Maximum Density for Mixed Species Stands

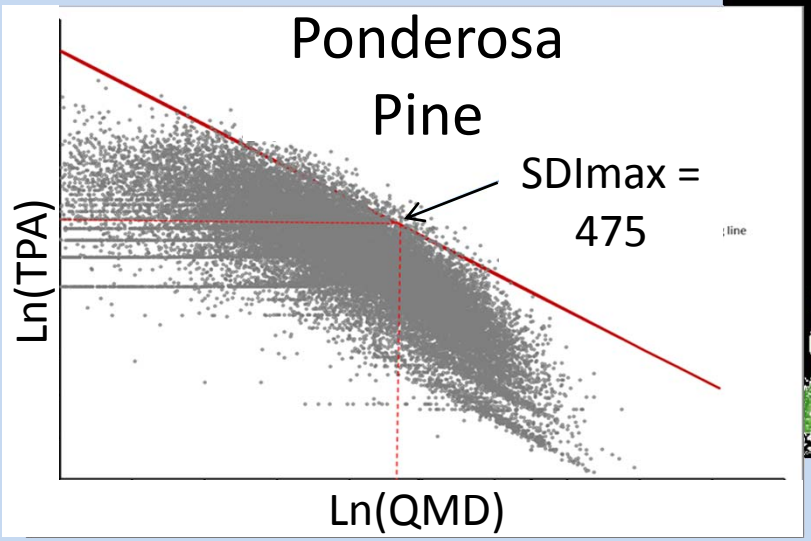
Mark Coleman Mark Kimsey Scott McLeod
Roberto Volfolvics-Leon Terry Shaw

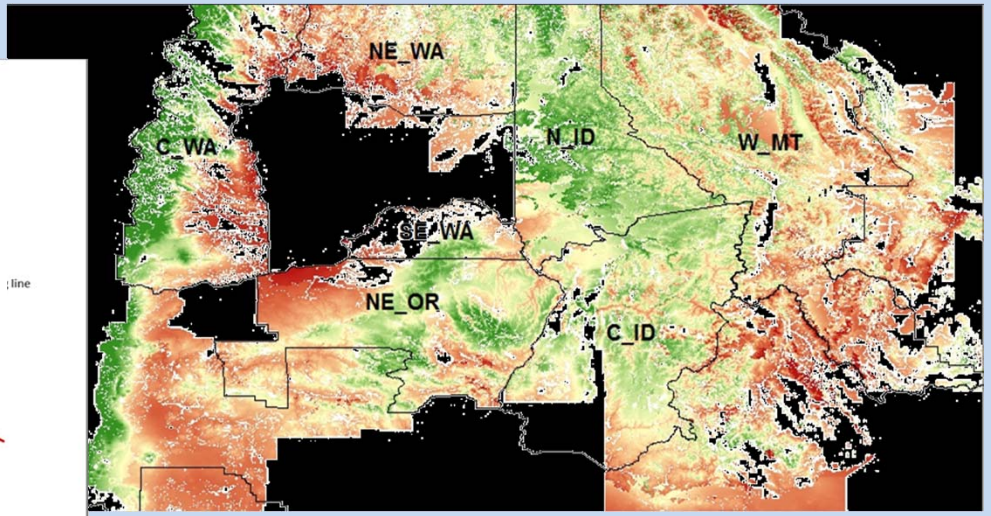
Outline

- Background on IFTNC models
- Previous approaches to find maximum density in mixed stands
- Addressing stocking questions for mixed stands
- Potential mixed-species model for maximum density

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



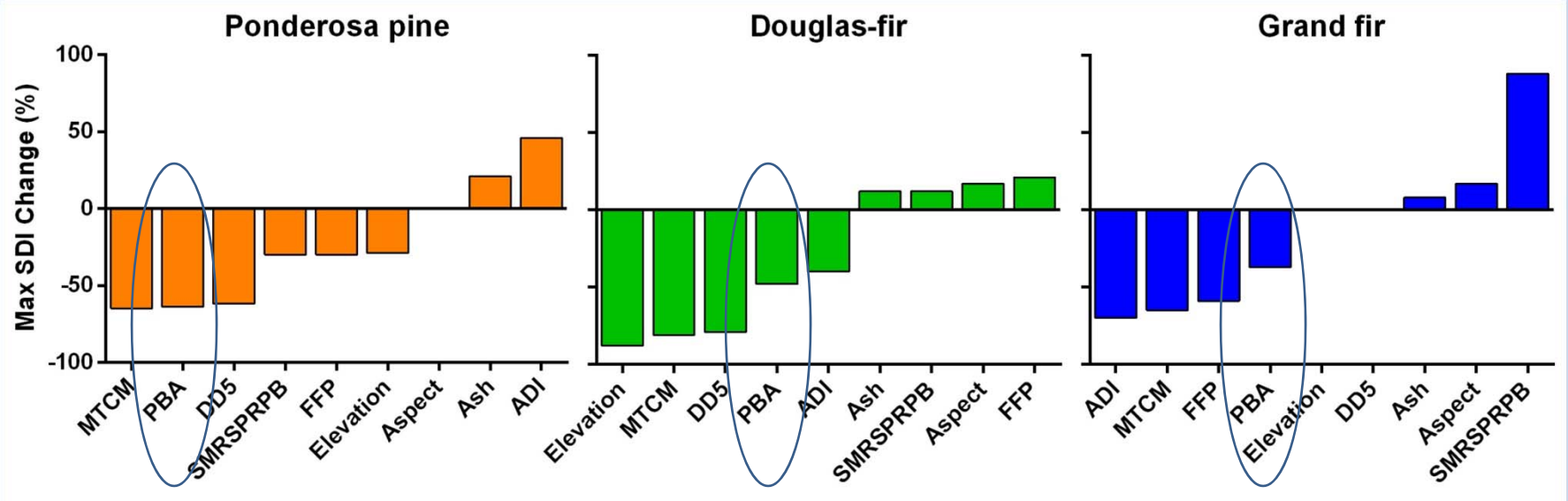


$$Ln(TPA) = b_0 + b_1 \cdot Ln(QMD) + b_{2i} \cdot RockType_i + b_3 \cdot Ln(ADI) + b_4 \cdot Ln(Elevation) + b_5 \cdot Ln(Prop.\ BA) + b_6 \cdot Ln(Prop.\ BA) \cdot Ln(QMD)$$

