

Factors affecting soil carbon accumulation in Massachusetts forests

Integrating geology/geography, vegetation, and soil properties as factors



**MASSACHUSETTS
GEOLOGICAL SURVEY**



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Intros

Cropland

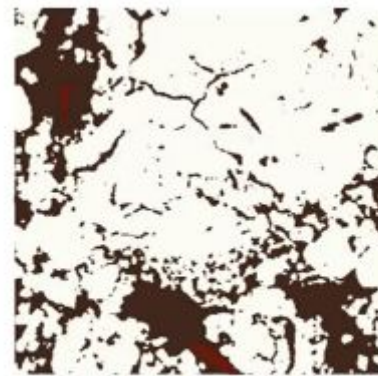
Grassland

Forest

Wetland



Gas flux measurement



2D 3D image analysis

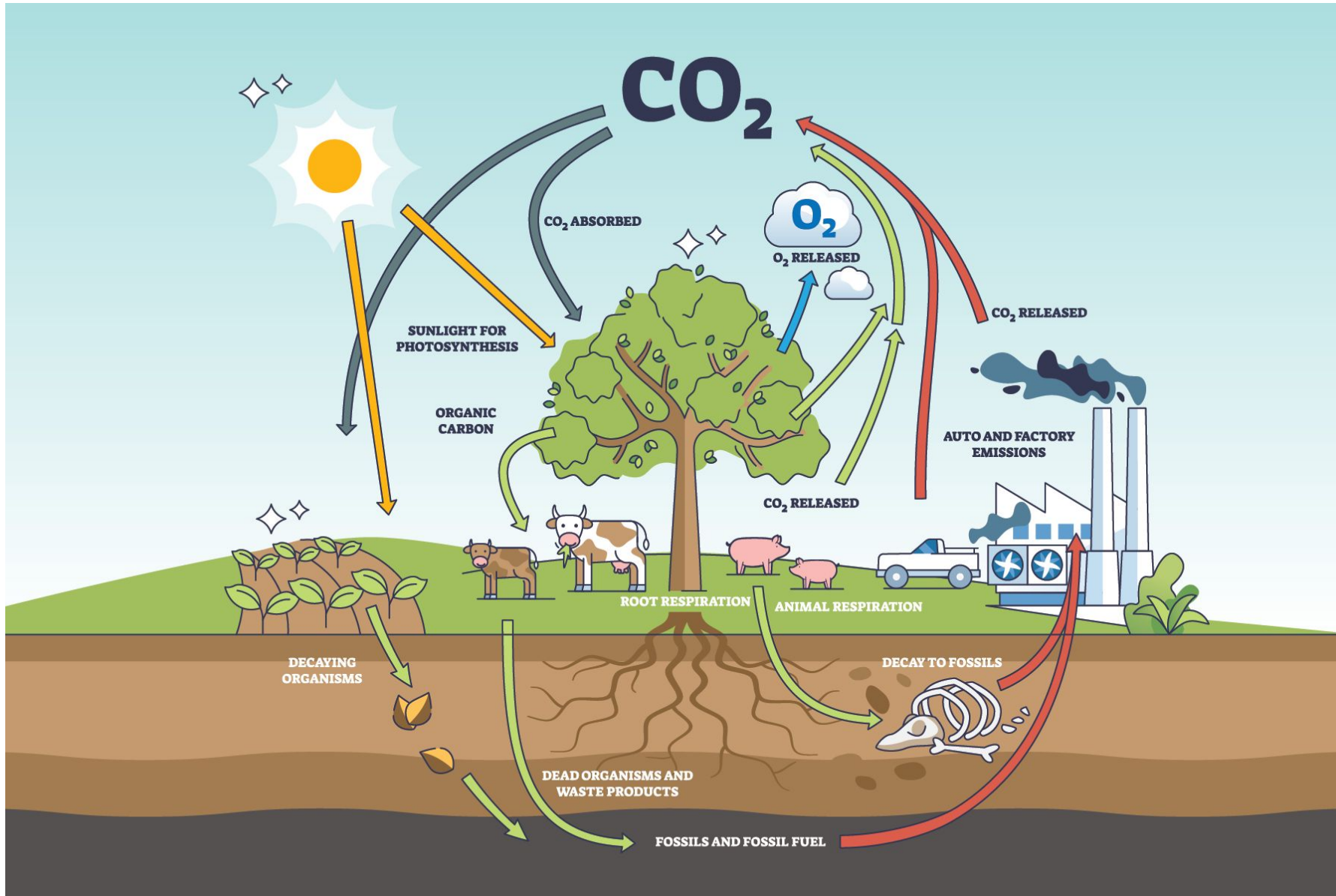


Isotope labeling



Deep coring

Soil carbon cycle



Atmospheric carbon pool

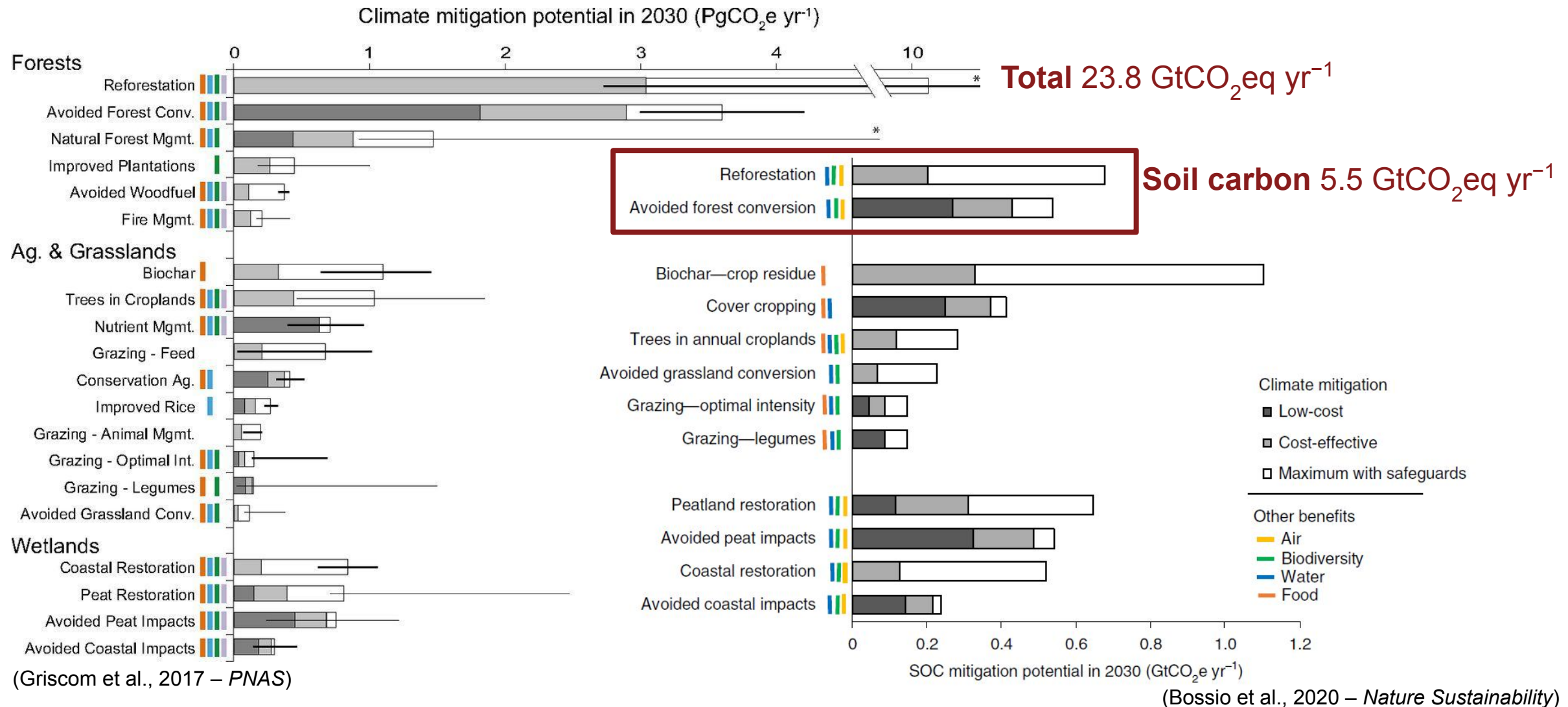


3.3 times

Soil carbon pool

(Lal et al., 2004 – Science)

