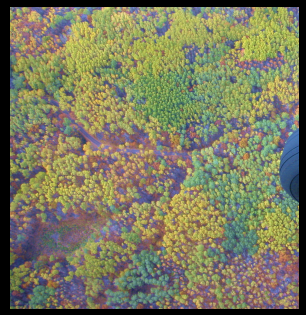
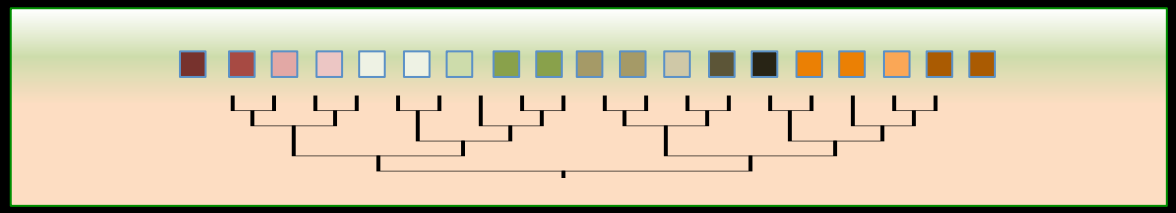
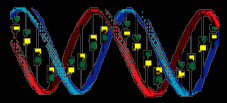
Linking remotely sensed optical diversity to genetic, phylogenetic and functional diversity to predict ecosystem processes

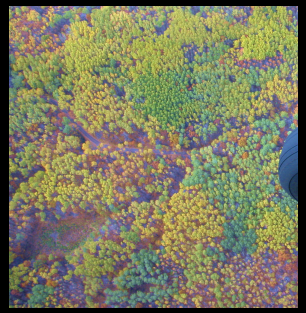




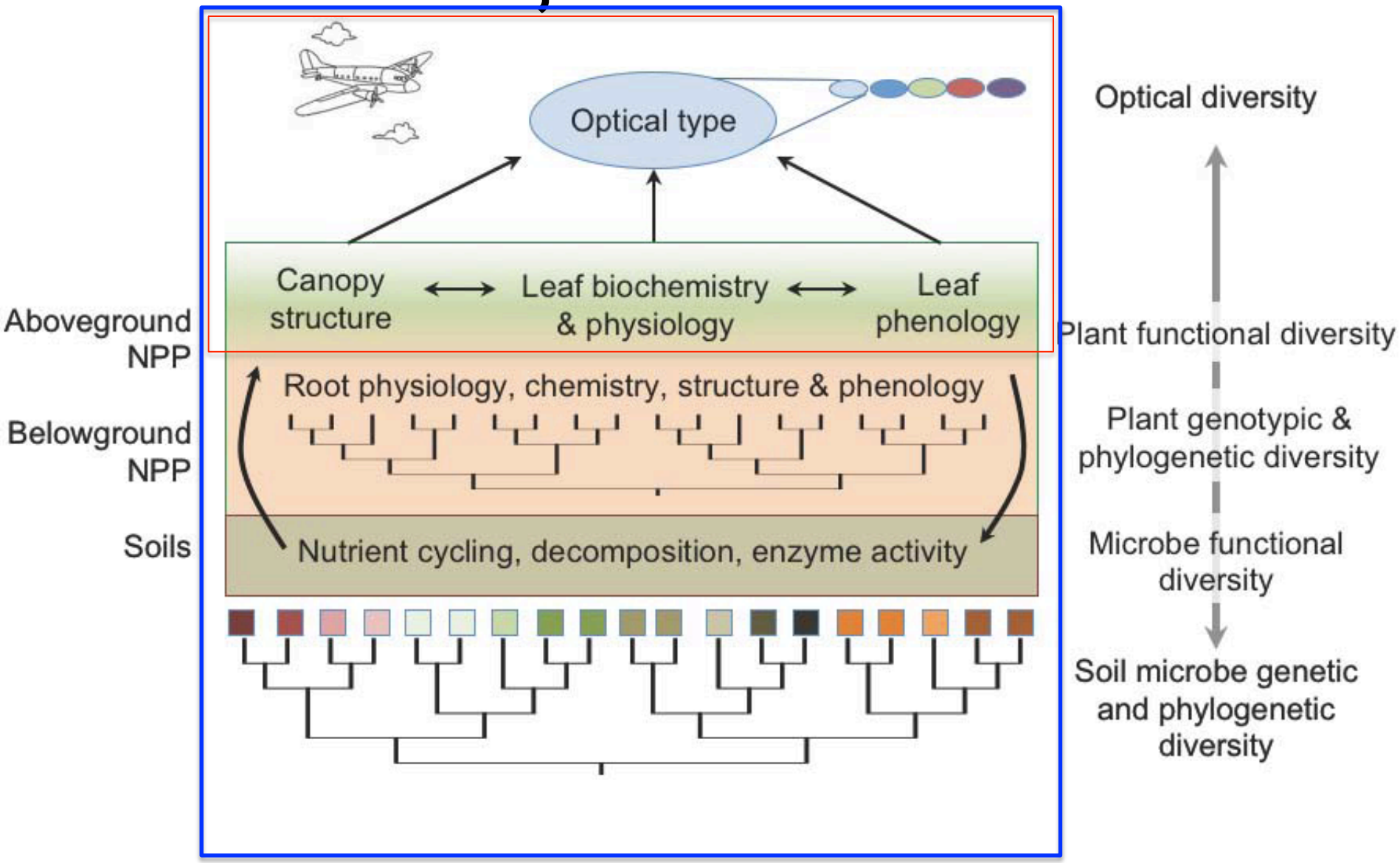


Linking remotely sensed optical diversity to genetic, phylogenetic and functional diversity to predict ecosystem processes

…starting with plants, the base of primary productivity, and linking to other trophic levels

