

Exploring biodiversity through optical diversity

John Gamon (jgamon@gmail.com) &
Dimensions of Biodiversity Team



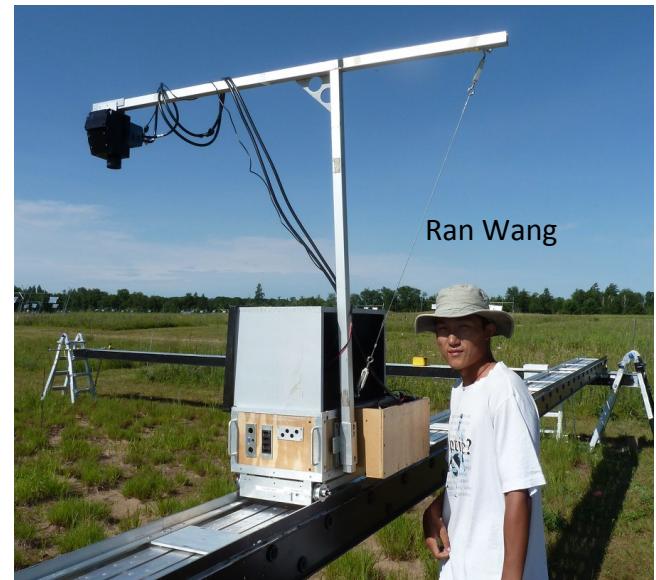
Dimensions of Biodiversity Team

- University of Minnesota:
 - Jeannine Cavender-Bares (PI), Keren Bitan
 - Rebecca Montgomery (phenology)
 - Sarah Hobbie
 - Peter Reich
 - David Tilman
- University of Wisconsin
 - Phil Townsend, John Couture, Clayton Kingdon
 - Rick Lindroth
- University of Nebraska
 - Art Zygierbaum, Abby Stilwell, Rick Perk
- Appalachian State University
 - Mike Madritch
- University of Alberta
 - John Gamon, Ran Wang



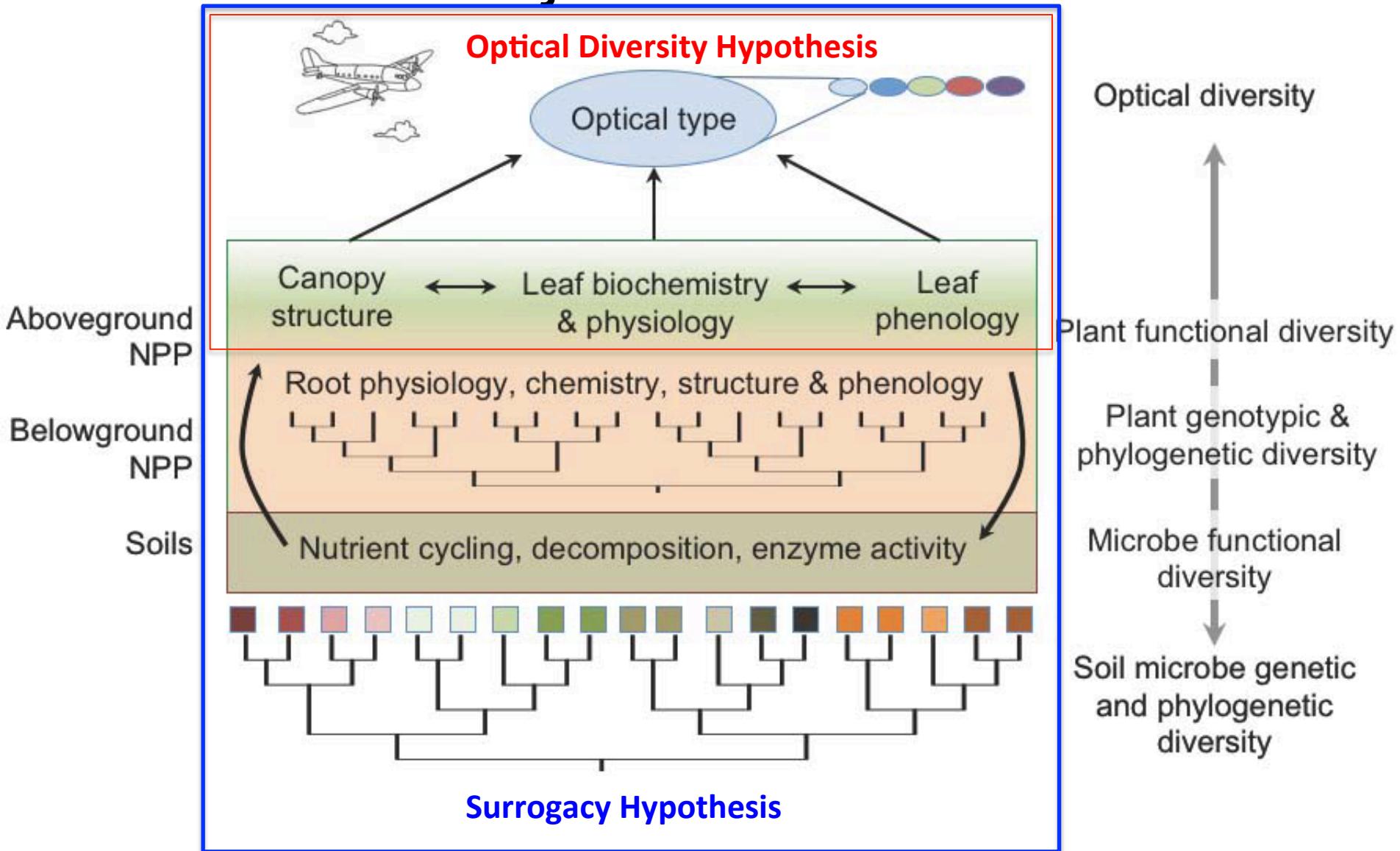
Alasdair MacArthur

Photo: Clayton Kingdon

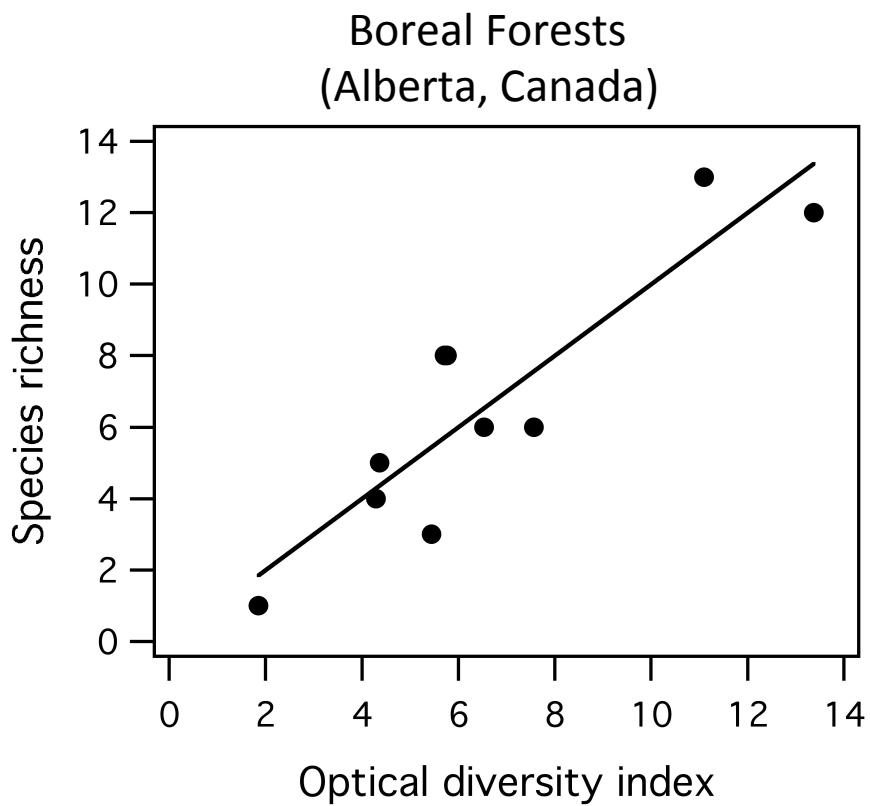
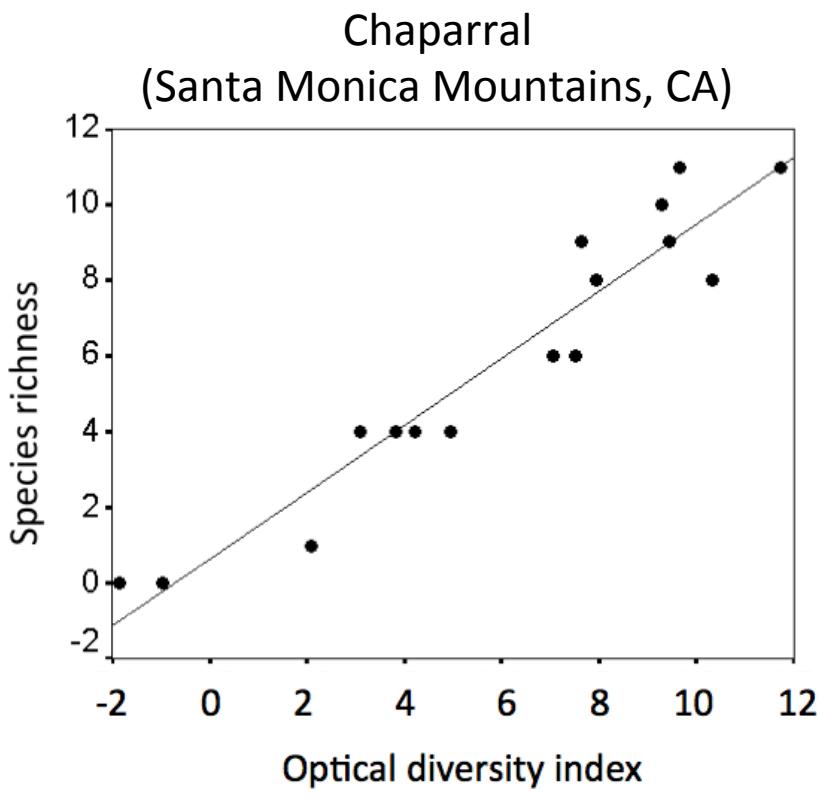


Ran Wang

Project Overview



Optical Diversity Detects Species Richness – but *why* & *how*?



