Spatial Variability in Soil Microbial Communities in a Nitrogen-Saturated Hardwood Forest Watershed

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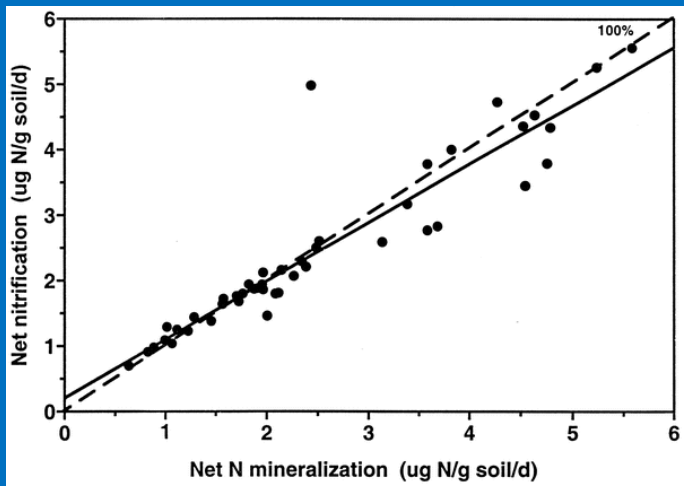
N saturation: Fernow Experimental Forest, West Virginia

- Stoddard (1994)
  - WS4 as classic example of Stage 3 N saturation
- Peterjohn et al. (1996)
  - cited seven symptoms of N saturation found on WS4 and treated WS3
- Gress et al. (2007)
  - confirmed that N limitation has given way to P limitation on several FEF watersheds
- Gilliam et al. (2001)
  - net nitrification as 100% of net N mineralization



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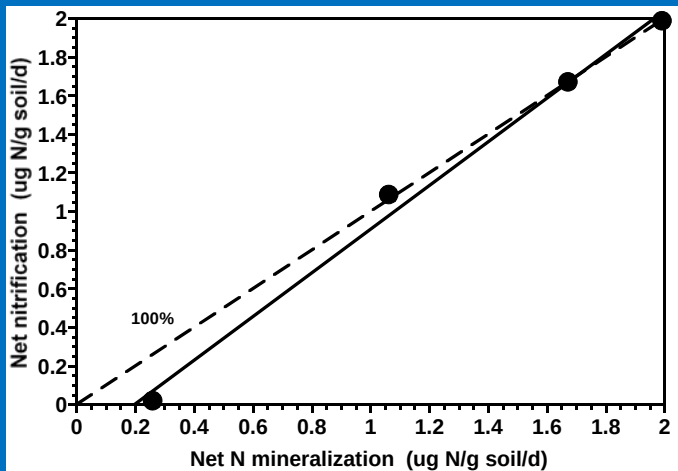
  - gradient in N processing, including sites in WS4



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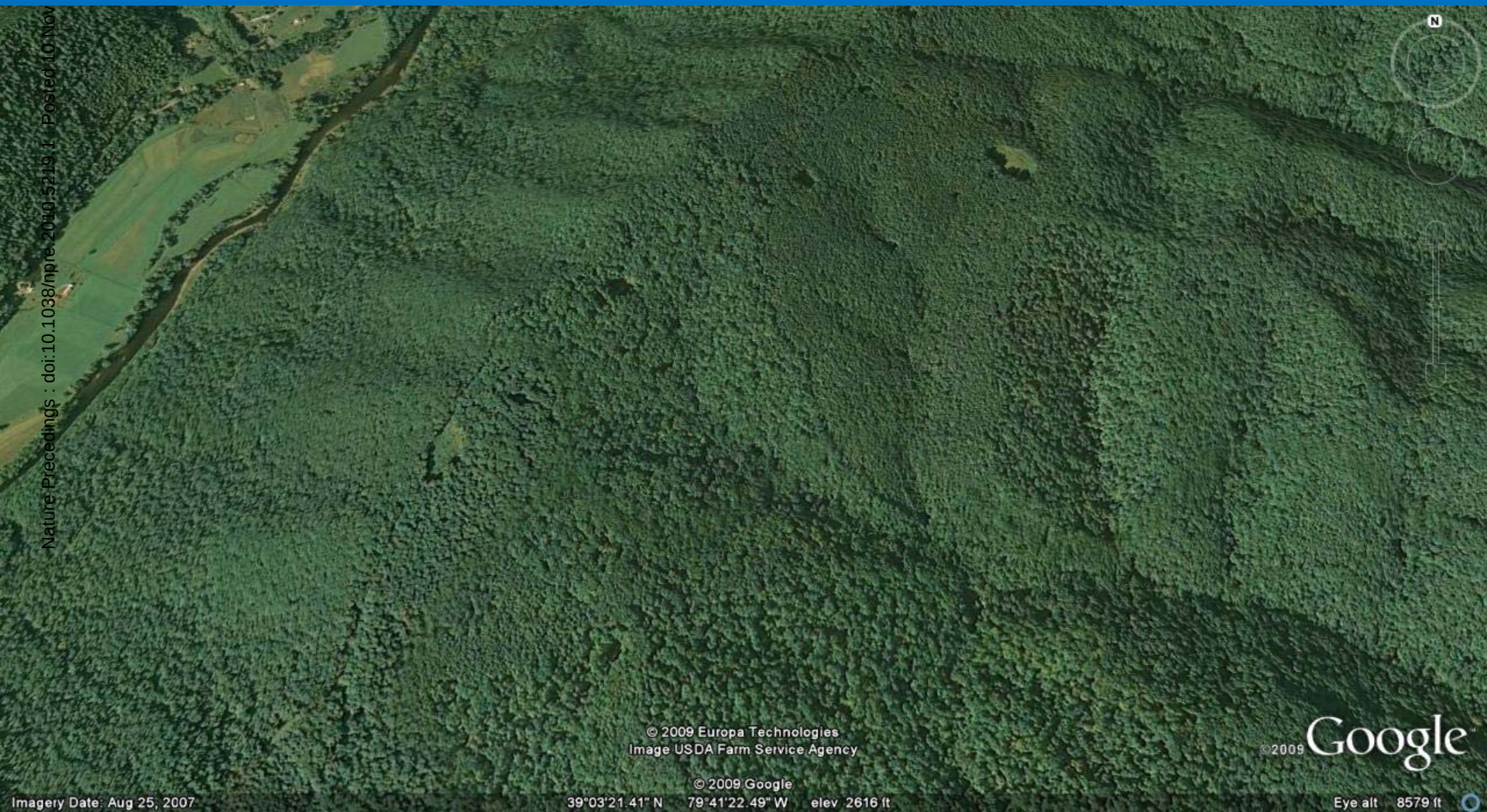

