Short-term growth and soil biological responses to post-thinning biomass removal and complementary soil amendments

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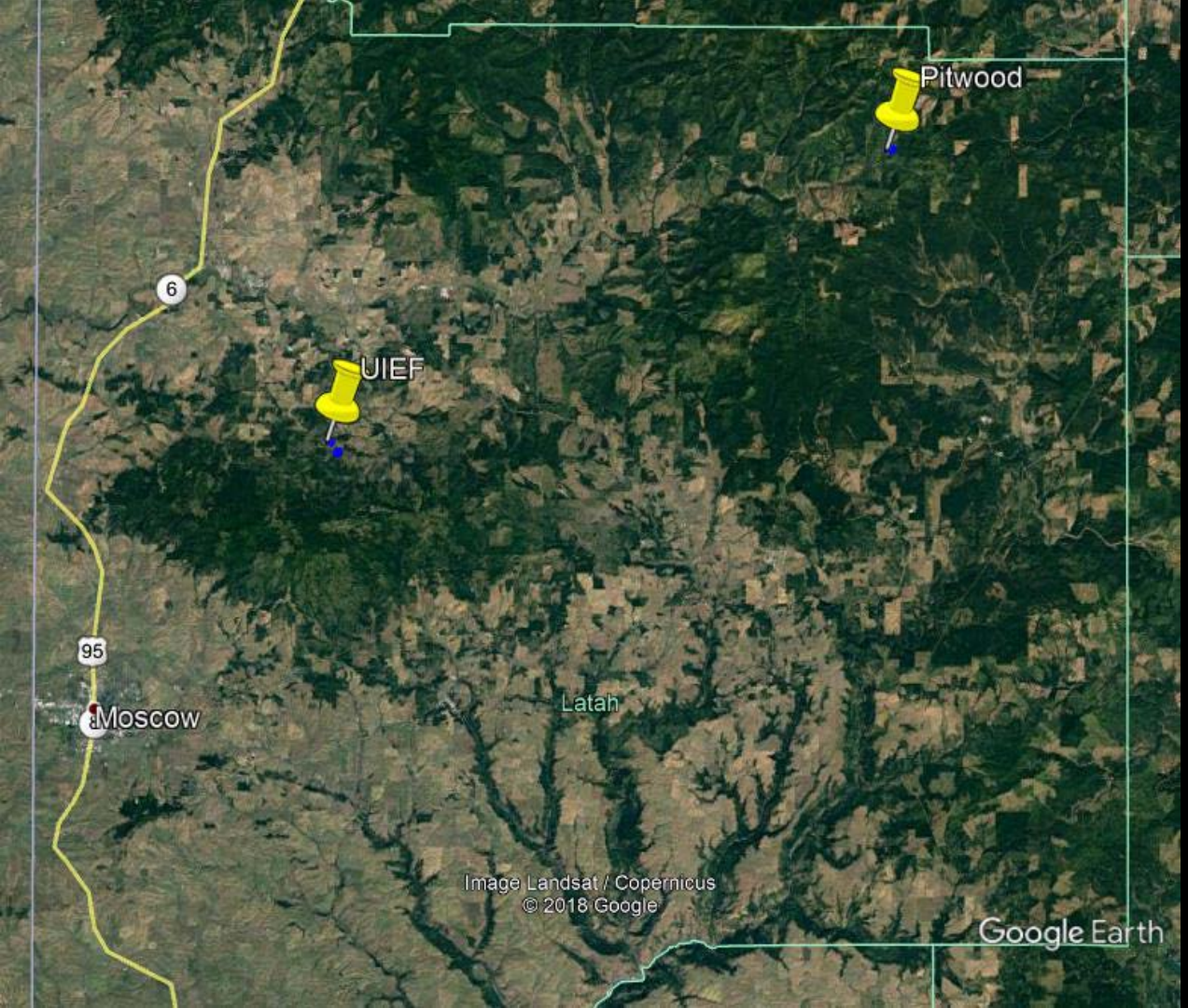
Does removal of thinning residues for bioenergy decrease site quality?

- Thinning produces abundant small-diameter wood
- Improves resource availability and stand quality
- Biomass removal extracts organic matter (N, C)
- Know more about whole-tree vs. bole-only impacts
- Few report effects of thinning residue removal, especially in small-diameter stands

Can soil amendments mitigate any negative impacts of biomass removal?

