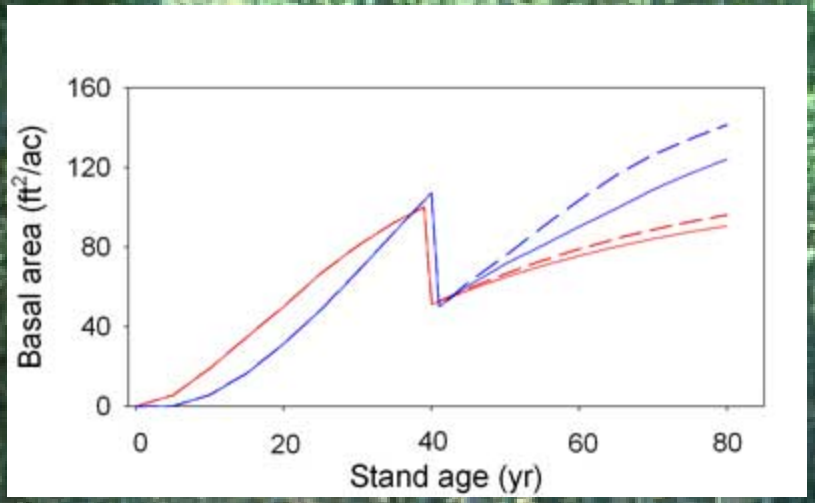


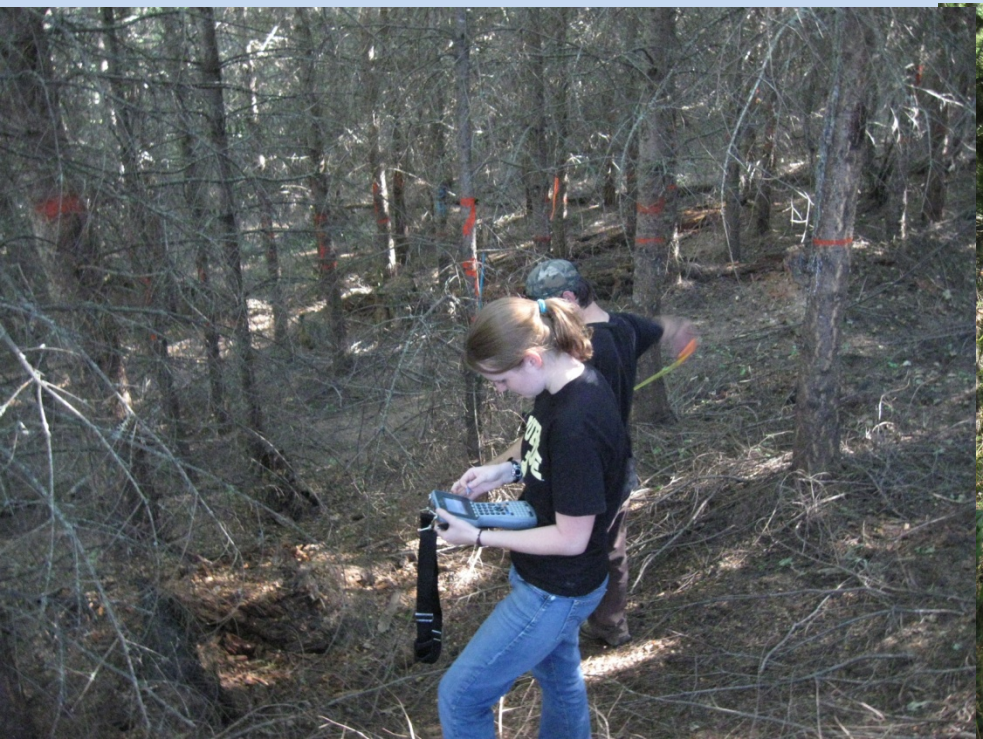
Synthesis of Thinning by Fertilization Trials

Mark Coleman

Several forest management and forest ecology questions provide information on density management

- Forest productivity studies
- Forest diversity
  - old growth vs. 2nd growth
  - Understory veg cover & diversity
  - habitat
- Biomass removals
- Clear-fell avoidance through uneven age management

Can nutrient availability be managed through stand density?