Zutta 2004

DeLancey 2014

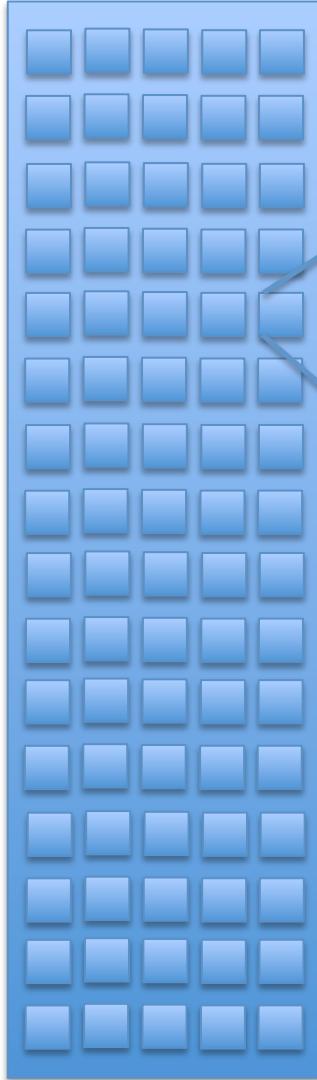
Remote sensing questions:

- *Why* does this work?
- What are we really detecting?
 - *leaf traits*?
 - *canopy structure*?
 - *phenology*?
- Can we detect underlying *functional* and *genetic* diversity?
- What is the *scale-dependence* of these topics?

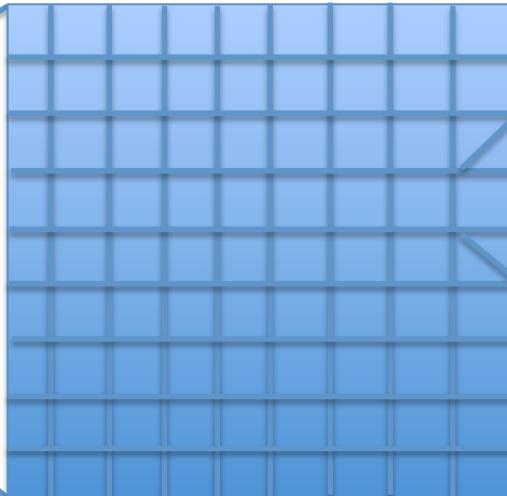


Multi-scale Sampling Scheme

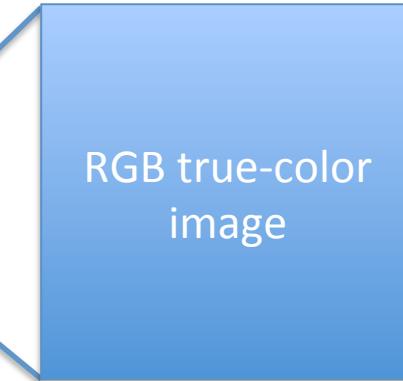
Airborne image



Plot image cubes – 9x9m
(airborne and proximal)