- Maintaining soil quality involves retention of soil organic matter
- Forest stands respond to N fertilizer
- Biochar amendments replenish organic matter


Pitwood
UIEF
6
95
Moscow
Latah
Image Landsat / Copernicus
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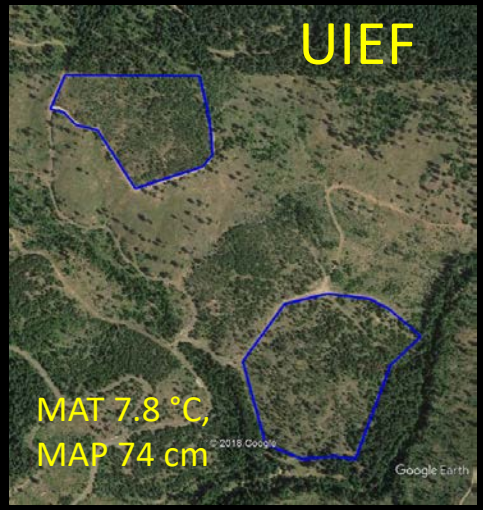
UIEF
MAT 7.8 °C,
MAP 74 cm
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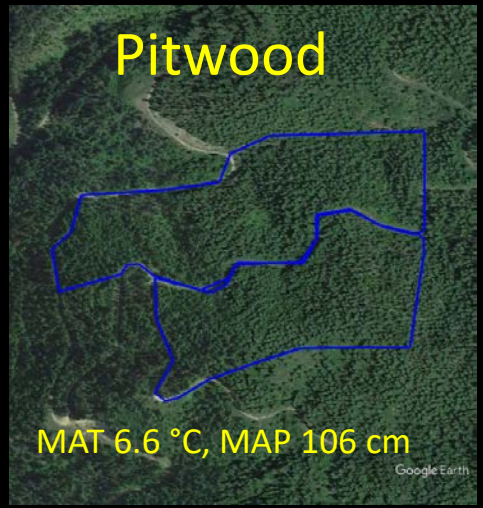
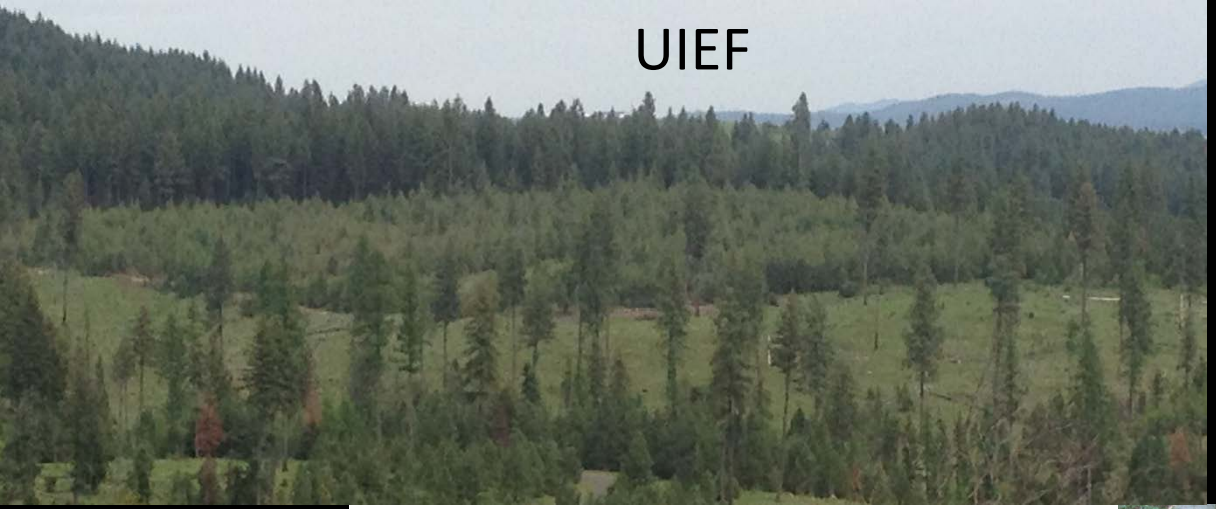
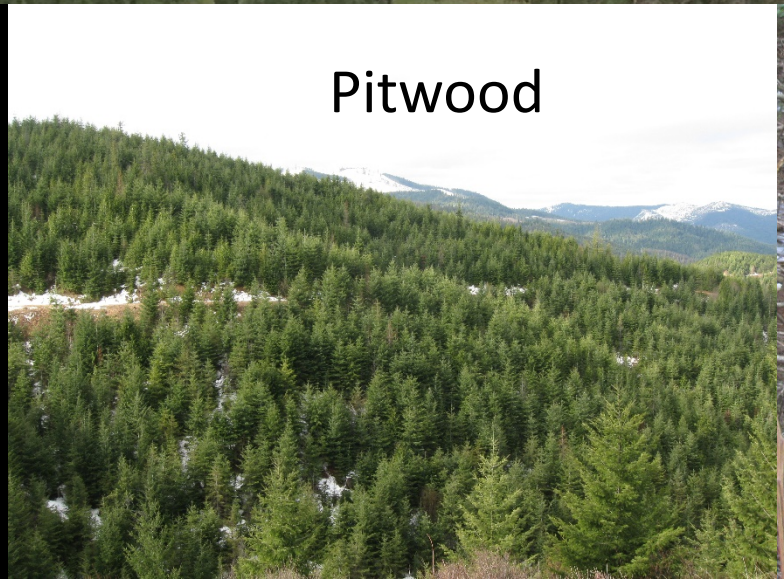

