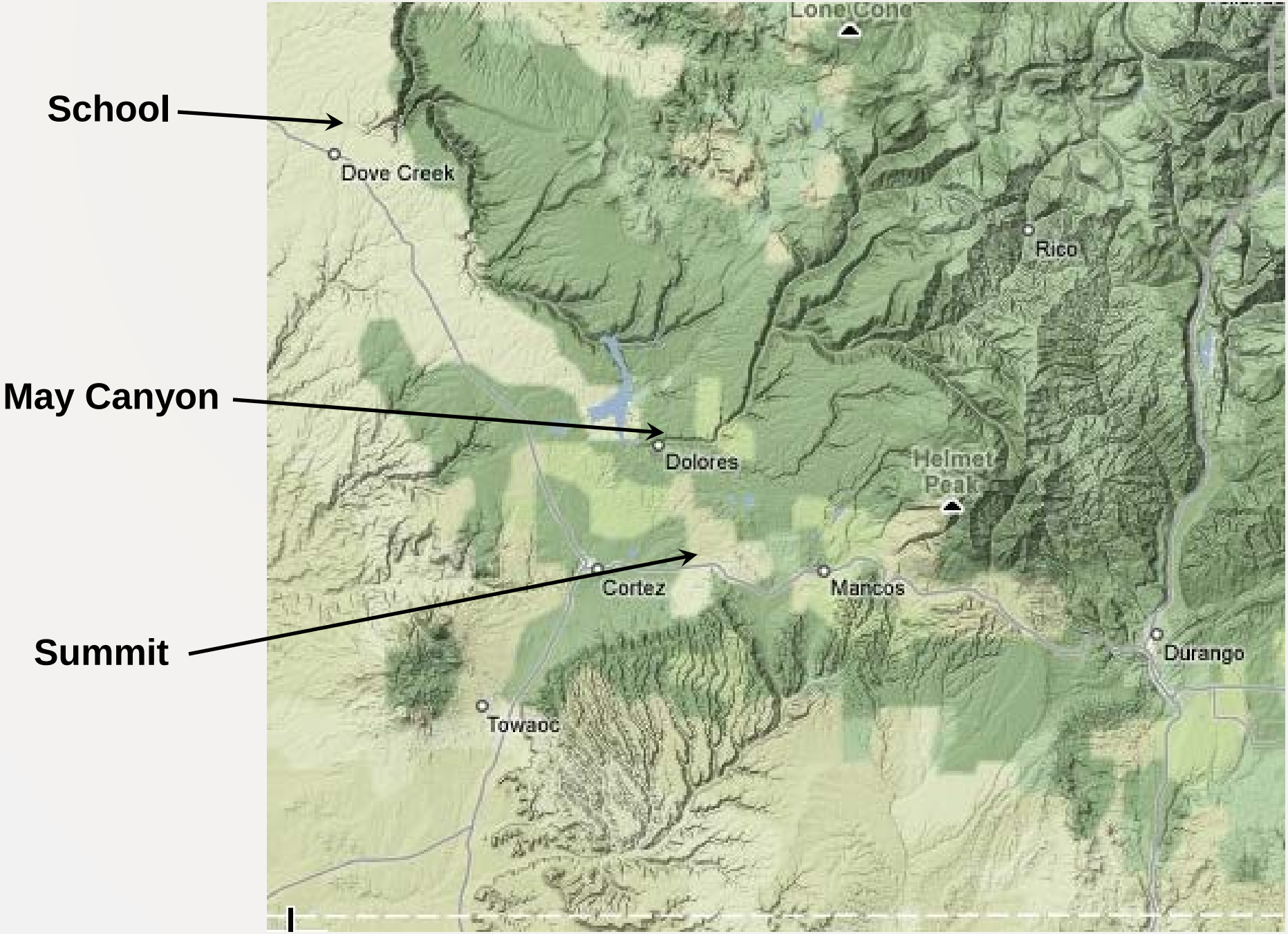
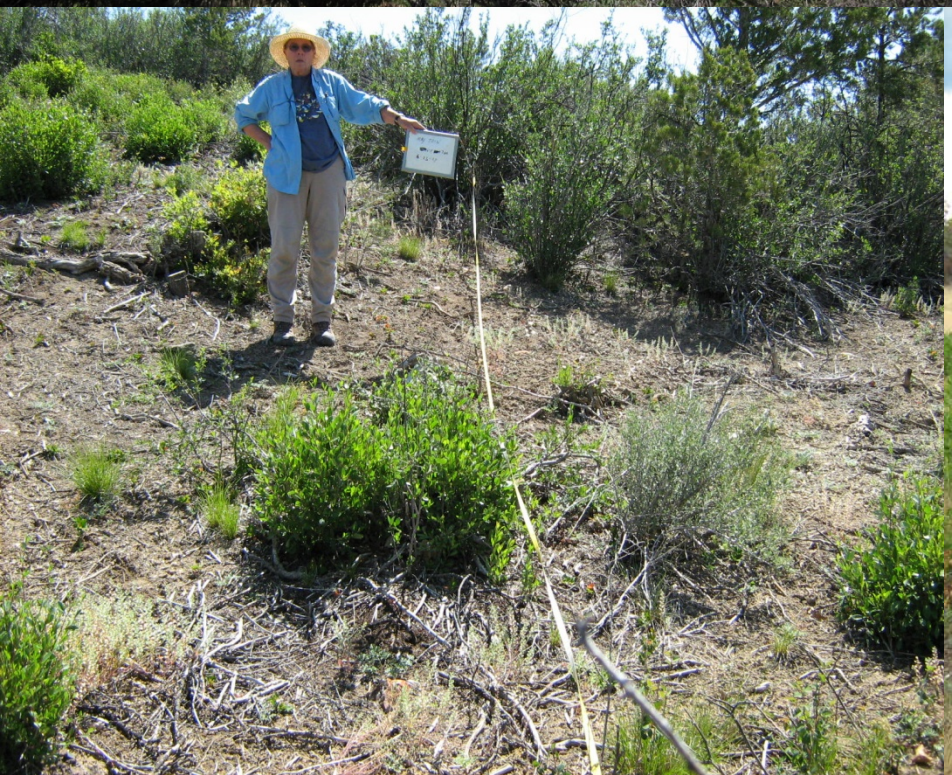
Soil, understory and shrub response to fuel reduction treatments in Pinyon-Juniper woodlands of southwest Colorado

By

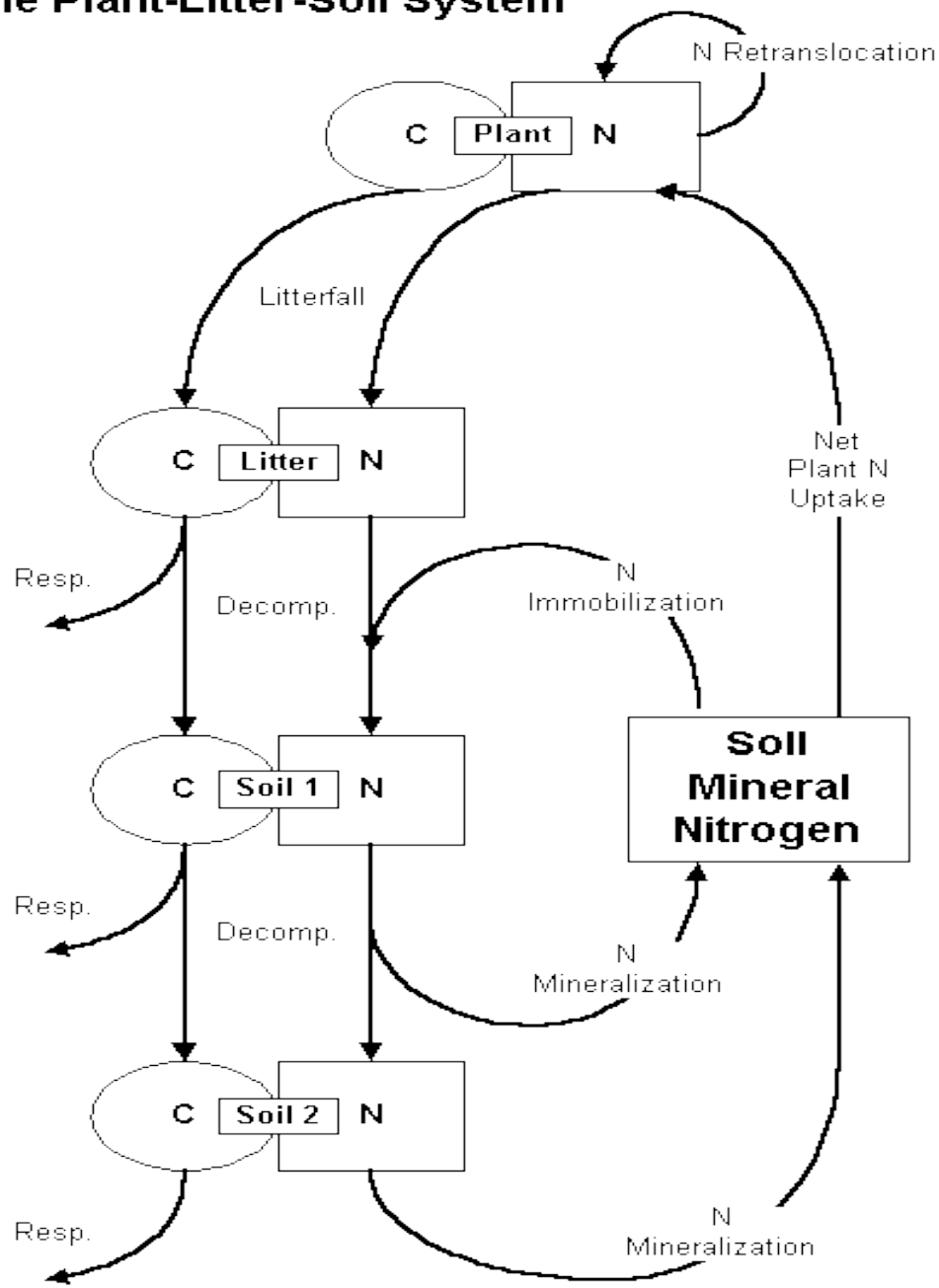
Steve Overby

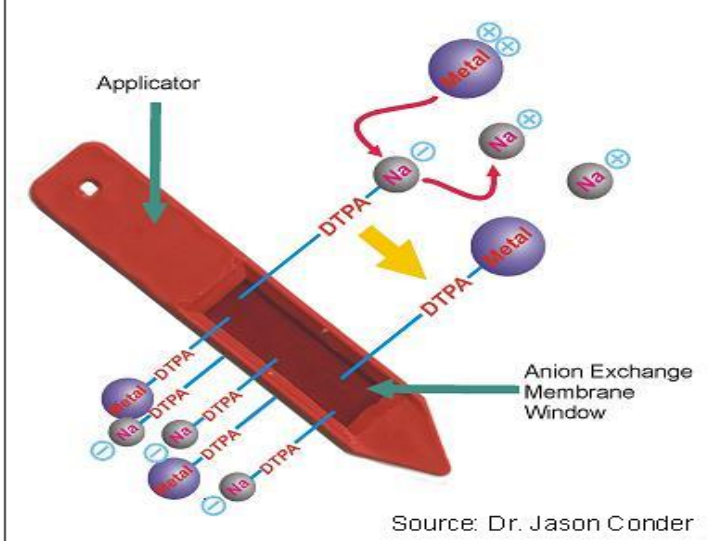
Gerald Gottfried


School
May Canyon
Summit
Lone Cone
Dove Creek
Rico
Dolores
Helmet Peak
Cortez
Mancos
Durango
Towaoc