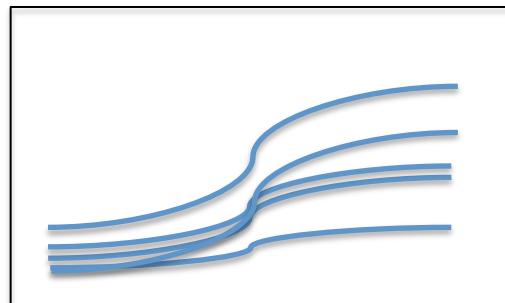
Headwall image
cube – 1x1 m



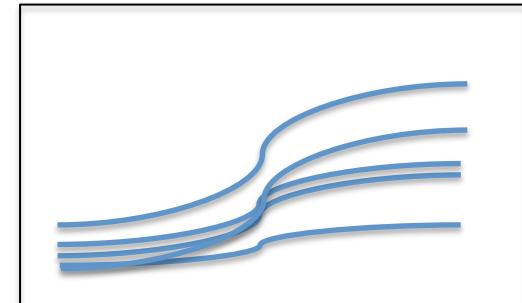
RGB true-color
image



Spectral variability plot



Spectral variability plot





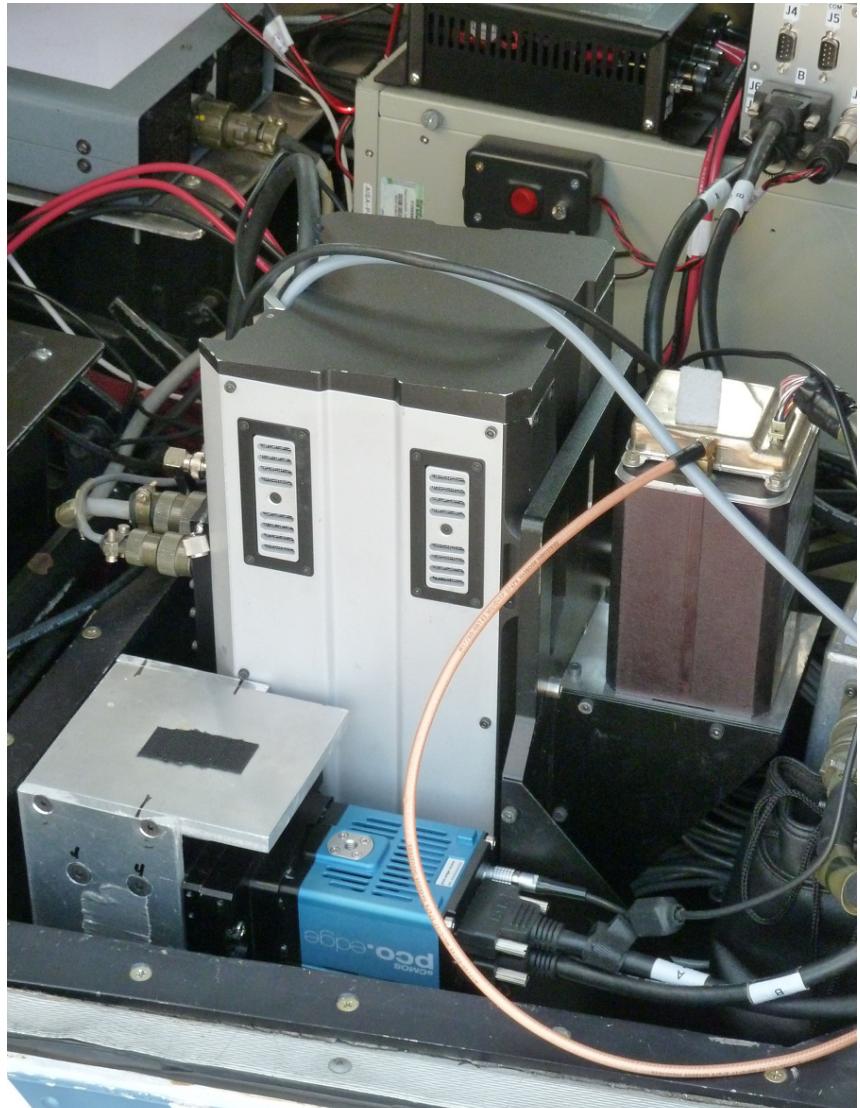
← Cedar Creek LTER

Phil Townsend and AVIRIS NG



Airborne Sampling

- AISA Eagle &
- Headwall E-Series



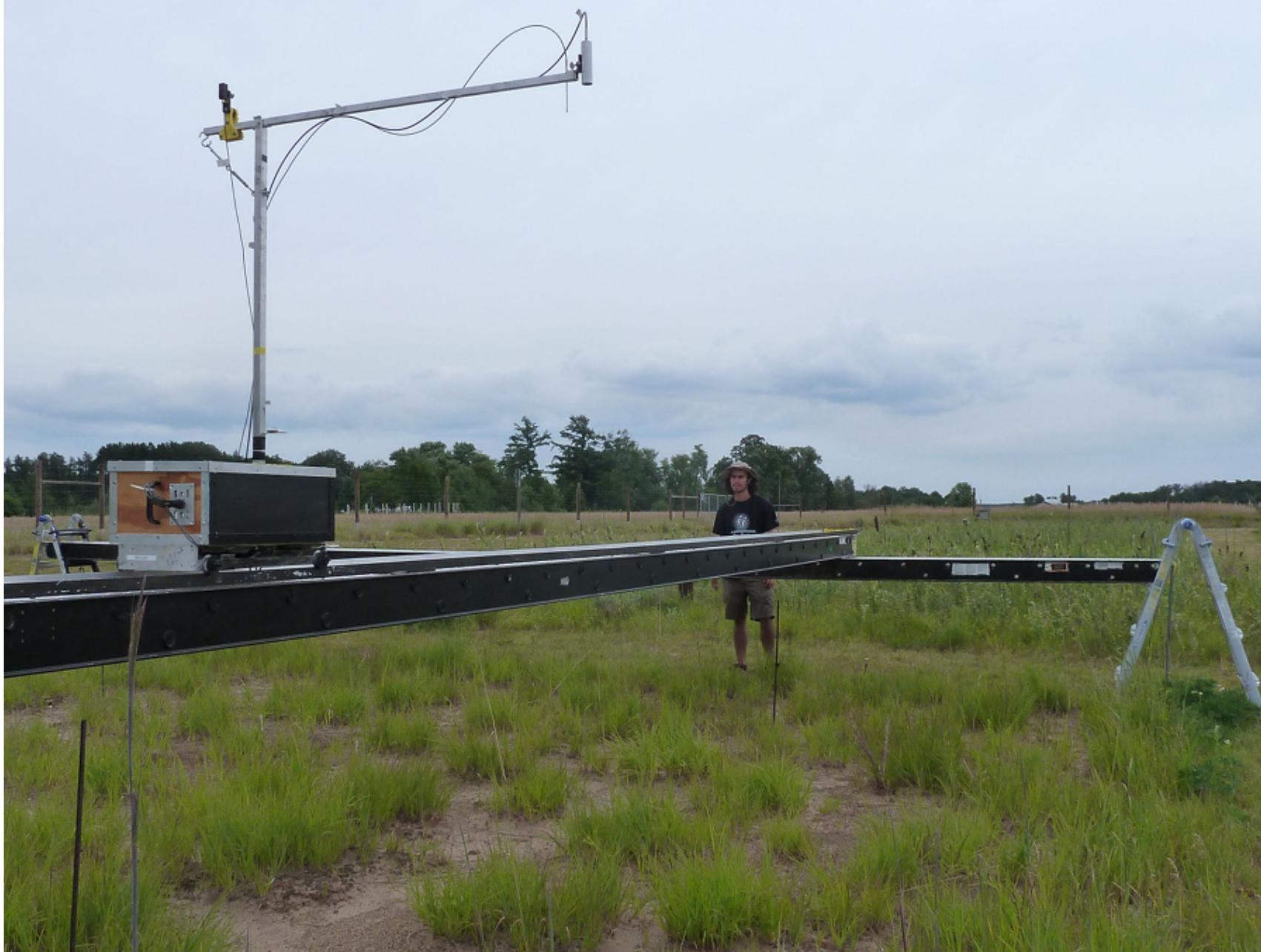
Cedar Creek Biodiversity Plots



N
↑

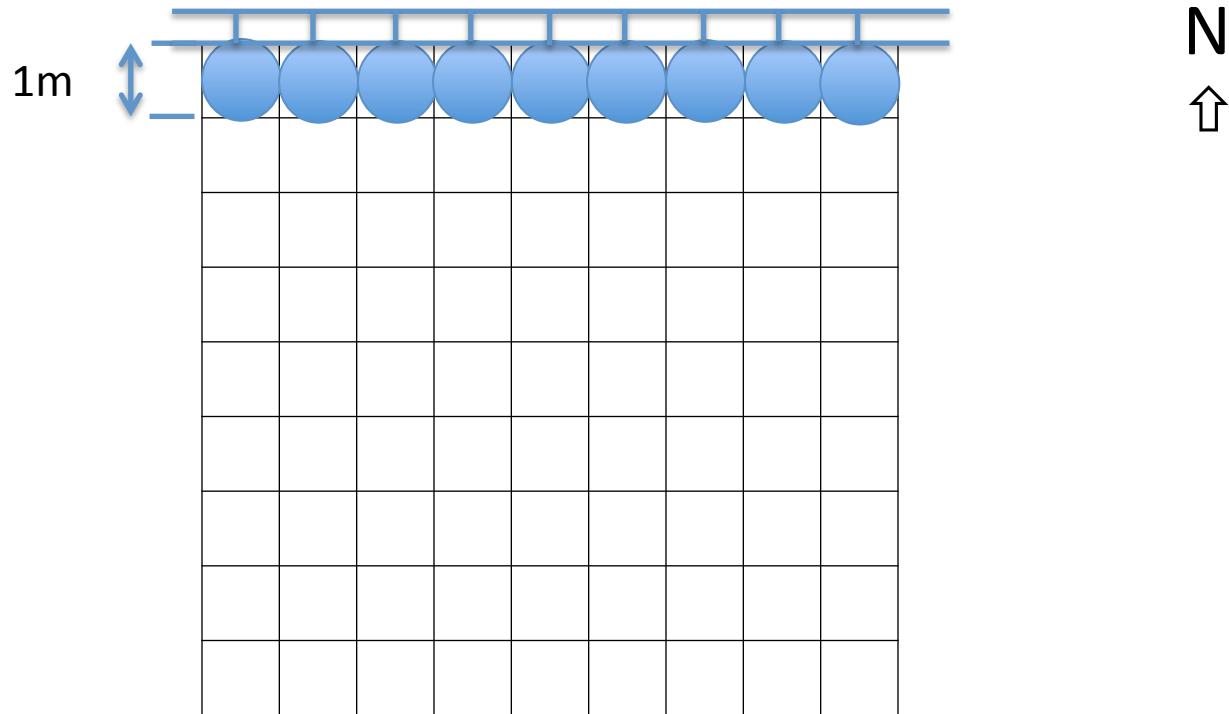
AISA Eagle Image Courtesy: A. Stilwell, R. Perk, A. Zygielbaum (U. Nebraska)

Field Spectrometer Mounted on the Tram



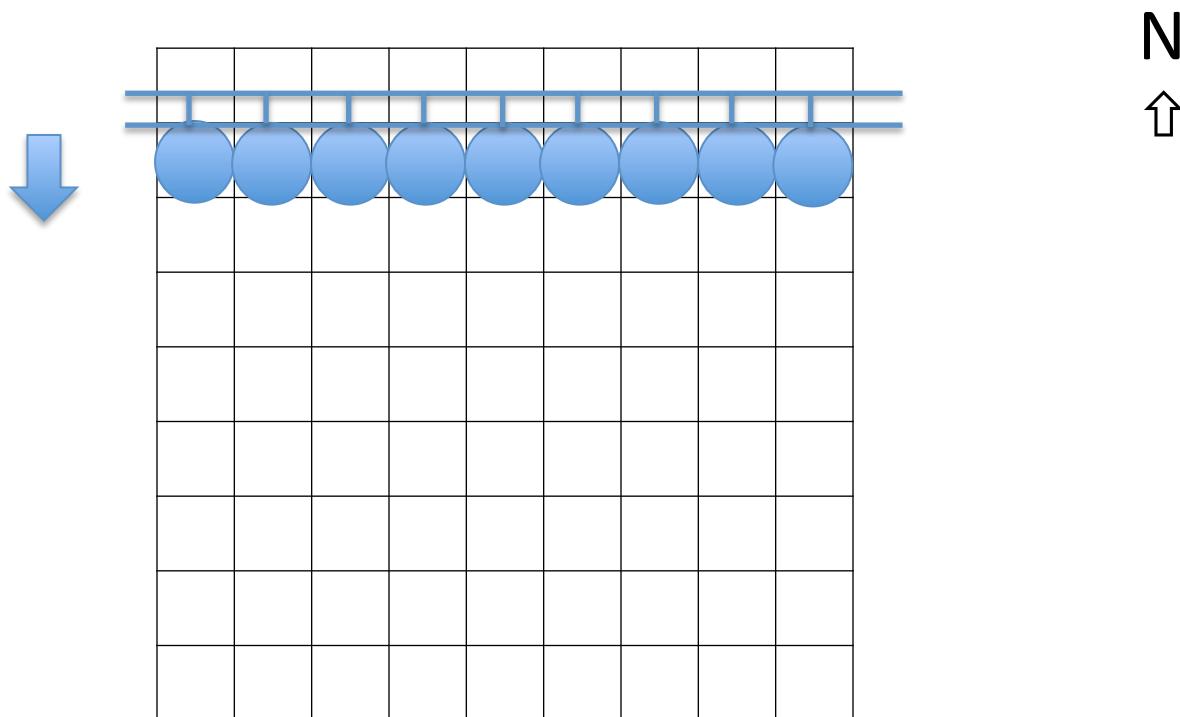
Plot Grid Sampling Design

(sampled from tram)