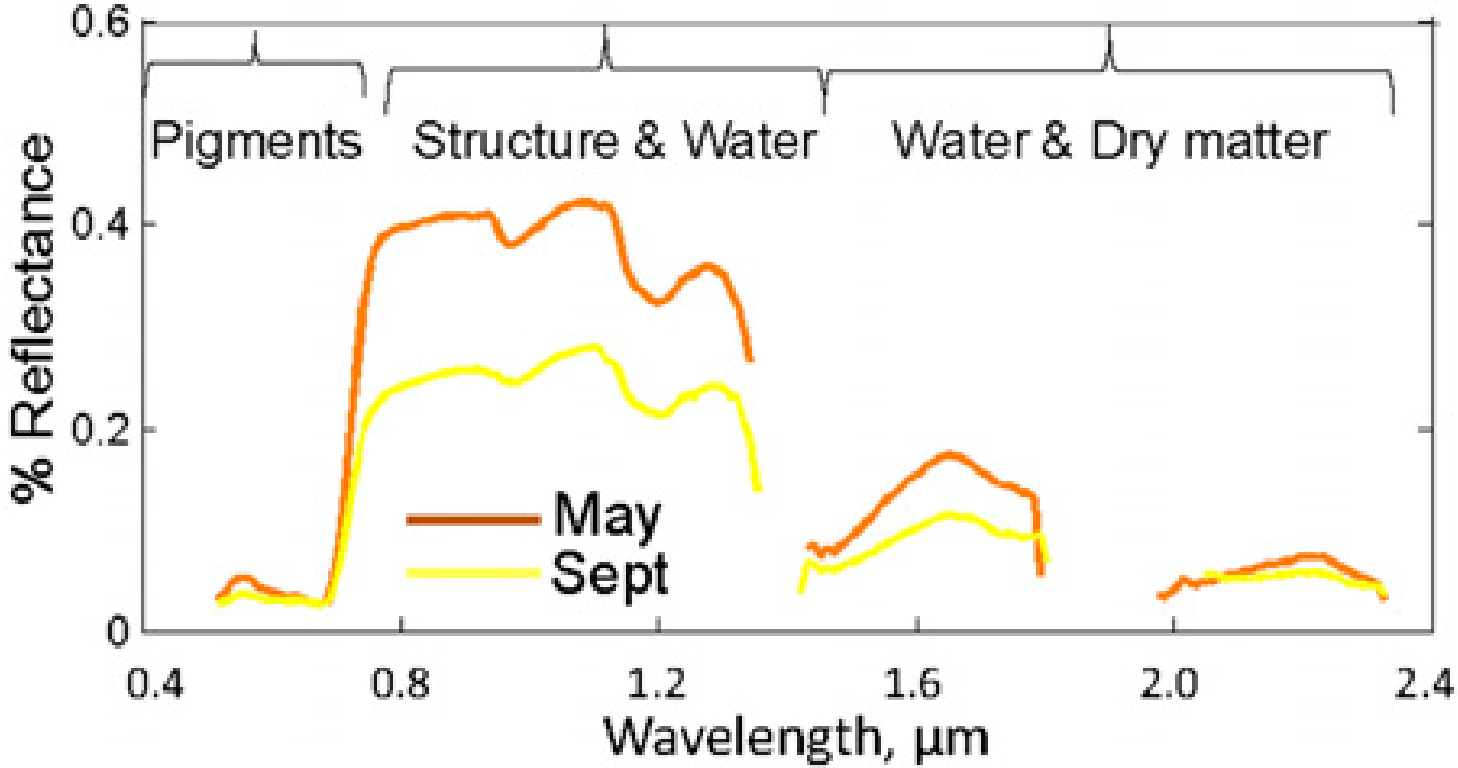


Project Overview

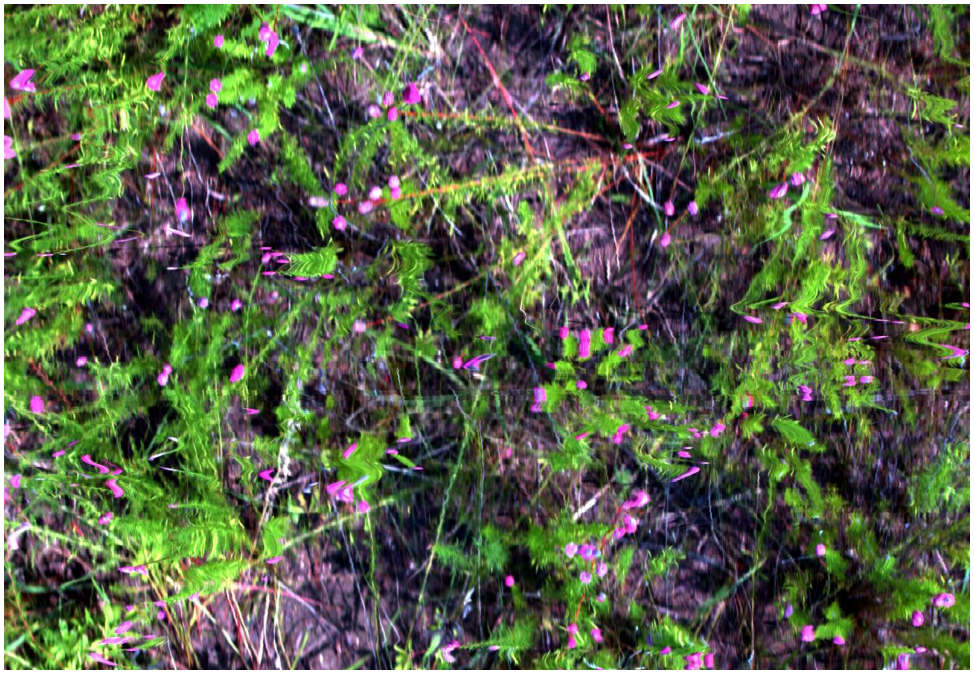


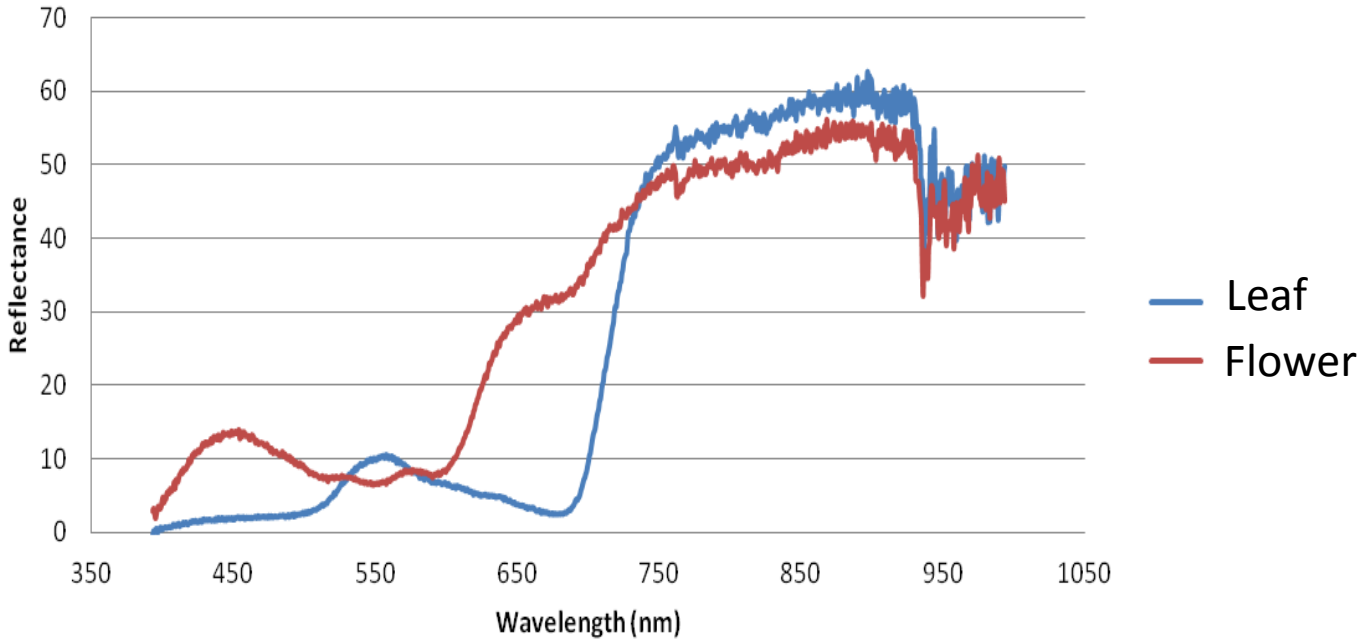
Start with manipulated diversity experiments in prairie and forest