Pitwood
MAT 6.6 °C, MAP 106 cm
Google Earth

UIEF



Pitwood



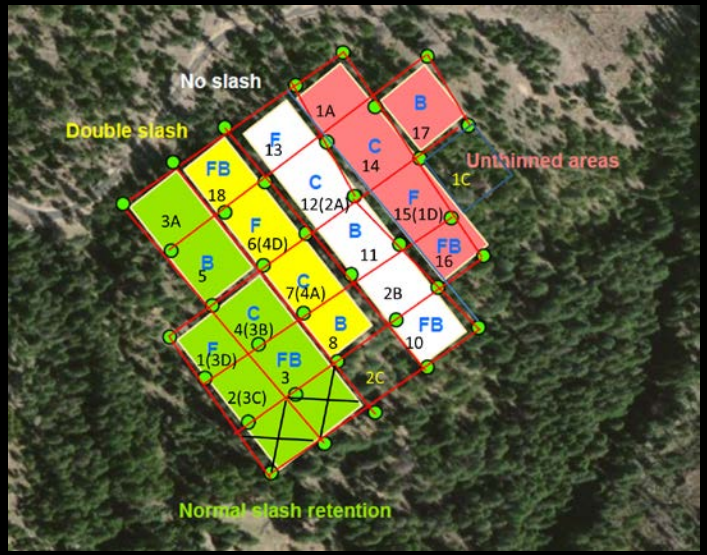
Experimental design

Unthinned control		0X, No biomass retention	
untreated	fertilizer	untreated	fertilizer
biochar	fertilizer & biochar	biochar	fertilizer & biochar
1X, All biomass retained		2x biomass retained	
untreated	fertilizer	untreated	fertilizer
biochar	fertilizer & biochar	biochar	fertilizer & biochar

4 biomass treatments
4 amendment treatments
Replicated 4x

Con, 0x, 1x, 2x
Con, Fert, BChar, FxBC
2 at Pitwood, 2 at UIEF

UIEF



4 biomass treatments
4 amendment treatments
Replicated 4x

Pitwood

Slash distribution

UIEF

UIEF

Pitwood

Initial and post thinning stand conditions

	TPH (trees ha^{-1})	QMD (cm)	BA (m^2 ha^{-1})	SDI (trees ha^{-1})	RD (Curtis)	Species distribution (% BA)						
						DF	GF	WH	RC	LP	PP	WL
			Pitwood									
Pre-thin	2625	9	17	481	40	42	15	17	26	1	0	0
Post-thin	467	17	10	237	17	59	8	14	18	<1	0	1
			UIEF									
Pre-thin	1563	12	16	440	33	10	14	0	0	14	53	9
Post-thin	373	14	6	136	11	13	13	0	0	14	55	5

Biomass and N added

	Pitwood		UIEF	
	1x	**2x**	**1x**	**2x**
DWD (Mg ha^{-1})	76±9	158±12	27±2	72±4
Nitrogen content (kg ha^{-1})	44±4	258±5	44±1	118±2