Background

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

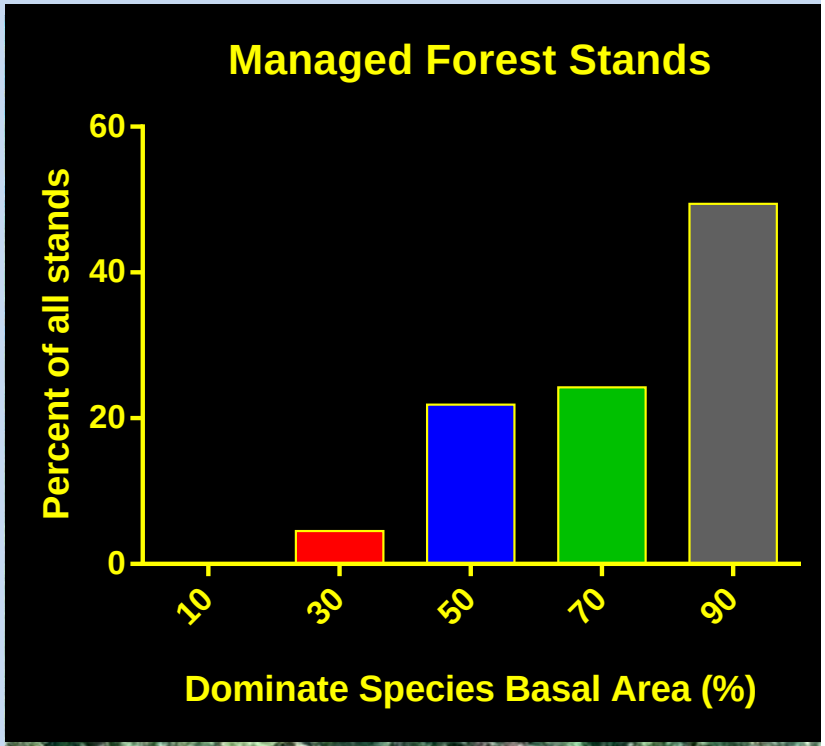
Shifts in Density by Factor



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

The challenge of mixed species stands

- Forest mensurationists frequently define density for even-aged single-species stands
- Mixed species stands are typical throughout the intermountain region
- So defining density for pure stands is not adequate



Mixed-species stand density management

- Requires knowledge self-thinning line:

  SDImax

- Management thresholds reference the self-thinning line

crown closure	15% of SDImax
imminent mortality	60%
self thinning line	100%

- Can’t model SDImax for all possible combinations

Previous approaches to mixed-stand SDImax

- Weighted sums
- Lowest component
- Two-species conceptual model

Previous approaches

Weighted sum of individual species

Species	SDImax[#]	Basal Area Percent
Douglas-fir	380	60%
Ponderosa pine	365	40%

[#]Cochran et al 1994 PNW-RN-513

SDImax = 380*0.60 + 365*0.40
= 374

OR

Select component species with the lowest SDImax

- Assures adequate growing space for less tolerant species
- Does not optimize land value

