



OREGON STATE  
UNIVERSITY



# **Species mixtures of red alder and Douglas-fir: An analysis**

HSC Summer 2012 meeting; Wind River, WA

Andrew Bluhm  
Hardwood Silviculture Cooperative  
Oregon State University

## Rationale

Binkley(2003) in "Seven decades of stand development in mixed and pure stands of conifers and nitrogen-fixing red alder".

Question:

What would be the productivity effects of mixing red alder with conifers?

- Site Class I & II lands (50%): decrease both total stand growth and conifer growth
- Site Class III lands (25%): the balance between competition and facilitation would be highly variable
- Site Class IV lands (25%): increase conifer growth

## **Rationale (con't)**

Thomas et al. (2005) in "Effects of red alder on stand dynamics and nitrogen availability"

"It is premature to conclude that any differences among treatments is the result of the presence or absence of red alder."

Binkley(2003) continues:

"The optimal balance of alders in a mixture with conifers on N-deficient sites probably varies with relative tree dominance and spatial patterning of the stand; more recent experiments with species-replacement designs will provide some insights into this balance..."

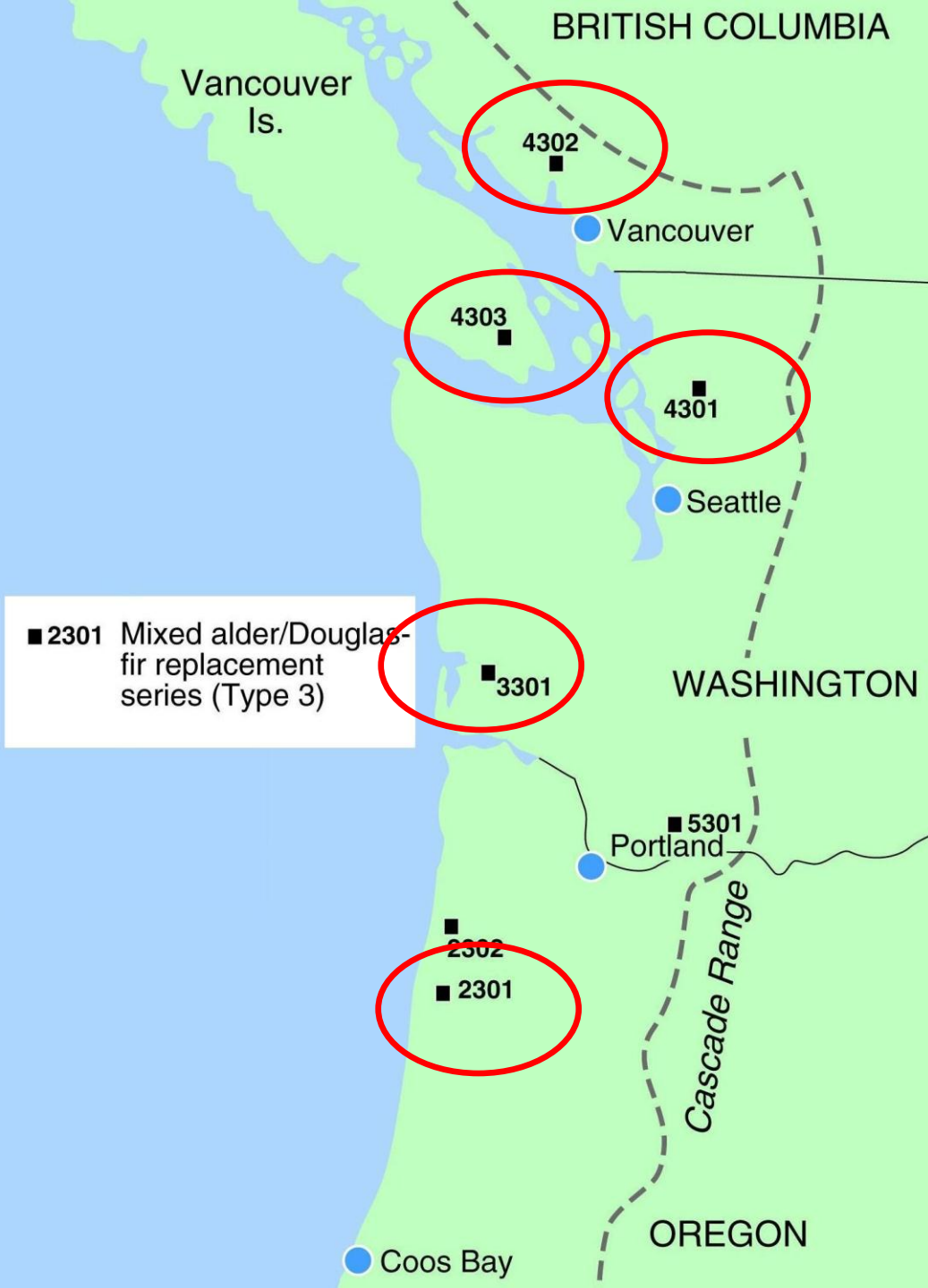
- HSC has established seven mixed species plantations of red alder and Douglas-fir throughout the PNW
- All sites located on nutrient poor land (Douglas-fir Class III or lower)
- The design is a replacement series
  - constant total stand density
  - changing proportions of each species
- One plot per site (no replication)

Treatment	%RA	%DF	TPA	Spacing (ft)
314	100	0	300	12
315	50	50	300	12
316	25	75	300	12
317	11	89	300	12
318	0	100	300	12

# Plot Layout



- Measurement plot is 1/3 acre
- At least a 66ft buffer
- Planted in pre-marked spots
- First and second year mortality
- Interplanting and/or rouging
- At age three all trees in the plot were permanently tagged
- Dbh, Ht, Hlc was taken at age 3, 6, 9, 12, 17



- #4302-East Wilson-BCMIN
  - Site Class IV ( $SI_{50}=82\text{ft}$ )
- #4303-Holt Creek- BCMIN
  - Site Class III ( $SI_{50}=109\text{ft}$ )
- #4301-Turner Creek- GYN/DNR
  - Site Class III ( $SI_{50}=97\text{ft}$ )
- #3301-Menlo- DNR
  - Site Class III ( $SI_{50}=98\text{ft}$ )
- #2301-Monroe Indian- ANE
  - Site Class III ( $SI_{50}=106\text{ft}$ )