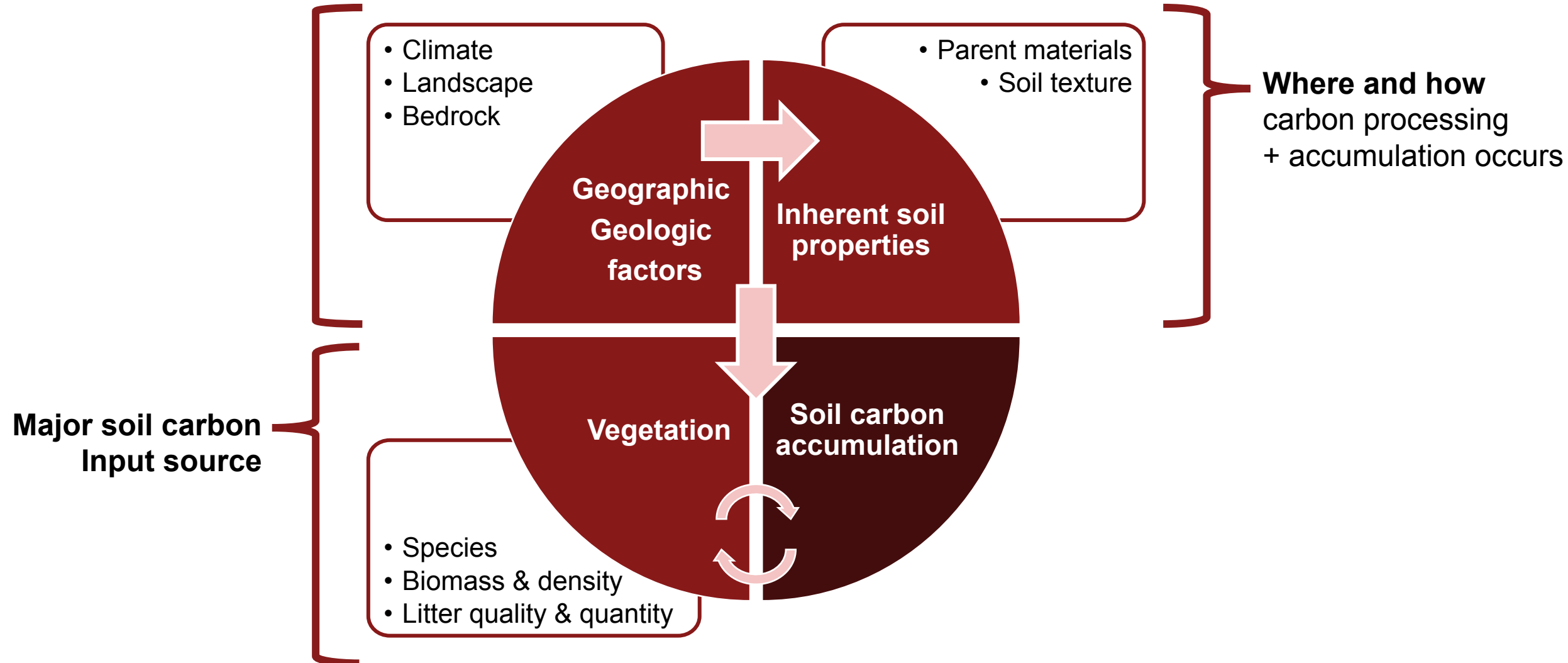
Why soil carbon is important?