Previous approaches

Hypothetical two-species SDImax

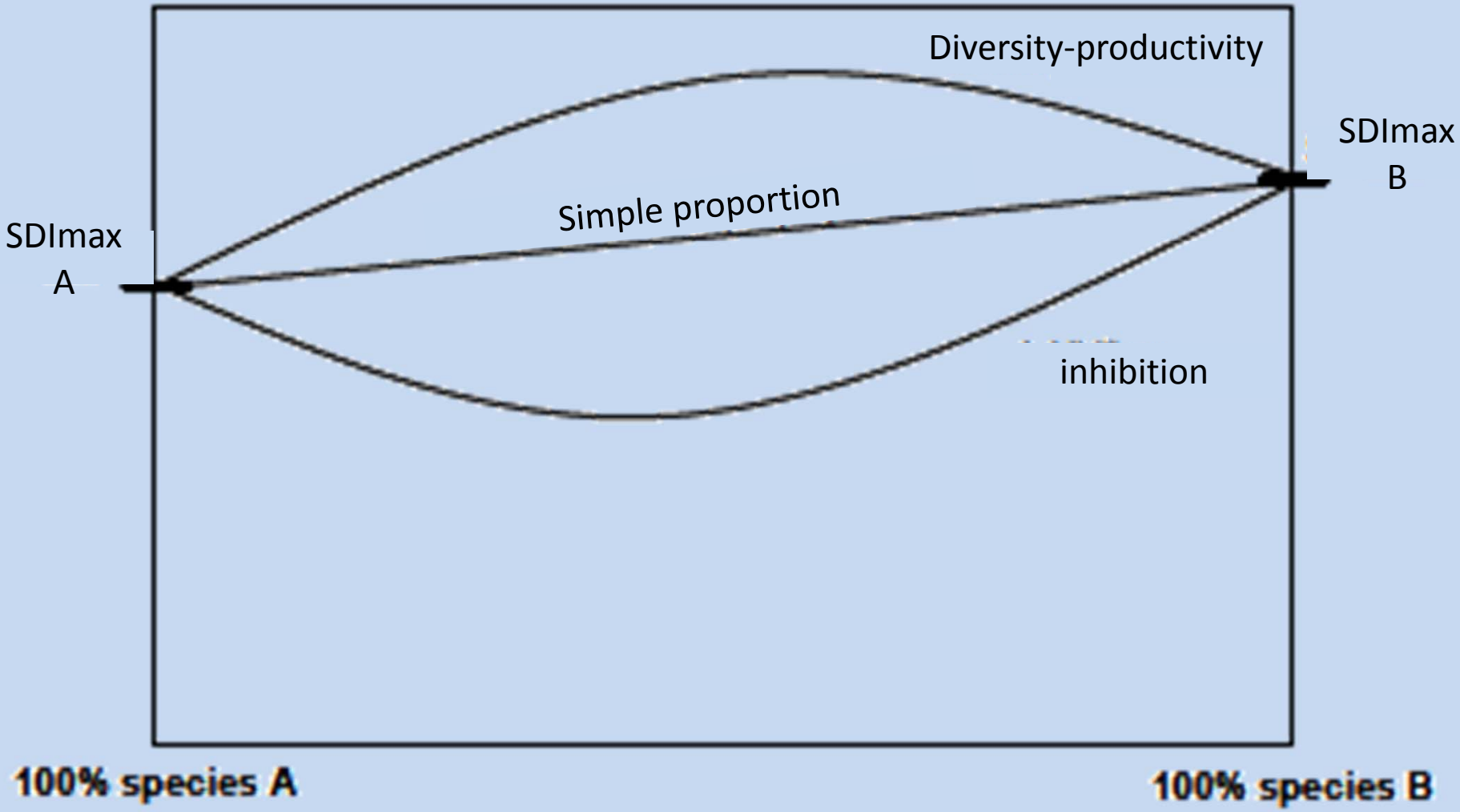


Fig 2, Shaw 2006. *In Proceedings SAF 2005 National Convention,, Ft. Worth, TX*

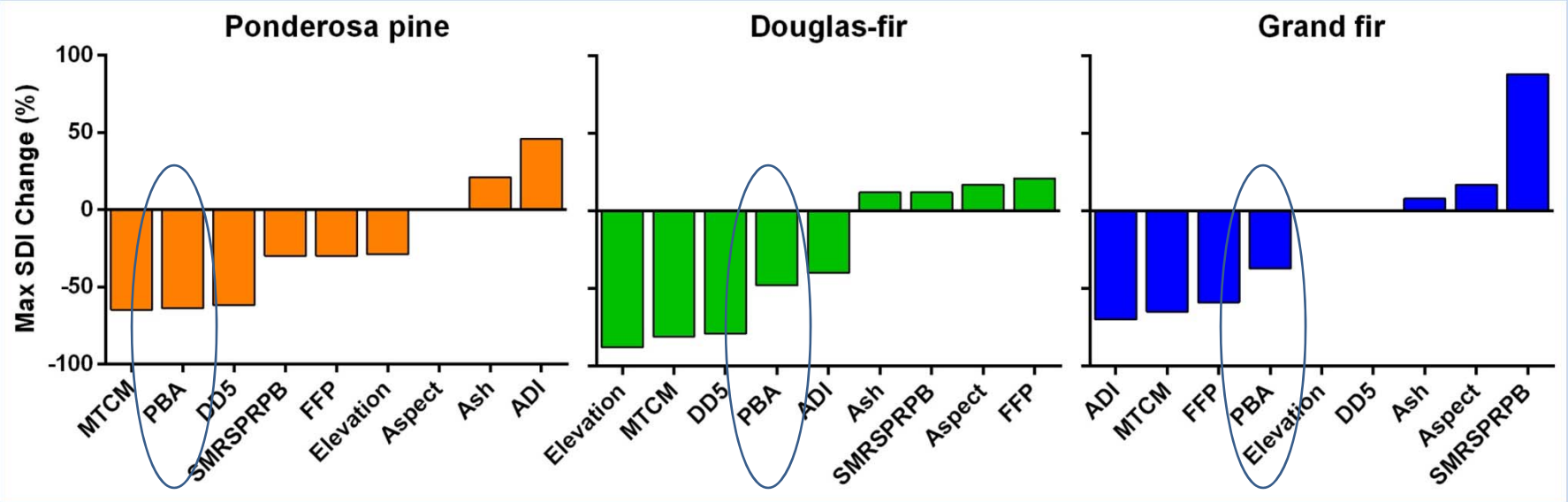
Addressing stocking questions

- Proportional basal area effects
- Successional climax
- Carrying capacity of mixes vs. single species

How does SDImax change with percent basal area?

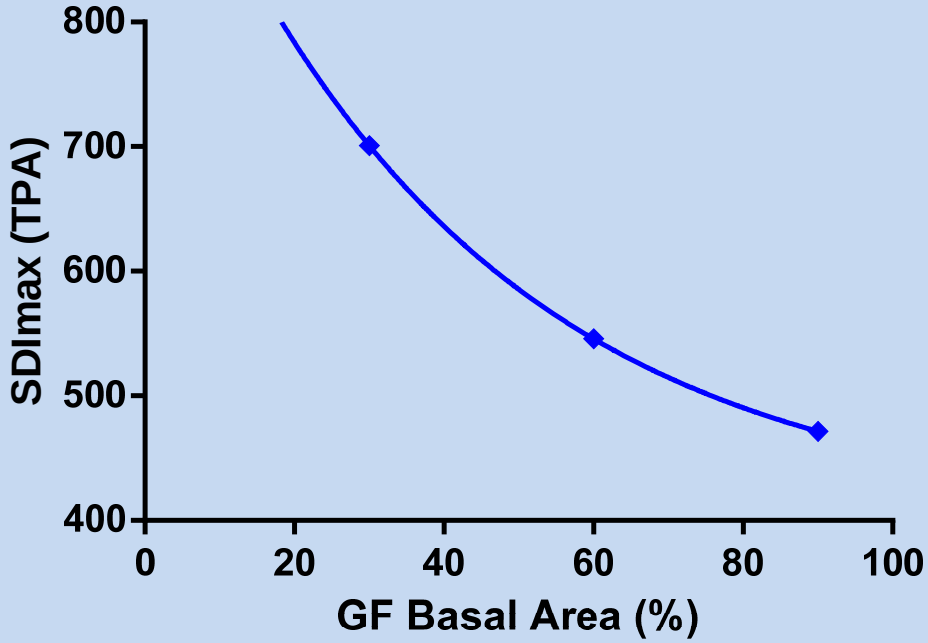
- Use IFTNC models to address questions

Shifts in Density by Factor



- PBA remains in every single species model
- The effect is negative

How does SDImax change with basal area percent?

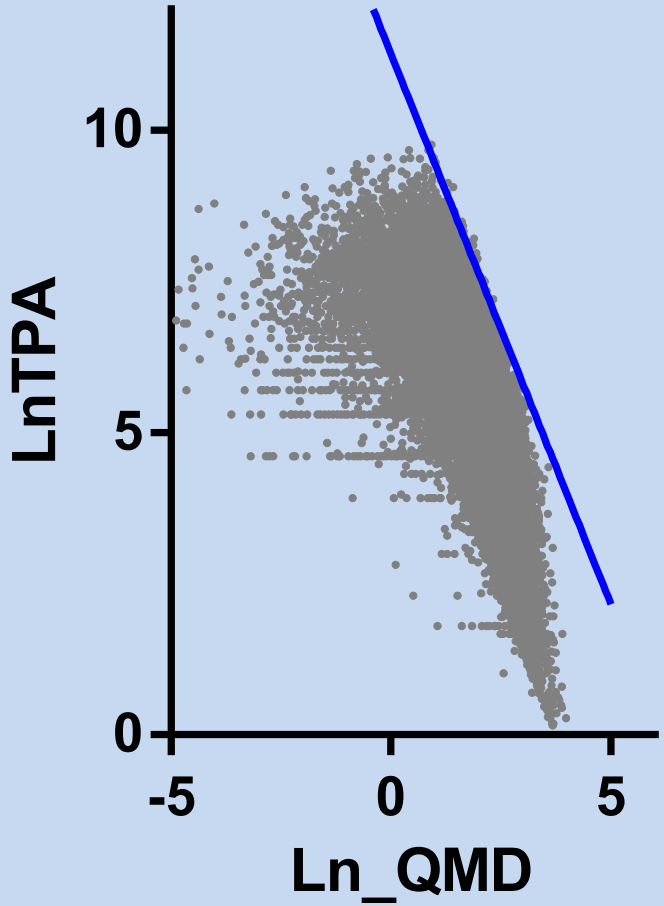


Model estimates with <u>changing PBA</u>

- Mixed stands have low proportion of GF and high SDImax
- SDImax declines with increasing proportion of GF

