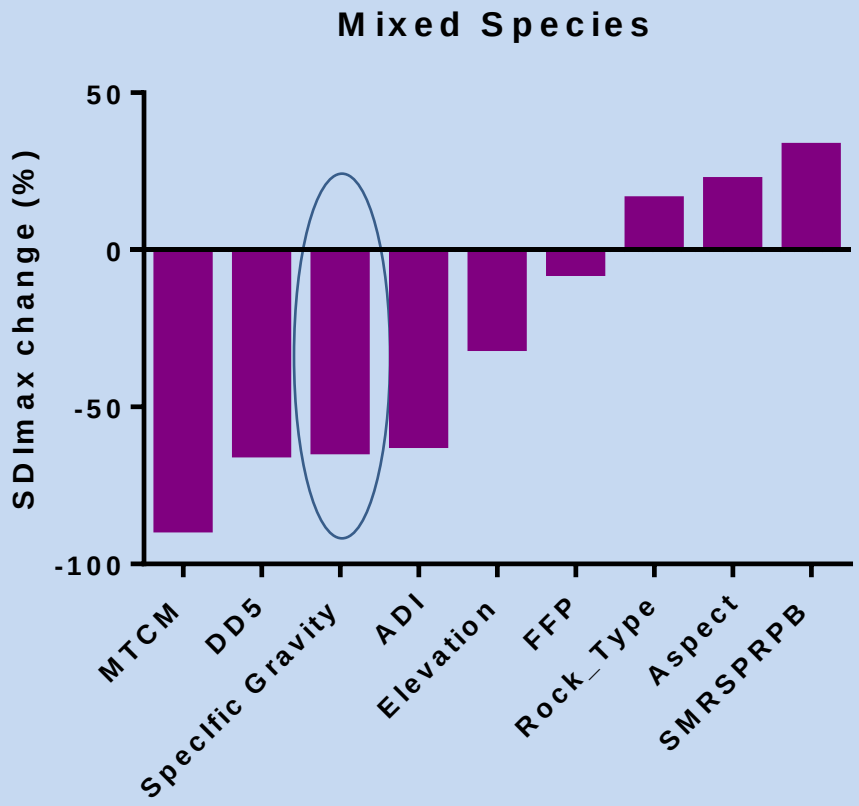
<u>Single-Species Factors</u>

- Basal Area
- Rock Type
- Elevation
- Aspect
- ADI
- DD5
- FFP
- MTCM
- SMRSPRPB

<u>Mixed-Species Factors</u>

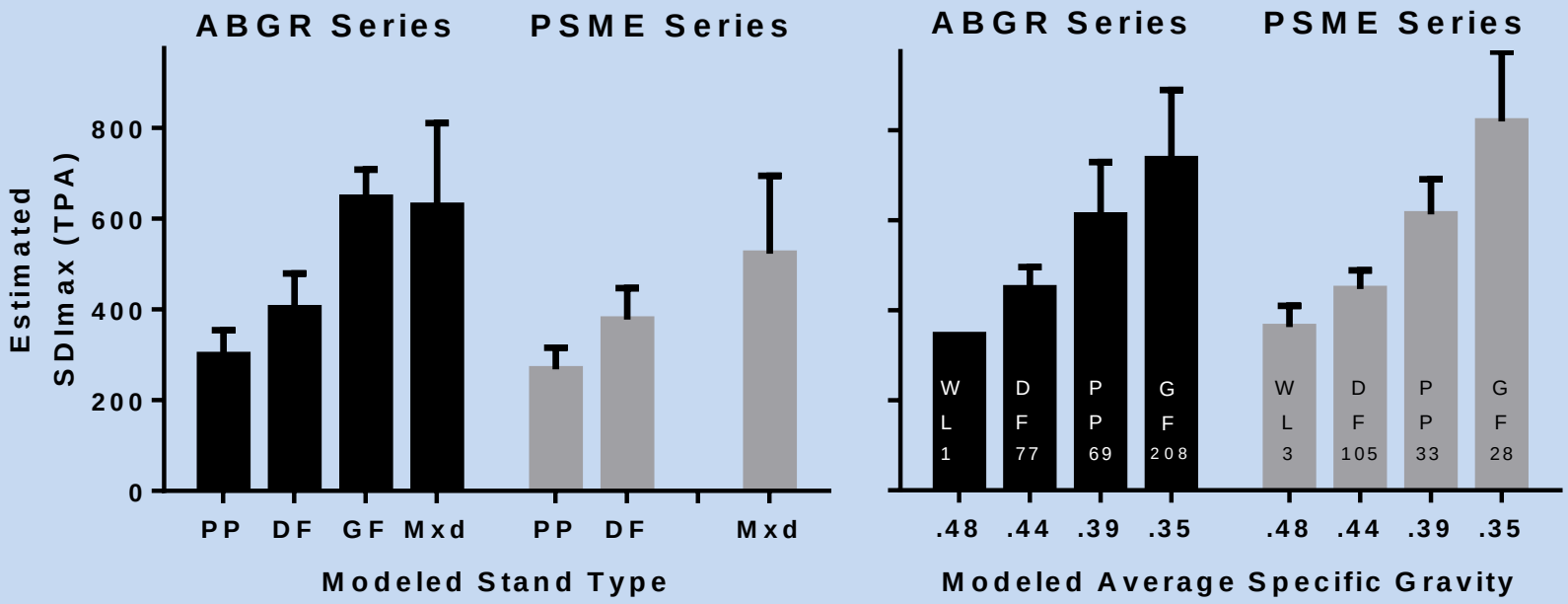
- Specific Gravity
- Rock Type
- Elevation
- Aspect
- ADI
- DD5
- FFP
- MTCM
- SMRSPRPB