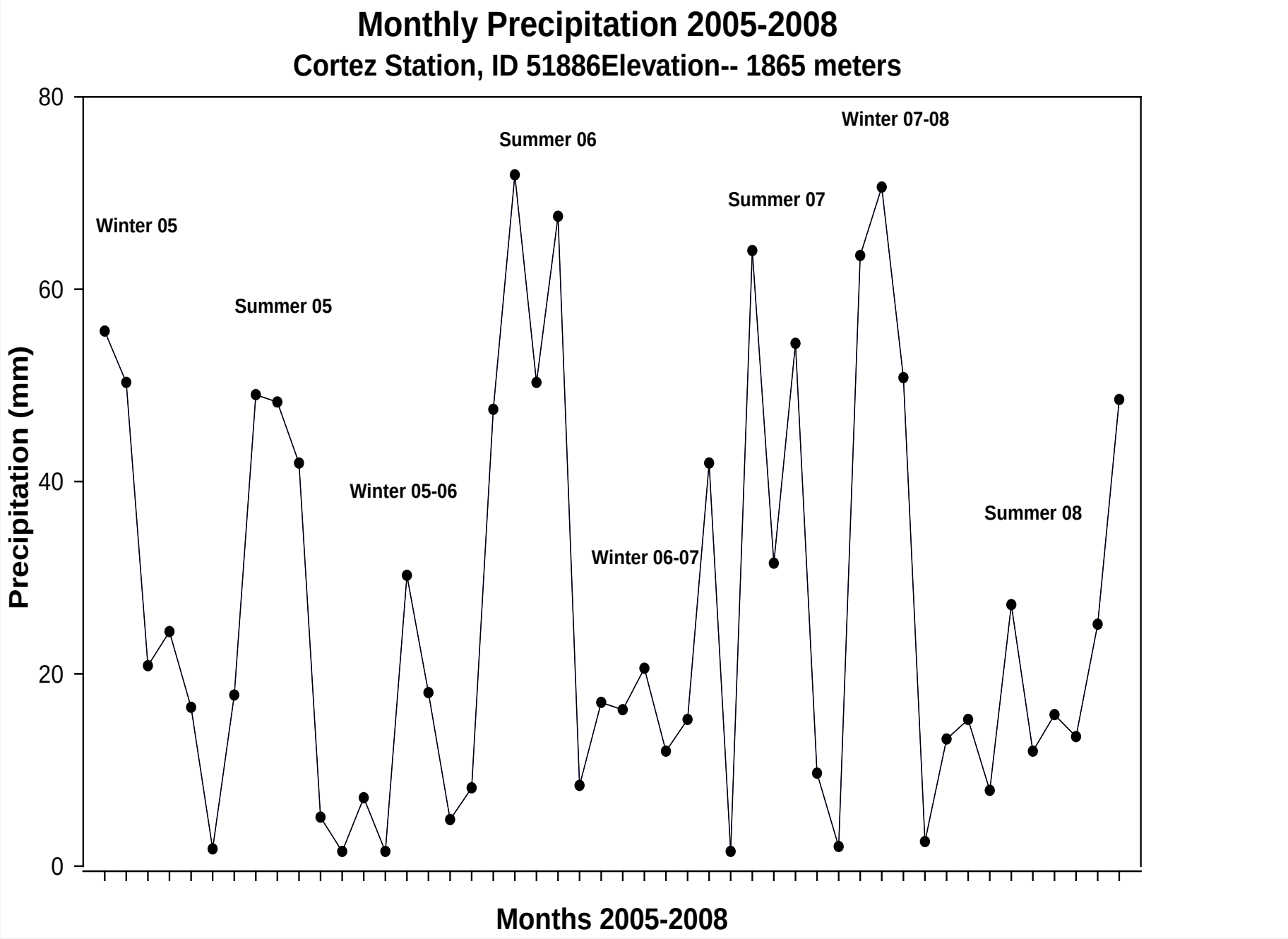


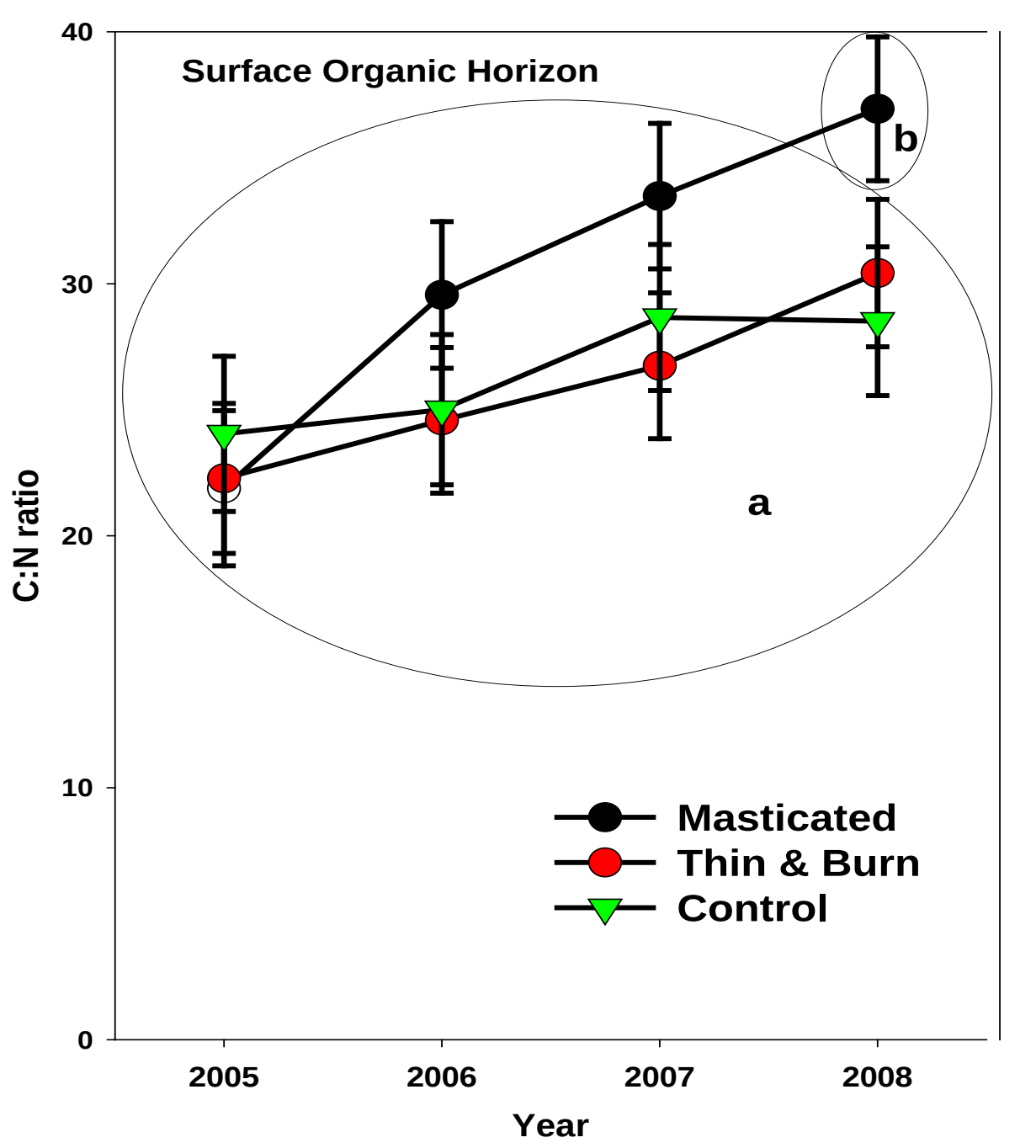
Primary Linkages between C and N in the Plant-Litter-Soil System



