Variability in imaging spectroscopy data across aspen stands is due to differences in genotype and foliar biochemistry.

Phil Townsend[1], Mike Madritch[2], Clayton Kingdon[1], Aditya Singh[1],Karen Mock[3] and Rick Lindroth[1]

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Source: USGS

Source: Wikimedia Commons, photo by Mark Muir

ELSEVIER

Forest Ecology and Management

Available online 29 January 2013

In Press, Corrected Proof — Note to users

Recent declines of *Populus tremuloides* in North America linked to climate

James J. Worrall[a], Gerald E. Rehfeldt[b], Andreas Hamann[c], Edward H. Hogg[d], Suzanne B. Marchetti[a], Michael Michaelian[d], Laura K. Gray[c]

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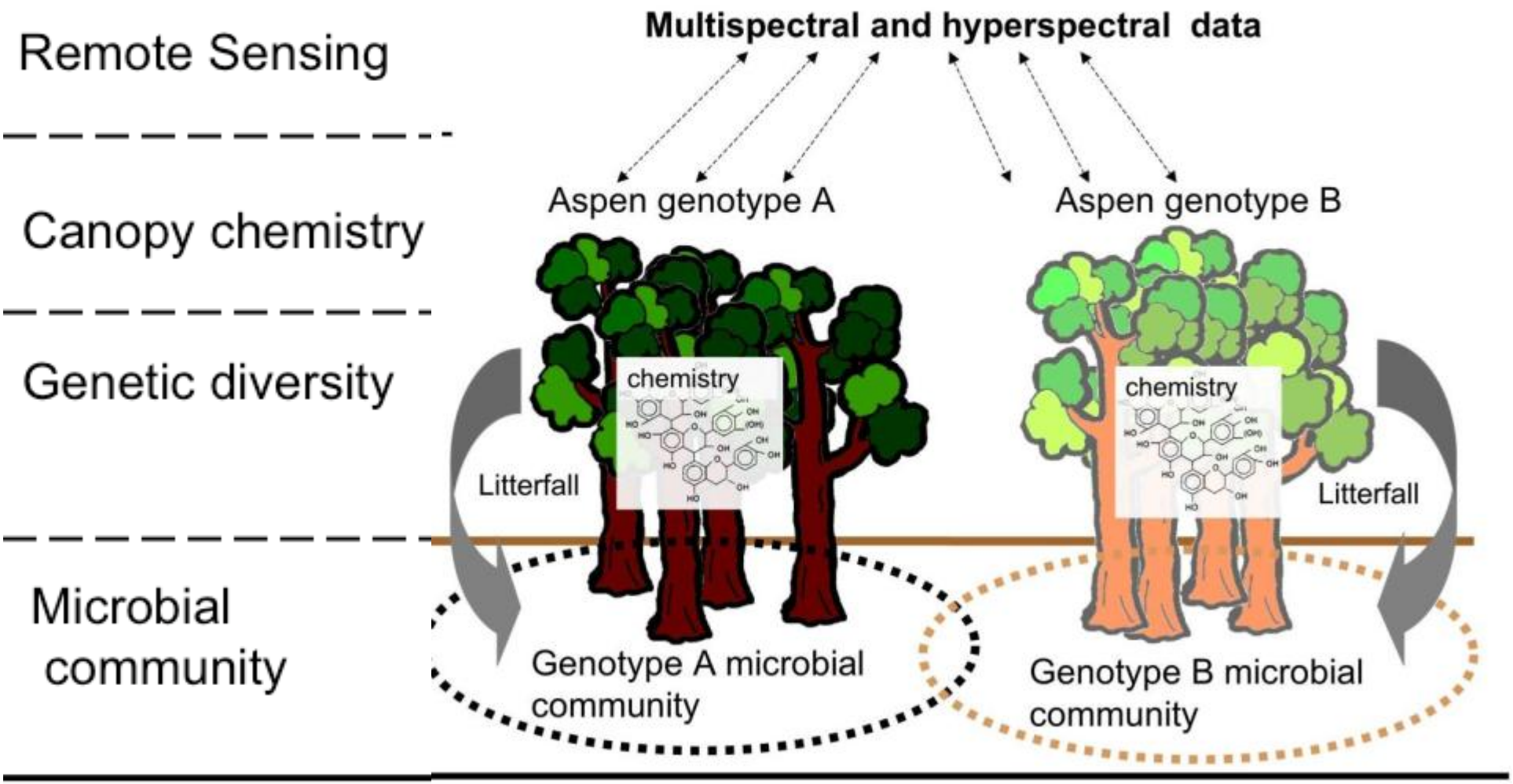
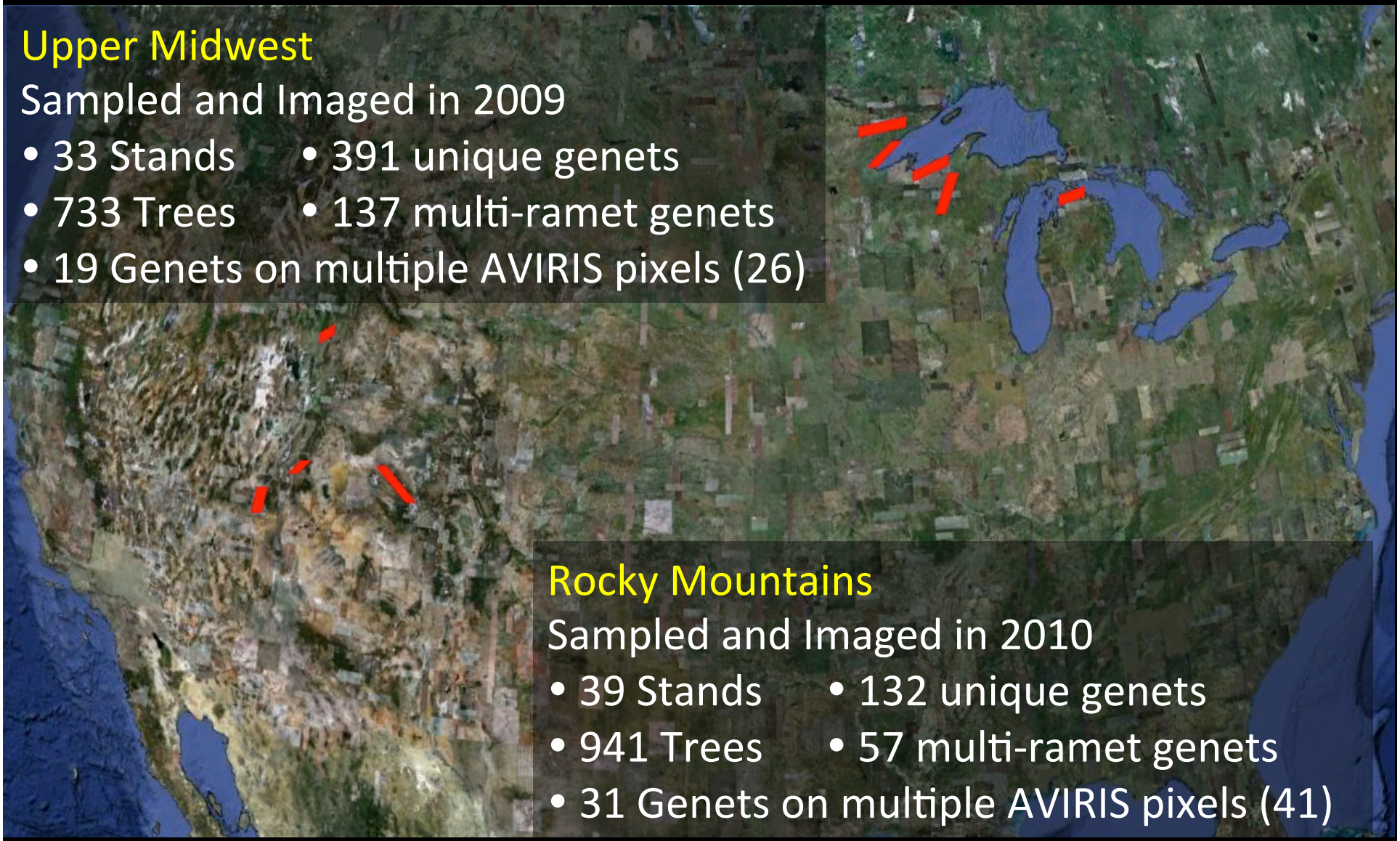
[b] US Forest Service, Rocky Mountain Research Station, Moscow, ID 83843, USA

