Assessing the accuracy of growth and mortality projections using a USFS 100-year forest monitoring dataset

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Introduction

- Catastrophic and high severity fires have been increasing in recent years
  - Fire suppression
  - Overstocking
  - Regeneration of shade tolerant species

- This issue is compounded considering climate change predictions
  - Warmer temperatures
  - Longer fire seasons

- Forests and stands which are overstocked are the most vulnerable to high severity fires
  - Insects and disease
 - Density related mortality
  - Ladder fuels

Introduction

- It is necessary to identify a carrying capacity for a forest to determine overstocking
  - Number of trees of a certain size
  - SDImax

- The carrying capacity or SDImax of a site can inform:
  - Management decisions
    - Thinning, harvest, stress
  - Risk assessment
    - Wildfire hazard, insects and disease
  - Model predictions
    - When overstocking will occur in the future
    - Ideal time or conditions to perform management

Carrying Capacity (SDImax)

- Difficult to observe or measure
    - Insects, disease, weather events

- Predicted / modeled
    - Habitat type, elevation, aspect, location (FVS)
    - Climate, soils (IFC)
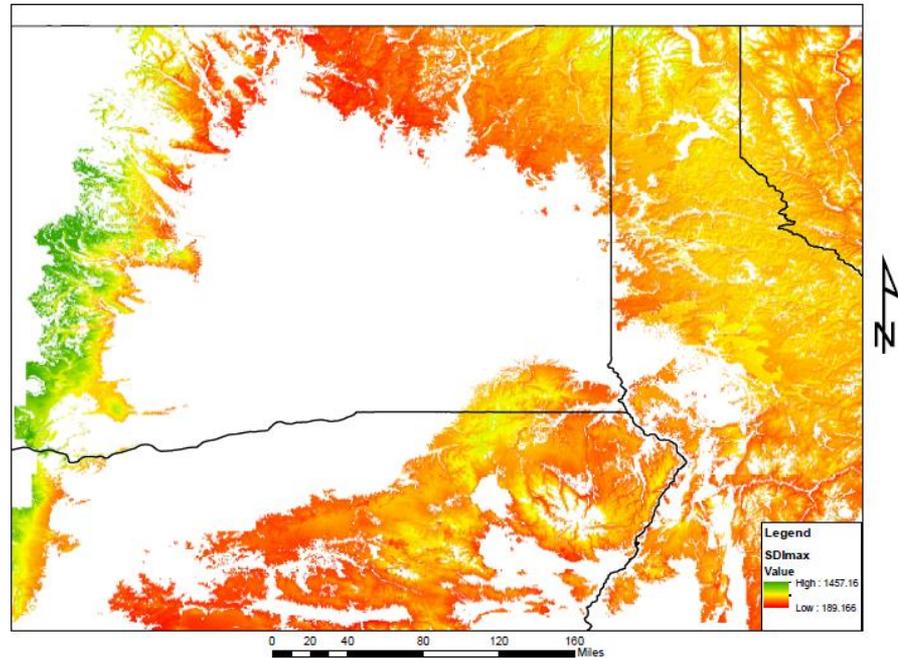
IFC model SDImax for Douglas-fir across the inland northwest

Objectives

- Assess the accuracy of FVS and IFC predictions of SDImax

- Determine the impact of different SDImax estimates on:
  - Tree mortality predictions
  - Modeled growth

- Recommend solutions for improving FVS

Database

- Acquired a large and long term database from John Byrne at the USFS RMRS.
  - Independent from FVS or IFC model
  - + 59,000 tree records
  - + 100 different plot installations
  - Some measured for more than 100 years

Site Selection

- Long term research installations
    - More than 30 years of data
    - Allow time for density related mortality

- Avoid stands impacted by disease / insects
    - Creates difficulties for determining correct SDImax
    - Blister rust (50% basal area white pine mortality)

http://www.forestryimages.org/browse/detail.cfm?imgnum=1371057

Site Selection

- 24 research installations in Northern Idaho
- 30 to 90 year measurement periods
- Initial QMD's from 2.6 to 15.7
- Initial SDI from 64 to 643
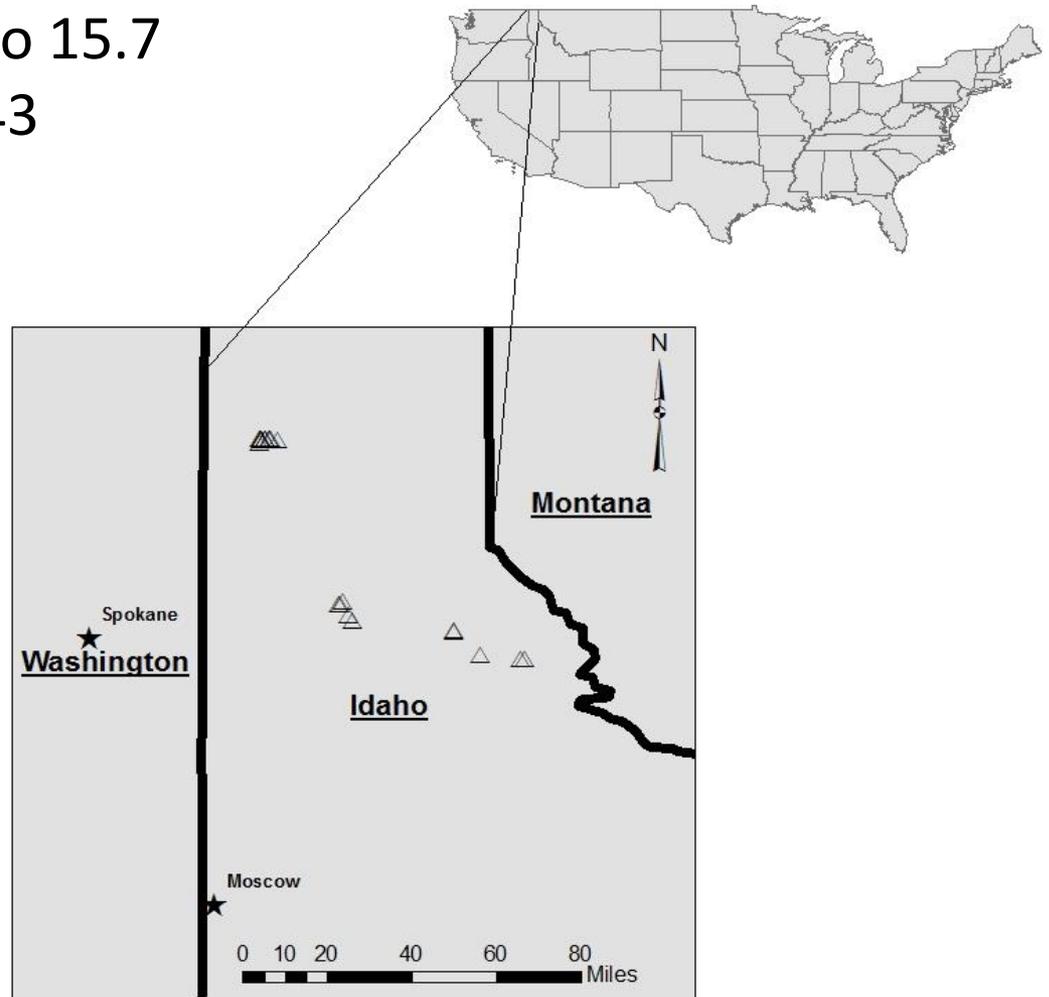
Methods and Modeling