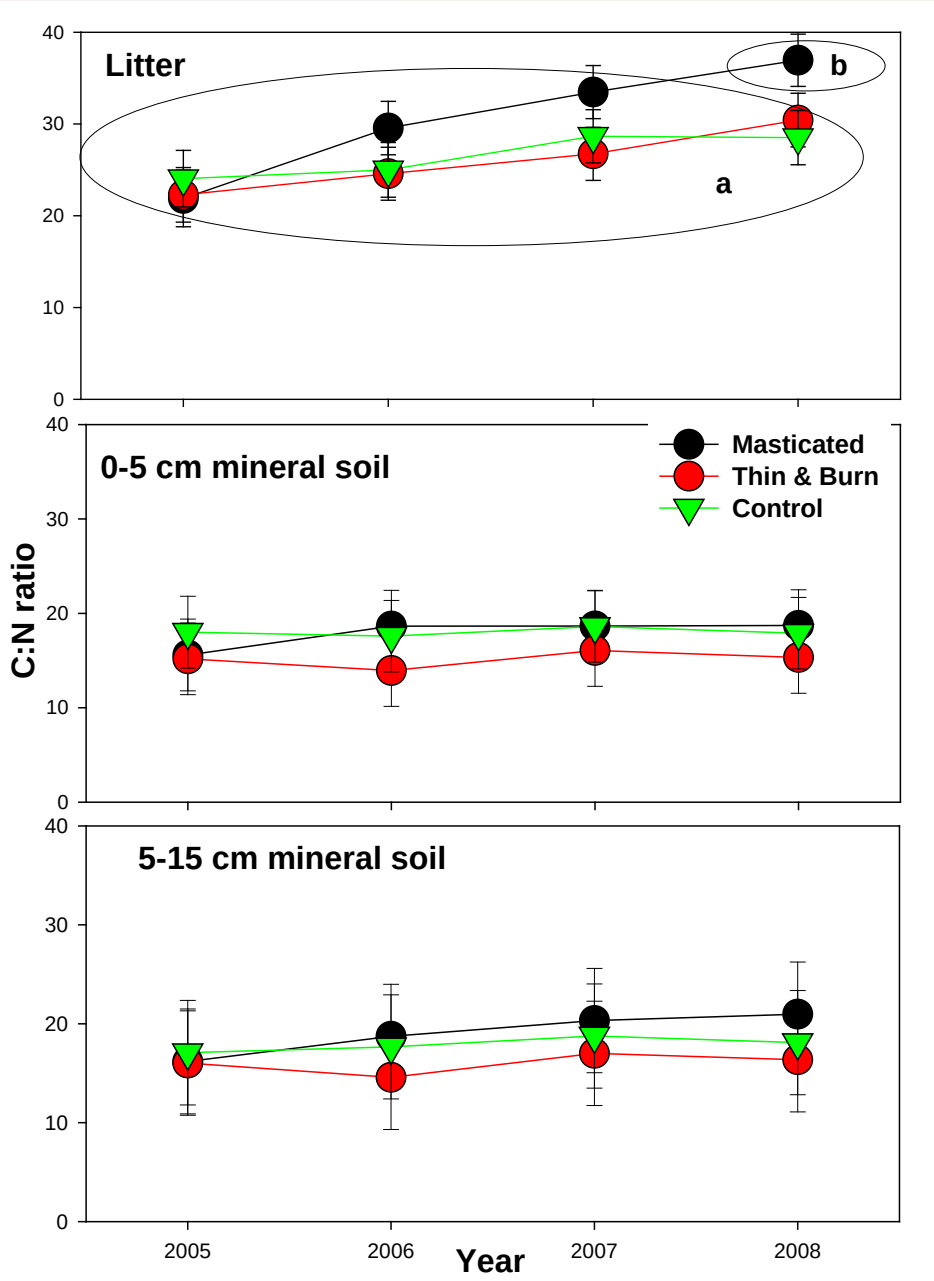


Source: Dr. Jason Conder

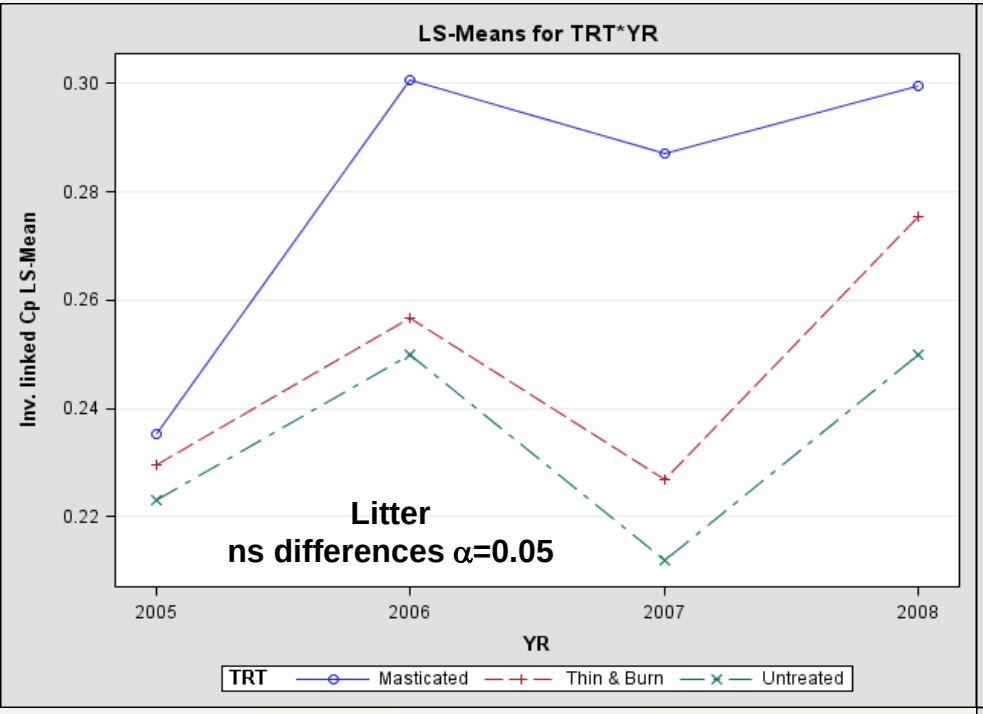

Monthly Precipitation 2005-2008
Cortez Station, ID 51886Elevation-- 1865 meters
Precipitation (mm)
0
20
40
60
80
Winter 05
Summer 05
Winter 05-06
Summer 06
Winter 06-07
Summer 07
Winter 07-08
Summer 08
Months 2005-2008

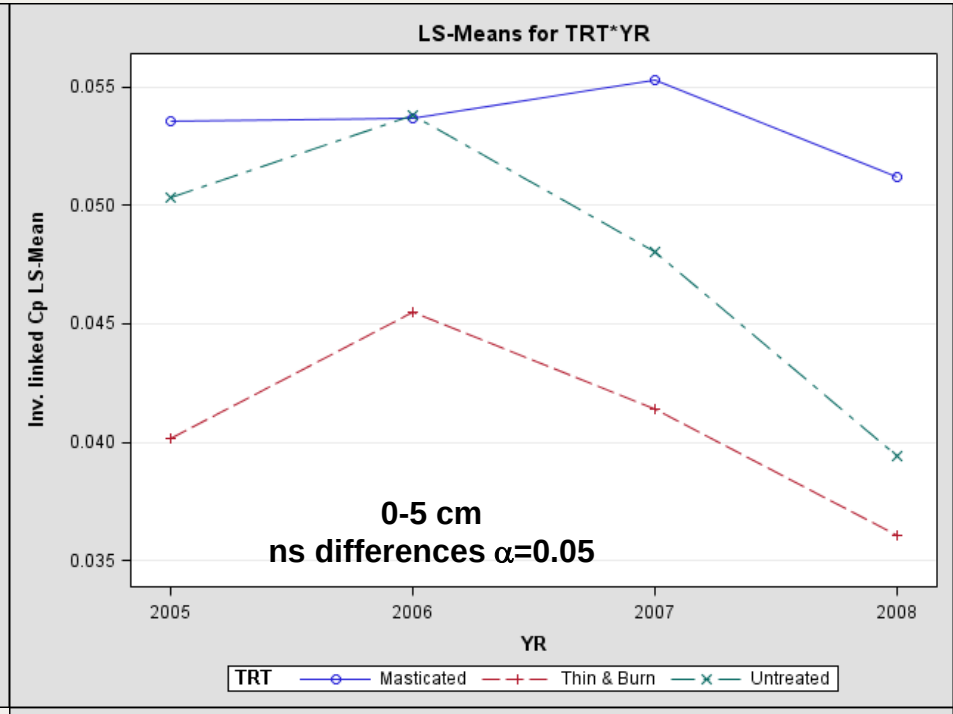

Surface Organic Horizon
C:N ratio
Year
40
30
20
10
0
2005
2006
2007
2008
a
b
Masticated
Thin & Burn
Control