[c] University of Alberta, Dept. of Renewable Resources, Edmonton, Alberta, Canada T6G 2H1

[d] Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta, Canada T6H 3S5


Remote Sensing
Canopy chemistry
Genetic diversity
Microbial community
Multispectral and hyperspectral data
Aspen genotype A
Aspen genotype B
chemistry
chemistry
Litterfall
Litterfall
Genotype A microbial community
Genotype B microbial community


Upper Midwest
Sampled and Imaged in 2009
• 33 Stands
• 391 unique genets
• 733 Trees
• 137 multi-ramet genets
• 19 Genets on multiple AVIRIS pixels (26)
Rocky Mountains
Sampled and Imaged in 2010
• 39 Stands
• 132 unique genets
• 941 Trees
• 57 multi-ramet genets
• 31 Genets on multiple AVIRIS pixels (41)


F107
F110
F109
F106
F108
F121
F101
F123
F122
F102
F124
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F117
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F120
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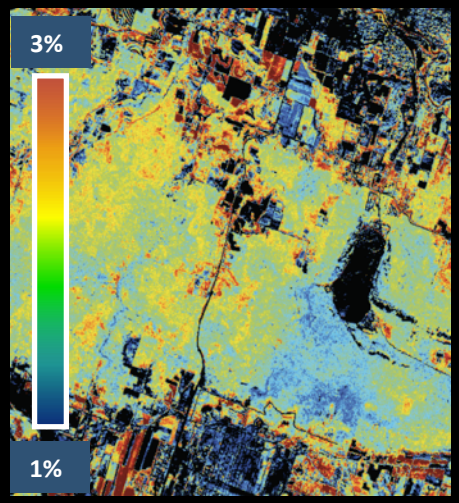
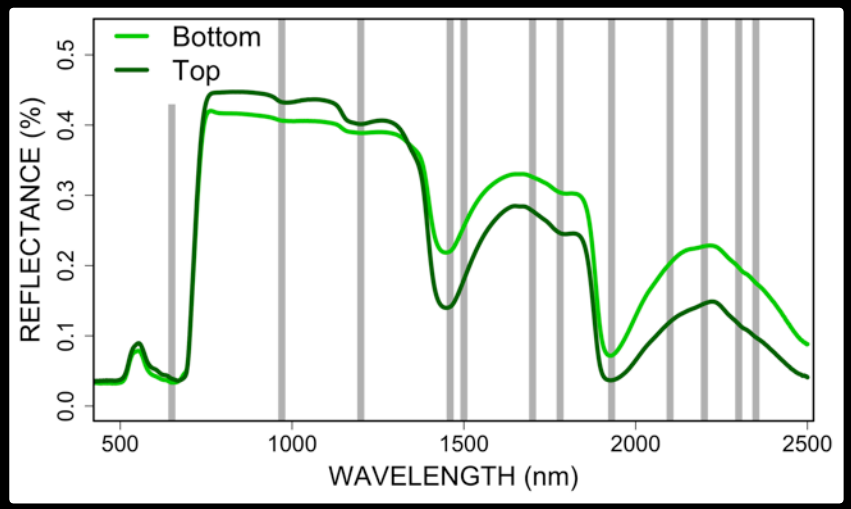
© 2012 Google
154 m
Google earth

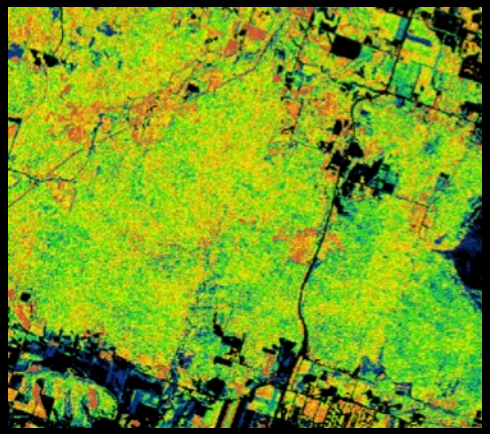
Foliar Nitrogen

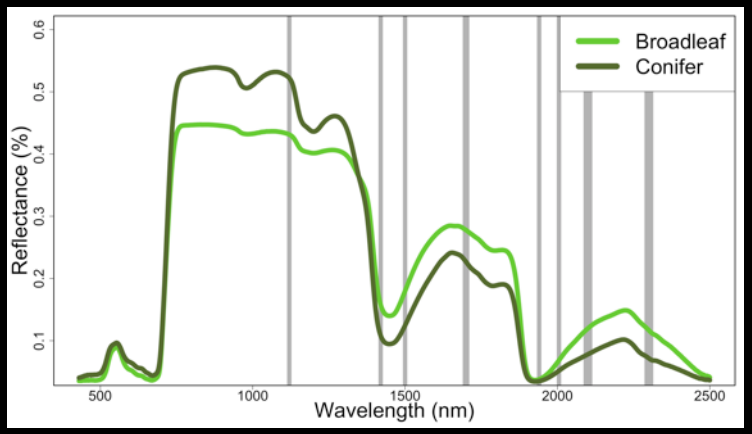
-photsynthetic capacity

Highly variable in aspen:
1.13%-3.72%









Foliar Lignin

-regulates liquid transport
-recalcitrant (decomposition)

