Intermountain Forest Tree Nutrition Cooperative

Harvest & Post-Harvest Nutrient Mitigation: Effects on soil and tree nutrition, growth and mortality

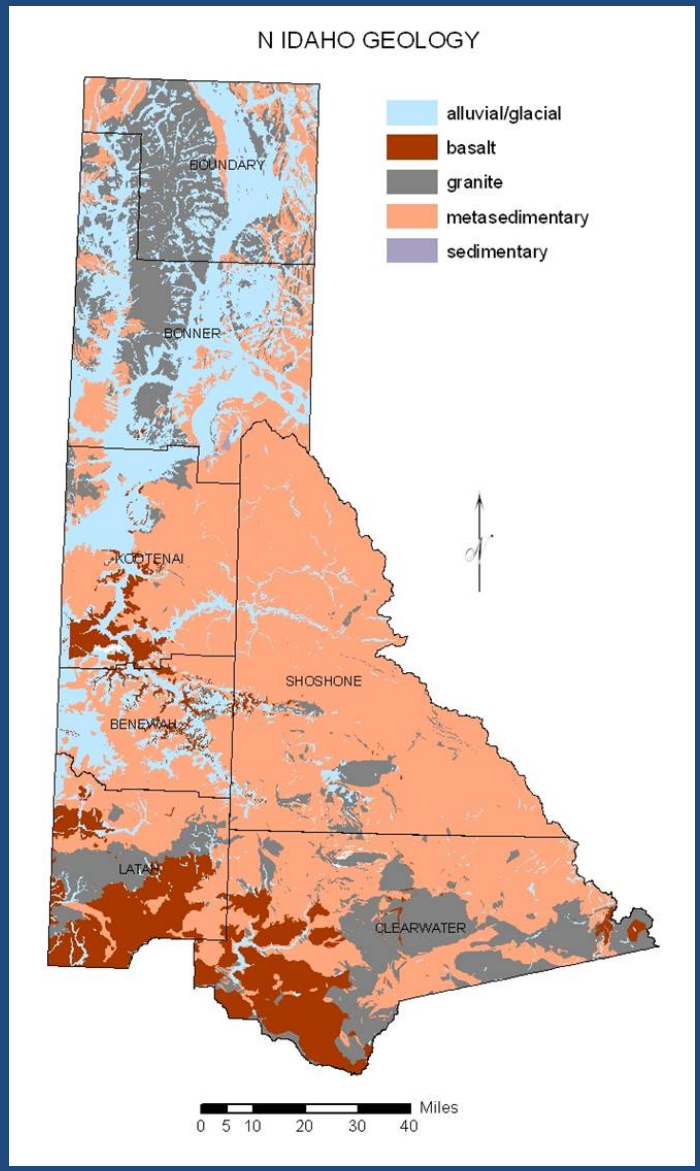
USFS Funded Add-on Project Update

April 7, 2015

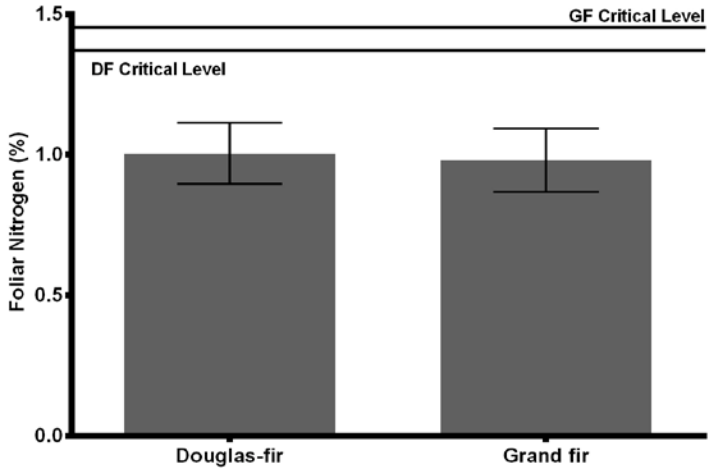
University of Idaho

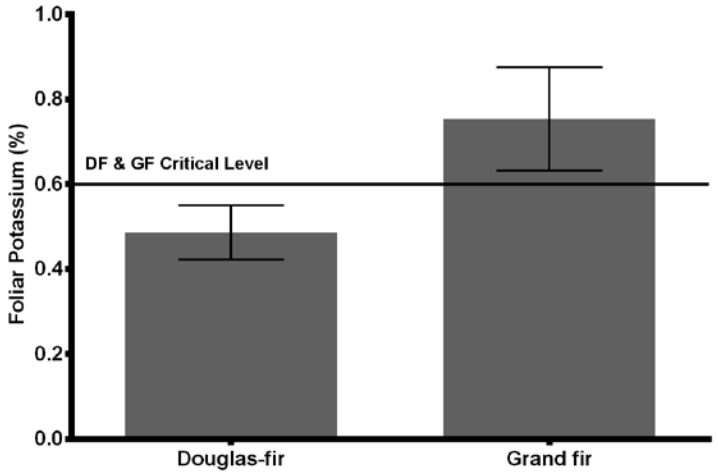
Project Background

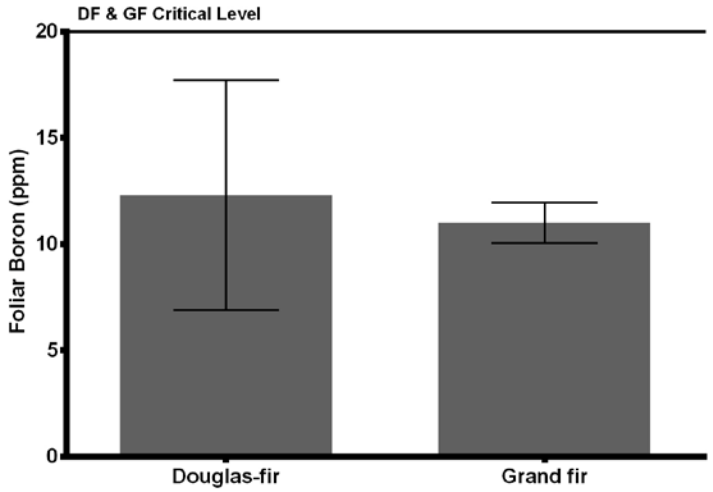
- Northern Idaho dominated by Belt Supergroup Metasediment Rocks
- Metasediment soils typically shallow, coarse textured and nutrient poor relative to basalt or granitic soils
- Forest stands throughout the region are often nutrient deficient – particularly on metasediment soil parent material
- USFS R1 often questioned or on harvest effects on long-term forest health and productivity
- Maintaining soil productivity is a common litigation or appeal point in Forest Service timber harvest projects.