- No other study reports more than 70 t ha^{-1}

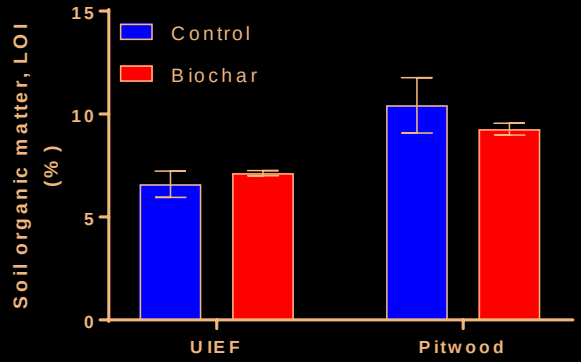
Biochar application

2.5 Mg ha^{-1}

Pitwood

UIEF

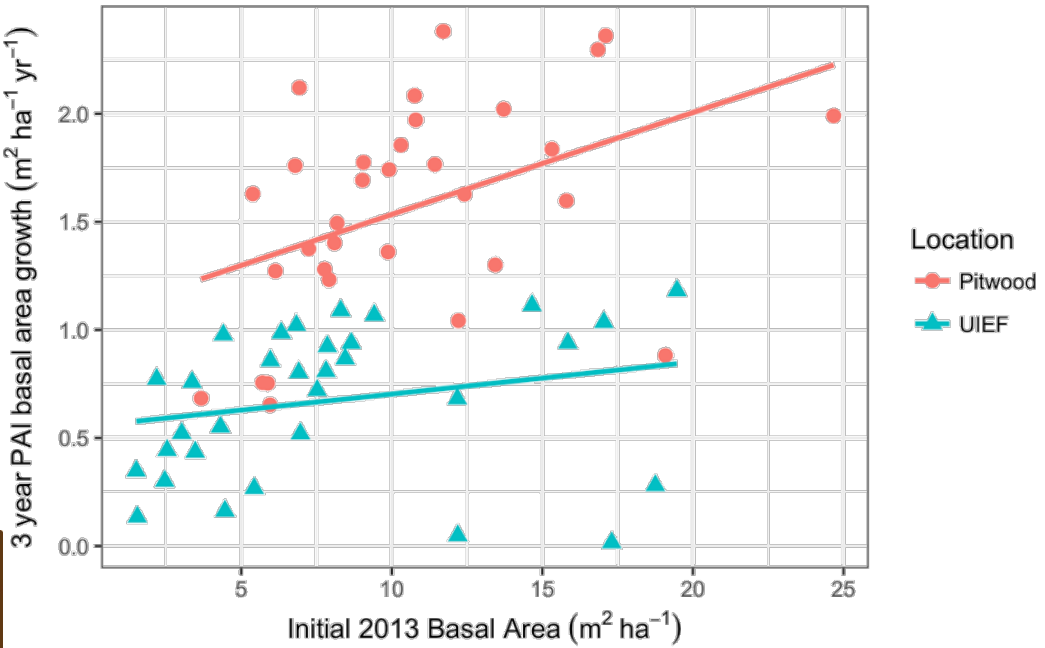
No impact on soil carbon concentration



Fertilizer application

224 kg ha^{-1}

BA growth depended on location



- Growth at Pitwood was twice that at UIEF
- Response to initial basal area depended on location

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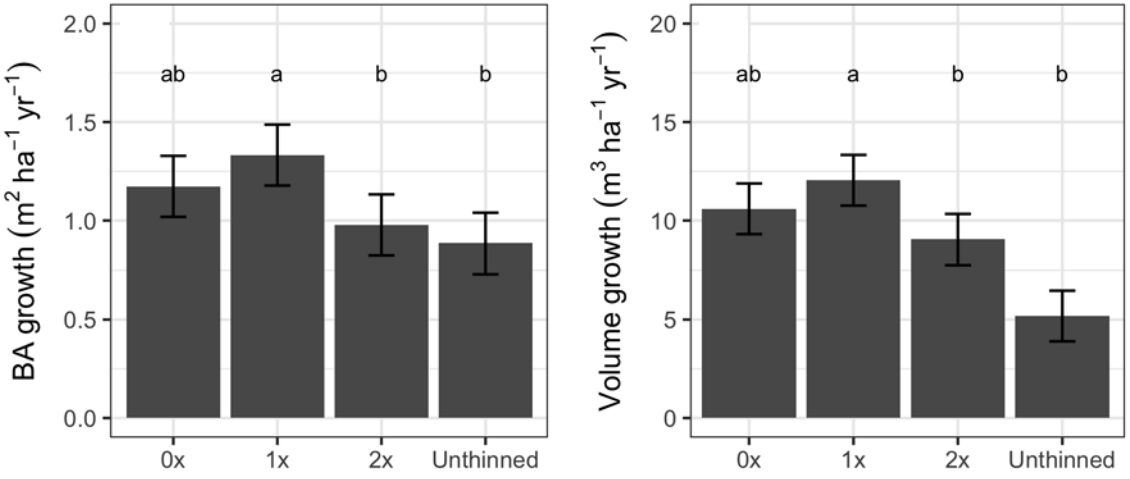
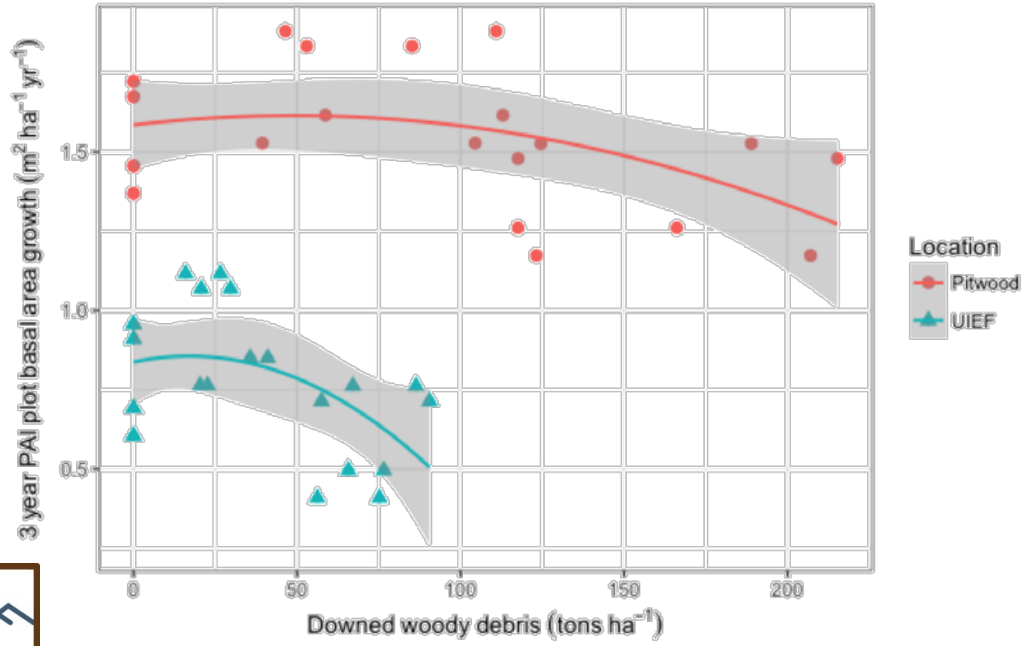
Biomass treatment response