Site Class estimates come from NRCS:  
<http://websoilsurvey.nrcs.usda.gov/app/>

## Methods/Analysis

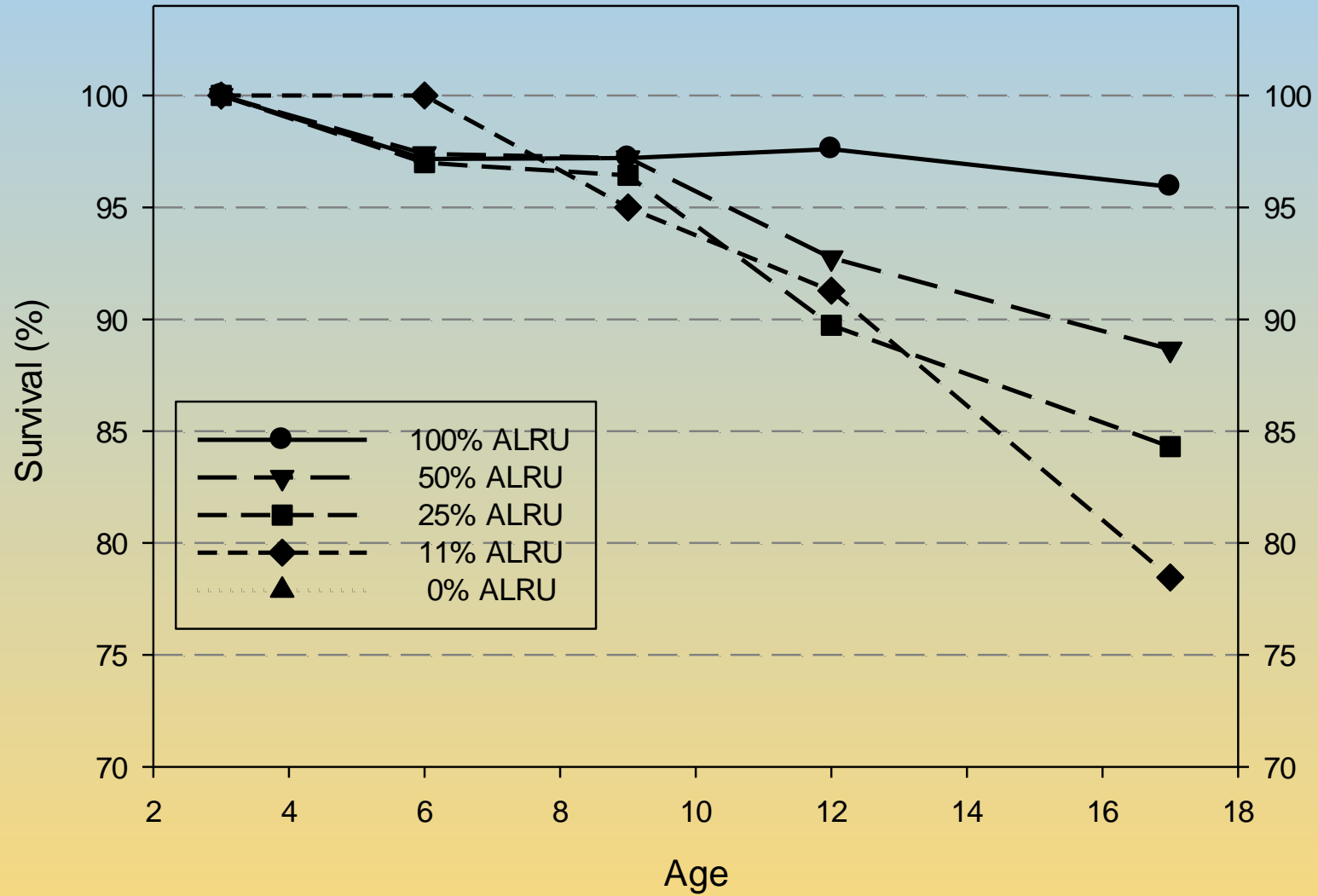
- Survival was calculated as the tpa relative to age 3
- DBH was calculated as the quadratic mean diameter (QMD)
- Height and height to live crown (HLC) was calculated as the arithmetic mean
- Missing HTs, HLCs and CRs were estimated using the ORGANON growth model (RAP and SMC versions)
- Individual tree stem volume index (SVI) was calculated as  
$$SVI = DBH^2(m) * HT(m)$$
- SVI/acre was calculated and used to calculate relative yield (RY)
- RY is defined as species mixture yields relative to yields in pure species
  - Relative land output (RLO)

# Objectives

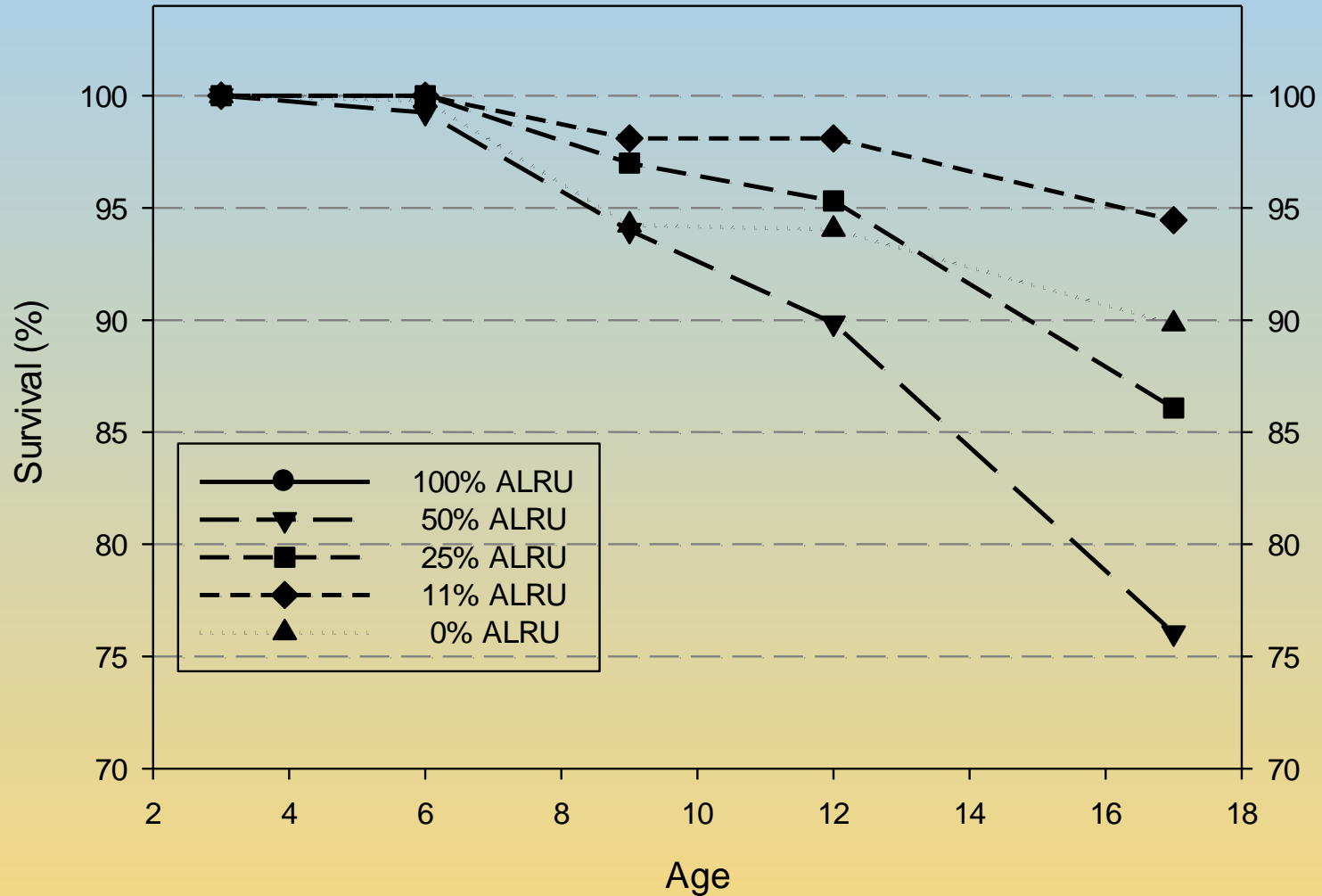
- To examine the effect of species proportion (%) on:
  - Survival, DBH, HT, SVI, SVI/acre, and RLO
- Specifically:
  - Does increasing red alder percentage correlate with increasing red alder performance?
  - Does any red alder percentage correlate with decreasing Douglas-fir?
  - Are mixed species stands more productive than pure stands?