- SDImax was determined from either FVS or IFC

- For each measurement period, calculated:
  - Trees per acre (TPA)
  - QMD
  - SDI
  - Basal Area
  - Volume

- First and second (calibration) measurement periods entered into FVS
  - Modeled to end of measurement period (30 to 90 years)

SDImax
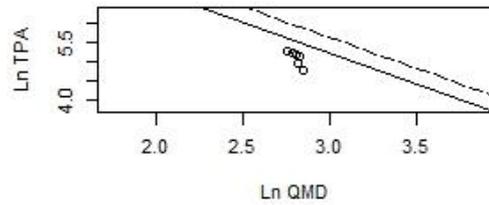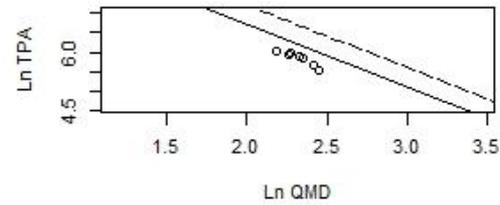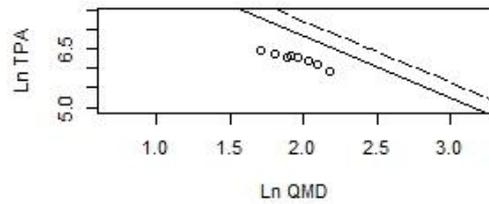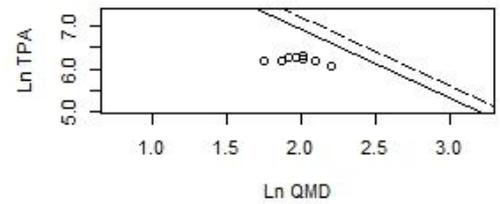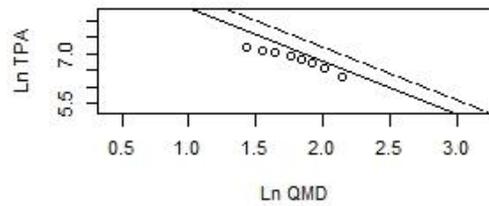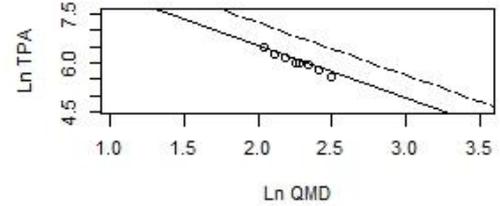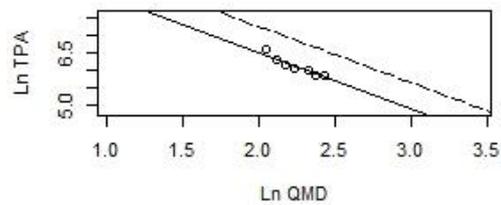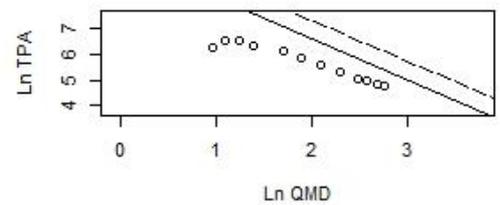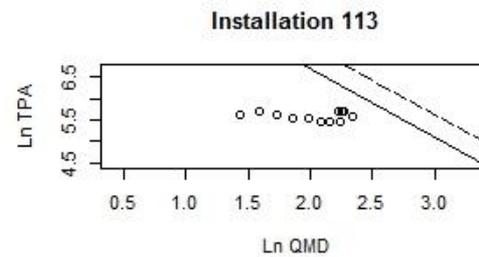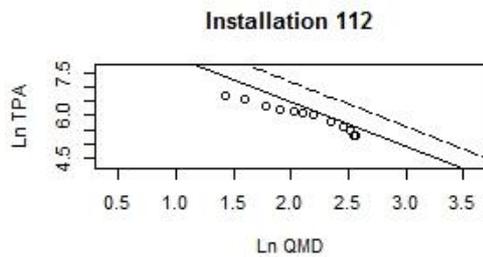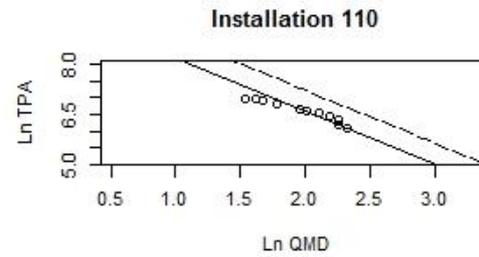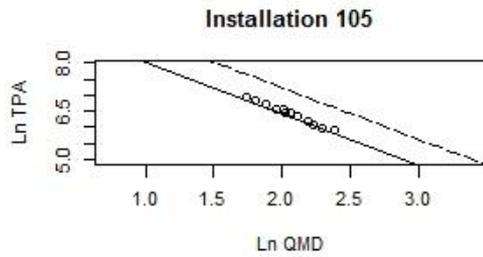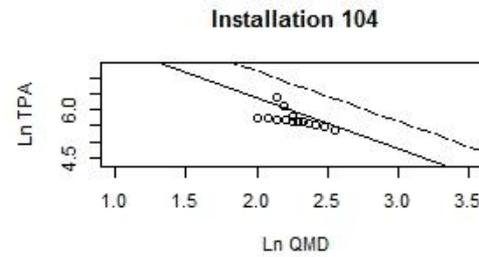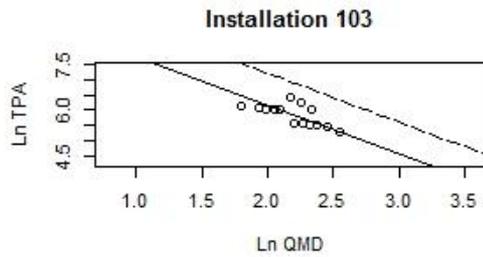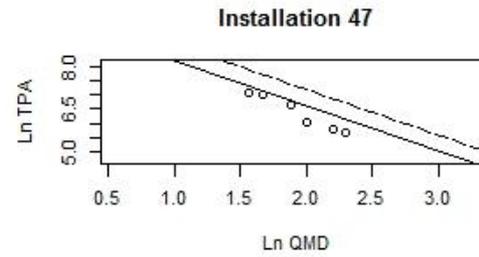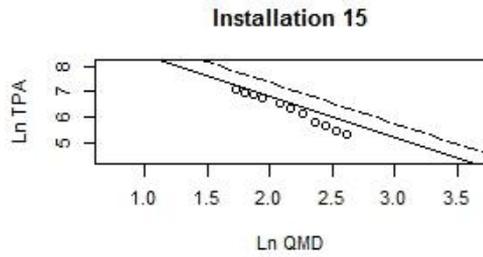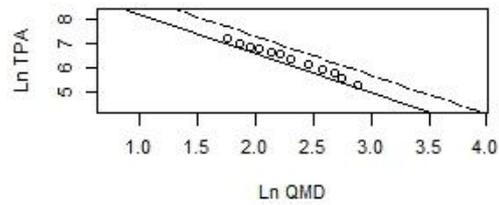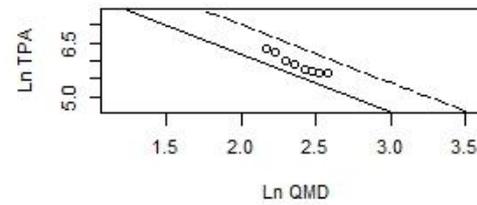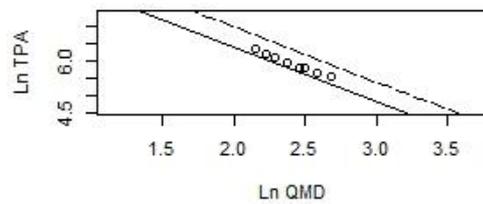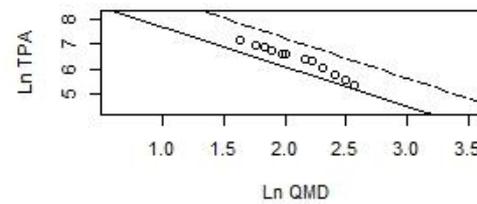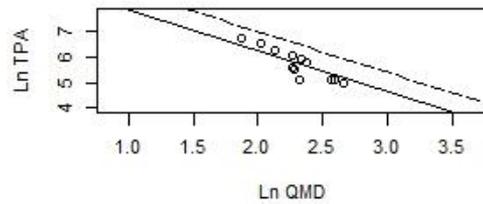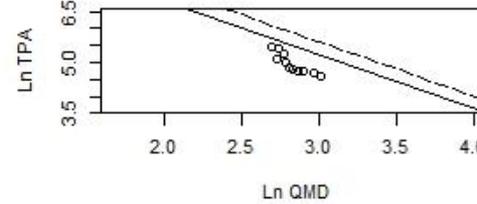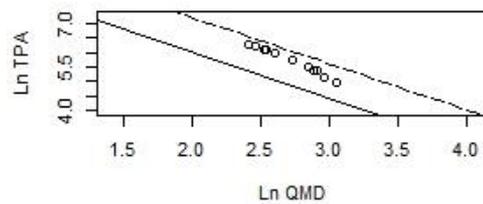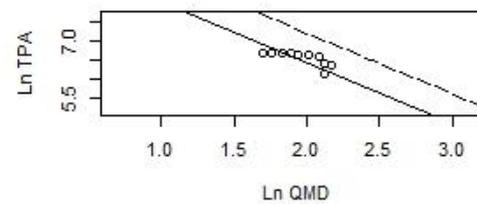
SDImax

