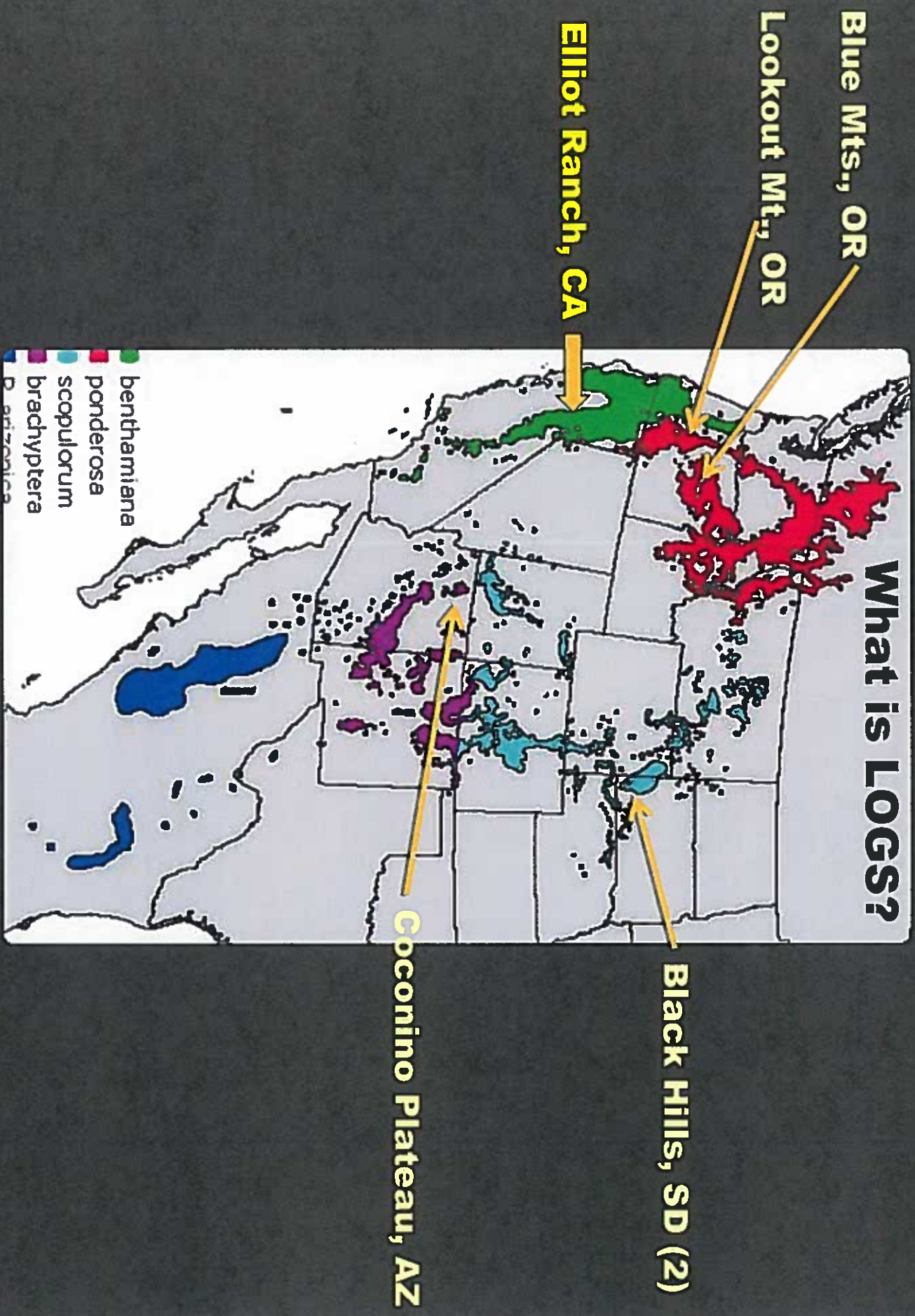


**Elliot Ranch LOGS Study:
Can an old experiment
tell a new story?**

**Jianwei Zhang, William Oliver, & Martin Ritchie
PSW Research Station
Redding, California**

What is LOGGS?



Blue Mts., OR

Lookout Mt., OR

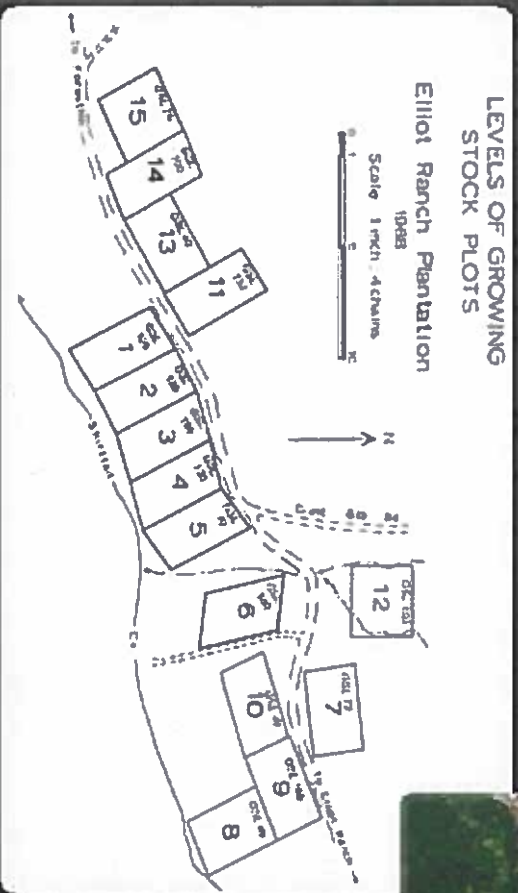
Elliot Ranch, CA

Black Hills, SD (2)

Coconino Plateau, AZ

OBJECTIVES

“to determine (1) optimum stand densities for maximum growth of usable wood per tree and per acre over a range of site qualities and average diameters and (2) growth and yield obtainable with repeated thinning” (Myers 1967).



Elliot Ranch LOGS



These ponderosa pine trees are a part of a long term study comparing tree growth and bush development when trees are thinned to different spacings. The trees were planted in 1950, following Elliot Ranch fire and have been thinned three times since 1970 by the U.S. Forest Service Experiment Station. The results of this study will help guide the management of pine plantations, resulting from wildfires throughout the Sierras.



HISTORY

- ❖ **Original stand was burned in 1936 (McKenzie Mill Fire)**
 - **Spacing 6' by 8'**
 - **In 1960, the Volcano Fire burned the surrounding stands, not plantation**
- ❖ **Unsuccessful plantings (within 4- yrs) due to deerbrush**
 - **LOGS plots were established on 20-yr-old plantation in 1969**
- ❖ **Brush and snag field was burned in 1949 (Elliot Ranch Fire)**
 - **Three clay-loam soils**
- ❖ **Plantings were made in 1950**
 - **Precipitation is about 60"**
- ❖ **1-1 stock from the appropriate seed zone**
 - **Site index: 120 ft at 50 yrs**

Study Design & Measurements

- ❖ **Five growing stock levels (GSLs)**
 - Repeatedly thinned back to original GSL
- ❖ **Three replications**
 - **1/2-acre plot size**
- ❖ **All trees were tagged**
 - **DBH, height, and others were measured every five years from 1969 to 2009**