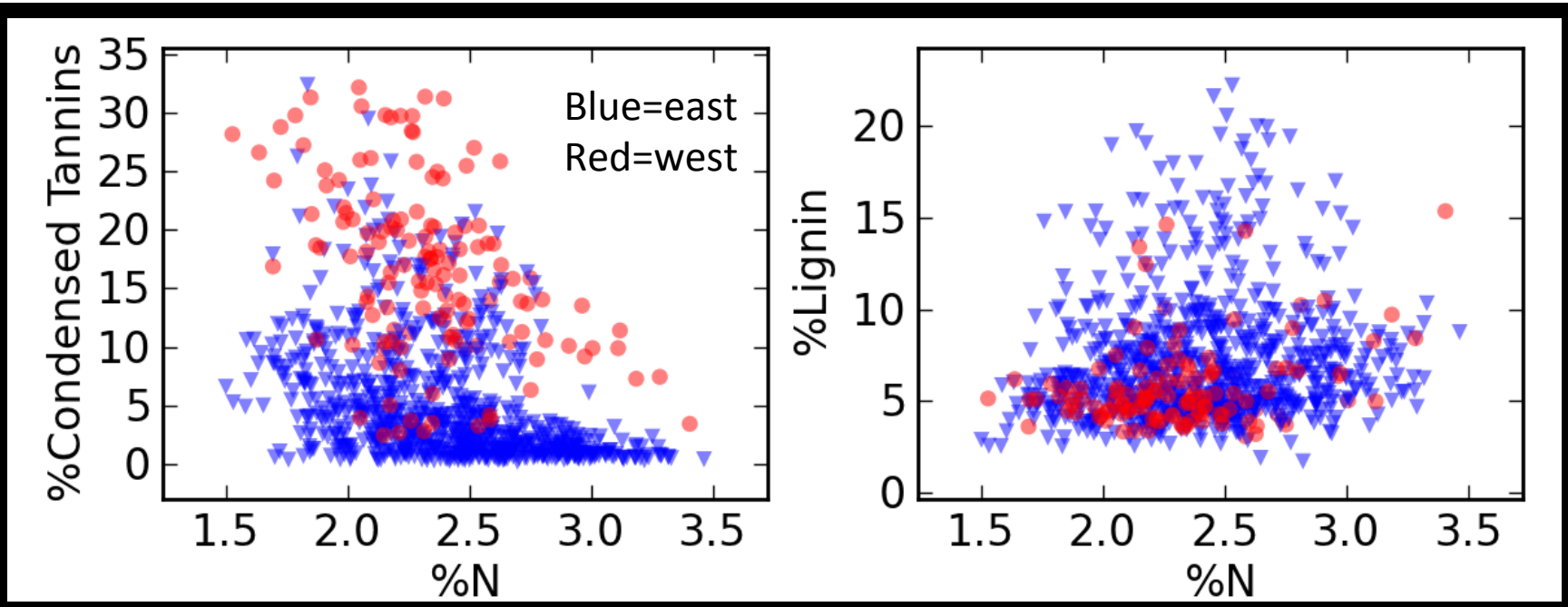
1.47%-22.21%

Condensed Tannins

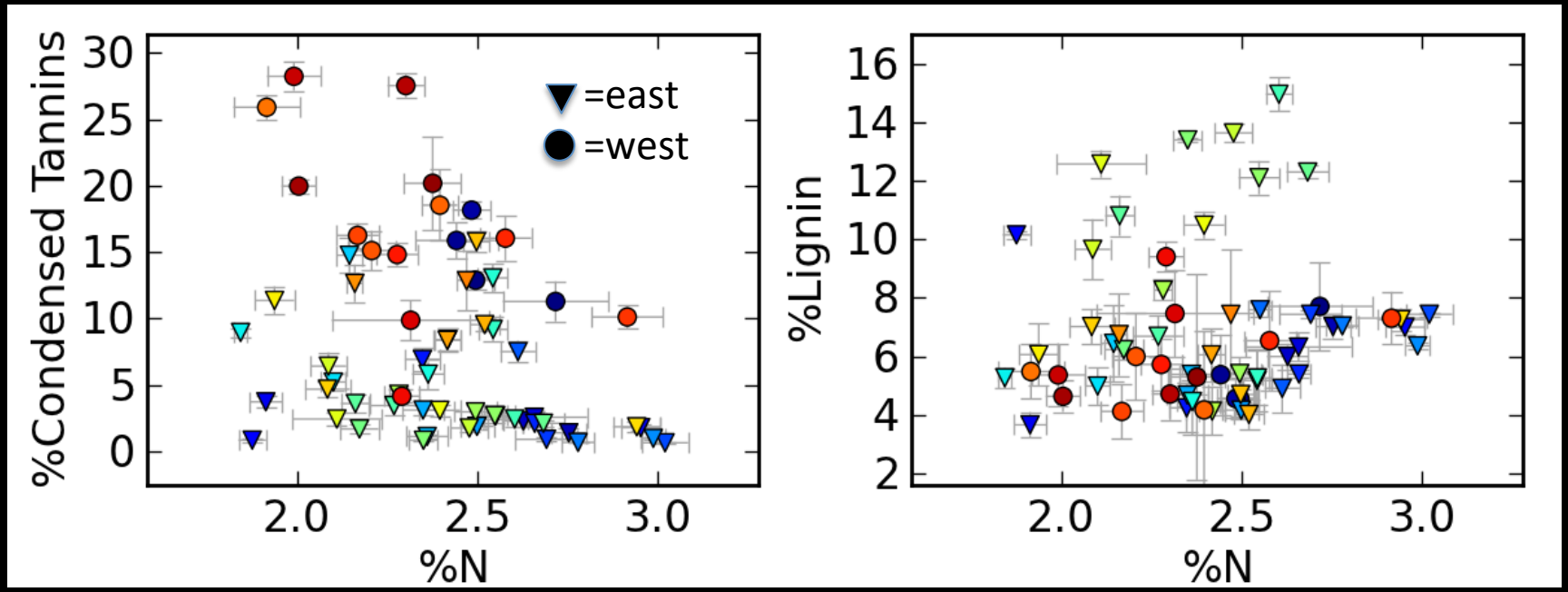
-secondary metabolite
-variability not fully understood

0.20%-30.34%

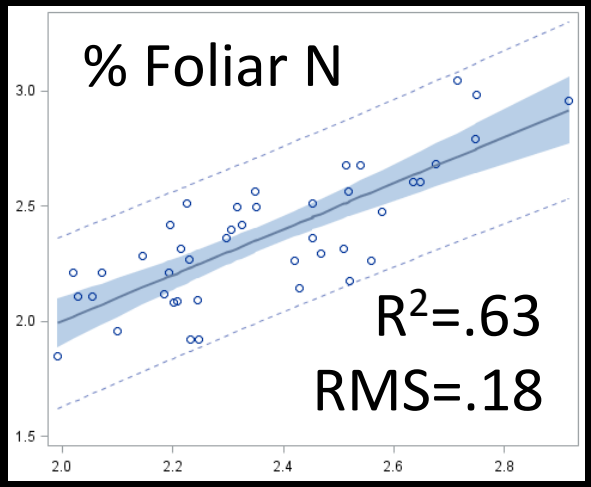
- Strongly influence belowground processes
- Affect soil microbes (decrease respiration)
- Slow decomposition
- Reduce N mineralization rates
- Chelate metals