SDImax

SDImax

- IFC model is accurately predicting SDImax in general
- Careful using FVS default SDImax!
- How does this impact model predictions?
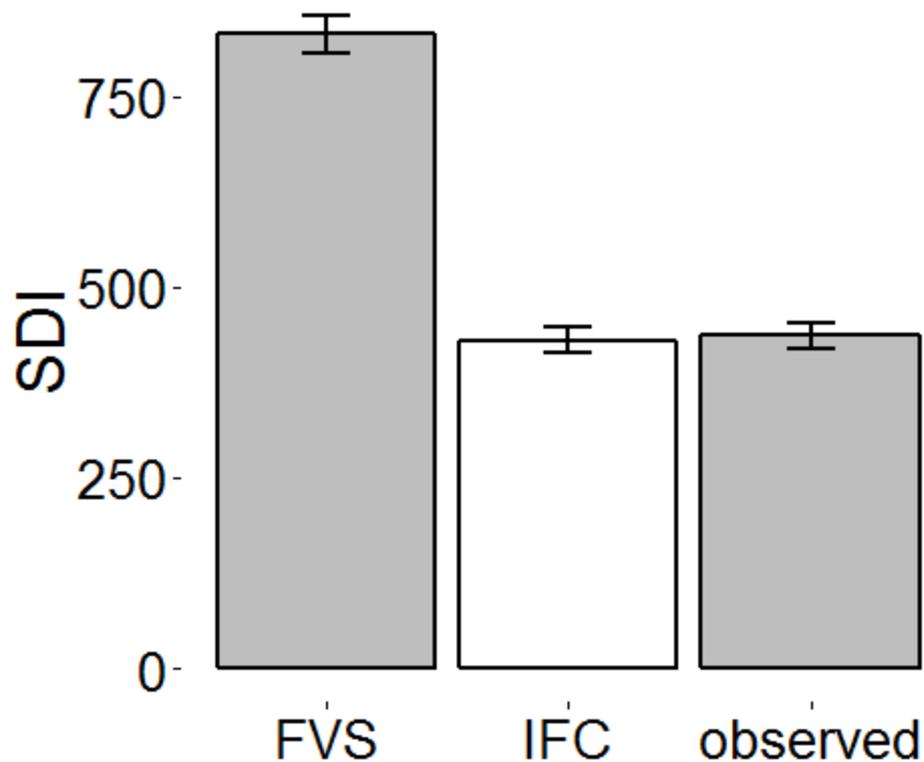
Mortality
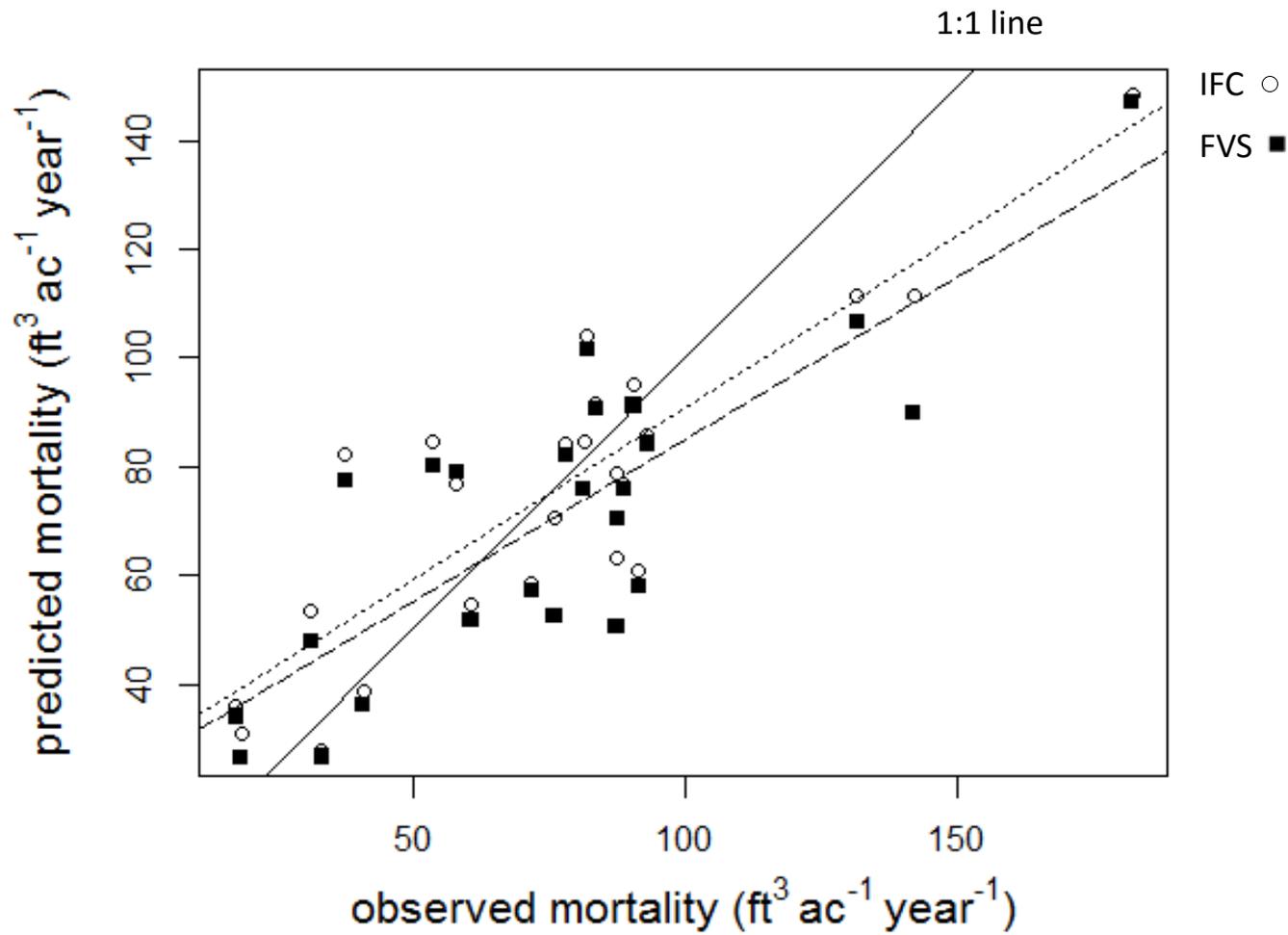
Mortality
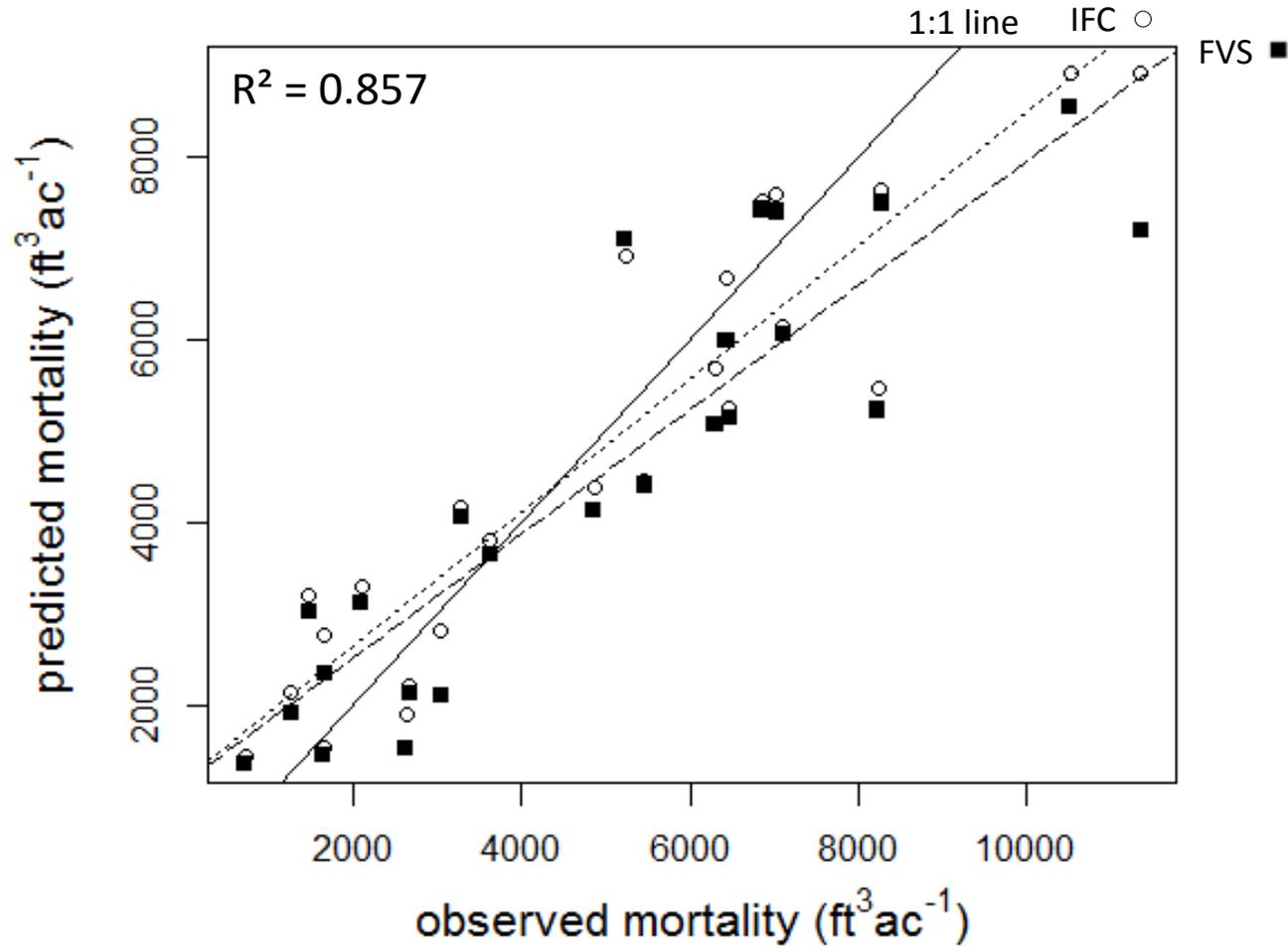
Mortality