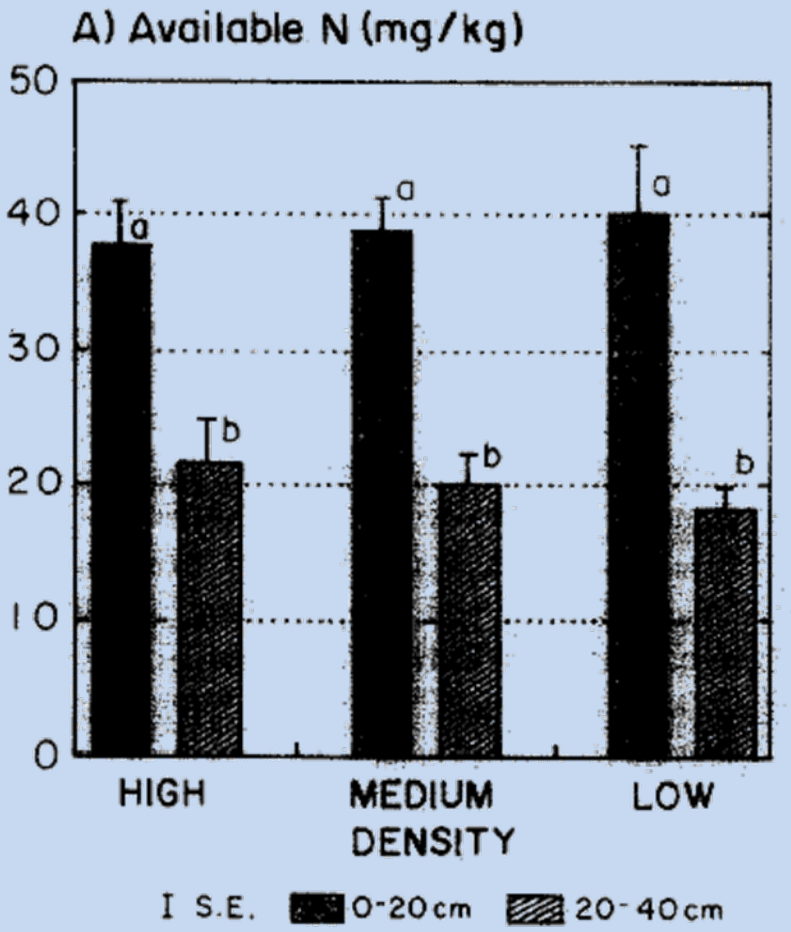


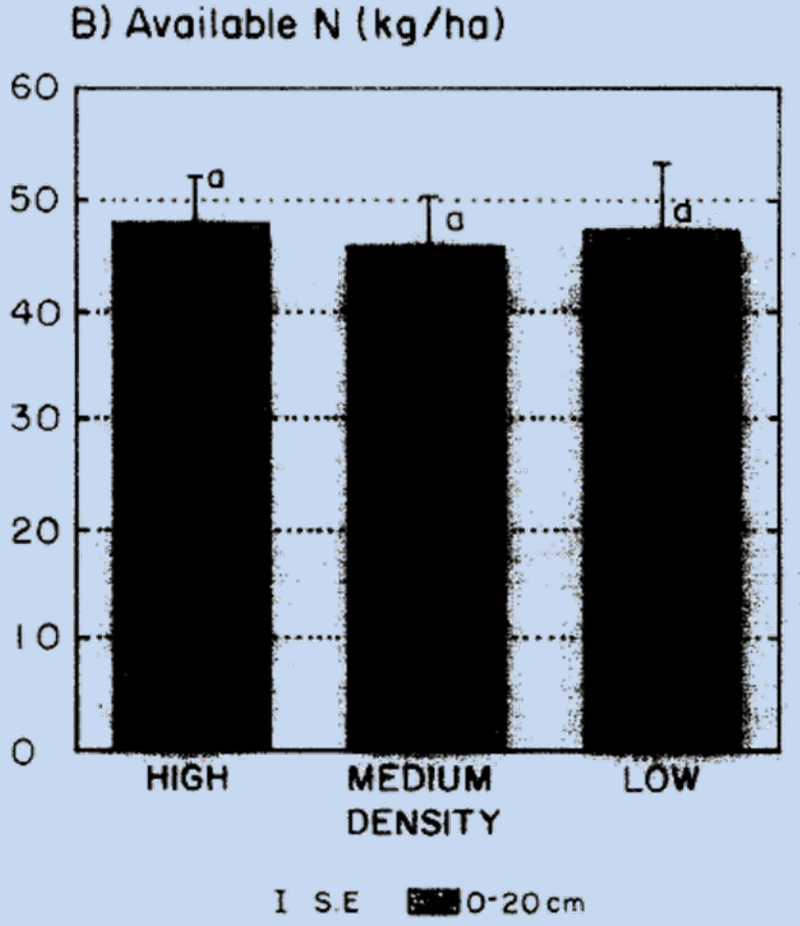
Stand density and nutrient availability

- Low density → high growing space
- Best response on high quality sites
- Opportunities for fertilization
- Light interception correlates with stand growth response
- Understory vegetation responds too