Fernow Experimental Forest , West Virginia

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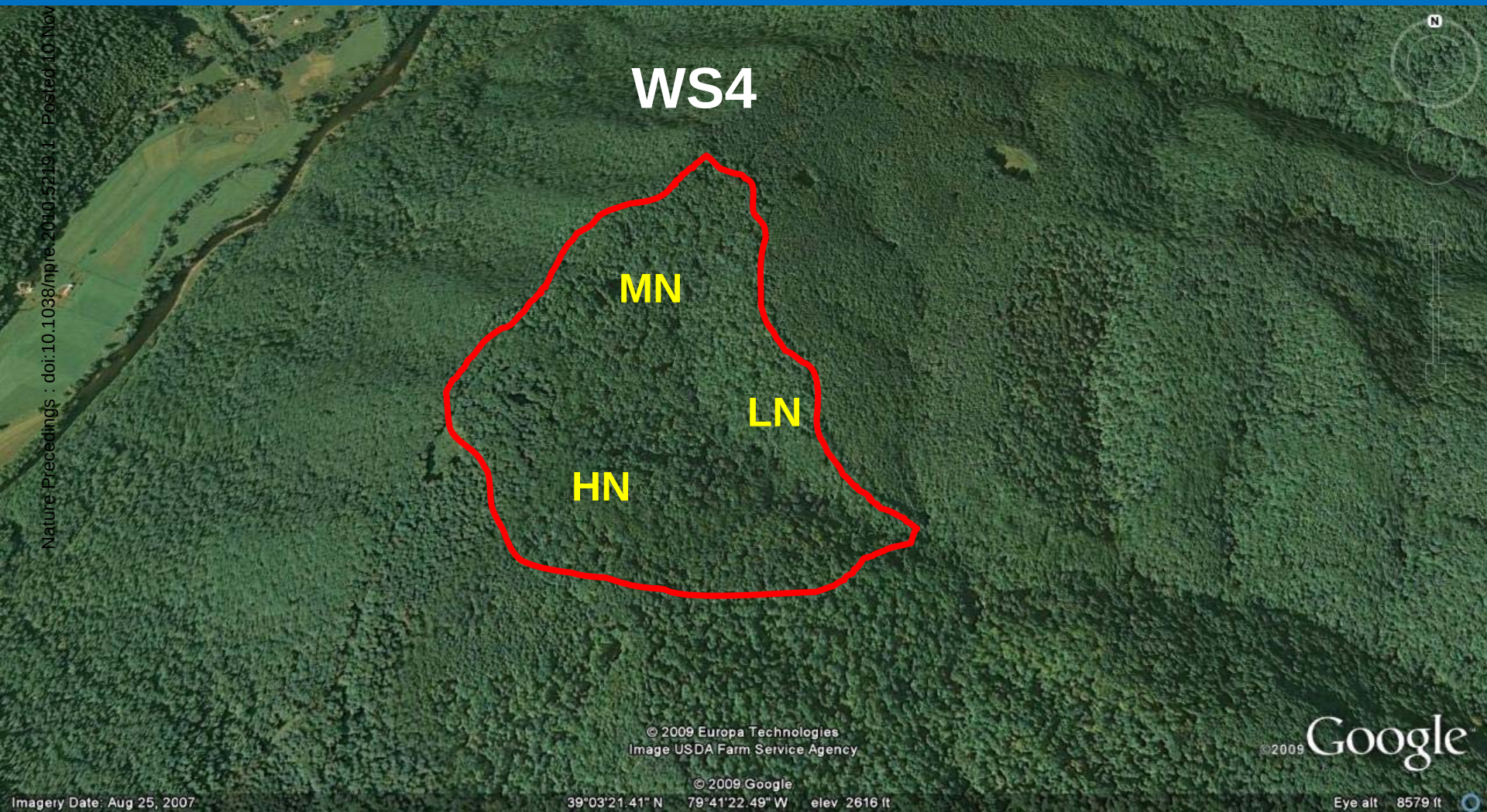