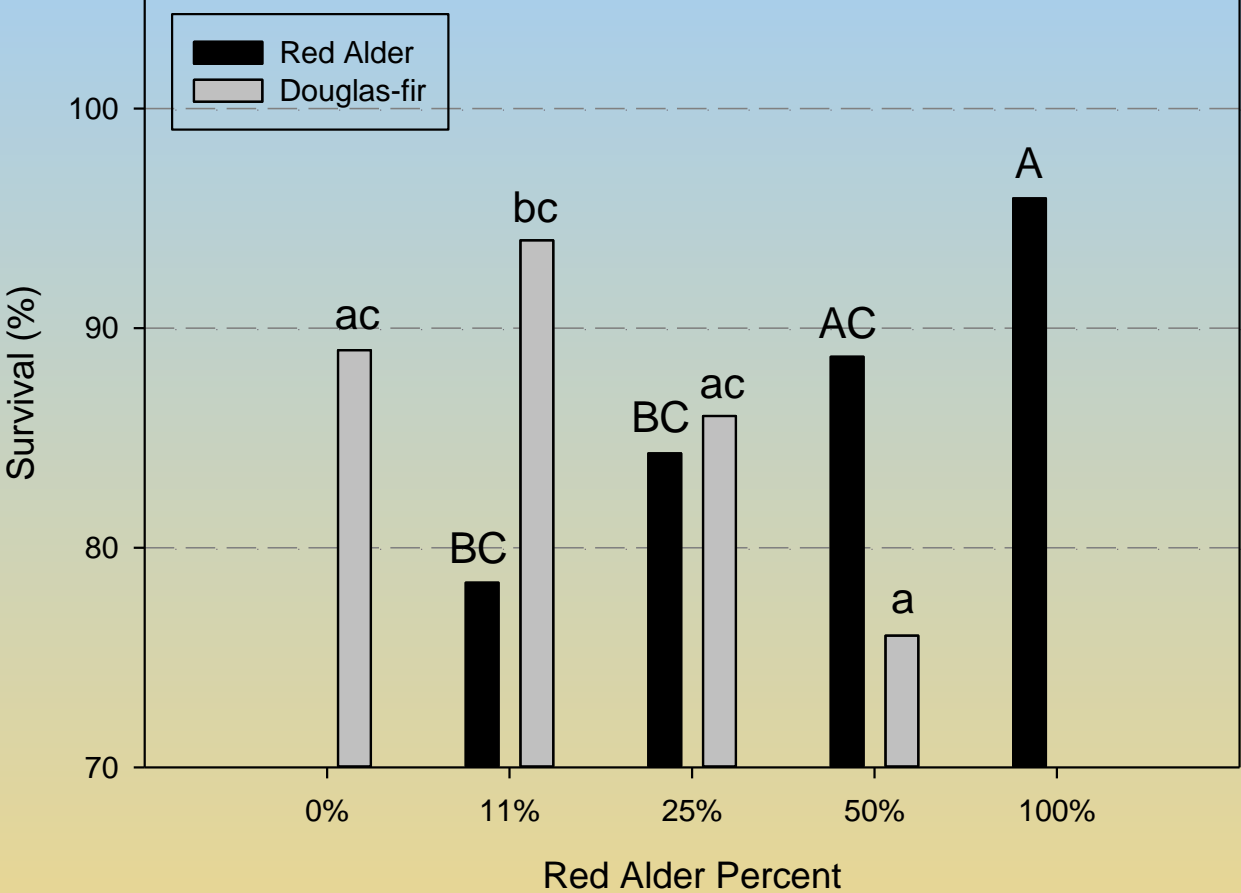
# Red Alder Survival



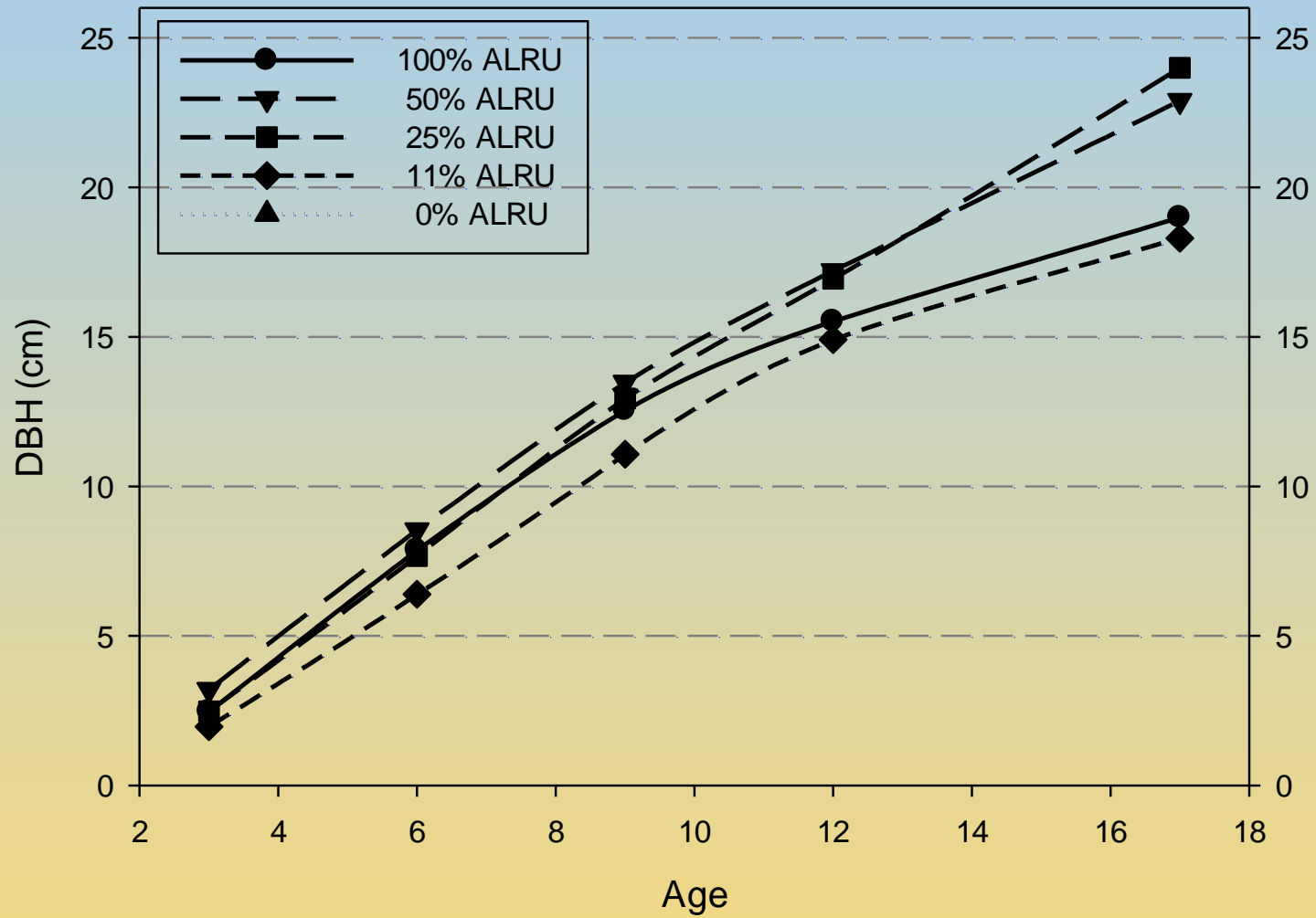
# Douglas-fir Survival



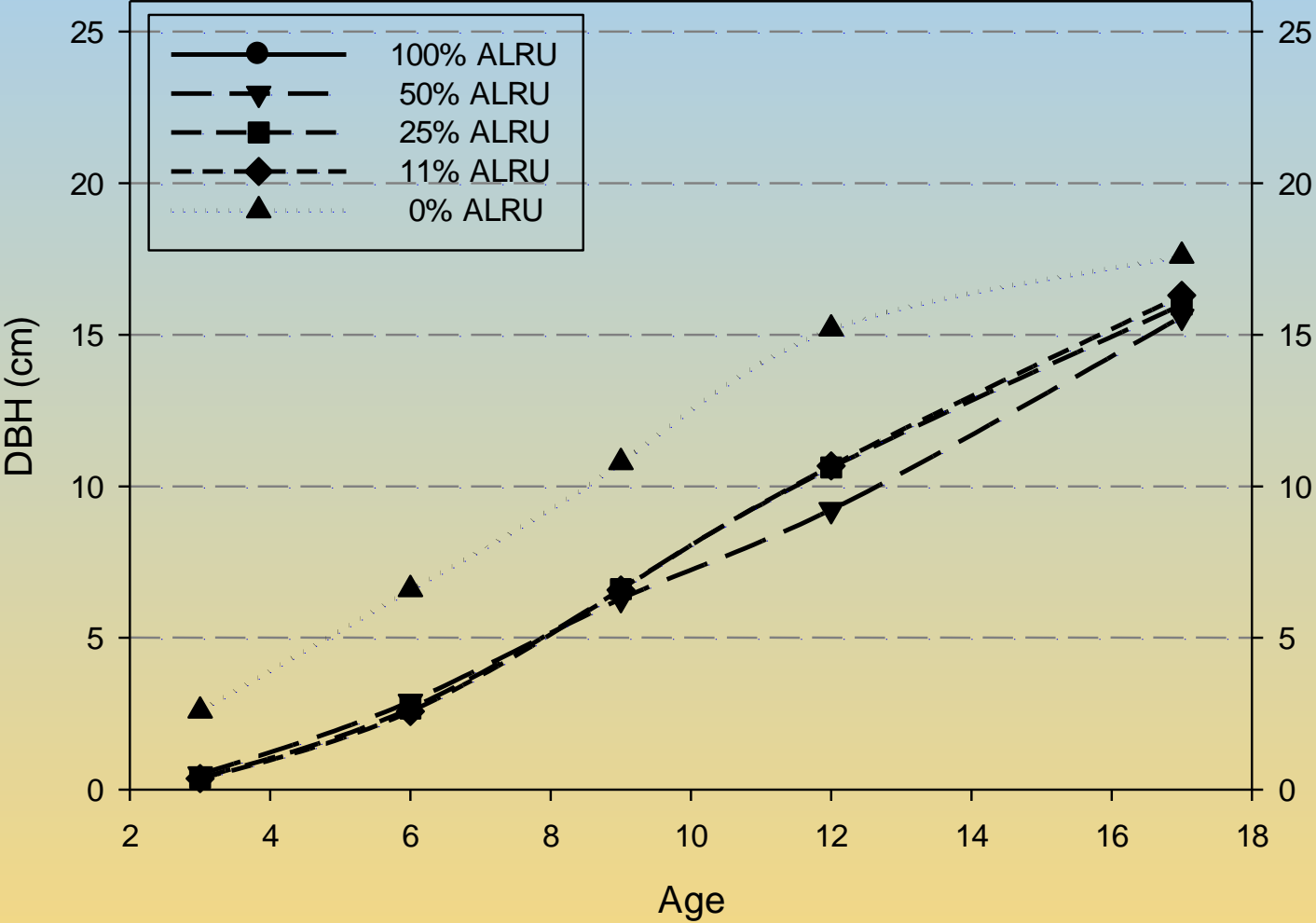