GSL40



GSL70



GSL130



GSL160



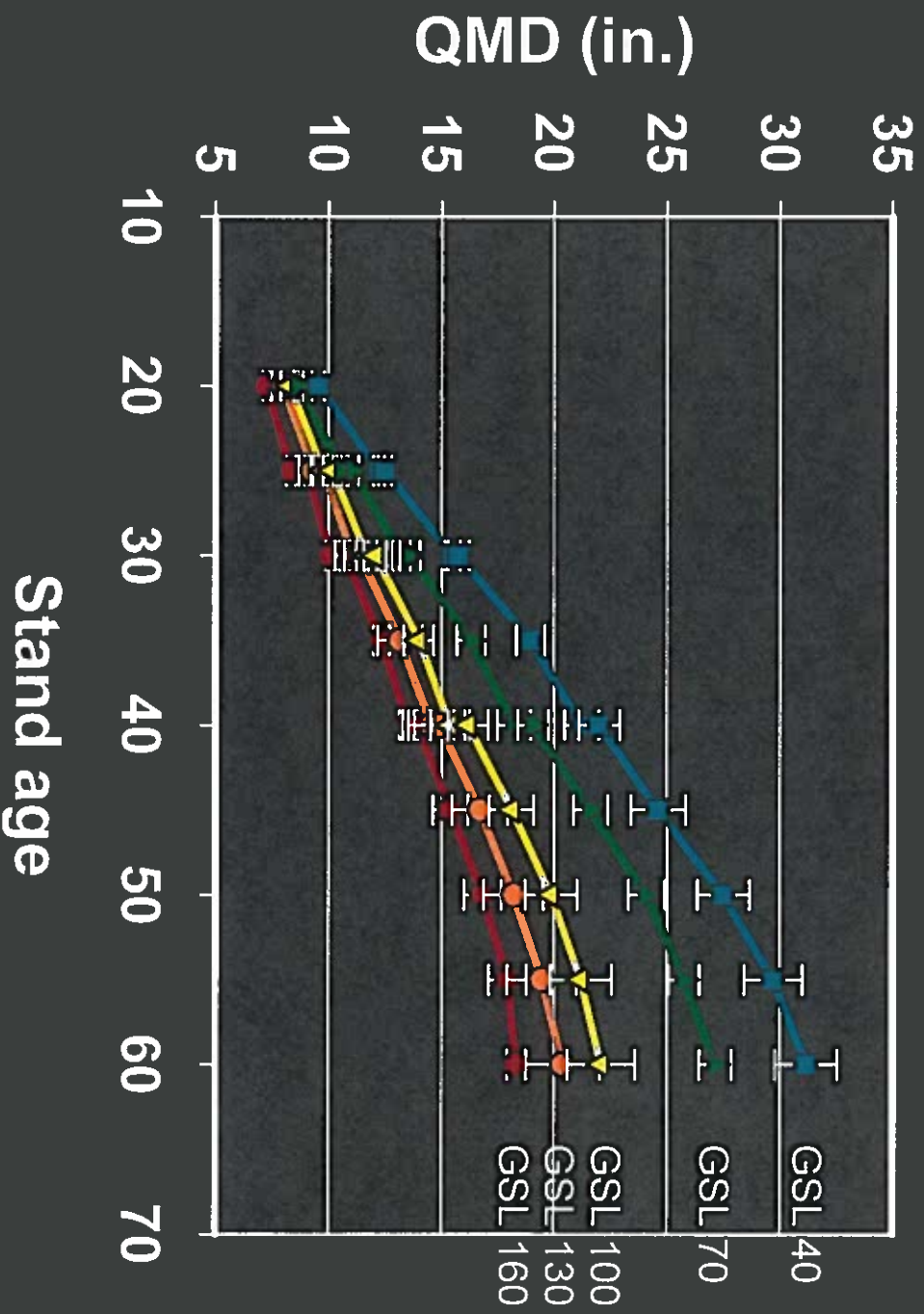
GSL100

Happy 2009 inventory crew

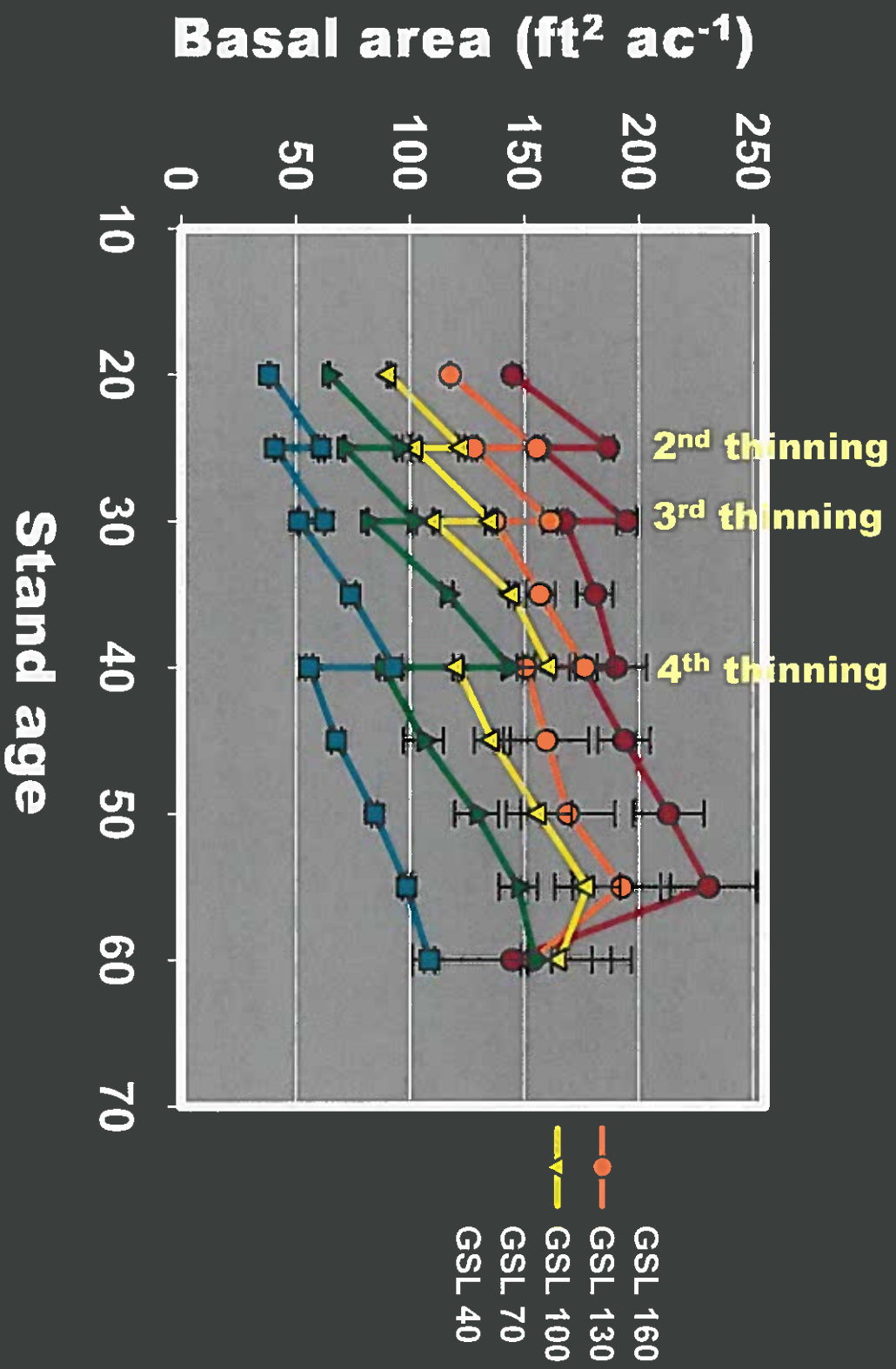


RESULTS

