122599 [student competition #]

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Roots to Regolith Sources of OM across the National Ecological Observatory Network (NEON) Soil Plots

Authors: Adrian Gallo[1], Jeff Hatten[1], Katherine Heckman[2], Lucas Nave[3], Angela Possinger [6], Michael SanClements[4,5], Brian Strahm[6], Tyler Weiglein[6]

[1]Oregon State University, Corvallis, OR, Forest Engineering, Resources, & Management Department. [2]USDA Forest Service, Climate, Fire & Carbon Cycle Sciences, Northern Research Station. [3]University of Michigan, Pellston, MI, Biological Station and Department of Ecology and Evolutionary Biology. [4]National Ecological Observatory Network (NEON), Boulder, CO. [5]University of Colorado, Boulder, CO, Institute of Arctic & Alpine Research (INSTAAR). [6]Virginia Tech, Blacksburg, VA, Department of Forest Resources and Environmental Conservation.

Oregon Coast Range – Jory Soil Profile

Acknowledgements

Yvan Alleau – Lab Wizard

Co-authors: Jeff Hatten, Katherine Heckman, Lucas Nave, Angela Possinger, Michael SanClements, Brian Strahm

Fellow graduate students: Lauren Matosziuk, Maggie Bowman, Dave Frey, Tyler Weiglein.
Undergraduate helpers: Maylita Brougher, Ethan Donahue, Chantal Jorgensen, Hayden England.

NFS Macrosystems Biology 1340504
NSF Macrosystems Biology RAPID 1733885

Conclusions [Take-home Messages]

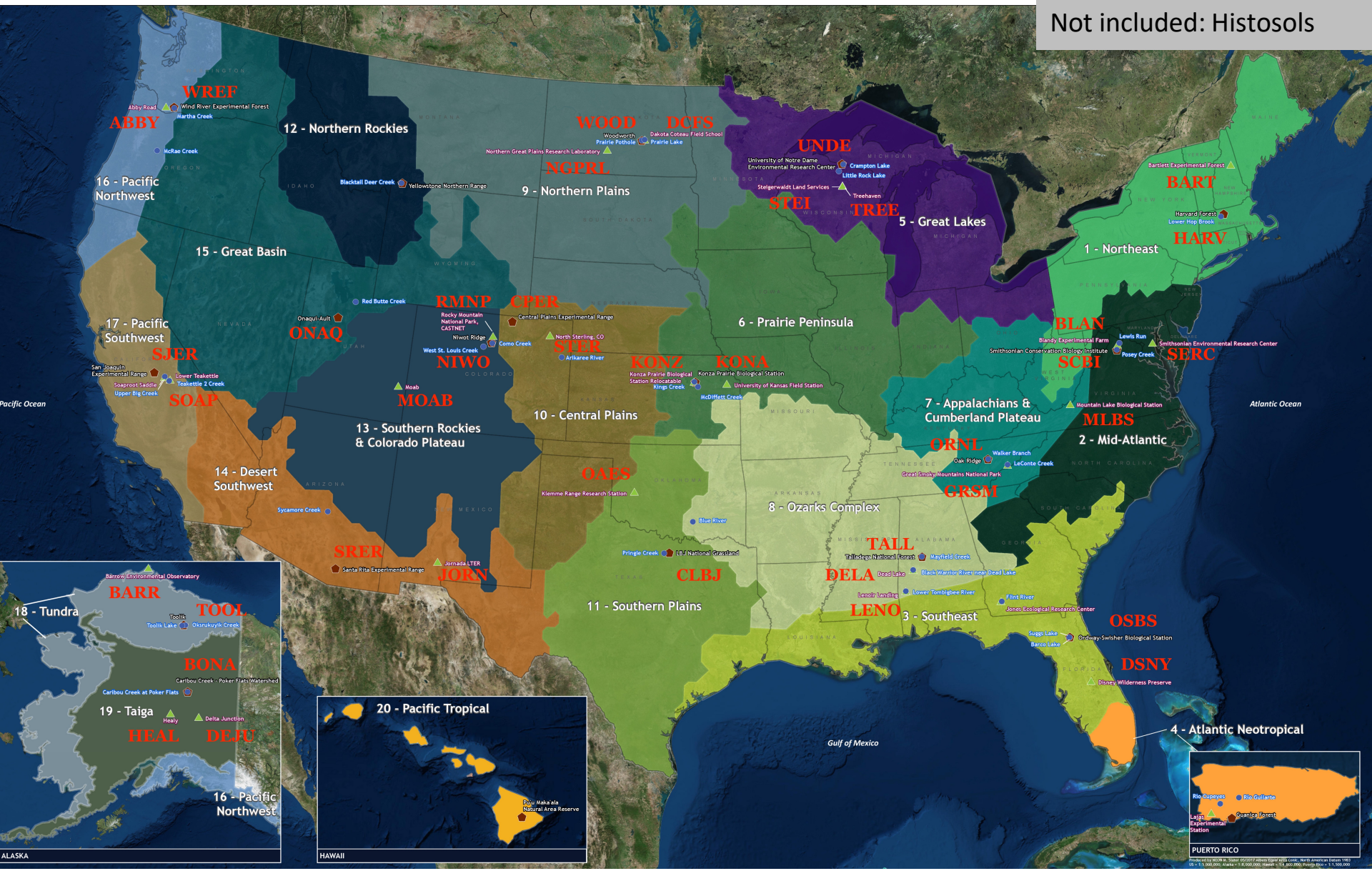
- Lignin = Plant tracer
  - Lignin is abundant *ACROSS* ecosystems
  - Lignin is abundant *DOWN* soil profiles
  - Majority of lignin (i.e. plant OM) is stabilized by mineral associations

- Angiosperm vs Gymnosperm SOM signal is **robust**

- [Future Work] Roots vs Shoots

NEON Project

Observation time: 30-yrs
Eco-climatic domains: 20
Terrestrial sites: ~40
Soil Orders: 11 out of 12
Not included: Histosols



NEON Project

Observation time: 30-yrs
Eco-climatic domains: 20
Terrestrial sites: ~40
Soil Orders: 9 out of 12
Not included: Histosols

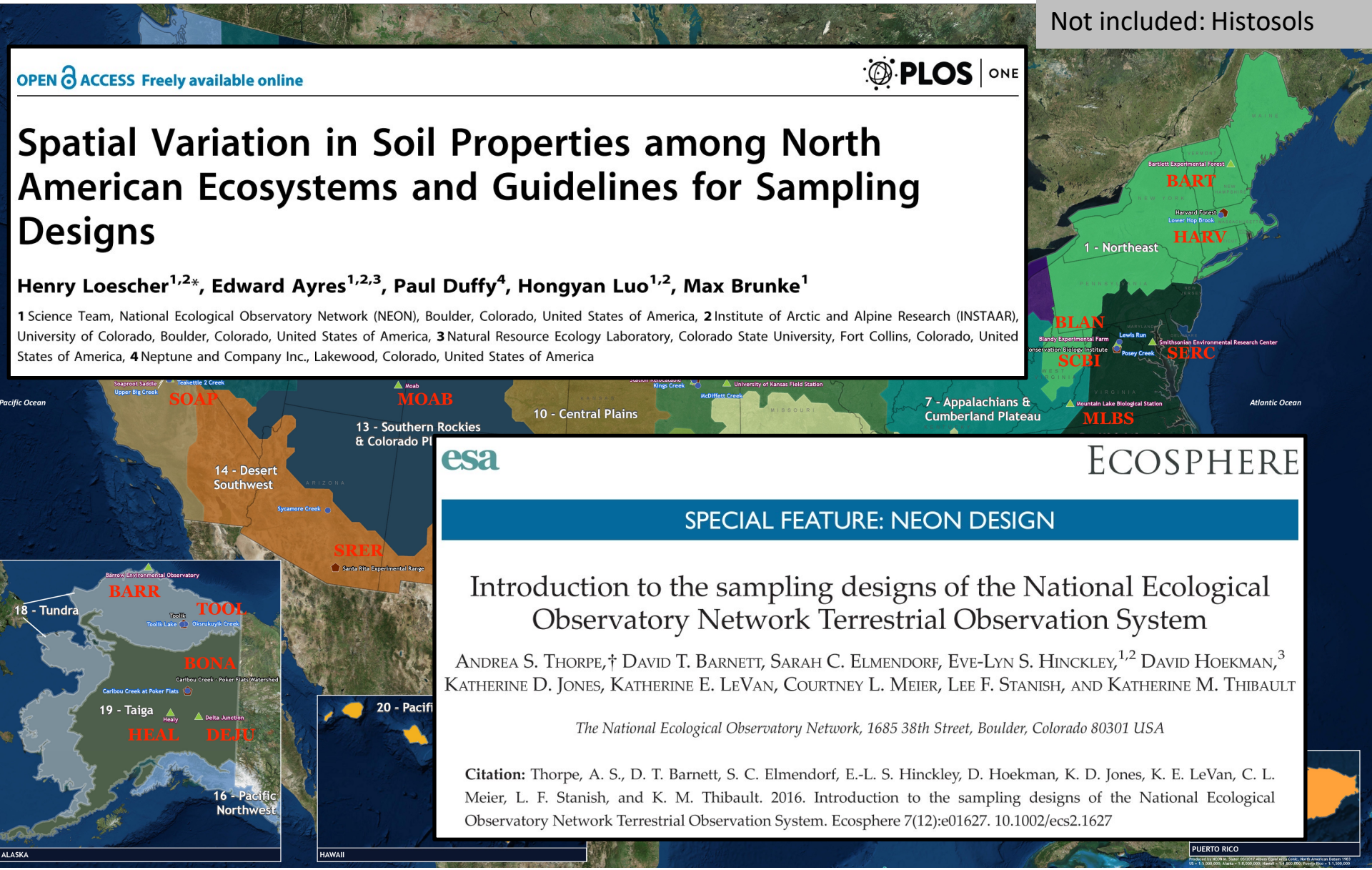
OPEN ACCESS Freely available online

PLOS ONE

Spatial Variation in Soil Properties among North American Ecosystems and Guidelines for Sampling Designs

Henry Loescher[1,2]*, Edward Ayres[1,2,3], Paul Duffy[4], Hongyan Luo[1,2], Max Brunke[1]

1 Science Team, National Ecological Observatory Network (NEON), Boulder, Colorado, United States of America, **2** Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, Colorado, United States of America, **3** Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado, United States of America, **4** Neptune and Company Inc., Lakewood, Colorado, United States of America



esa ECOSPHERE

SPECIAL FEATURE: NEON DESIGN

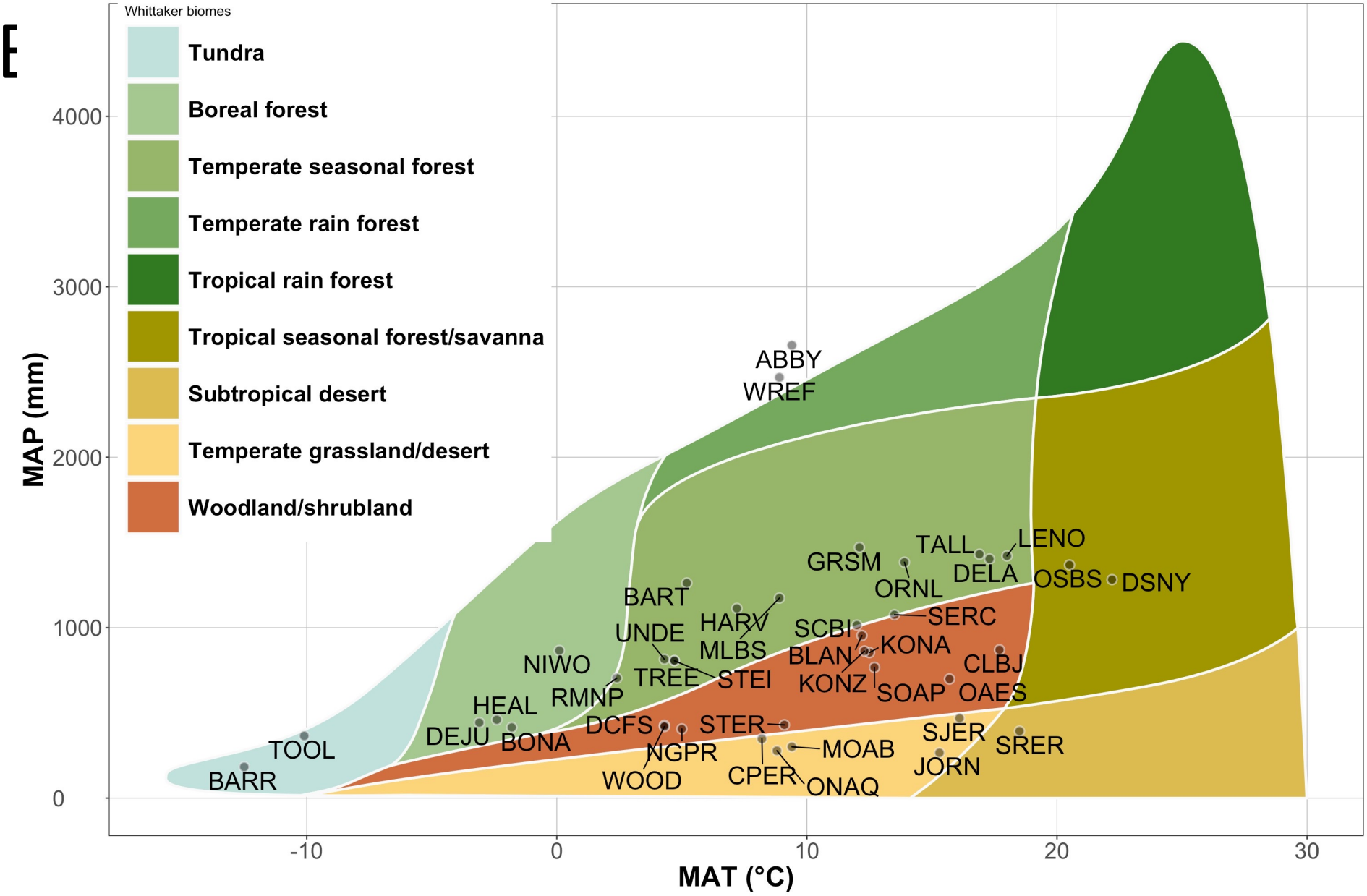
Introduction to the sampling designs of the National Ecological Observatory Network Terrestrial Observation System