# 17 Year Survival



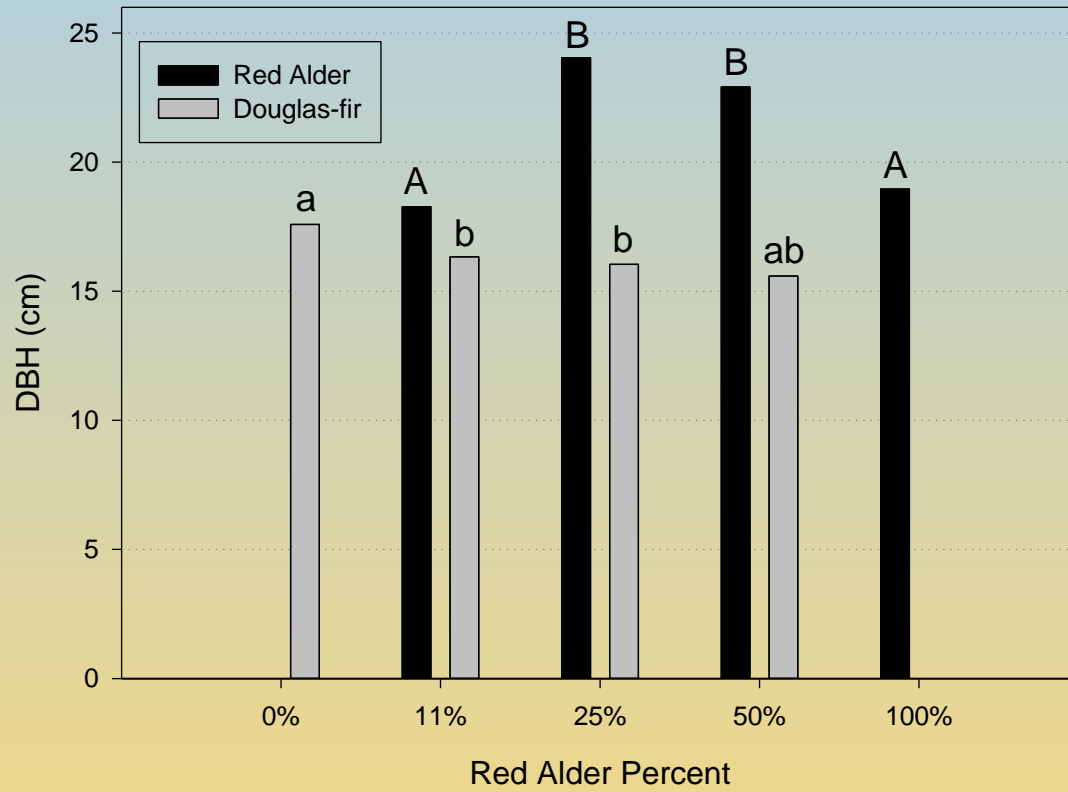
# Red Alder Dbh



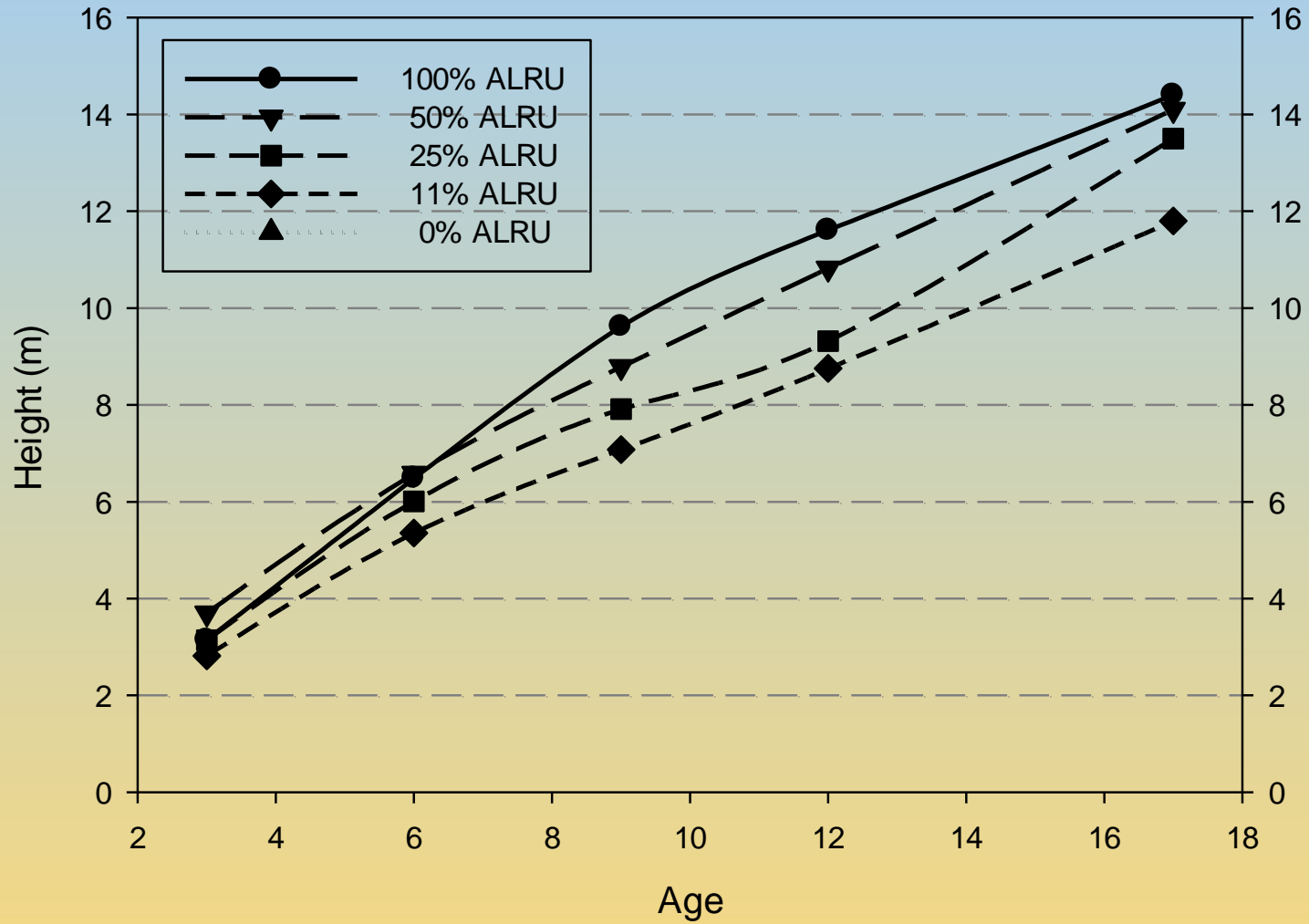
# Douglas-fir Dbh



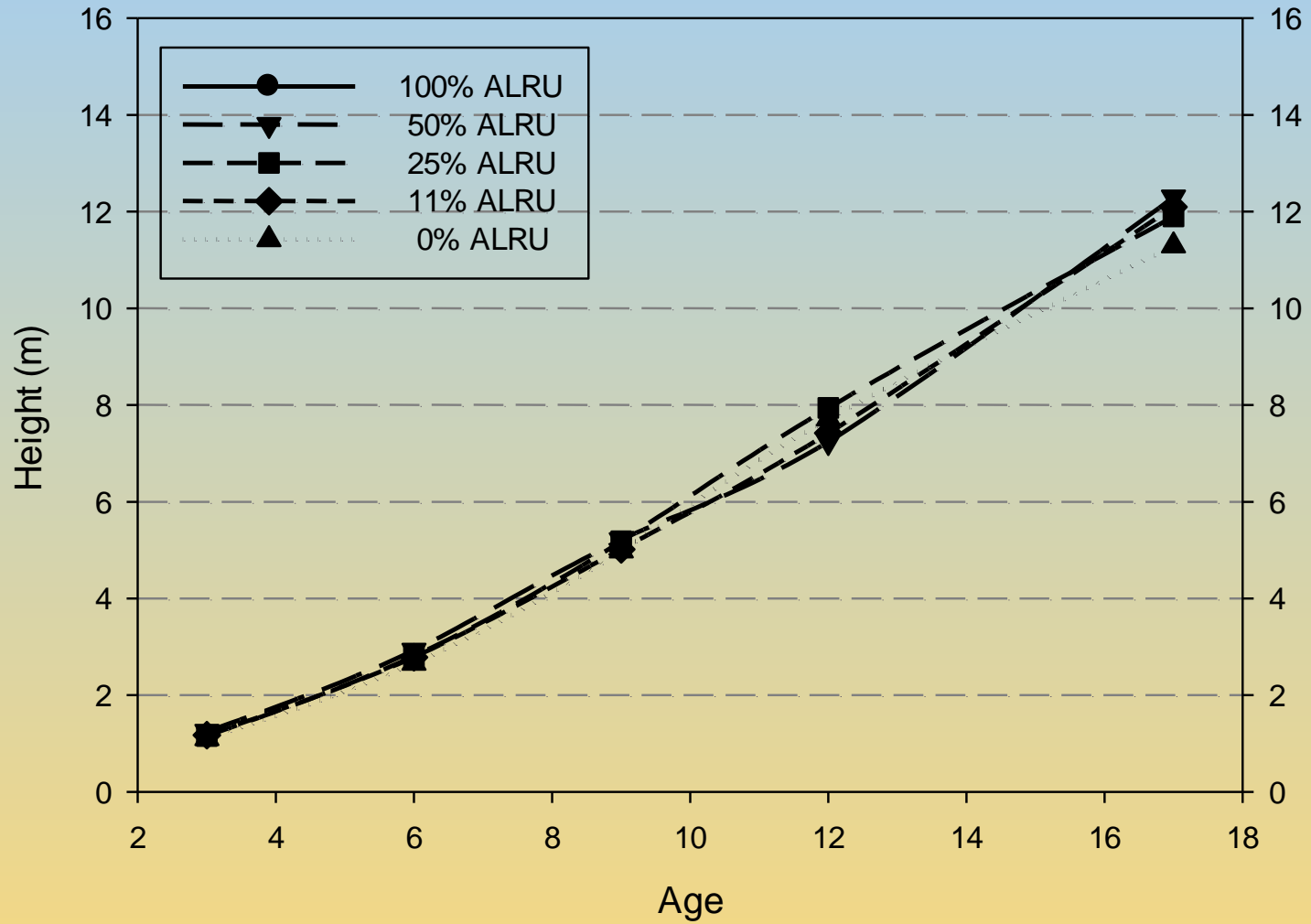