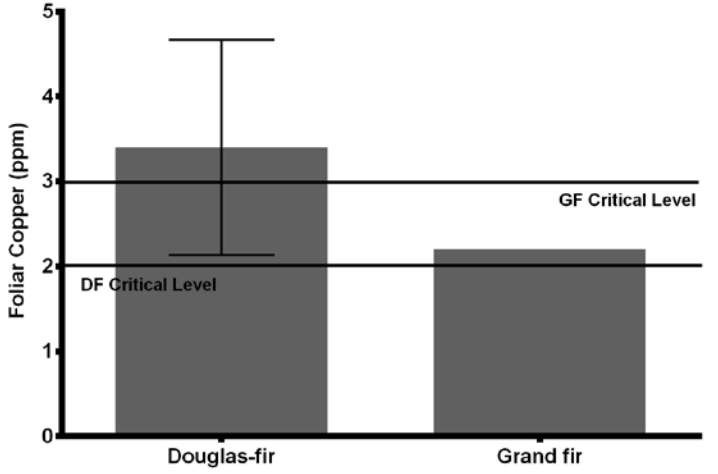


Observed Limitations on the St Joe



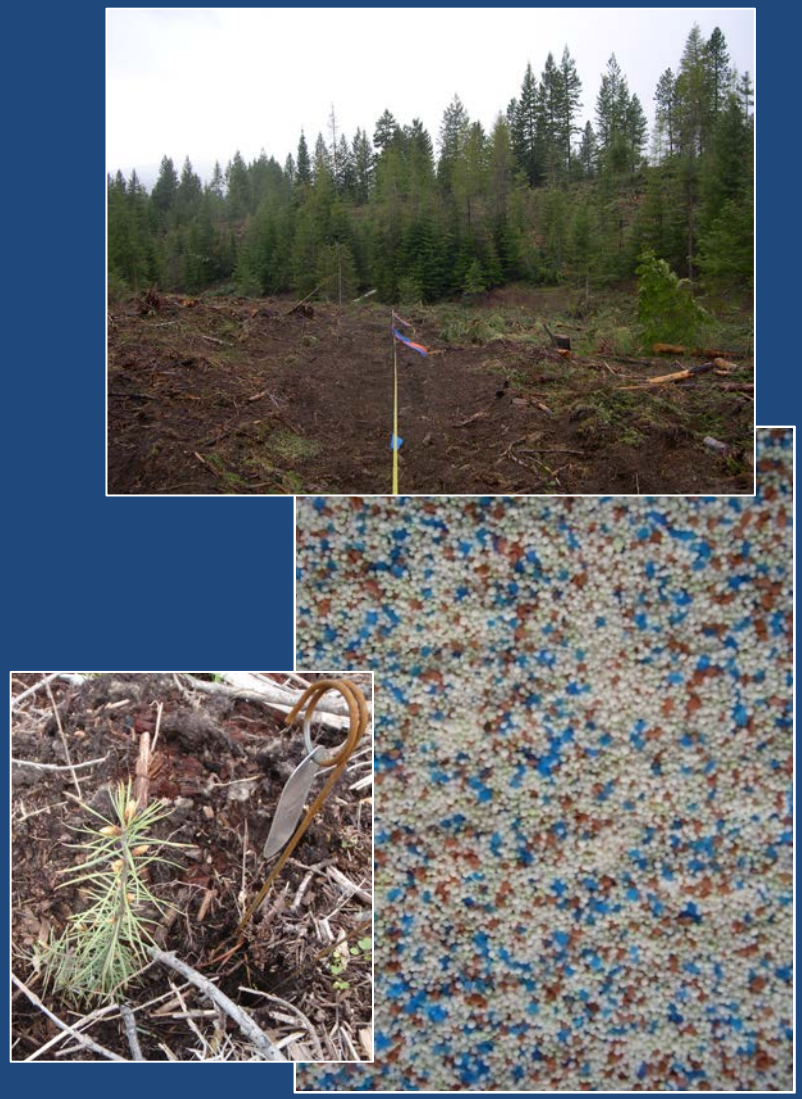




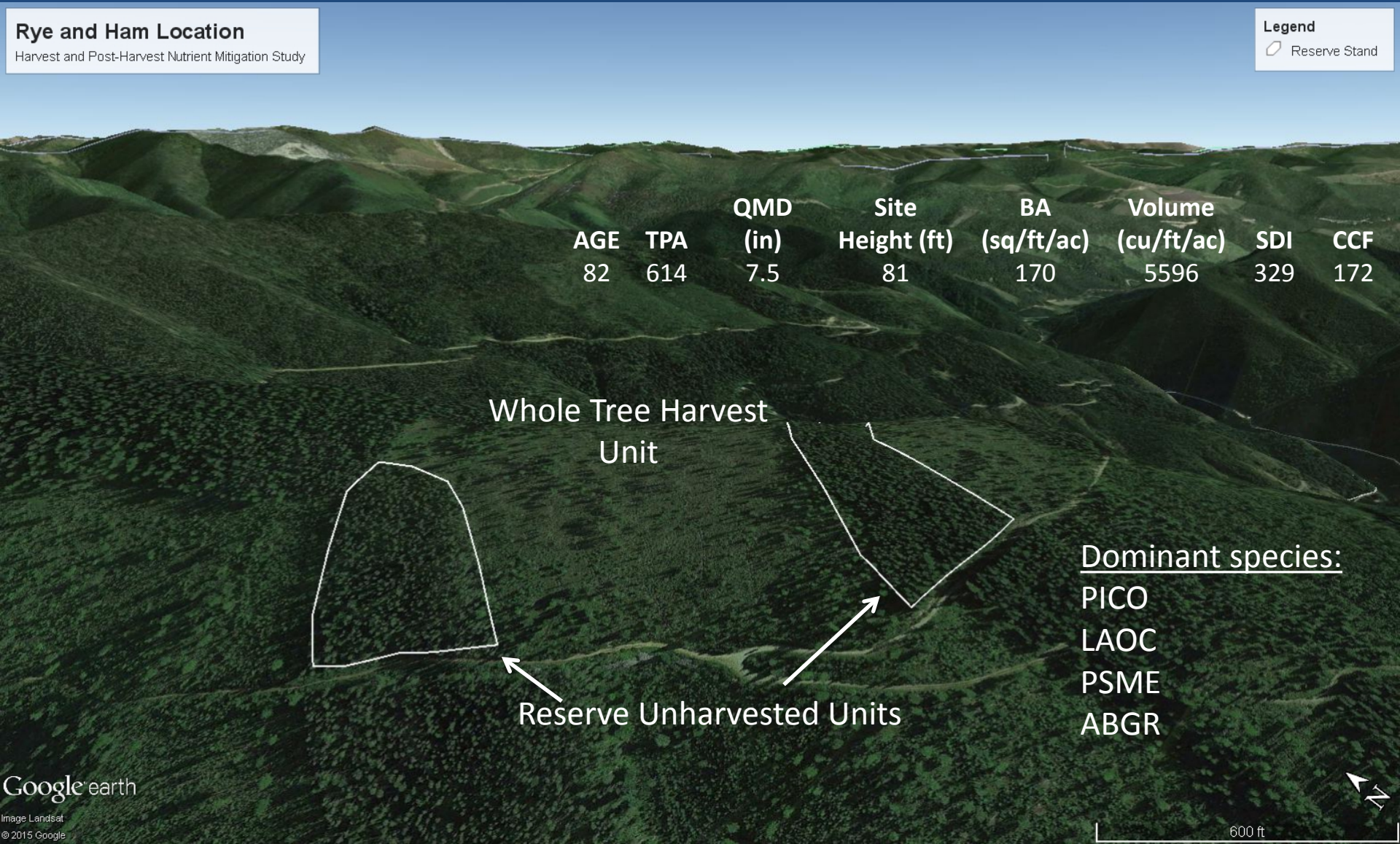


Project Initiation

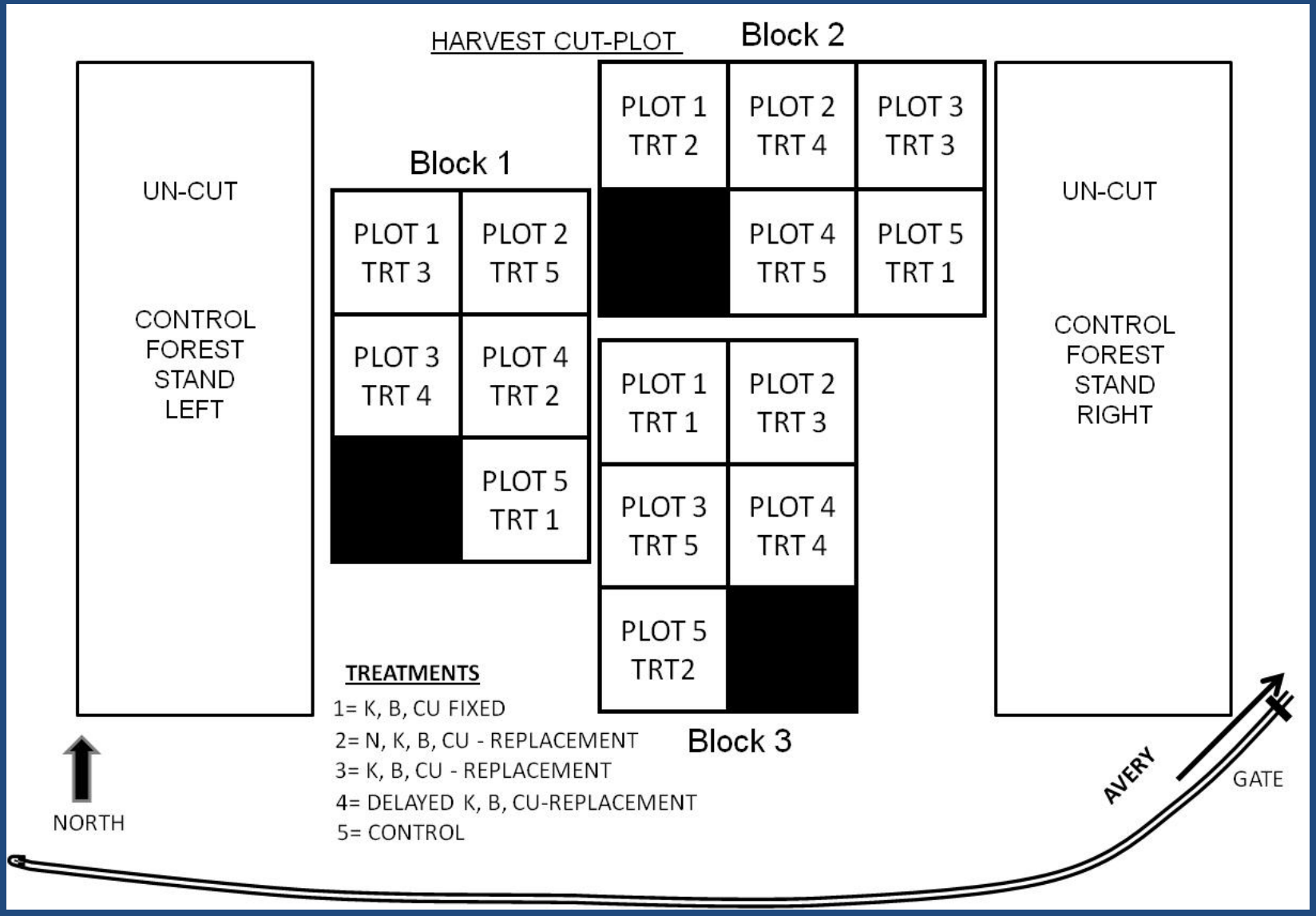
- Premise: Whole-tree harvesting removes nutrients from forest sites
  - Question 1: Does whole-tree harvesting reduce soil nutrient availability and thereby negatively impact plant nutrition?
  - Question 2: Is post-harvest fertilization an effective tool for maintaining forest soil nutrient pools at pre-harvest levels?
  - Question 3: How does harvesting and post harvest nutrient mitigation effect seedling nutrition and productivity?
  - Question 4: How does shifts in nutrient availability impact soil microbial communities, which are critical for nutrient cycling?