ANDREA S. THORPE,† DAVID T. BARNETT, SARAH C. ELMENDORF, EVE-LYN S. HINCKLEY,[1,2] DAVID HOEKMAN,[3] KATHERINE D. JONES, KATHERINE E. LEVAN, COURTNEY L. MEIER, LEE F. STANISH, AND KATHERINE M. THIBAULT

The National Ecological Observatory Network, 1685 38th Street, Boulder, Colorado 80301 USA

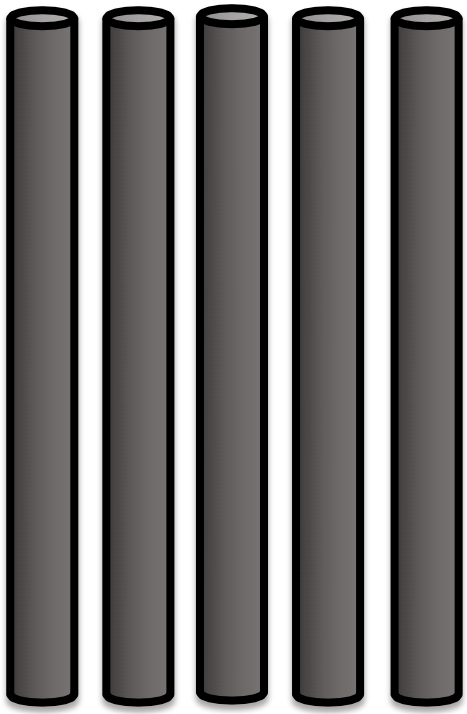
Citation: Thorpe, A. S., D. T. Barnett, S. C. Elmendorf, E.-L. S. Hinckley, D. Hoekman, K. D. Jones, K. E. LeVan, C. L. Meier, L. F. Stanish, and K. M. Thibault. 2016. Introduction to the sampling designs of the National Ecological Observatory Network Terrestrial Observation System. Ecosphere 7(12):e01627. 10.1002/ecs2.1627

NEON Project ~ Whittaker



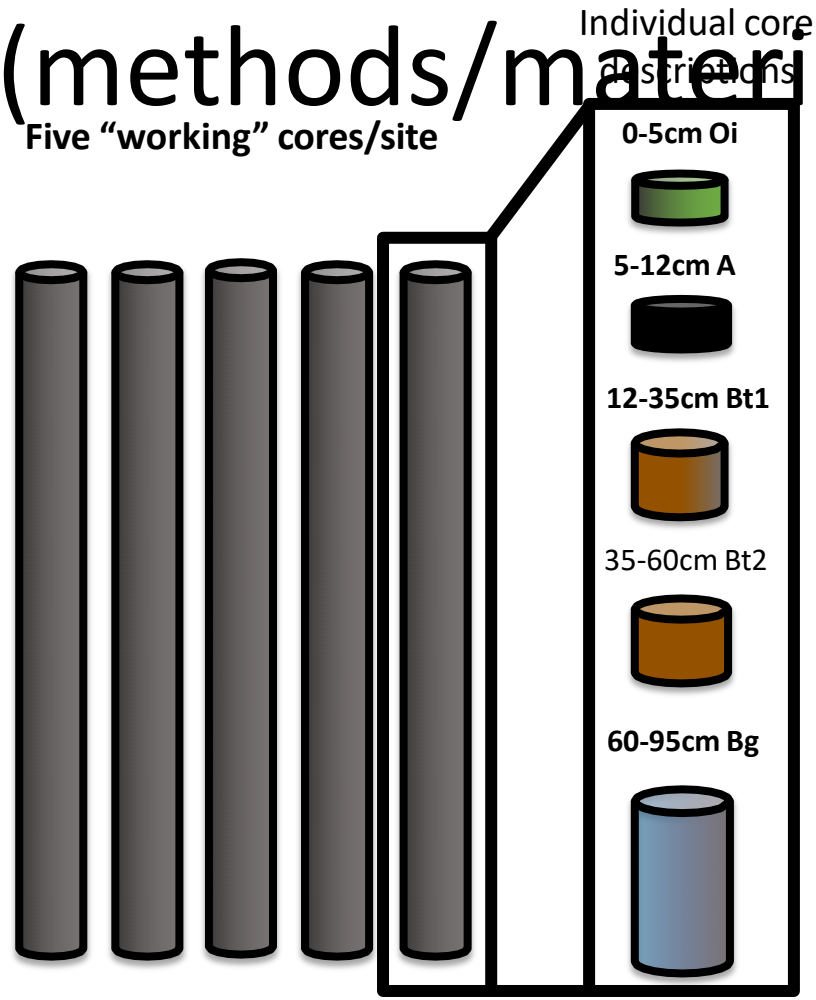
This Project (methods/materials)

Five “working” cores/site



Five “archive” cores/site frozen upon arrival to OSU & stored at the Univ. Michigan Biological Station - Michigan (Nave)

This Project (methods/materials)



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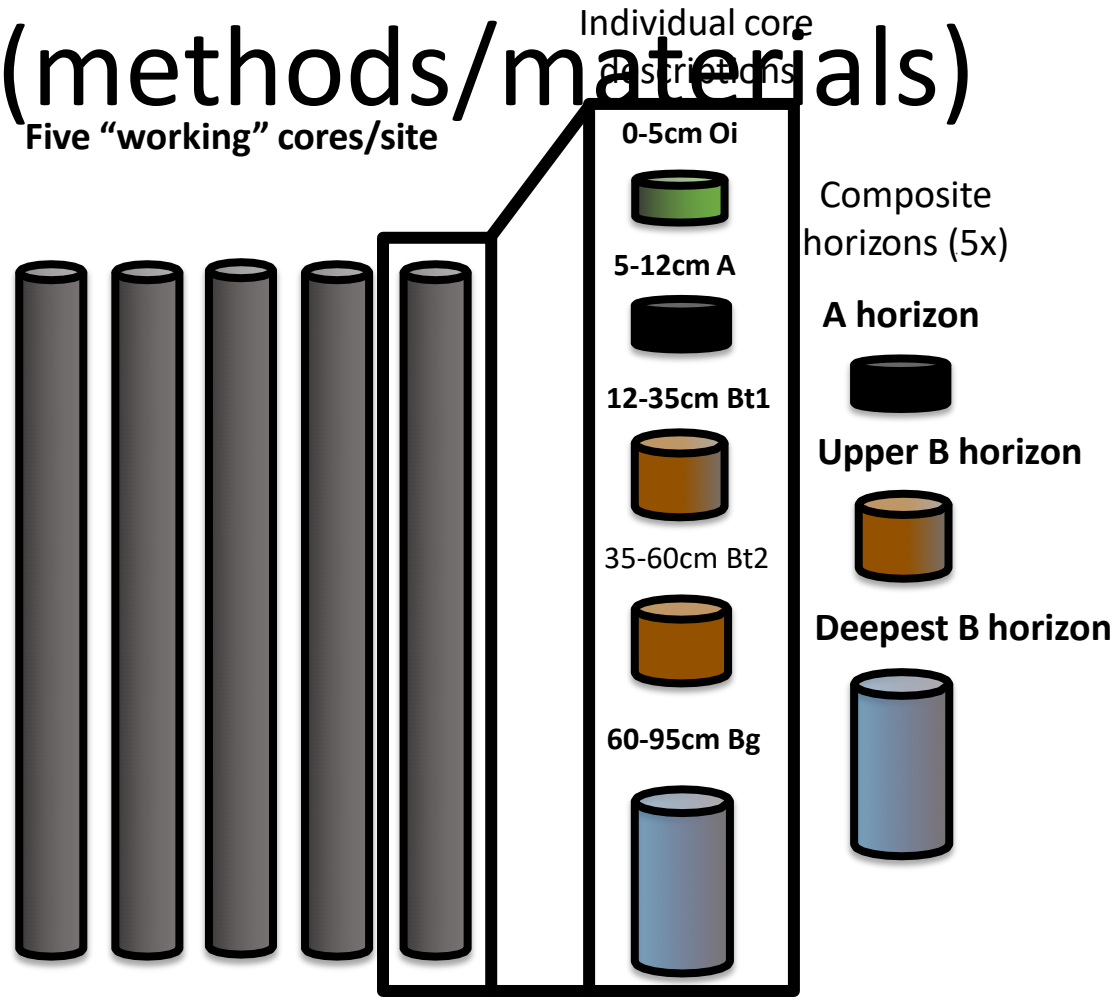

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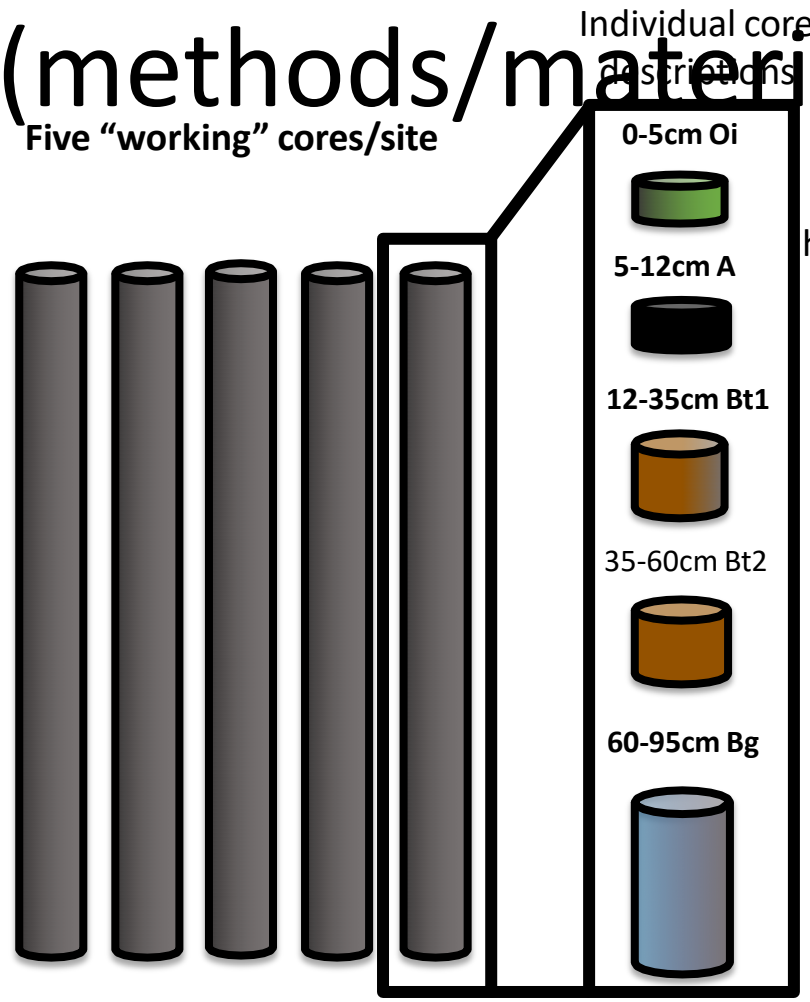


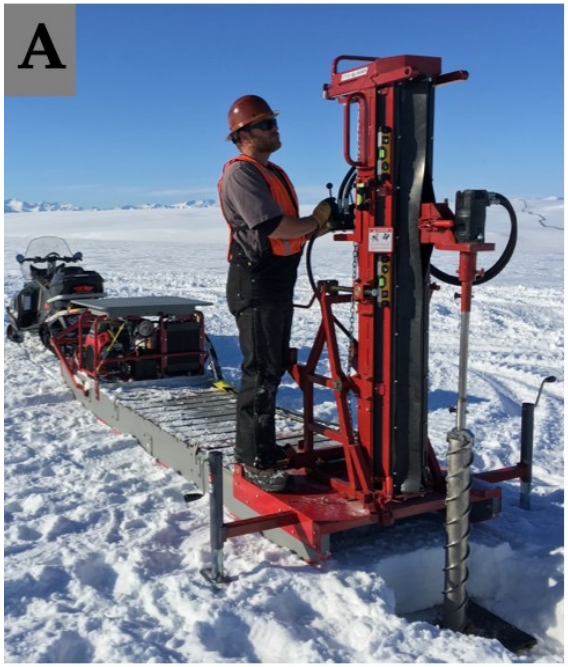
Five "archive" cores/site frozen upon arrival to OSU & stored at the Univ. Michigan Biological Station - Michigan (Nave)