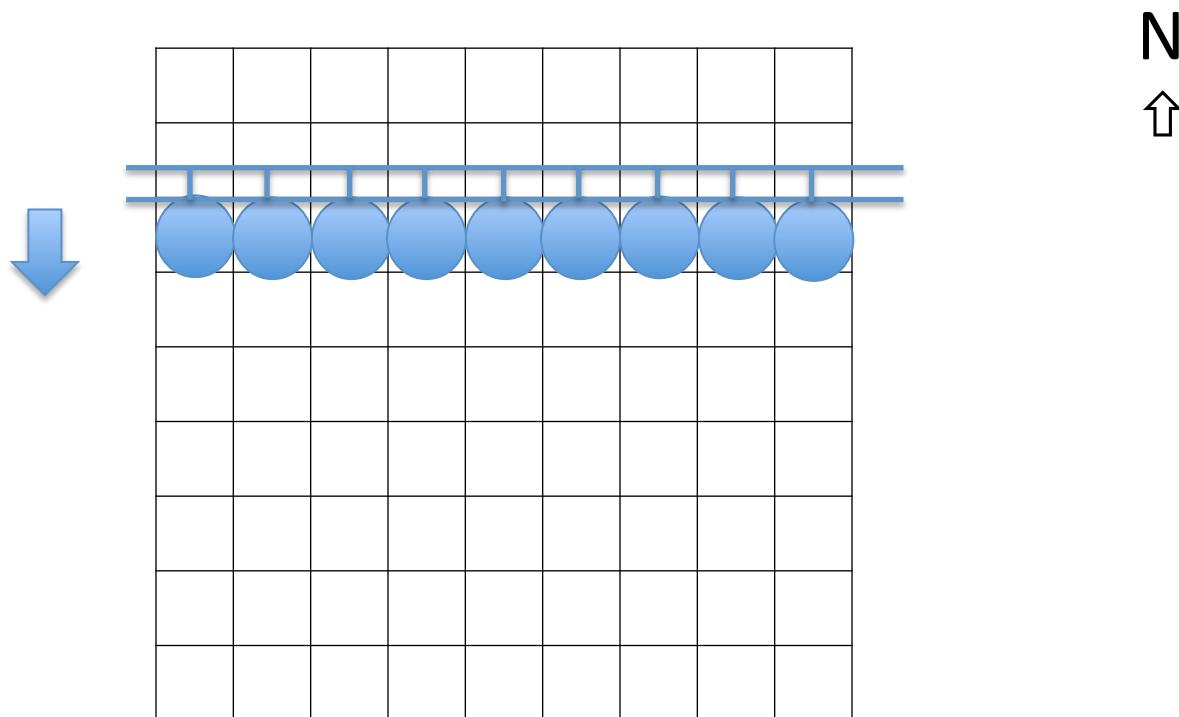
Plot Grid Sampling Design

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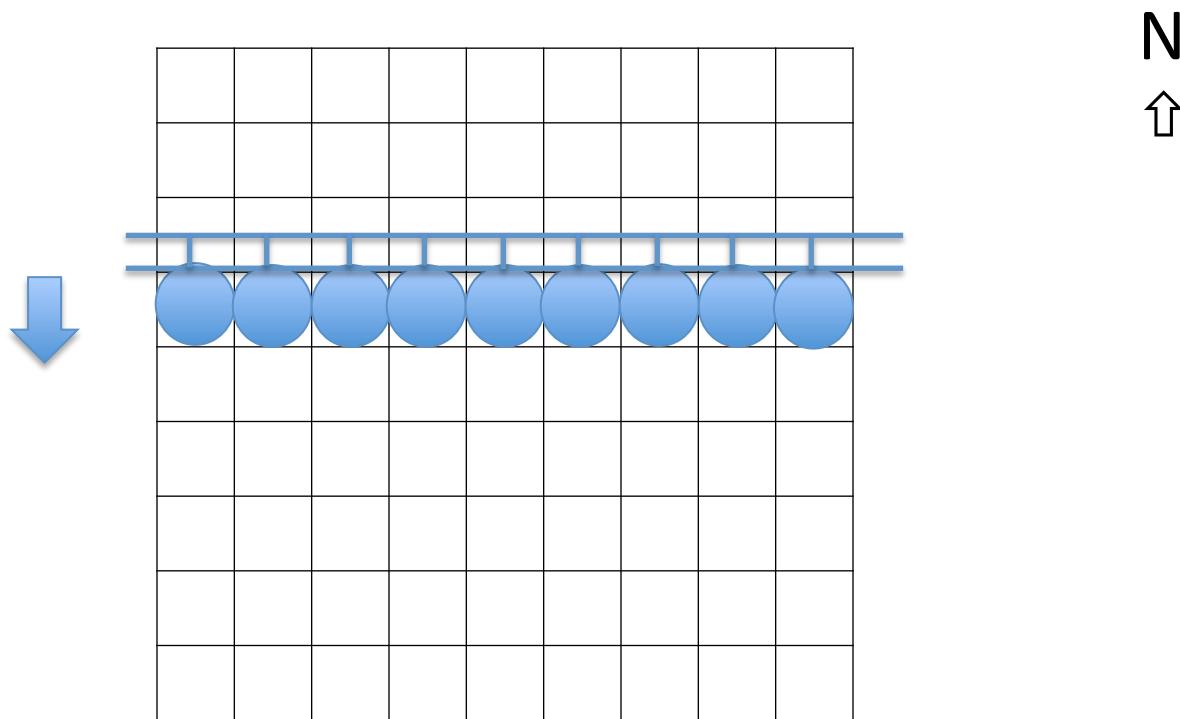
Plot Grid Sampling Design

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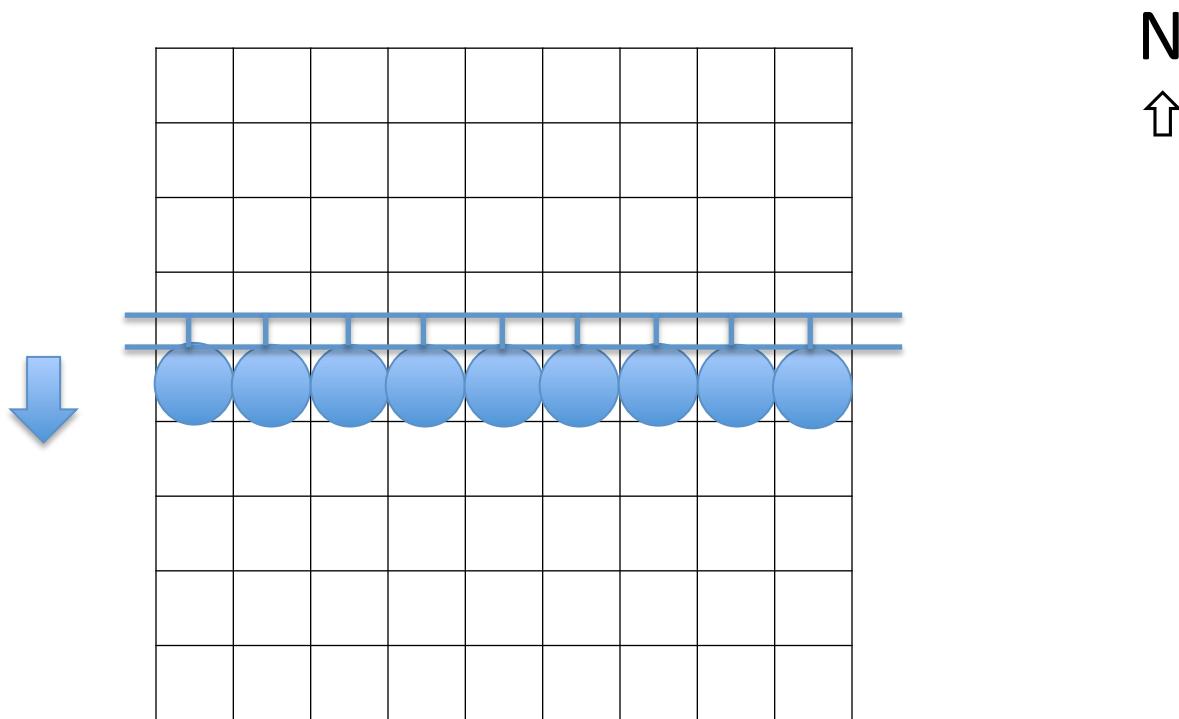
Plot Grid Sampling Design