IFTNC Mixed Species Model

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



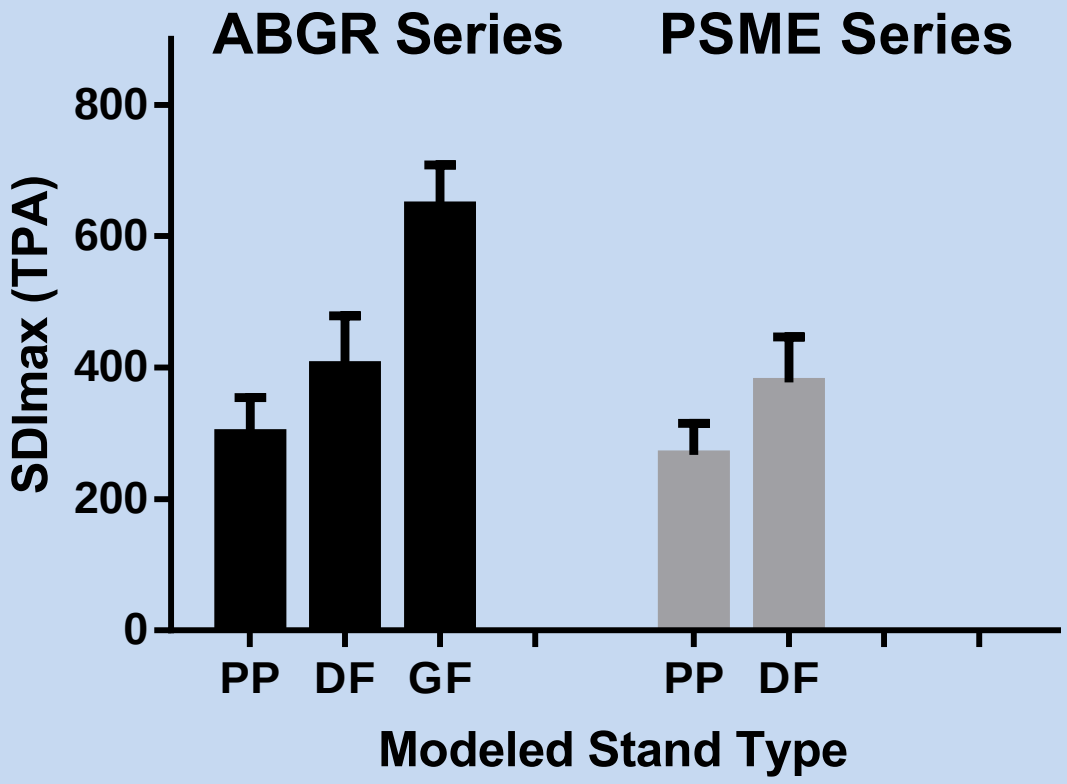
Do successional climax species have the greatest stocking potential on a site?

- IDL inventory data includes vegetation series
- Used these calls to identify sites with different climax vegetation

Veg Series	Stands
ABGR	850
PSME	586

Do successional climax species have the greatest stocking potential on a site?

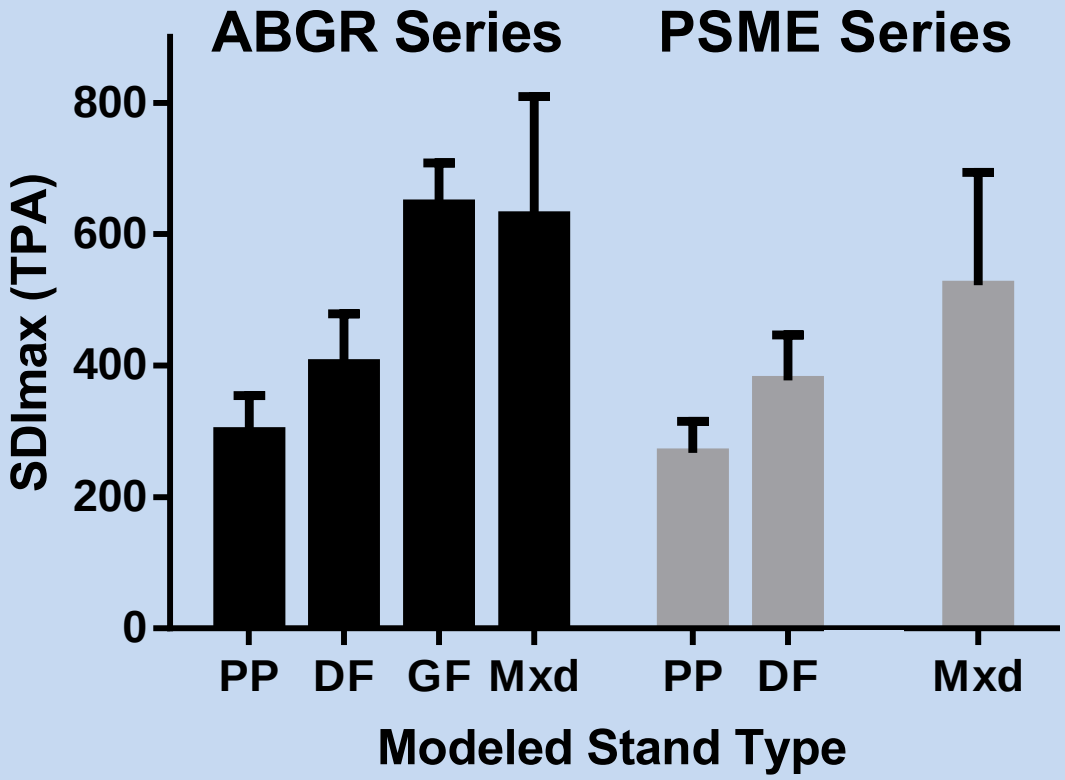
- Yes
- Single species models predict greater SDImax for the climax species than others



Do mixed stand have higher carrying capacity than pure stands?