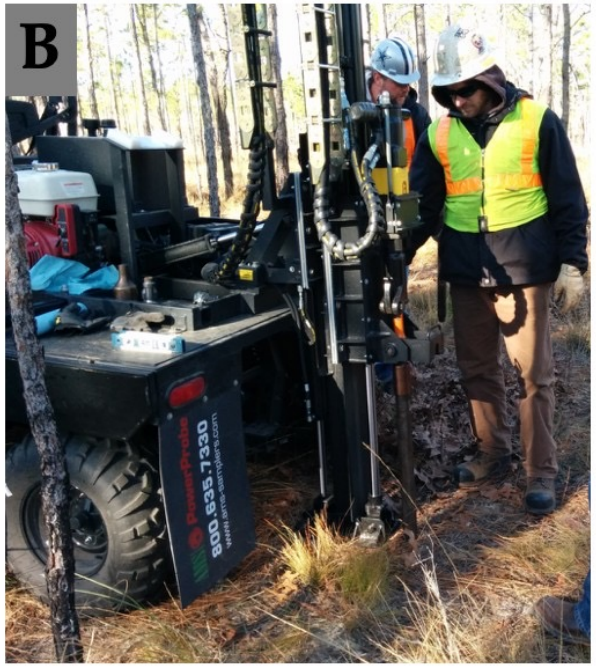
Oregon State (Hatten/Gallo)
Soil characterization, pH, organic solvent extractions, **biomarkers**, BPCA, elemental analysis-ICP.

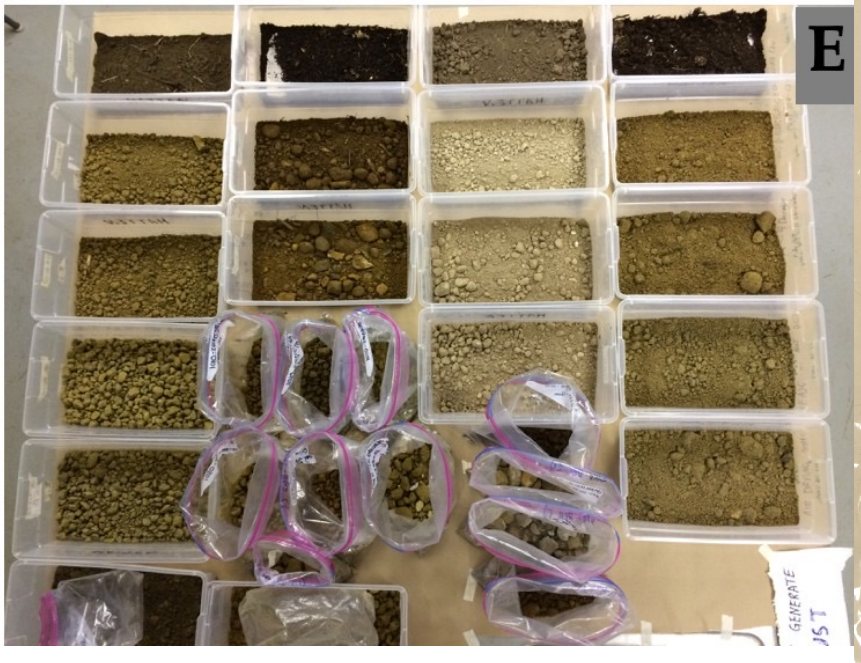
Virginia Tech (Strahm + Possinger + Weiglein)
Incubations (1yr) 2x3 tempXmoisture treatments, CO_2 respiration, stable isotopes, particle specific surface area.

USDA Forest Service (Heckman)
Density separation, clay minerology, ^{14}C

University Colorado (SanClements/Bowman)
Cold/hot water extracts, UV-vis fluorescence, mass spectrometry







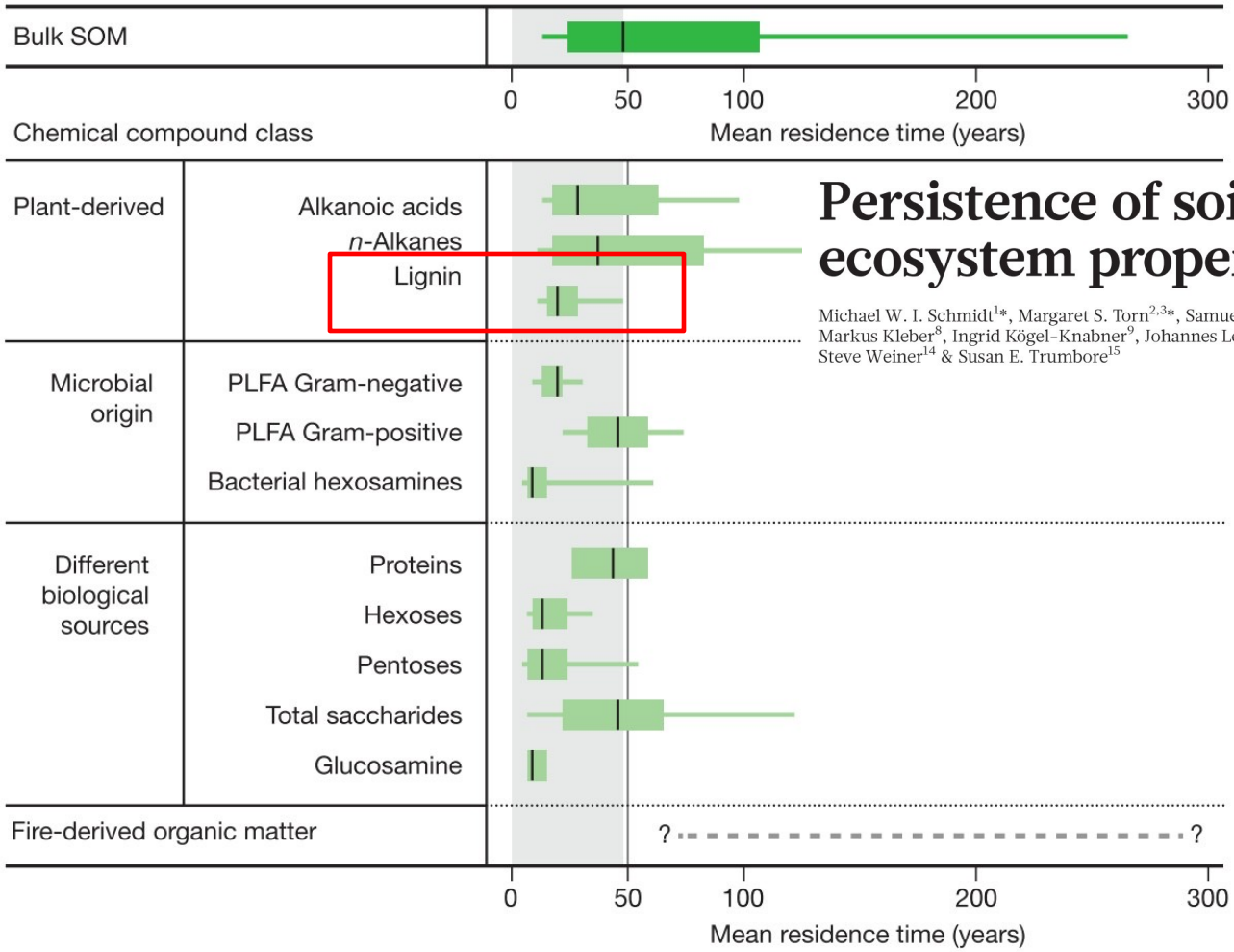
A & B) Soil coring apparatus in Alaska and Florida respectively

C) 10 Soil cores collected per site, collection down to 200cm

D) Example of an open core from Wind River Experimental Forest (WREF)

E) Compositing & drying soils horizons of similar characteristics for analysis

Methods: Lignin = Plant Sources



Persistence of soil organic matter as an ecosystem property

Michael W. I. Schmidt[1]*, Margaret S. Torn[2,3]*, Samuel Abiven[1], Thorsten Dittmar[4,5], Georg Guggenberger[6], Ivan A. Janssens[7], Markus Kleber[8], Ingrid Kögel-Knabner[9], Johannes Lehmann[10], David A. C. Manning[11], Paolo Nannipieri[12], Daniel P. Rasse[13], Steve Weiner[14] & Susan E. Trumbore[15]