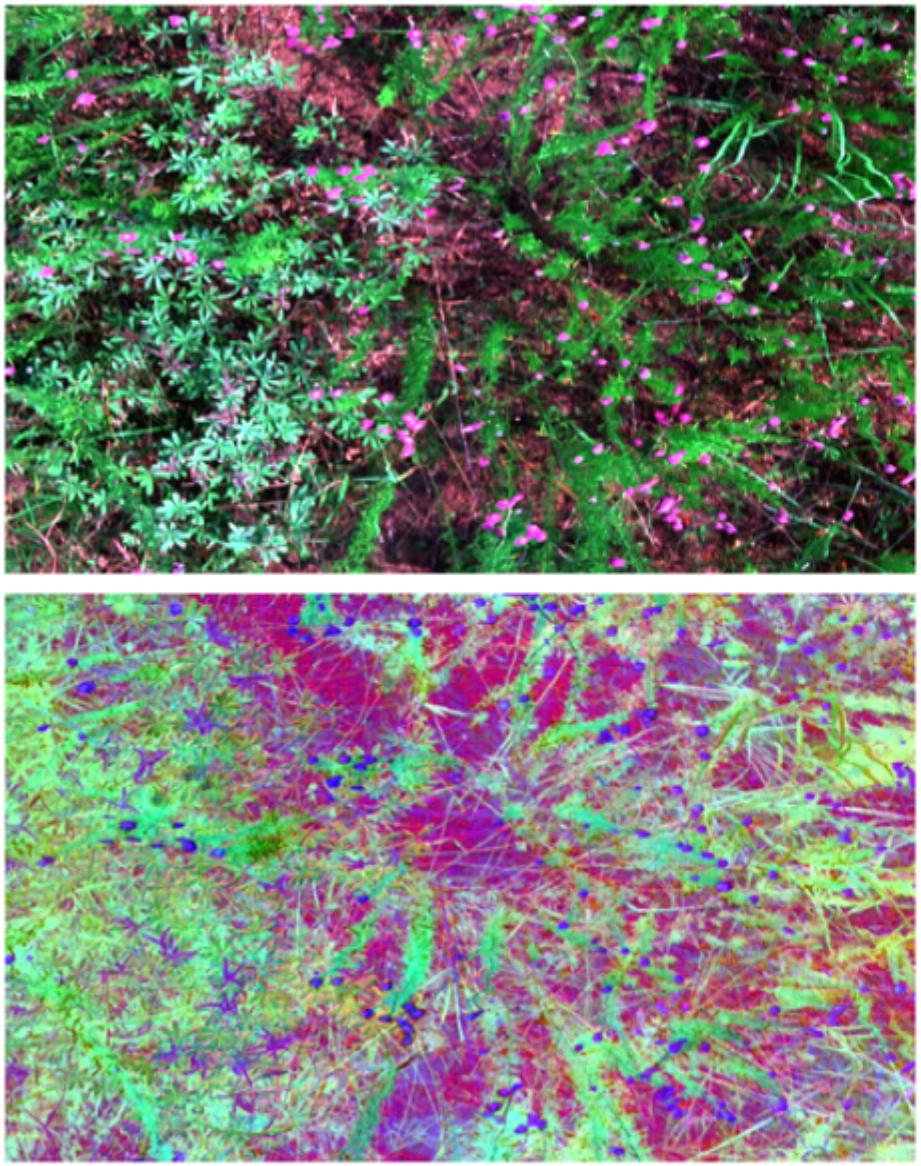
Plant chemistry and structure

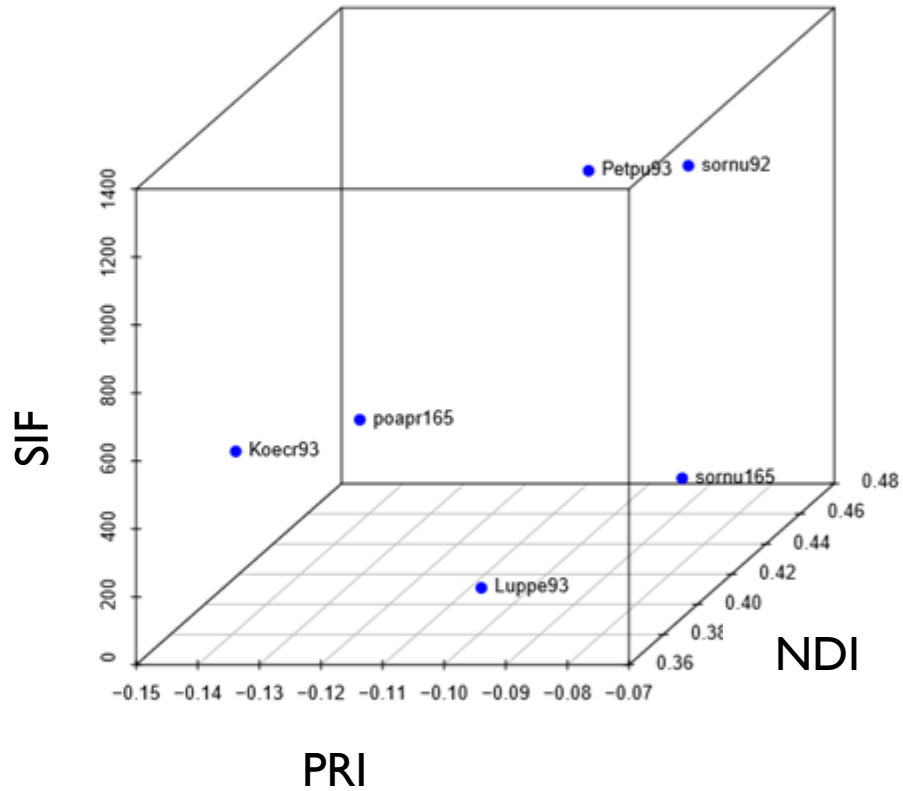


Ustin 2013

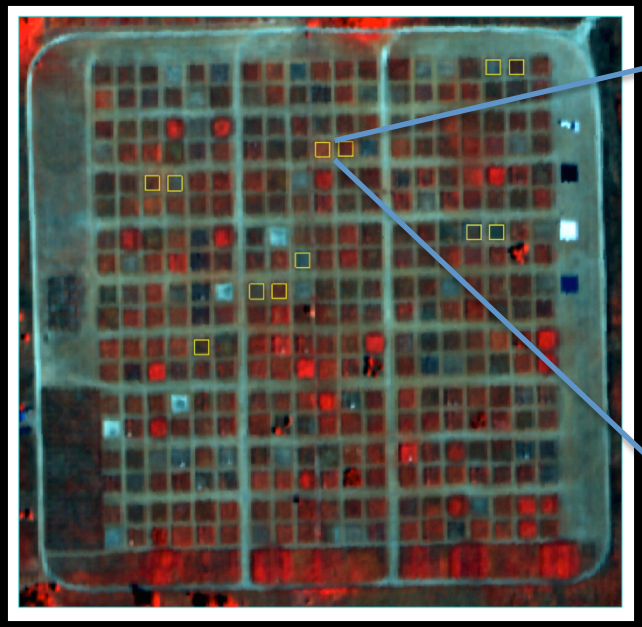


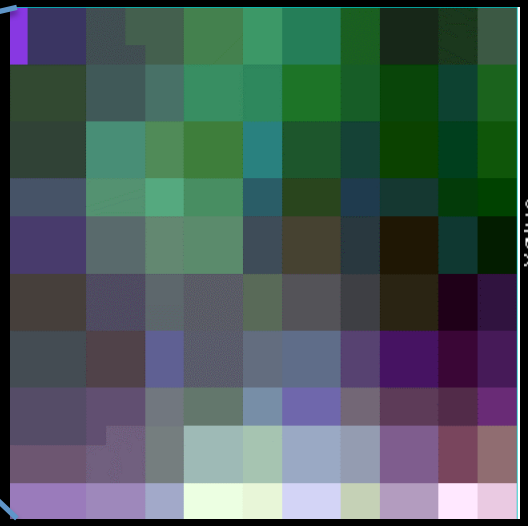

70
60
50
40
30
20
10
0
Reflectance
350
450
550
650
750
850
950
1050
Wavelength (nm)
Leaf
Flower

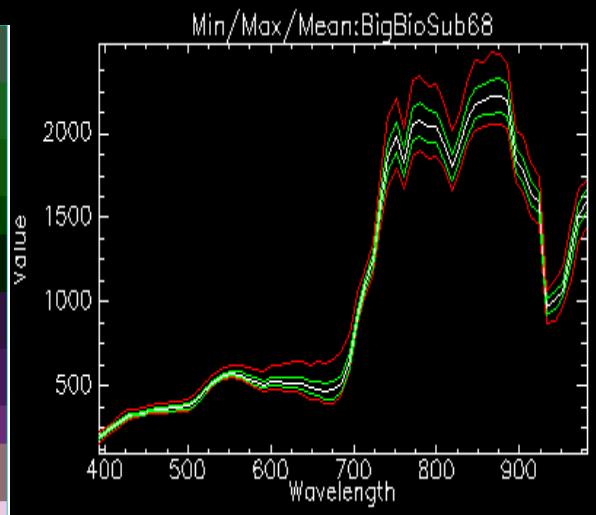


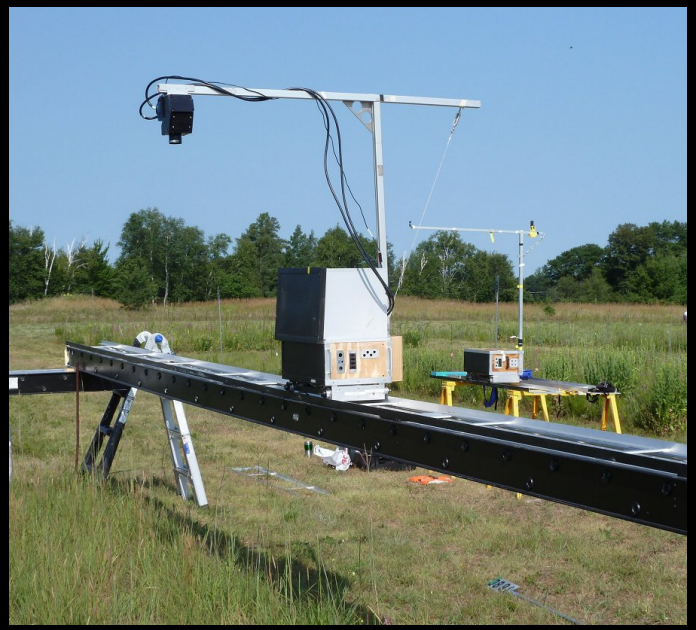

SIF
PRI
NDI
Petpu93
sornu92
poapr165
Koecr93
sornu165
Luppe93
0
200
400
600
800
1000
1200
1400
−0.15
−0.14
−0.13
−0.12
−0.11
−0.10
−0.09
−0.08
−0.07
0.36
0.40
0.42
0.44
0.46
0.48

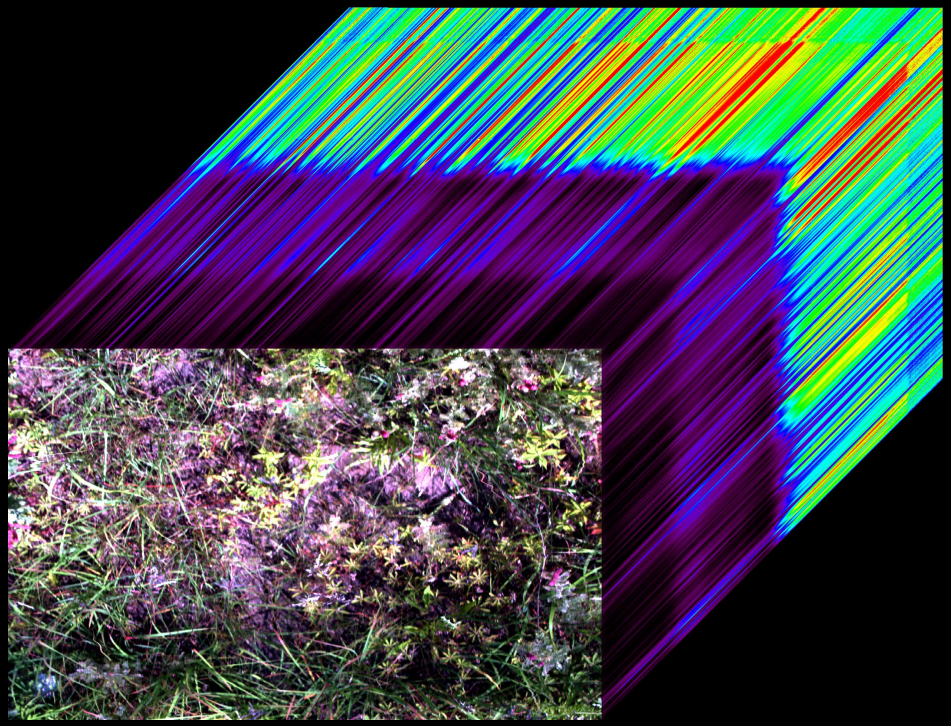
30-year Biodiversity Experiment at Cedar Creek



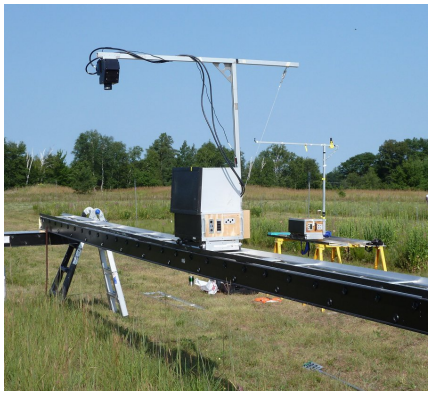



Min/Max/Mean:BigBioSub68
Value
2000
1500
1000
500
400
500
600
700
800
900
Wavelength



