

Quantitative Color and Soil C - A Simple Low Cost Approach to Estimate C in Forest Soils

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Today's Talk

- 'Quantifying' Color
- 'Darkness' to predict C
- Soil Redness
- Predictive Accuracy

Why Soil C?

Significance

- 'Bank of C' – $< \frac{1}{2}$ of terrestrial C stored in soils
- Supports critical function and 'ecosystem services'
- Indicator of soil quality
- Poorly constrained across scales local \rightarrow global

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Need

- A simple low cost tool to quantify soil C - plot \rightarrow landscape

Color – Primary Interface with Soils

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Pigments -

- Primary Minerals
- Oxides
- Salts
- SOM



'Quantifying' Color



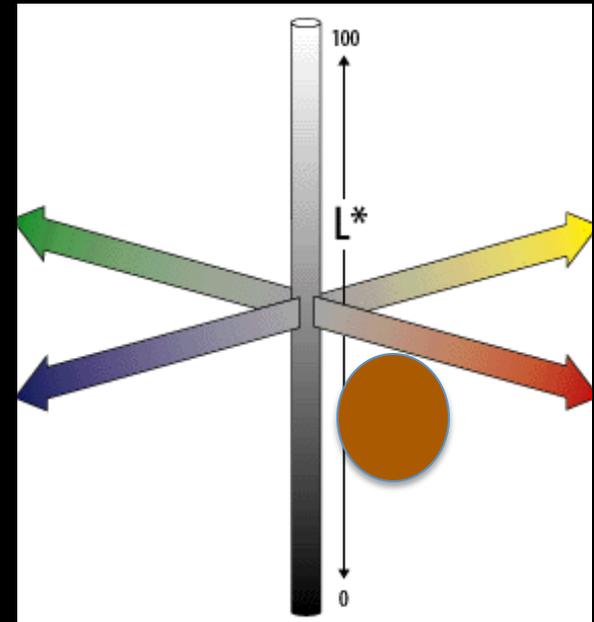
Spectral Measures

- **Chromameters**
- Optical and Objective
- Standardized light/collection conditions
- Rapid, reproducible, quantitative
- Reduces visible EM spectrum to 'Master' color space (CIE xyz)
- Data easily transformed to color spaces (LAB, RGB, Munsell)

Robust and Quantitative

CIE LAB (1976) - complete color space (numeric and visualization) & stimulus align with dominant soil pigments

- L – Black (0) → White (100)
- A⁺ – Gray to Red
- B⁺ – Gray to Yellow



Region of the color space occupied by soil samples

Simple is Better – Color is Best!

Objective –

Develop quantitative relationships between soil color and C to support accurate estimation across a broad range of forest soils

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Mode –

- Group based models
- Explore ‘additional colors’ to support prediction
- Generalized prediction - Simple → ‘complex’