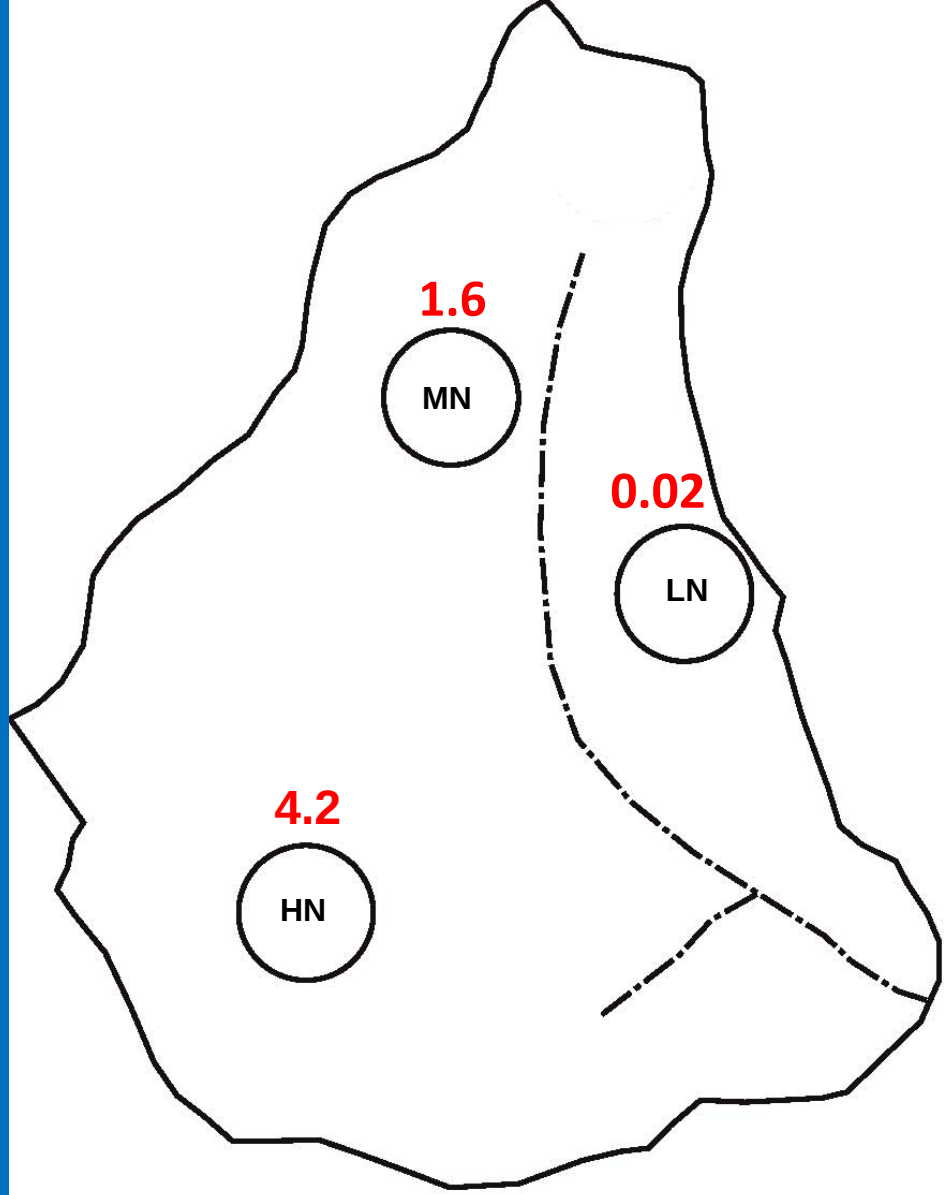


N gradient at Fernow Experimental Forest—WS4

In situ **nitrification**
(g N/m²/mo)