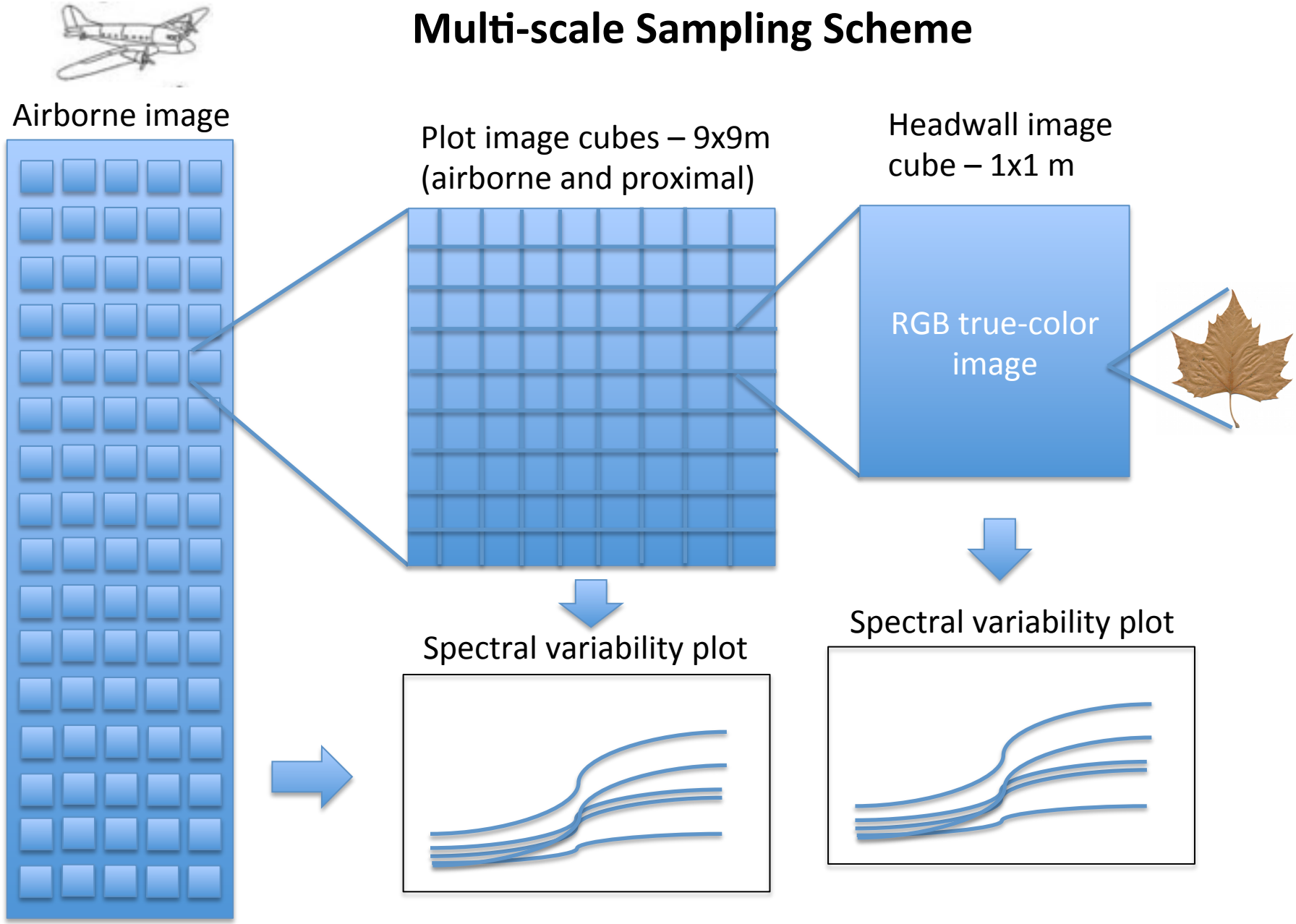


Productivity (NDVI) varies with species richness over time

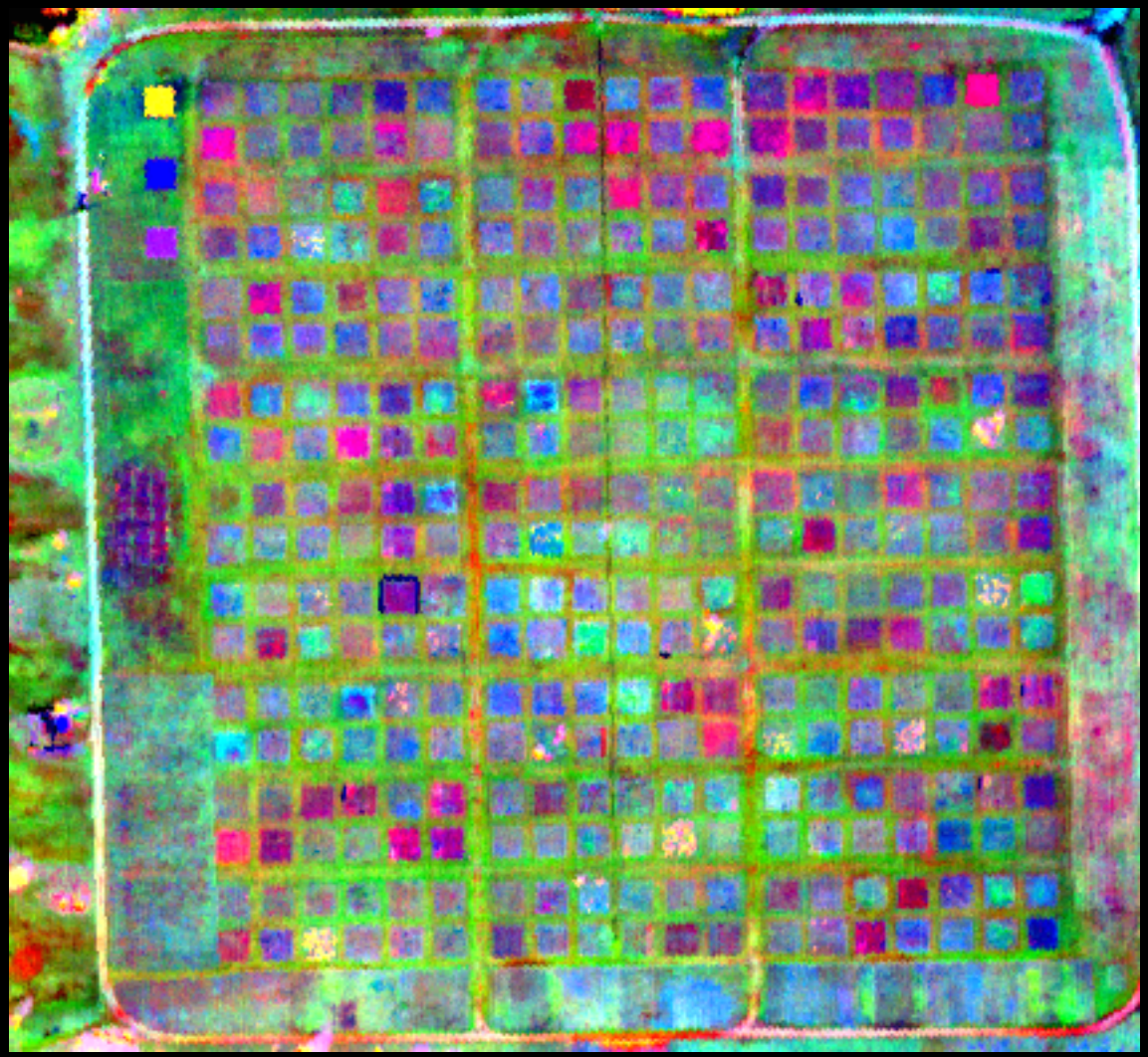


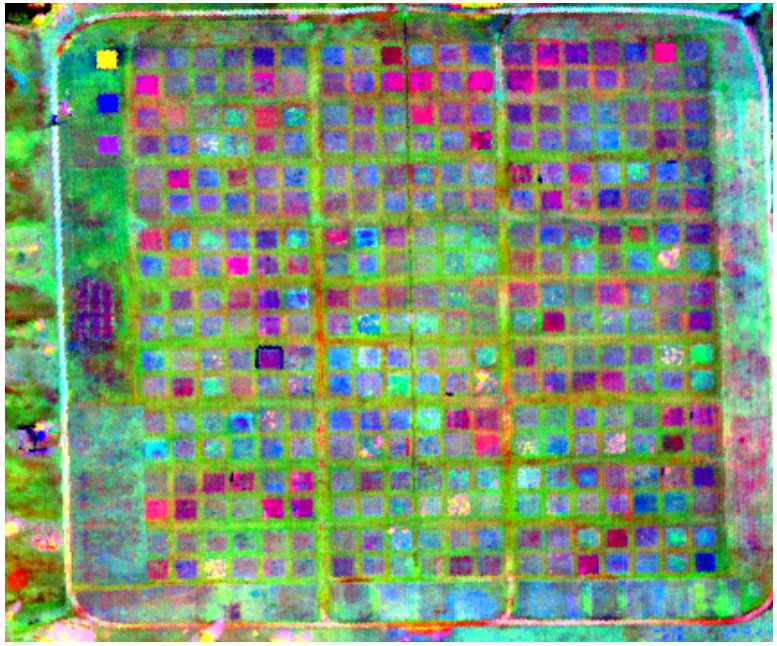
Some unpublished data are not shown

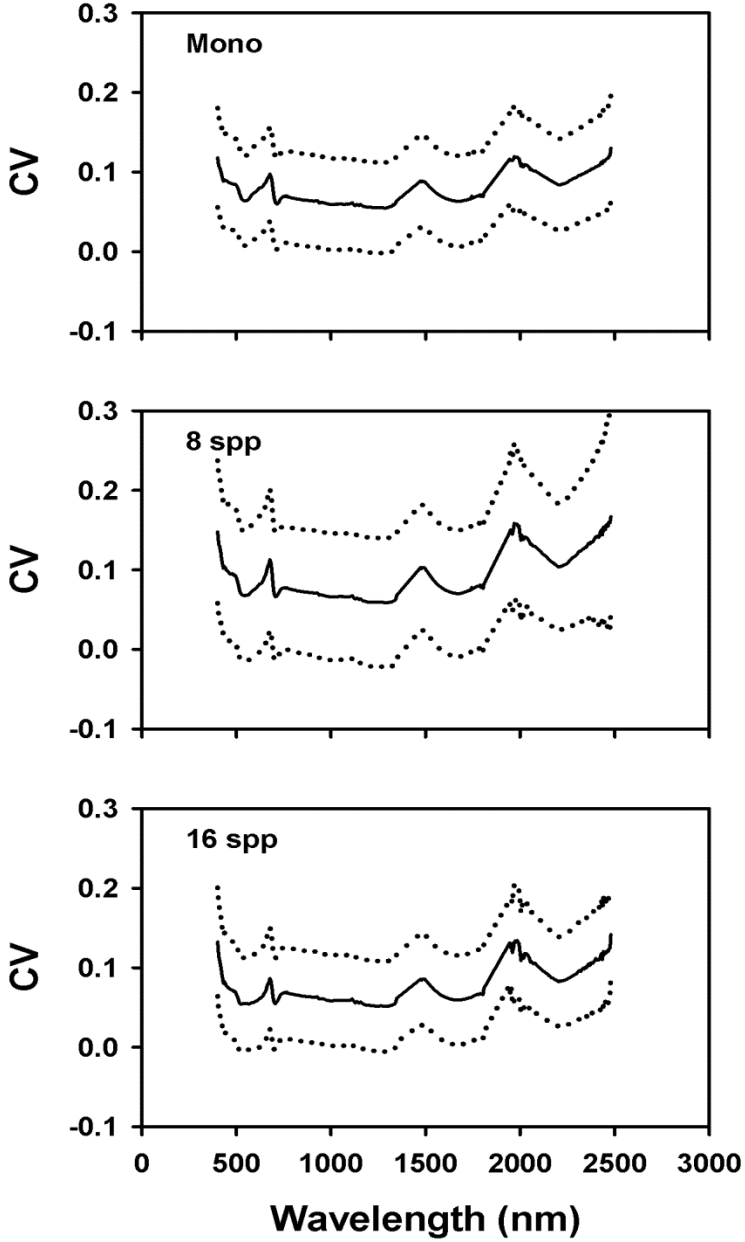
Multi-scale Sampling Scheme



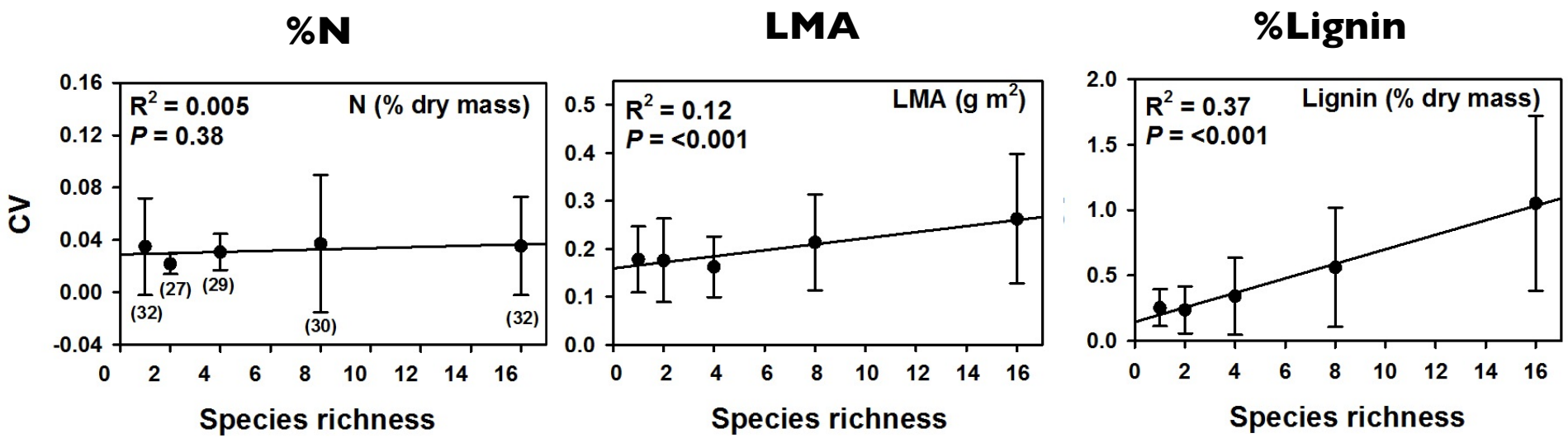