Cellulose ~ 300 g/kg

Lignin ~ 200 g/kg

Lipids ~ 125 g/kg

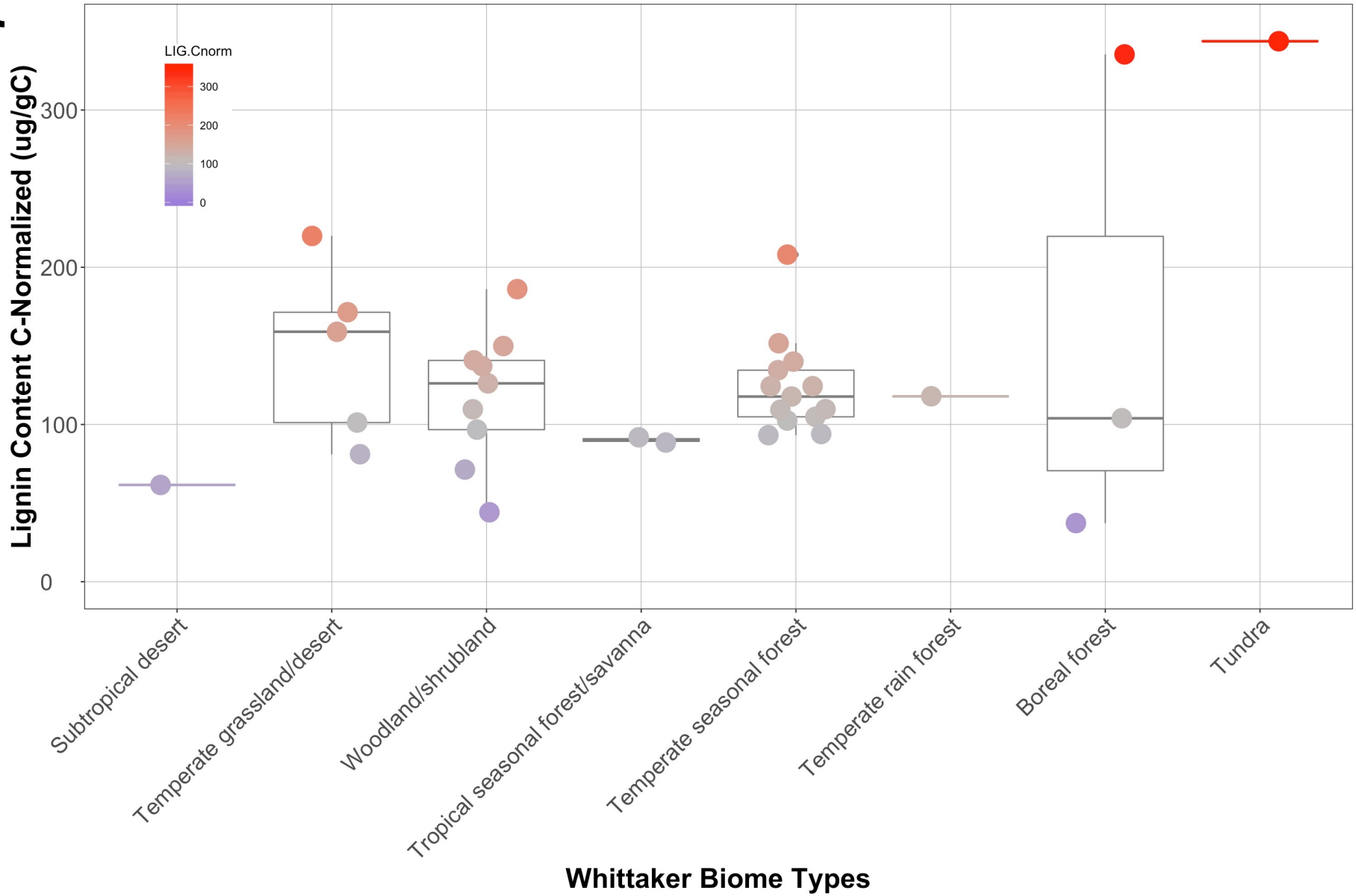
Proteins ~ 60 g/kg

Solubles 50-100 g/kg

Inorganics 40 g/kg

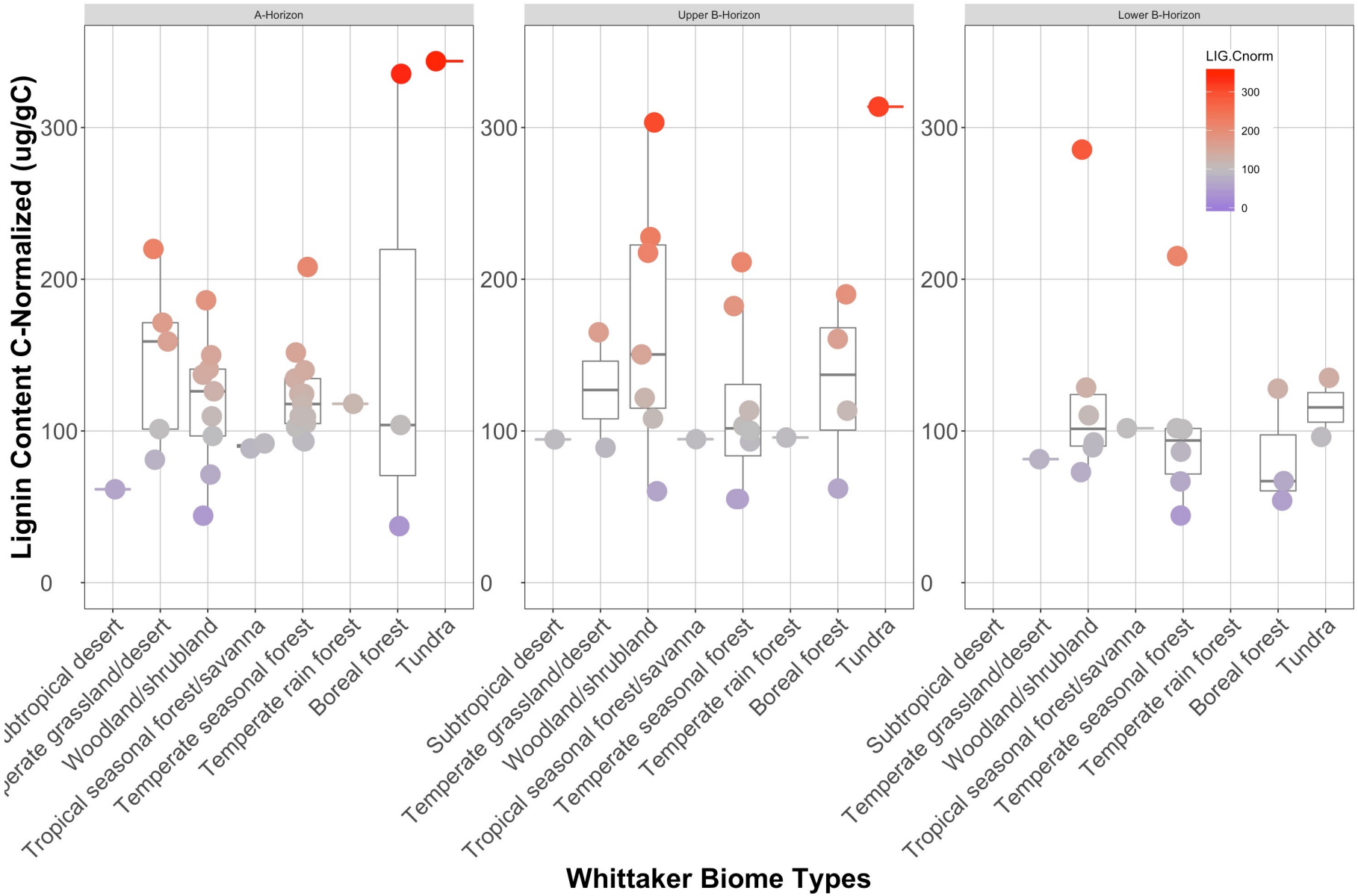
Figure 1. "[T]he importance of initial quality fades and the initially fast-cycling compounds are just as likely to persist as the slow."

Results: Lignin Across Ecosystems



Results: Lignin Across Ecosystems

[A-Horizon] [Upper B-Horizon] [Lower B-Horizon]



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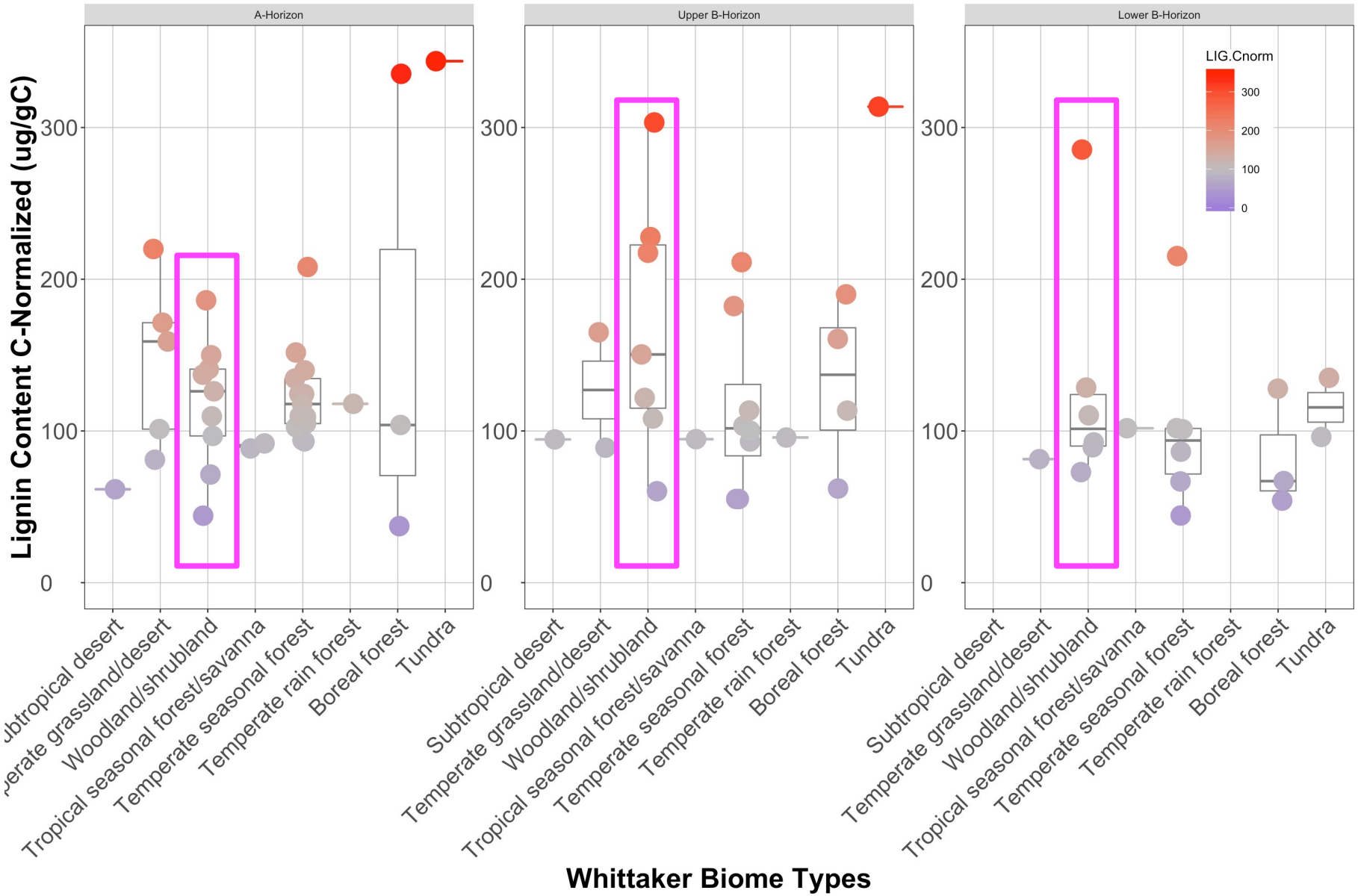
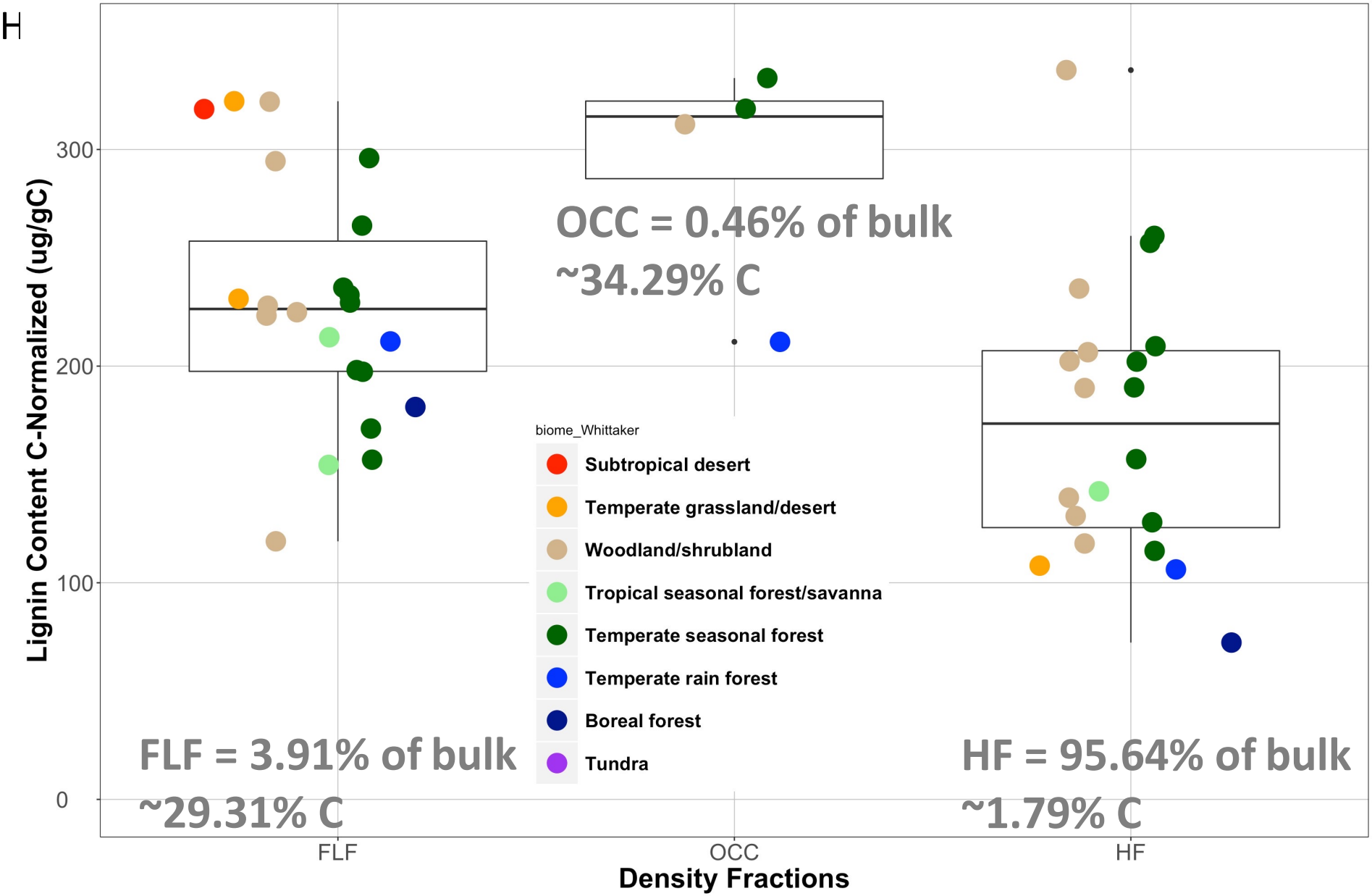
[A-Horizon] [Upper B-Horizon] [Lower B-Horizon]