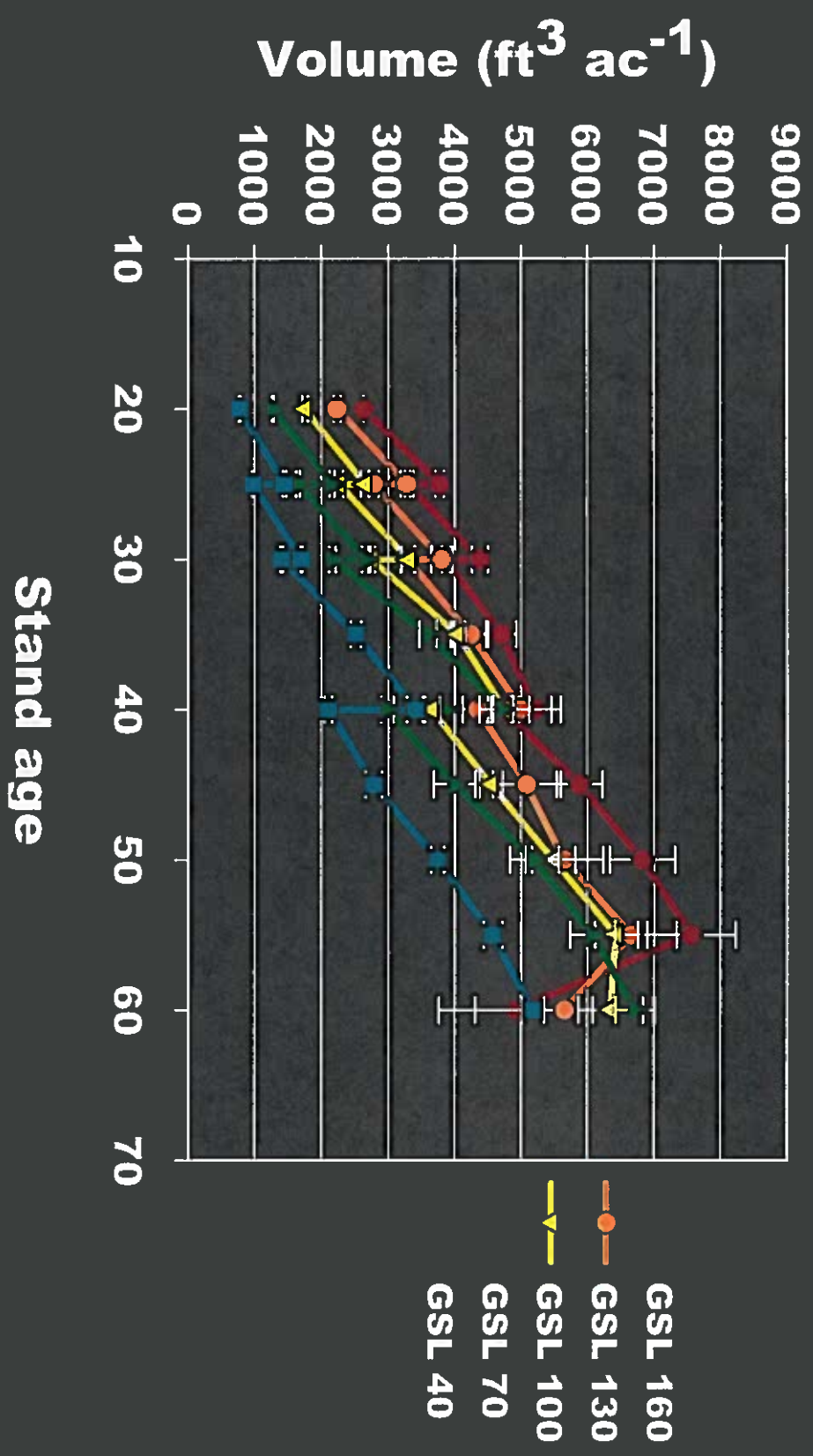
Diameter



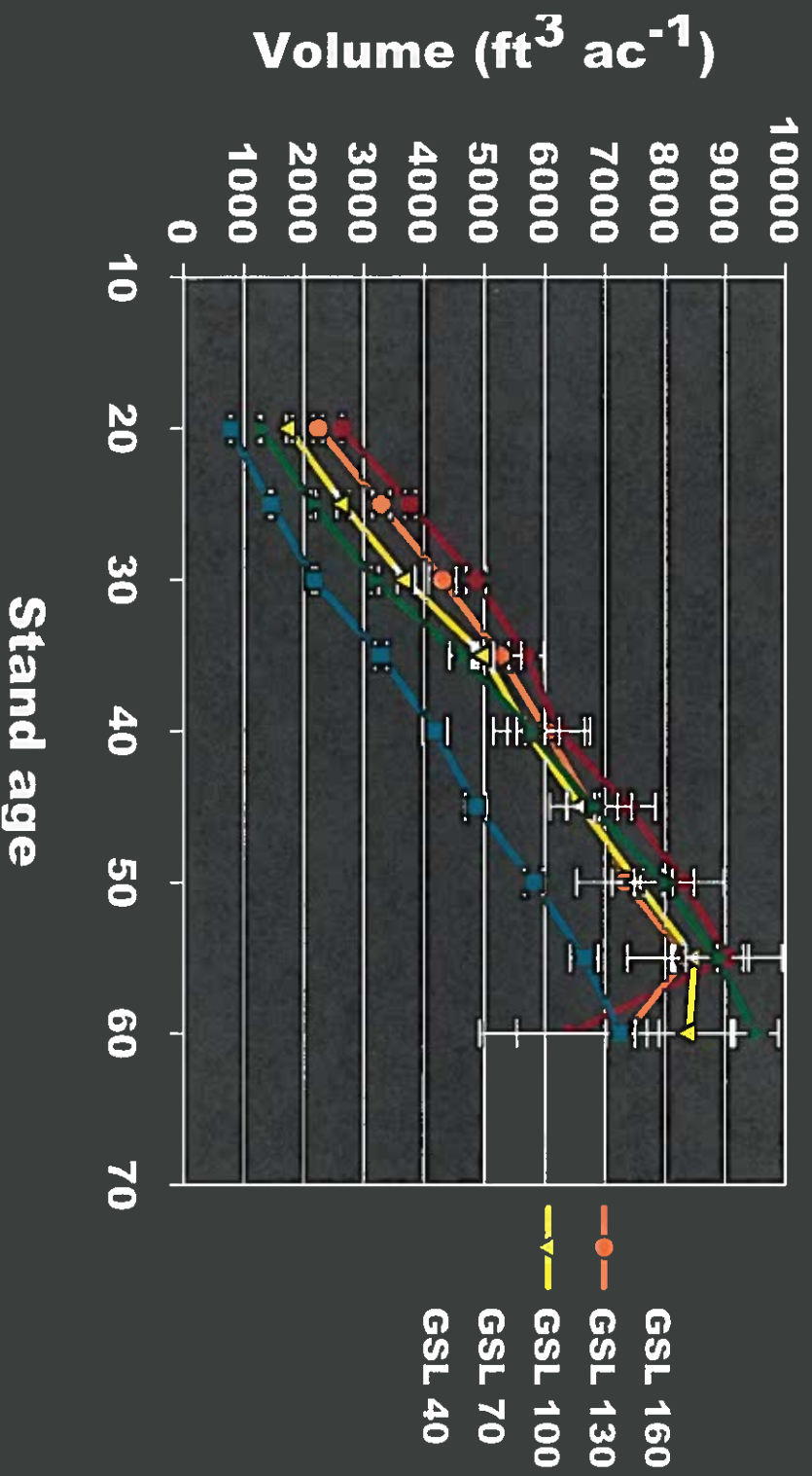
Basal area

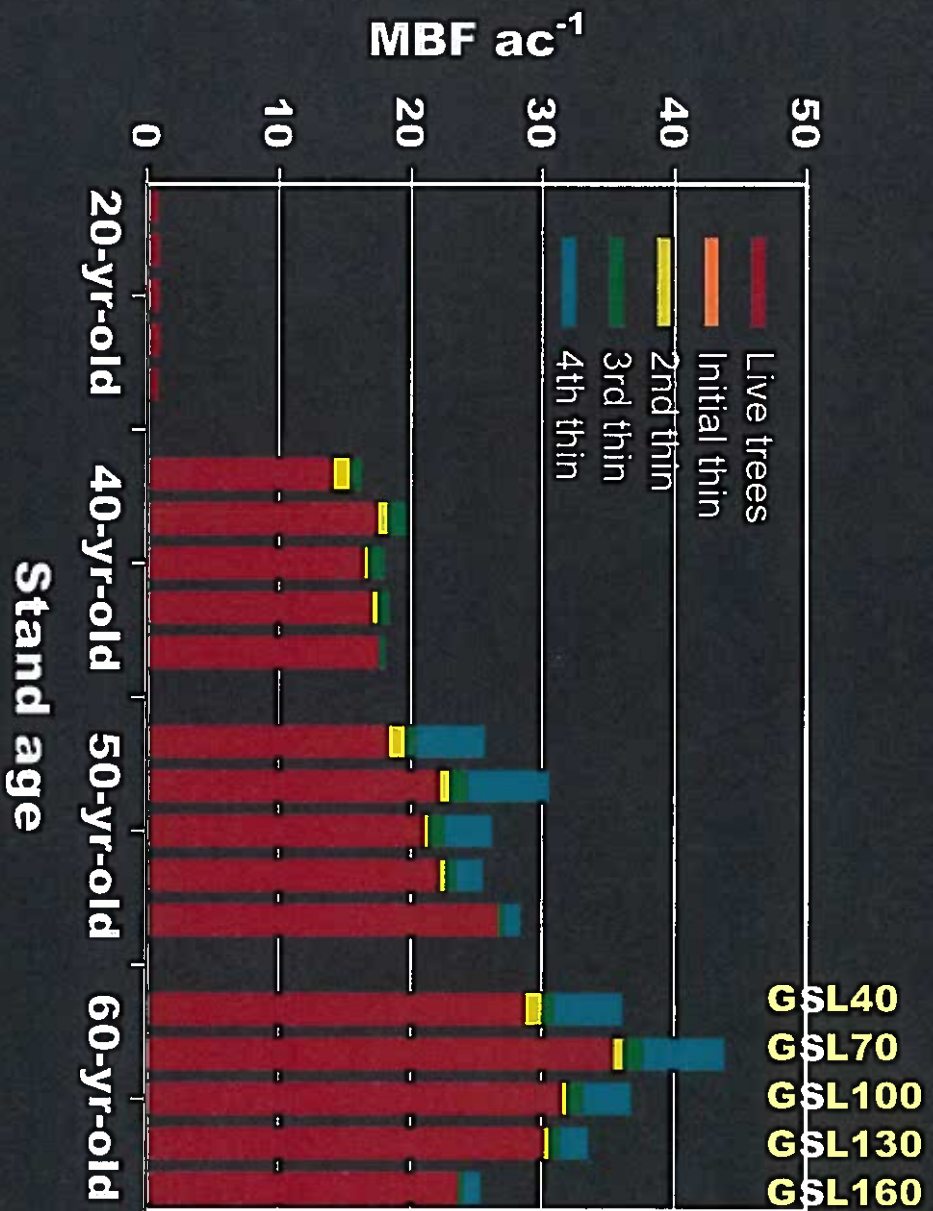


Live tree volume