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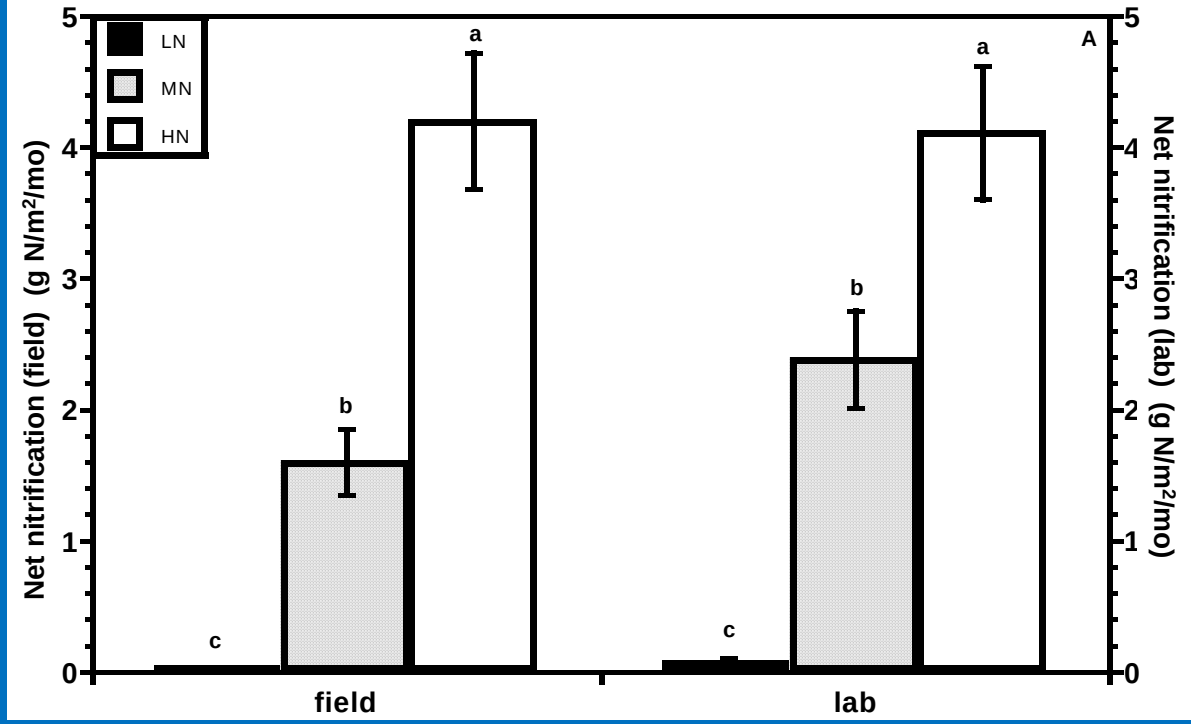

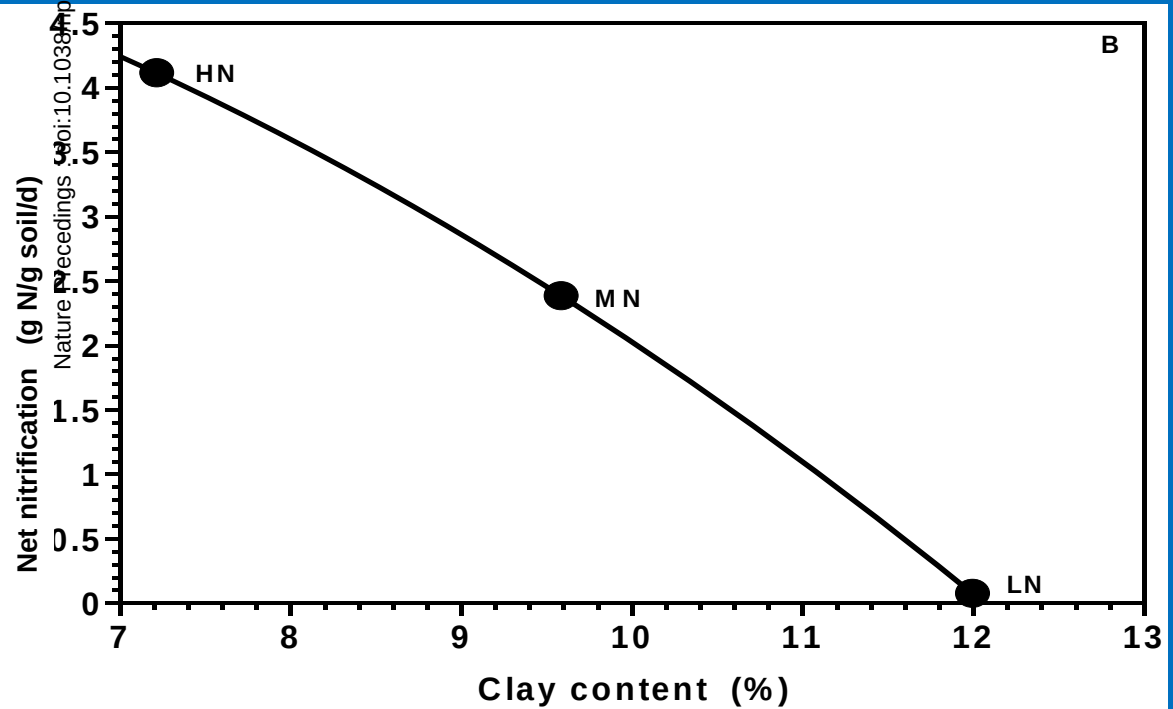

Purpose

Characterize microbial community composition in N-saturated soils

Questions

1) Do microbial composition and biomass vary along the weathering/clay/nitrate availability gradient of WS4?
2) What measured environmental factors best predict the observed variation in microbial community composition along the gradient?