30-year Biodiversity Experiment at Cedar Creek






Mono
8 spp
16 spp
CV
0.3
0.2
0.1
0.0
-0.1
0
500
1000
1500
2000
2500
3000
Wavelength (nm)

Some functional traits vary with vegetation diversity more than others



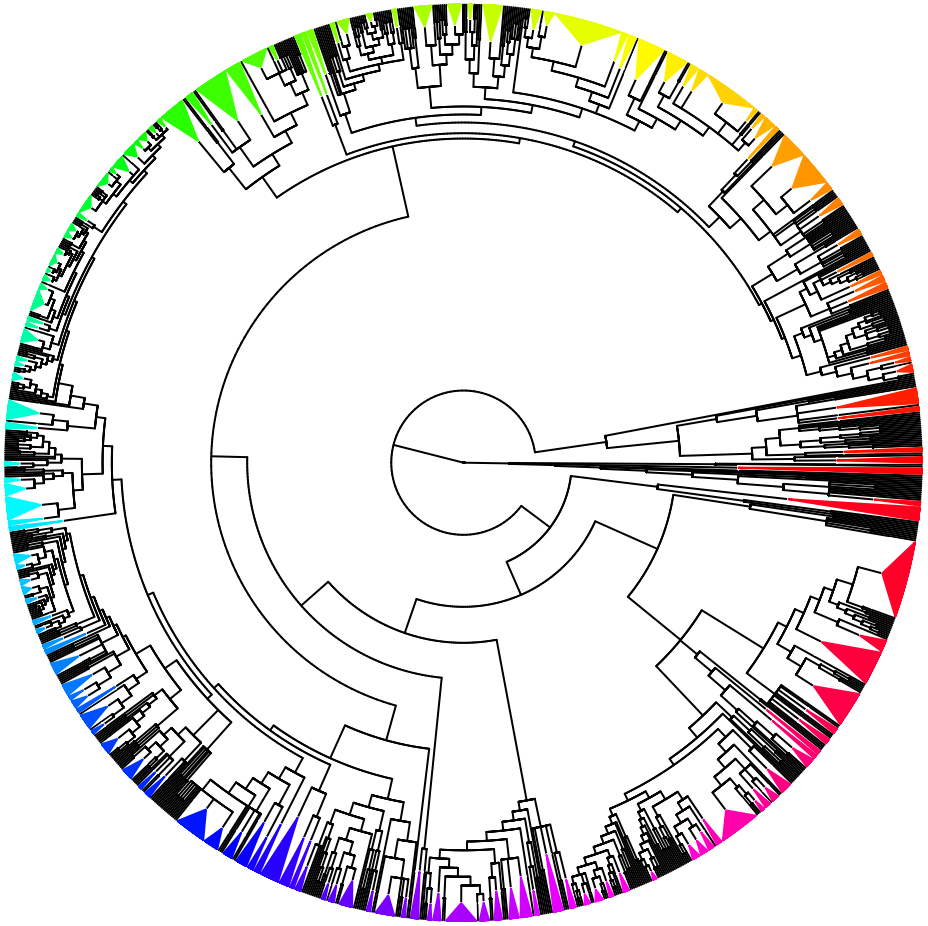
Optical diversity is associated with vegetation biodiversity