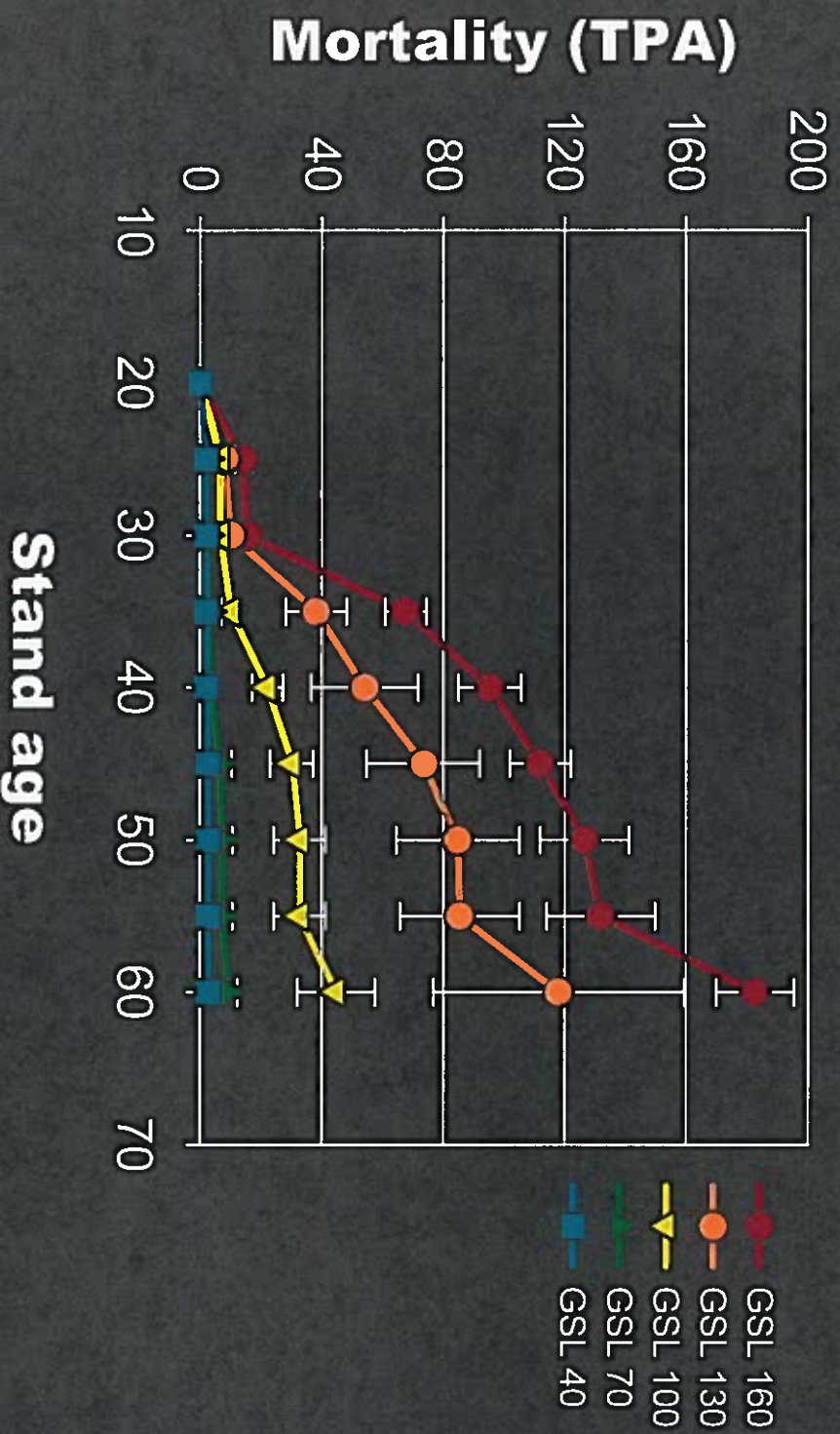
Total volume production





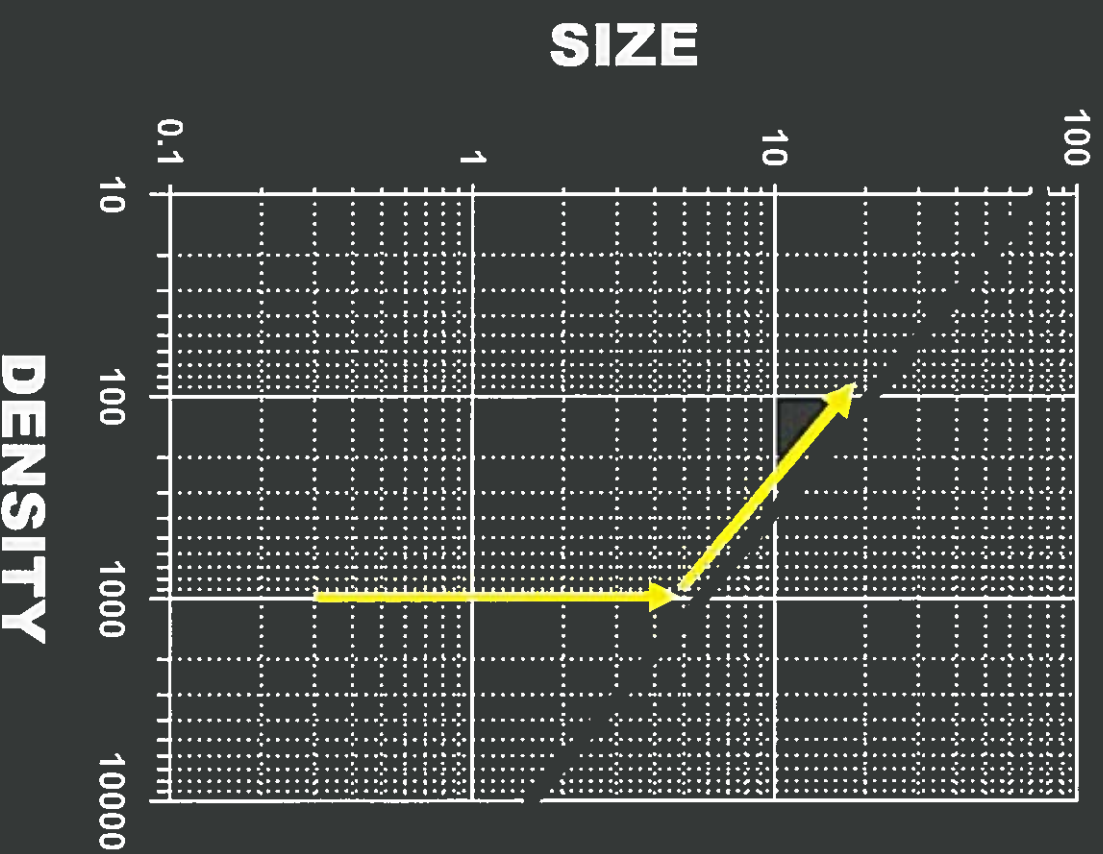
**Can we explain?
If so, can we
predict?**