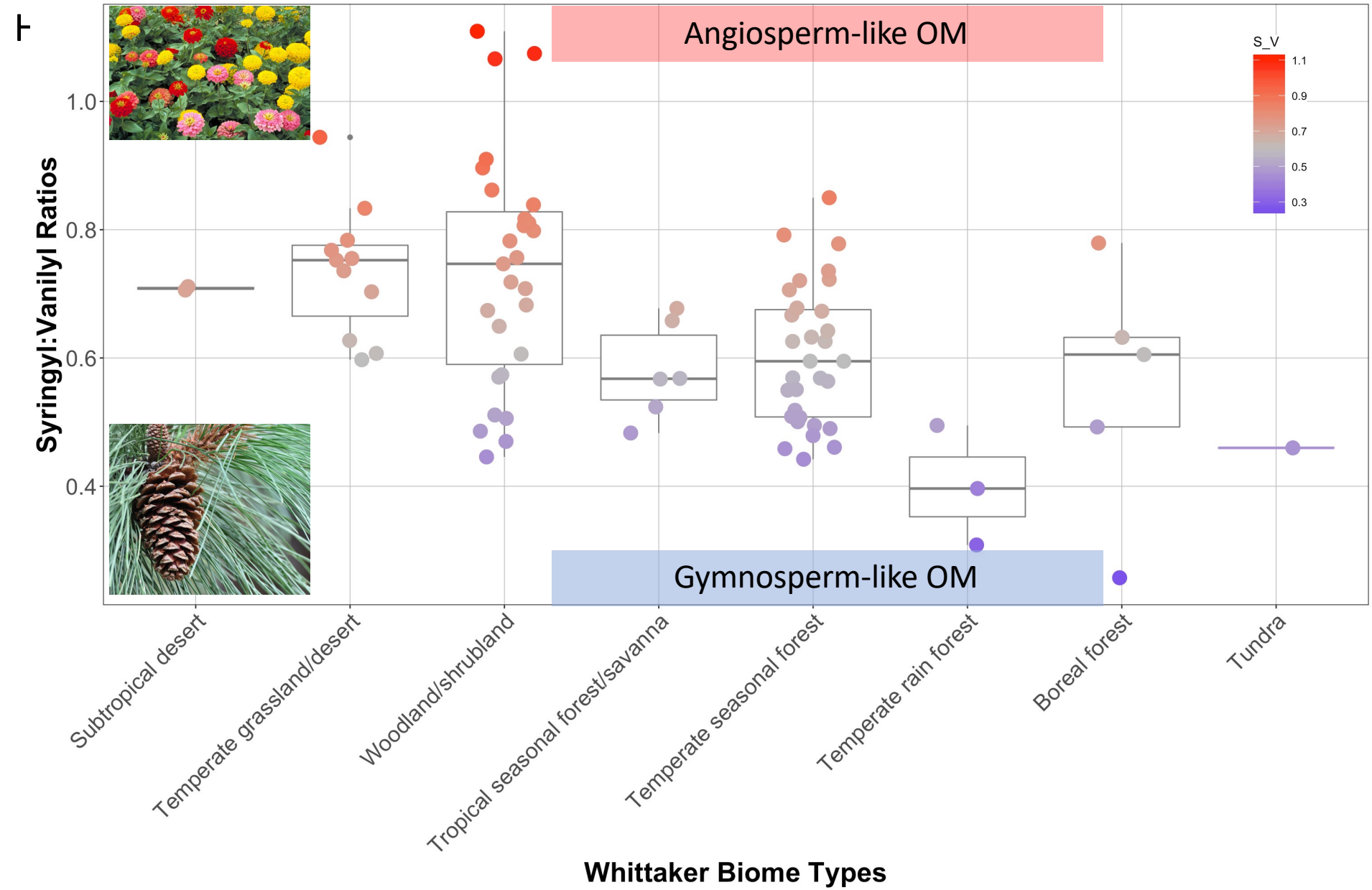
Results: Lignin Stabilized by HF [A-H



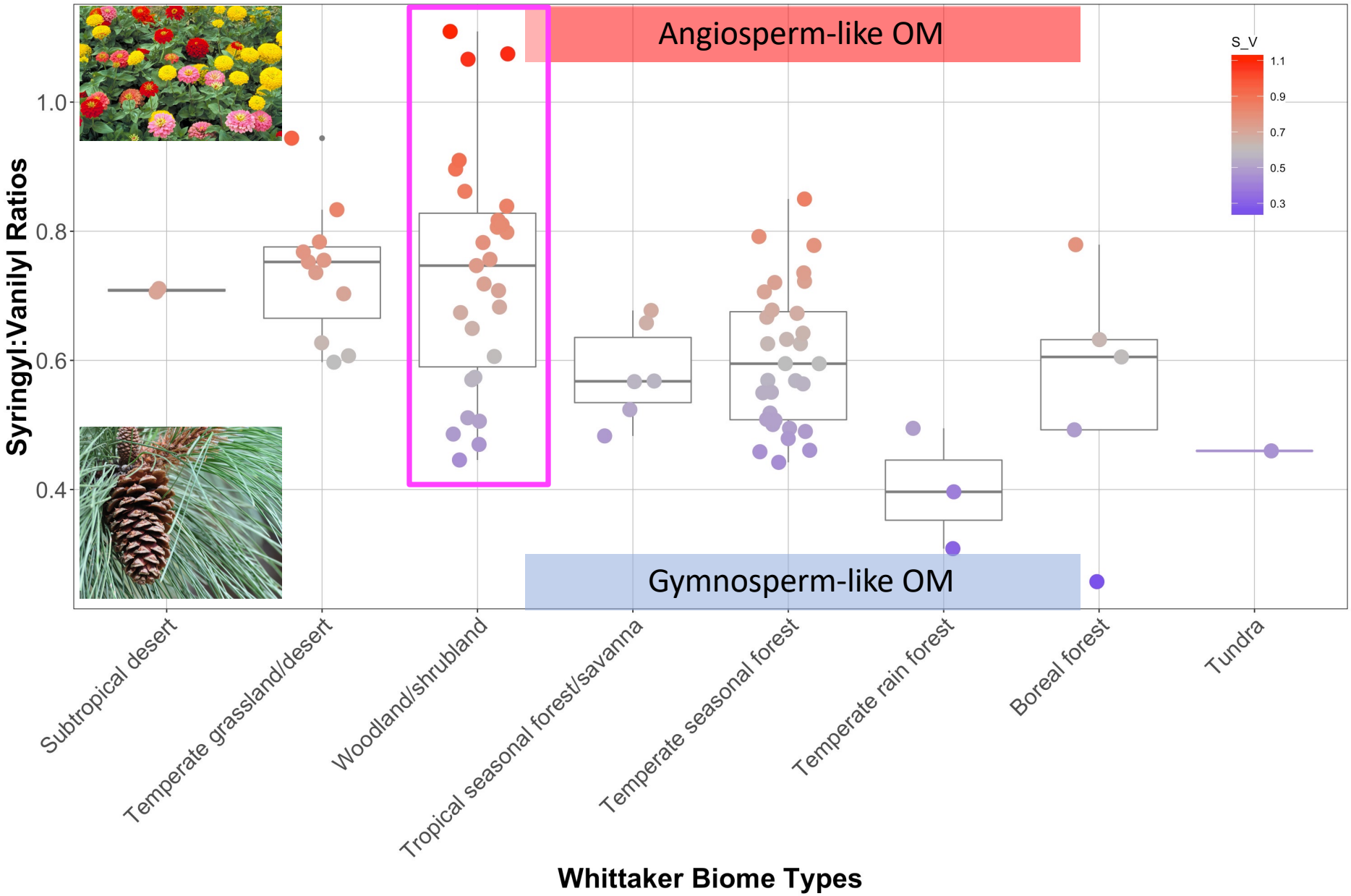
Results: Source of OM [A-

Horiz

Results: Source of OM [A-



Results: Source of OM [A-Horizon]



Results: Source of OM

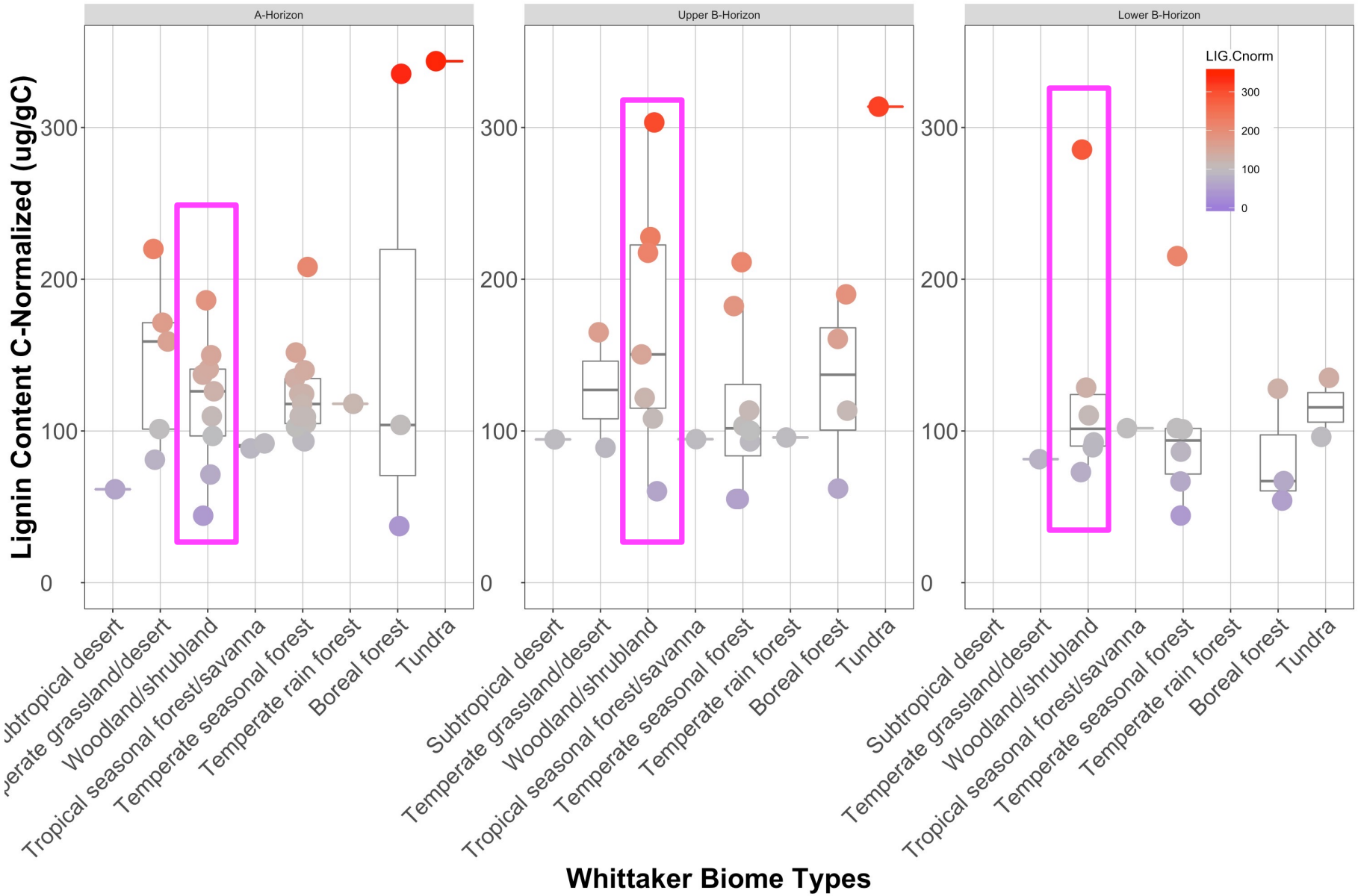
[A-Horizon] [Upper B-Horizon] Lower B-Horizon

Results: Source of OM

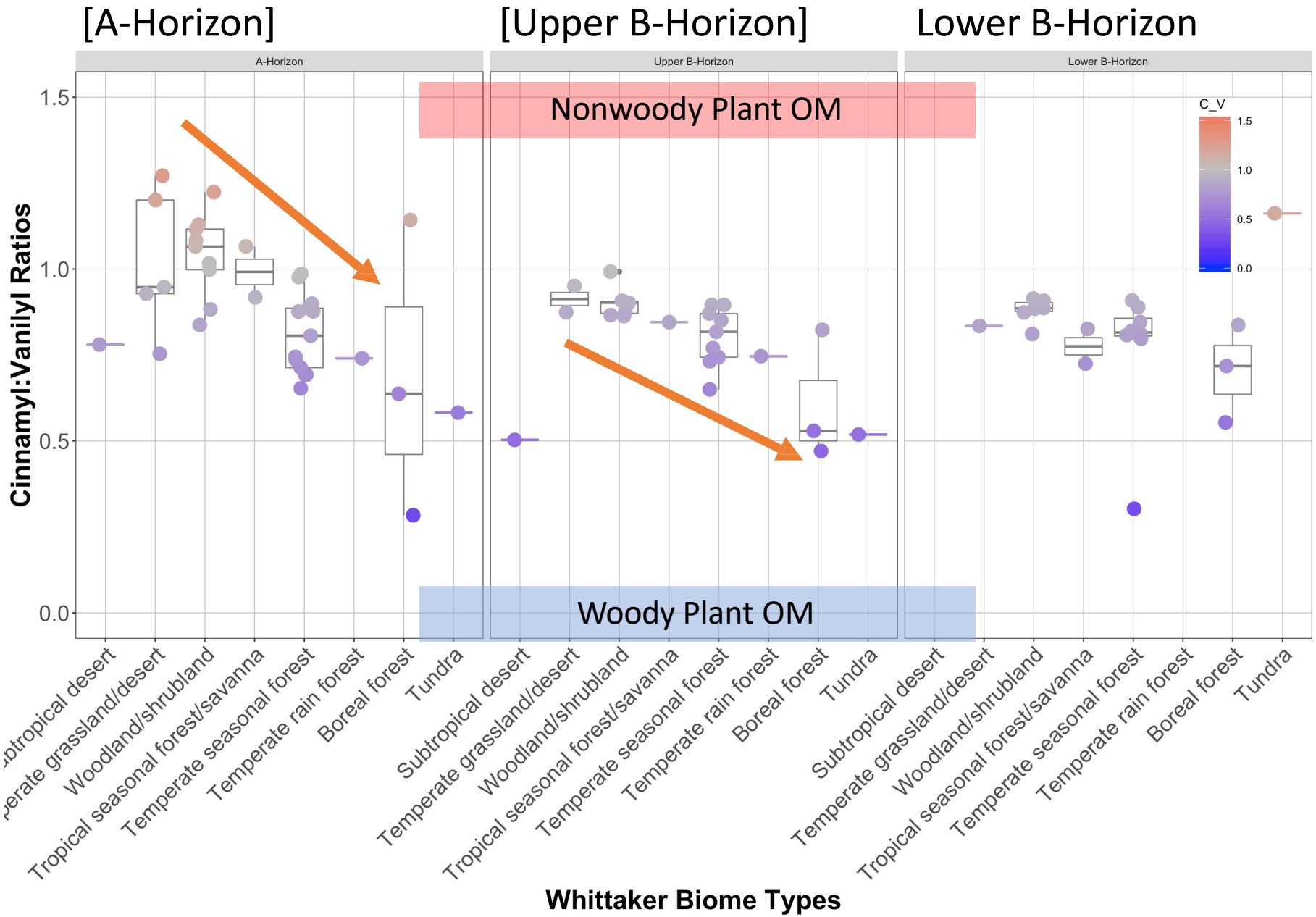
[A-Horizon] [Upper B-Horizon] Lower B-Horizon

Results: Lignin Across Ecosystems

[A-Horizon] [Upper B-Horizon] [Lower B-Horizon]



Results: Source of OM



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- Angiosperm vs Gymnosperm SOM signal is **robust**

- [Future Work]
  - Suberin~Roots & Cutin~Shoots *ACROSS* sites

Thank You!