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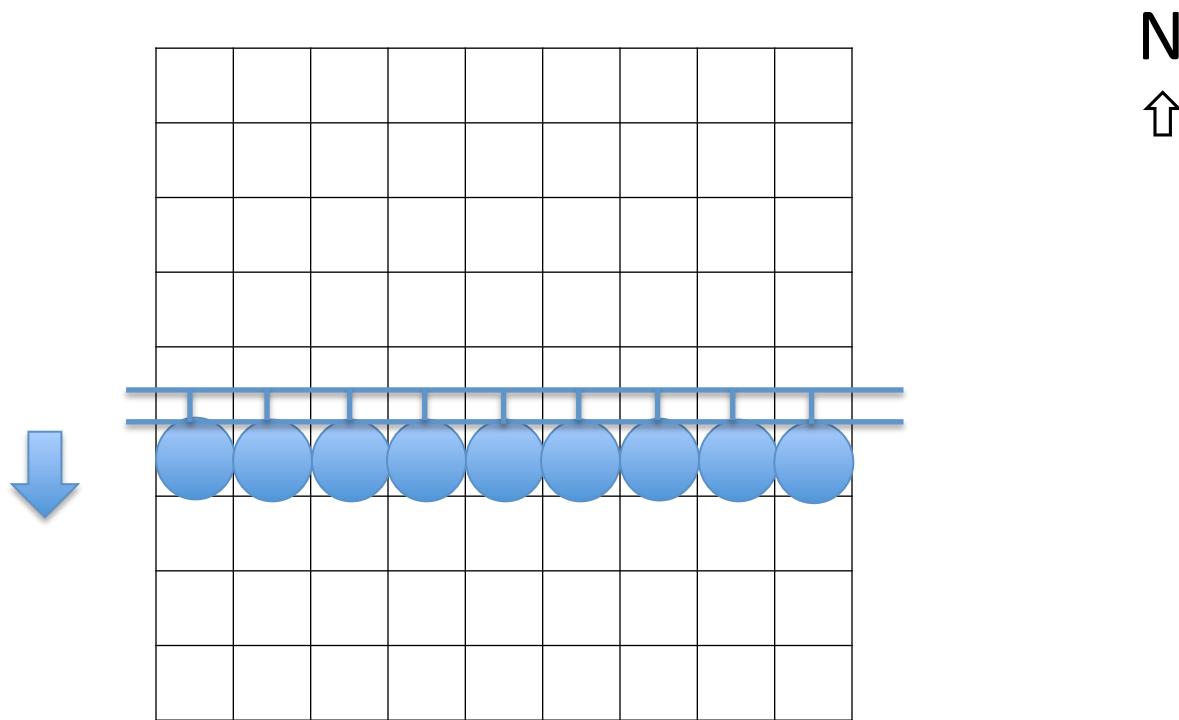
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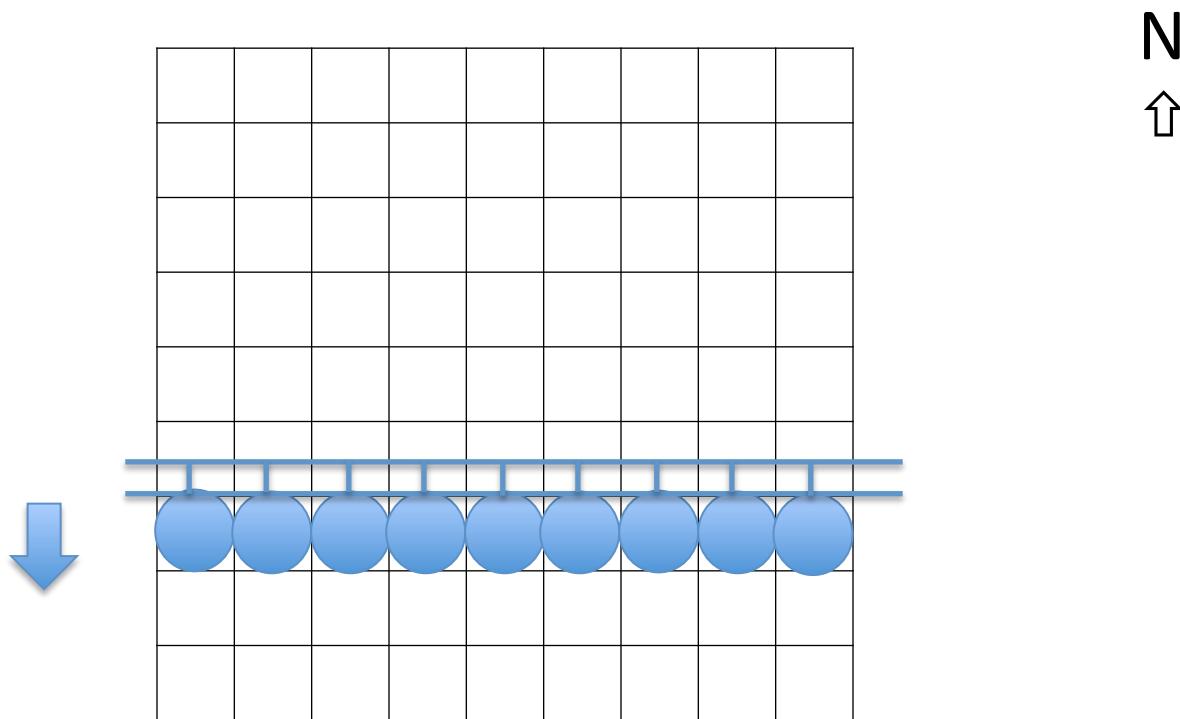
Plot Grid Sampling Design

(sampled from tram)



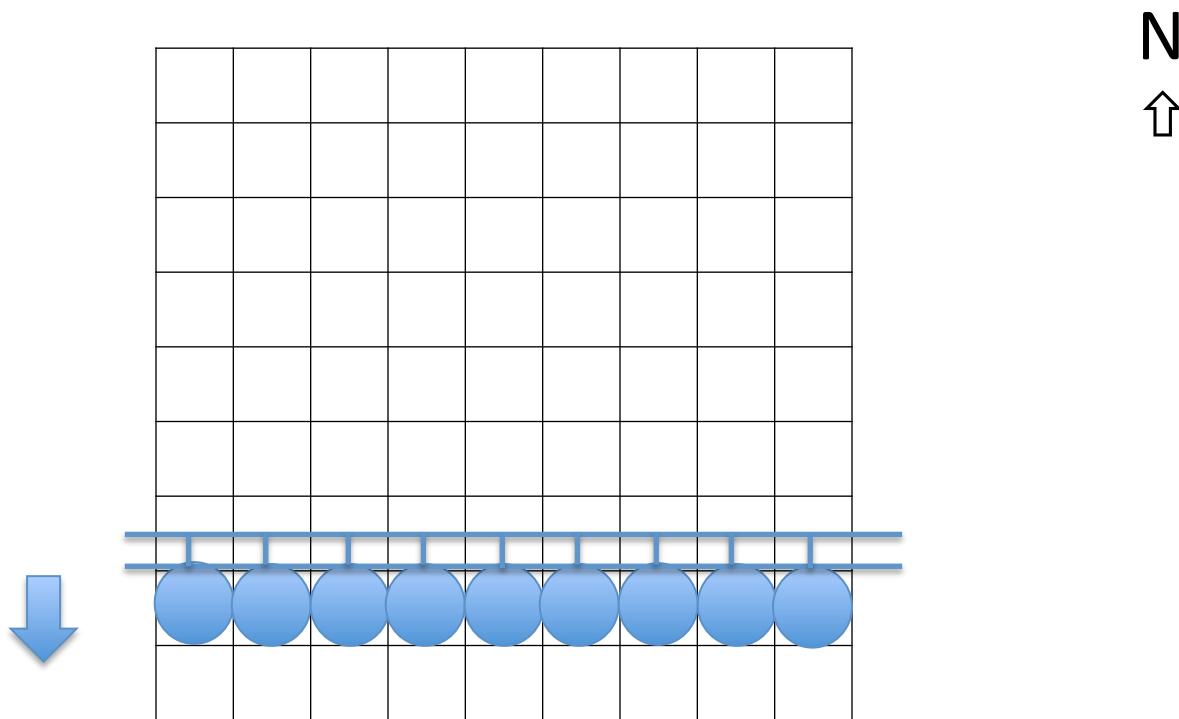
Plot Grid Sampling Design

(sampled from tram)