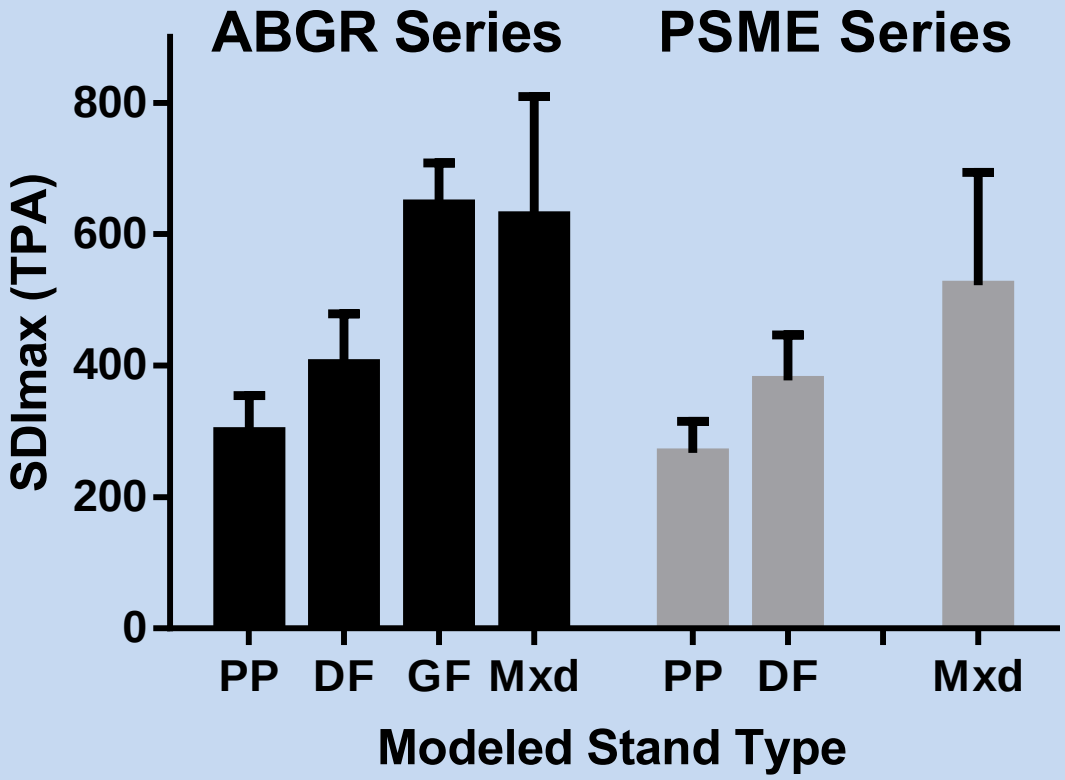
Mixed-Species Model
Removed species-specific filters during analysis

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



Is the site quality effect greater than species effect?

- No
- Predicted SDImax for pine and Douglas-fir are similar on either veg series
- Strong species differences
- Variation in mixed stands is more likely due to species mix rather than site variation



That's nice, but

How do we determine SDImax for mixed stands?

- Weighted sums are mathematical, not biological
- Can't expand Shaw's two-species model to three or more
- Our all-species mixed stand model
  - is a lumped average
  - suggests individual species are important
- Still need a way to separate species in the mixed stand model

Potential mixed-species model

SDImax is related to wood density

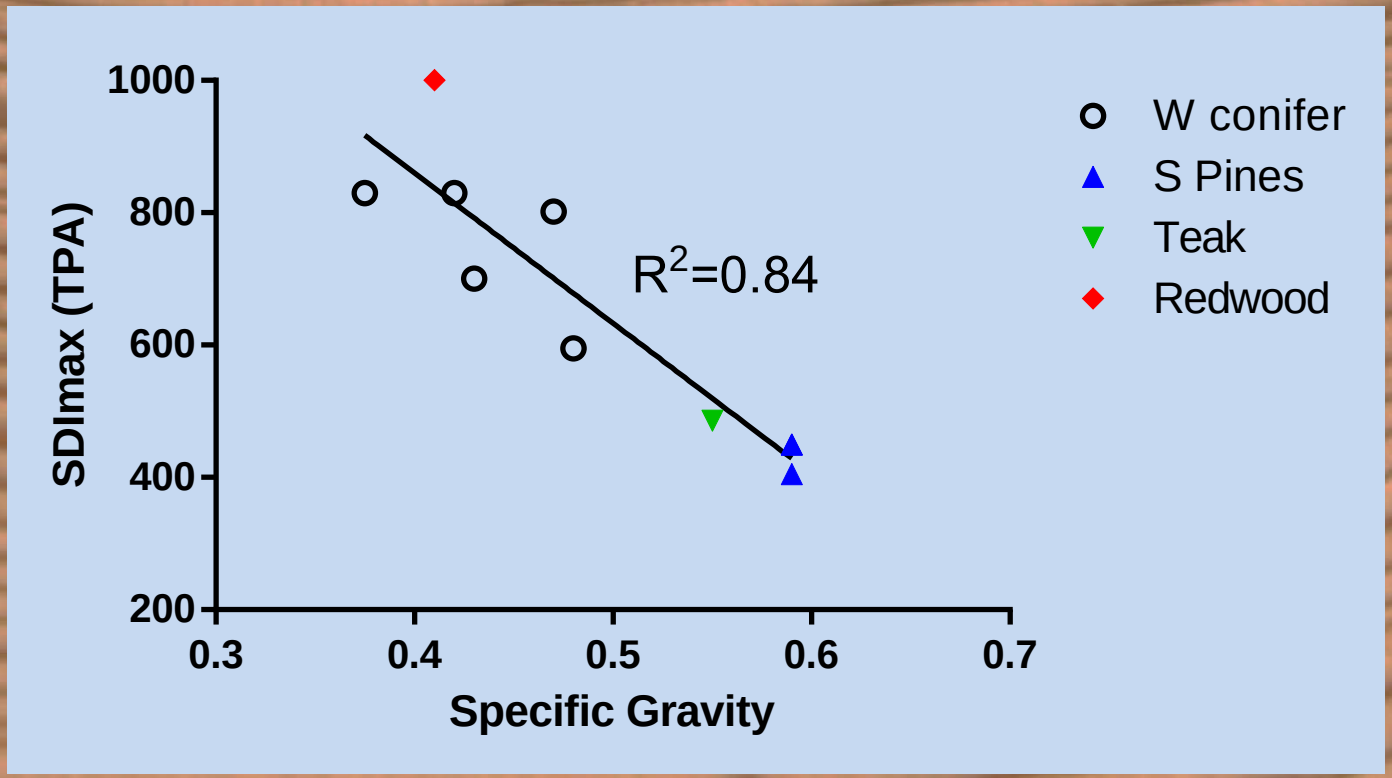
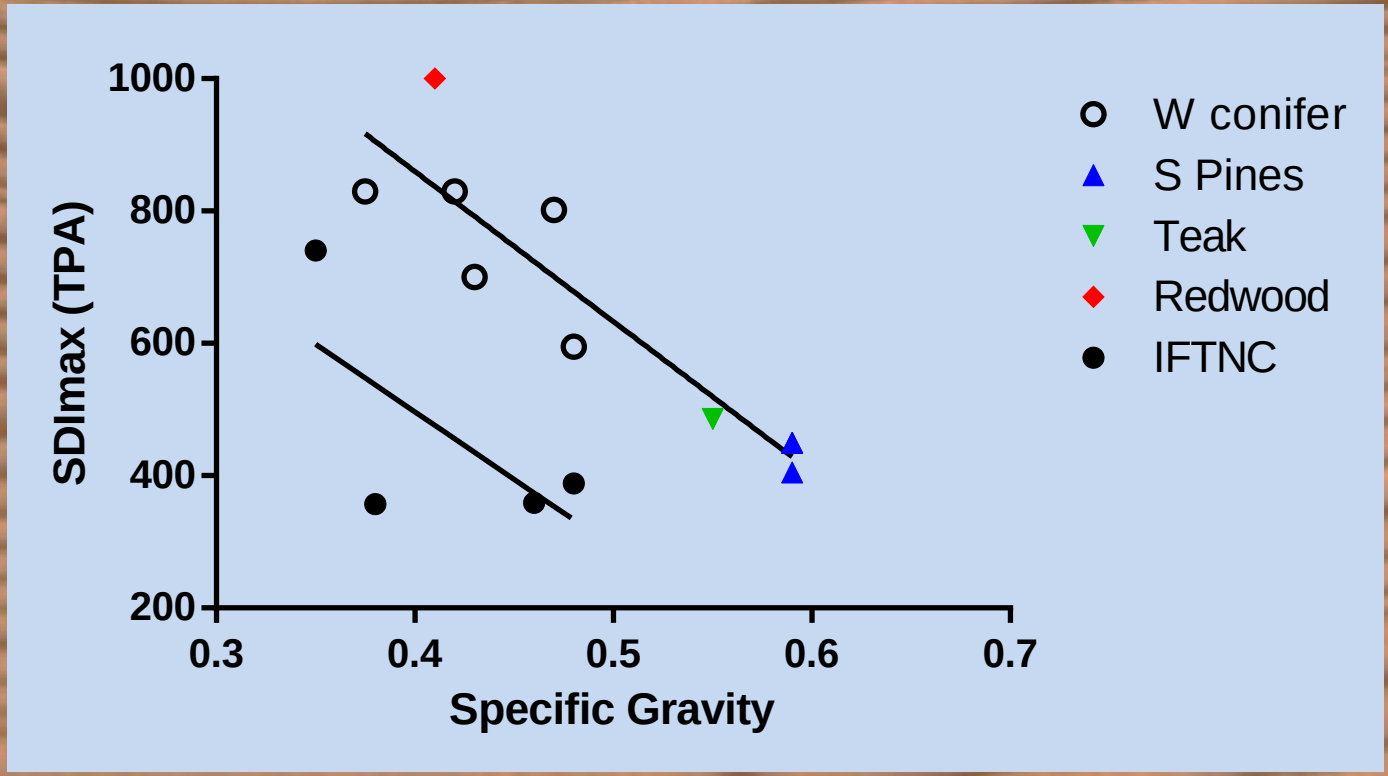