- Predicted mortality fairly well
- Initial basal area had a strong control on mortality (p < 0.001)
- No differences between SDImax (p = 0.817)
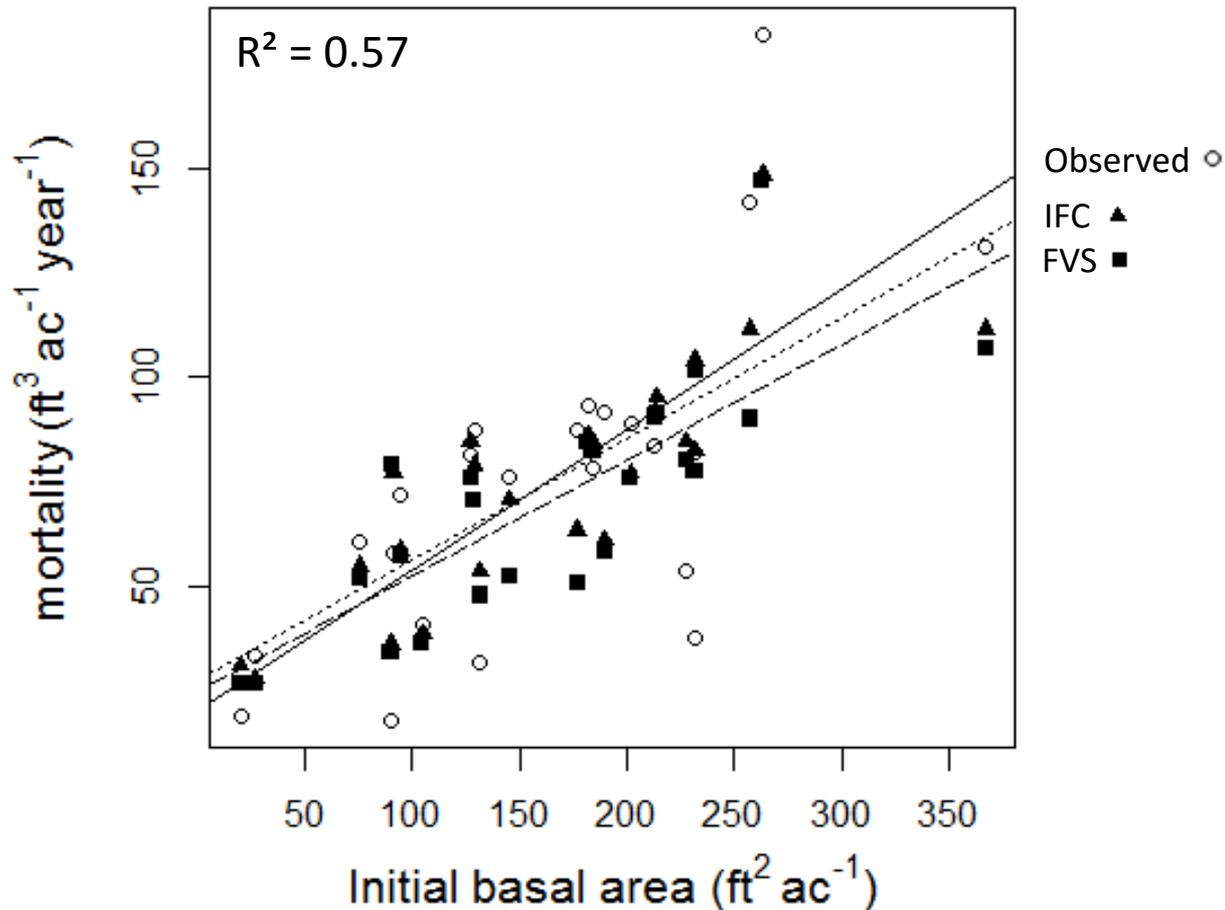
Growth (Accretion)

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Growth (Accretion)

- Growth predicted fairly well over the measurement periods
- Predictions not impacted by SDI (p = 0.24)