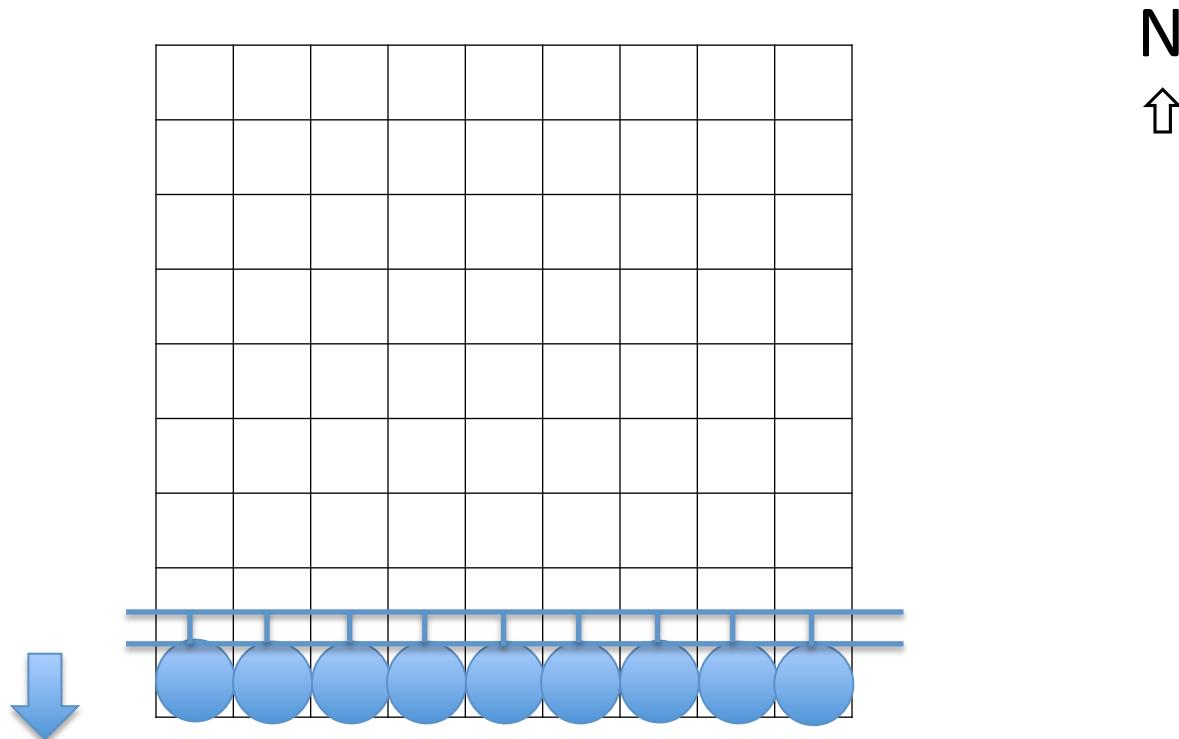
Plot Grid Sampling Design

(sampled from tram)



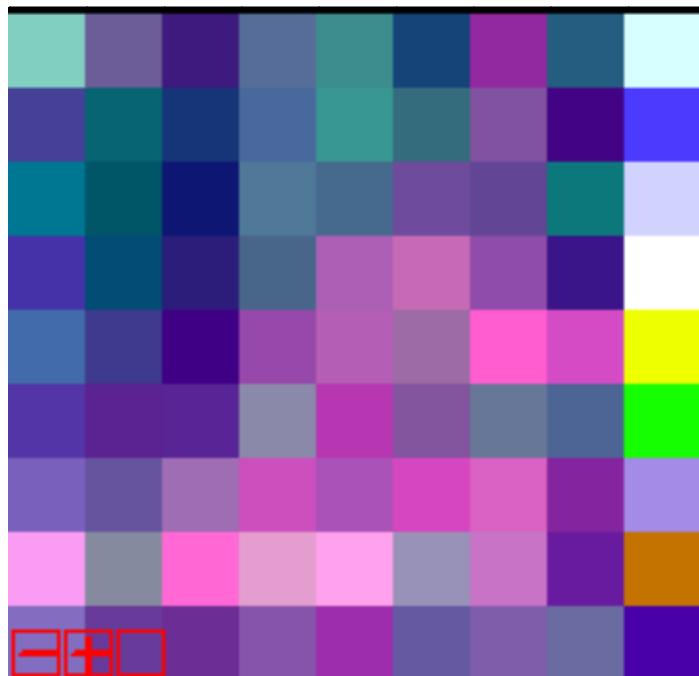
Plot Grid Sampling Design

(sampled from tram)

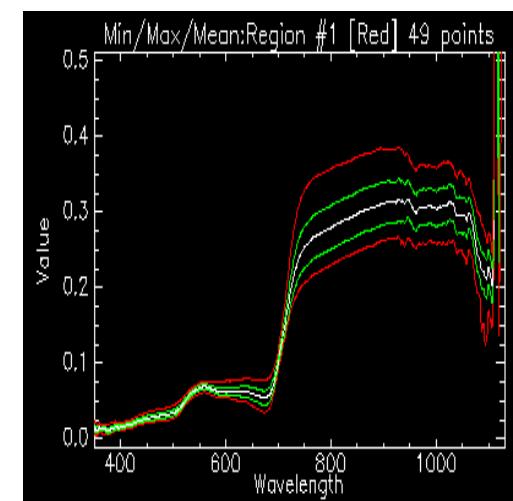


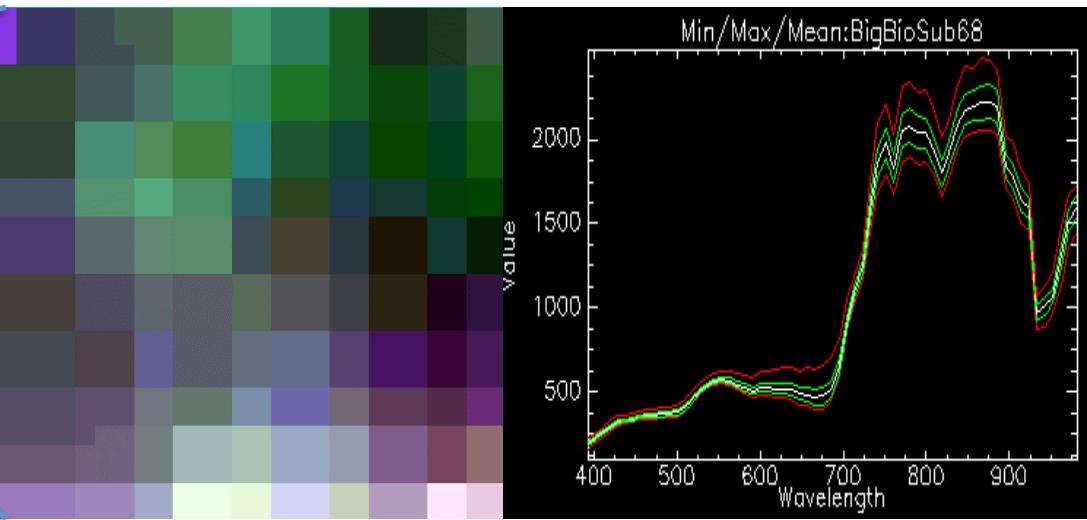
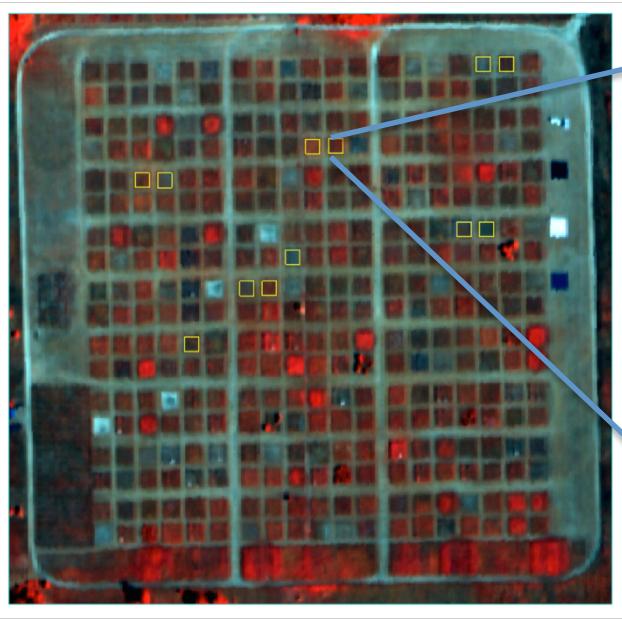
Synthetic Plot Image

(sampled from tram)

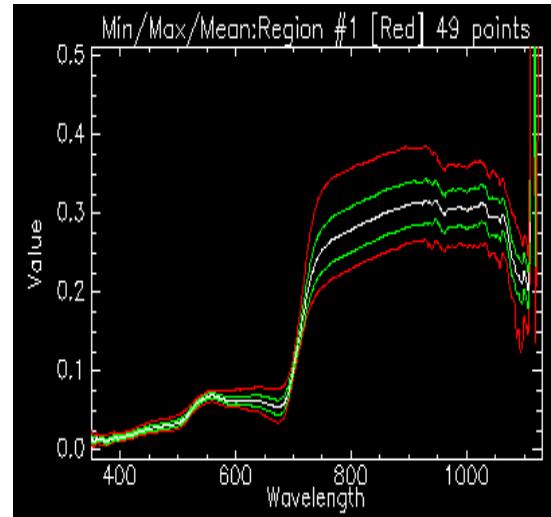
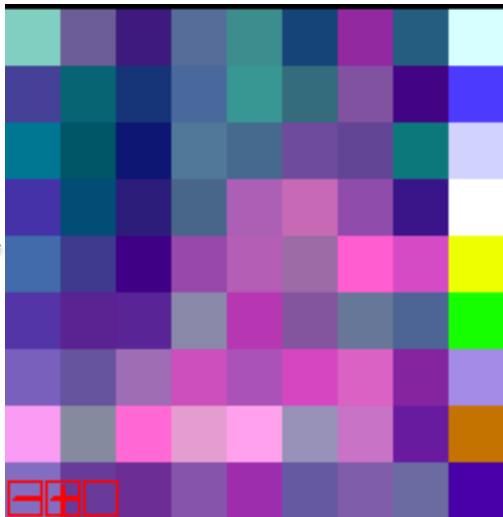