Specific gravity effect on SDImax



Potential mixed-species model

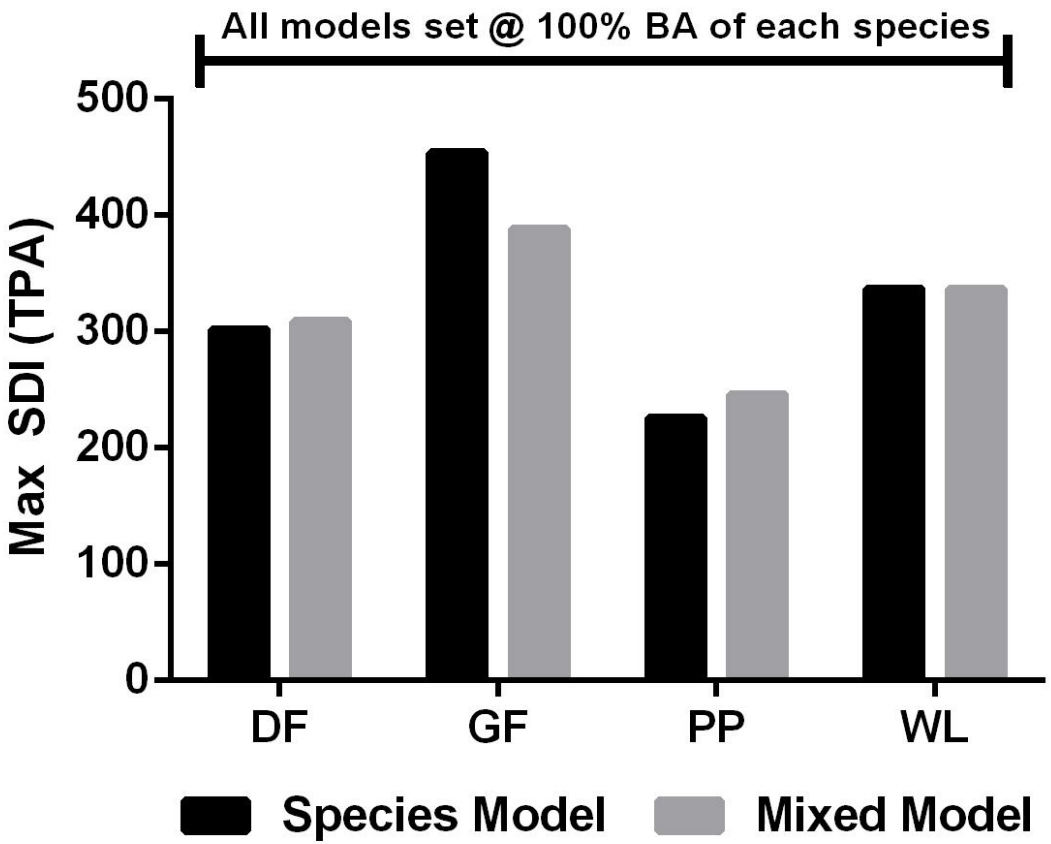
Variation in mixed species model and specific gravity