Study Site Selection



Study Design



Site Biomass & Removal Metrics

Overstory Biomass and Nutrients (lbs acre^{-1})							
	Foliage	Branches	Total Crown	Unmerch Bark	Merch Bark	UnMerch Wood	Merch Wood
Total Biomass	**6,771**	**13,468**	**20,239**	**1,199**	**5,794**	**39,816**	**176,983**
N	74	46	120	2	11	12	52
K	33	34	67	2	10	48	211
B	0.17	0.09	0.26	0.01	0.05	0.16	0.70
Cu	0.14	0.76	0.90	0.01	0.04	0.74	3.3

Total, Remaining and Removed Nutrient Biomass (lbs acre^{-1})			
Nutrient	**Total**	**Remaining[1]**	**Removed**
N	197	67	130
K	338	58	280
B	1.2	0.2	1.0
Cu	4.9	0.8	4.1

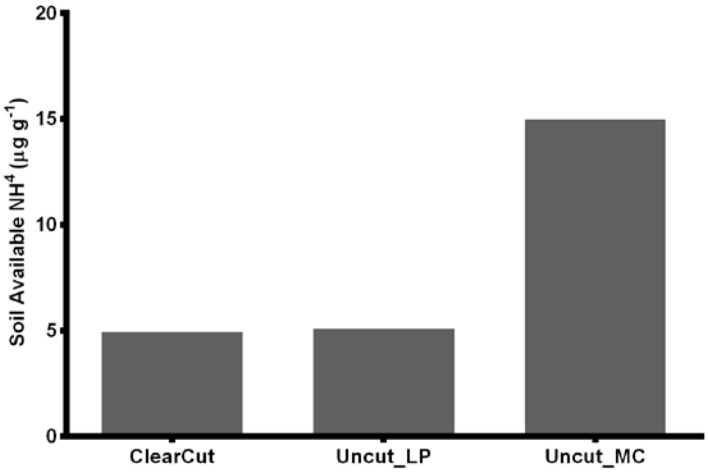
Treatment Applications

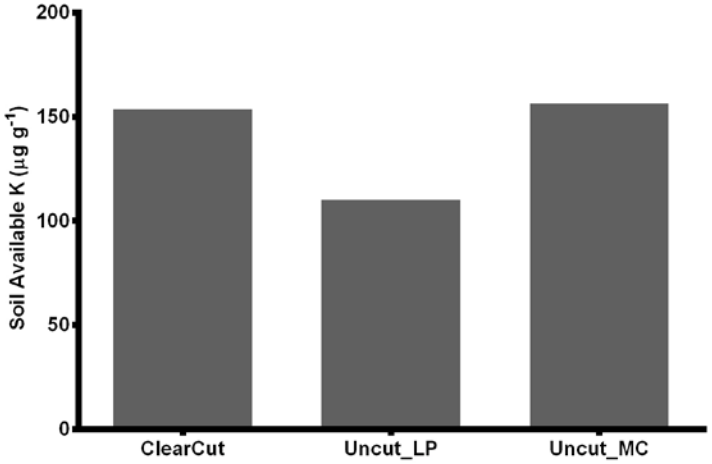
Treatment	Application Rates[1] (lbs ac^{-1})	Timing
K, B, Cu Fixed Rate	170K, 3B, 10Cu	Immediate
K, B, Cu Replacement	280K, 1B, 4Cu	Immediate
N, K, B, Cu Replacement	130N, 280K,1B, 4Cu	Immediate
K, B, Cu Delay Replacement	280K, 1B, 4Cu	4 Years
Control (No Fert - harvest)	-	-
Control (No Fert - no harvest)	-	-

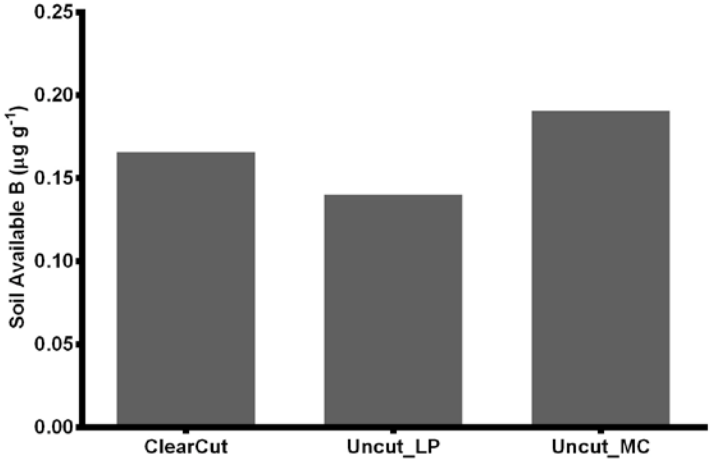
Question #1

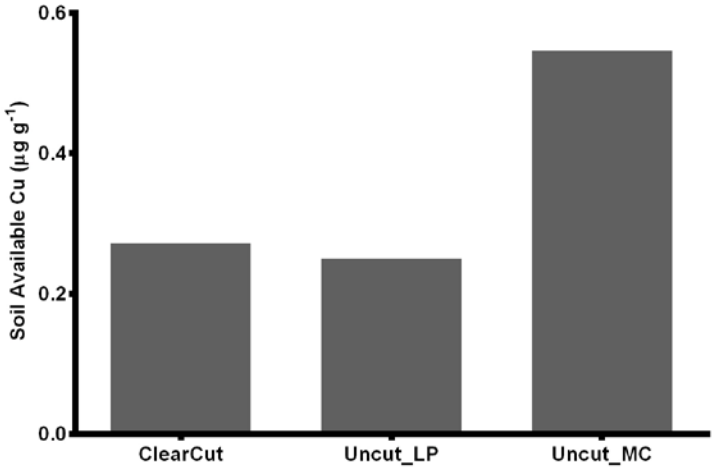
- Question 1: Does whole-tree harvesting reduce soil nutrient availability and thereby negatively impact plant nutrition?