3-yr periodic annual increment



- Best growth at 1x slash retention
- Slowest growth when not thinned or when 2x biomass is retained

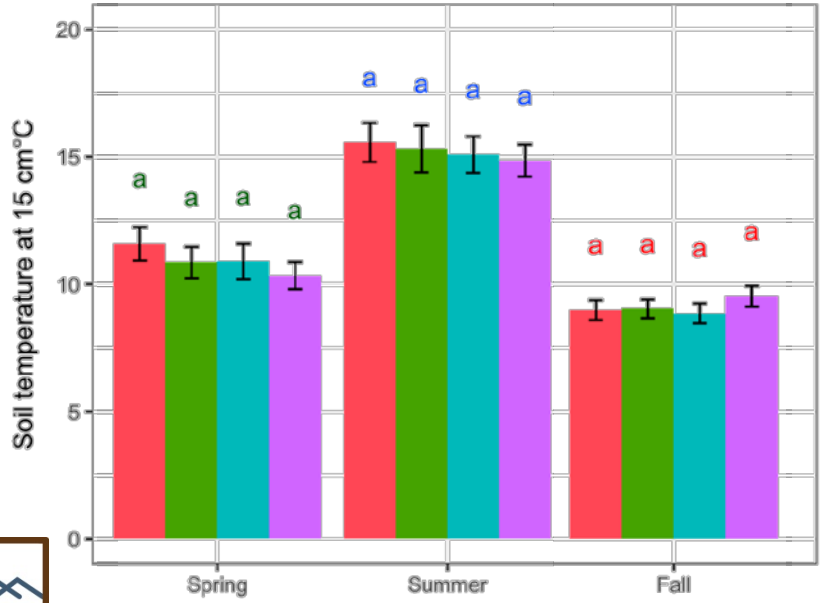
Growth decline at high slash is consistent between locations