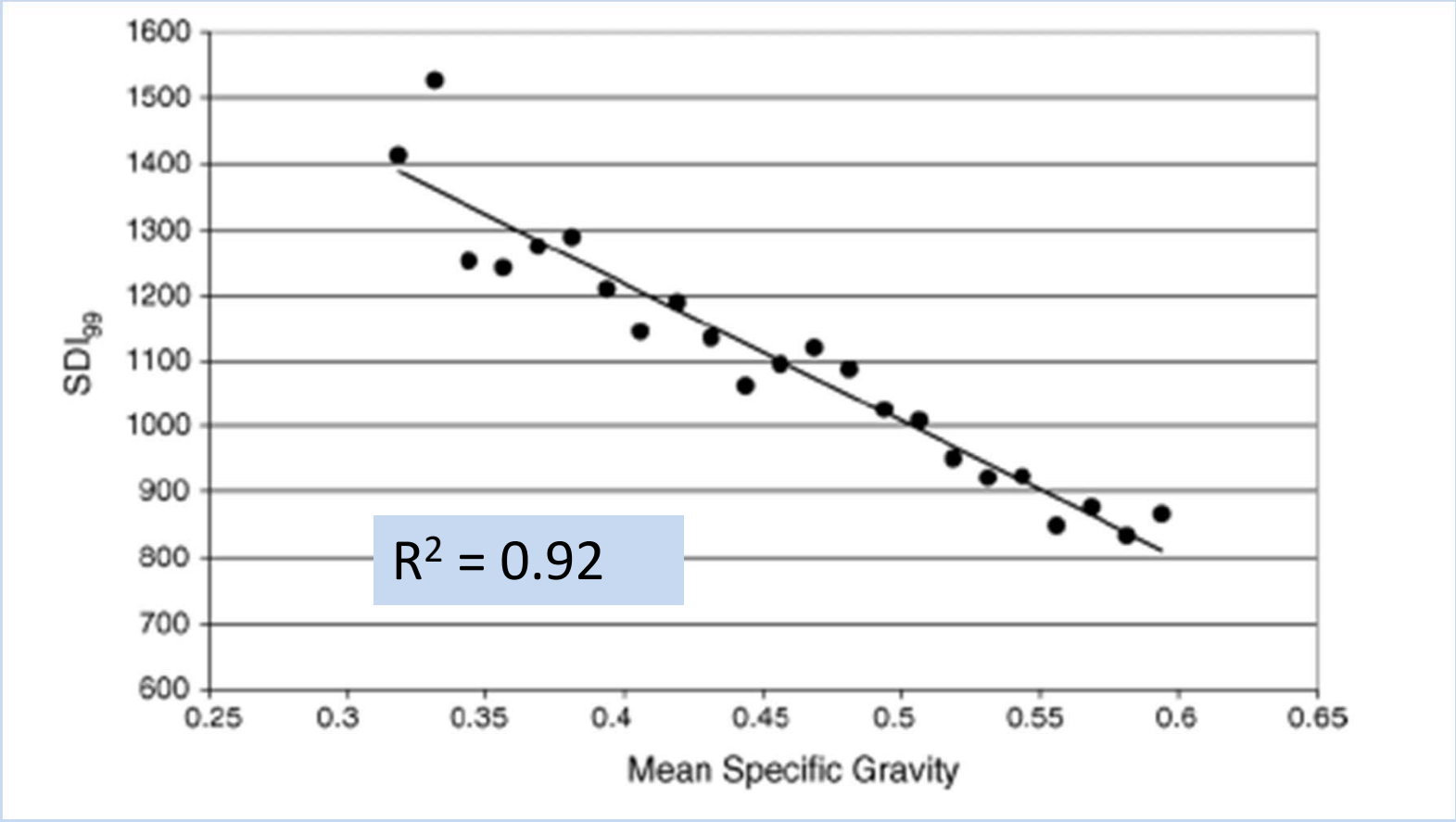
Table 2, Dean and Baldwin 1996 FEM 81:25