SDImax and FVS predictions

- SDImax differ greatly

- Similar predictions of growth and mortality?
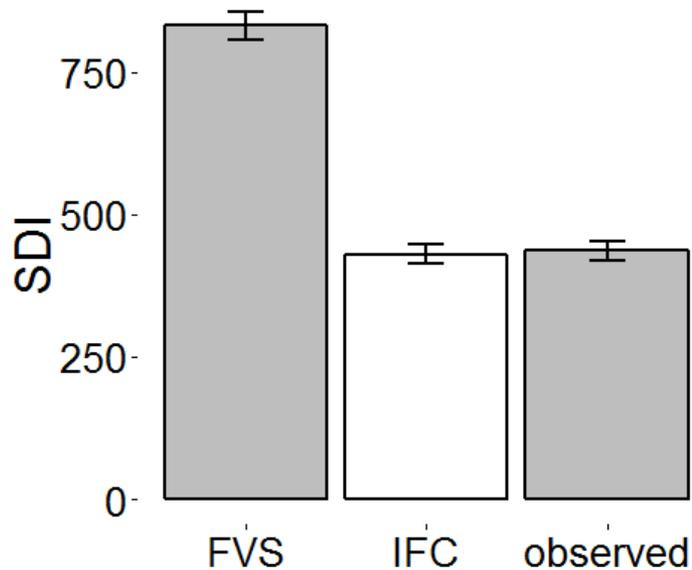
Solution?