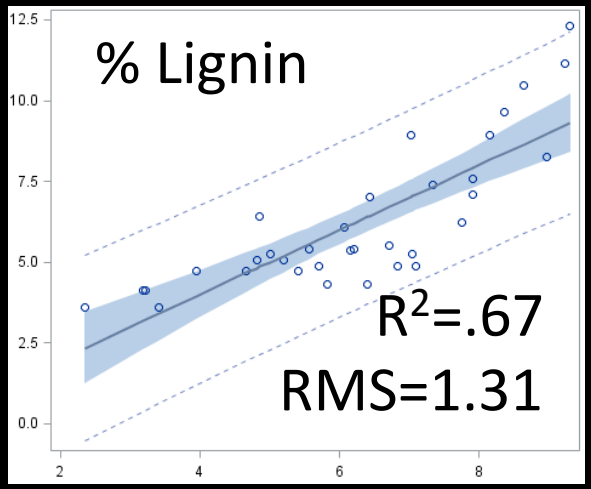


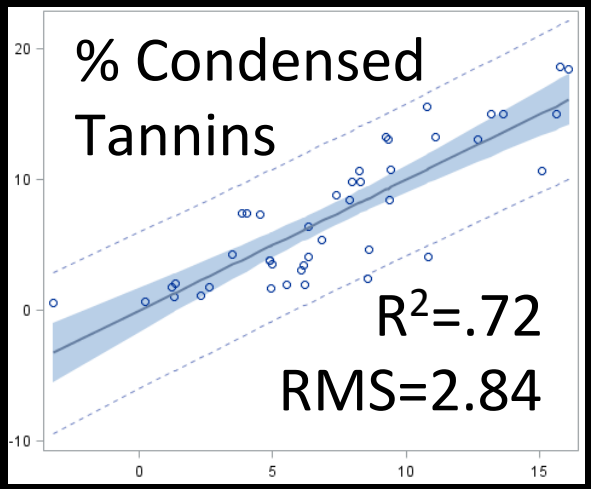
Variations in Foliar Chemistry

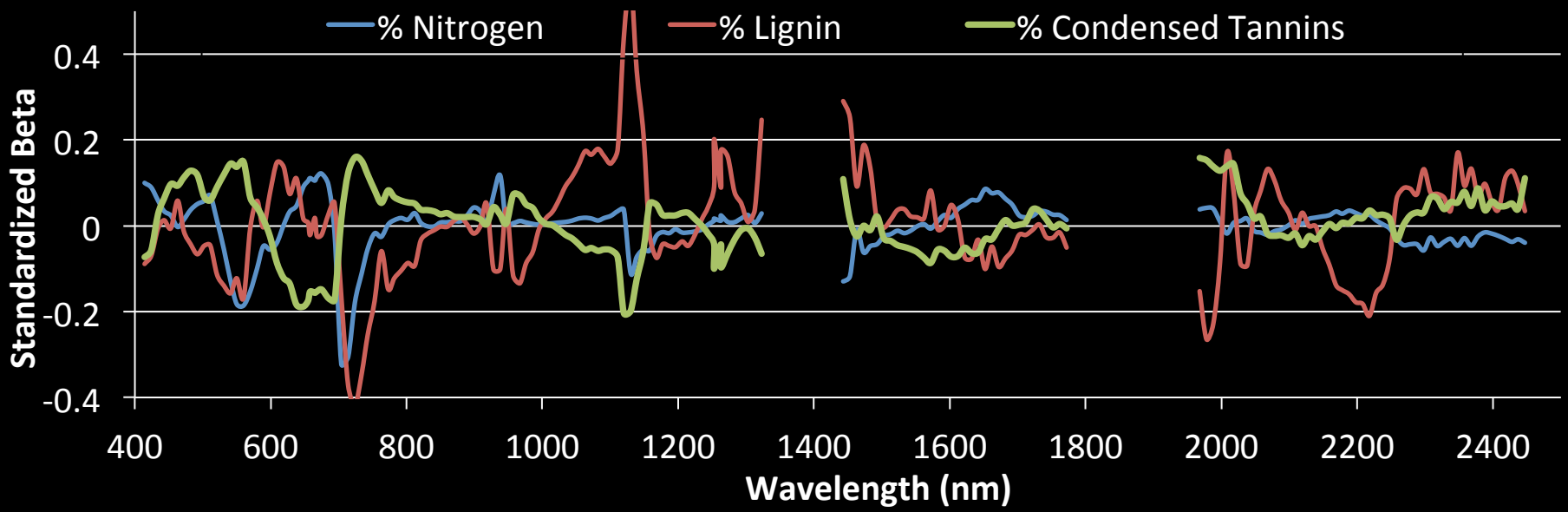


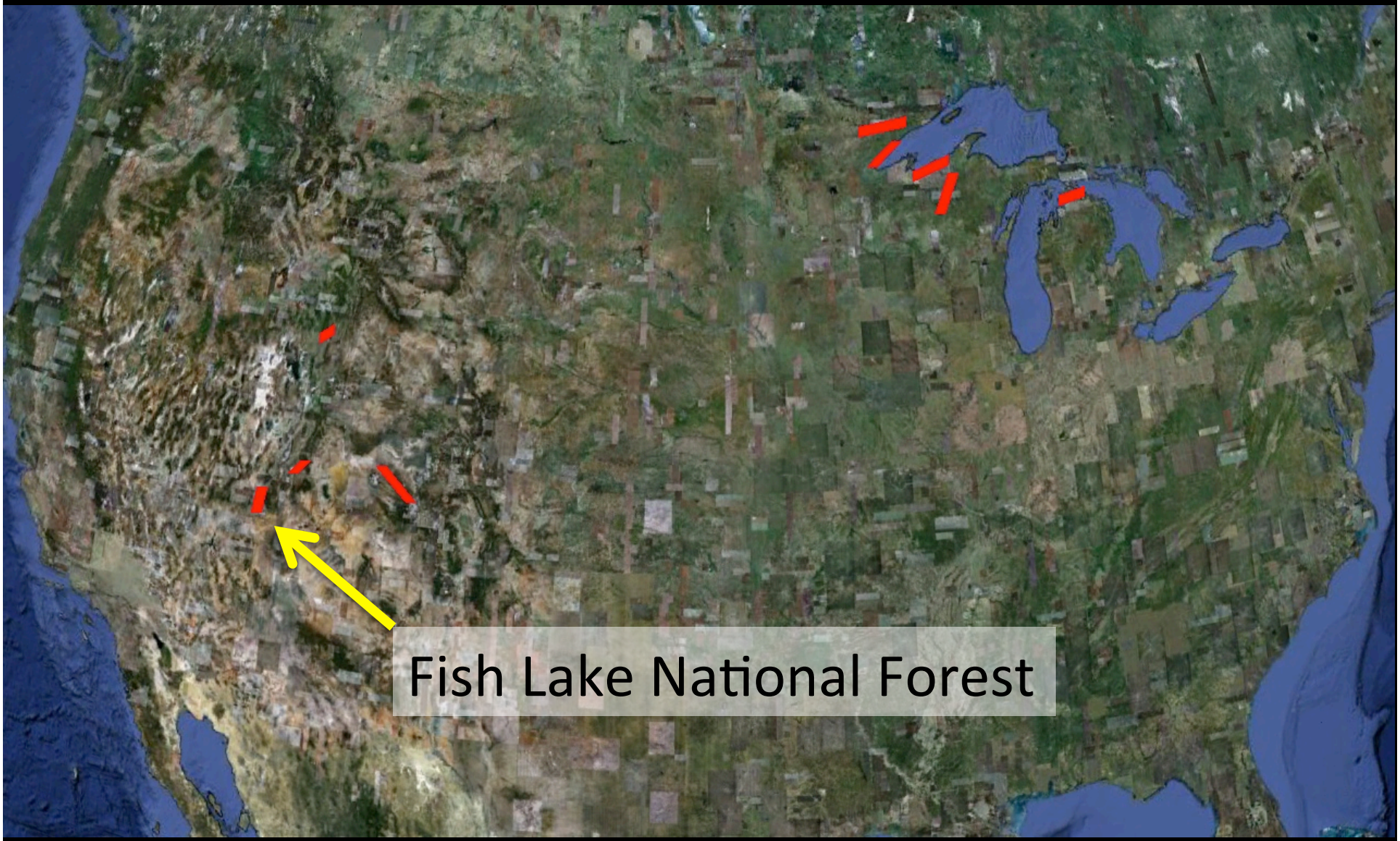