IFTNC data is ~similar



Potential mixed-species model

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

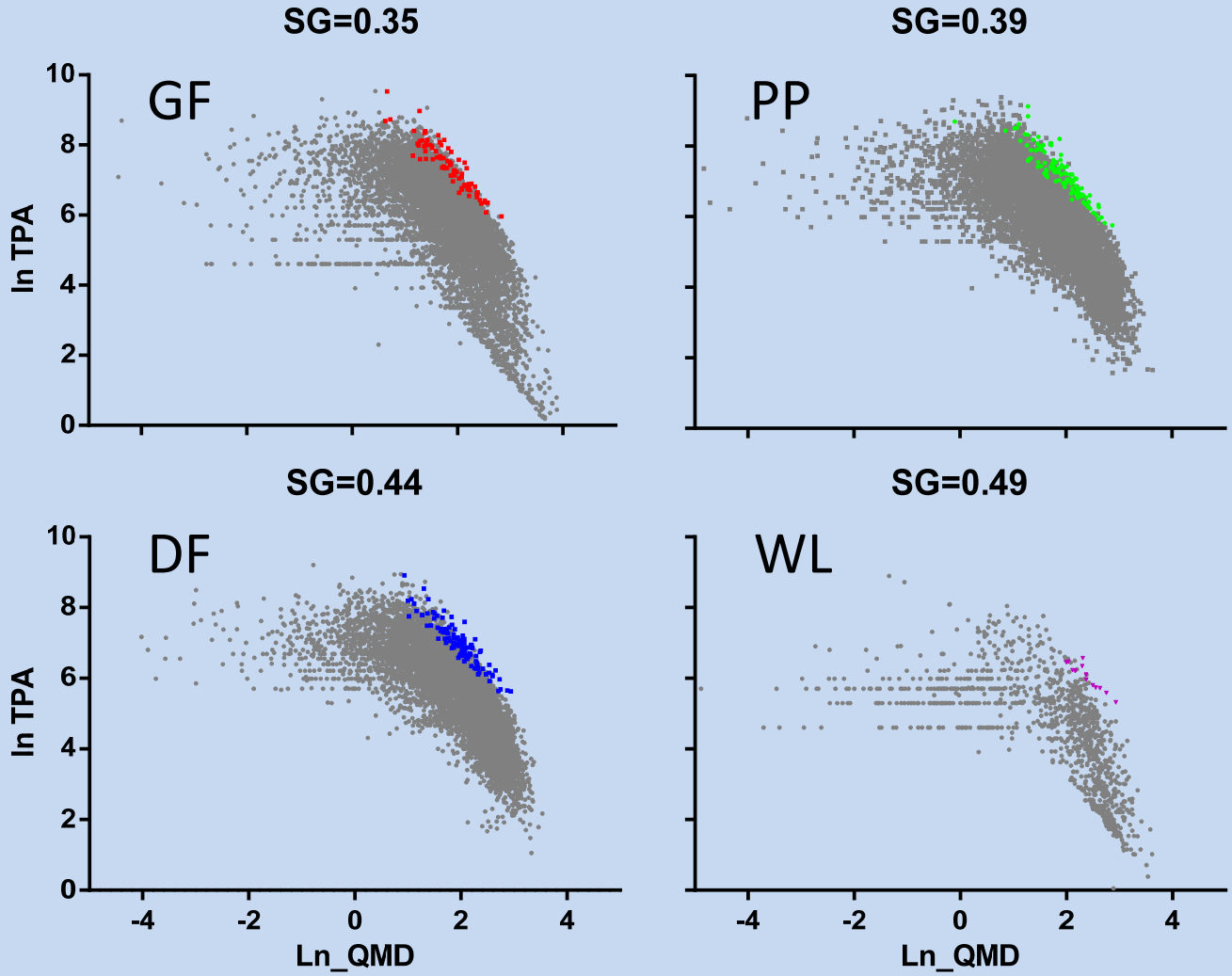
Relative Density
RD = SDI / SDImax

Where

$SDImax = 3547 - 3927\ SG_{mean}$

Woodall et al 2006 FEM 226:368

4 of 13 specific gravity classes represent individual species



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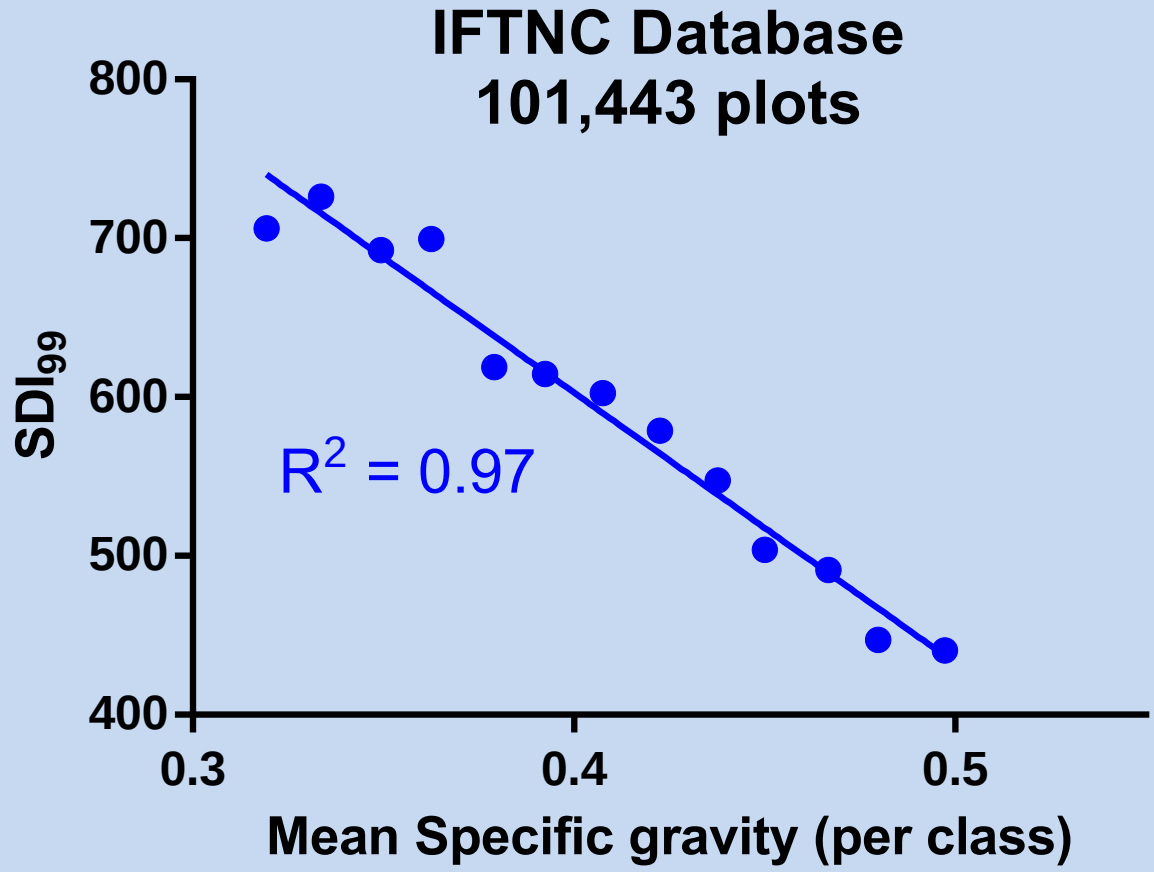