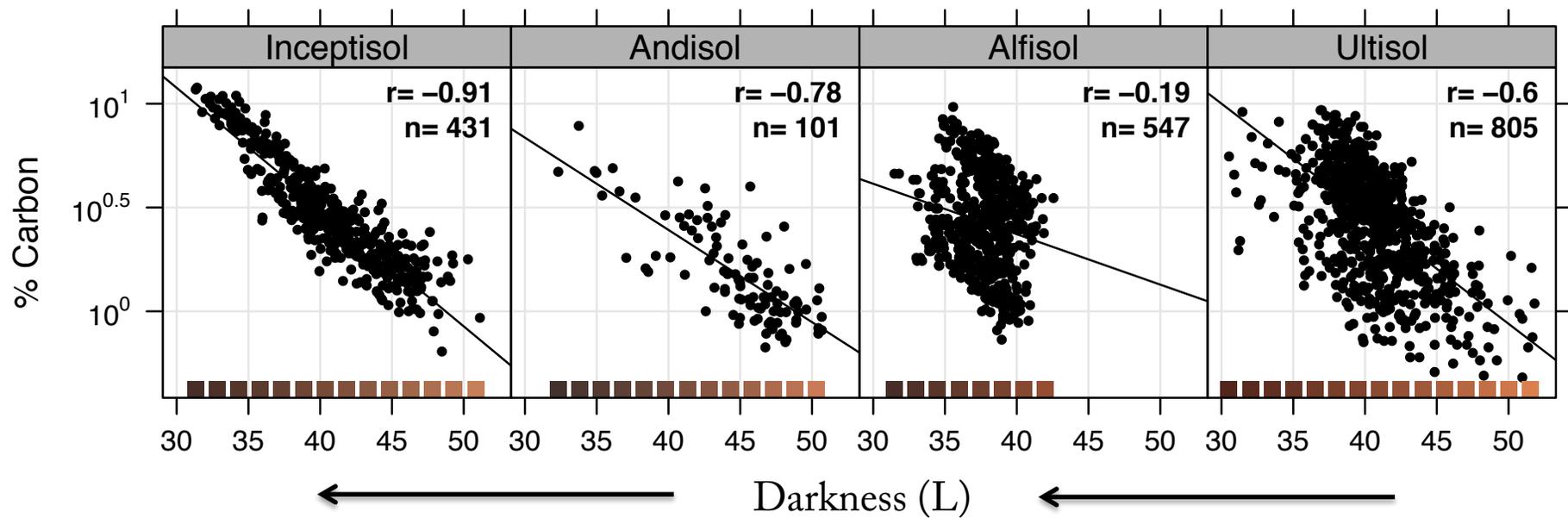
Representative Forest Soils

Forest Ecosystem	Parent Material	Soil
Mixed Conifer	Ash	Vitrixerands
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Ponderosa Pine	Basalt	Haploxeralfs
Ponderosa Pine	Basalt	Haploxeralfs
Mixed Conifer	Granodiorite	Dystroxerepts
Mixed Conifer	Granodiorite	Dystroxerepts
Mixed Conifer	Granodiorite	Xerumbrepts
Mixed Conifer	Granodiorite	Dystroxerepts
Mixed Conifer	Intermediate Lahar	Haploxeralfs
Mixed Conifer	Intermediate Lahar	Halohumults
Mixed Conifer	Intermediate Lahar	Haploxeralfs
Mixed Conifer	Intermediate Lahar	Xerumbrepts
Mixed Conifer	Mafic Lahar	Halohumults
Mixed Conifer	Mafic Lahar	Haplohumults
Mixed Conifer	Mafic Lahar	Palexerults
Redwood	Mixed Sedimentary	Haplohumults