Soil N availability, N-mineralization is not affected by thinning

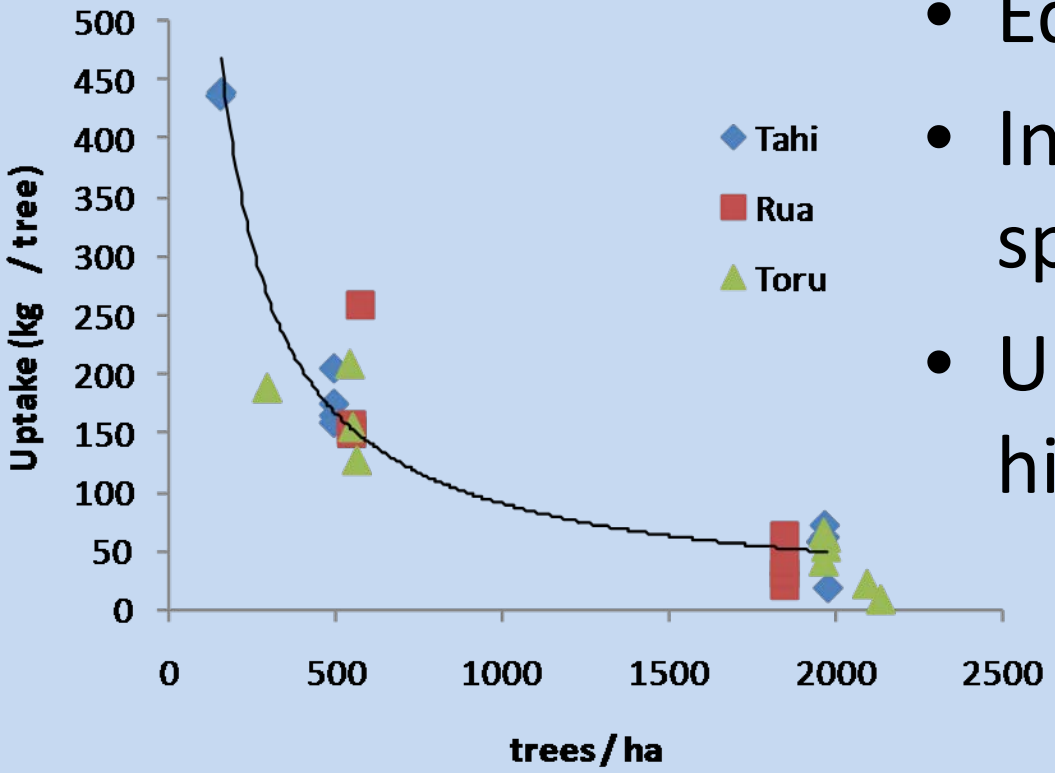
Martinez and Perry 1997





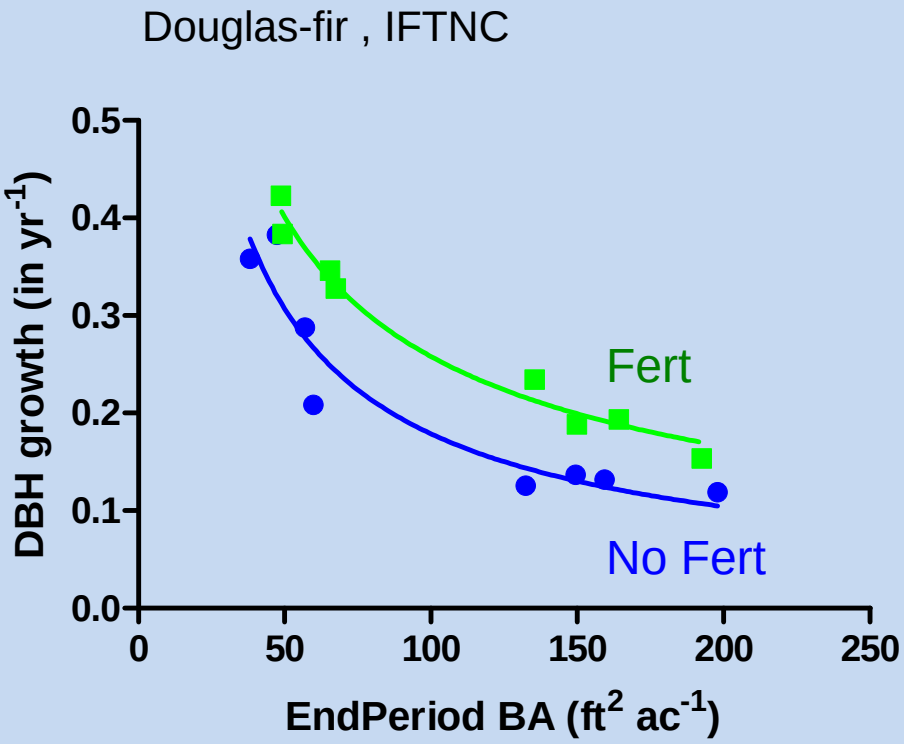
Residual tree nutrient availability increases as stocking decreases

Radiata Pine (Beets & Pollock, 1987)



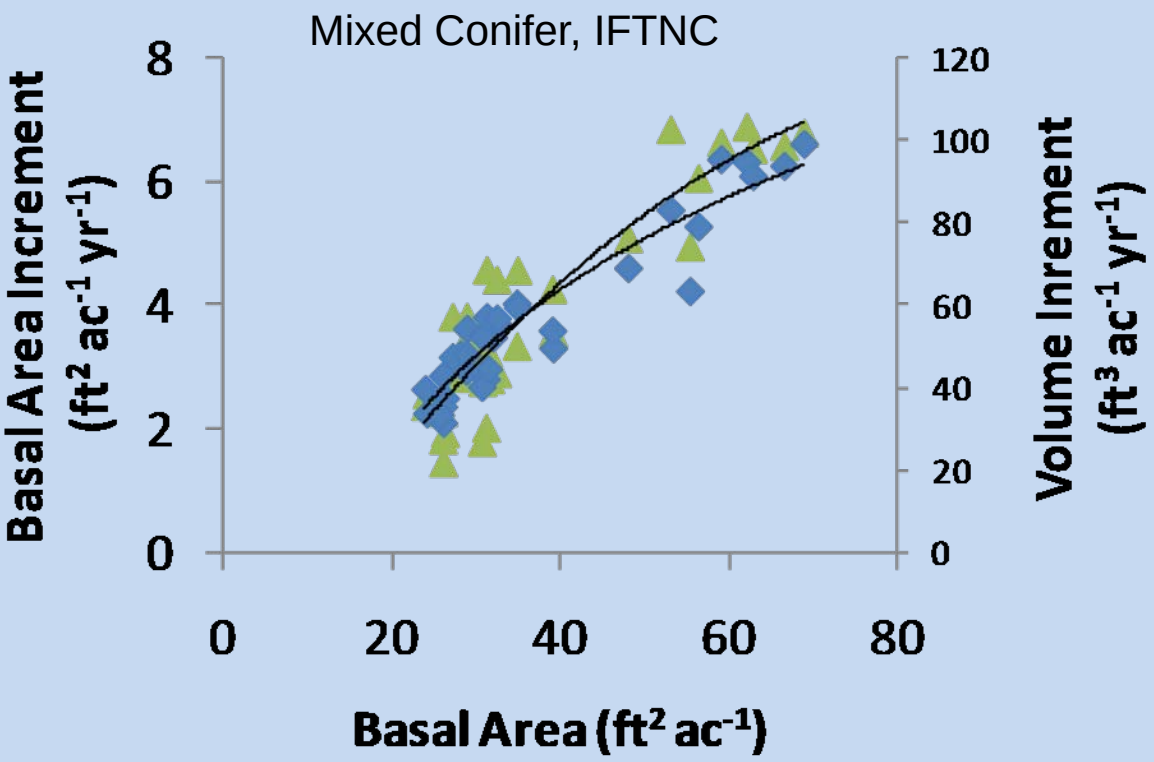
- Equal supply
- Increased growing space
- Uptake per tree is highest at low density