Methods

- **Fernow Experimental Forest , West Virginia**

Great on hot dogs and French fries—see you at the ballgame Thursday night!

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- 3 sites within WS4 (~35 ha, control, >120 yr)

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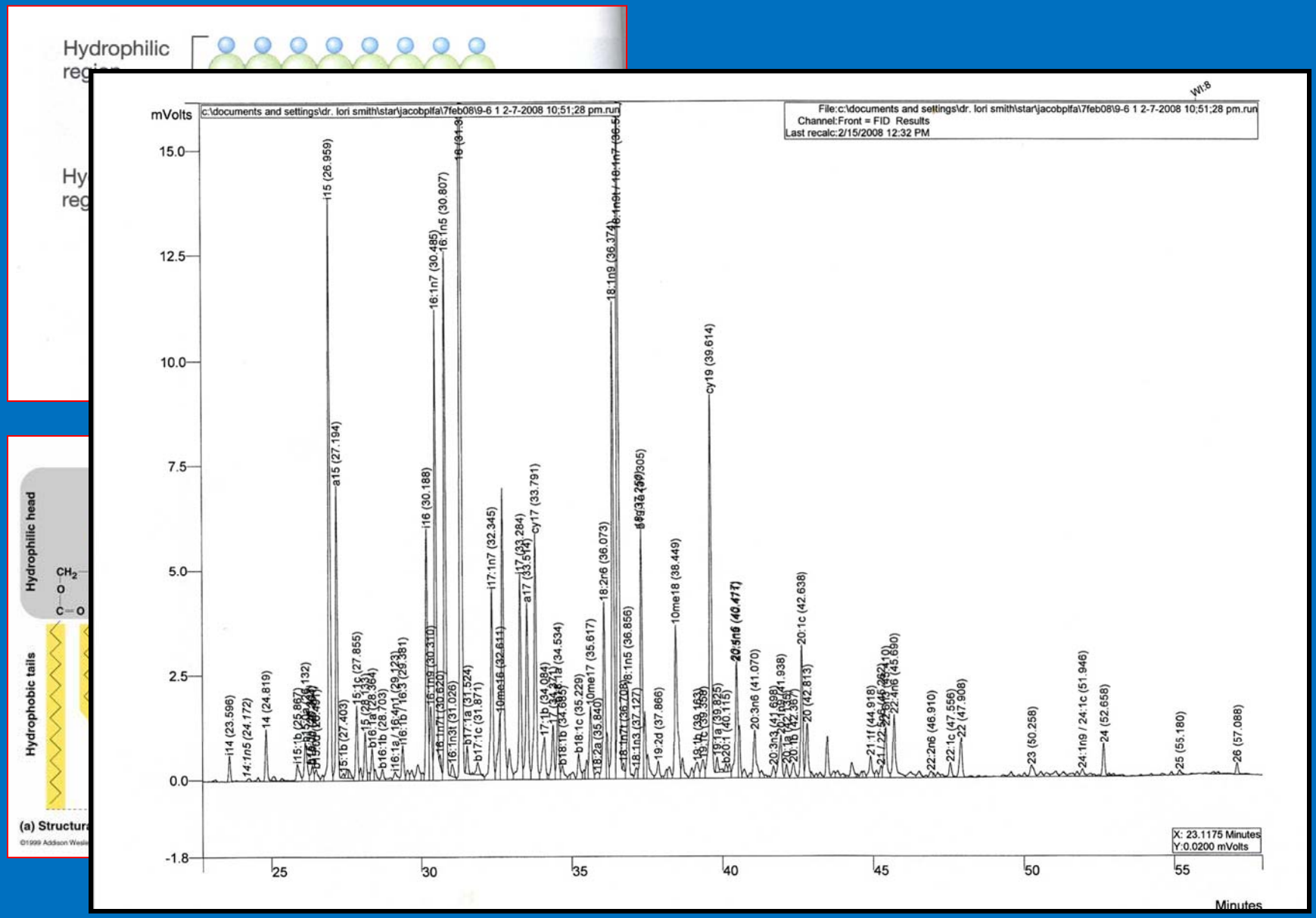
Phospholipid Fatty Acid analysis (PLFA)



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Methods

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- 3 sites within WS4 (~35 ha, control, >120 yr)
- At each site:
  - mineral soil taken to 5 cm depth
  - 3 samples taken randomly
- PLFA analysis for soil microbial community
- 1N KCl extraction/analysis for NH_4^+ and NO_3^-
- Moisture, pH_w, pH_s, organic matter
- Data analysis: ANOVA, CCA, NMDS (with environmental factor overlay)

Table 1. Site characteristics of study areas within WS4, Fernow Experimental Forest, West Virginia. Data are means (1 SE). Different letters denote significant differences (P<0.05) between sites.