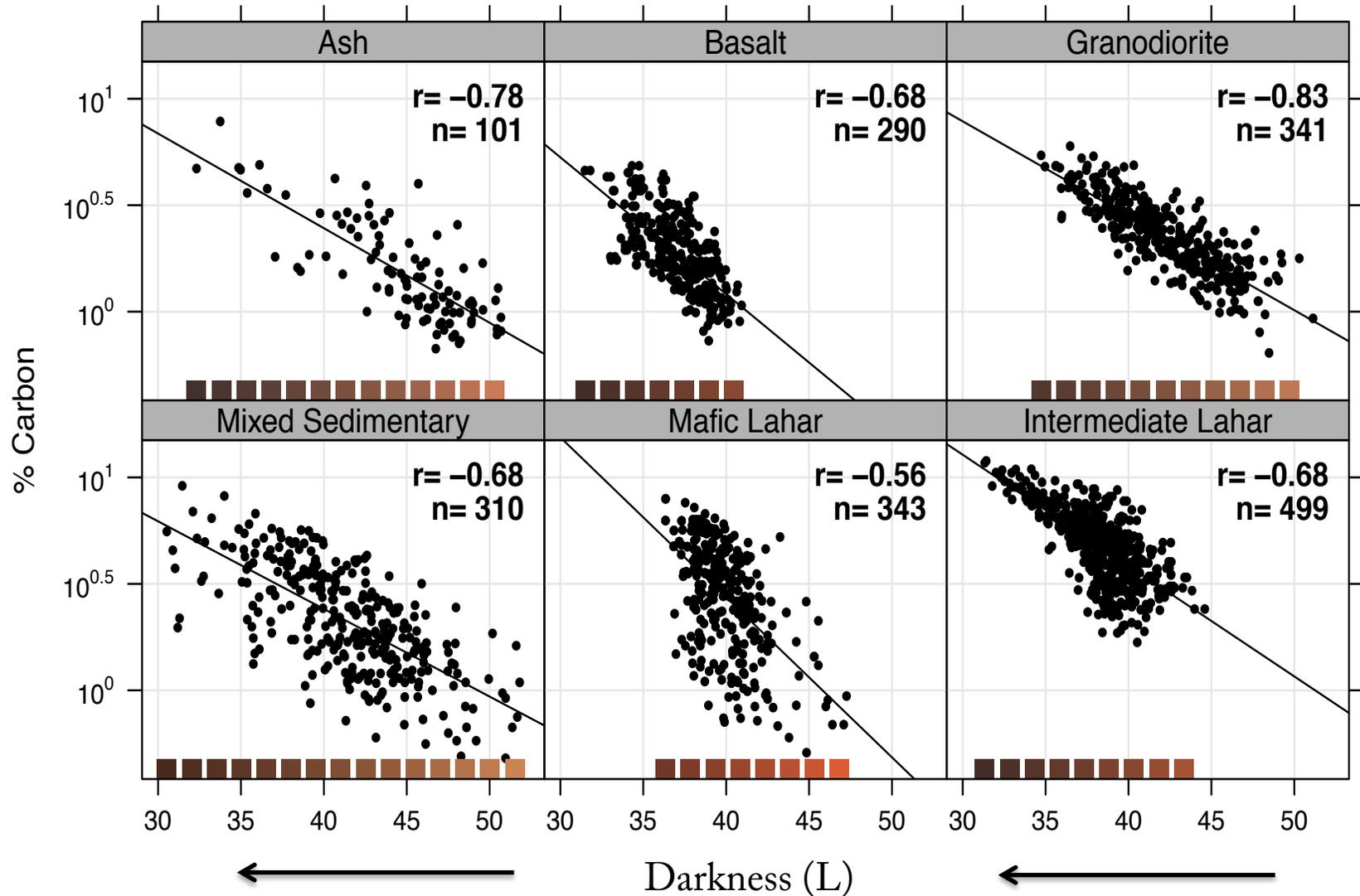
Extensive Properties

- Major Conifer ecosystems
- Broad soil and Parent Material properties
- Altitude, Climatic and productivity gradients
- Site and landscape based sample collection

Darkness to Predict C

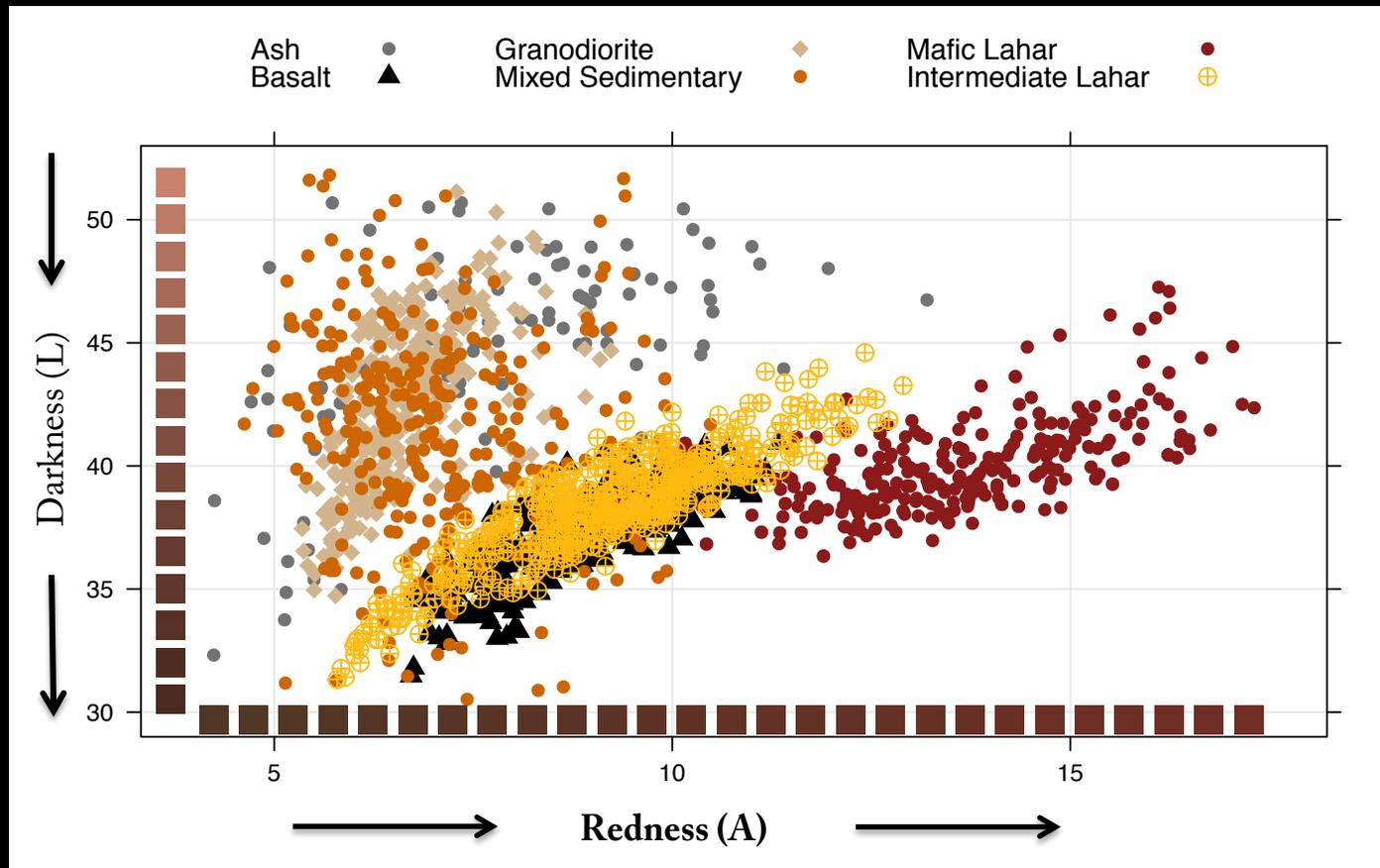
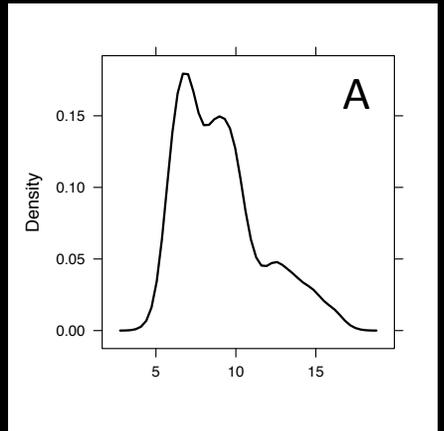