Mapping Foliar Chemistry with AVIRIS

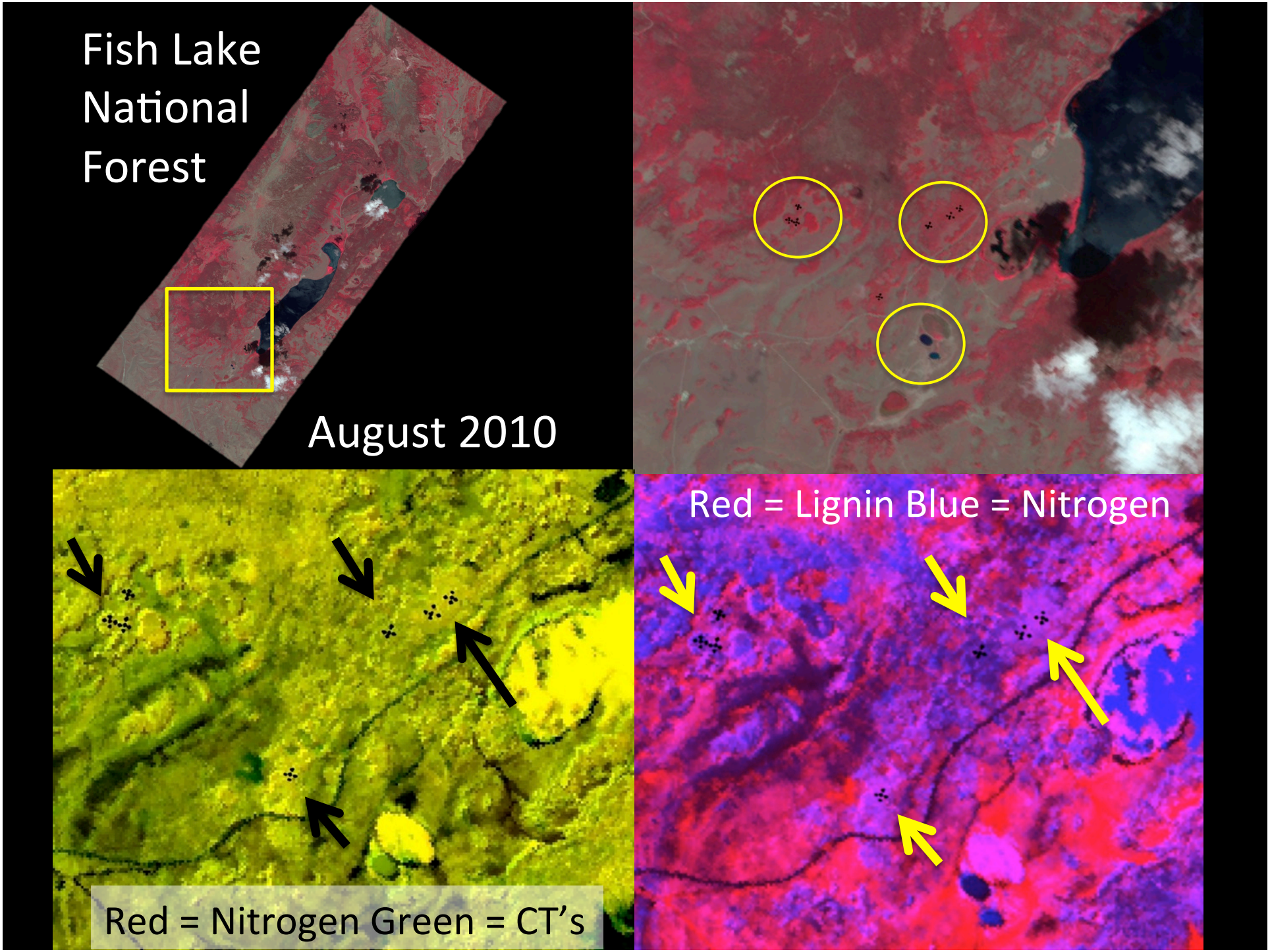


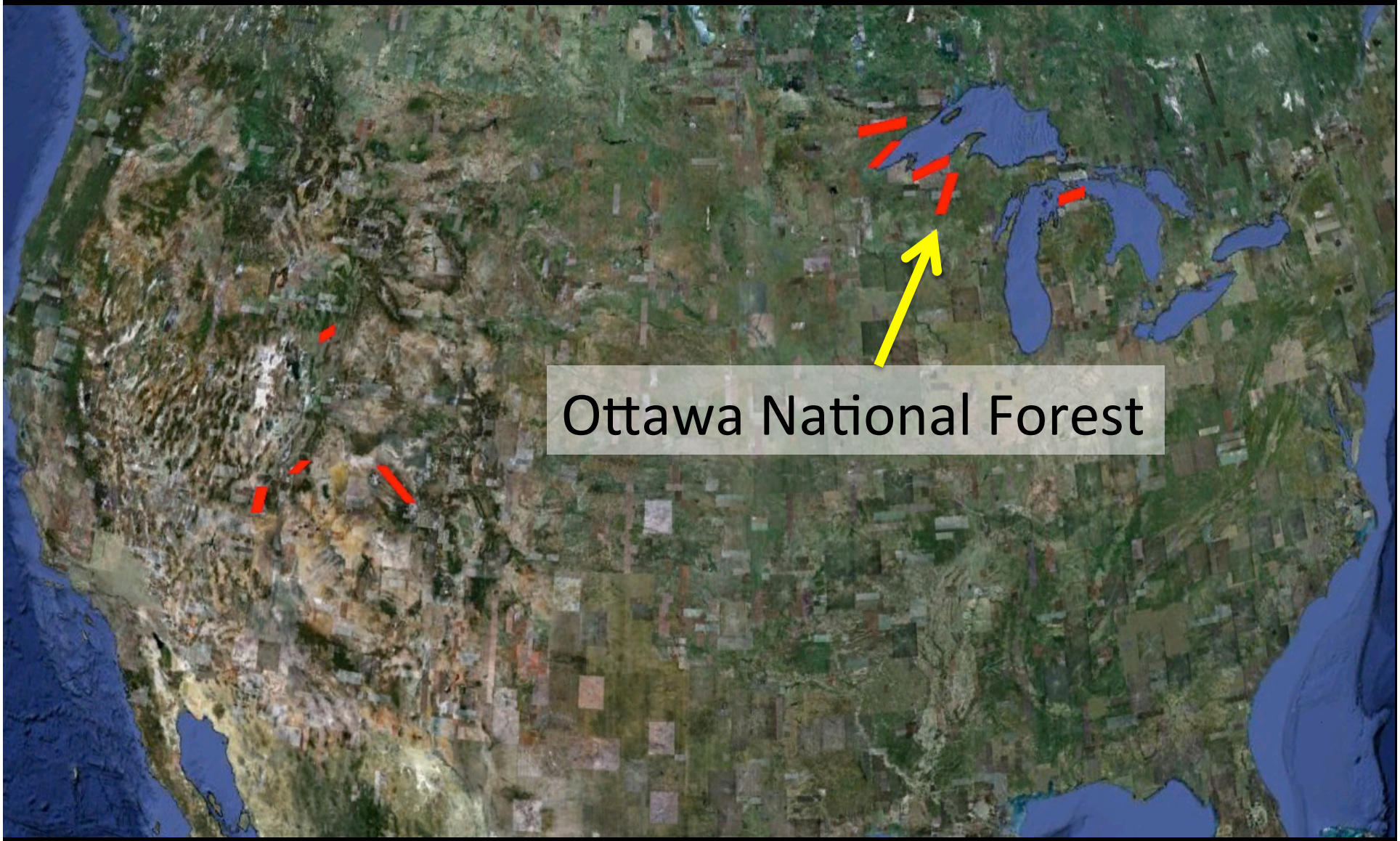


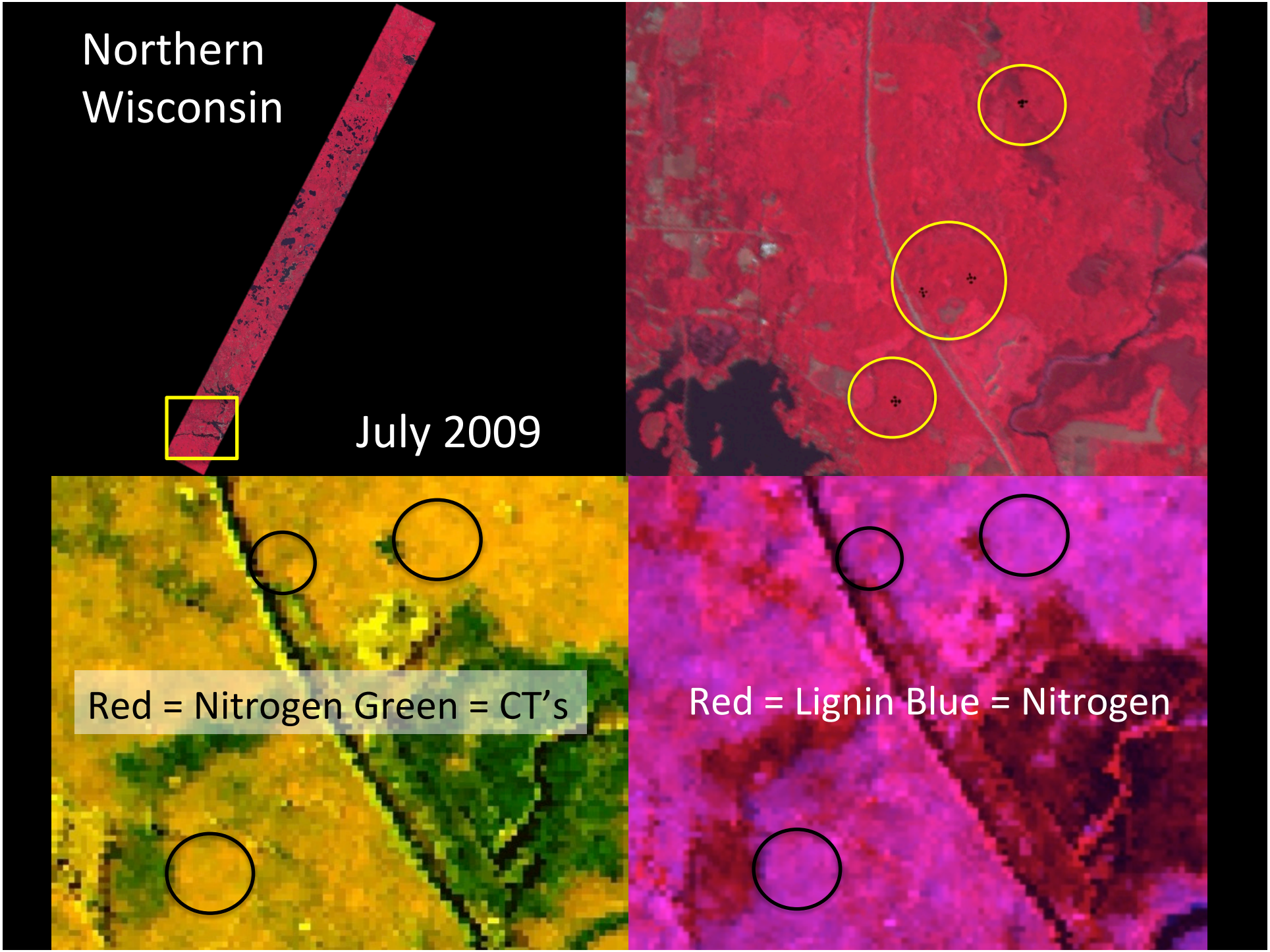




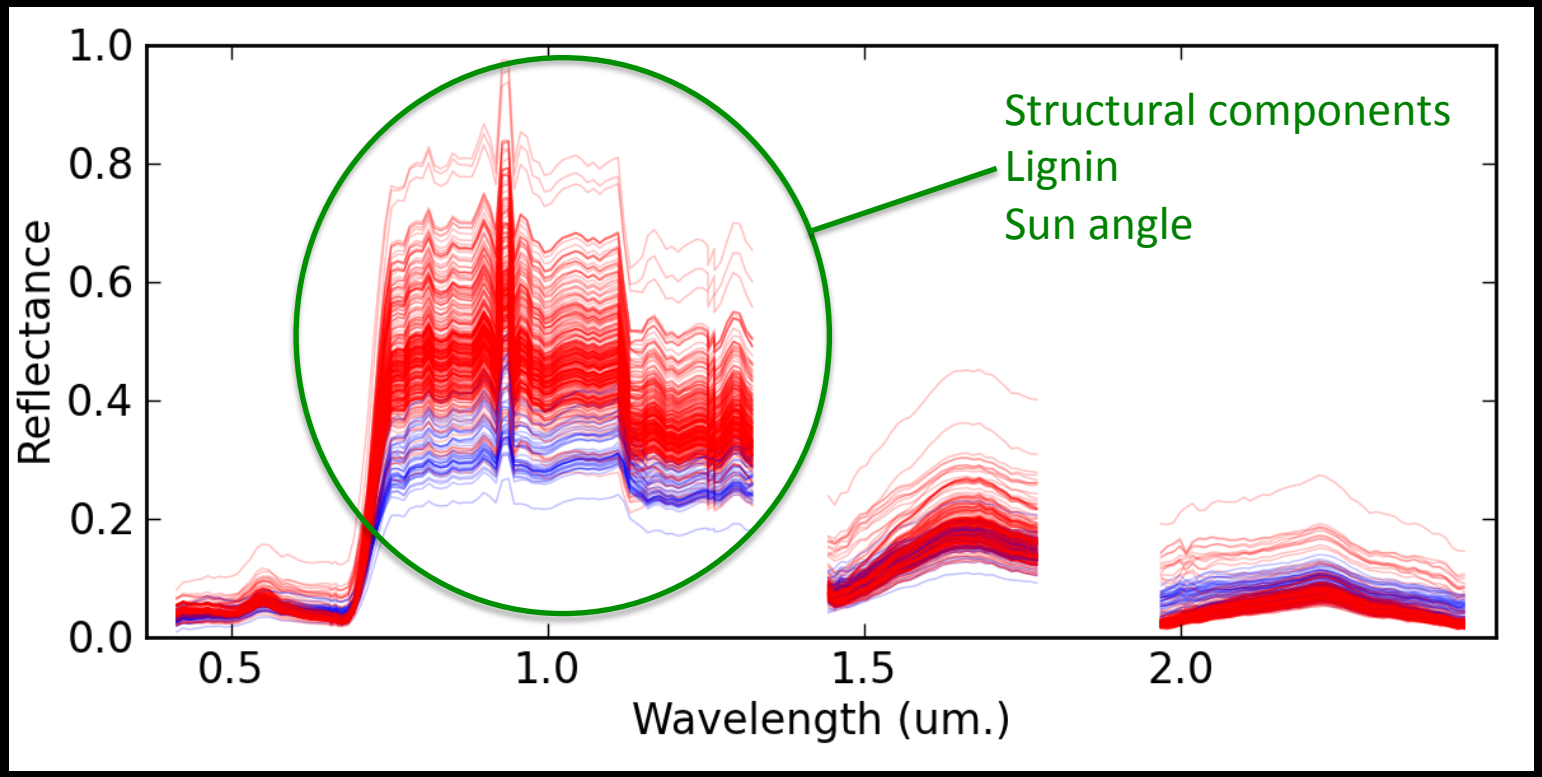