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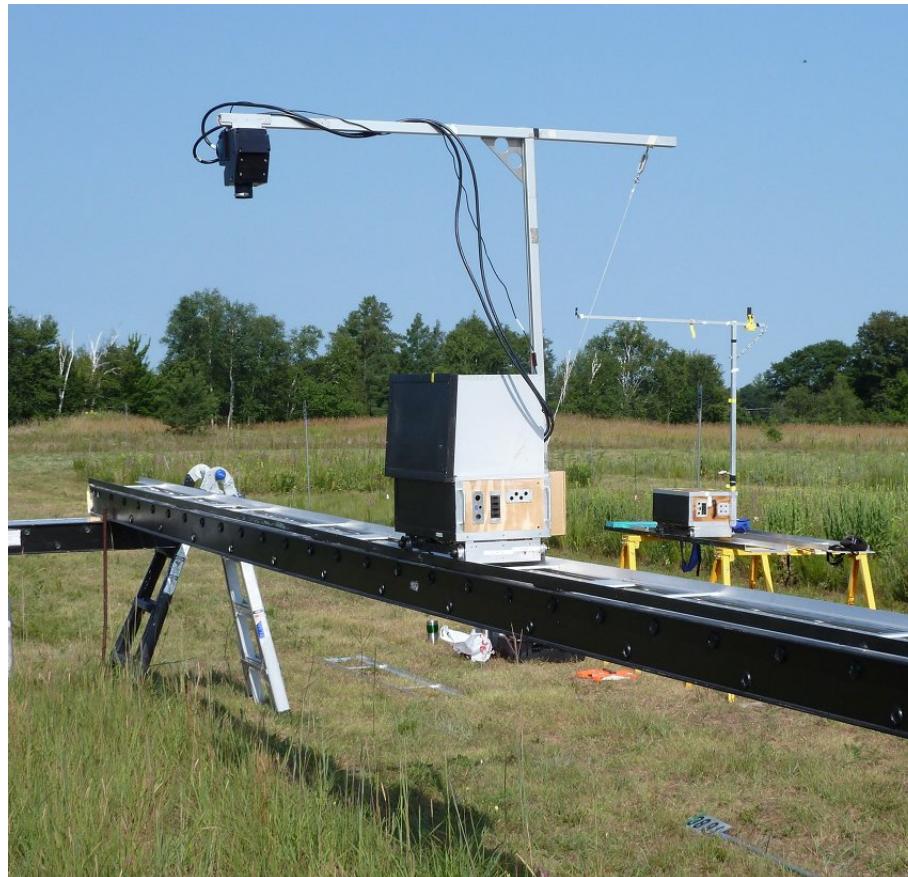


Plot 68 (SR = 16)

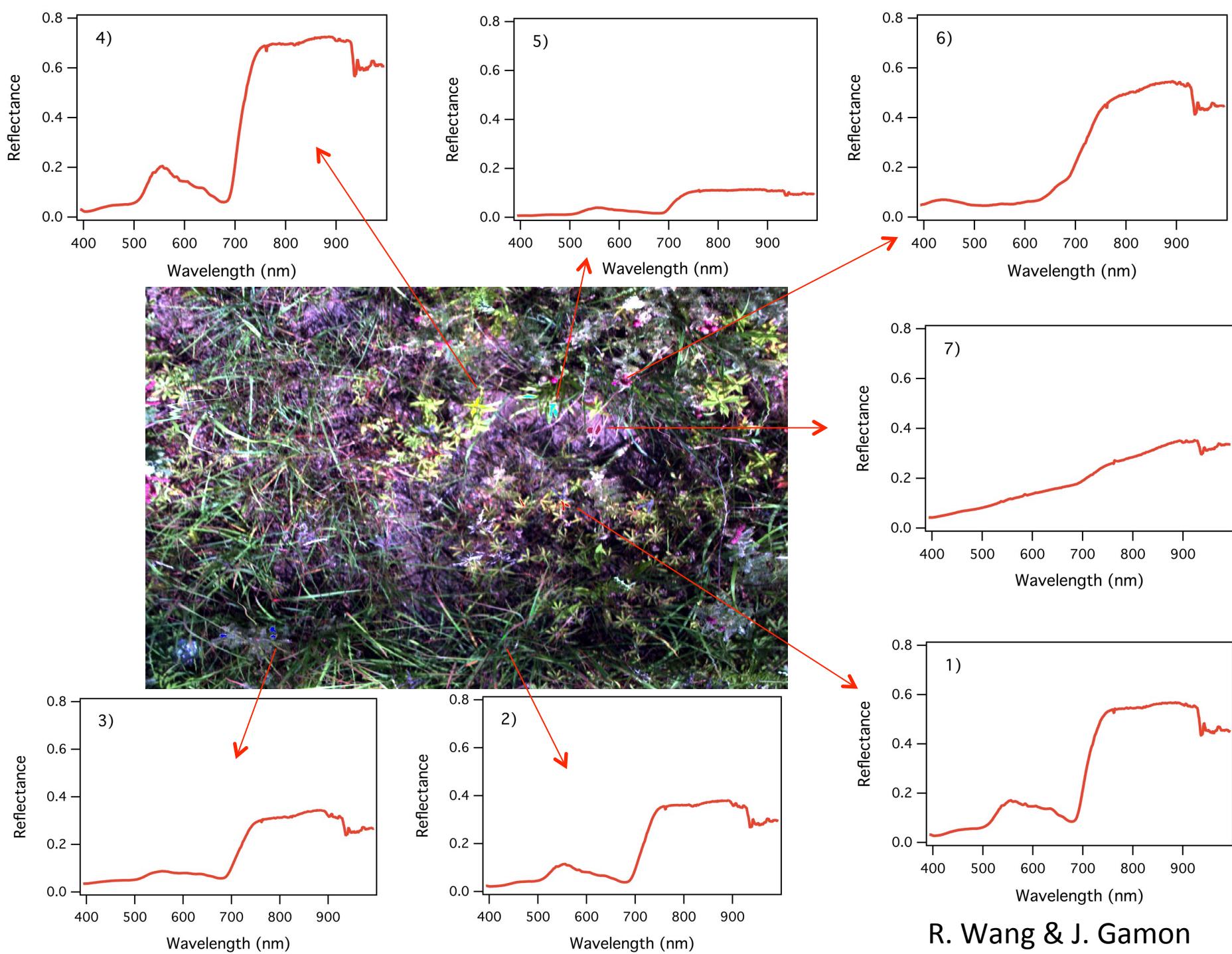


Top figures - Abby Stilwell, Bottom figures – Ran Wang & J. Gamon

Imaging Spectrometer on Tram



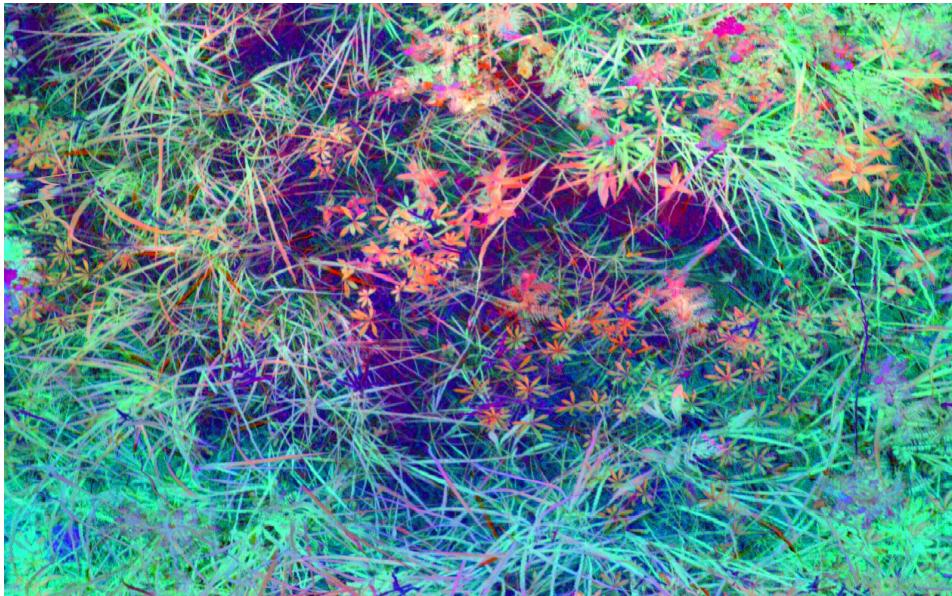
Ran Wang operating the Headwall E-Series