"The first mortality rate estimate, RA, predicts individual tree mortality based on habitat type, species, diameter, diameter incre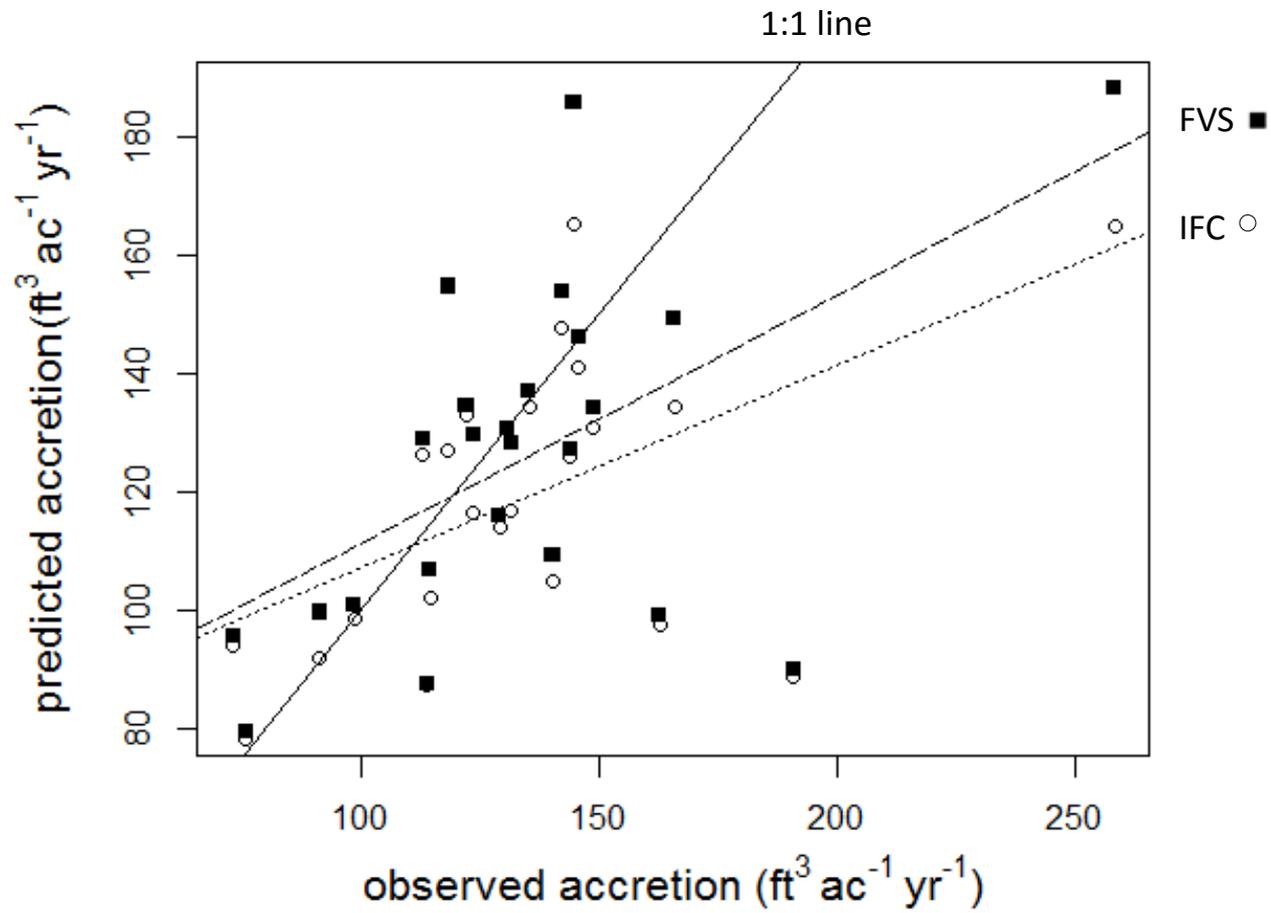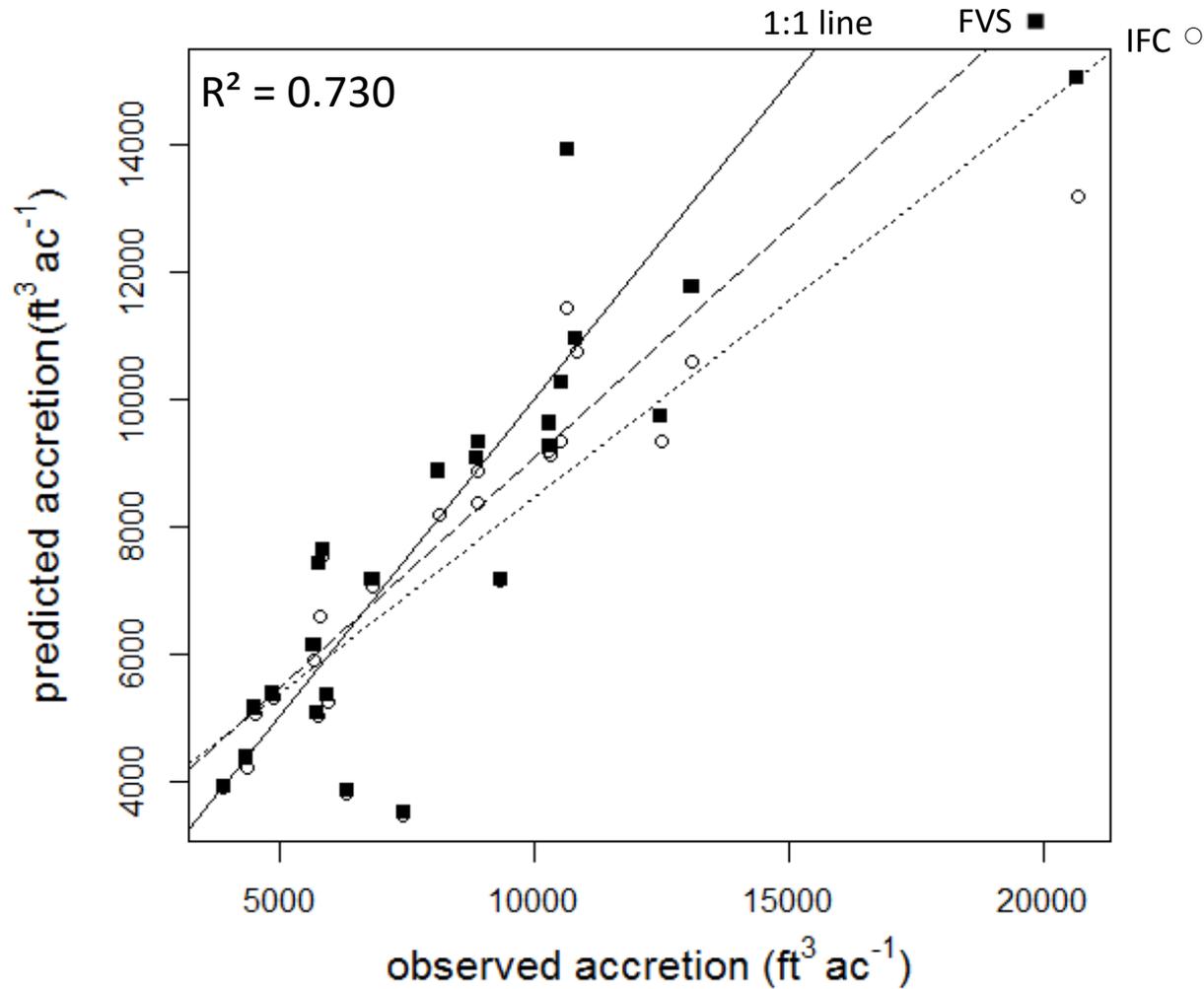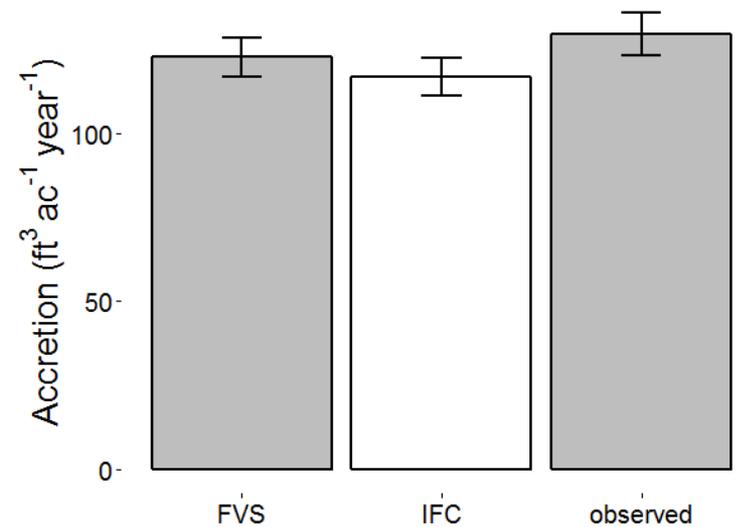