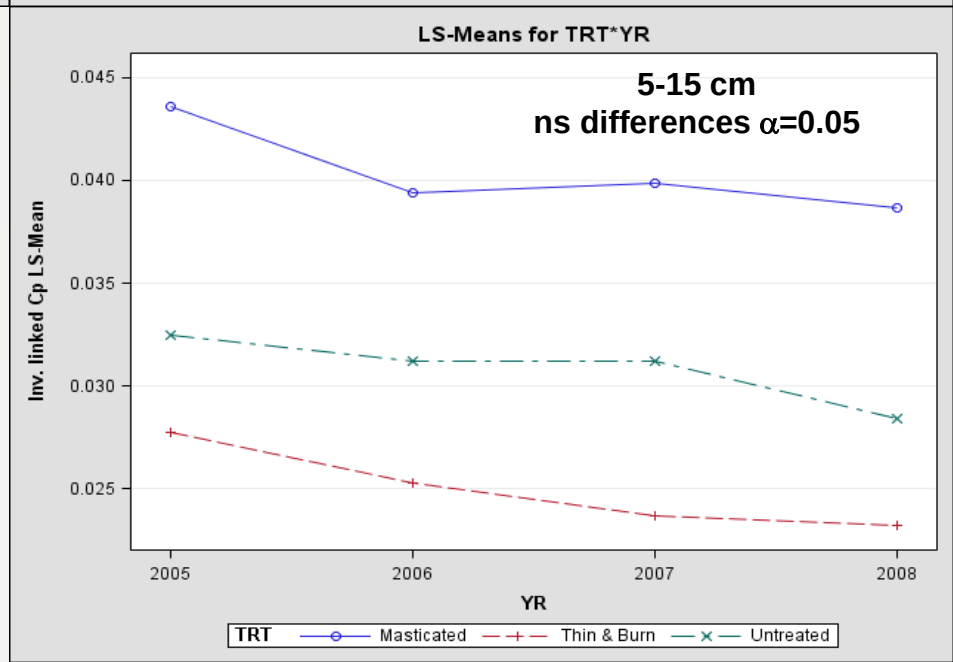
Carbon : Nitrogen Ratio



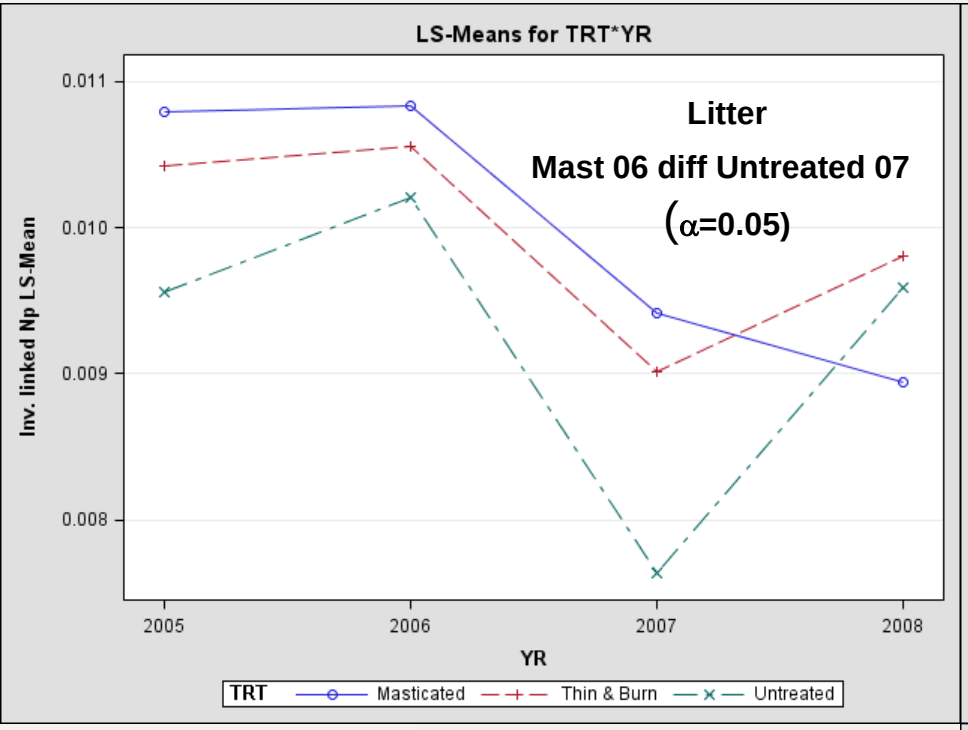
Total Carbon

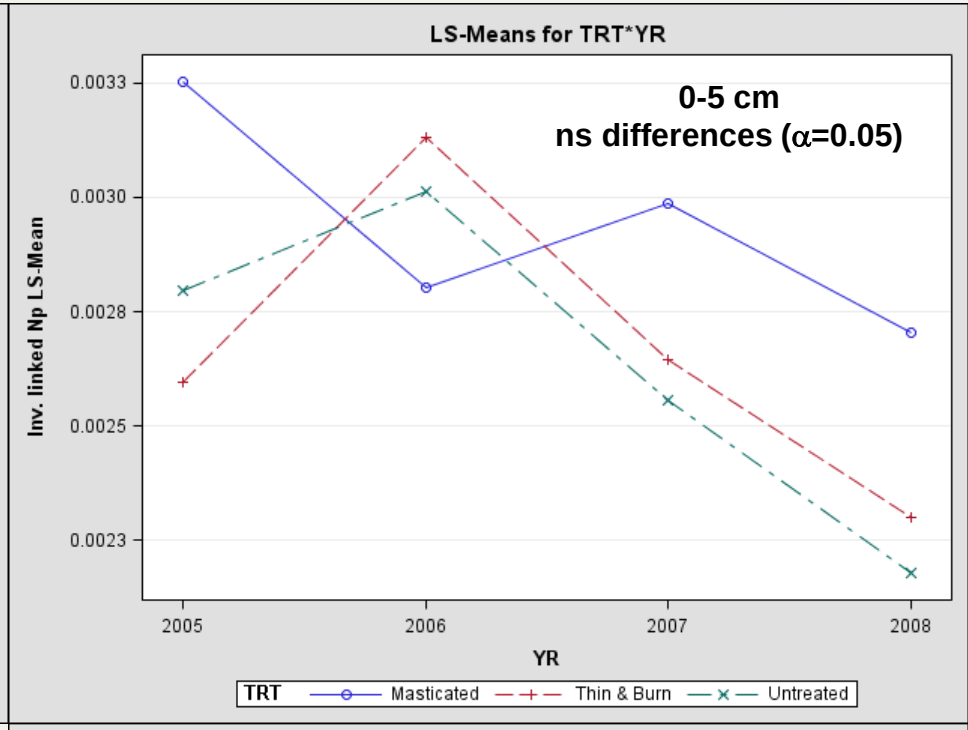


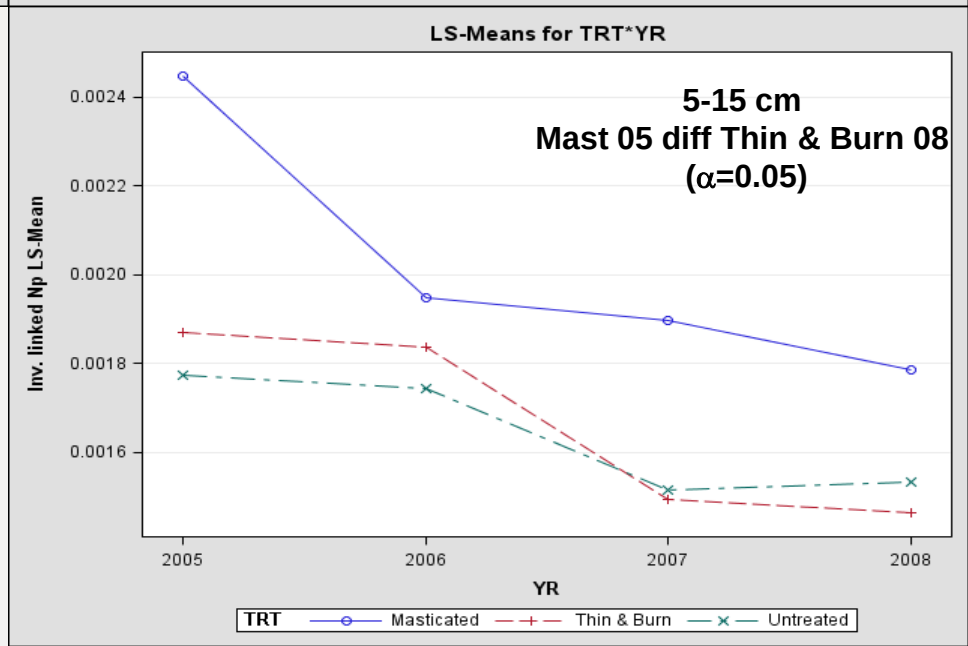




Total Nitrogen



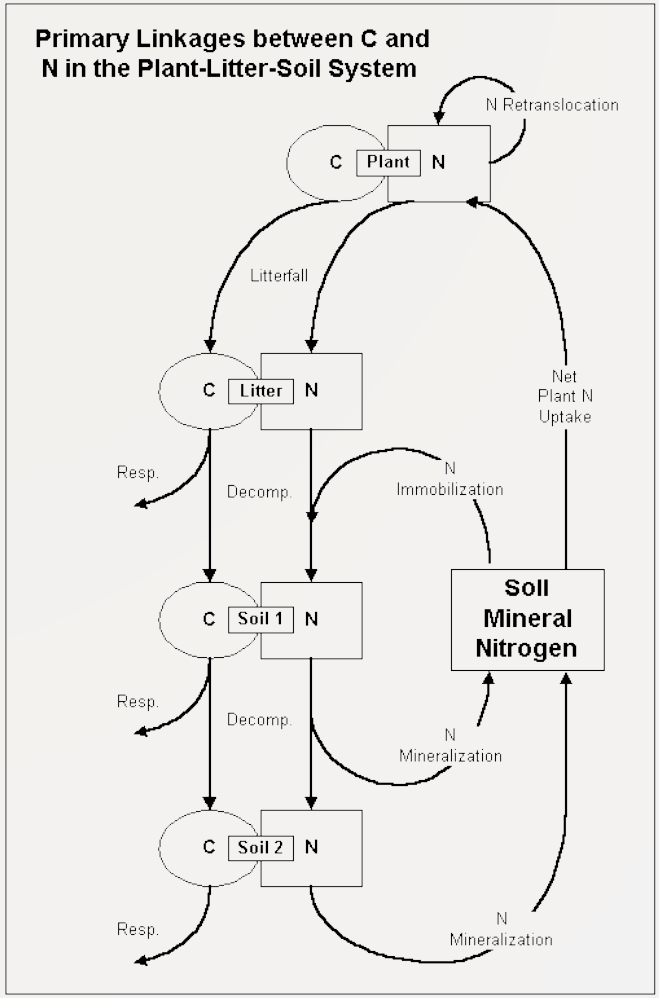




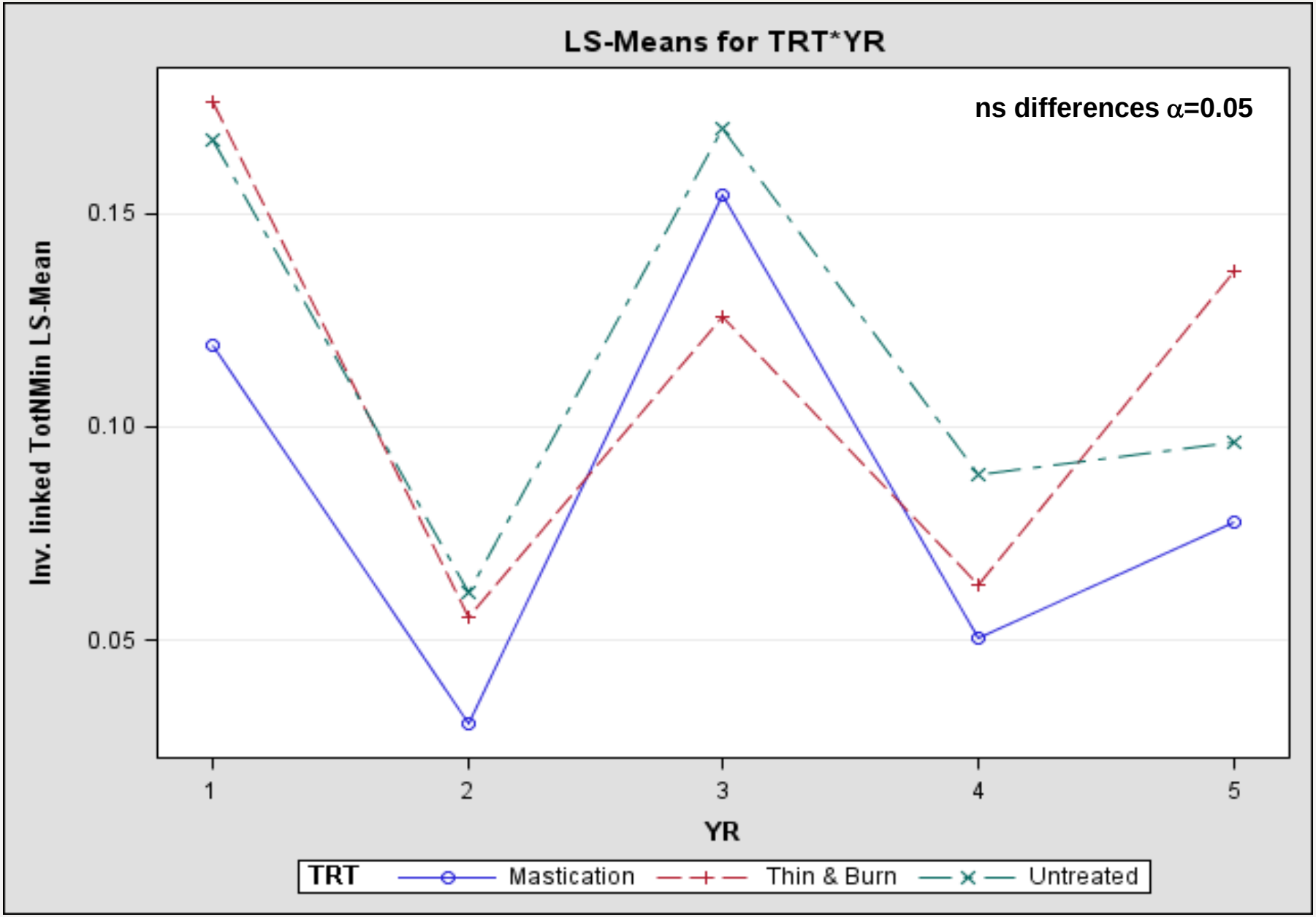
Nitrogen Results

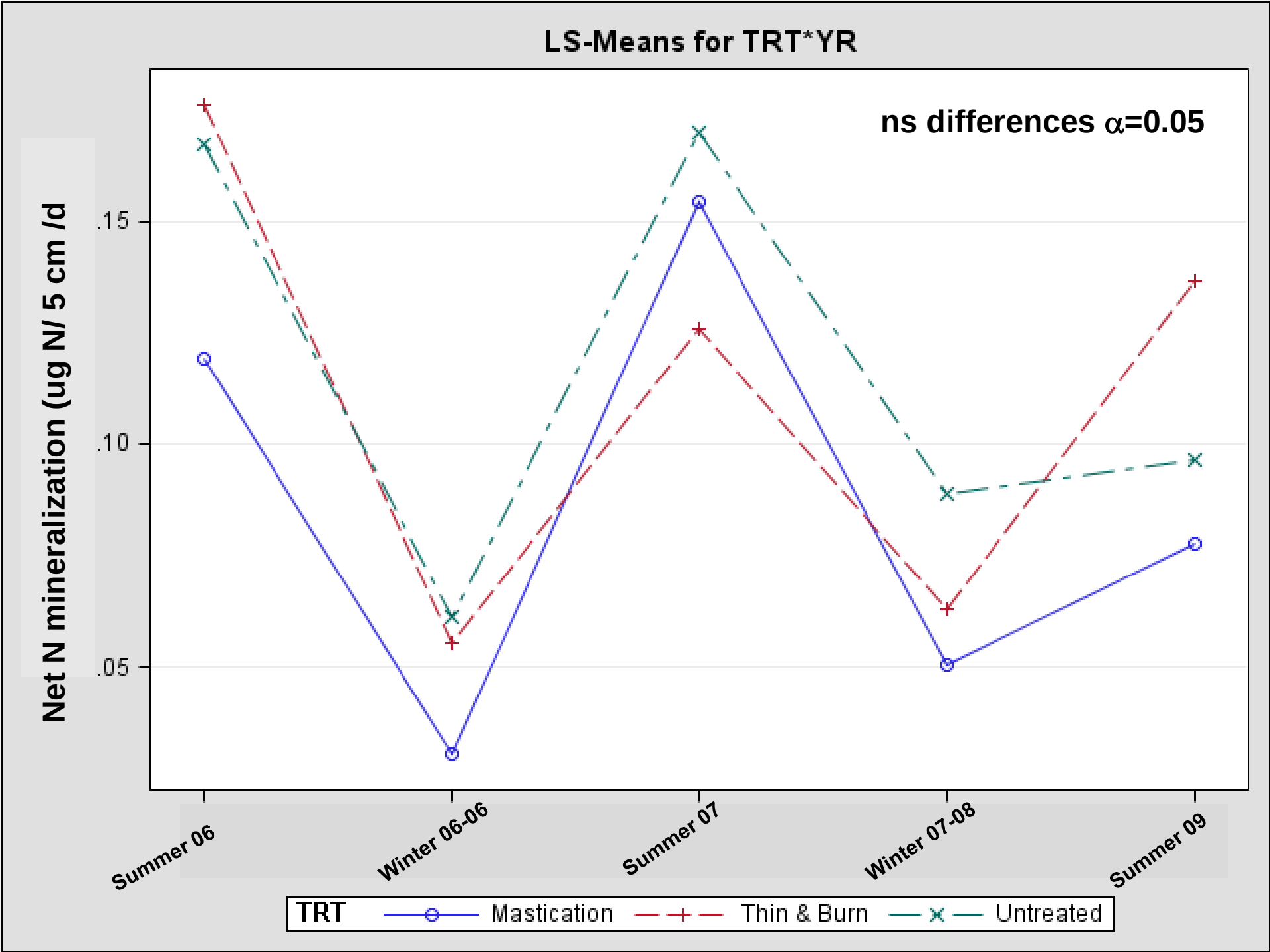
- **C to N ratios in the litter layer significantly increased by the third year following treatment.**