Spectral Detection of Photosynthetic Activity

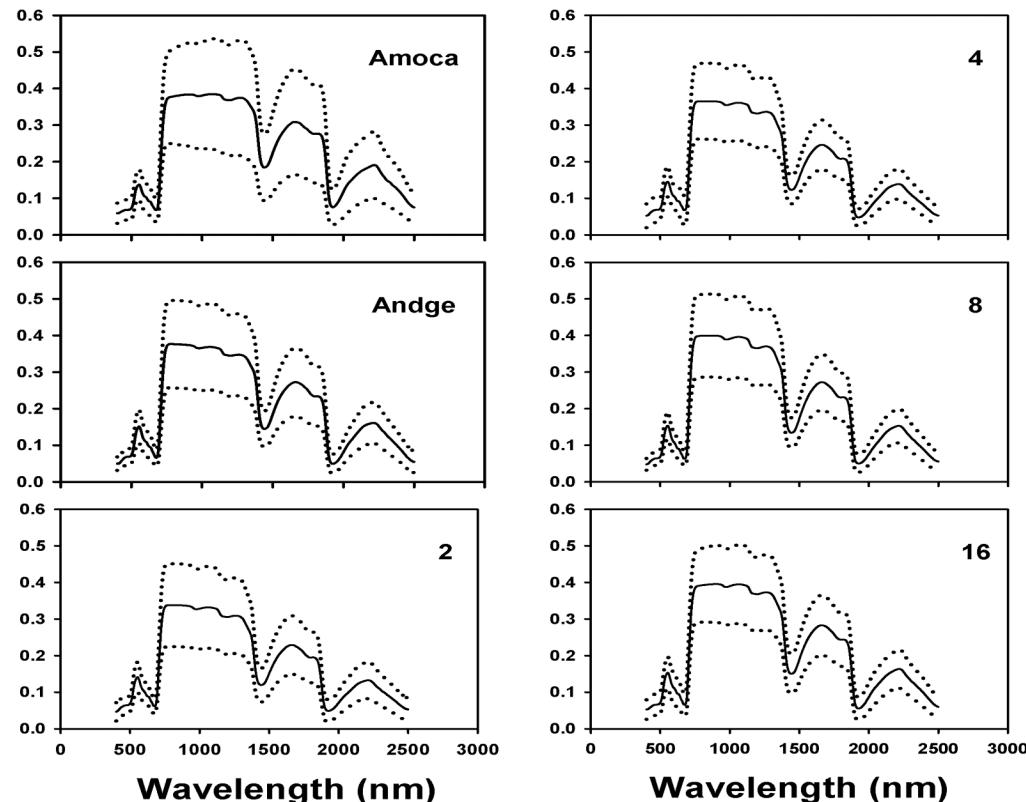


True-color image
(Plot 30, SR = 16)



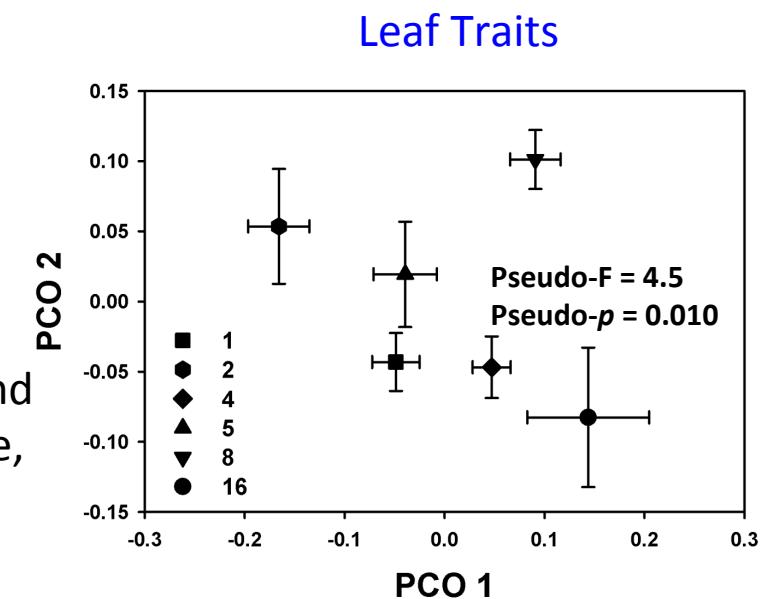
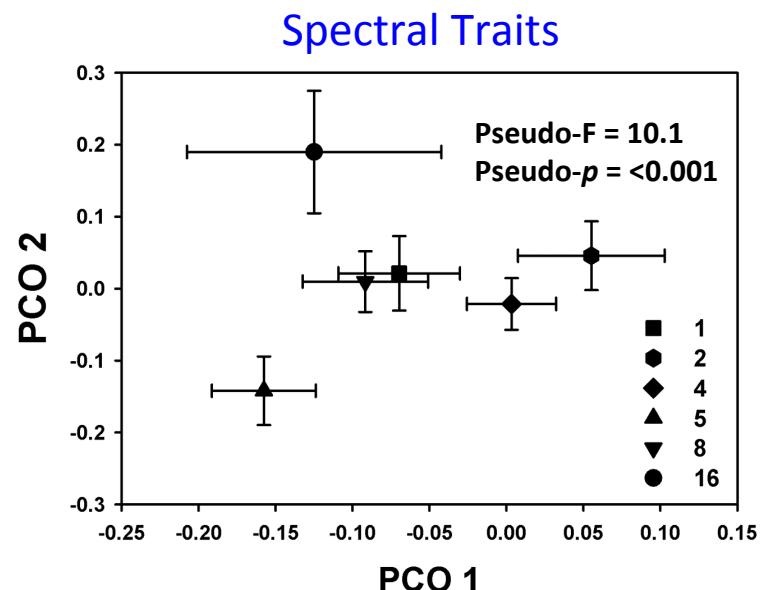
False-color image:
Red = Fluorescence
Green = Chlorophyll
Blue = PRI

Leaf Trait Analysis

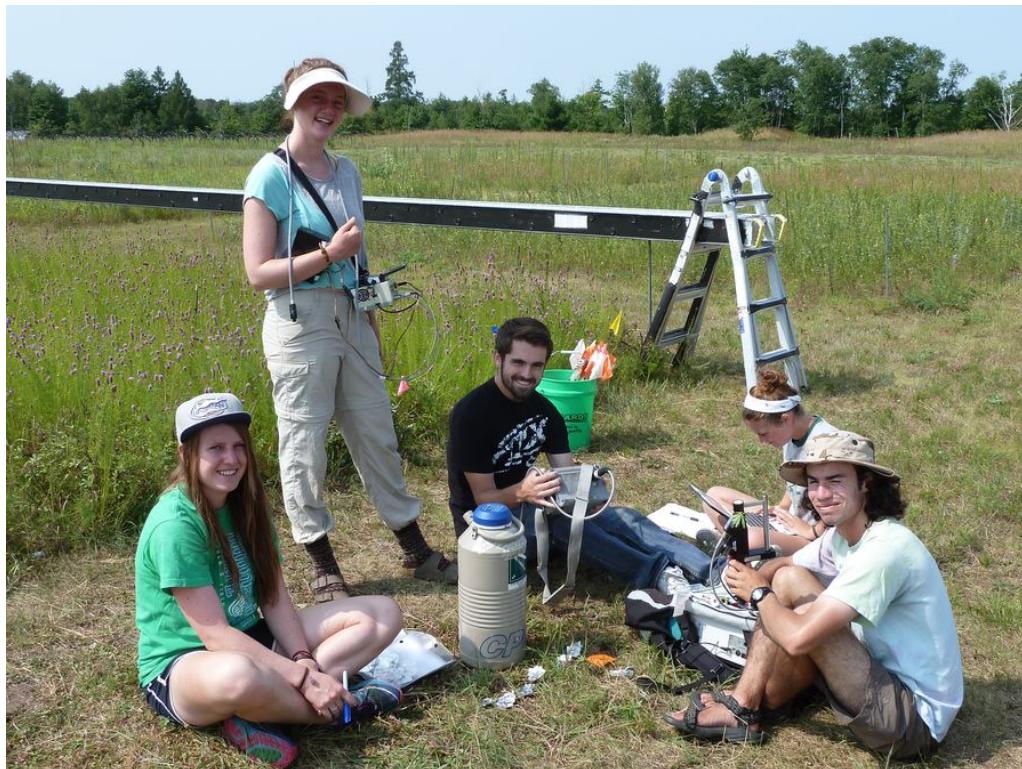


Principle coordinates analysis (PCO) of leaf spectra and other leaf traits (N, C, C:N, LMA, fiber, lignin, cellulose, NDWI, Chl, PRI) distinguish diversity levels.

(Courtesy J. Couture and P. Townsend)



Sampling leaf traits



Initial Conclusions:

- *Optical Diversity* detects species richness
 - Scale dependence not yet clear.
- *Surrogacy* – diversity affects productivity
 - Diversity linked to ecosystem function.
 - This relationship evolves over the season
- *Leaf traits, canopy structure, and phenology* are all important!
 - Relative effect not yet clear.