@AdrianCGall

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Adrian.Gall@oregonstate.edu

Yvan Alleau – Lab Wizard

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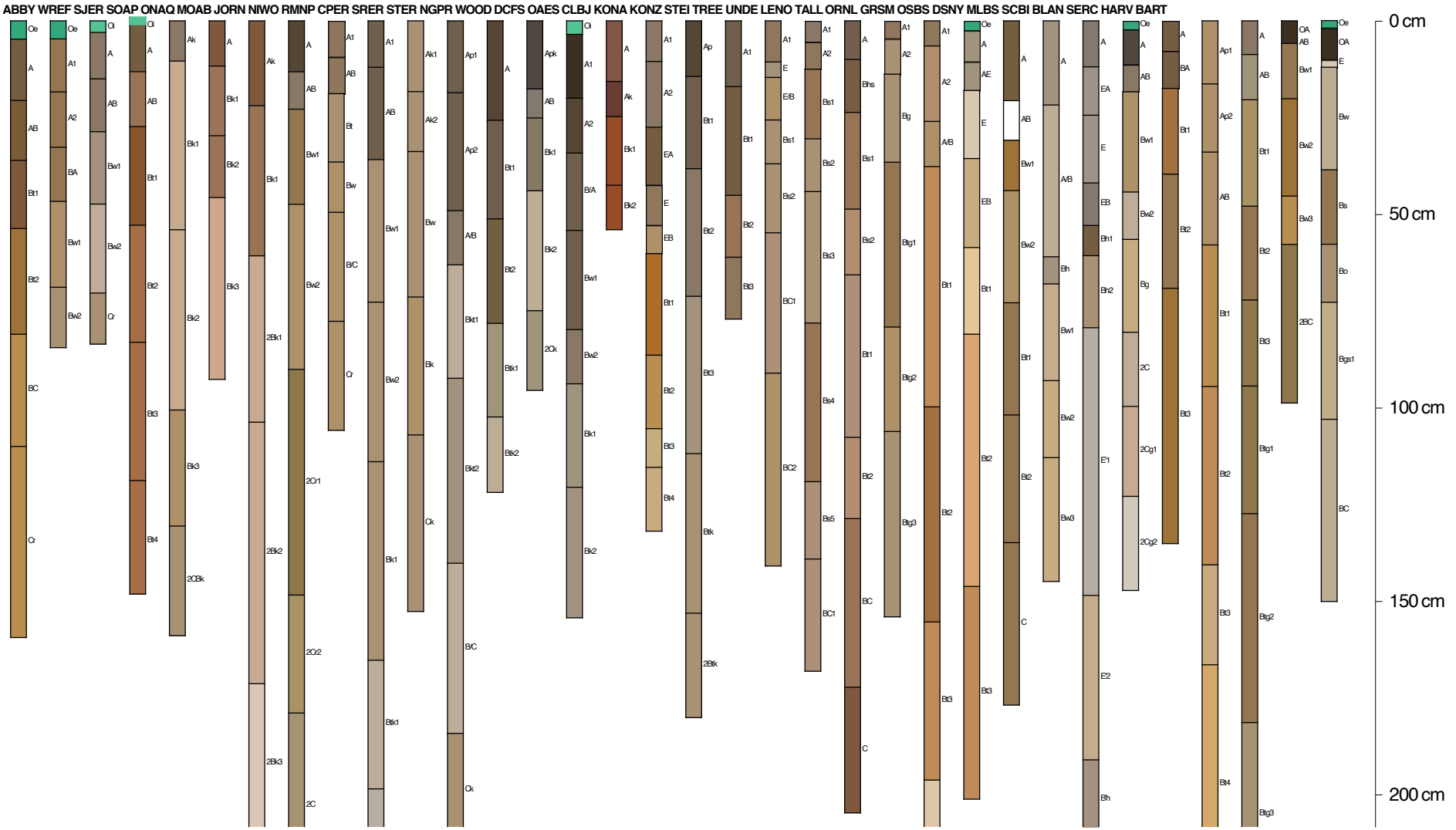
Extra Slides

[Spodosol in Quebec Canada]

Beth Avera – PhD Candidate at Colorado State University

Results: Soil Color [Air Dry Munsell Color -> sRGB space]

|← West Coast Kansas East Coast →|



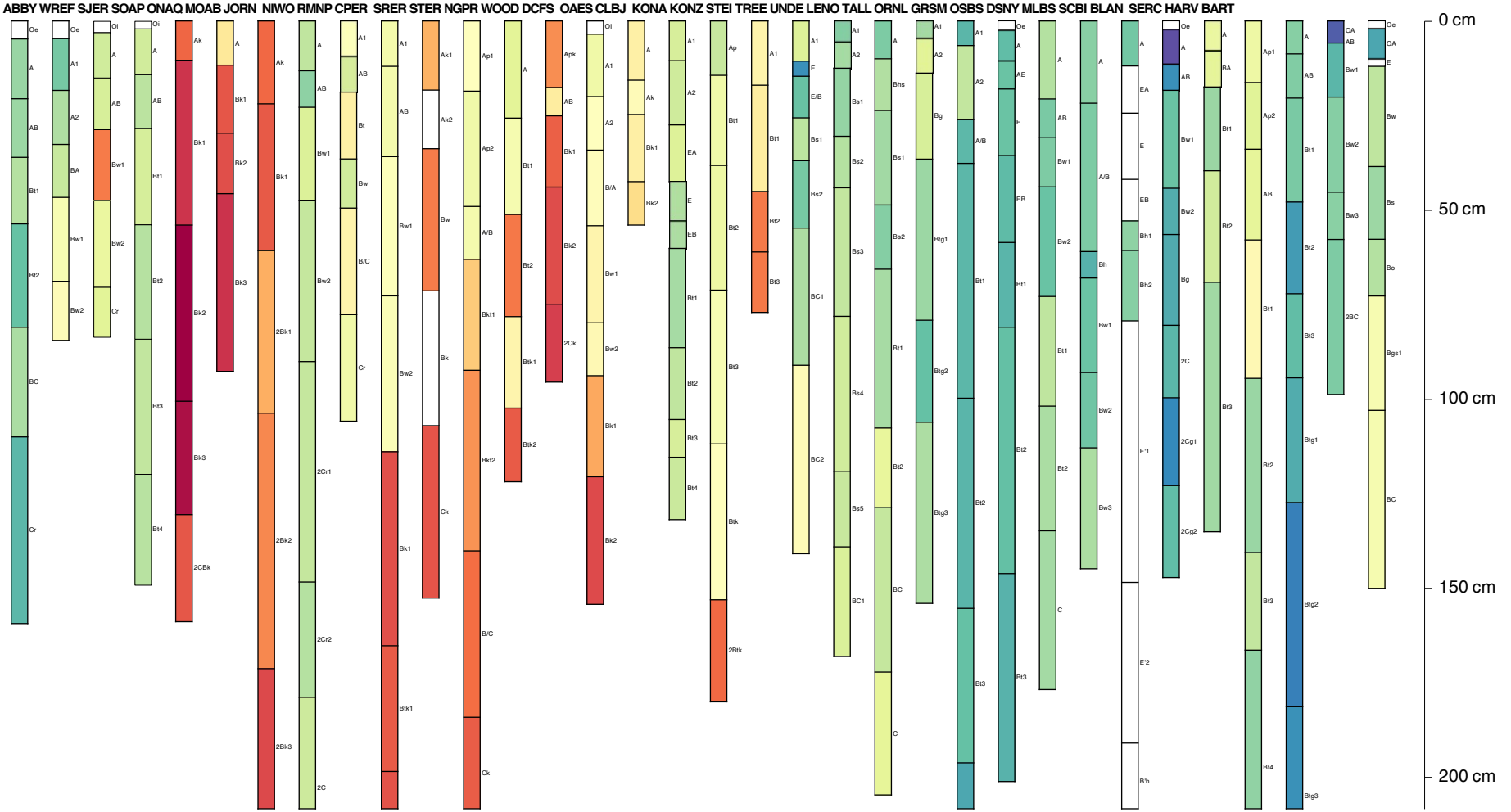
Figures using RStudio aqp() package by Beaudette