Early Soil Findings – 2 Yrs Post-Harvest

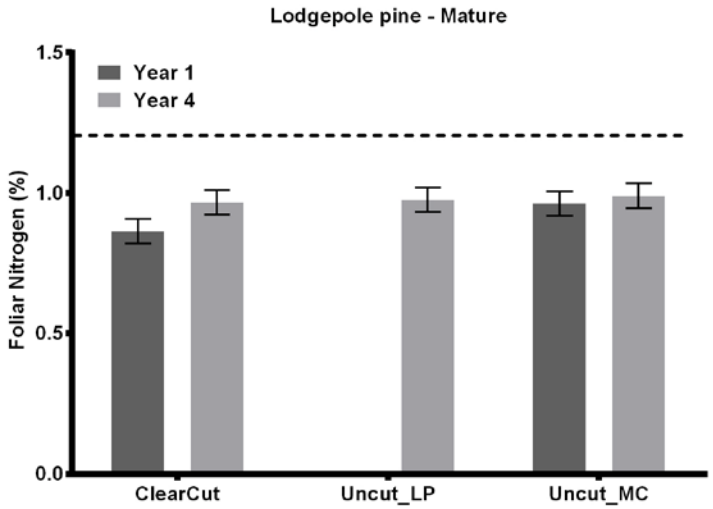


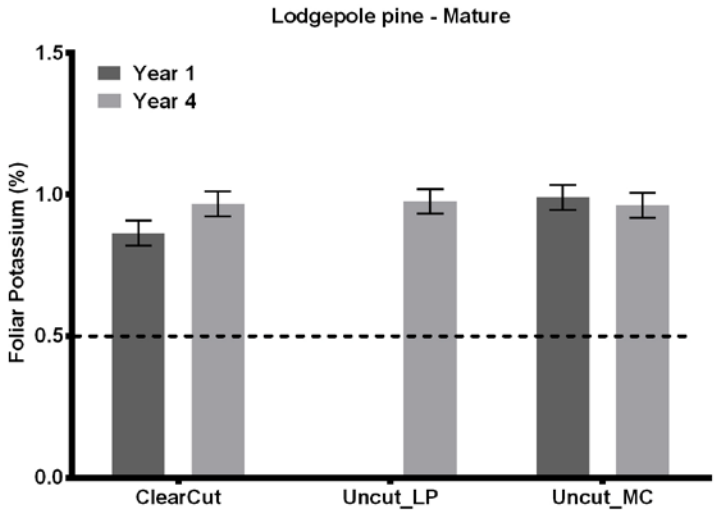


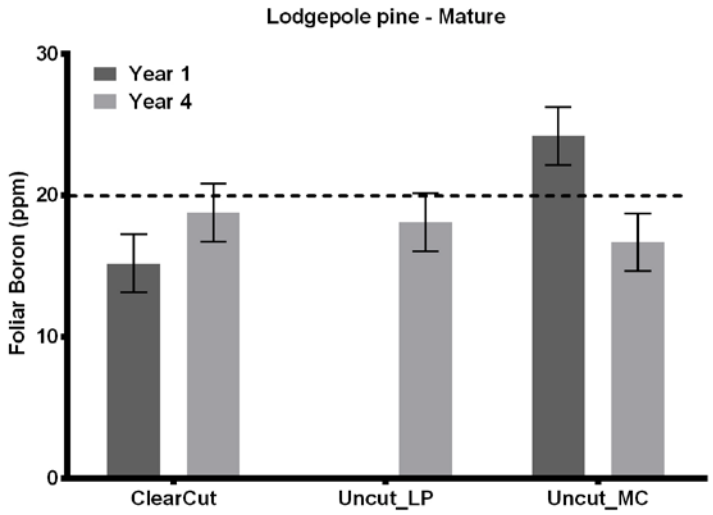


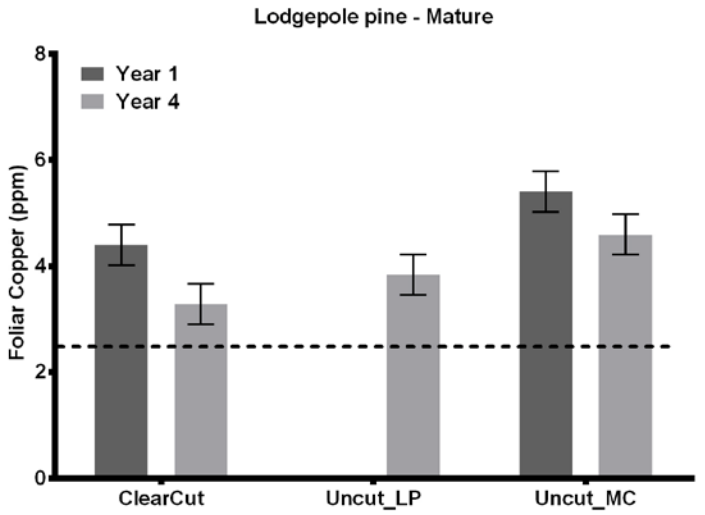


Mature PICO Foliar Nutrition









Question #1 Summary Findings

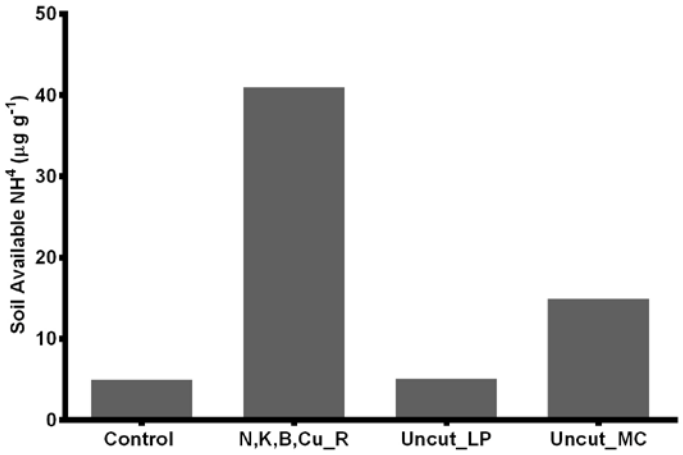
- Over the monitoring period, whole tree harvesting did not significantly impact soil nutrient pools
  - when comparing between similar stand types

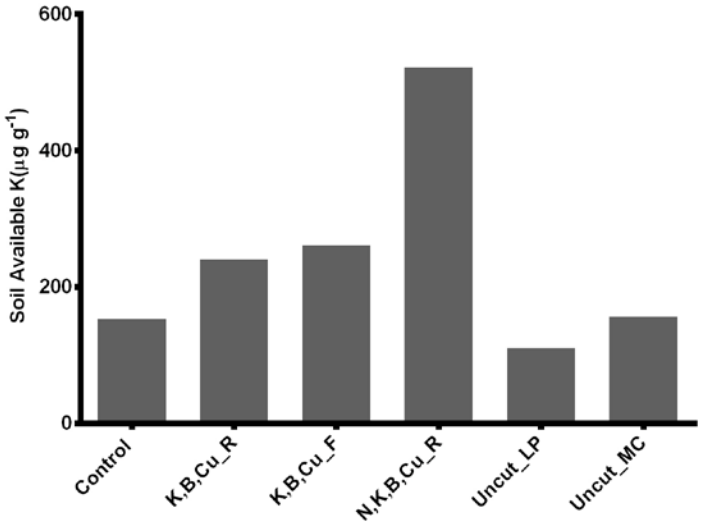
- Dominant tree species showed no overall decline in foliar nutrition as a consequence of whole tree harvesting

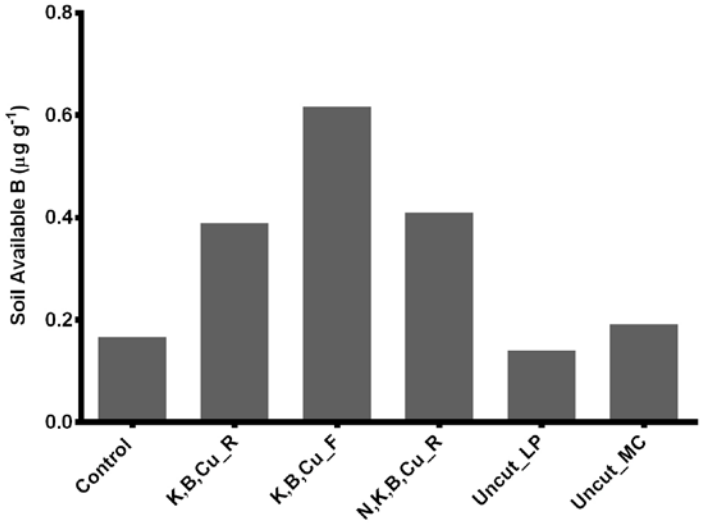
Question #2

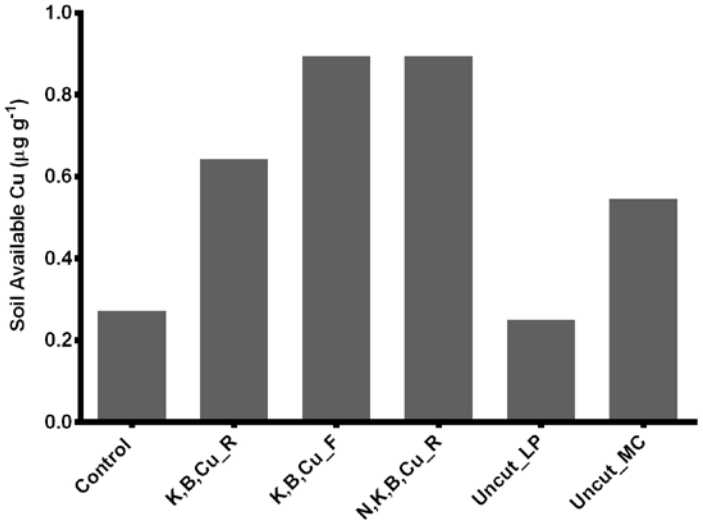
- Is post-harvest fertilization an effective tool for maintaining forest soil nutrient pools at pre-harvest levels?