- **The ratio now exceeds 30:1 implying N deficiency and likely immobilization of N.**

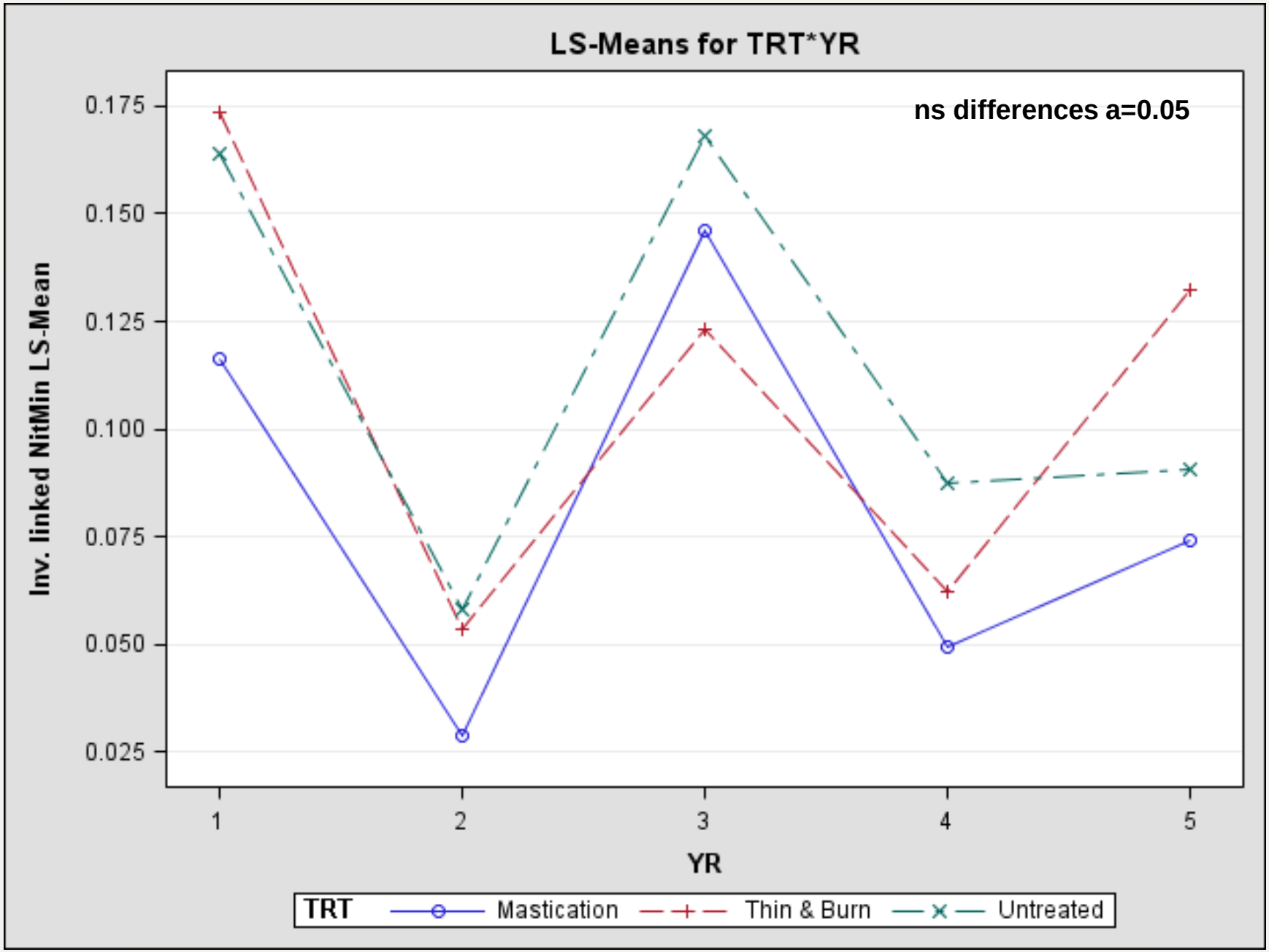


Total Nitrogen Mineralization (ug N / 0-5 cm mineral soil / day)

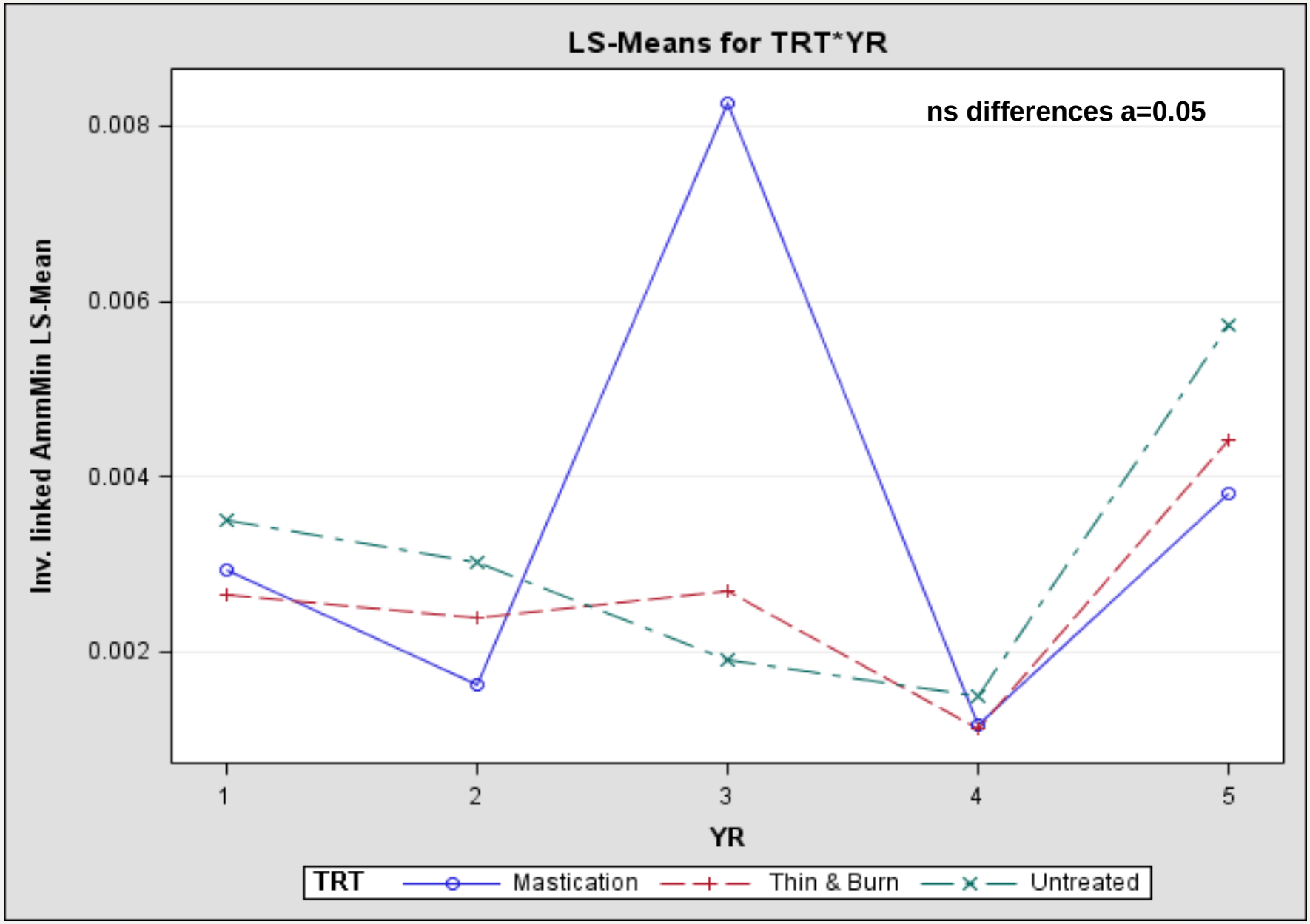



LS-Means for TRT*YR
ns differences α=0.05
Net N mineralization (ug N/ 5 cm /d
.15
.10
.05
Summer 06
Winter 06-06
Summer 07
Winter 07-08
Summer 09
TRT
Mastication
Thin & Burn
Untreated

Nitrification (ug N / 0-5 cm mineral soil / day)



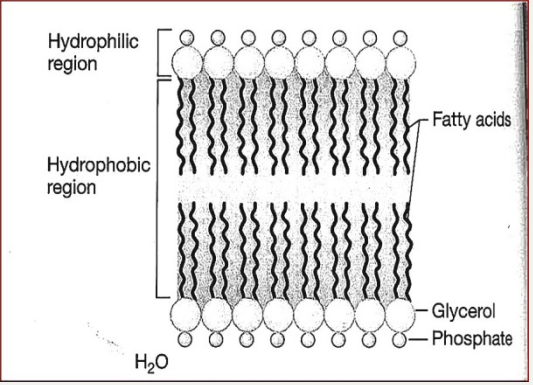
Ammonification (ug N / 0-5 cm mineral soil / day)



Net N Mineralization

- **The surface mineral soil layer did not exceed the 30:1 C:N ratio, therefore neither treatment affected net N mineralization at the plot level.**

- **Net N mineralization in the surface mineral soil is dominated by nitrification.**