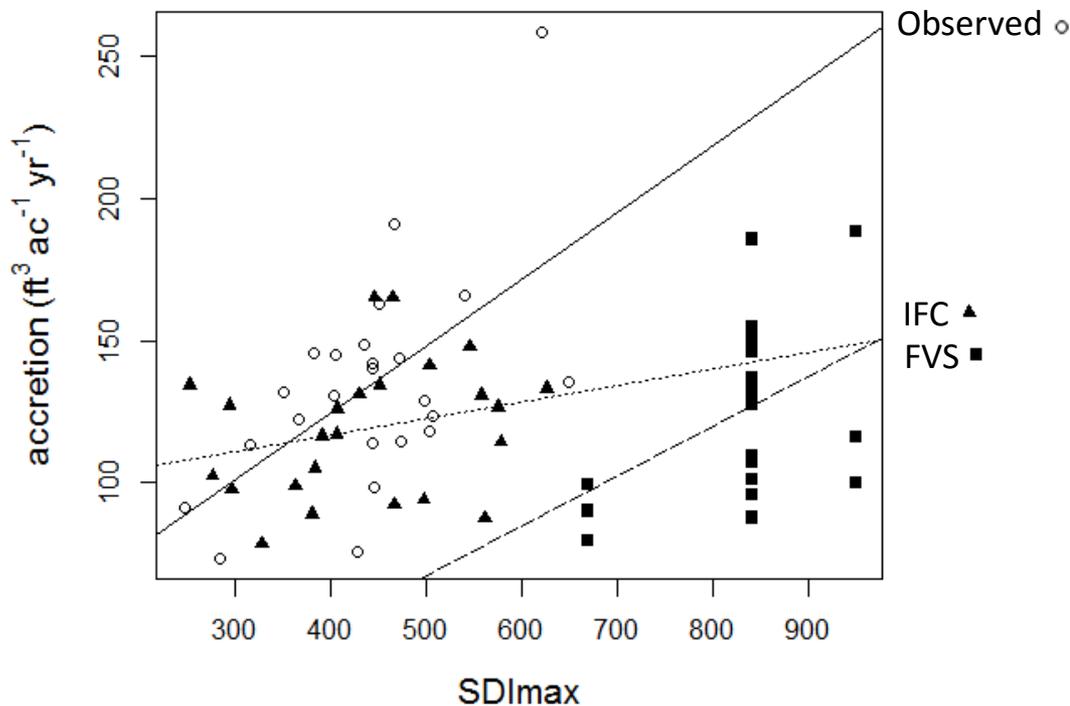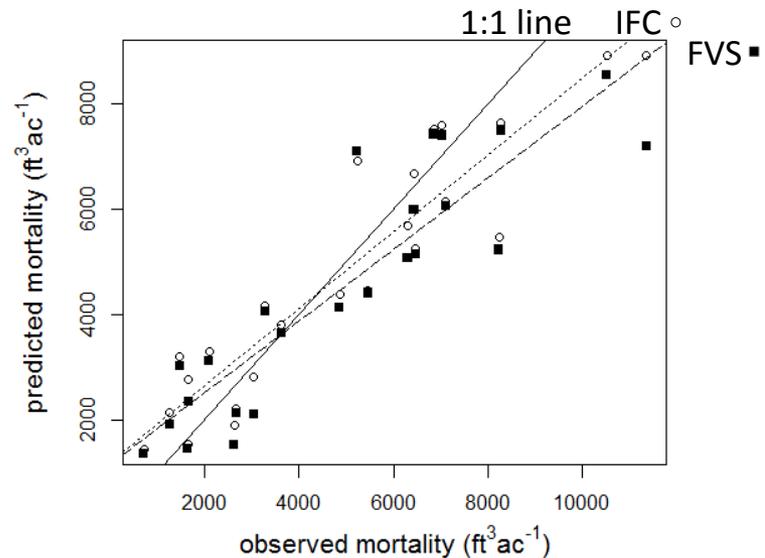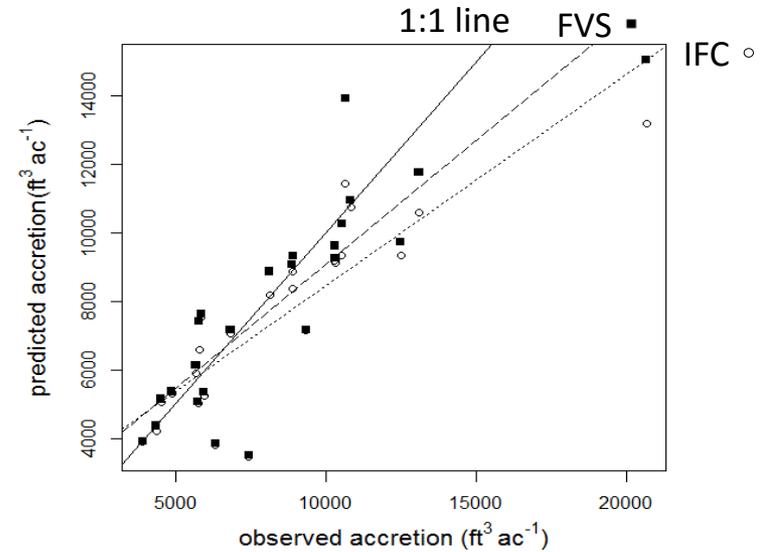ment, estimated potential diameter increment, stand basal area, and a trees' diameter relative to the average stand diameter."