Soil Nutrient Pools

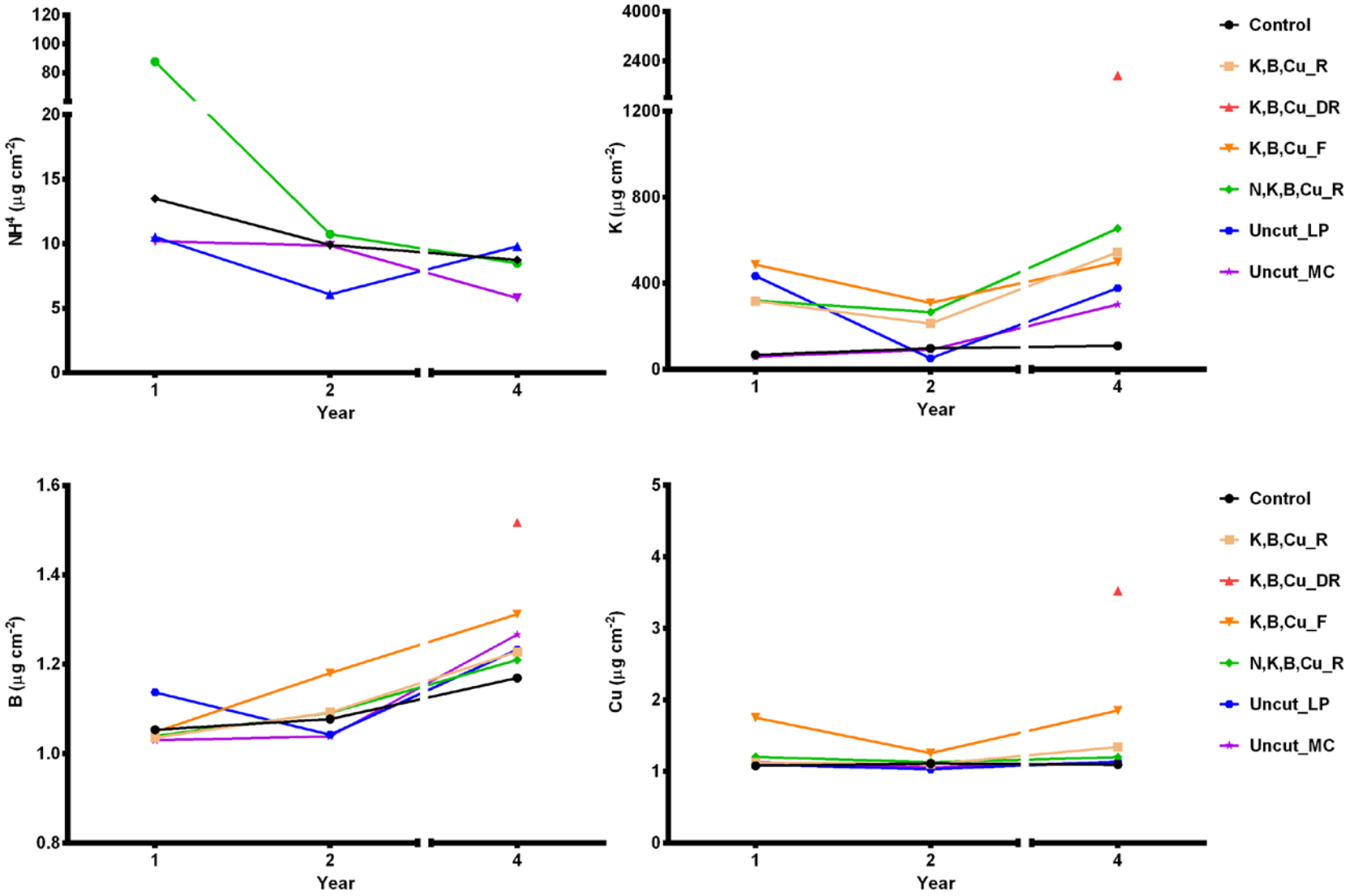








Soil Nutrient Flux



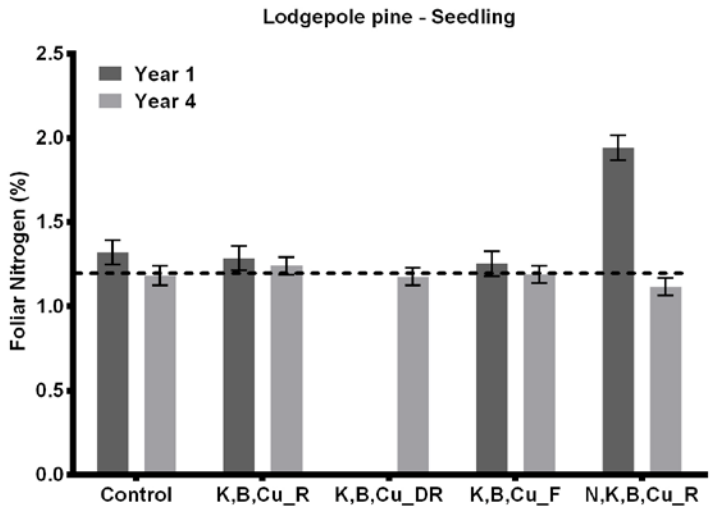
Question #2 Summary Findings

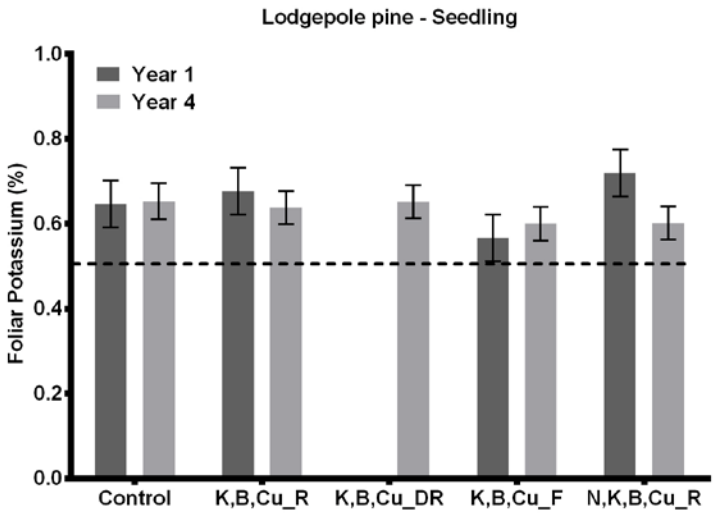
- Traditional soil extractions indicate that post-harvest fertilization significantly increases soil nutrient pools
- Ion exchange resins suggest nutrient amendments are assimilated rapidly (N, B), with only K showing longer-term soil availability
- As shown previously, harvesting did not negatively impact soil nutrient pools during monitoring period

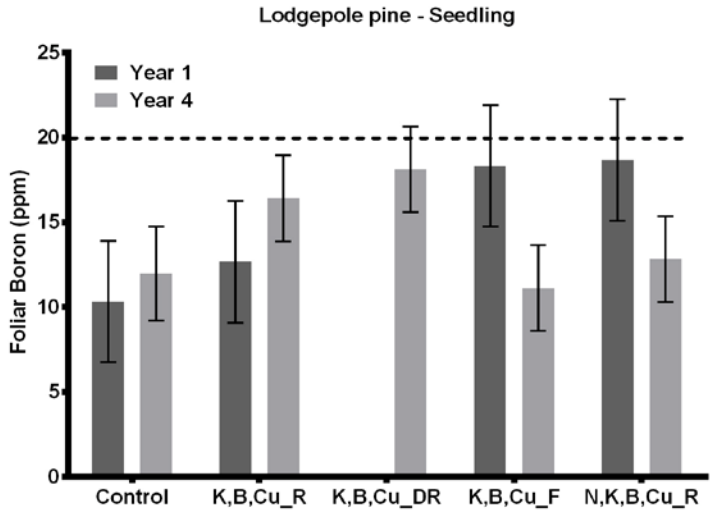
Question #3

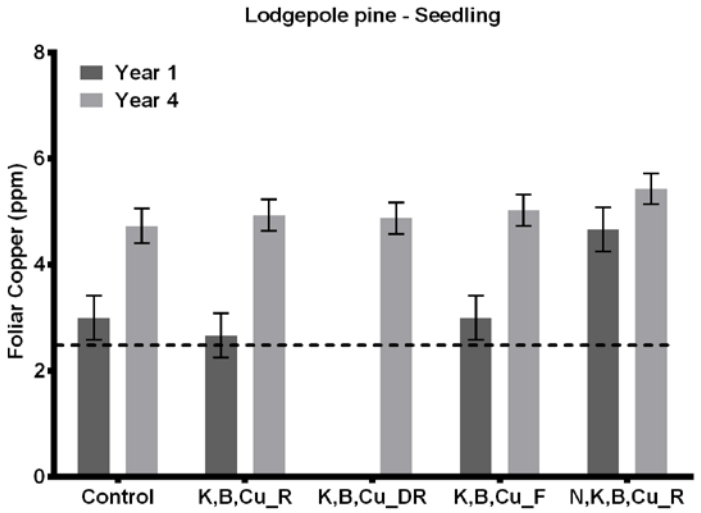
- How does harvesting and post harvest nutrient mitigation effect seedling nutrition and productivity?