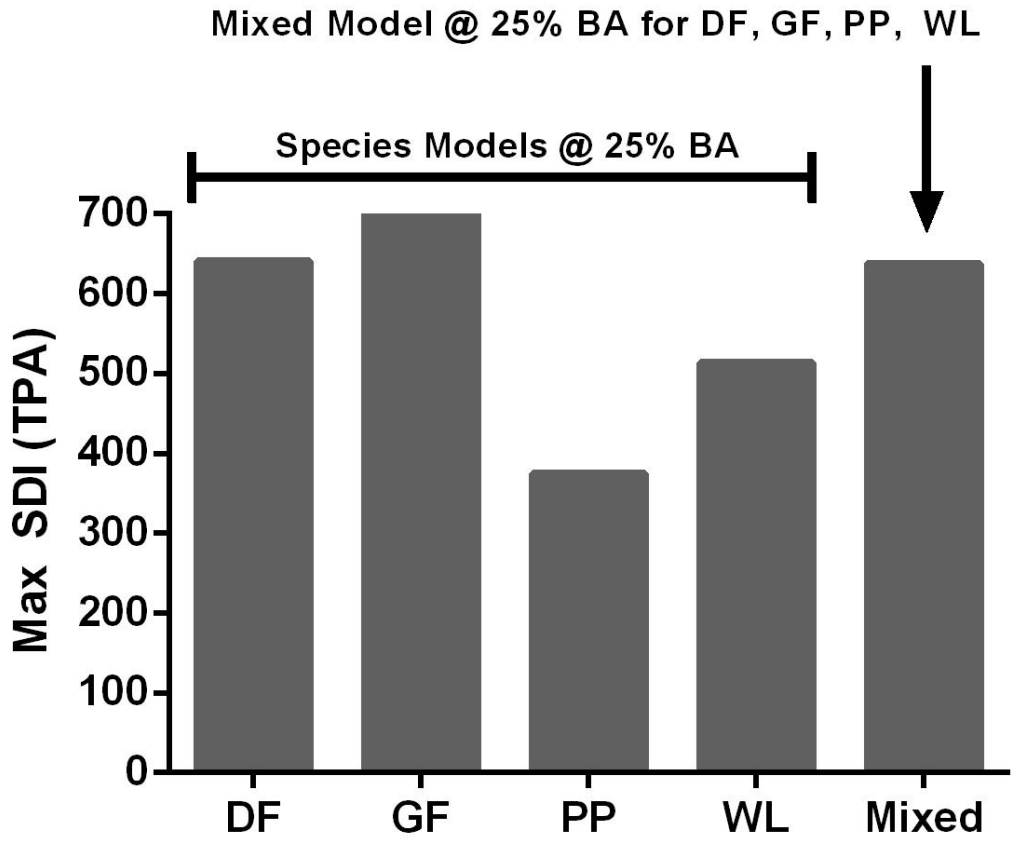
Addressing mixed species by including variables for each species

- DF BA ratio
- GF BA ratio
- PP BA ratio
- WL BA ratio

Maximum Stand Density Model Comparisons at 100% BA



Maximum Stand Density Model Comparisons at 25% BA



Conclusions

- Forest site carrying capacity is essential for identifying management thresholds
- Species-specific size-density relations are available
- Half of Inland Northwest managed forest stands include more than one species
- Mixed-species size-density relations are not available
- Approaches used previously are summations, approximations or 2-species mixes