Tree density (TPA) dynamics



Size-Density Relationship

- Self-thinning rule, or
- $-3/2$ power rule, or
- Yoda's law (1963)

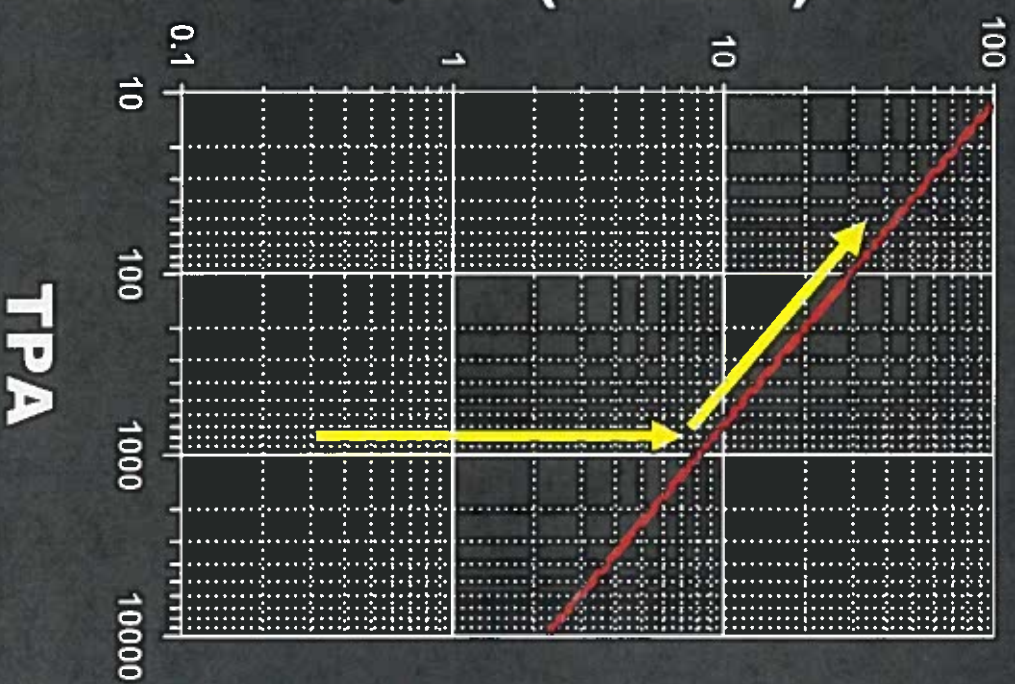


Stand Density Index (Reineke 1933)

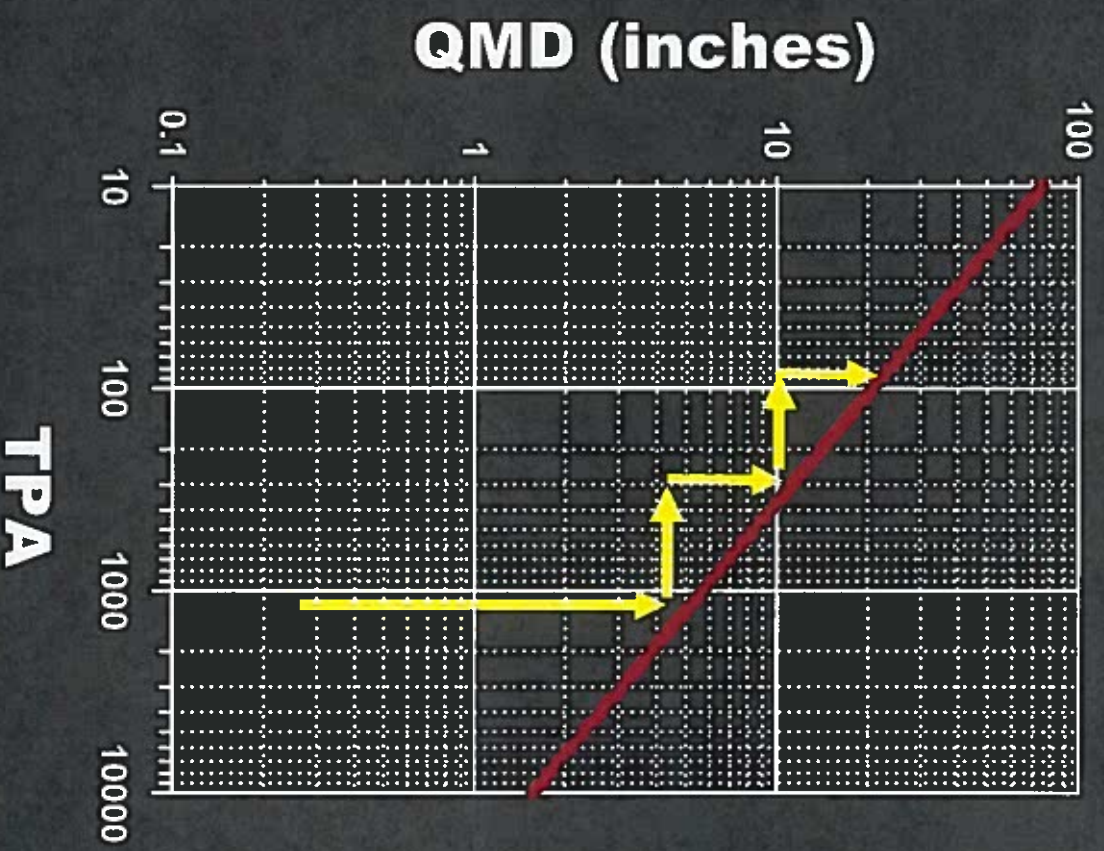
$$SDI = TPA \left(\frac{QMD}{10} \right)^{1.77}$$



QMD (inches)