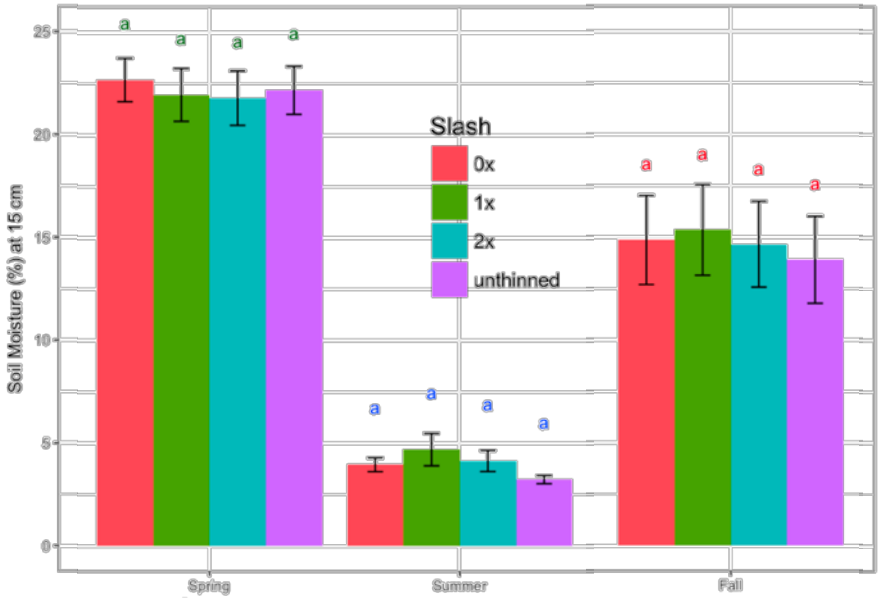


- *PAI basal area growth response to downed woody debris by location with fitted quadratic curve.*
- *What's causing the growth decline with high slash?*

Soil temperature and moisture

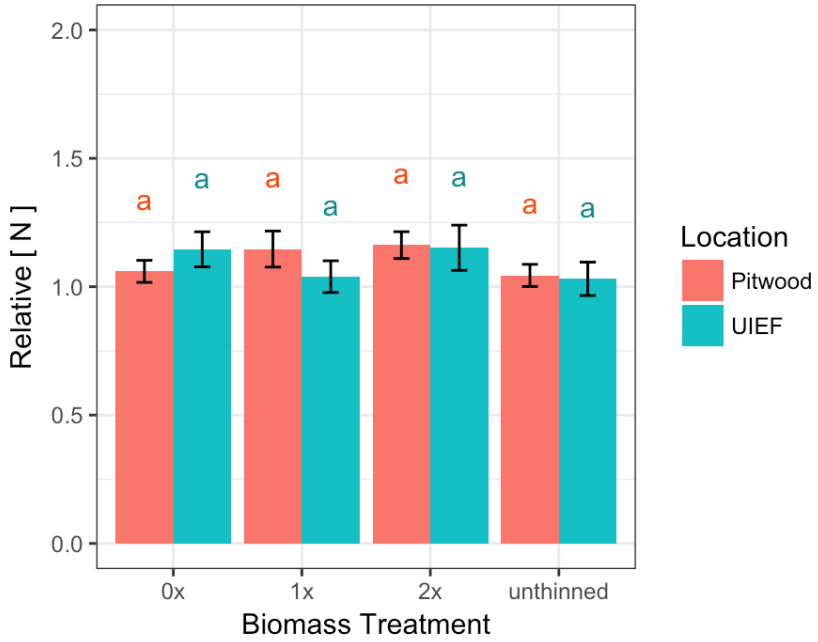
not different among biomass treatments





N limitation

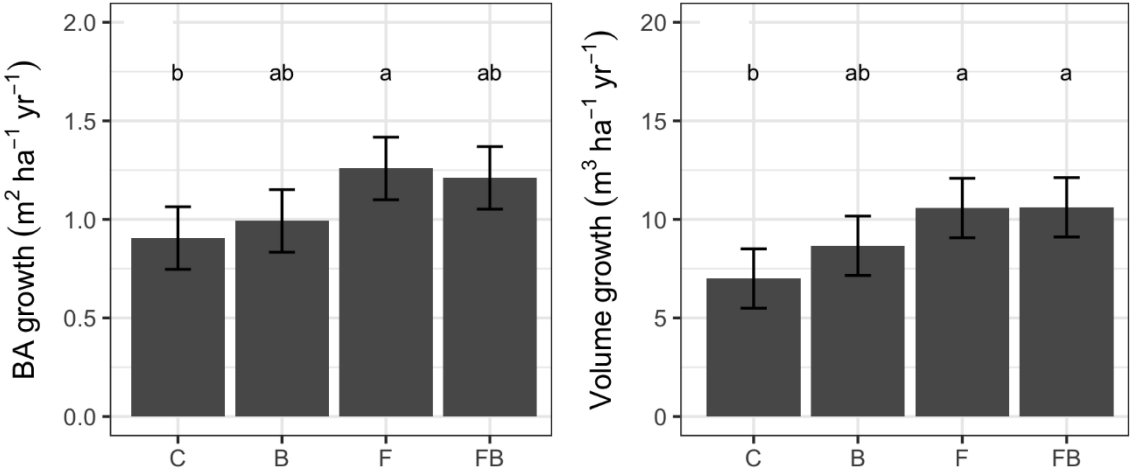
probably not causing Growth decline



- No statistical differences among treatments or locations
- 2x tends to have improved nutrition