SR PD FD

Some unpublished data are not shown

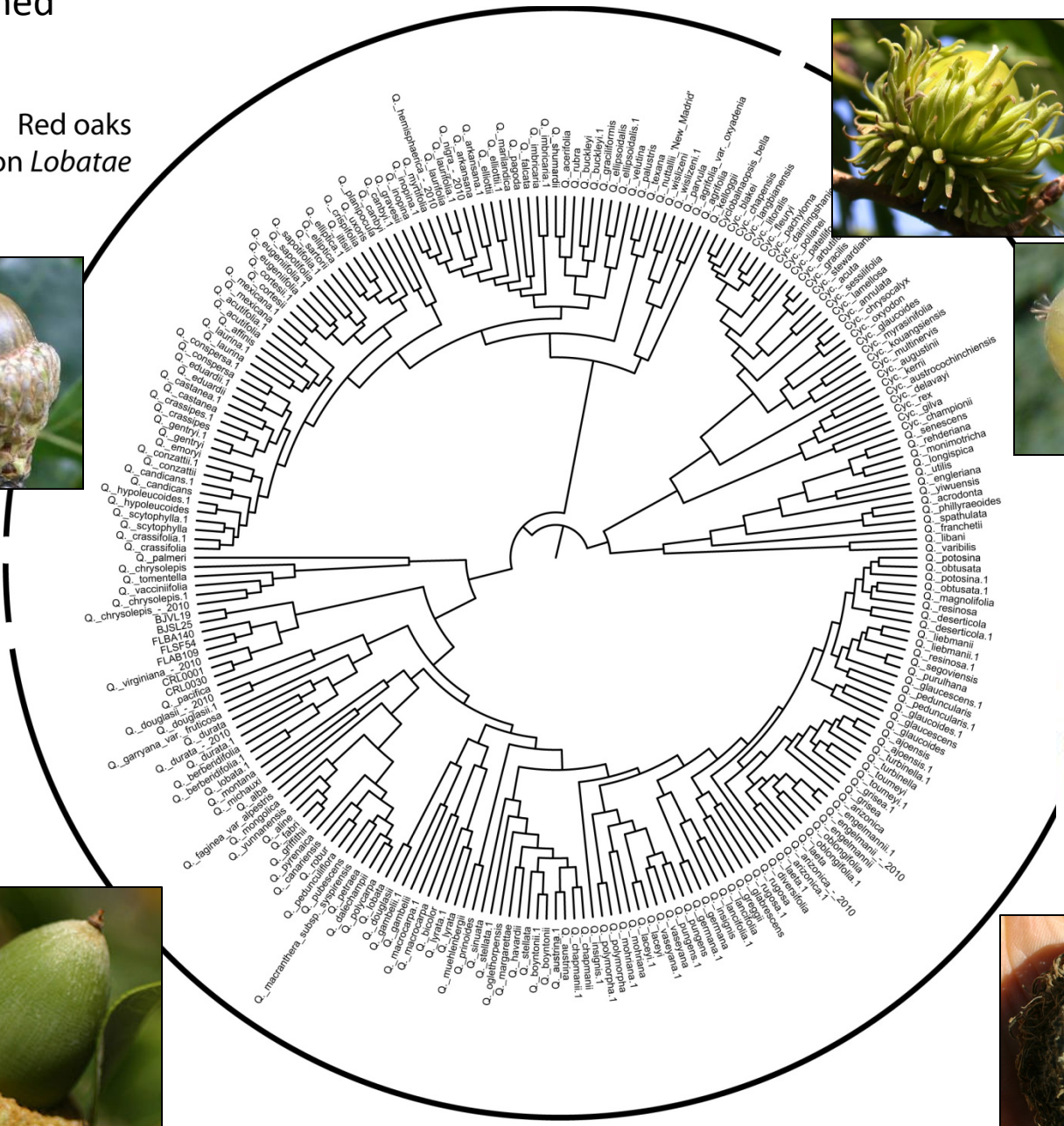
How well can we detect the phylogenetic diversity of plants on Earth?

Shared evolutionary history and niche conservatism cause traits to be predictable from phylogeny (to some degree)



Hipp *et al*, unpublished

Red oaks
Section *Lobatae*



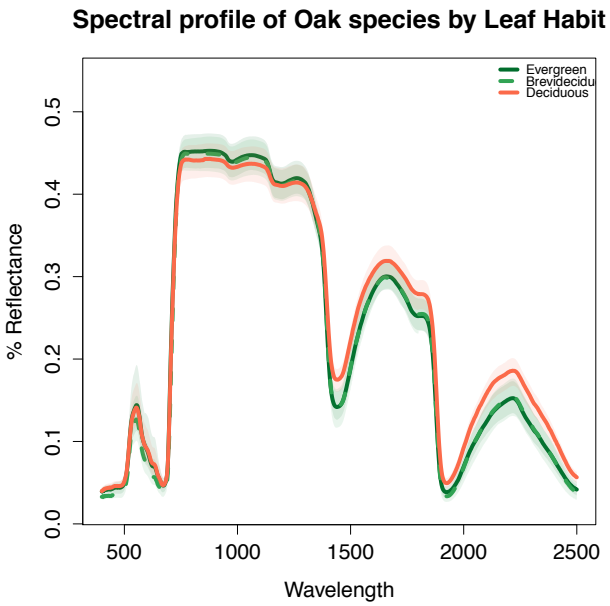
Intermediate oaks
Section *Protobalanus*