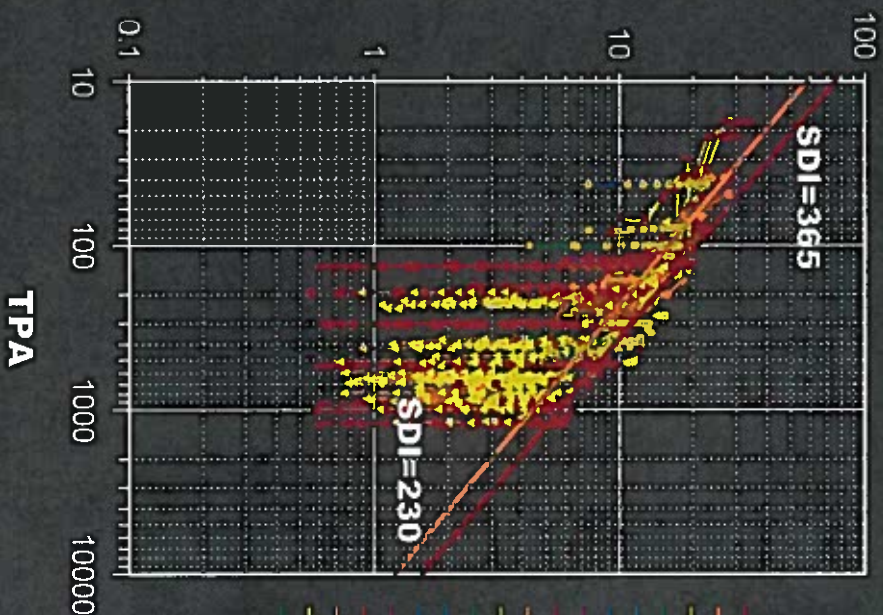
SDI for PIPPO with beetles:



Maximum Stand Density (SDI)

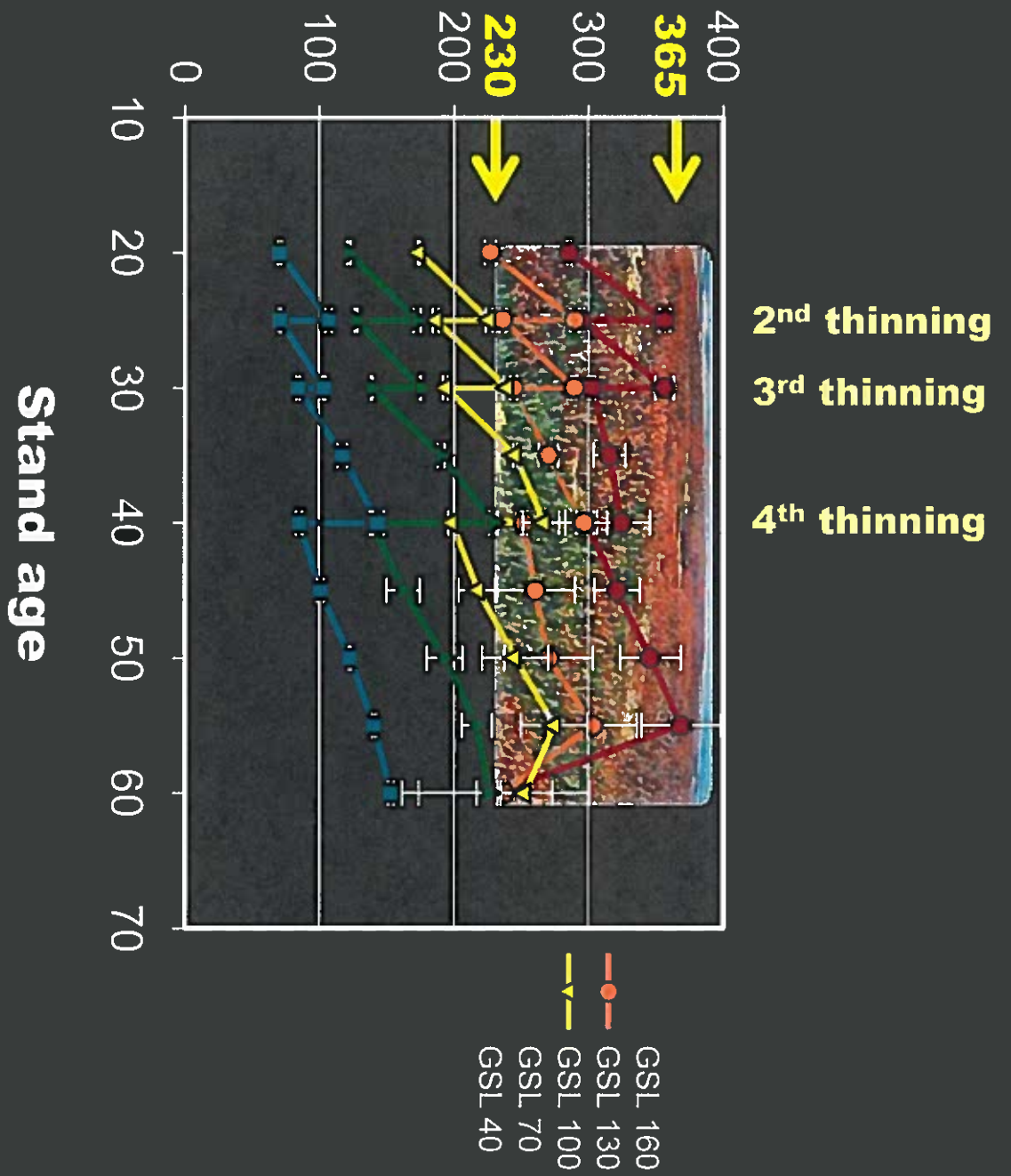


QMD (in.)

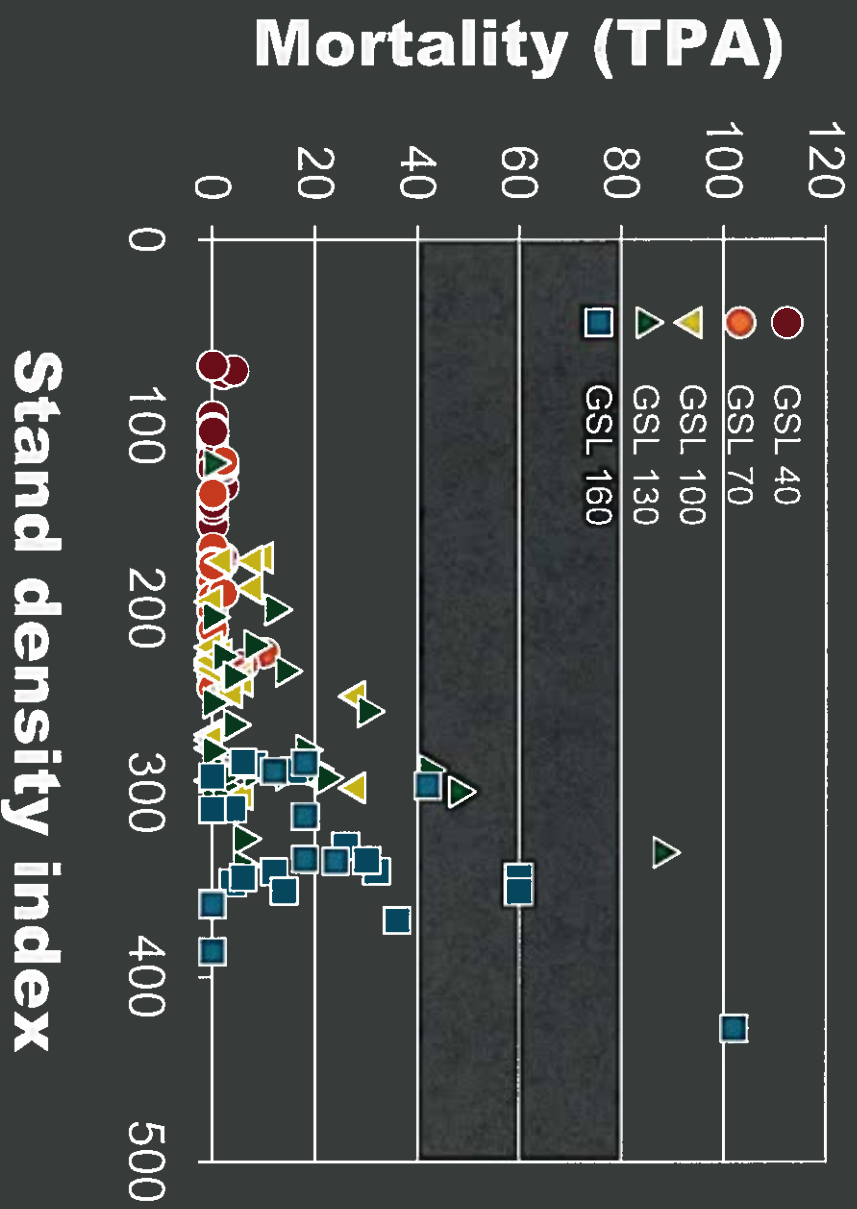


- Challenge EF
- Tough Spring Ridge
- Elliot Ranch
- Edson Creek
- Show Plantation
- Sugar Hill
- Adin Pass
- Antelope
- Blacks Mtn EF
- Dockwell
- Hat Ok Rim
- Hog Lake
- Jelly Camp
- Joseph Ck
- Washington Mtn
- KC Reservoir
- Spaulding Butte
- Prattville