Seedling PICO Foliar Nutrition

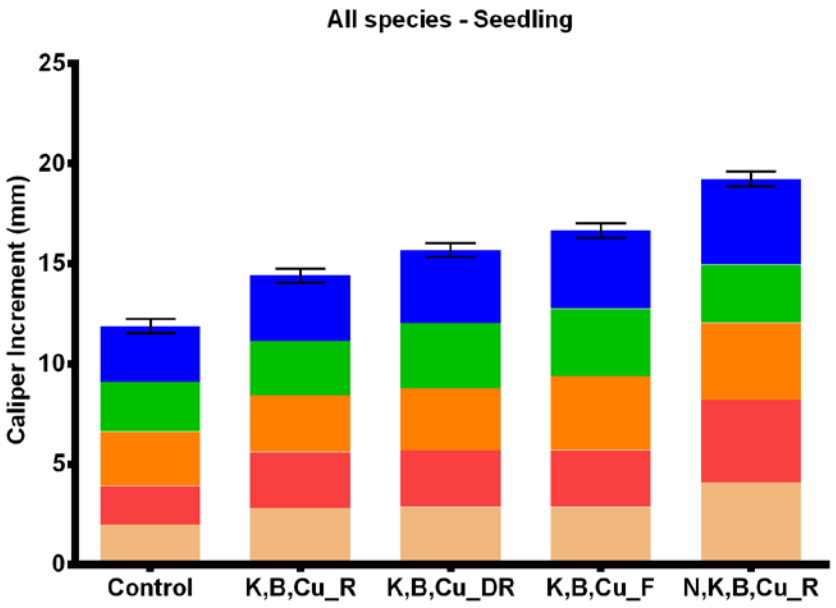


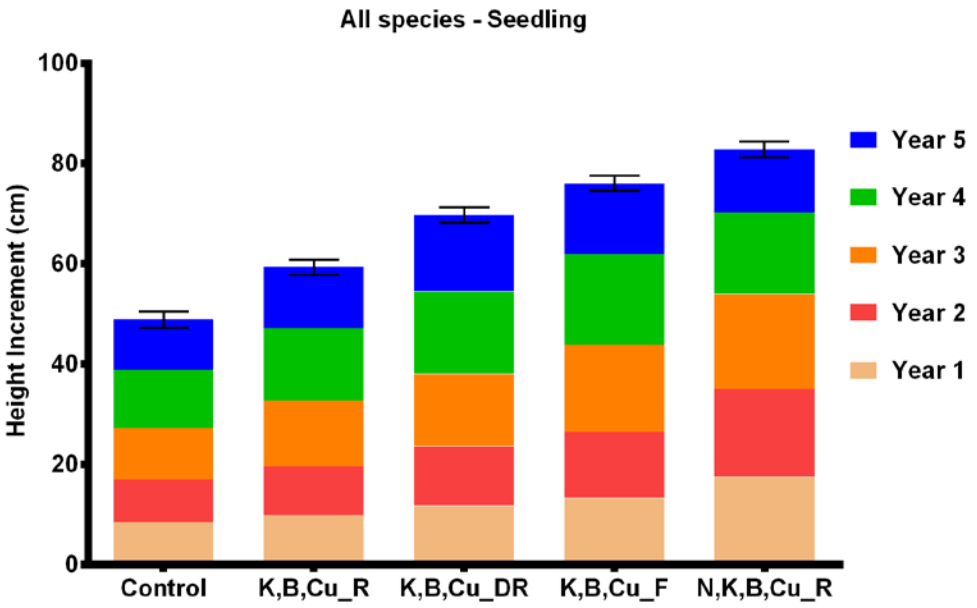




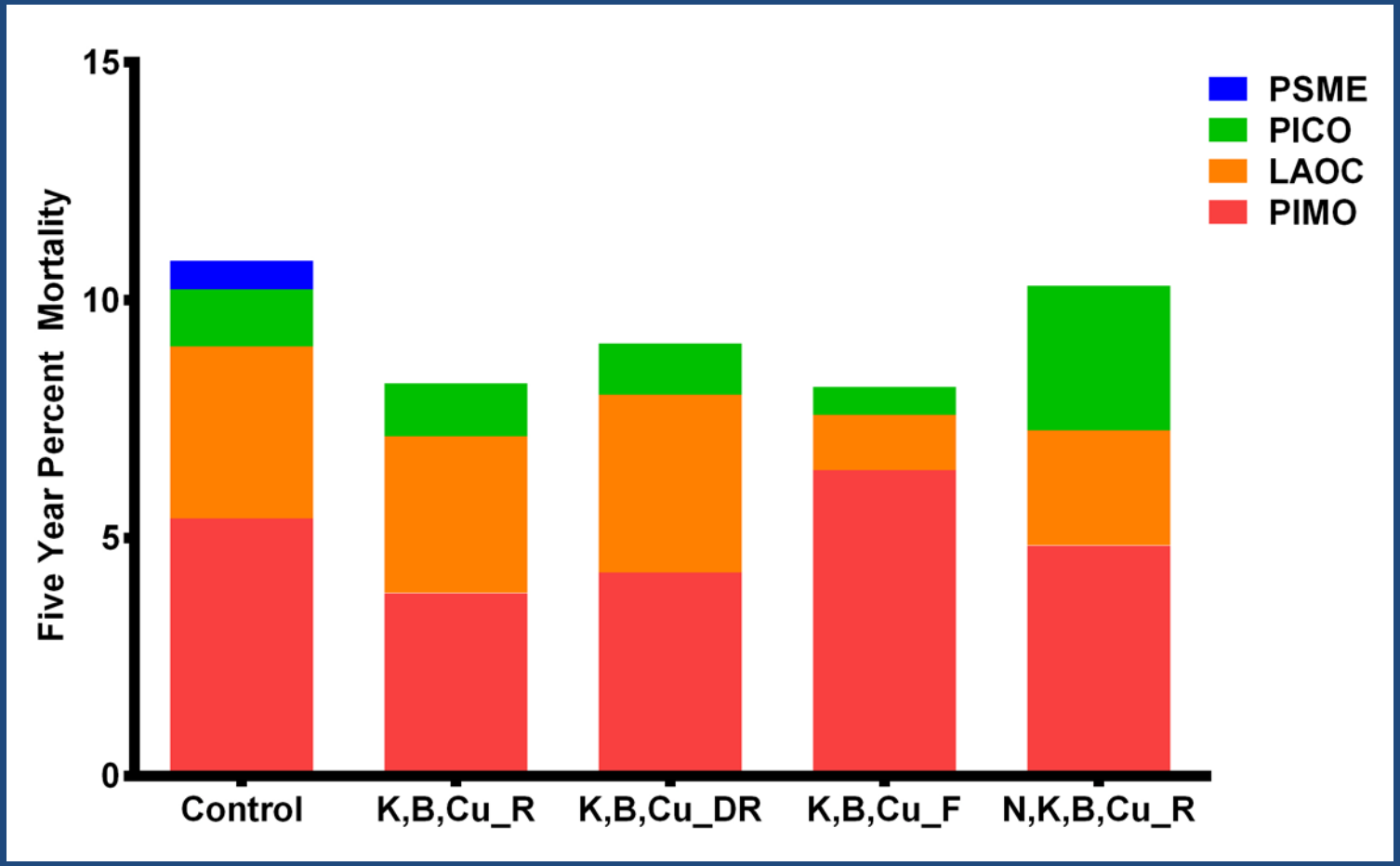


Seedling Growth – All Species





Seedling Mortality – By Species



Question #3 Summary Findings

- Nitrogen and boron fertilization temporarily overcame deficiencies for PICO and LAOC, but was not effective over the entire monitoring period
- Potassium was not limiting for lodgepole pine or western larch
- Copper treatments showed a delayed response at best, an analytical method change at worse

Question #3 Summary Findings

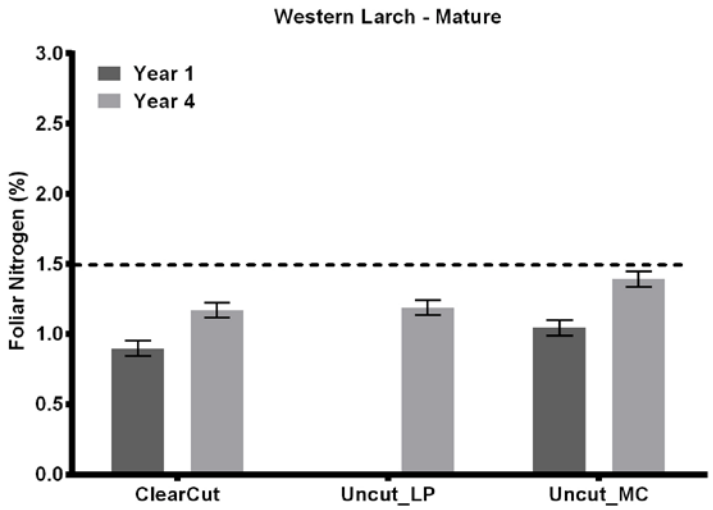
- Nitrogen significantly increased overall seedling growth for the first three years, then showed no significant annual growth differences thereafter, relative to other treatments
- Douglas-fir and western white pine showed no caliper-height growth response to N
- Foliar nutrient deficiencies suggest multi-nutrient growth response (wo/N) primarily to B additions