# 17 Year DBH



# Red Alder Height

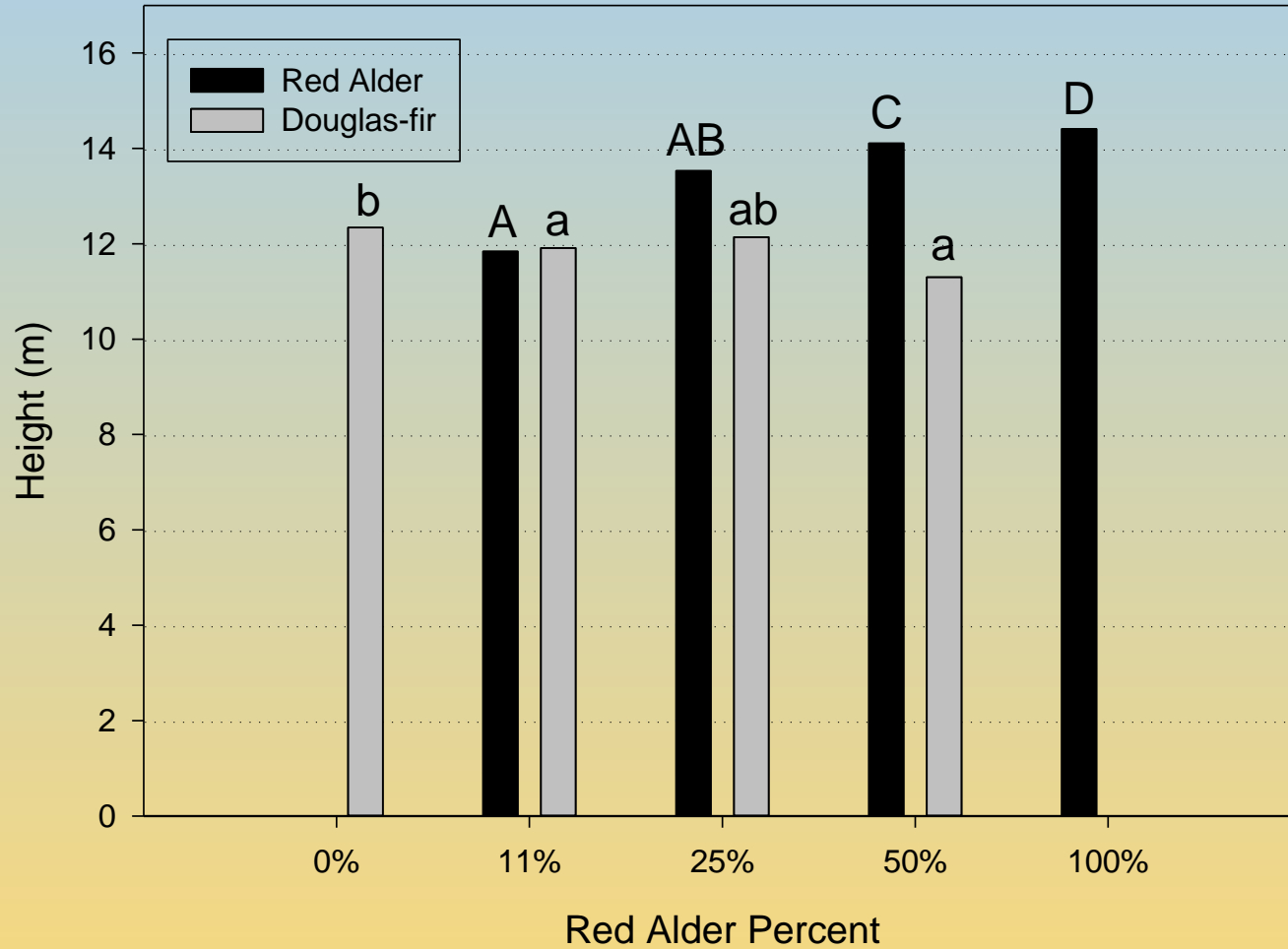


# Douglas-fir Height

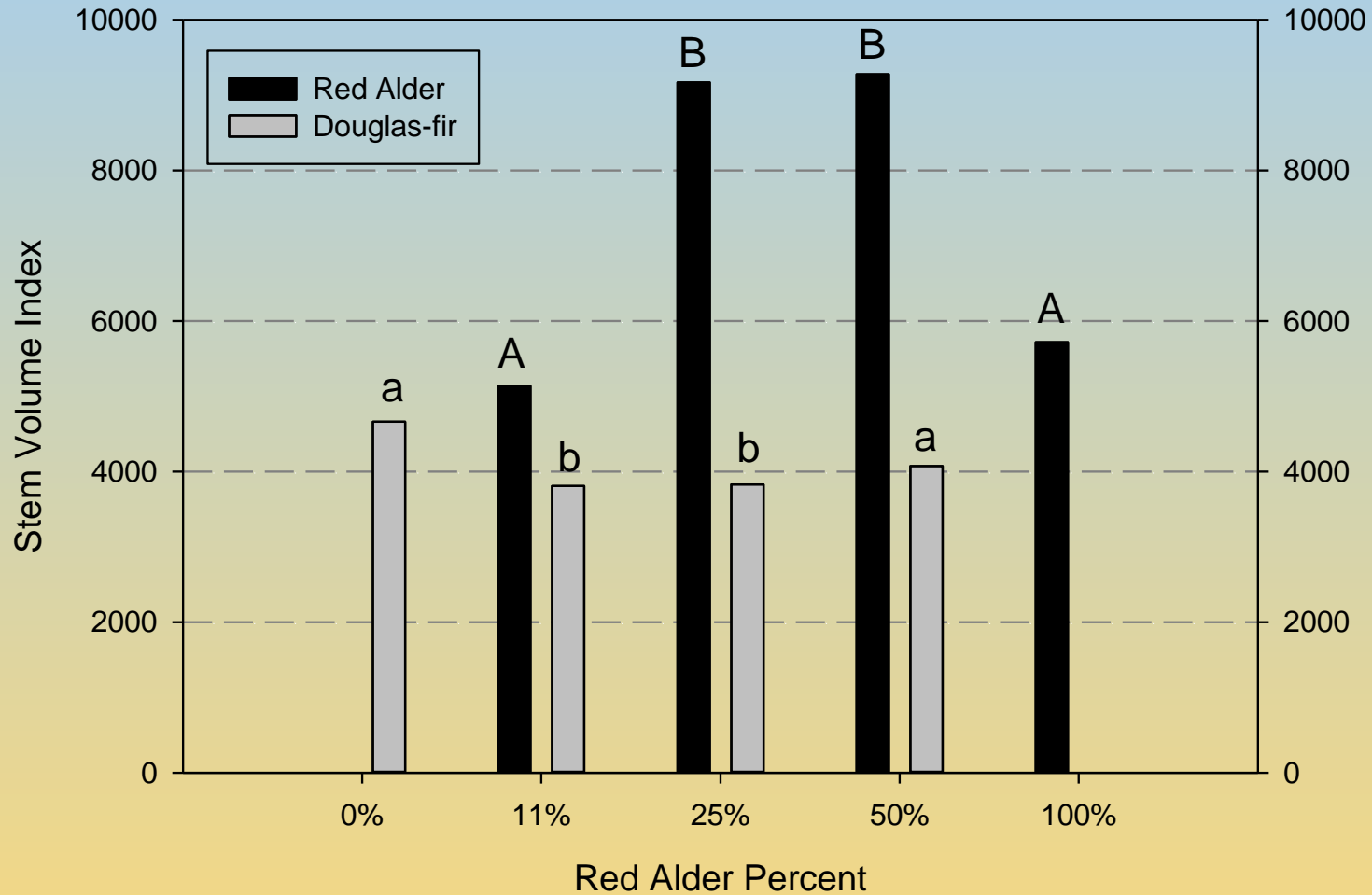