Stand Density Index (SDI)



Mortality vs. SDI



In Summary:

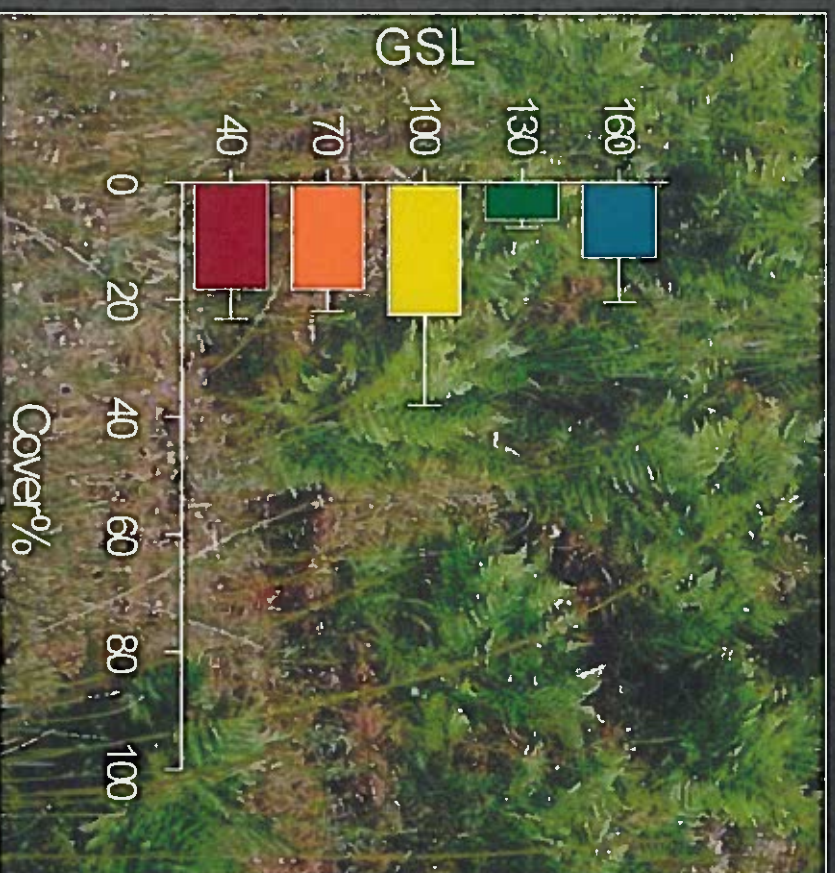
Without density management, mortality was high and growth rates low, producing many smaller trees