Soil could provide up to 25% of the mitigation potential attributed to natural climate solutions

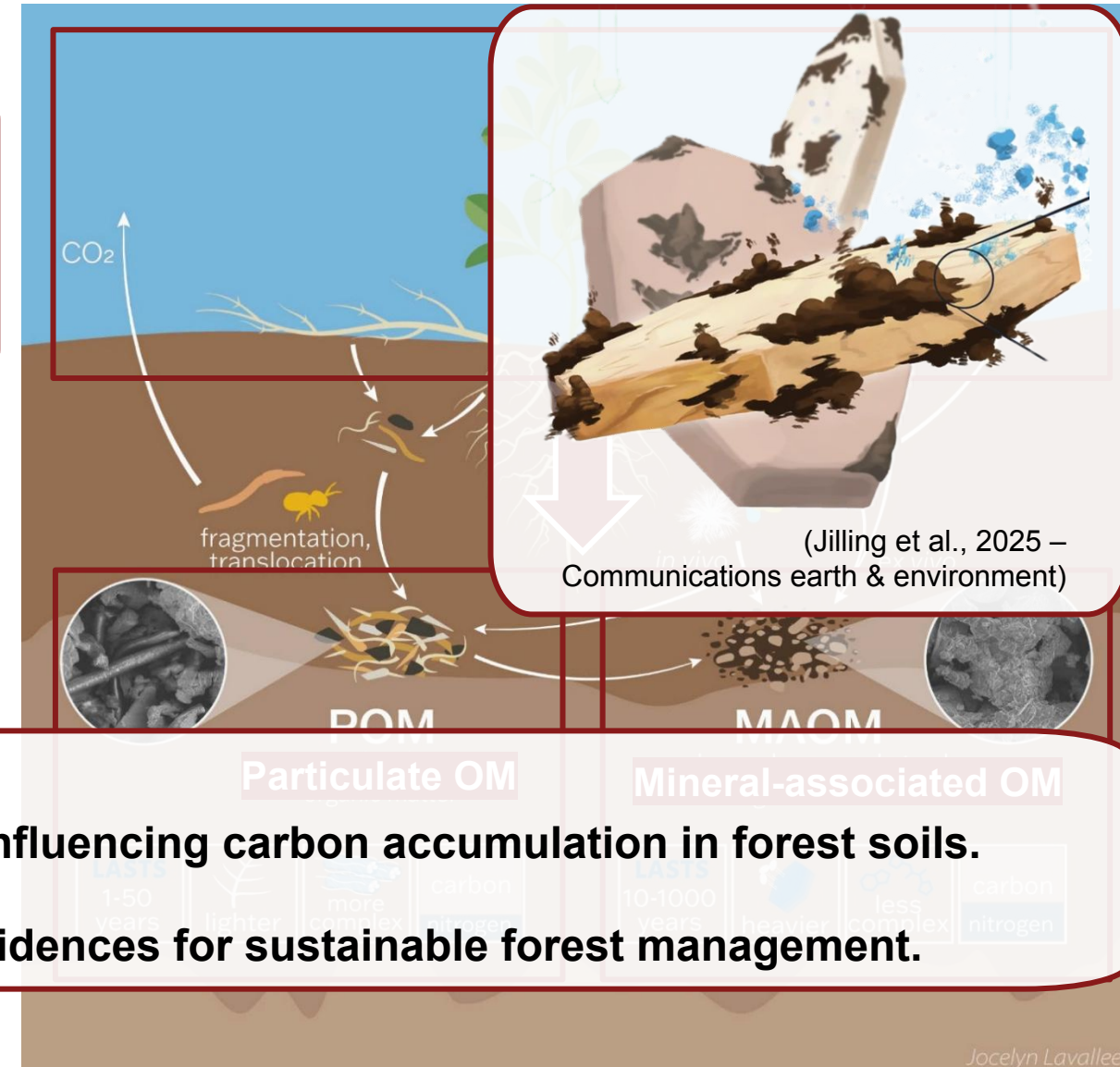
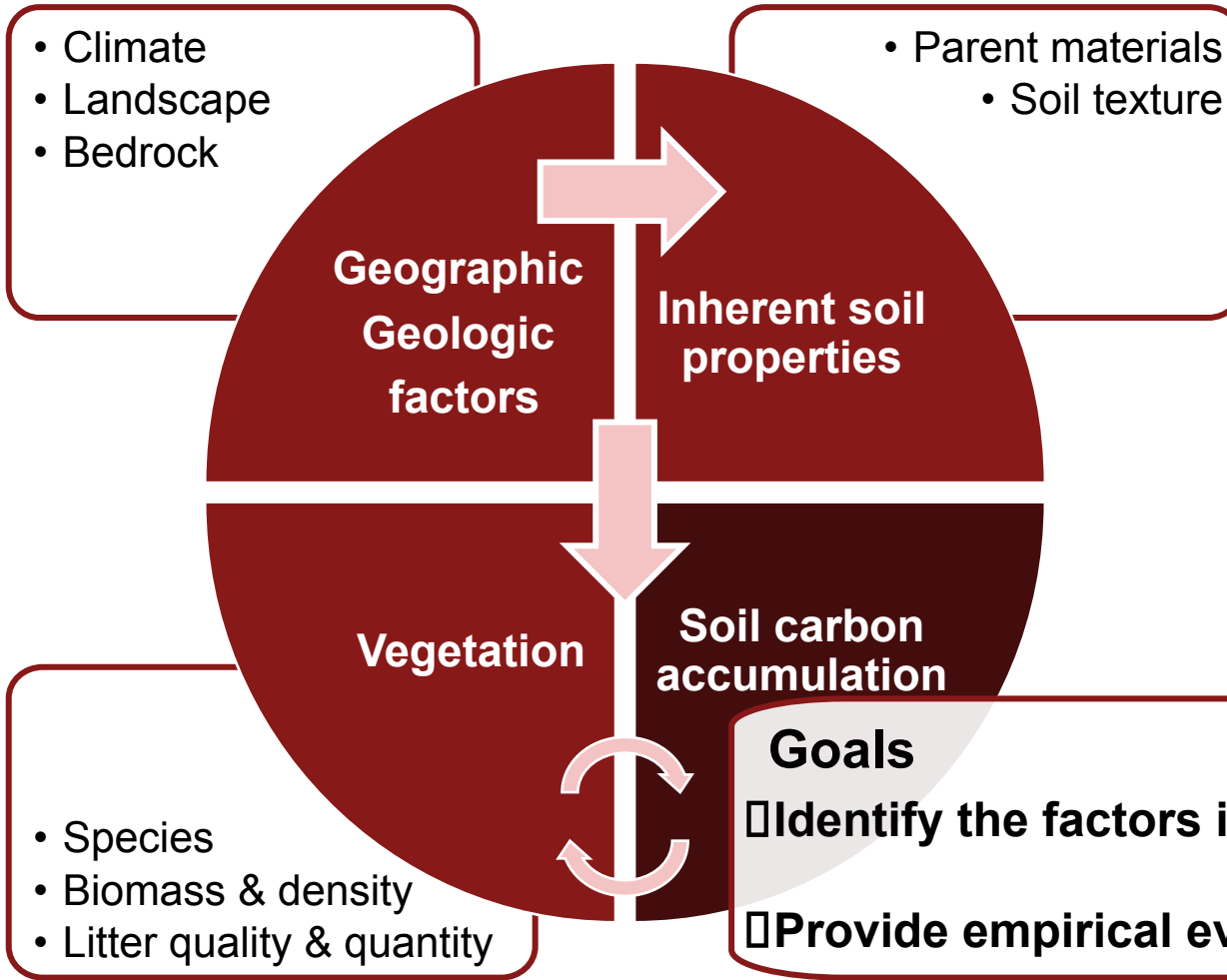
Soil carbon accumulation