Fish Lake National Forest

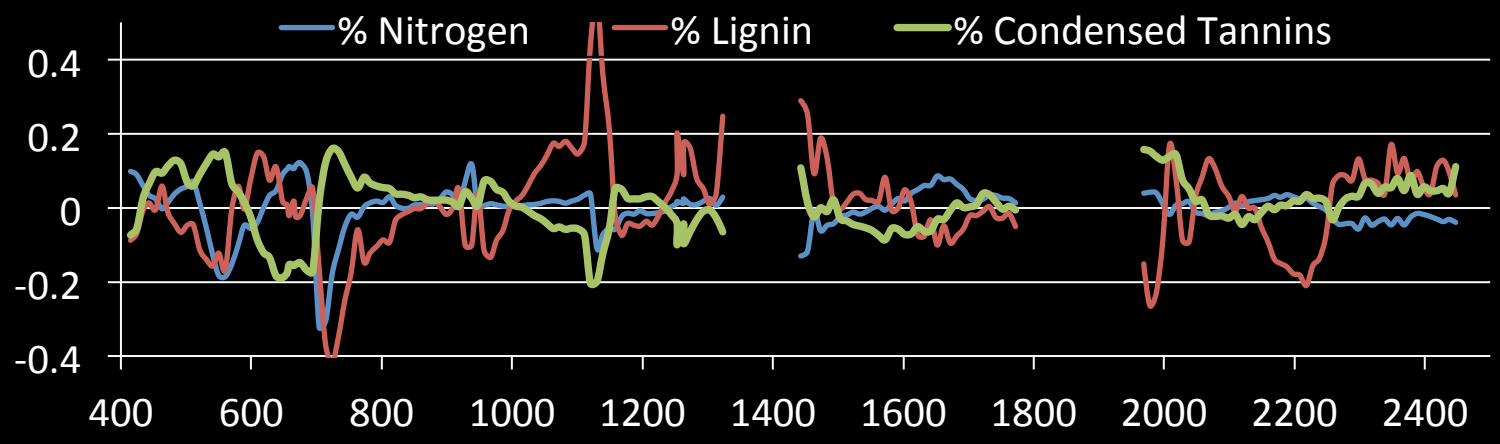

Fish Lake
National
Forest
August 2010
Red = Nitrogen Green = CT's
Red = Lignin Blue = Nitrogen


Ottawa National Forest


Northern