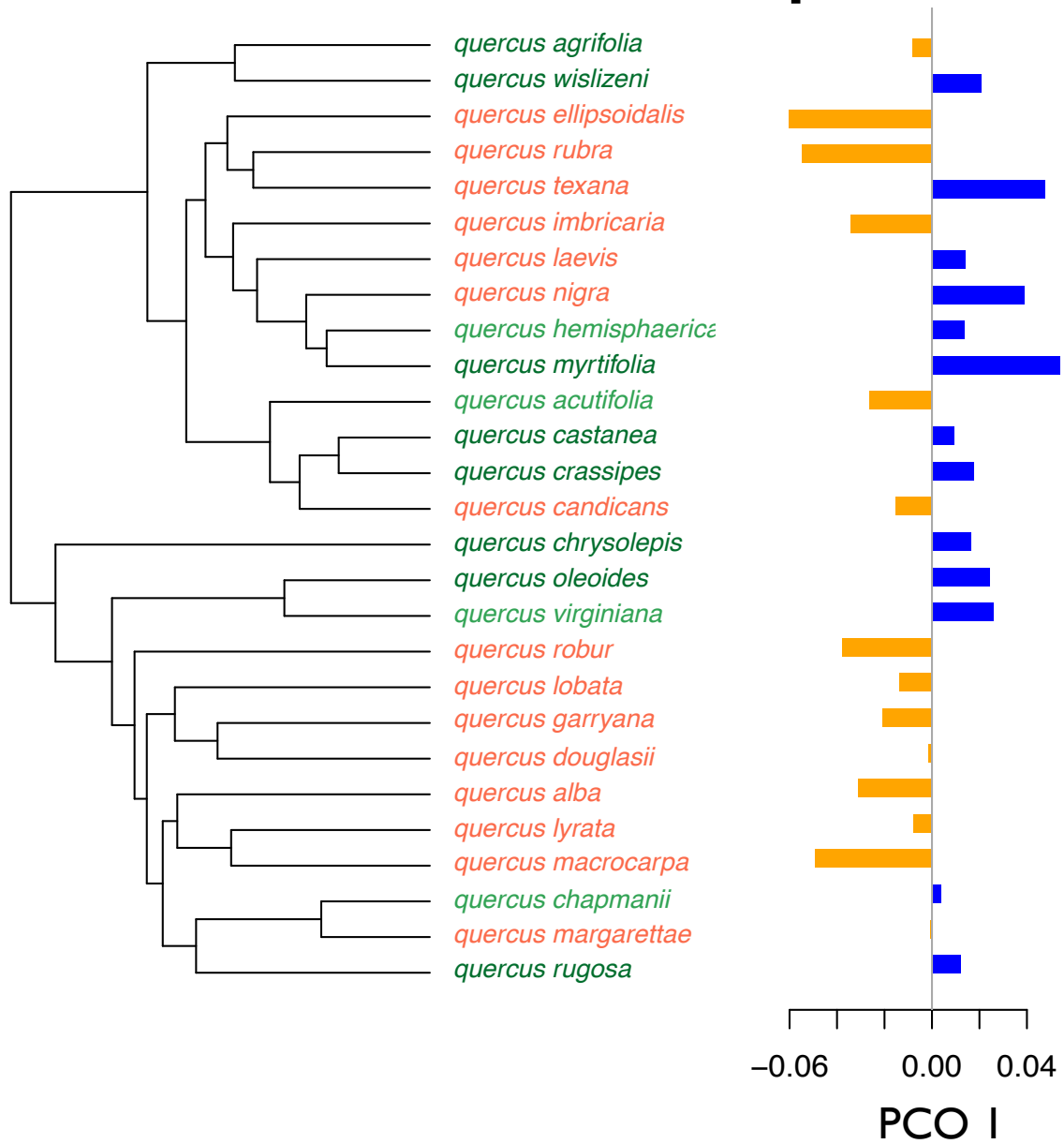
Live oaks
Virentes

Vlad & Marina Butsky / CC-BY 2.0

White oaks -- Section *Quercus*

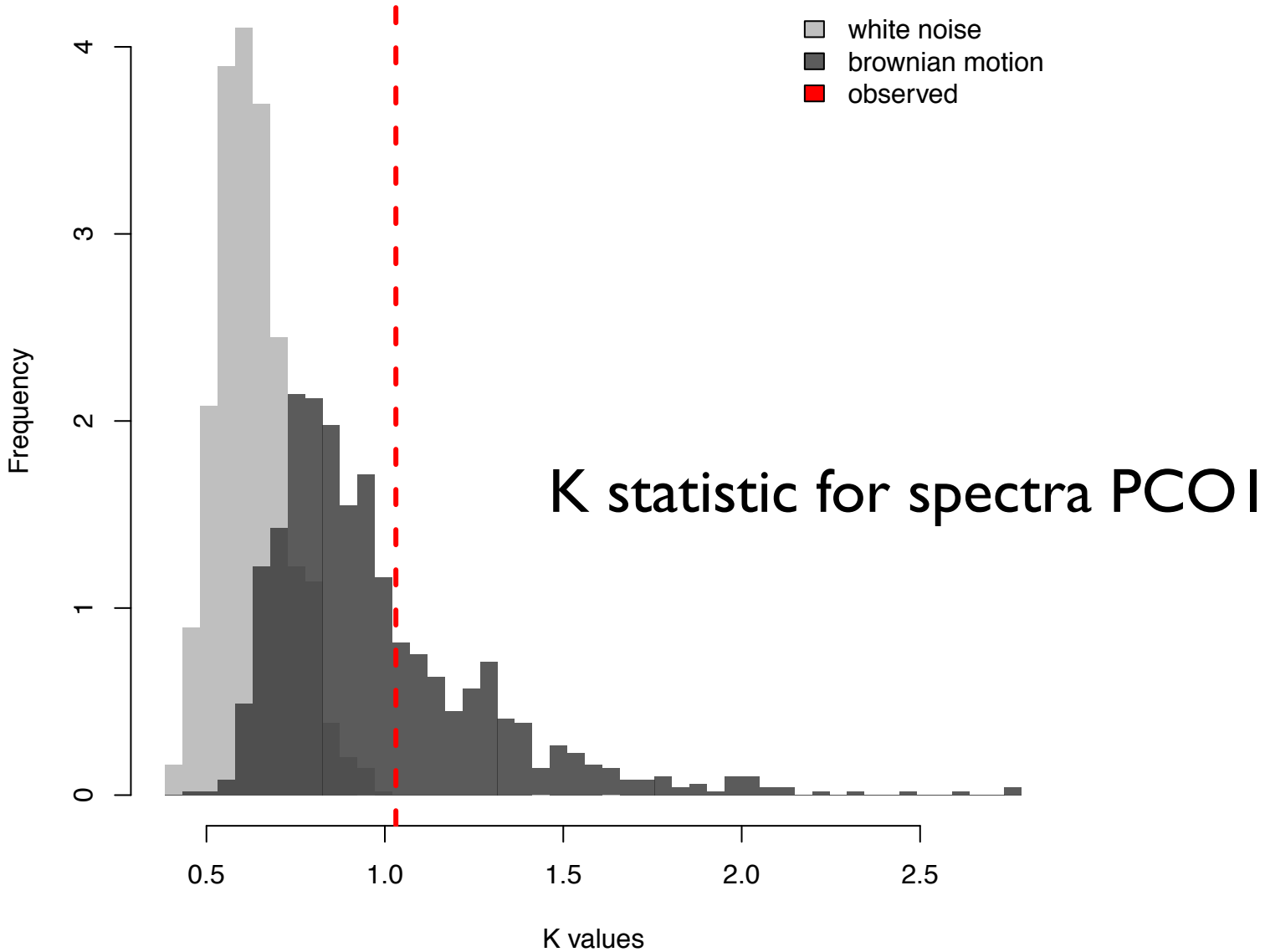
Phylogenetic distribution of leaf spectra



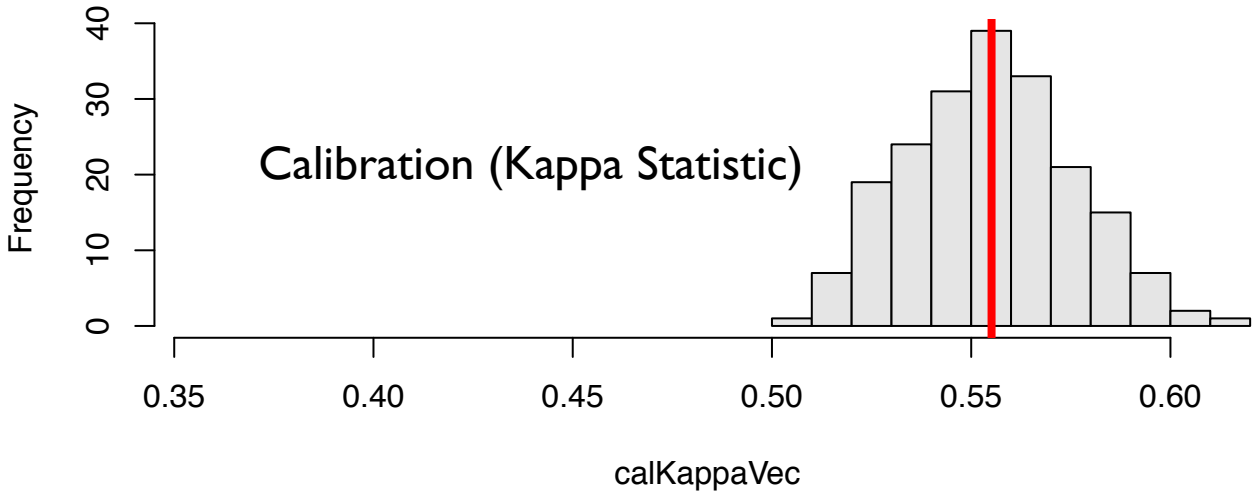


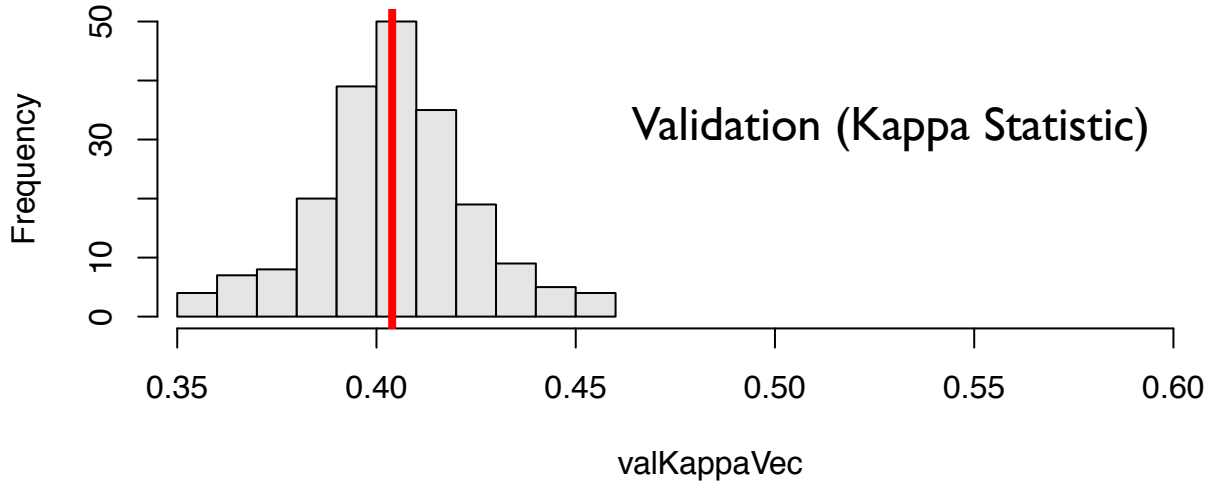
- Evergreen
- Nearly Evergreen
- Deciduous