Characteristic	Site		
	LN	MN	HN
Elevation (m)	808	838	833
Slope aspect (°)	240	120	70
Clay (%)	12.0 ± 1.1[a]	9.6 ± 0.1[b]	7.2 ± 0.5[c]
Organic matter (%)	44.5 ± 13.8[a]	22.8 ± 1.3[a]	20.1 ± 2.4[a]
Moisture (%)	57.4 ± 7.1[a]	42.3 ± 0.8[b]	41.8 ± 2.0[b]
pHw	4.18 ± 0.20[b]	5.01 ± 0.13[a]	4.61 ± 0.10[ab]
pHs	3.10 ± 0.20[b]	3.96 ± 0.12[a]	3.89 ± 0.04[a]
Extractable NH_4 (µg N/g soil)	118.7 ± 29.4[a]	89.2 ± 2.7[a]	80.2 ± 14.2[a]
Extractable NO_3 (µg N/g soil)	0.0 ± 0.0[b]	2.4 ± 0.4[b]	21.1 ± 6.0[a]
Fungal:bacterial ratio	24.2 ± 6.3[a]	10.9 ± 0.4[b]	12.1 ± 0.5[ab]
Microbial biomass (nmol g^{-1} soil)	530 ± 128[a]	386 ± 27[a]	399 ± 47[a]

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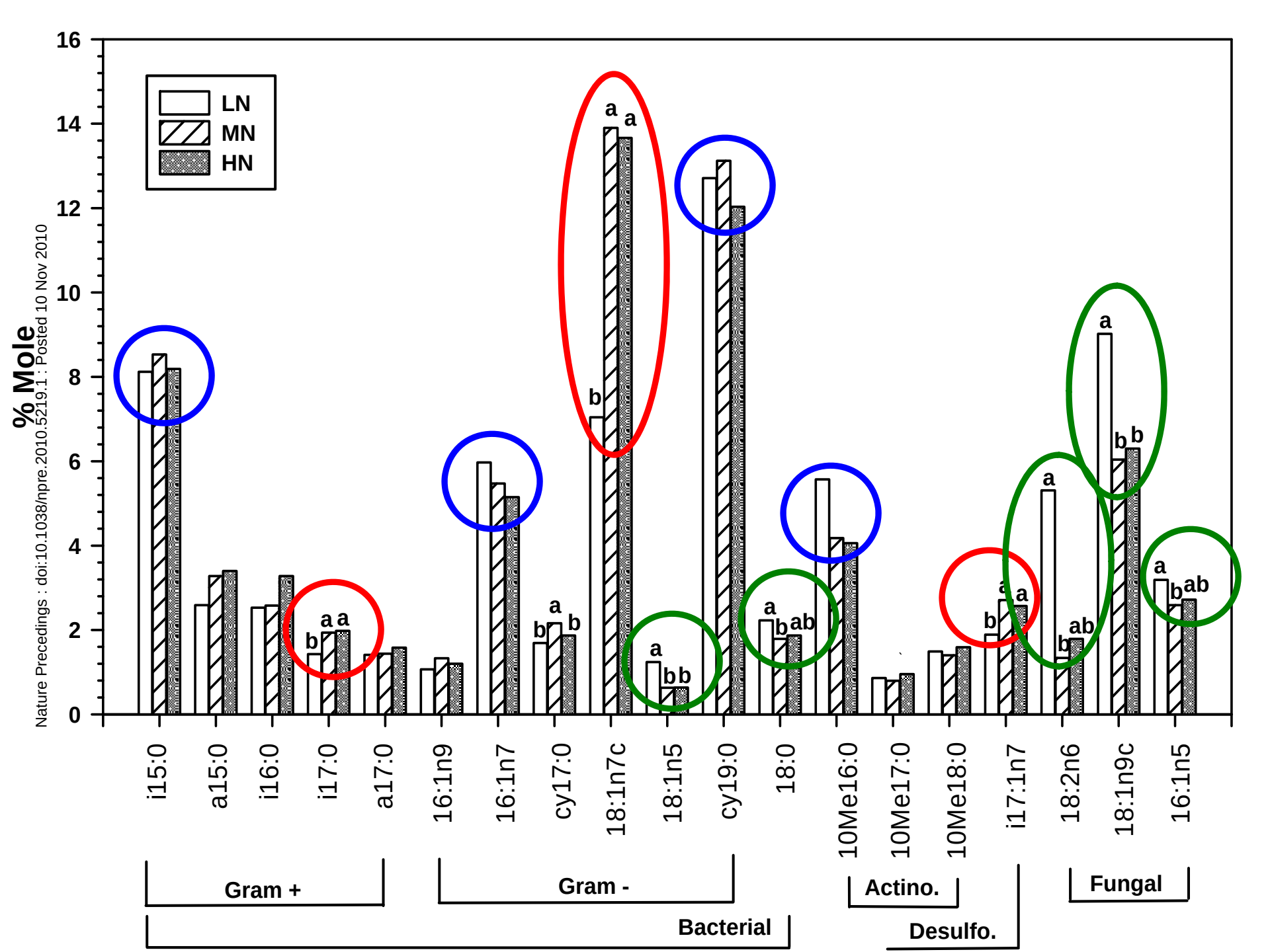