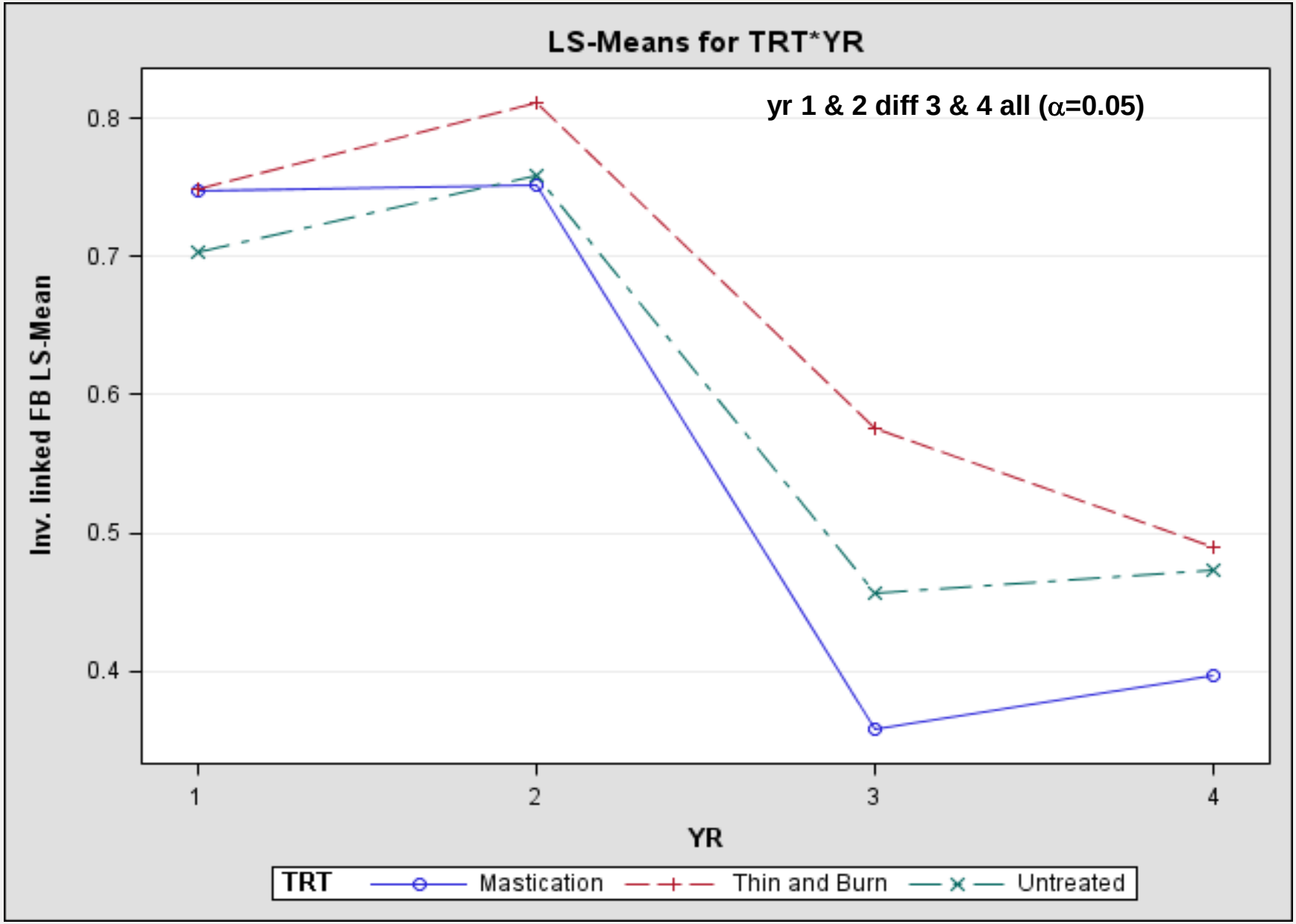
Phospho-lipid Fatty Acid Analysis (PLFA)

- **PLFAs are essential components of every living cell with high biological specificity.**
- **Used as a biomarker for active microrganisms and index for total microbial biomass.**
- **PLFAs are quickly degraded when an organism dies.**
- **PLFAs are not found in storage products.**
- **Total PLFA pattern by multivariate statistics (MRPP). Changes in PLFA fingerprint equates to changes in microbial community.**
- **Changes in specific PLFAs can be used as indicators of changes in specific organism groups.**

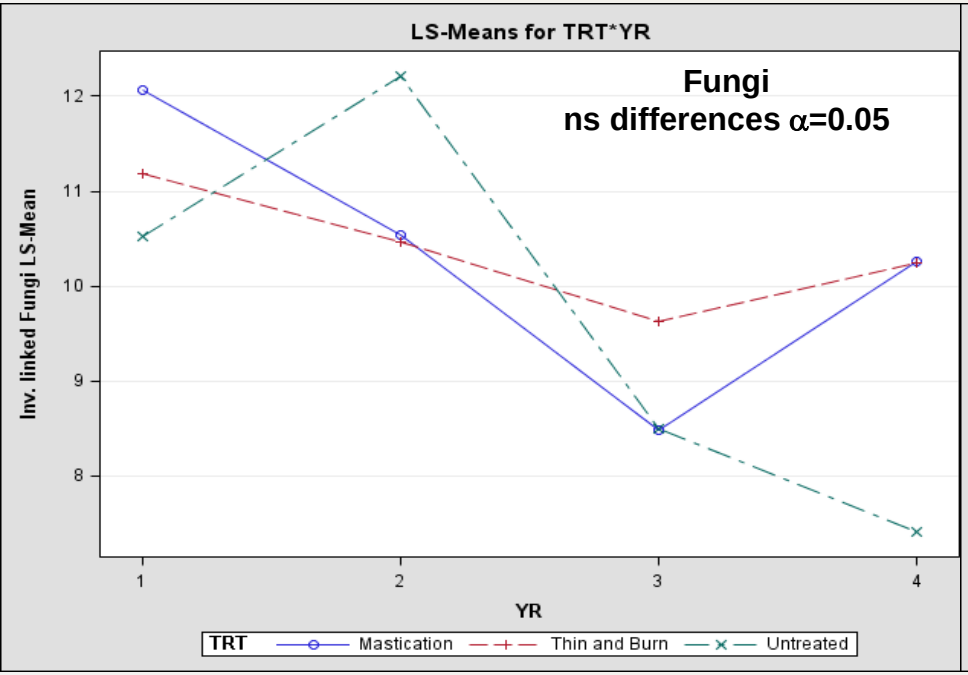
Multi-response Permutation Procedure of treatment effects on Microbial community structure (PLFA), SW Colorado P-J sites.

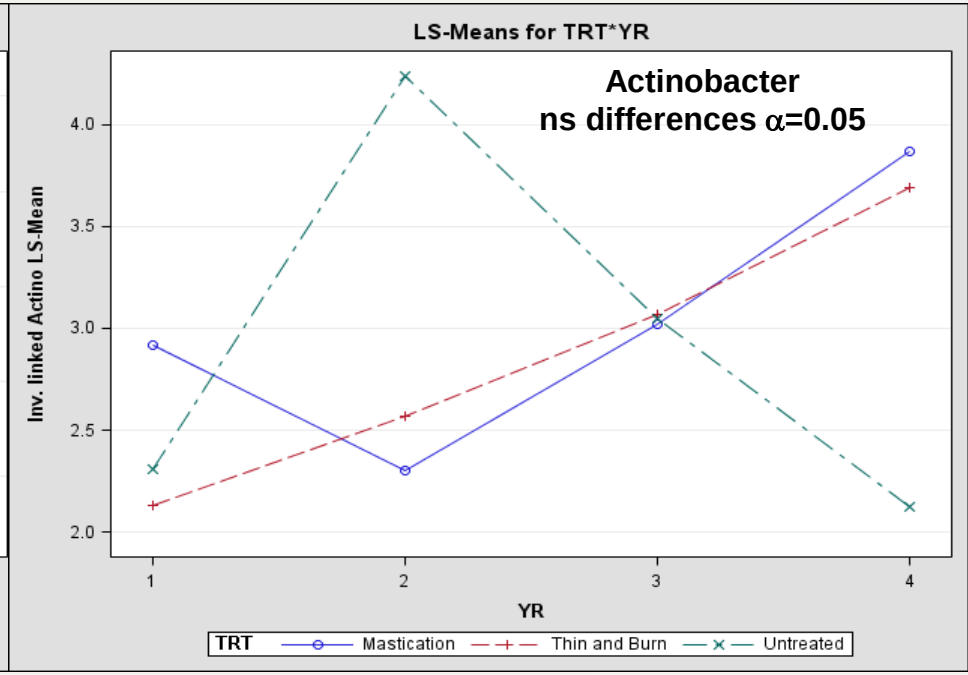
	Groups Included in Subset				Simultaneous evaluation Ho: groups are similar
	Mastication	Thin and Burn	Control	Single test p-value	Decision for alpha = 0.05
2005 Pre-treatment	1	1	0	ns	accept
	1	0	1	ns	accept
	0	1	1	ns	accept
2006 Post-treatment	1	1	0	0.0452	reject
	1	0	1	0.0011	reject
	0	1	1	2.38E-04	reject
2007 Post-treatment	1	1	0	4.81E-07	reject
	1	0	1	1.11E-06	reject
	0	1	1	0.0054	reject
2008 Post-treatment	1	1	0	3.54E-04	reject
	1	0	0	1.45E-07	reject
	0	1	1	7.10E-04	reject

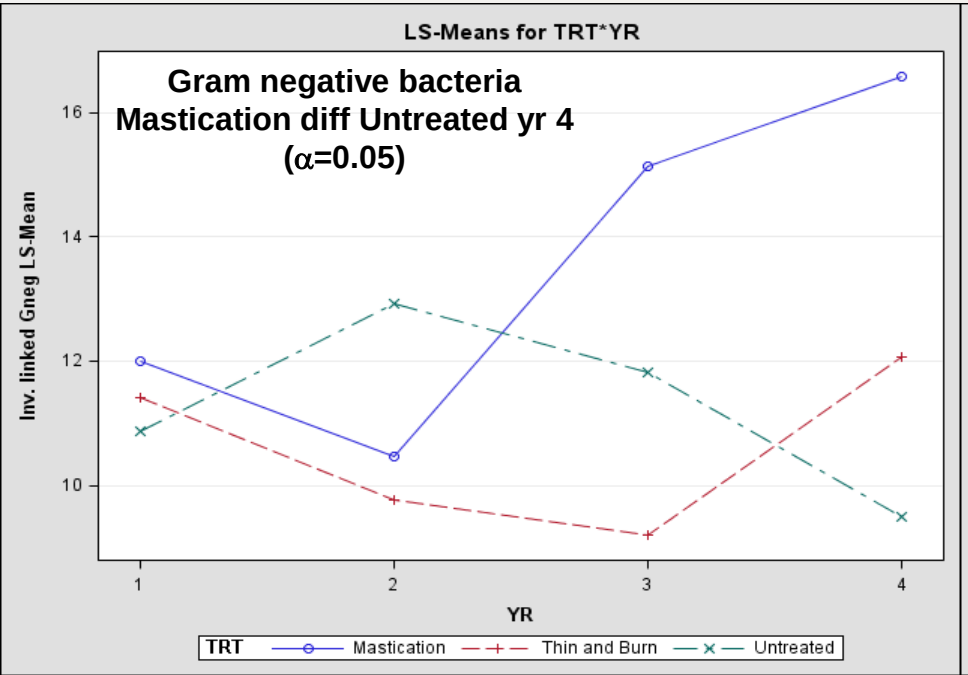
Fungal : Bacterial Ratio

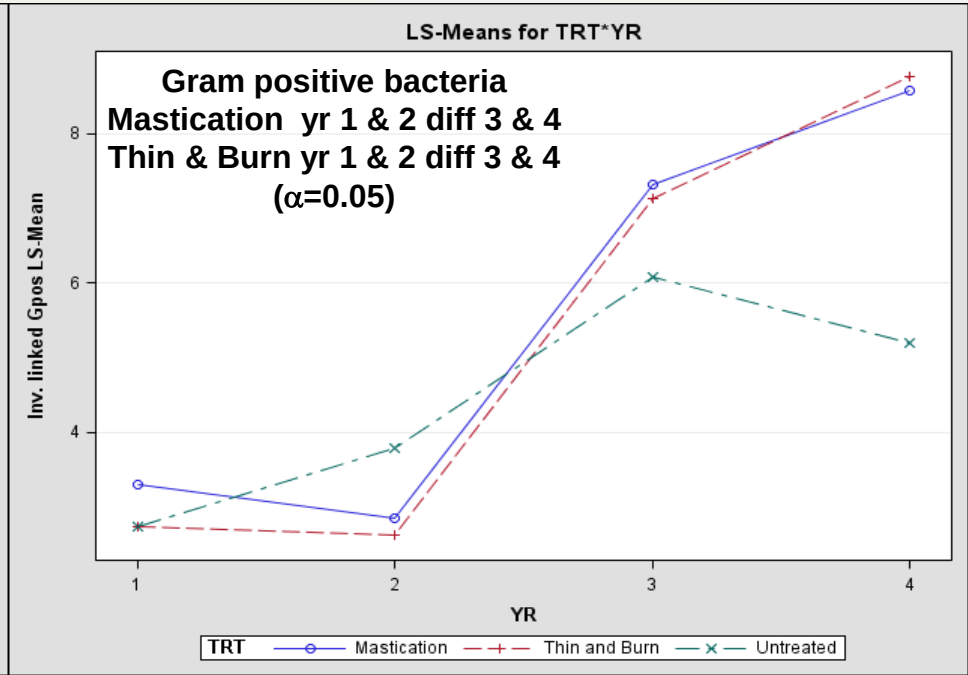


Microbial biomass by Group based on PLFA (nmol / g 0-5 cm mineral soil)