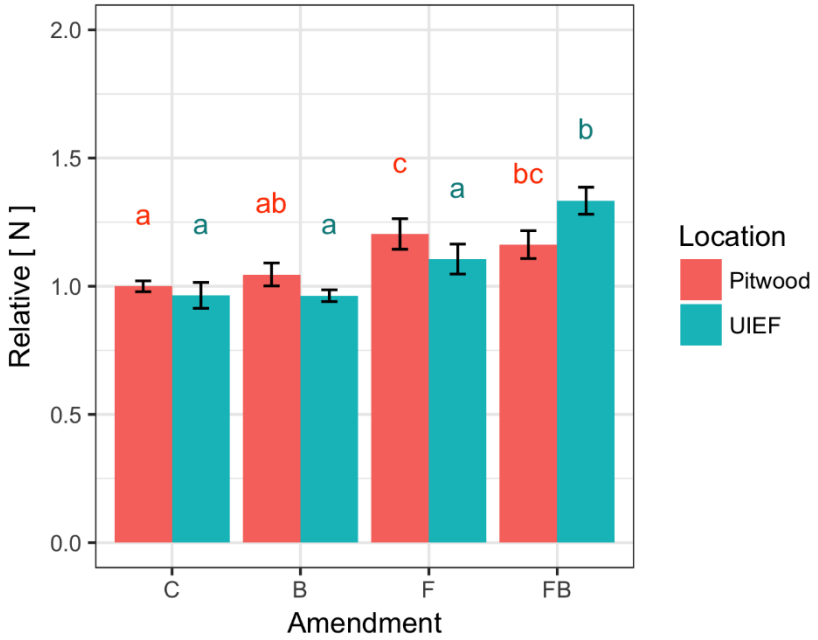
Amendment treatment response

3-yr periodic annual increment



- Growth responded to fertilizer, not biochar
- Potential to mitigate nutrient loss through fertilization
- Biochar increases soil carbon with no detrimental effects

Leaf N responded to fertilizer



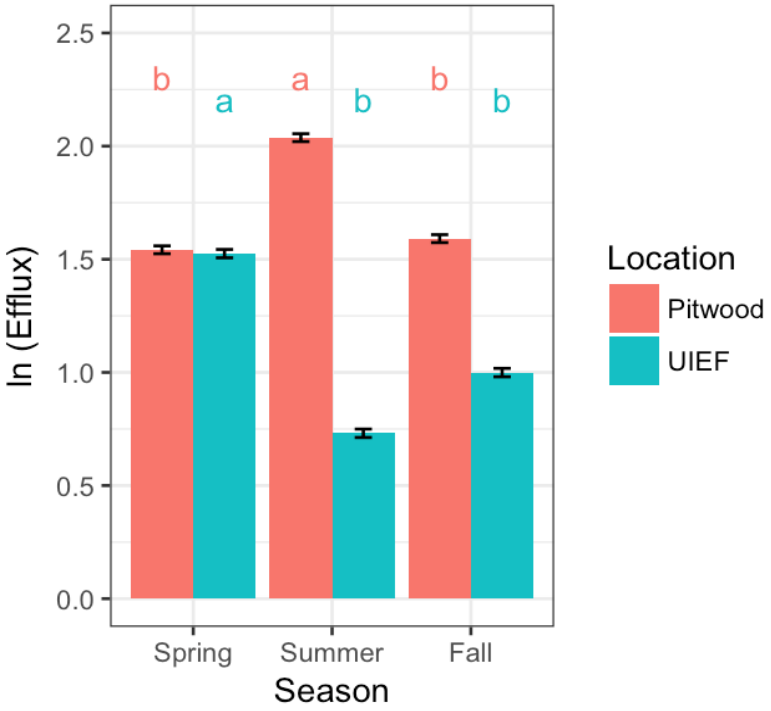
- Stronger response at UIEF than Pitwood
- Can say fertilized trees took up more N than non-fertilized

Soil biology measurements

Field measurements of soil respiration

Lab assays of exoenzyme activity

Soil respiration



- Season largely controls soil respiration
- Seasonal patterns differed between locations
- No biomass or amendment treatment effects