Stochastic Frontier Regression Model:

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

Proc QLIM in SAS

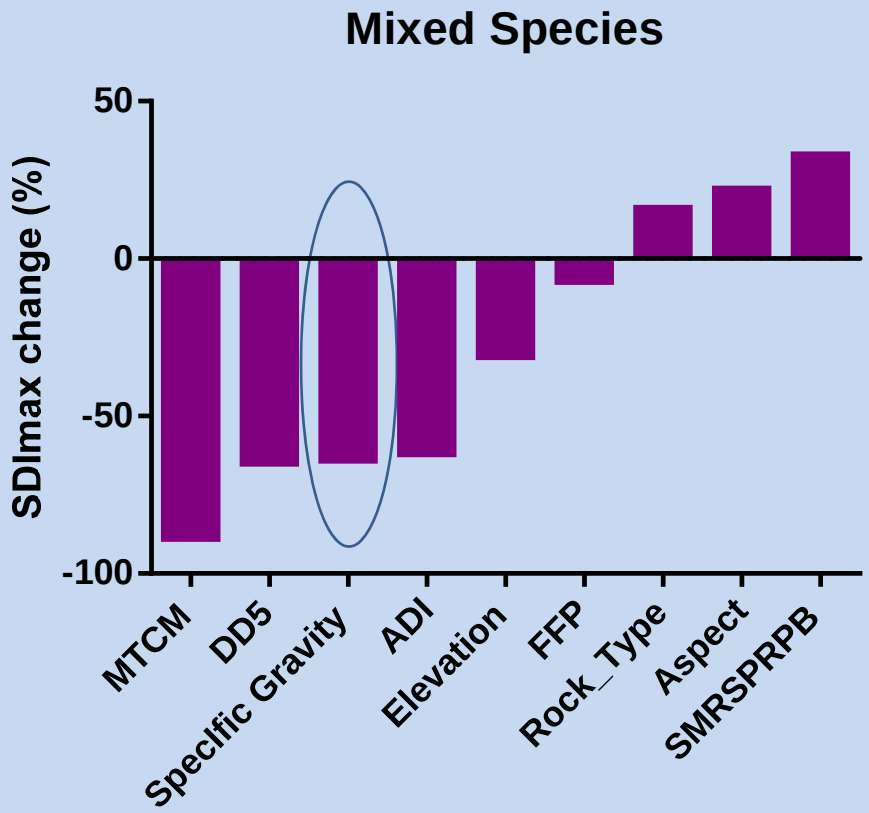
<u>Single-Species Factors</u>

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

<u>Mixed-Species Factors</u>

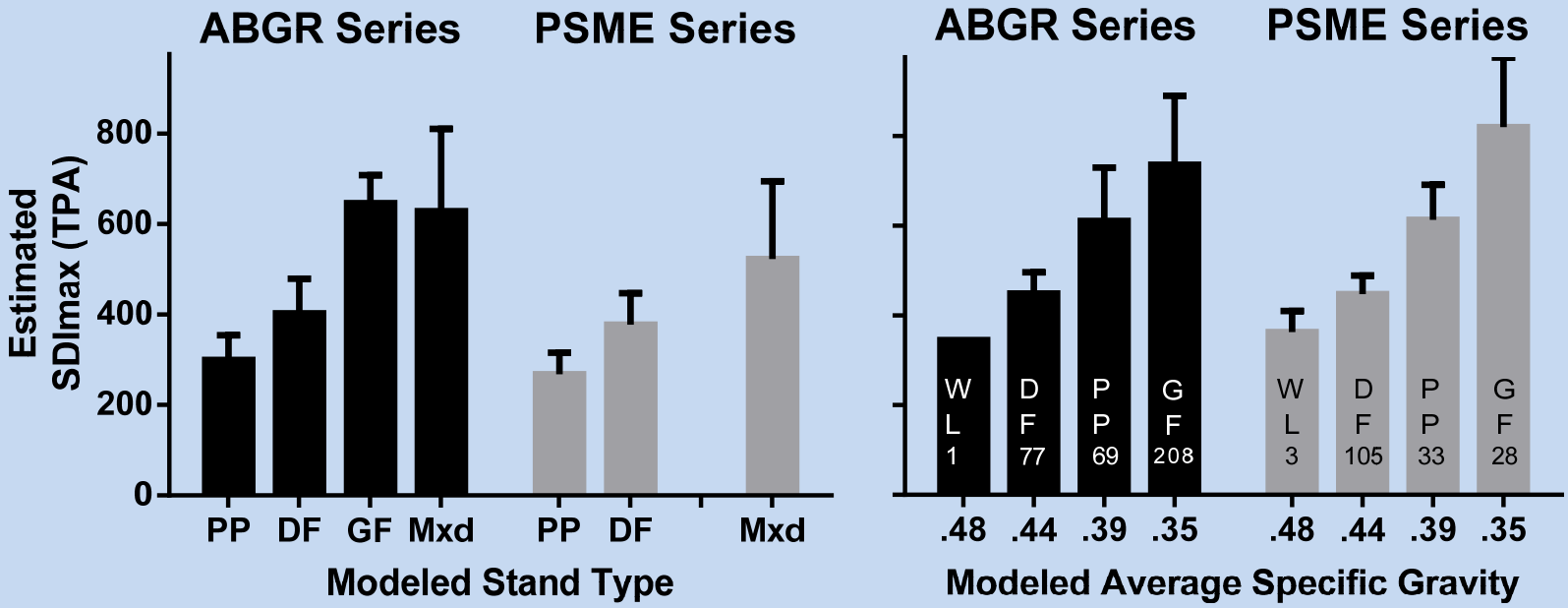
- Specific Gravity
- Rock Type
- Elevation
- Aspect
- ADI
- DD5
- FFP
- MTCM
- SMRSPRPB

Specific gravity effect on SDImax



Potential mixed-species model

Variation in mixed species model and specific gravity



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 model was developed using IFTNC DB
- Mixed-species model was 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
- Generalized model including specific gravity may replace the need for multiple species-specific models