**Today, we manage
our forests for not
only wood, but also
other ecosystem
services**

Understory Vegetation Cover, Age 60

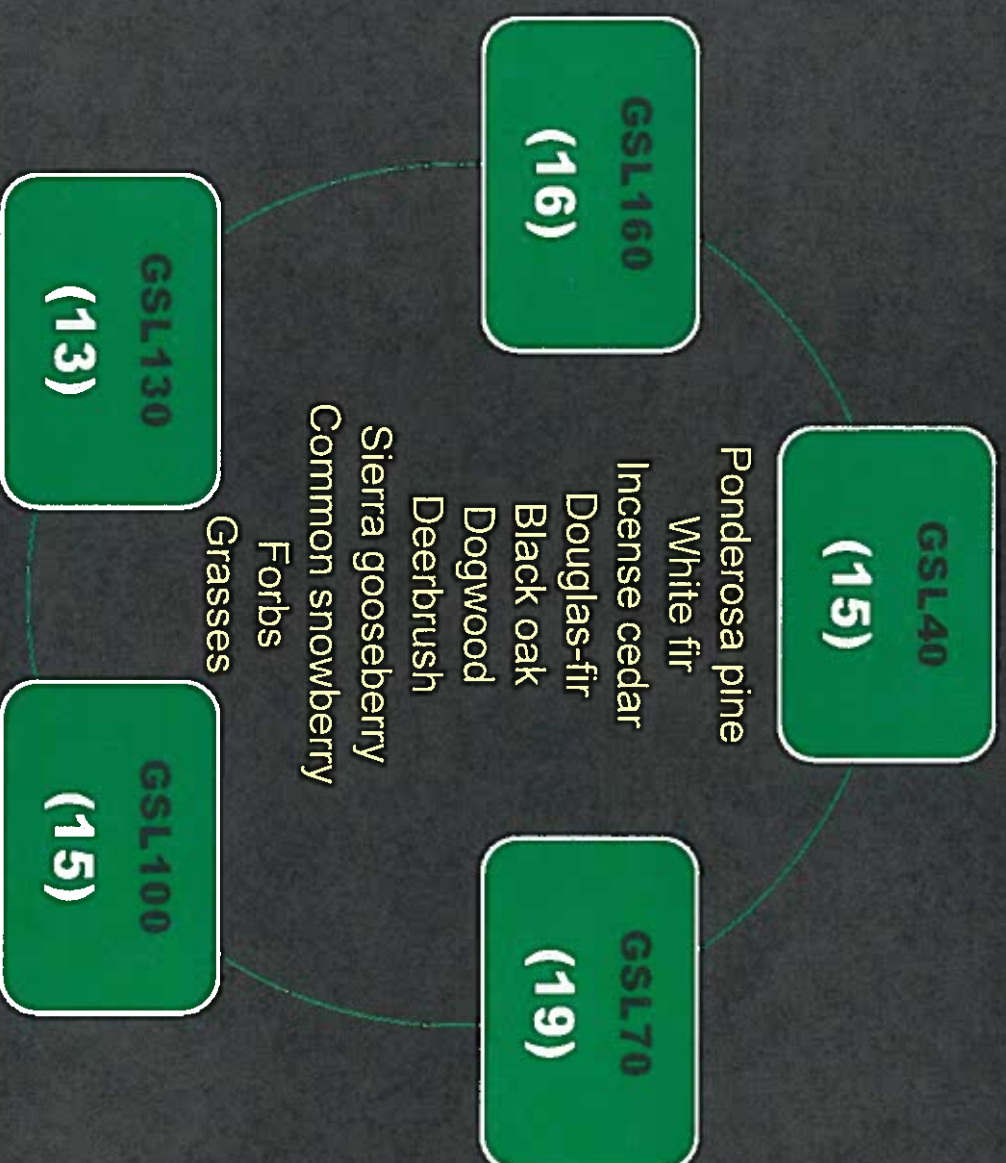
Grasses & Forbs



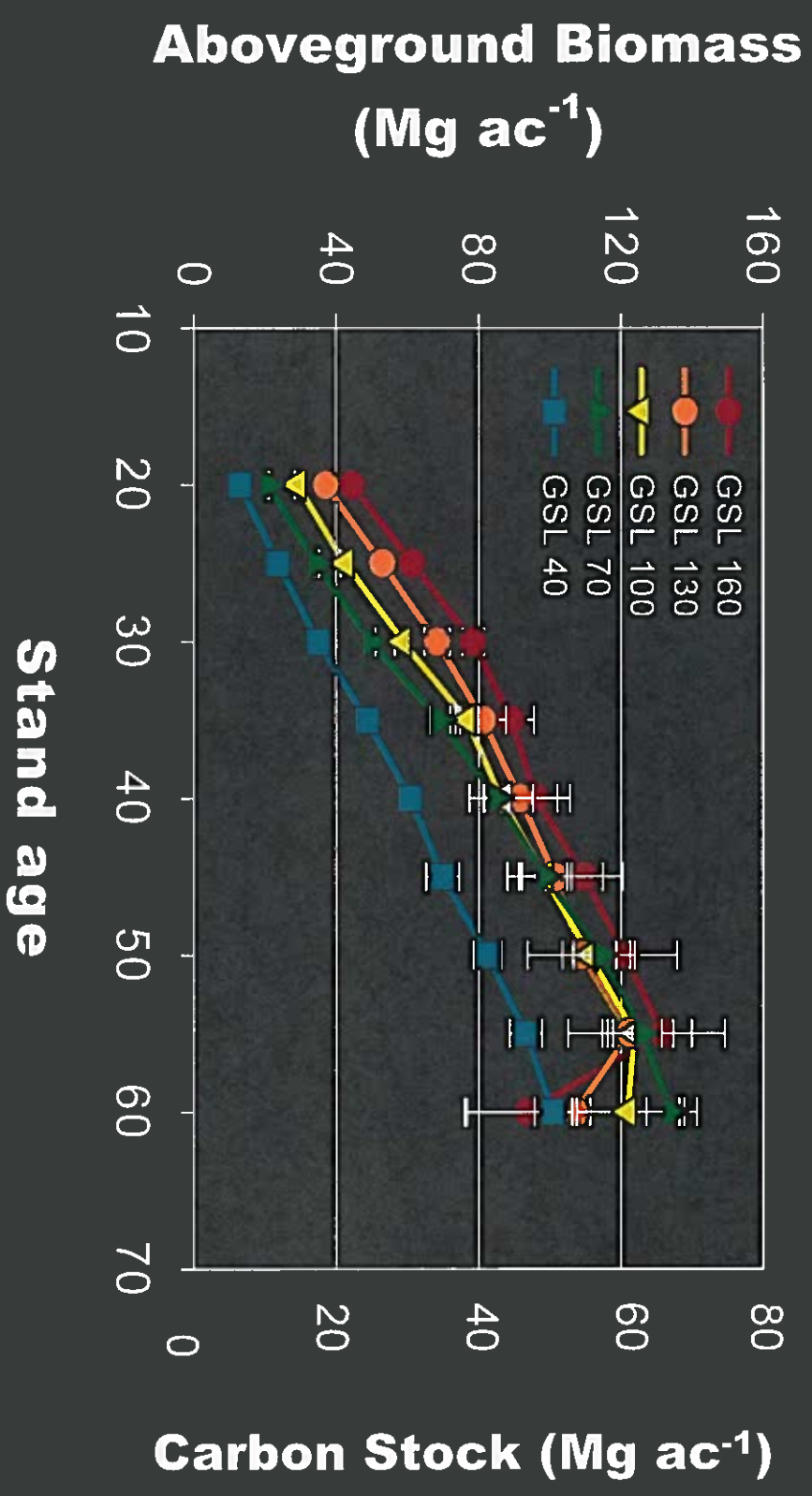
Woody understory

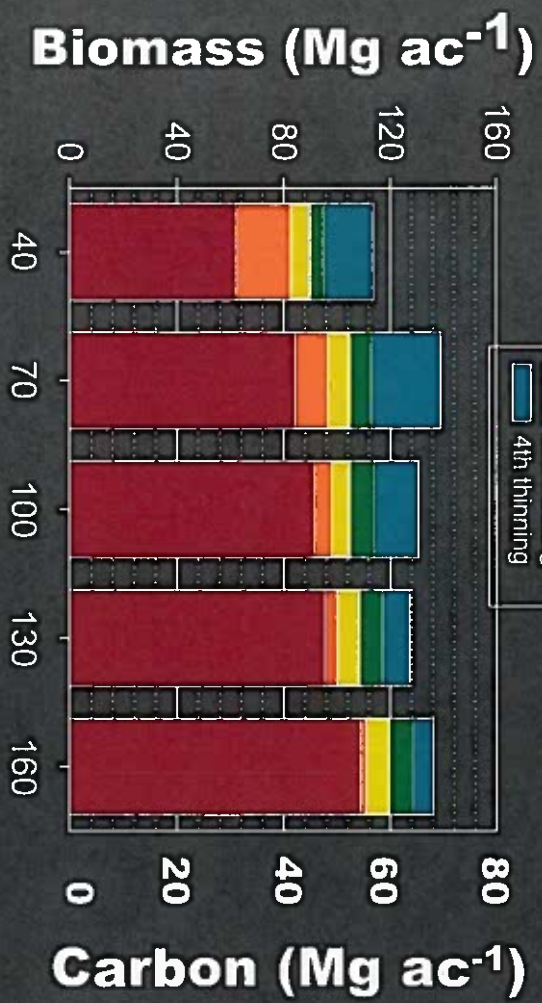


Plant Species Diversity



How did density affect aboveground carbon?



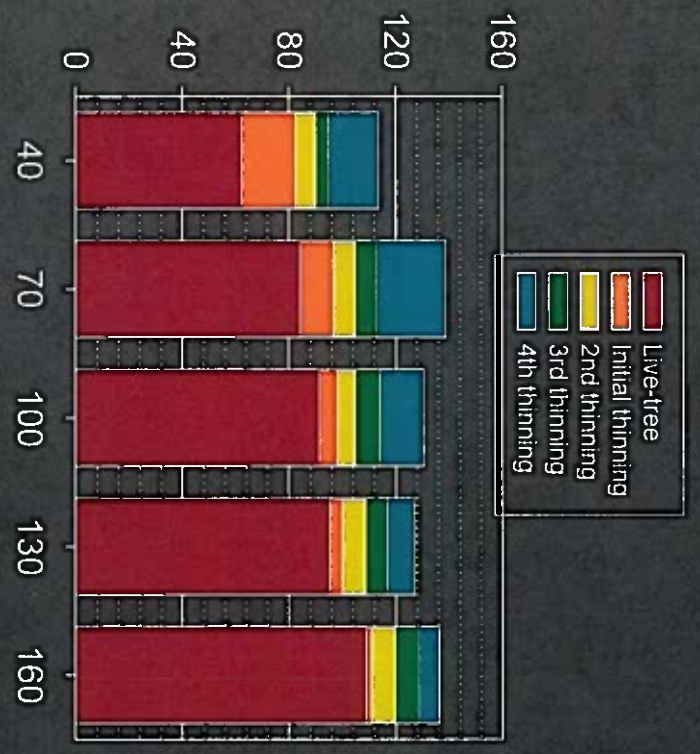


**Cumulative
aboveground
tree carbon**



Cumulative
aboveground
tree carbon

Biomass (Mg ac⁻¹)



Carbon (Mg ac⁻¹)



GSL

Biomass (Mg ac⁻¹)



Carbon (Mg ac⁻¹)



GSL

AT AGE 60

AT AGE 55

Summary

- ❖ Stand density at 70 ft² per acre (SDI = 128) produced the most biomass, board feet, and even cumulative volume at ER-like site quality
- ❖ If management goal is to produce the larger trees, stand density could be 40 ft² per acre (SDI=75)
- ❖ Reducing stand density enhanced understory development and did not affect plant species diversity

Summary (cont.)

- ❖ Lower density stands showed less mortality
- ❖ Oliver's limiting SDI of 365 appeared to characterize size-density dynamics well
- ❖ Vigorous stands ($BA_{\bar{}} \leq 100$, $SDI_{\bar{}} \leq 183$) sequestered more carbon for live tree aboveground

Conclusions

- ❖ **Forests must be managed for wood production, wildlife habitat, forest resilience for insects, diseases, and wildfires, and carbon sequestration and storage**
- ❖ **At any similar site quality, a stand should be thinned not more than 100 ft²/ac (SDI < 185). Maintaining SDI 120-185 requires repeated thinning.**

Acknowledgement:

- ❖ All former and present members of Vegetation Dynamics Team
- ❖ Sierra Pacific Industries, Inc.
- ❖ Sierra-Cascade Intensive Forest Management Research Cooperative