Individual trees grow faster in thinned stands



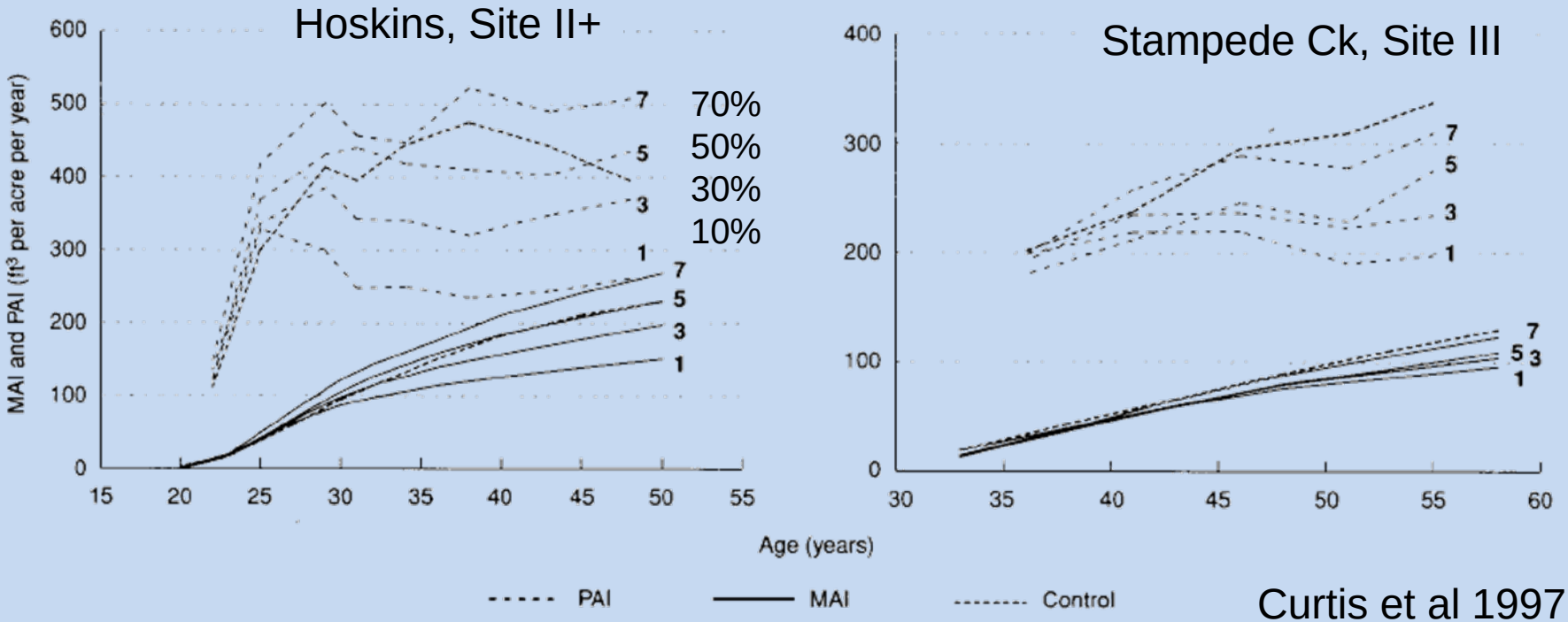
- Increased resource availability results in faster tree growth
- Fertilizer increases tree growth
- Response to thinning is greater than response to fertilizer

Stands grow faster in unthinned stands



- Greater numbers allow rapid accumulation of stock
- Trees are smaller and slower growing at high stocking
- Mortality eventually occurs with overstocking