Microbial Dynamics

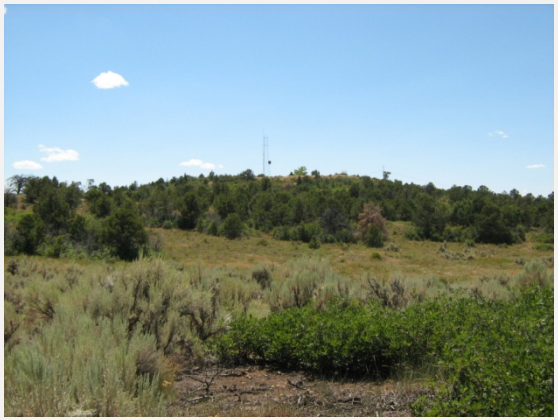
- **Fuel reduction treatments altered the microbial populations for all post-treatment years, yet the results are somewhat confounded by annual climate variation.**

- **Fungal:Bacterial ratios were not altered by treatments, yet the second and third years post-treatment where different than the first two years.**

- **Gram-negative bacteria in the mastication showed the greatest difference post-treatment during the dry summer of 2008. This may be a reflection of greater soil moisture due to greater ground cover created by masticated material on the soil surface.**

Multi-response Permutation Procedure of understory frequency, SW Colorado P-J sites

	Groups Included in Subset				Simultaneous evaluation Ho: groups are similar
	May Canyon	School	Summit	Single test p-value	Decision for alpha = 0.05
2005 Pre-treatment	1	1	0	ns	reject
	1	0	1	ns	accept
	0	1	1	ns	reject



May Canyon

School

Summit

Multi-response Permutation Procedure of understory frequency for May Canyon and Summit, SW Colorado P-J sites

	Groups Included in Subset				Simultaneous evaluation Ho: groups are similar
	Mastication	Thin and Burn	Unthinned	Single test p-value	Decision for alpha = 0.05
May Canyon Post-treatment	1	1	0	0.1	reject
	1	0	1	0.1	reject
	0	1	1	0.1	reject
Summit Post-treatment	1	1	0	0.0452	reject
	1	0	1	0.0011	reject
	0	1	1	2.38E-04	reject

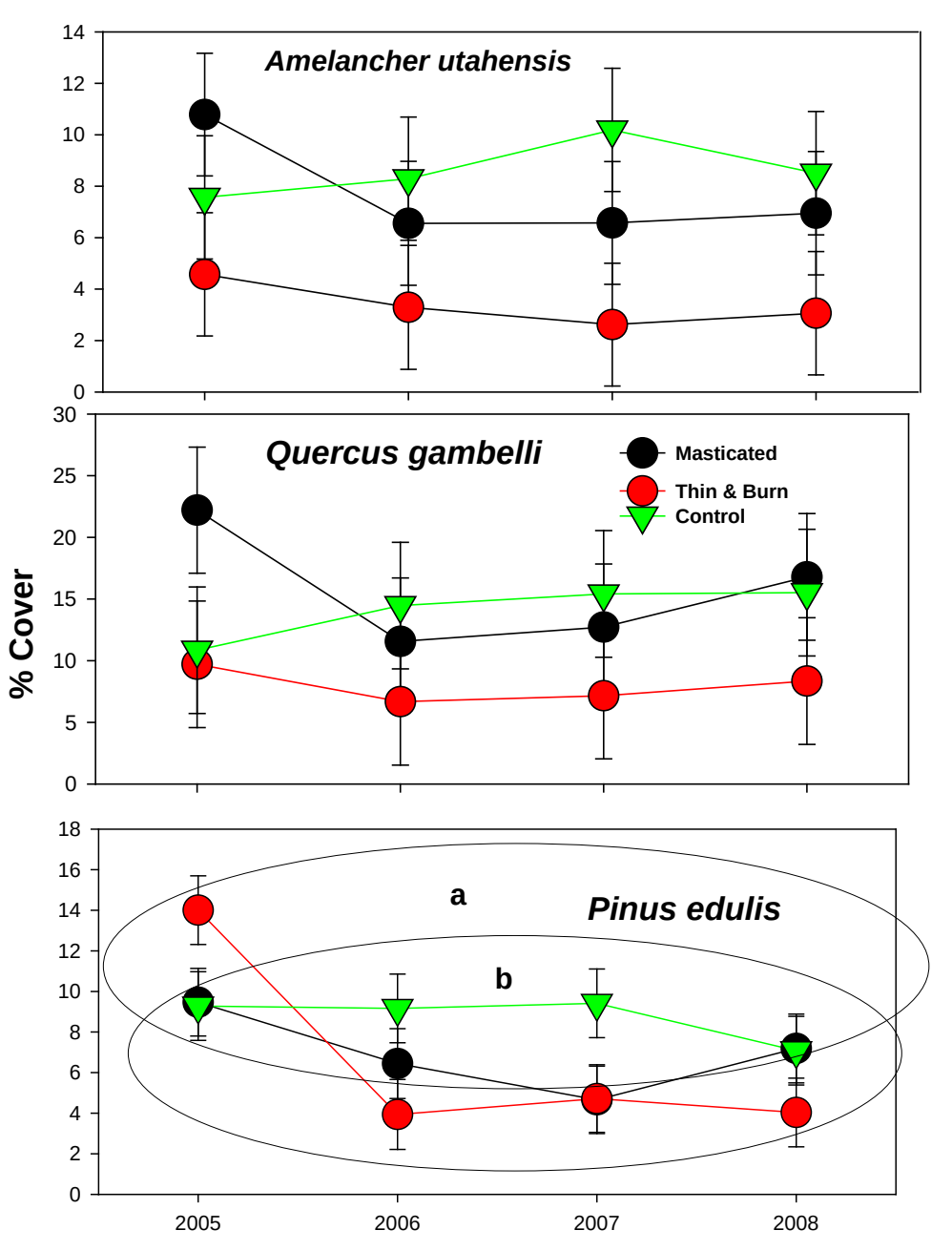
Cheatgrass Post-treatment

		May		School		Summit	
		frequency	**% increase**	**frequency**	**% increase**	**frequency**	**% increase**
2005	Untreated	212		45		11	
2006	Untreated	146		30		6	
2007	Untreated	218		36		7	
2008	Untreated	152	81	60	93	15	85
2005	Mastication	119		49		152	
2006	Mastication	138		40		146	
2007	Mastication	140		47		179	
2008	Mastication	119	111	112	135	149	104
2005	Thin & Burn	31		1		1	
2006	Thin & Burn	103		13		3	
2007	Thin & Burn	115		11		27	
2008	Thin & Burn	113	**356**	57	**2700**	11	**1367**

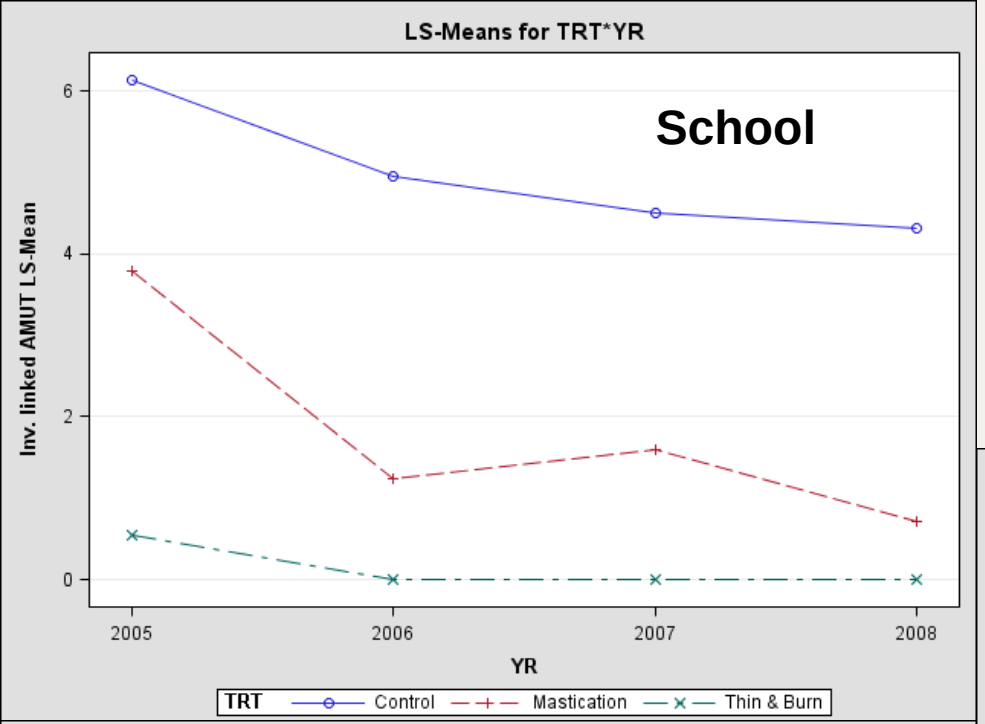
Thin & Burn treatment (August 2009) at Summit

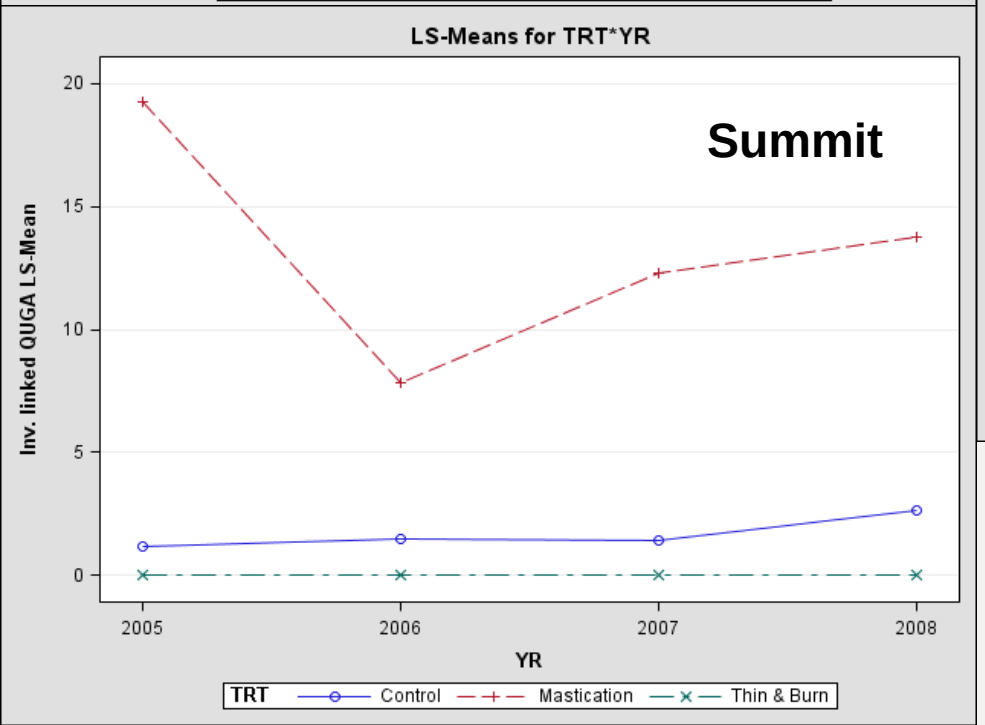
Thin & Burn treatment (August 2009) at Summit