Wisconsin
July 2009
Red = Nitrogen Green = CT's
Red = Lignin Blue = Nitrogen

Spectral variability between genets:



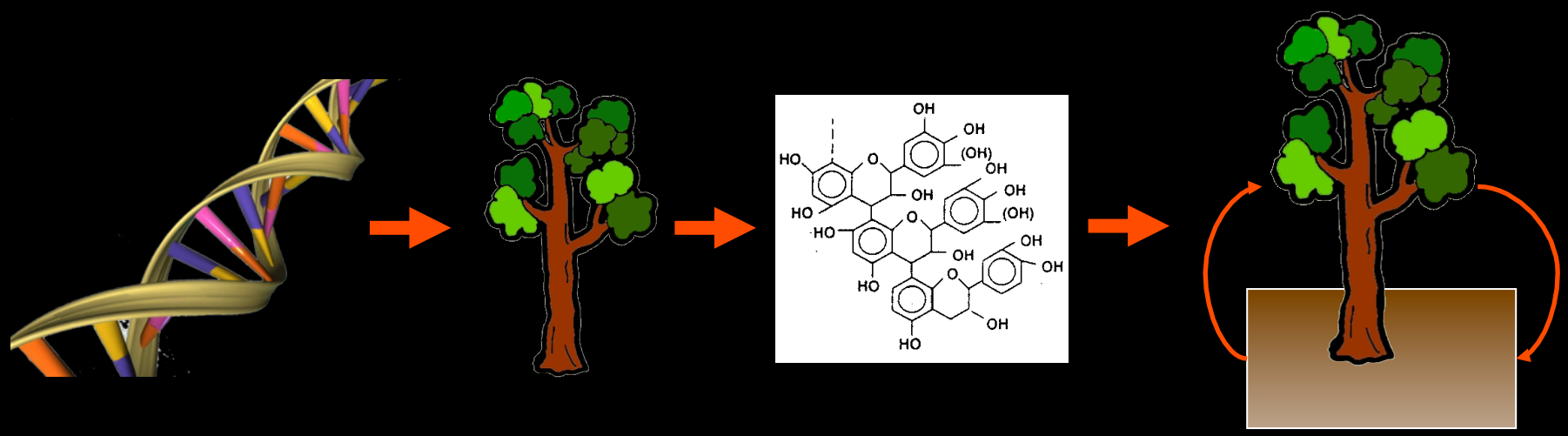


Are genets distinguishable by spectra?