LOGS showed volume growth response depends on site class

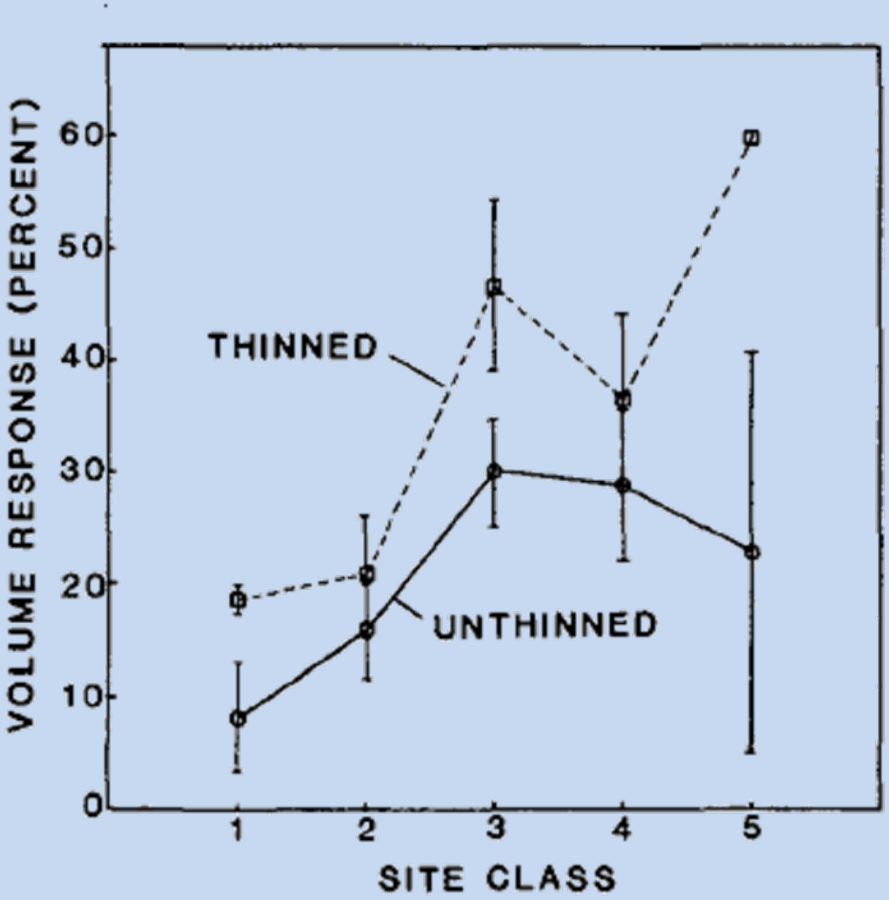


Curtis et al 1997

- Greater response to thinning on high site
- Expect to improve thinning response through fertilization

Costal Douglas-fir

Regional Forest Nutrition Research Program (=SMC)