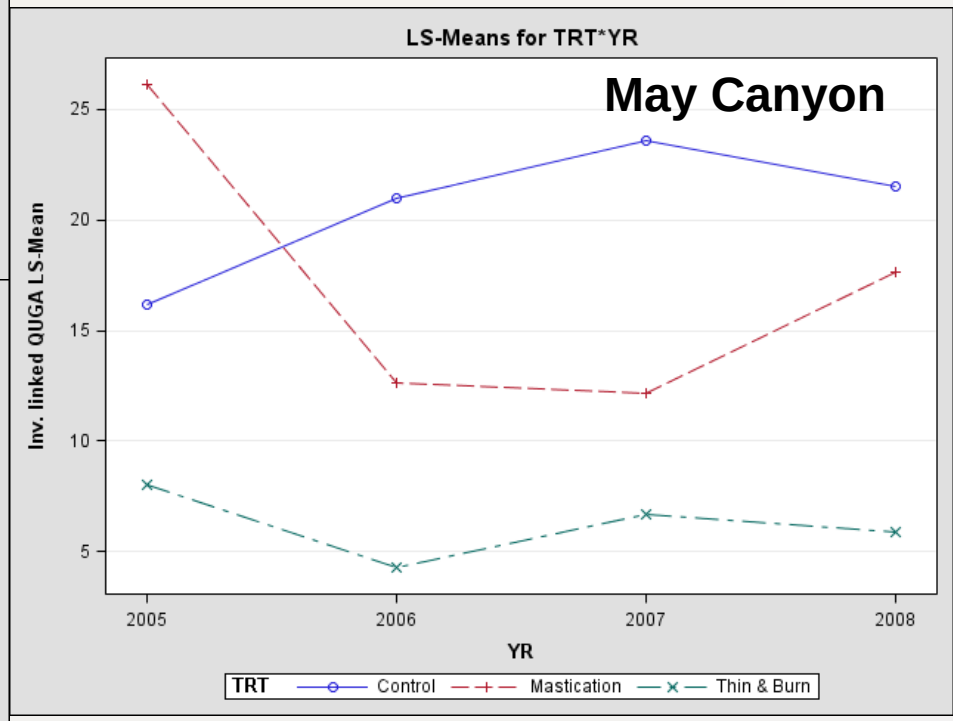
% cover by major species



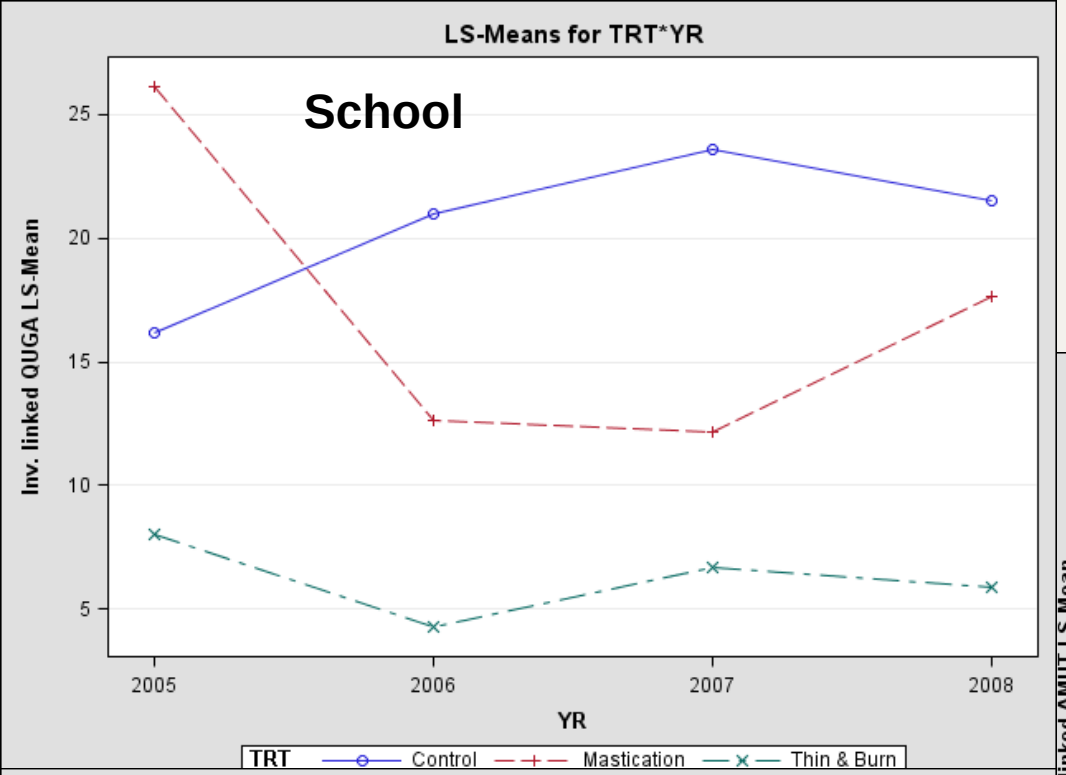
Gambel Oak

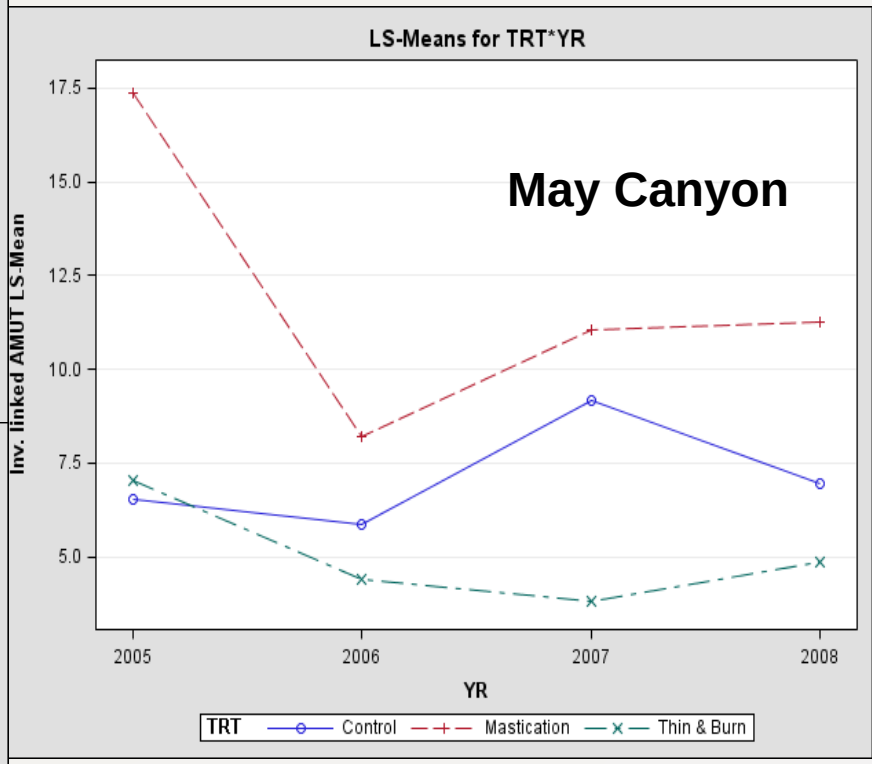

LS-Means for TRT*YR
School
Inv. linked AMUT LS-Mean
6
4
2
0
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn

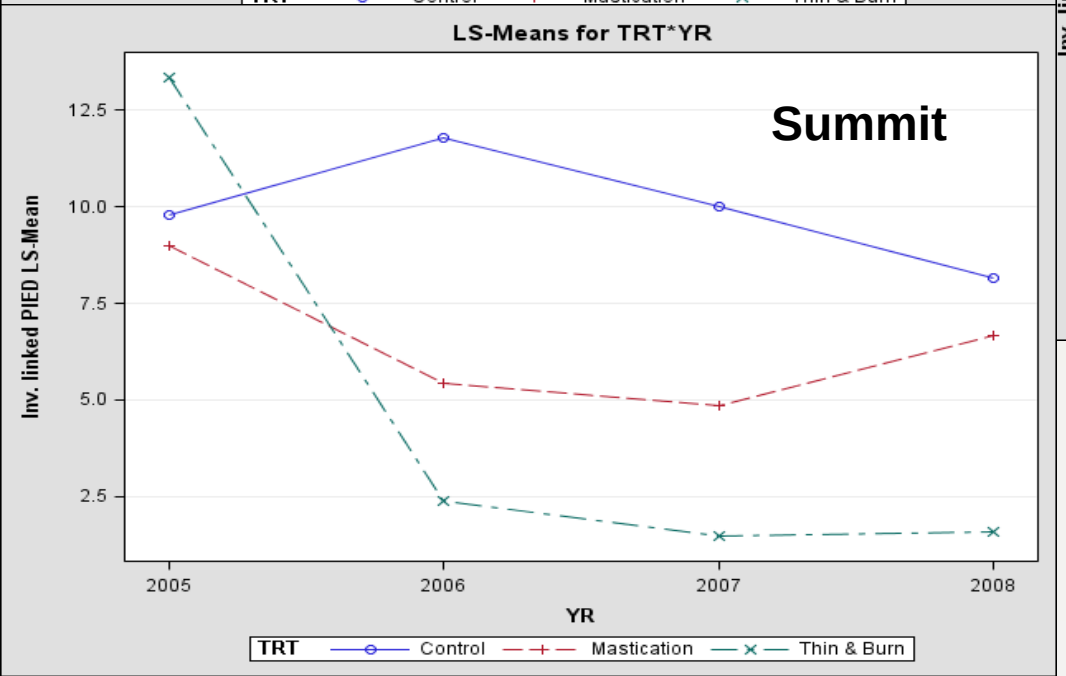

LS-Means for TRT*YR
Summit
Inv. linked QUGA LS-Mean
20
15
10
5
0
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn


LS-Means for TRT*YR
May Canyon
Inv. linked QUGA LS-Mean
25
20
15
10
5
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn

Pinyon


LS-Means for TRT*YR
School
Inv. linked QUGA LS-Mean
25
20
15
10
5
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn


LS-Means for TRT*YR
May Canyon
Inv. linked AMUT LS-Mean
17.5
15.0
12.5
10.0
7.5
5.0
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn


LS-Means for TRT*YR
Summit
Inv. linked PIED LS-Mean
12.5
10.0
7.5
5.0
2.5
2005
2006
2007
2008
YR
TRT
Control
Mastication
Thin & Burn

Mastication treatment (August 2009) at Summit

CONCLUSION

- Mastication altered carbon:nitrogen ratios in the litter layer, but not soil compared to controls or thinning and burning. This had no detectable influence on N mineralization in the upper mineral soil layer, and exerted little influence on the microbial population.

- Mastication did not alter the N mineralization rates in the soil (0-5 cm) compared to controls or thinning and burning

CONCLUSION

- **Cheatgrass frequency was most affected by thin and burn treatments, while mastication resulted in only small increase in frequency.**

- **Mastication resulted in decreases in Pinyon, Gambel Oak, and Utah Serviceberry cover estimates at all sites, though not significantly.**