Range of Characteristics: Soil pH

3 4 5 6 7 8 9 10

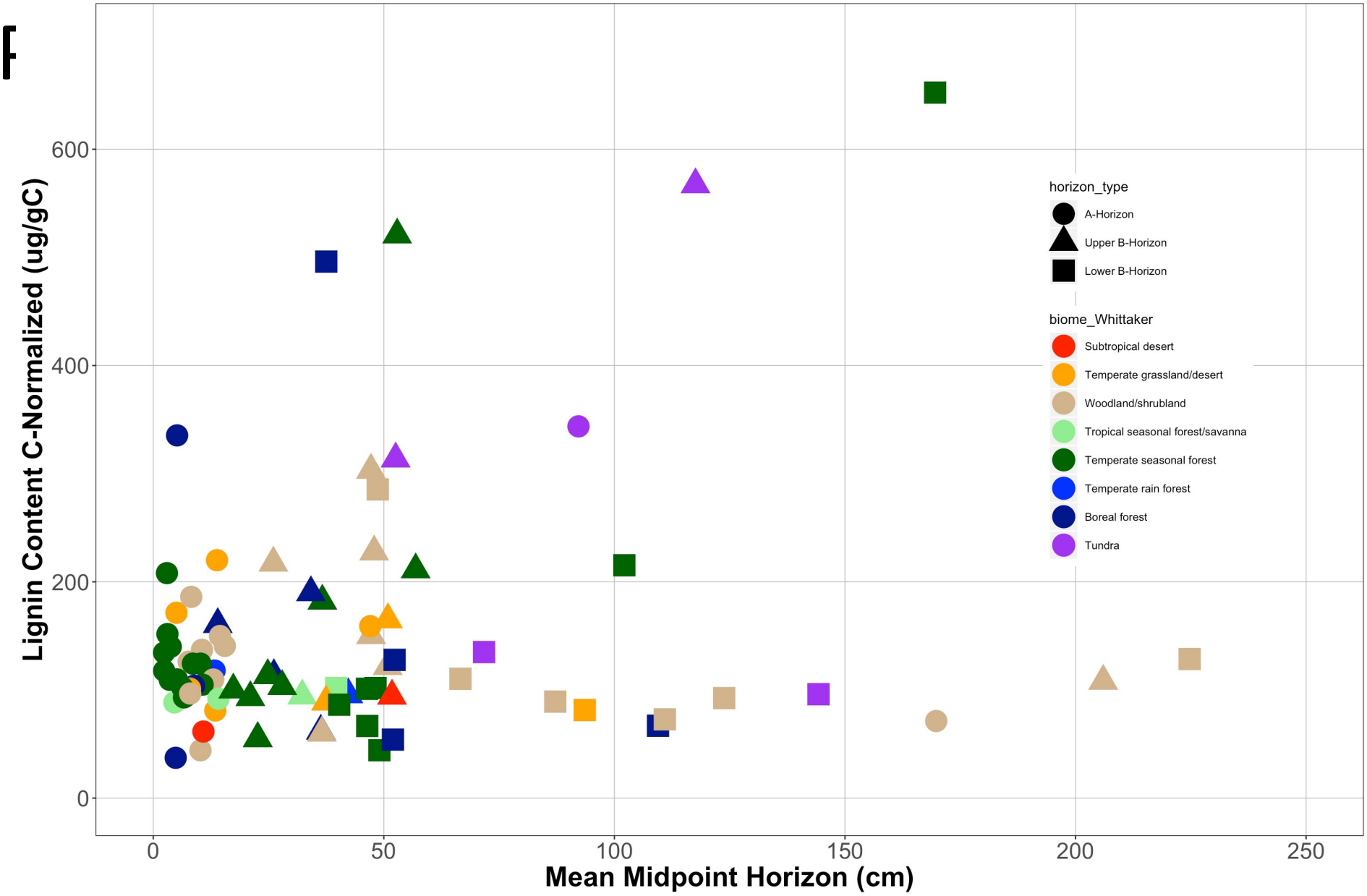
West Coast → | Kansas | ← East Coast

+ Permafrost soils

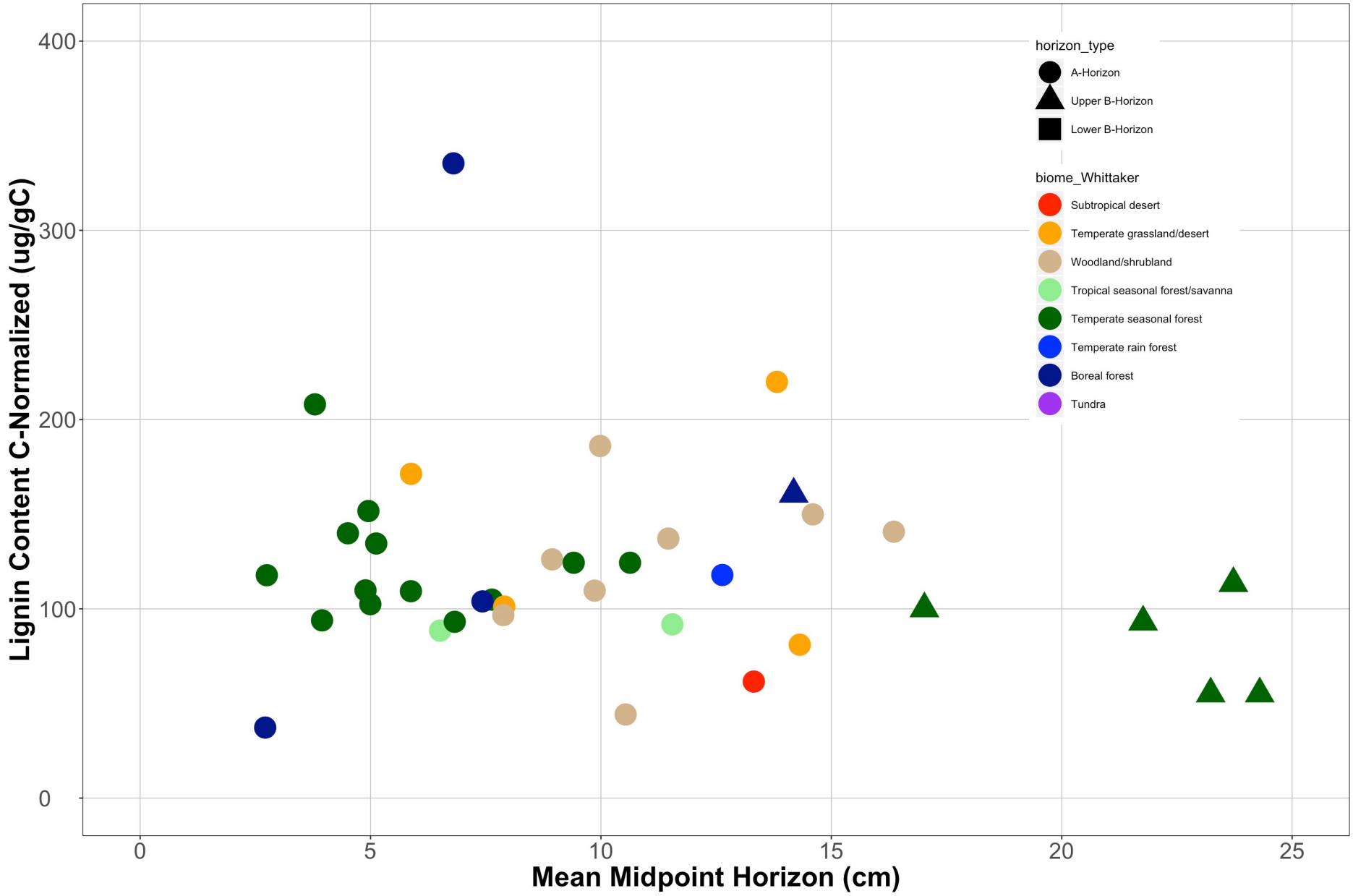


Results: Lignin Down Soil

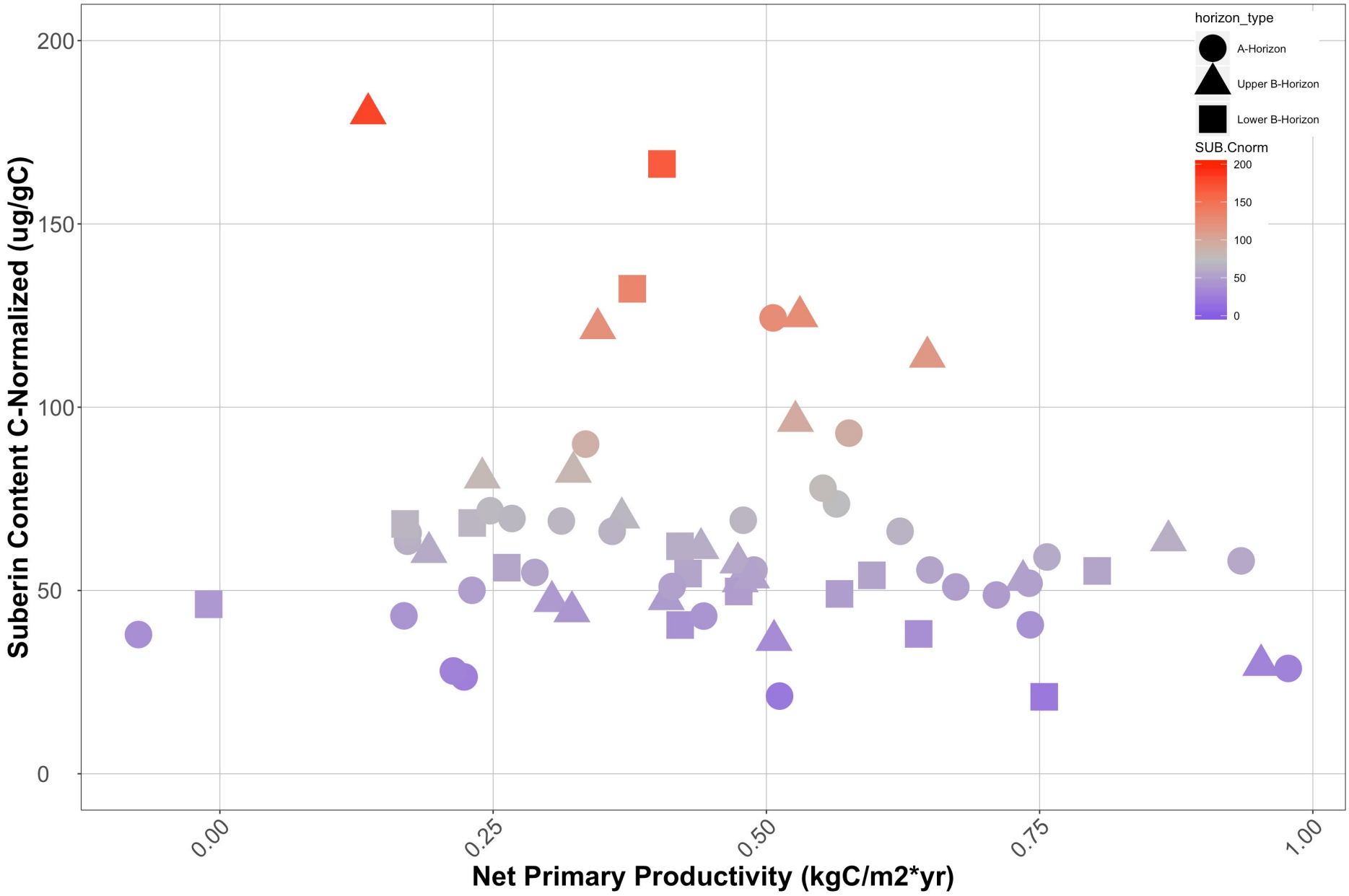
F



Results: Lignin in Shallow Soils



Results: Suberin ≠ Roots [across ecosystems vs NPP]