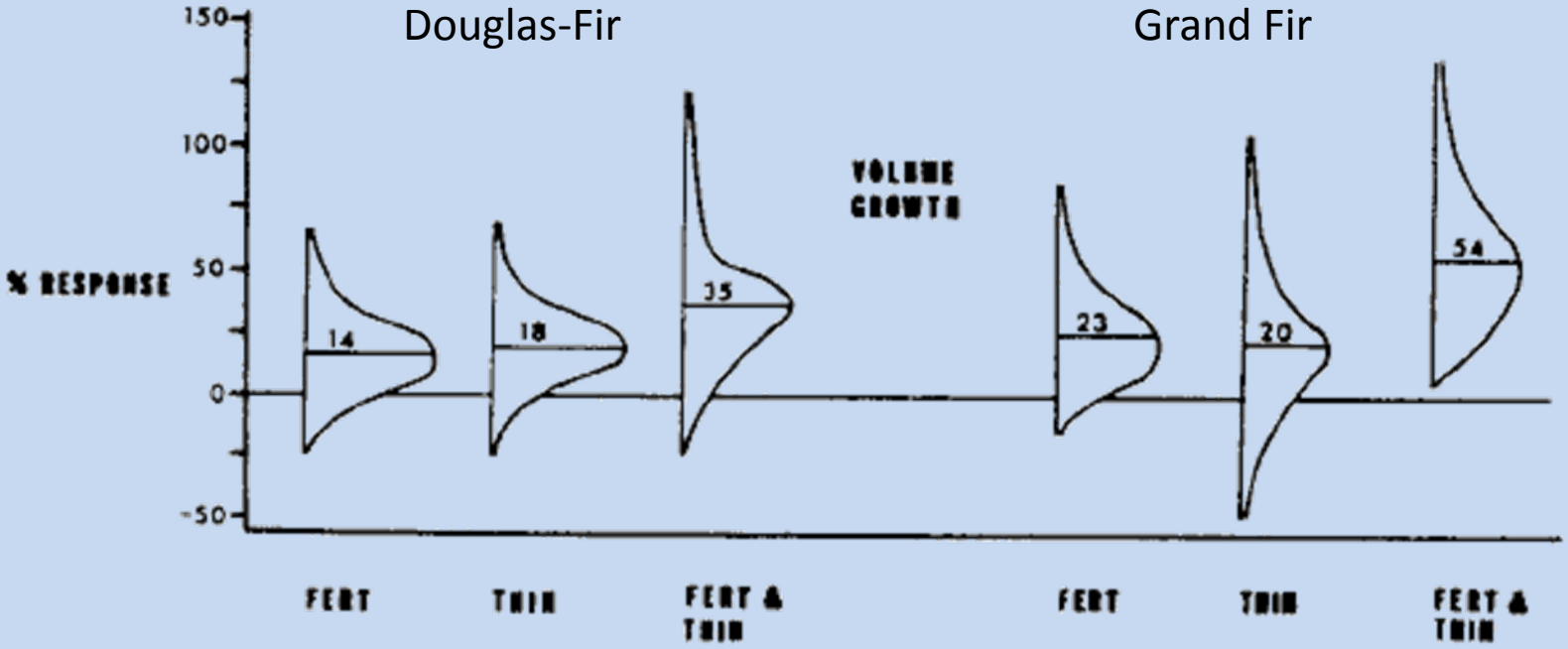


Fertilizer response increases with decreasing site quality

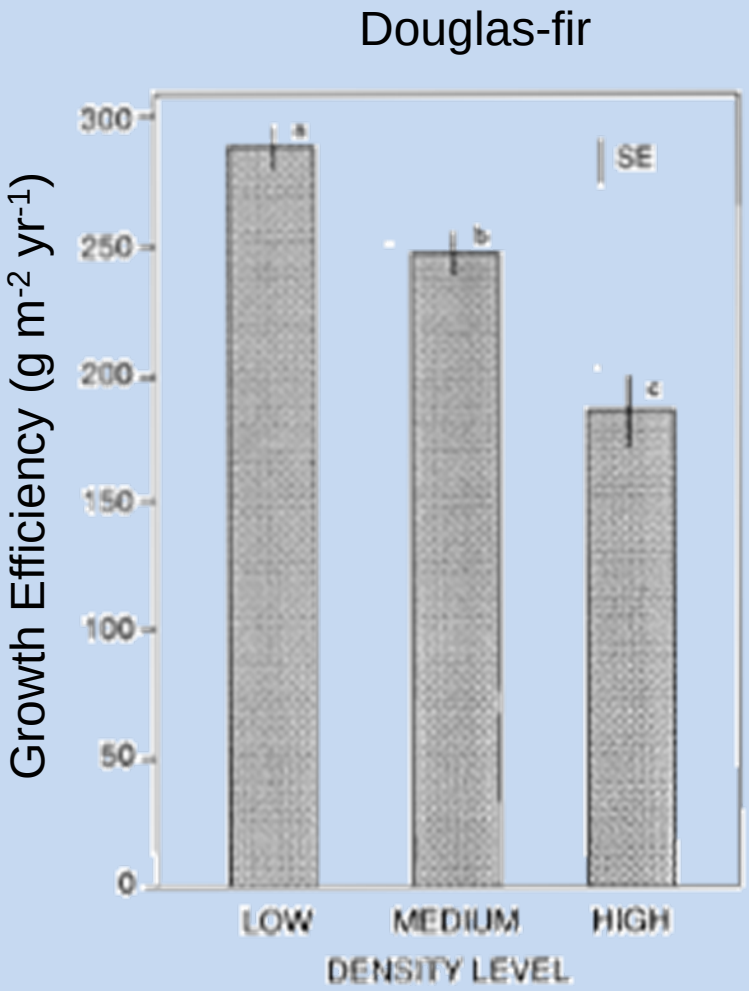
Edmonds & Hsiang 1987

Thinning with fertilization is additive

Scanlin & Loewenstein 1979



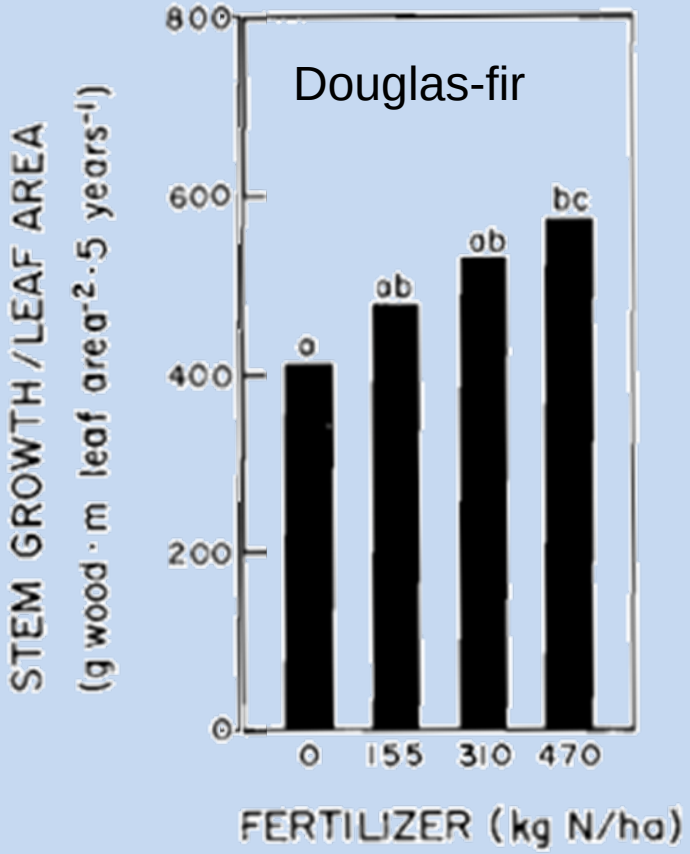
Growth efficiency = Production per unit leaf area



- Thinning removes leaf area
- Trees are growing faster
- GE is highest a low densities