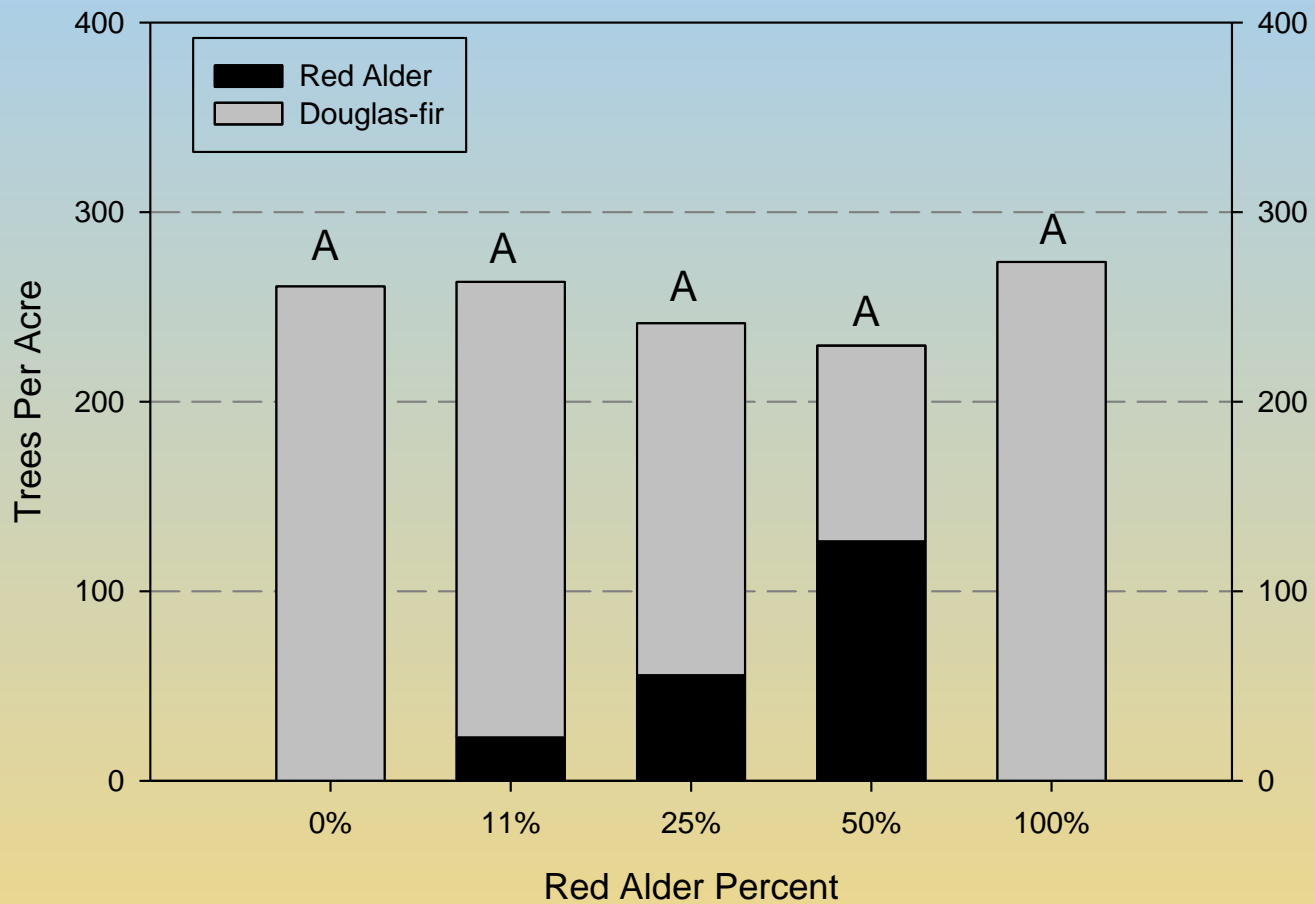
# 17 Year Height



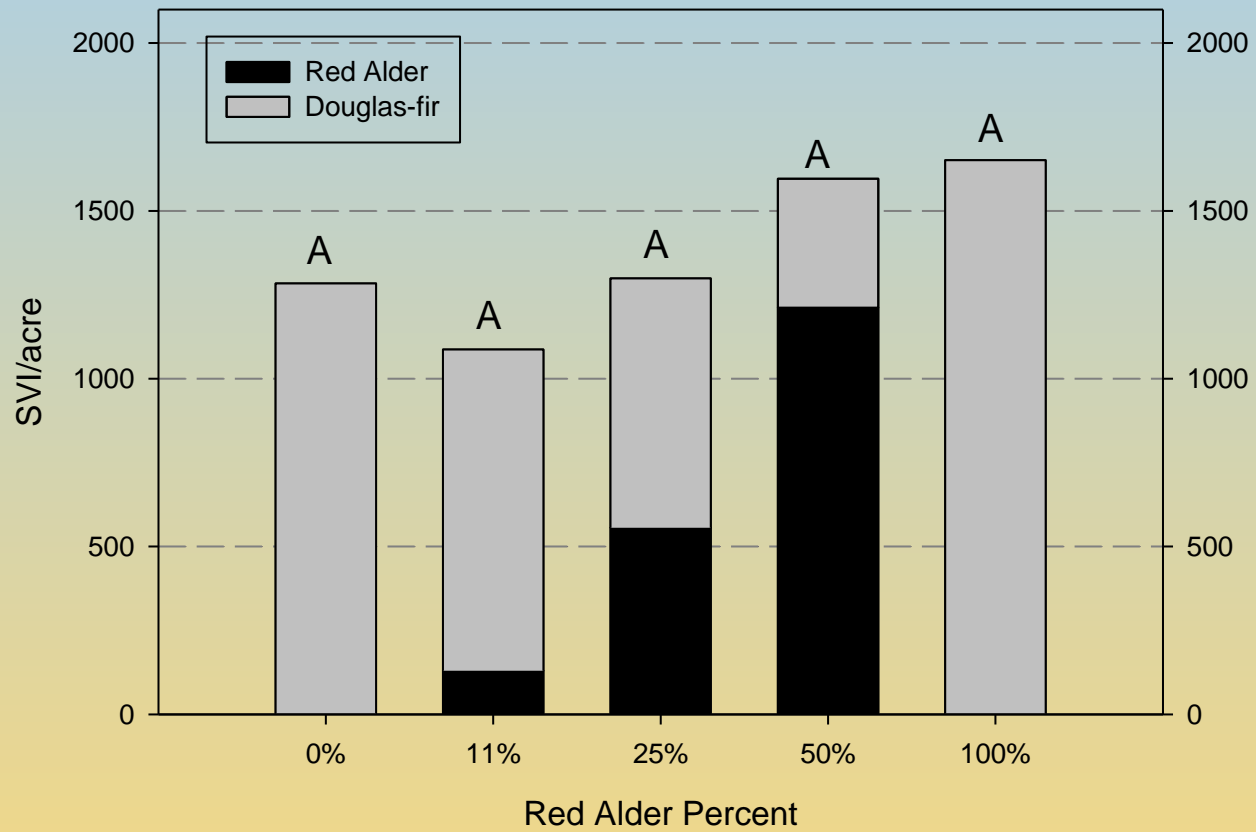
# 17 Year Individual Tree Stem Volume Index [DBH(cm)<sup>2</sup>\*HT(m)]