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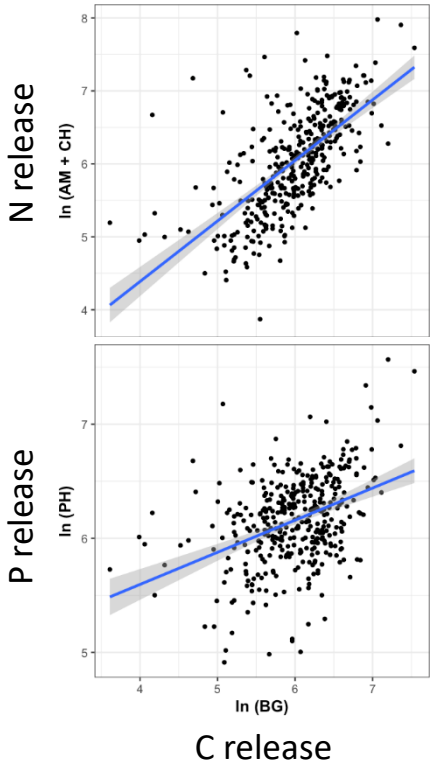
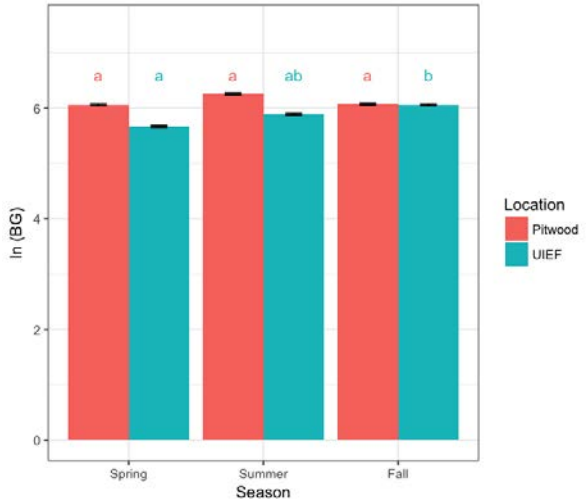
Soil exoenzyme activities





- Nutrient release depends on carbon release
- Seasonal patterns differed between locations
- No biomass or amendment treatment effects

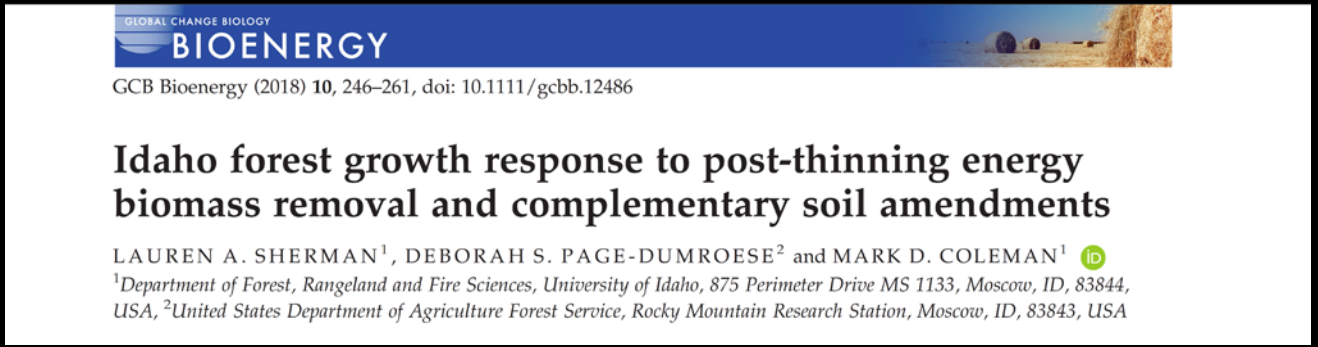
Conclusion

- Removal of thinning residues for bioenergy is not harmful for tree growth
- Retaining excessive slash does lower tree growth
- Fertilizer, not biochar, can mitigate detrimental effects
- Observed responses are short term.
- Assessing thinning impacts yields results quicker than harvest-impact studies

Conclusion cont.

- Expected 10- or 20-year responses
  - Thinned trees will be superior size and quality
  - 2x biomass will no longer be detrimental
  - Fertilizer will no longer affect growth or foliar nutrients, but total volume (yield) will be greater
  - Biochar may show positive response, at least it won't be detrimental

Thank you



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Idaho forest growth response to post-thinning energy biomass removal and complementary soil amendments

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Soil Biology analysis of variance results

Biomass (B)	ns	ns	ns	ns
Amendment (A)	ns	ns	ns	ns
Location (L)	ns	ns	**	***
Season (S)	***	ns	ns	***
B * L				*
A * L				*
A* S			**	
L * S	**			***
ln (BG)		***	***	
ln (MC)	***	***	***	***
ln (LOI)	**	***		***
Temperature	***	***	***	***
pH	ns			***
*P<0.10, **P<0.05, ***P<0.01, ns=not significant				

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