Velazquez-Martinez et al 1992

Growth efficiency increases with fertilization



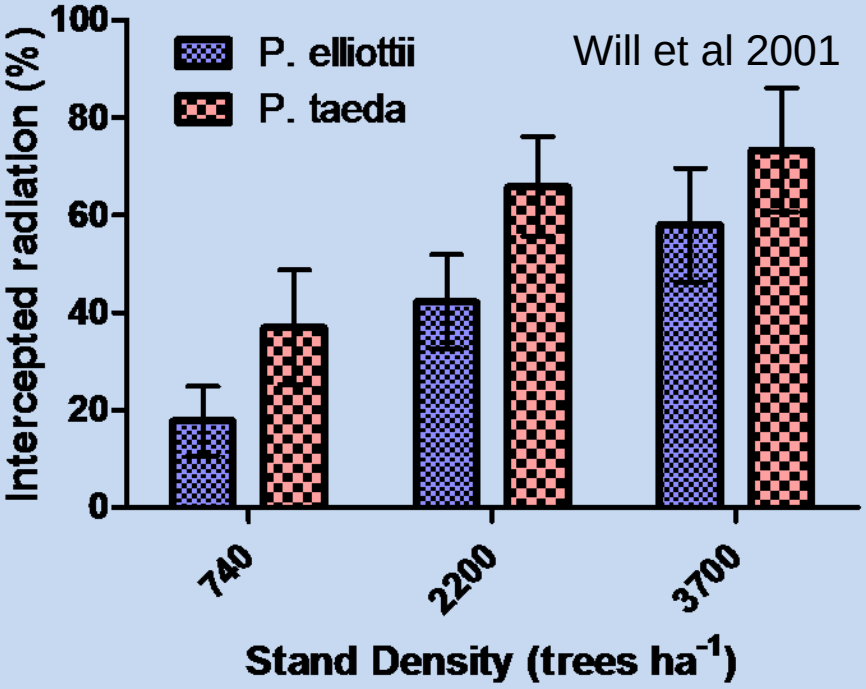
Binkley & Reid 1984

- Fertilization increases stem growth more than canopy leaf area

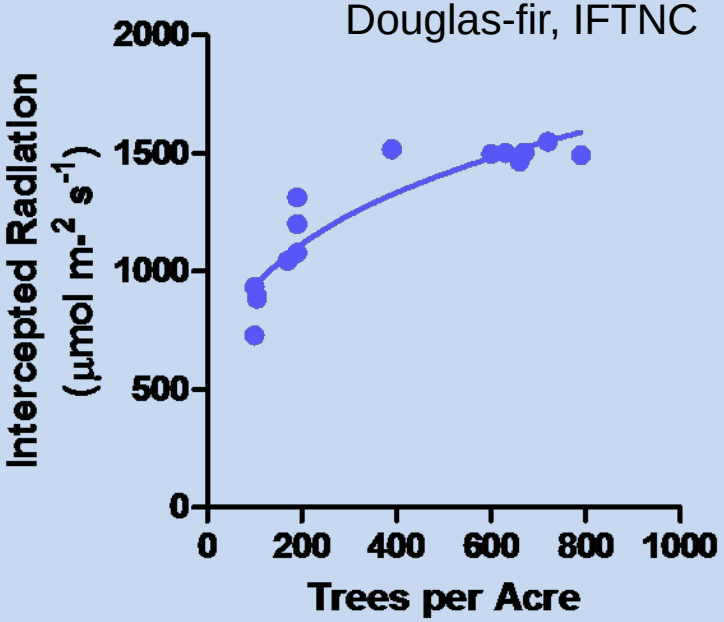
Ceptometers estimate leaf area through light interception measurements

- Intercepted radiation and canopy leaf area are proportional
- Assumes uniform canopy