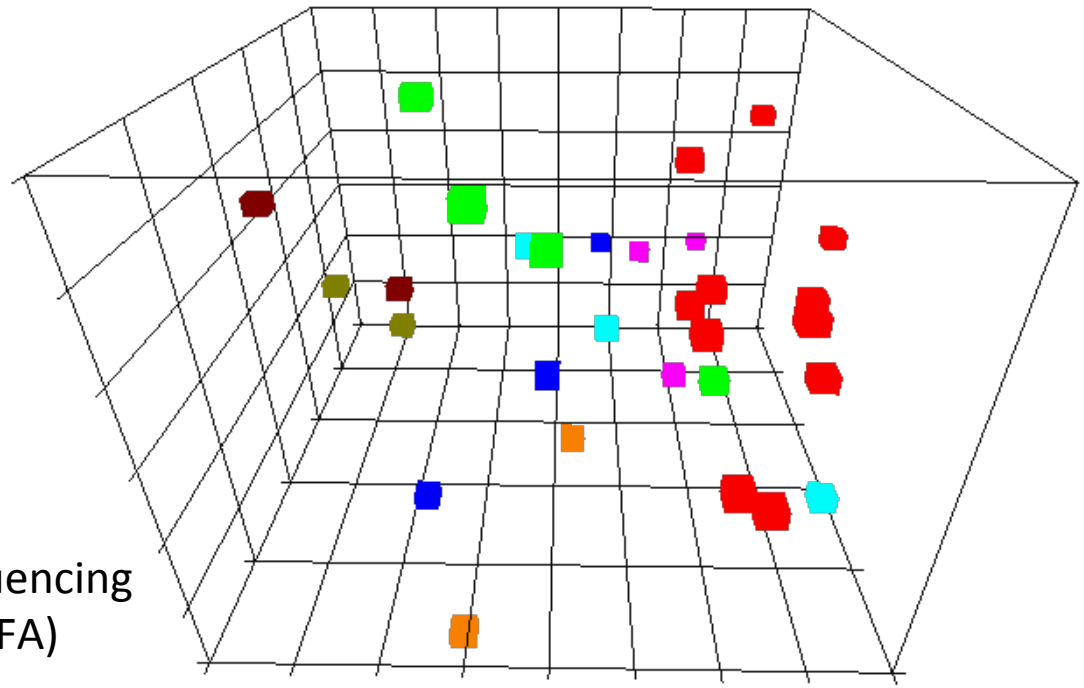
- Leaf traits correspond with traits related to belowground microbial function (and therefore spectra)
- Foliar and soil traits differ among genets, with foliar traits being more separable.
- Genets can be discriminated on the basis of leaf traits alone, but accuracies are much higher when using imaging spectroscopy.

Linkage to Soil Microbial Dynamics

- Biodiversity occurs at all levels of ecological organization (community, species, genetic, functional [chemical], etc.)
- Belowground processes:



Linkage to Belowground Function

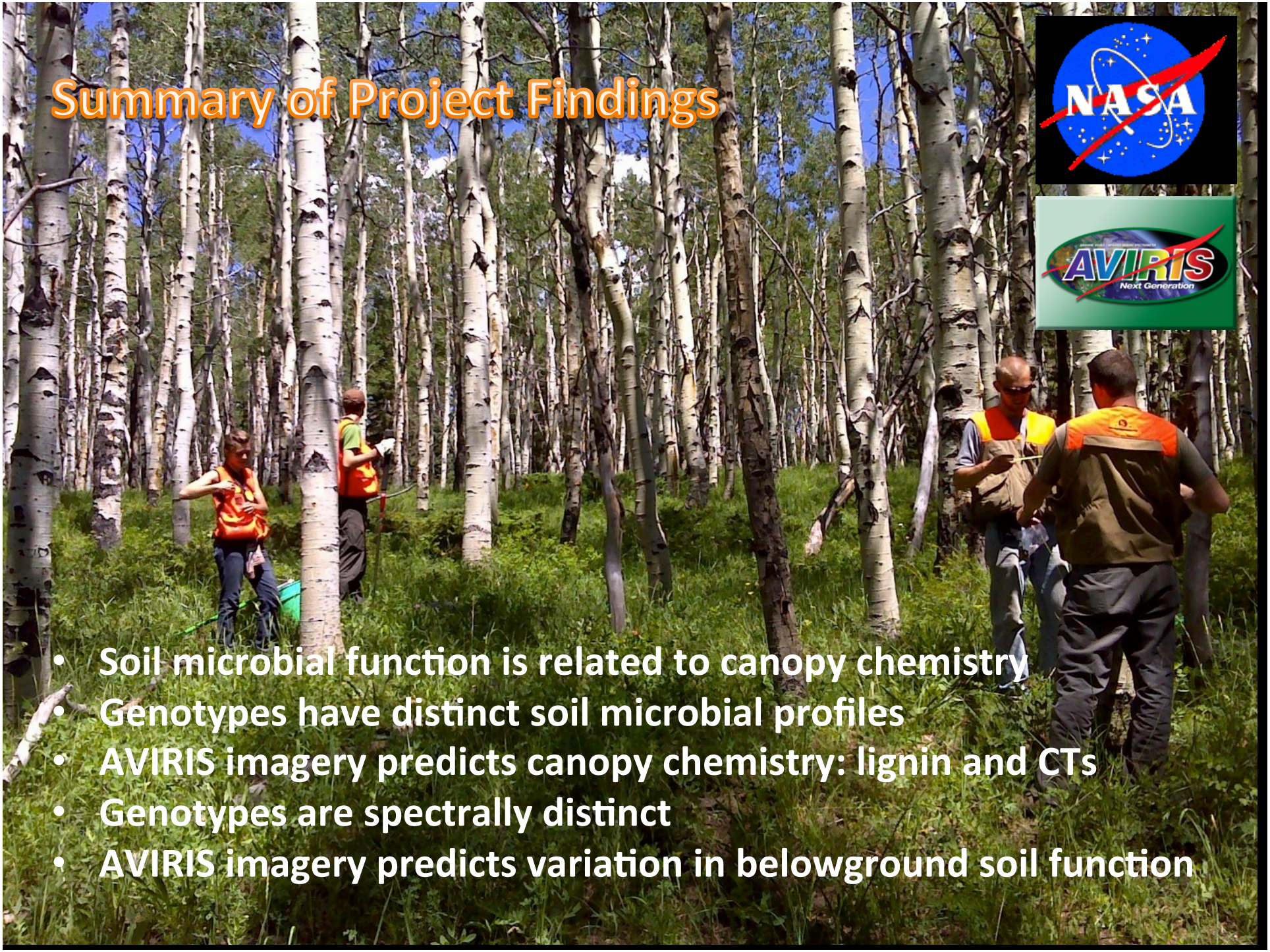


Illumina bacterial sequencing
(pyrosequencing vs PLFA)
515f/806R primers

NMS
3 axis explain ~ 95% variation
in known bacterial classes

MRPP
T = -3.45
A = 0.16
P = 0.0016

-next gen sequencing of soil microbes, bacterial/fungal DNA
-construct barcode of barcoded primers
-match sequences against a known library of organisms
-hundreds of species that are unknown (larger w/ finer taxon)
-unknown kingdom is very very small (<0.01%),
-the percentage of unknown genus ID's is large (75%)
-we used class (35-40% unknown)



Summary of Project Findings

- Soil microbial function is related to canopy chemistry
- Genotypes have distinct soil microbial profiles
- AVIRIS imagery predicts canopy chemistry: lignin and CTs
- Genotypes are spectrally distinct
- AVIRIS imagery predicts variation in belowground soil function