"The second mortality rate estimate, RB, is dependent on the proximity of stand basal area to the site maximum... and the rate of basal area increment."

- FVS Inland Empire (IE) variant Overview

"When there are a relatively large number of small trees in the stand, the predicted mortality rates for small trees are relatively high. The mortality rates predicted for large trees are unaffected by the number of trees in the stand. As stand basal area increases, however, mortality rates for all trees increase."

- Essential FVS: A User's Guide to the Forest Vegetation Simulator
So. . .

Conclusions

- FVS does not directly use SDImax in the IE variant (Northern Idaho)

- However, predictions of growth and mortality appear accurate over long time periods

- IFC model predicts SDImax well
  - Why care about SDI?

SDI vs BA

- Less information on basal area max than SDI and SDImax

- Density management diagrams

TPA	QMD	BA	SDI	SDImax	% SDImax	BAmax	% BAmax
150	13	138	228	500	46%	390	35%
1500	4	131	346	500	69%	390	34%

PONDEROSA PINE
Figure 5

https://spaces.usu.edu/display/SILVI/Stand+management+diagrams
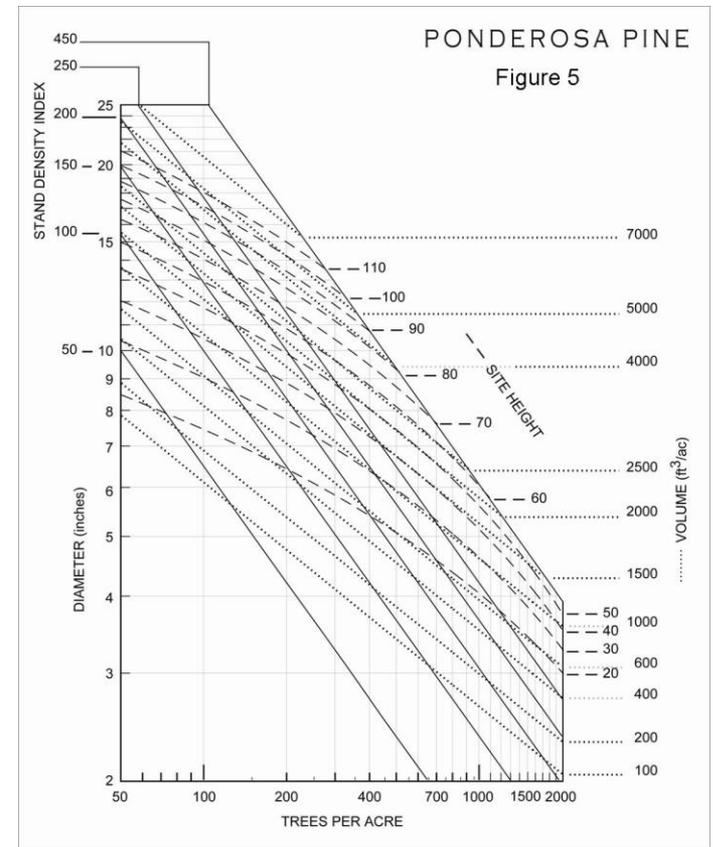
Conclusions / Recommendations

- Use both!

- Predict future growth and mortality with FVS
  - SDI is still calculated within FVS

- Identify carrying capacity (SDImax) and density management targets with IFC model

- Use a combination of FVS and IFC to predict when to manage/harvest a stand

Acknowledgements

- The USFS RMRS and John Byrne
  - FVS help desk for technical support

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Questions?