# 17 Year Density



# 17 year Stem Volume Index (SVI) per acre



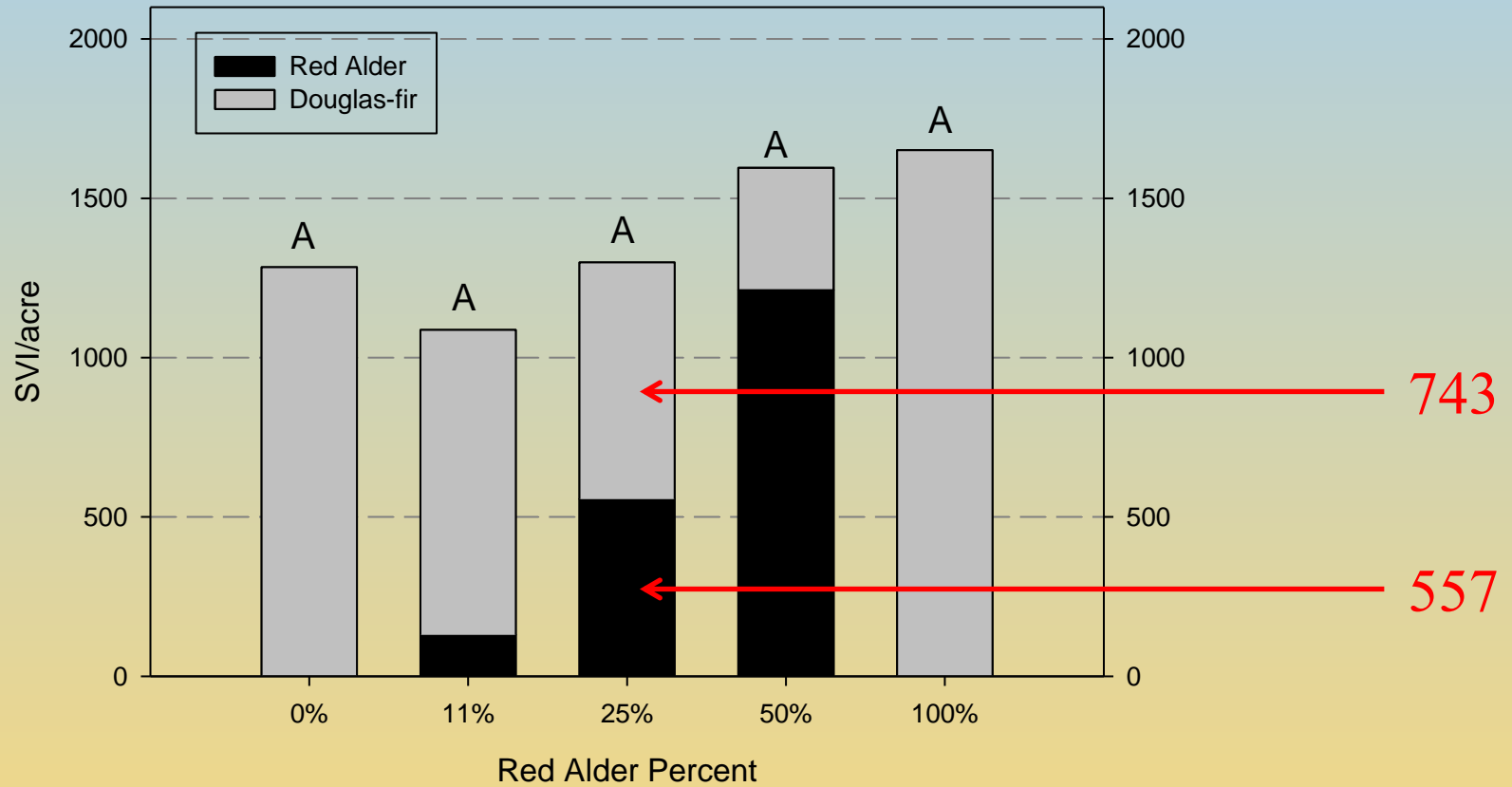
Relative land output (RLO) = (the yield of Douglas-fir in mixture + the yield of red alder in the mixture)/ (the equivalent fraction of Douglas-fir in pure stand + the equivalent fraction of red alder in pure stand).

$$\text{RLO}_{25} = \frac{\text{SVI/acre}_{25} \text{ PSME} + \text{SVI/acre}_{25} \text{ ALRU}}{(\text{SVI/acre}_{100} \text{ PSME}) * 0.75 + (\text{SVI/acre}_{100} \text{ ALRU}) * 0.25}$$

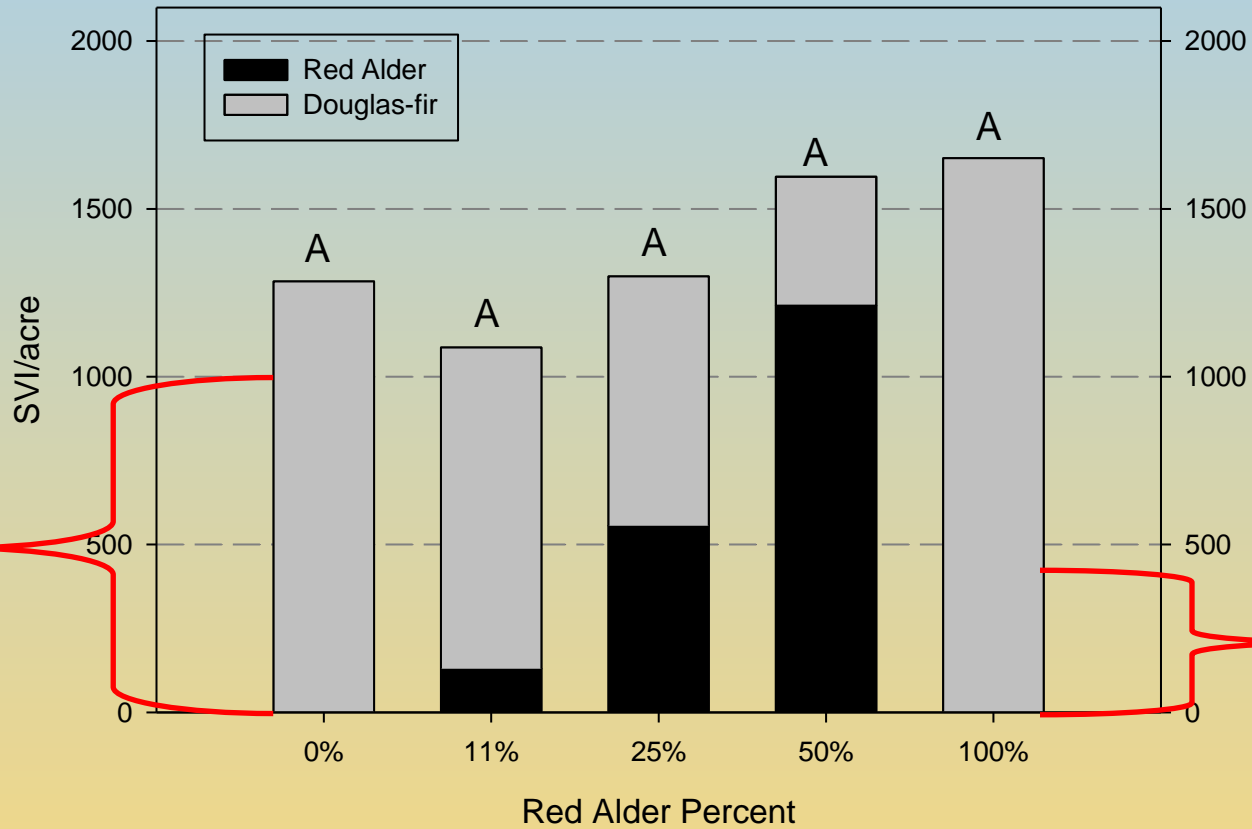
$$\text{RLO}_{25} = \frac{743 + 557}{1284 * 0.75 + 1651 * .25}$$