Conclusions

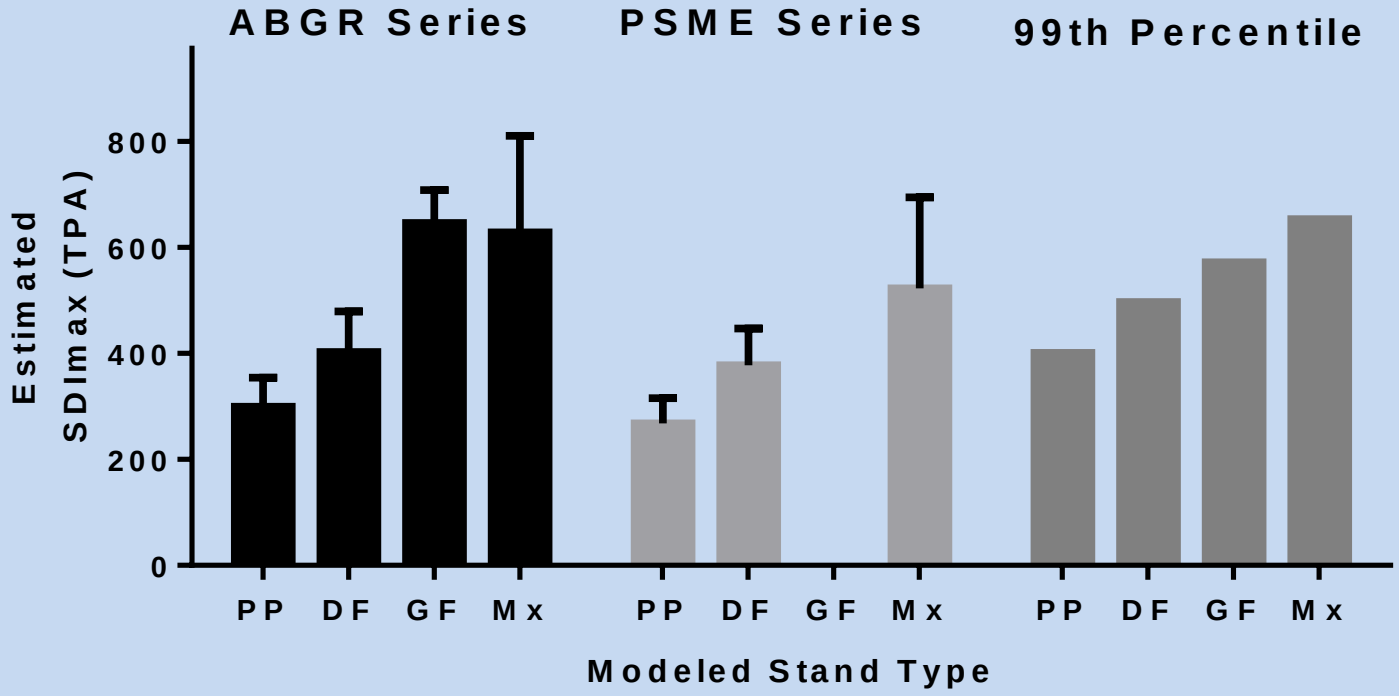
- Mixed species SDImax models were developed using IFTNC DB
- Mixed-species models are more variable than single species
- Variation in mixed species stands is likely due to range of species and sites included
- Average specific gravity of species mix holds promise for identifying SDImax on individual sites
- Properly implemented generalized model for mixed species may replace numerous single-species models

Validating SDImax models

- 99th percentiles as proxy for SDImax
- Follow trend of density in long-term data
- Identify stands with a range of mortality rates
- Comparing FVS predictions to actual stocking while changing maximum density setting