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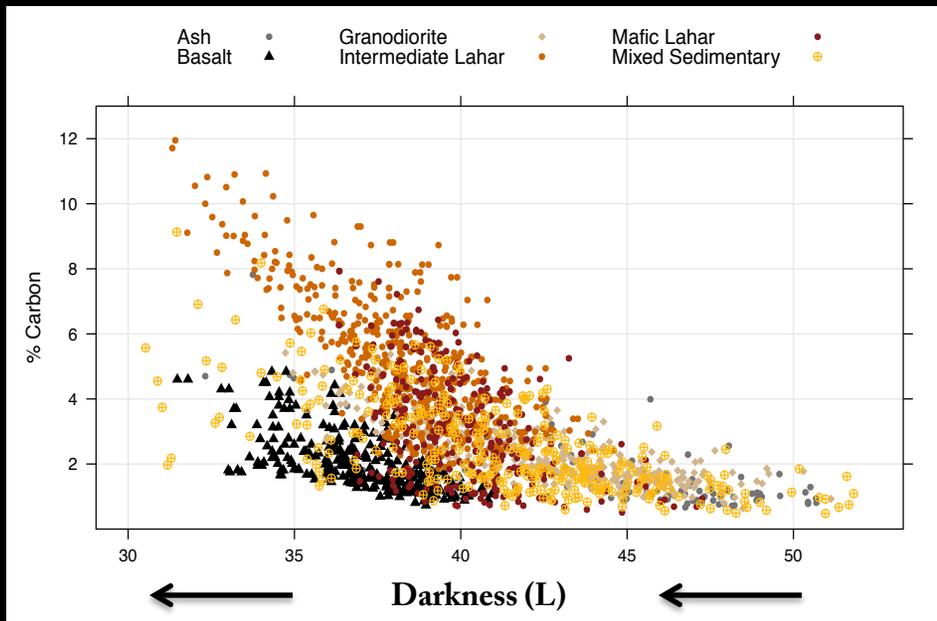


Additional Color Info??