$$\text{RLO}_{25} = 0.94$$

# 17 year Stem Volume Index (SVI) per acre



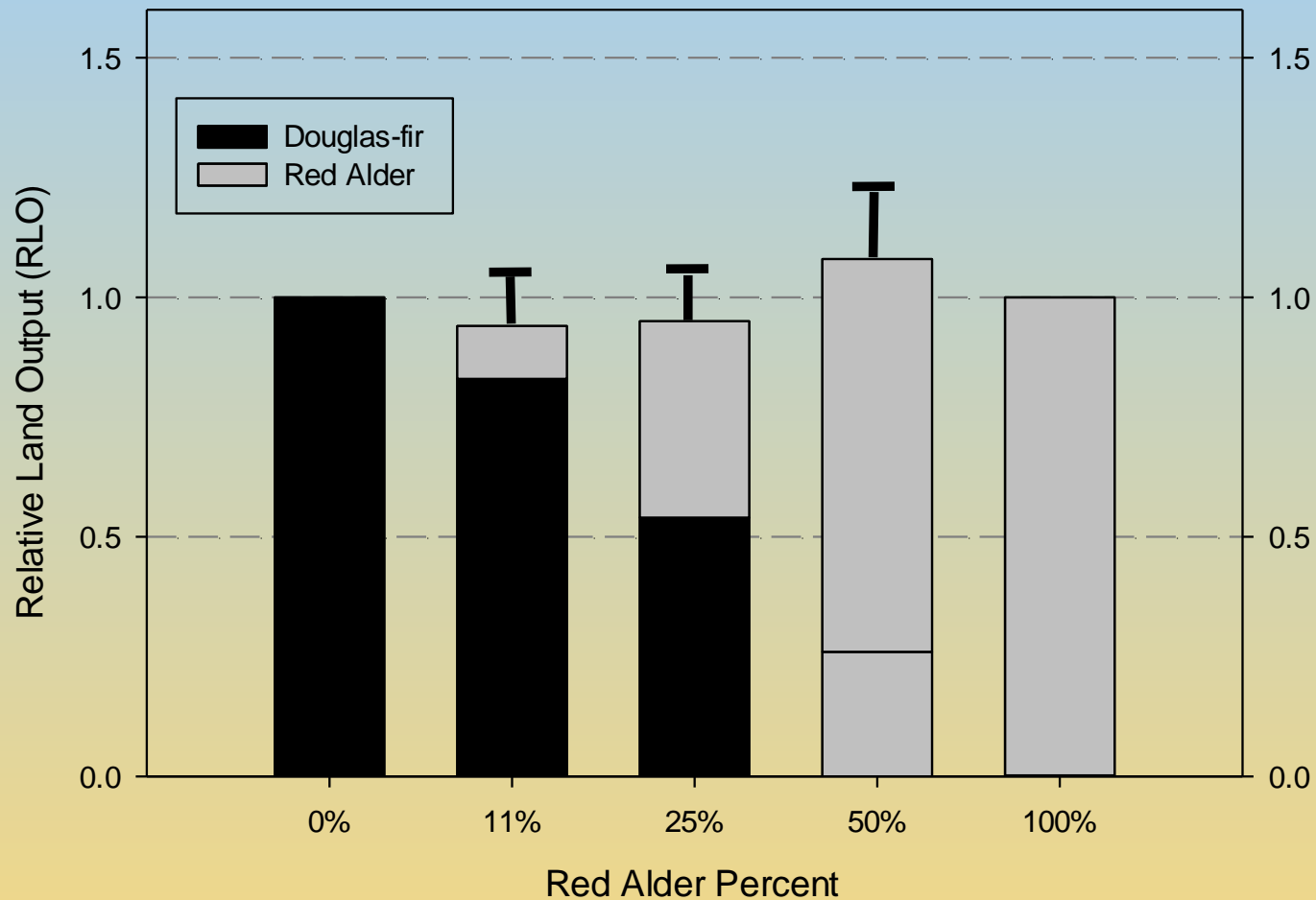
# 17 year Stem Volume Index (SVI) per acre



$1284 \times 0.75$

$1651 \times 0.25$

# 17 Year Relative Land Output (RLO)





# Conclusion

## Red alder- better performance with increasing red alder proportion?

- Survival increased with increasing RA%- Yes
  - Surprising because the neighbors are bigger (less growing space/more intraspecific competition)
  - This relation will likely change through time due to:
    - Increasing RDs with increasing RA%
    - Overtopping by Douglas-fir with decreasing RA%

## Conclusion (con't)

### Red alder- better performance with increasing red alder proportion?

- DBH was greatest in the intermediate RA%- No
  - For the 100%RA: DBH growth reductions corresponding with the approach to the self-thinning line (intraspecific)
  - For the 11%RA: DBH growth reductions corresponding with competition for resources with Douglas-fir (interspecific)?
- This relation will likely change through time due to:
  - Overtopping by Douglas-fir (suppression): decreasing red alder DBH with decreasing RA%

## **Conclusion (con't)**

### **Red alder- better performance with increasing red alder proportion?**

- HT increased with increasing RA%- Yes
- Like DBH:
  - This relation will likely change through time due to:
    - Overtopping by Douglas-fir (suppression)

## **Conclusion (con't)**

### **Red alder- better performance with increasing red alder proportion?**

- SVI was significantly greater at the two intermediate RA%.
- Reflect greater DBHs at the two intermediate RA%

## Conclusion (con't)

### **Douglas-fir- decreased performance with any species mixture?**

- Survival was greatest in the 11RA% and decreased with increasing RA%- Kind of
  - The peaking pattern was not necessarily unexpected because of the potential facilitative effects of low RA% (unreported)
  - Survival decreasing at high RA% was expected due to overtopping by the red alder
- These patterns will not likely change through time:
  - Douglas-fir heights have caught up
  - Once above the red alder, RDs are low, so no self-thinning (assuming light limitation)

## Conclusion (con't)

### **Douglas-fir- decreased performance with any species mixture?**

- DBH and HT was mostly independent of RA%, with a slight reduction with any RA%- Kind of
  - The independence of DBH and HT (or lack of a negative relationship with increasing RA%) is surprising b/c of the well-published competitive effects of red alder
  - These patterns will likely change through time:
    - Douglas-fir growth is independent of red alder (no/little inter-specific competition), so
    - Increasing growth with increasing RA% (less intra-specific competition)

## **Conclusion (con't)**

### **Douglas-fir- decreased performance with any species mixture?**

- SVI was greater in pure stands than any RA%- Yes
  - SVI integrates both DBH and HT (independent of RA%), so slight effects are exaggerated

## **Conclusion (con't)**

### **Are mixed species stands more productive than pure stands?**

- SVI/acre was greatest in pure red alder stands- No
- RLO/acre was slightly greater in the 50%RA than pure stand-Kind of
  - This may change through time favoring the 50% mixture
    - 50% species mixture compared favorably to pure stands
    - To date: more alder more productivity
    - Future: adding (independent) Douglas-fir growth to the red alder total



# Summary

## Red Alder

- To date: growth/stand dynamics influenced by other red alder (interspecific competition). Except for maybe the lowest RA%
- Future: growth/stand dynamics will be increasingly influenced by increasing DF% and with time

## Douglas-fir

- To date: Growth independent of RA% (except a slight penalty on SVI at high RA%)
- No penalty with red alder, but then again, no benefit either
- Future: the stand will grow like the red alder is not there

## **Summary (con't)**

### **Productivity of species mixtures**

- To date: growth/stand dynamics influenced by other red alder (interspecific competition). Except for maybe the lowest RA%
- Future: growth/stand dynamics will be increasingly influenced by increasing DF% and with time

**•Questions/Comments?**

**•Alternative conclusions (What am I missing?)**

**•Additional/further analyses?**