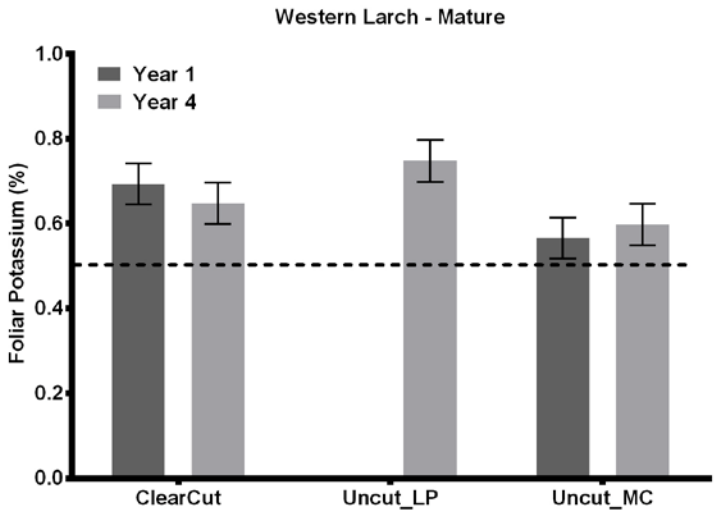
Summation

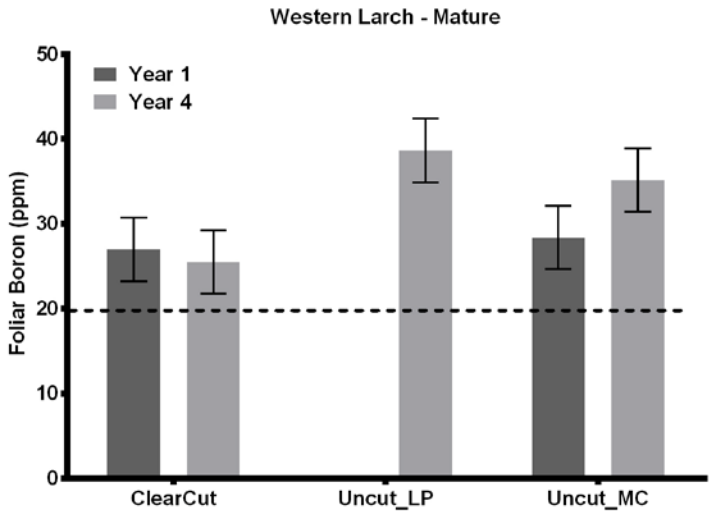
- No evidence at 5 yrs that whole tree harvesting has:
  - Reduced soil nutrient supply
  - Negatively impacted tree nutrition
- Post-harvest nutrient mitigation temporarily:
  - Relieved native soil nutrient limitations
  - Increased growth (primarily a N & B response)
- Year 10 measurements (Fall 2017) will reassess trends