Redness (A) - categorize soils/groups
- help constrain predictions



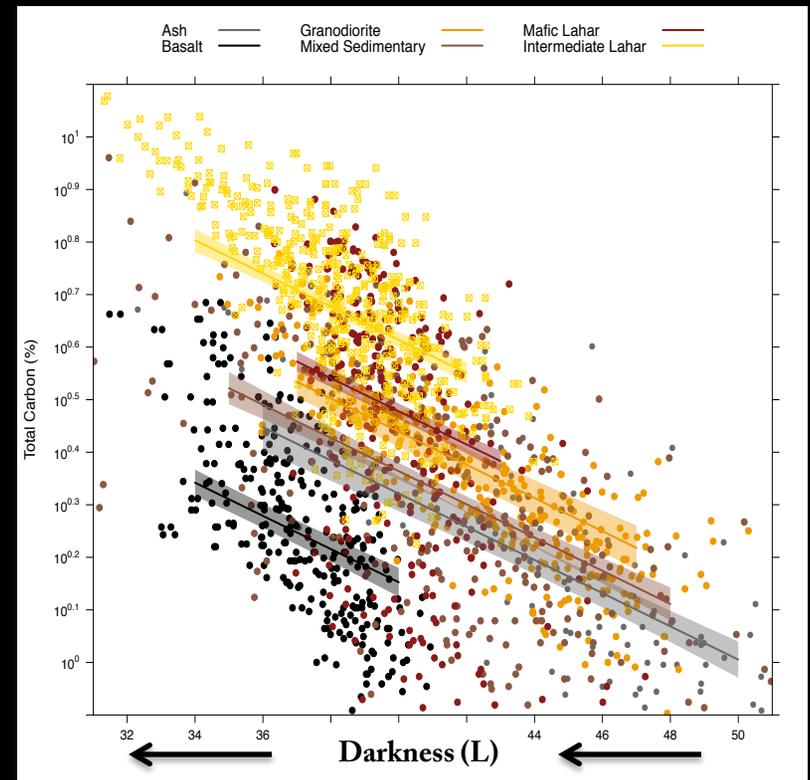
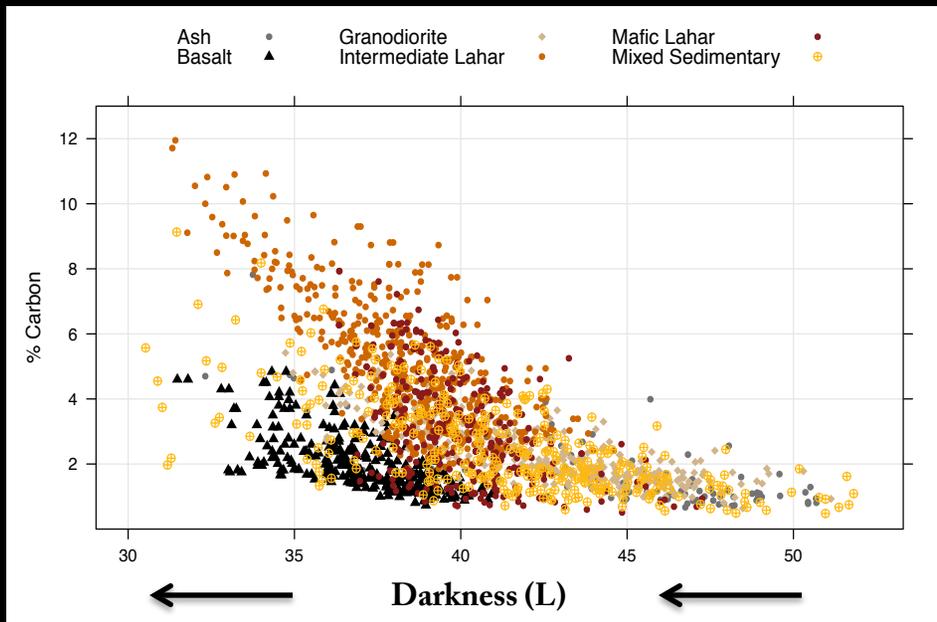
An 'Ordinary' Framework



Ordinary Least Squares Framework

- $\ln(\text{Carbon}) \sim L + A (*\text{group})$
- Aligns Model Slopes
- Support prediction at multiple scales