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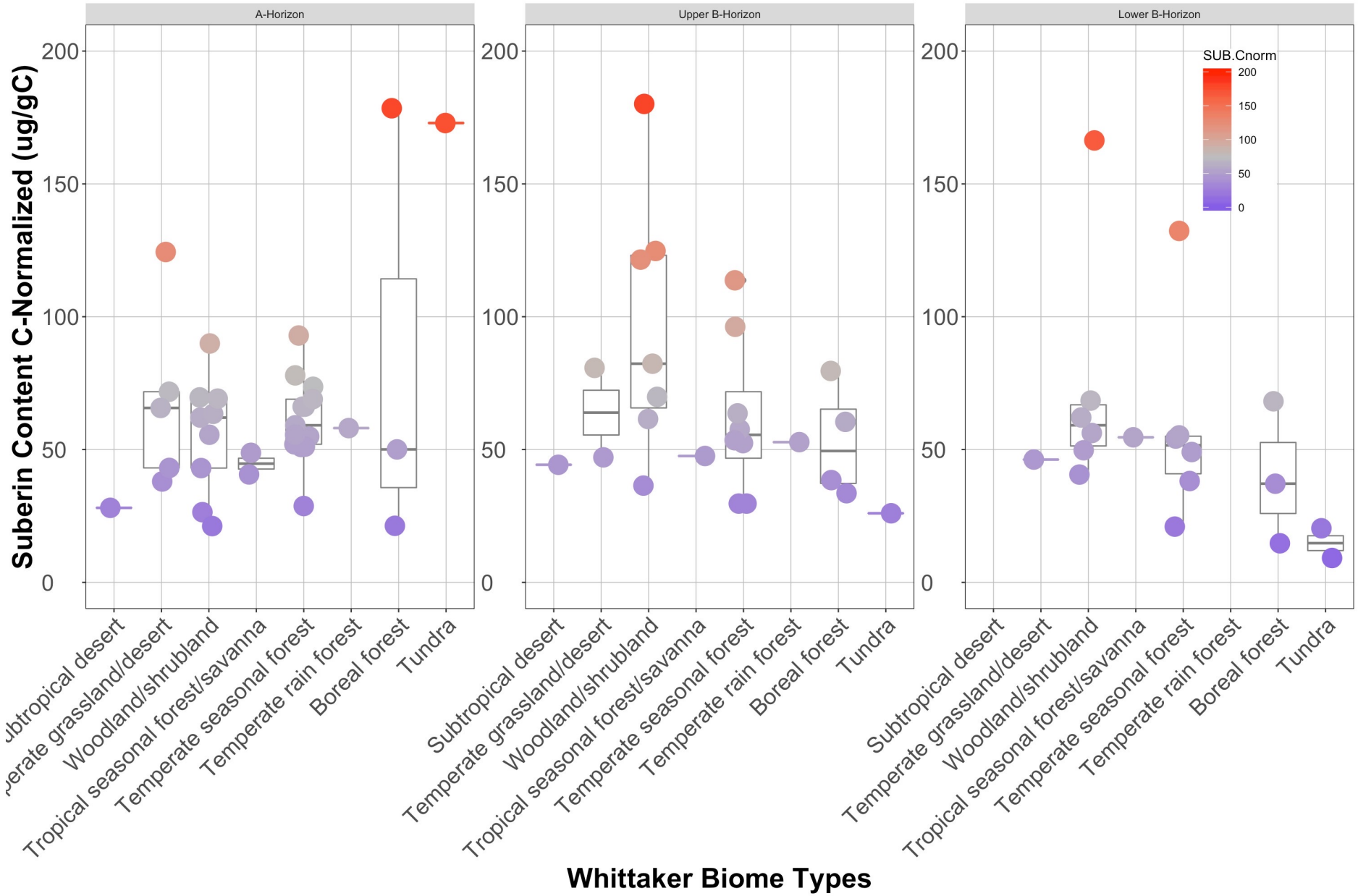
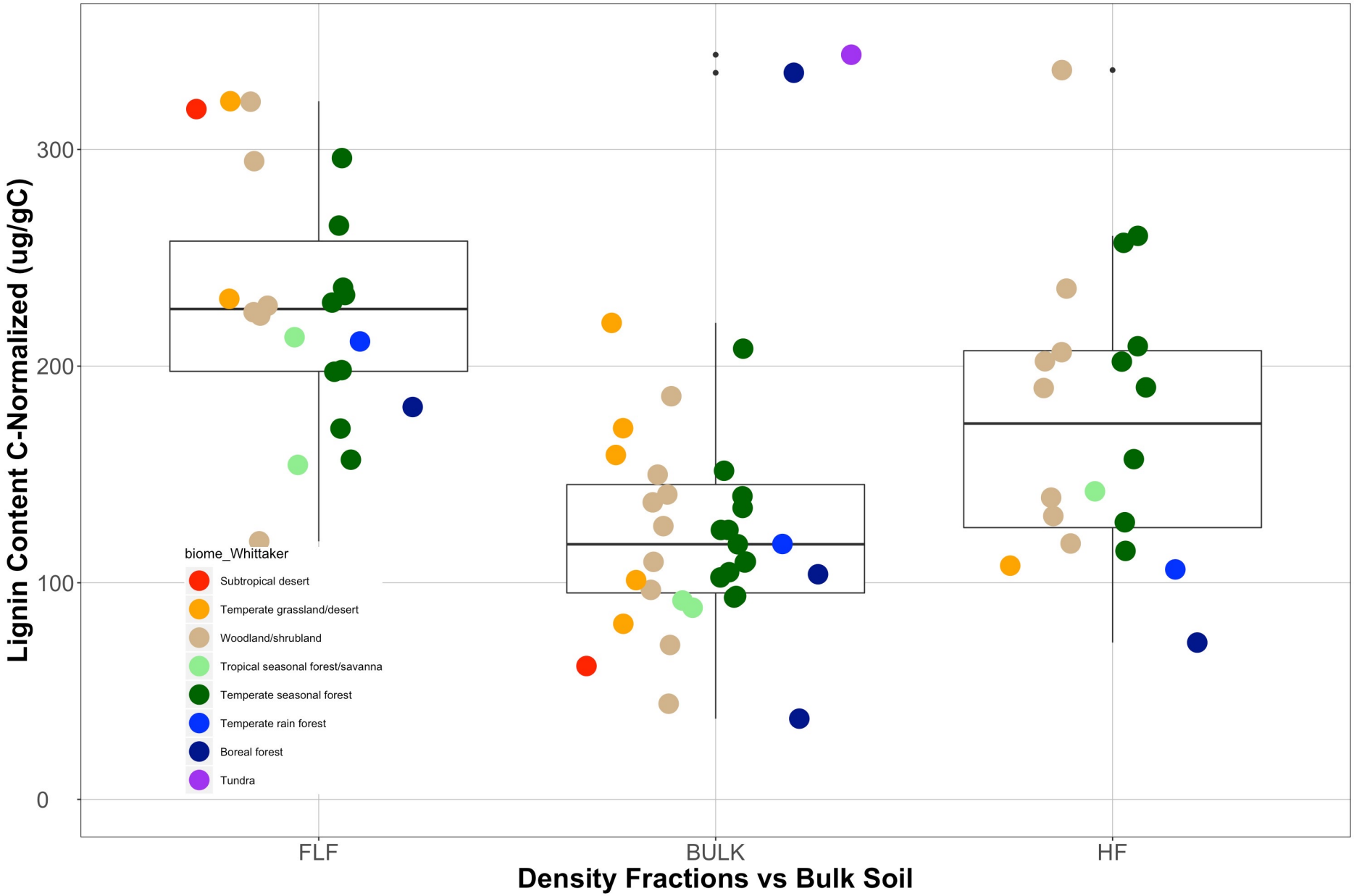
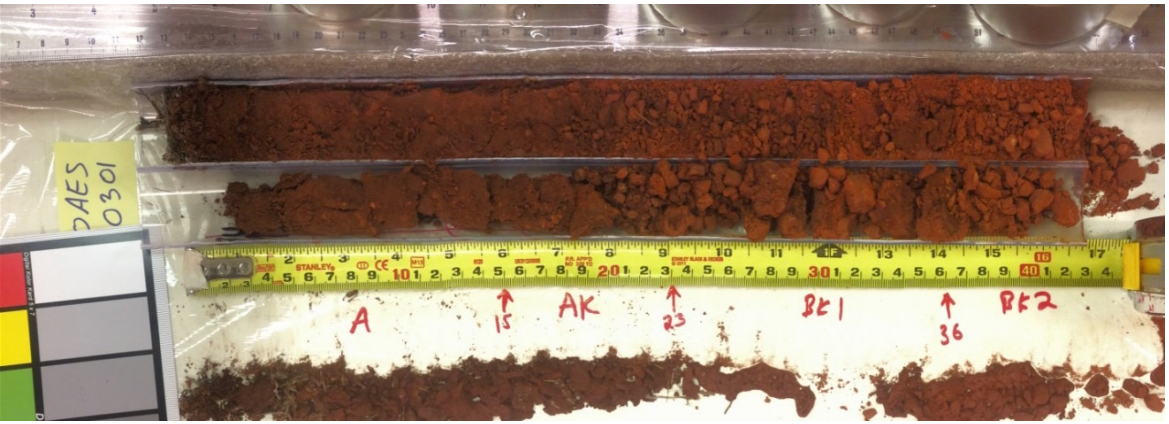


Results: Lignin Stabilized by HF



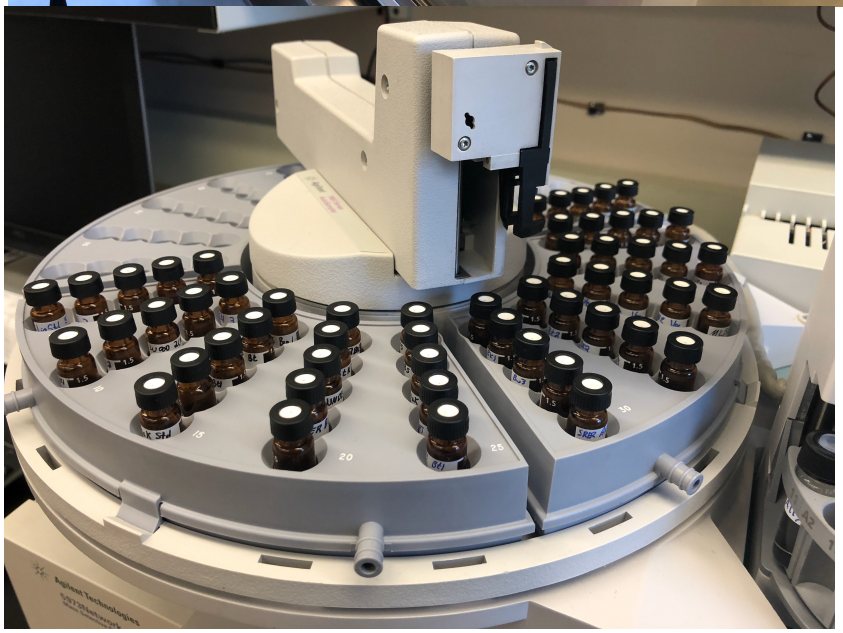
STEI

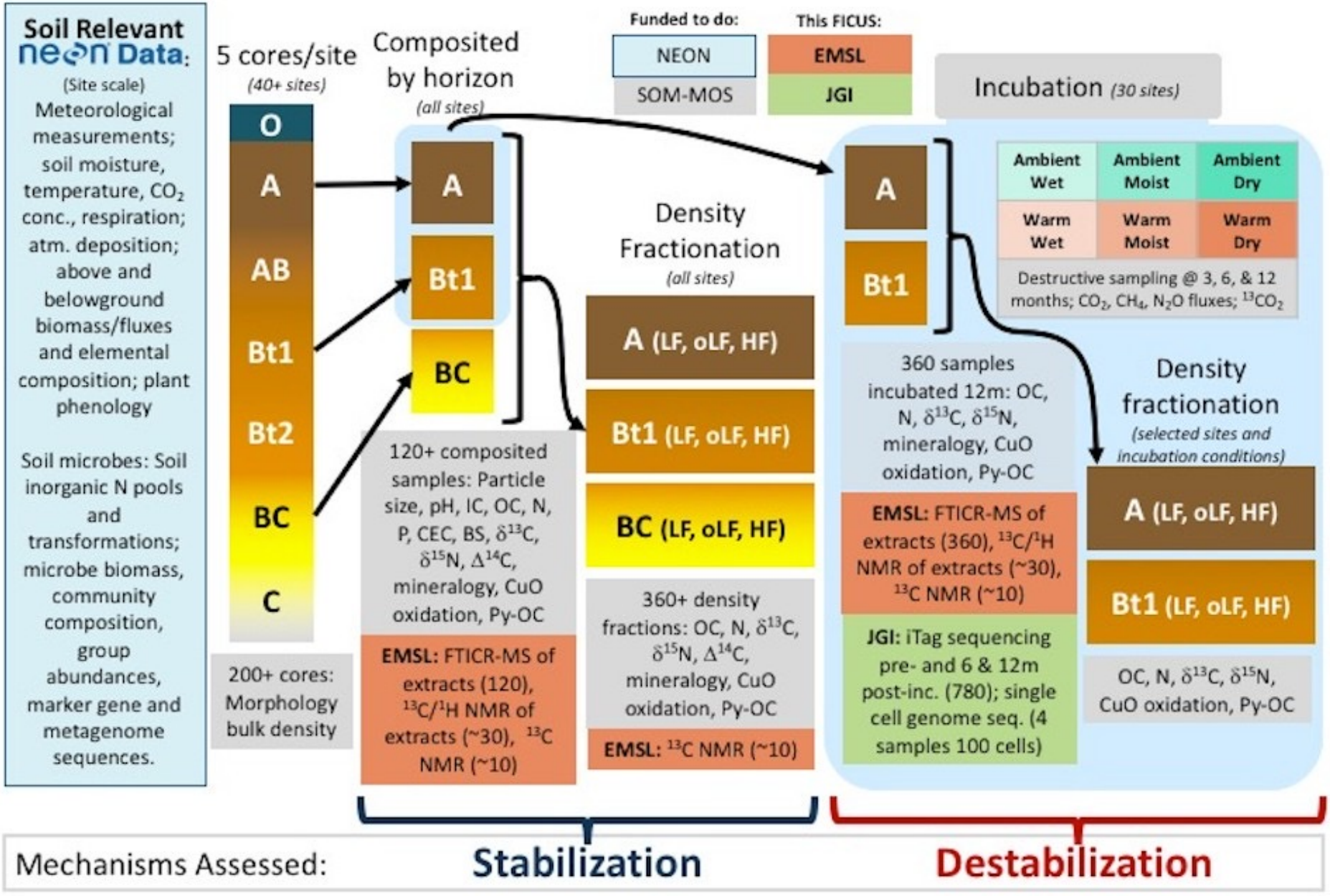


OAES


Benzene
Polycarboxylic Acids
HNO3


CPER180315 - A1 [5]
INCUBATE - SOM - MOS
Composite Horizon Mass (g)=388
OSU
VT
SERC031115 – A [5]
INCUBATE - SOMMOS
Composite Horizon
Fine Fraction Mass (g)=357.5
OSU
VT
OSBS220215 - A [6]
INCUBATE - SOM-MOS
Composite Horizon Mass (g)=348.3
OSU
VT




Soil Relevant neon Data:
(Site scale)
Meteorological measurements; soil moisture, temperature, CO_2 conc., respiration; atm. deposition; above and belowground biomass/fluxes and elemental composition; plant phenology
Soil microbes: Soil inorganic N pools and transformations; microbe biomass, community composition, group abundances, marker gene and metagenome sequences.
5 cores/site
(40+ sites)
O
A
AB
Bt1
Bt2
BC
C
200+ cores: Morphology bulk density
Composited by horizon
(all sites)
A
Bt1
BC
120+ composited samples: Particle size, pH, IC, OC, N, P, CEC, BS, $\delta^{13}C$, $\delta^{15}N$, $\Delta^{14}C$, mineralogy, CuO oxidation, Py-OC
EMSL: FTICR-MS of extracts (120), $^{13}C/^{1}H$ NMR of extracts (~30), ^{13}C NMR (~10)
Funded to do:
NEON
SOM-MOS
This FICUS:
EMSL
JGI
Density Fractionation
(all sites)
A (LF, oLF, HF)
Bt1 (LF, oLF, HF)
BC (LF, oLF, HF)
360+ density fractions: OC, N, $\delta^{13}C$, $\delta^{15}N$, $\Delta^{14}C$, mineralogy, CuO oxidation, Py-OC
EMSL: ^{13}C NMR (~10)
Incubation (30 sites)
A
Bt1
Ambient Wet
Ambient Moist
Ambient Dry
Warm Wet
Warm Moist
Warm Dry
Destructive sampling @ 3, 6, & 12 months; CO_2, CH_4, N_2O fluxes; $^{13}CO_2$
360 samples incubated 12m: OC, N, $\delta^{13}C$, $\delta^{15}N$, mineralogy, CuO oxidation, Py-OC
EMSL: FTICR-MS of extracts (360), $^{13}C/^{1}H$ NMR of extracts (~30), ^{13}C NMR (~10)
JGI: iTag sequencing pre- and 6 & 12m post-inc. (780); single cell genome seq. (4 samples 100 cells)
Density fractionation
(selected sites and incubation conditions)
A (LF, oLF, HF)
Bt1 (LF, oLF, HF)
OC, N, $\delta^{13}C$, $\delta^{15}N$, CuO oxidation, Py-OC
Mechanisms Assessed:
Stabilization
Destabilization