Strong phylogenetic signal in spectral data

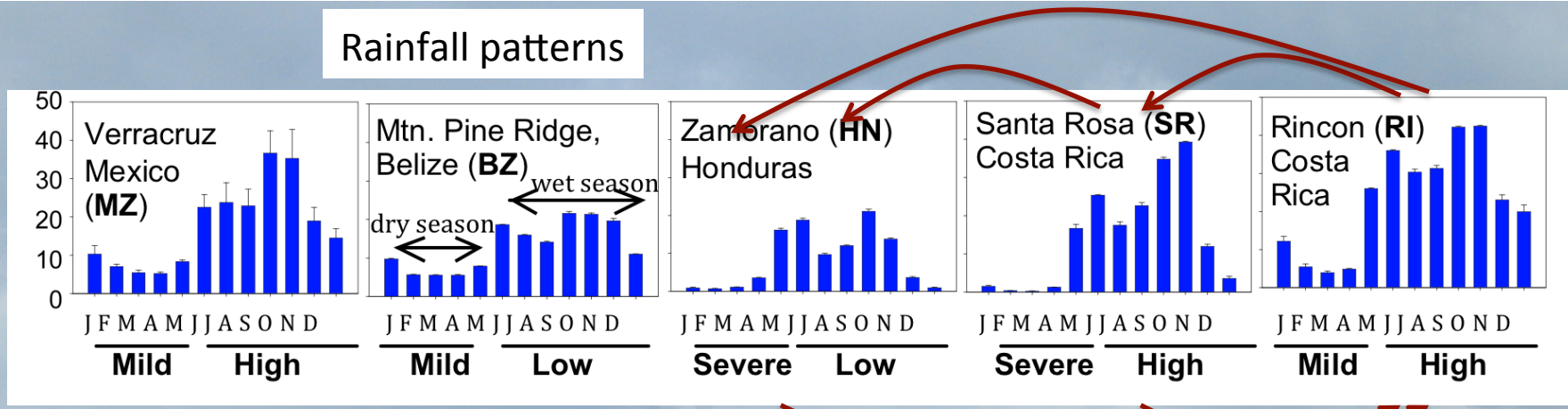


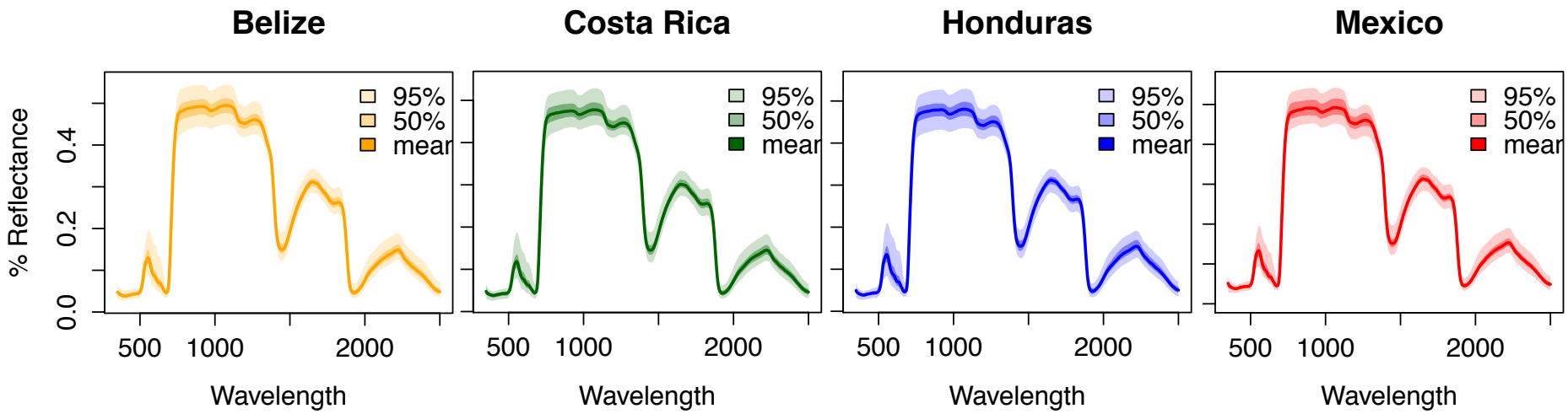
Partial Least Squares - Discriminant Analysis
Oak Species Spectra

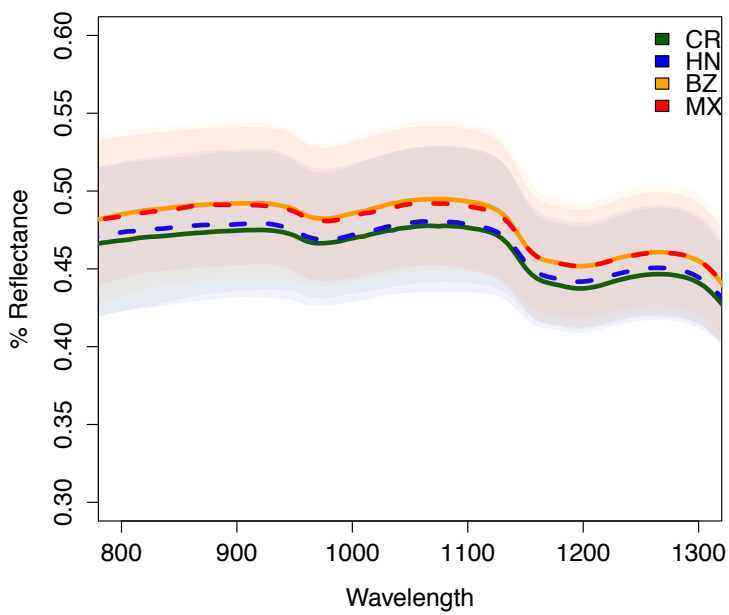


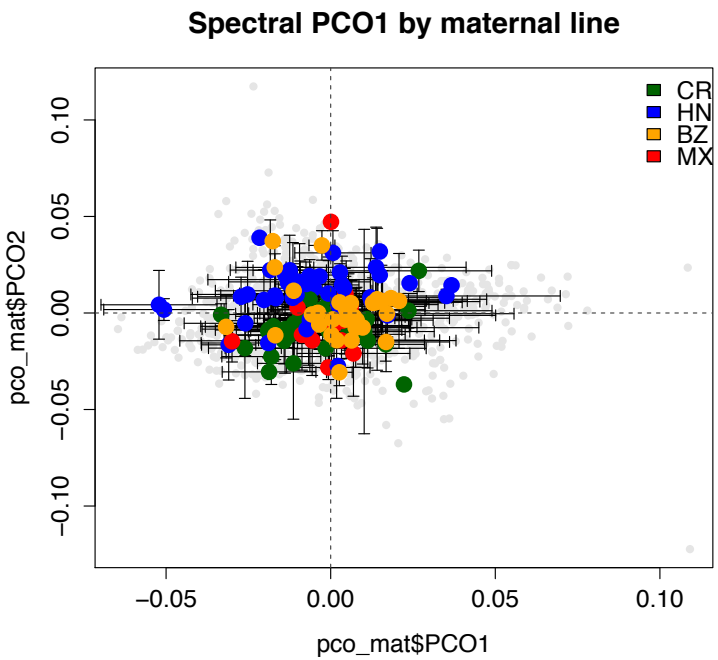


Rainfall patterns

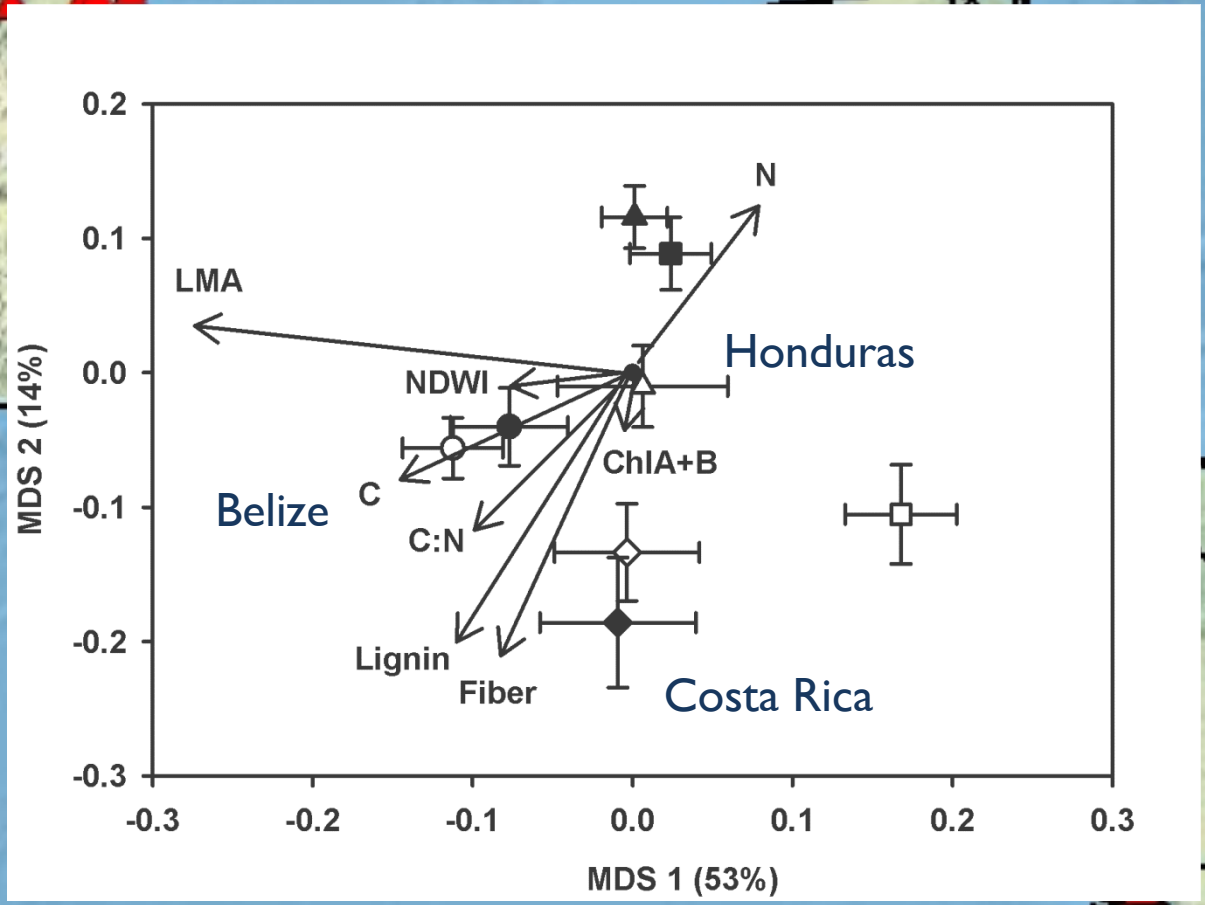



Belize
Costa Rica
Honduras
Mexico
% Reflectance
0.0
0.2
0.4
95%
50%
mean
500
1000
2000
Wavelength


CR
HN
BZ
MX
% Reflectance
0.30
0.35
0.40
0.45
0.50
0.55
0.60
800
900
1000
1100
1200
1300
Wavelength


Spectral PCO1 by maternal line
CR
HN
BZ
MX
pco_mat$PCO2
−0.10
−0.05
0.00
0.05
0.10
pco_mat$PCO1

We are able to detect differences among populations of the same species in watered and unwatered common environments using spectrally derived traits



Watered

Unwatered

Contributing Team

PIs

- Jeannine Cavender-Bares
- John Gamon
- Phil Townsend
- Art Zygielbaum
- Sarah Hobbie
- Mike Madritch
- Rebecca Montgomery

Post docs and students

- John Couture
- Ran Wang
- Keren Bitan
- Jose Meireles
- Aditya Singh
- Clayton Kingdon