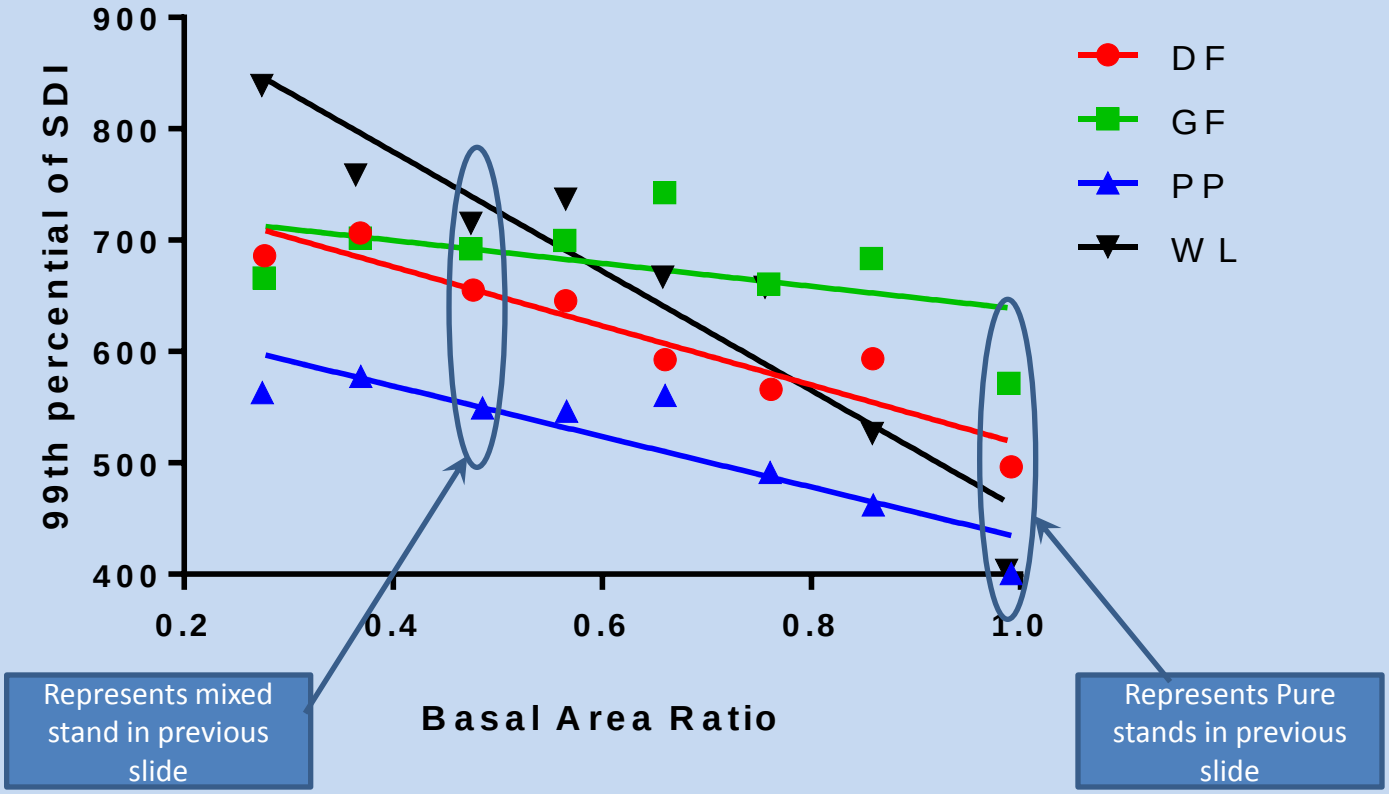
99th percentiles as proxy for SDImax

- Species ranks remain consistent
- Magnitude is similar
- Under estimate SDImax for early seral species



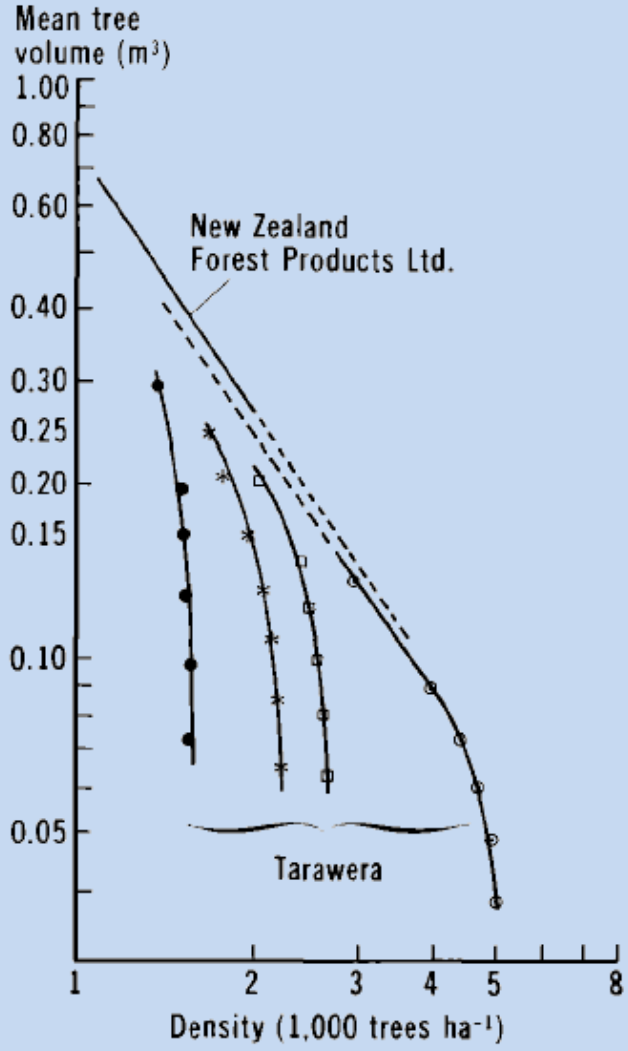
99th percentiles as proxy for SDImax

- SSImax is highest at low BA ratios
- Tends to decline as one species becomes dominate
- Steepest decline is in WL and DF, shallowest for GF



Follow trend of density in long-term data

- Tree growth continues until carrying capacity is reached
- Stressed trees succumb to various agents at immenent mortality through the self thinning line
- Predicted SDImax should exceed the zone of mortality



Drew and Flewelling 1977

Rotation for different spacing