An 'Ordinary' Framework

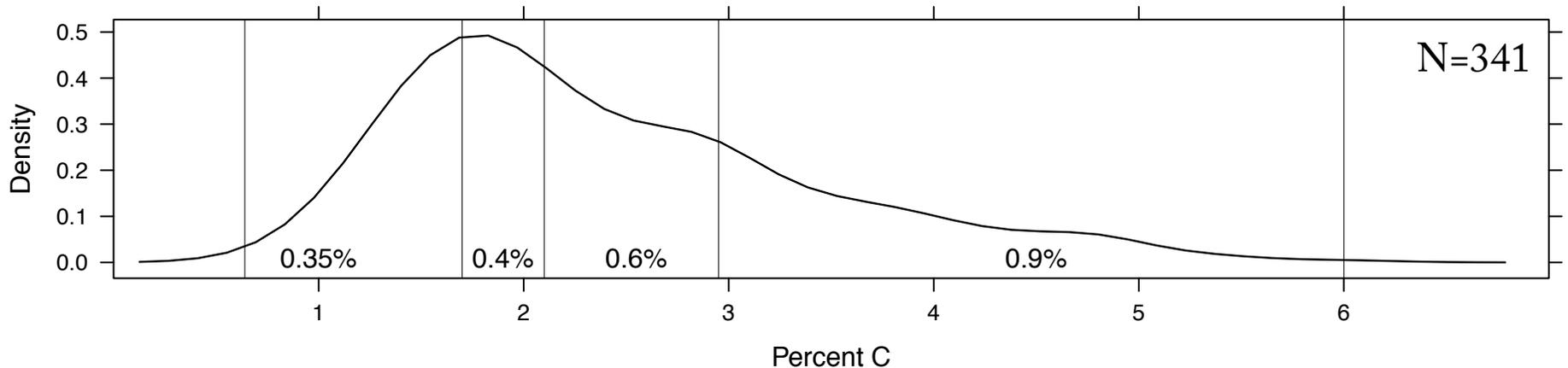


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'Granitic' Soils

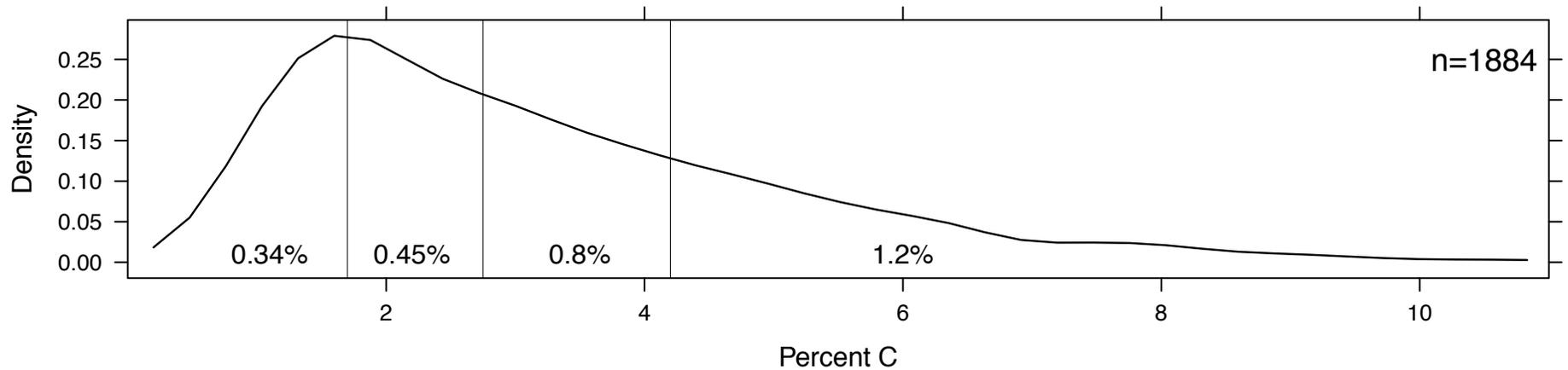
Soil C – Granodiorite



- 'Granitic' Entisols, Inceptisols and Mollisols cover ~ 12% (5.2 million ha) of California
- This model provides modest accuracy to estimate soil C with a simple point and click measurements

Across the Population

Soil C Population



- Most general model ($C \sim L+A$) provides suitable predictive power from $\sim 0.5 - 4 \% C$ (75% of the population)

Conclusions

- Color is the primary interface with soil – lets quantify it!
- Colorimetry – simple, easy to use & powerful for quantifying C
- Predictive accuracy varies but strong across scales
- Using redness (A) is important to classify soils and align models
- As always MORE data is needed with abundant opportunity to utilize existing samples and capture new ones as they are generated

Cleaning Out the Office?



or lost opportunity?

Questions?



Site or Soil Specific

- Initial application at site or soil scale – ‘small’ landowners
- ‘Customized’ models developed at low sample density (~ 100)