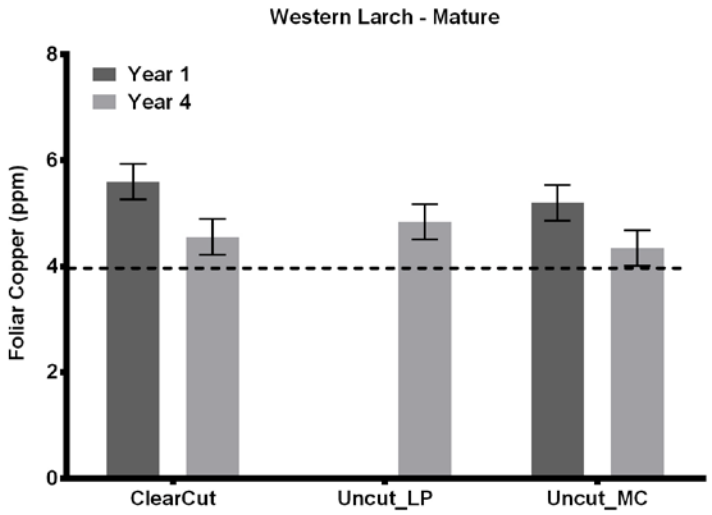
Understory Characteristics

Mature LAOC Foliar Nutrition

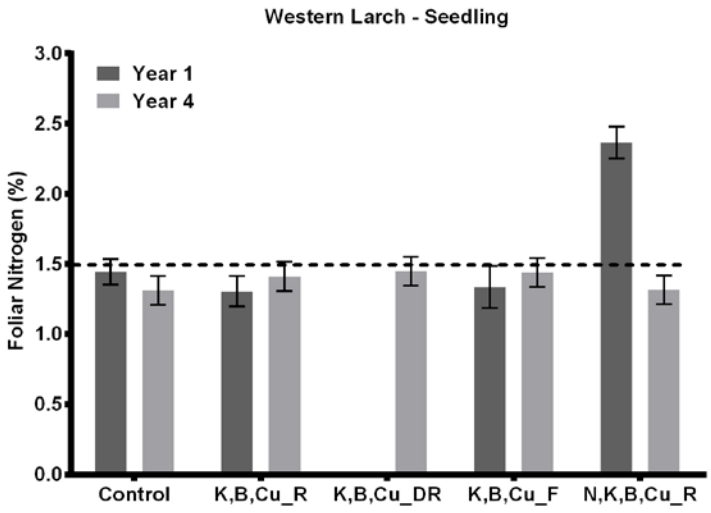


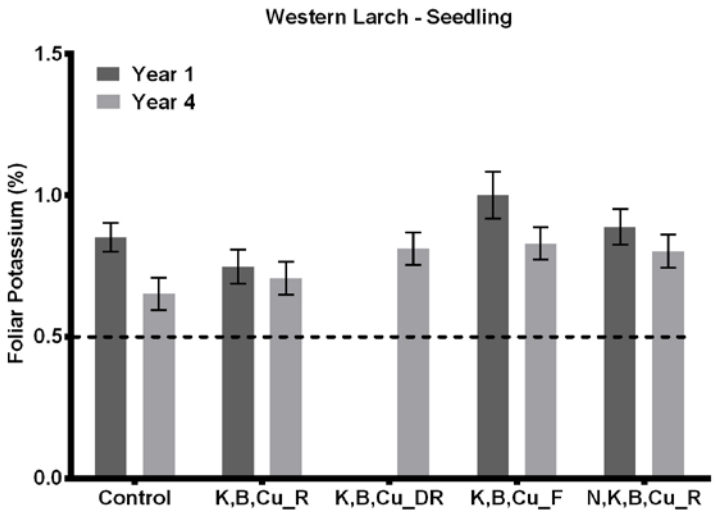


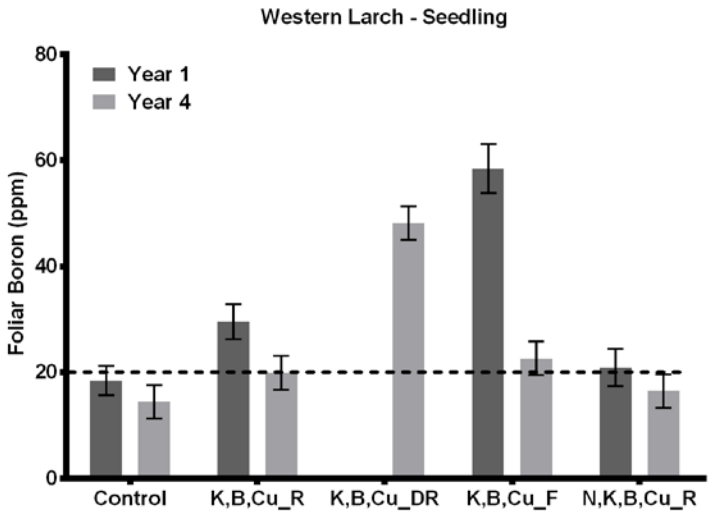


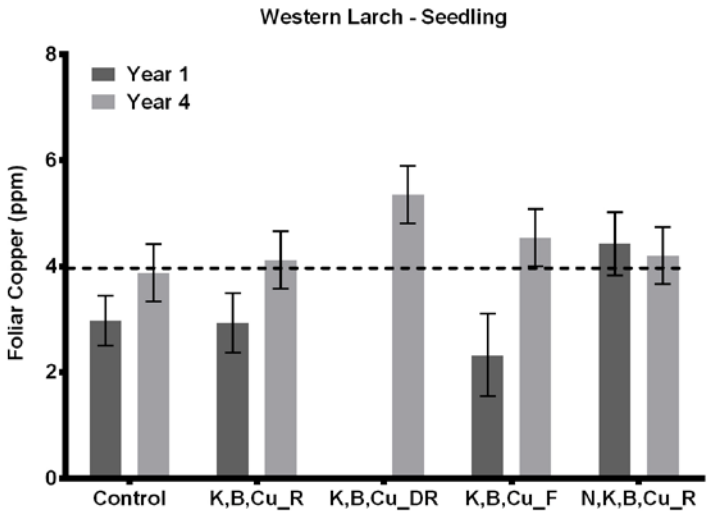


Seedling LAOC Foliar Nutrition

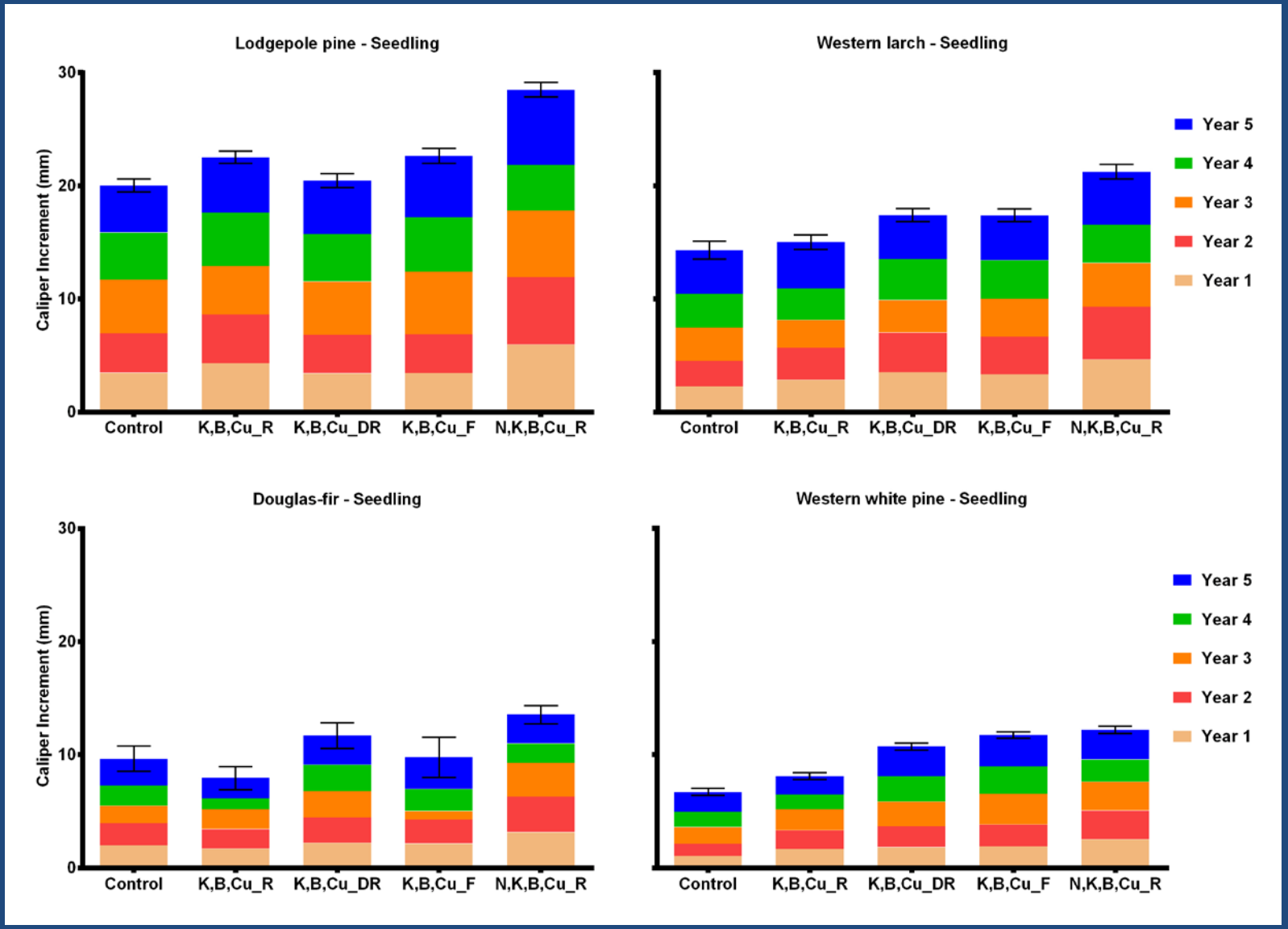




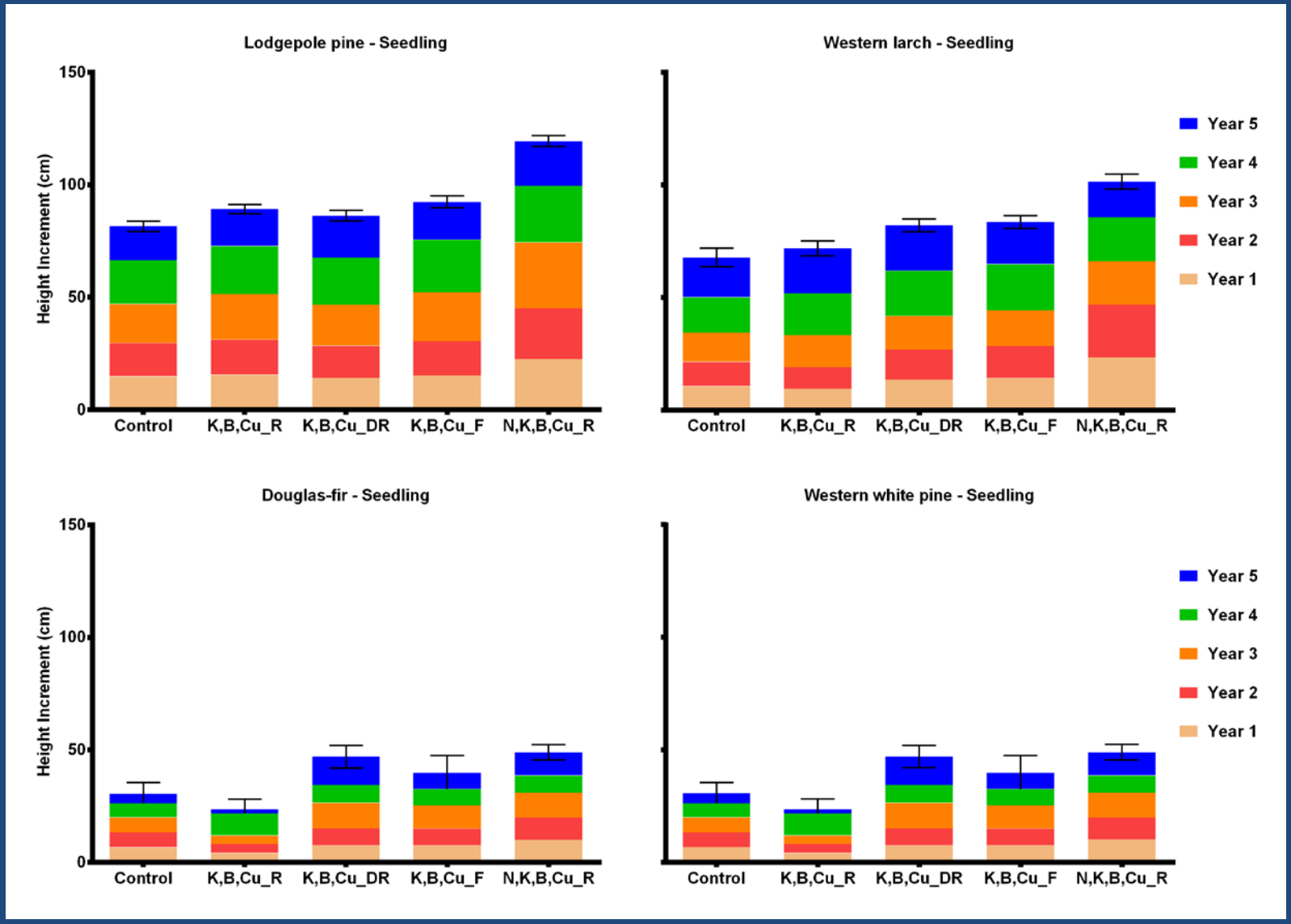




Seedling Caliper Growth



Seedling Height Growth



Nutrient Pool vs Nutrient Flux