Light interception increases with stand density

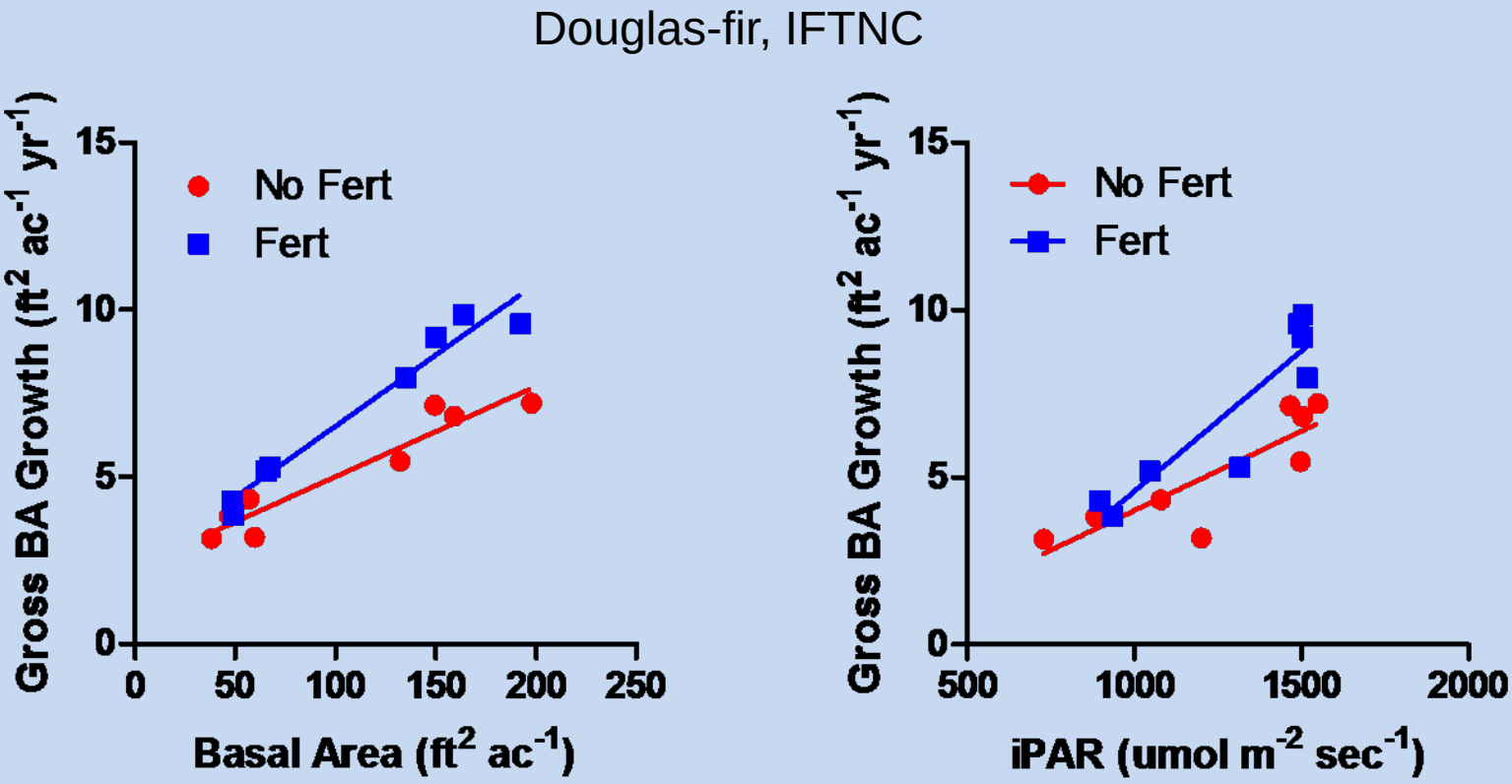


Will et al 2001



Douglas-fir, IFTNC

Density affects fertilizer response

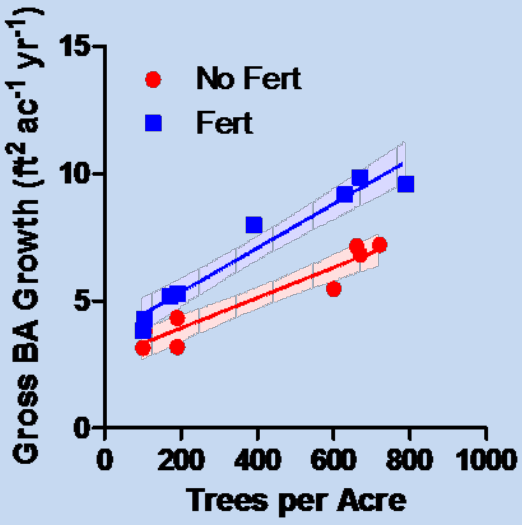


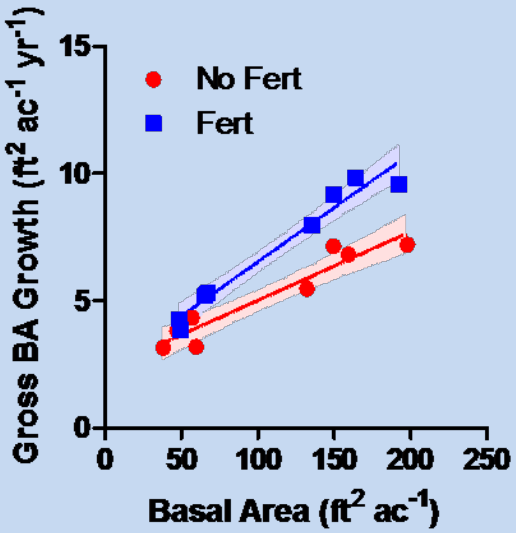
- Fertilizer response increases with stocking
- Light interception by the crown is proportional to growth

Why is there a low fertilizer response at low density?

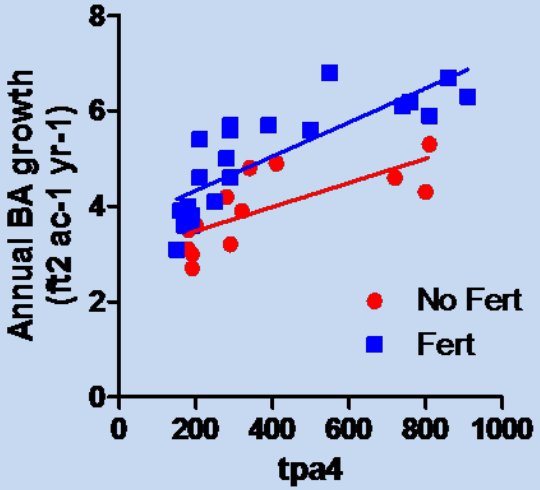
1. Increased growing space for individual trees
   - Improved nutrient availability by thinning
   - Decreased requirement for nutrient amendments
2. Nutrients released by tops and limbs
3. Understory acquires available nutrients

Douglas-fir, IFTNC



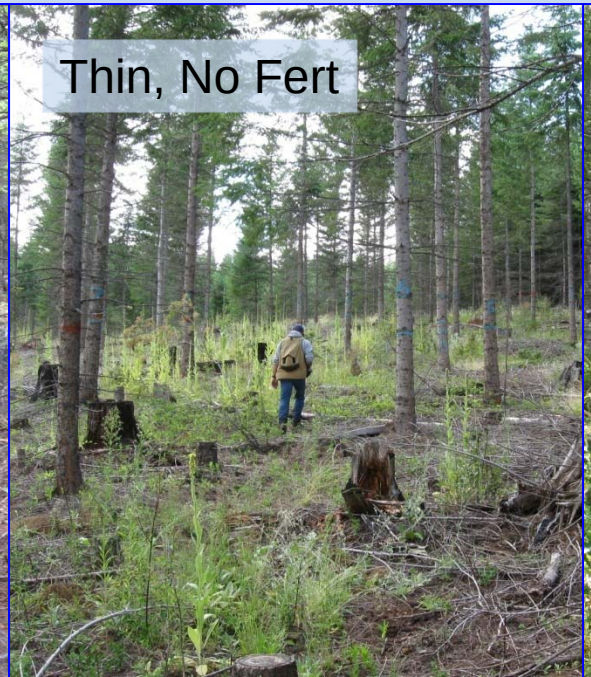


Mixed Conifer, IFTNC



Understory vegetation responds too

- Understory vegetation increases in biomass and diversity
- Changes habitat diversity
- Increased competition for resources



Conclusions

- Thinning improves nutrients and light
- A greater response to thinning is expected on better sites or with fertilization
- Improved growth efficiency from thinning and fertilization
- Light interception as a measurement tool
- Relevant to numerous forestry questions

Density management forest nutrition research questions

- What are the carrying capacities for Inland NW site types?
- Can fertilization be avoided through proper density management?
- Is there an optimal fertilization time relative to thinning?
- Will vegetation management improve thinning and thinning by fertilization response?

Density management links to other IFTNC research

- Site Type Initiative
- Bark beetle research
- Larch spacing trial
- Biomass removal and utilization
- Harvest operation studies
- Vegetation control research