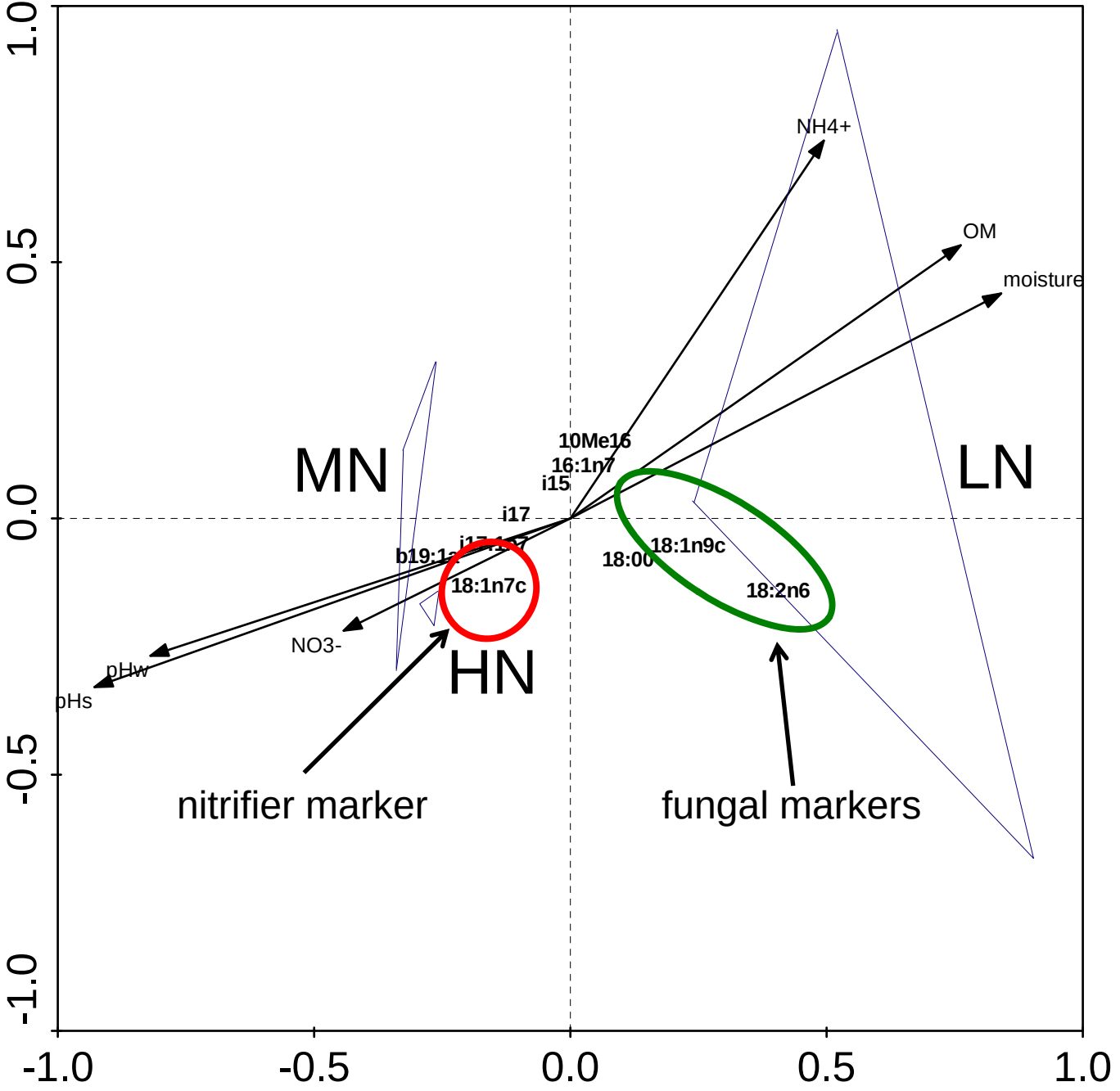

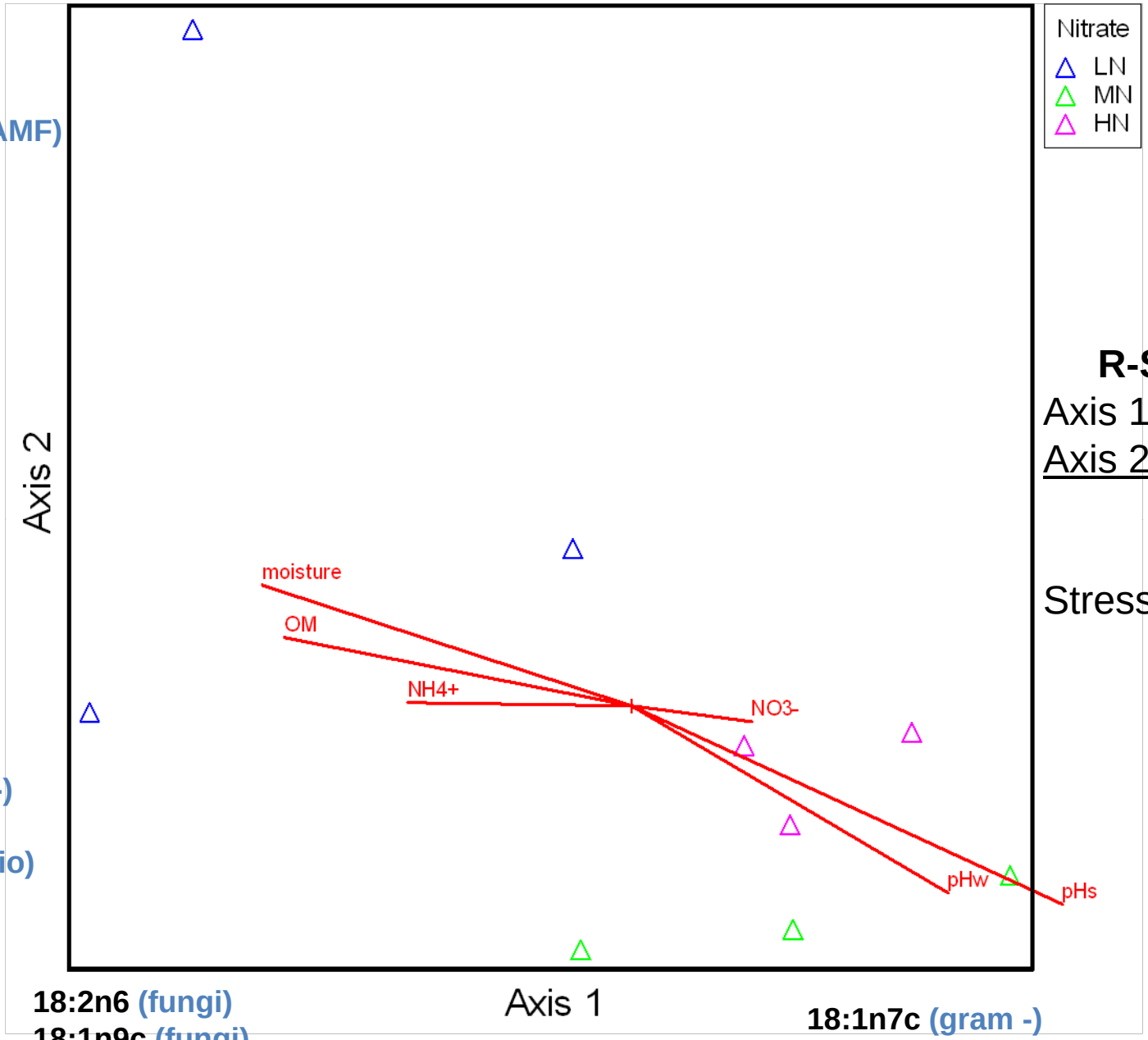

18:2n6 (fungi)
18:1n9c (fungi)
16:1n5 (gram-, AMF)
18:1n5 (gram -)

i17 (gram +)
cy17 (gram -)
i17:1n7c (desulfovibrio)

18:2n6 (fungi)
18:1n9c (fungi)

18:1n7c (gram -)
b19:1 (bacteria)
16:1n9 (bacteria)

R-Square

Axis 1	0.837
Axis 2	0.124
	0.962

Stress: 1.10

Conclusions

- ANOVA and CCA/NMDS demonstrate great variability in microbial community composition among sites

Predominance of fungal markers (18:2n6 and 18:1n9c) at the most weathered LN site and Gram – bacteria (18:1n7c) at the less weathered MN and HN sites

Multivariate analyses with environmental parameters and PLFA data suggest that acidic conditions at the LN site have selected for fungal dominance, possibly leading to low nitrate abundance

Other important factors known to exert influence on soil microbial communities, such as differences in plant community, and clay and organic matter content, may also be playing a role in determining the observed patterns

This just in

Gilliam FS, RL McCulley, and JA Nelson. 2010. Spatial variability in soil microbial communities in a nitrogen-saturated hardwood forest watershed. *Soil Science Society of America Journal* 74: in press.