What controls soil carbon accumulation



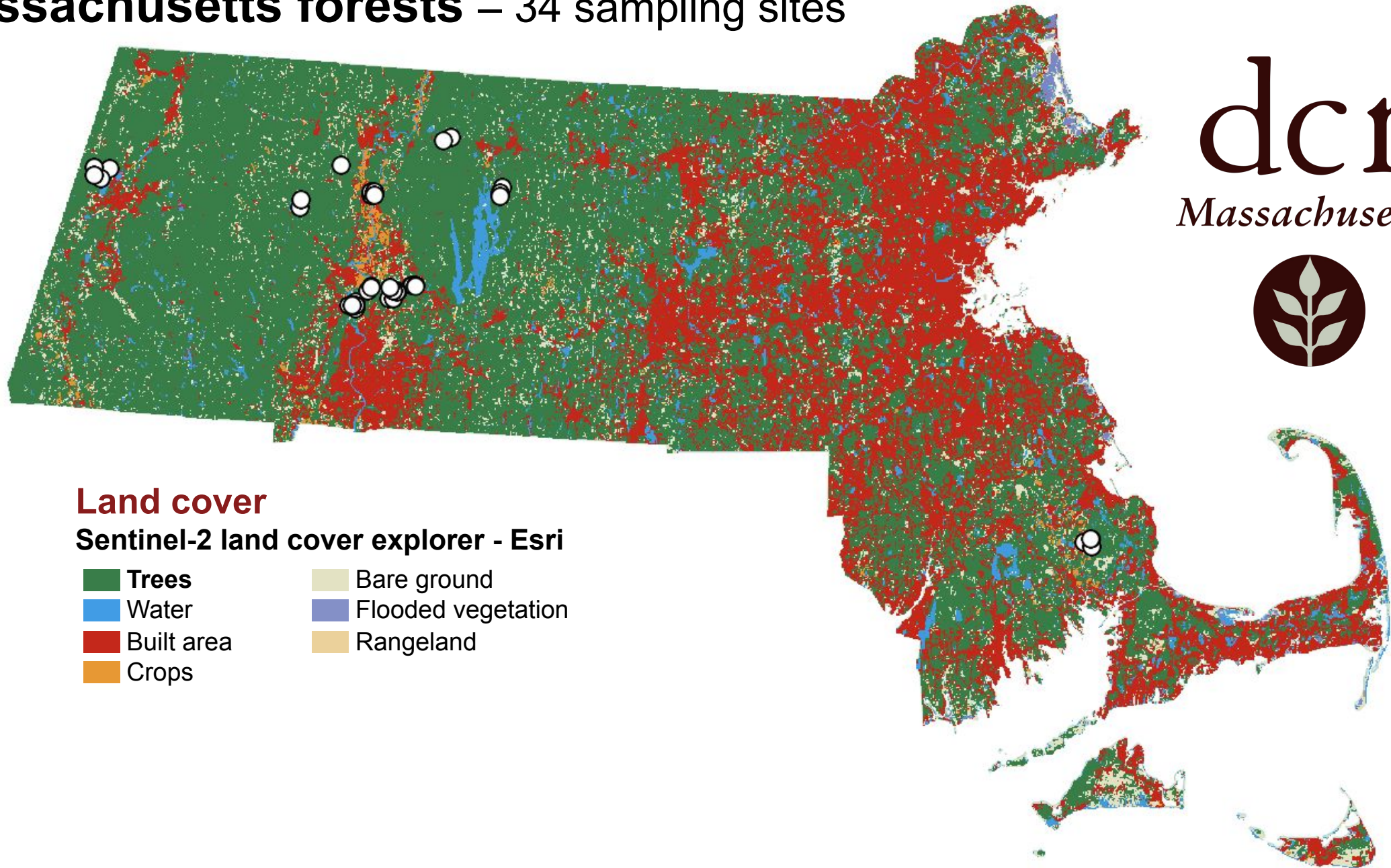
Soil carbon accumulation

What controls soil carbon accumulation



Massachusetts forests – 34 sampling sites

dcr
Massachusetts

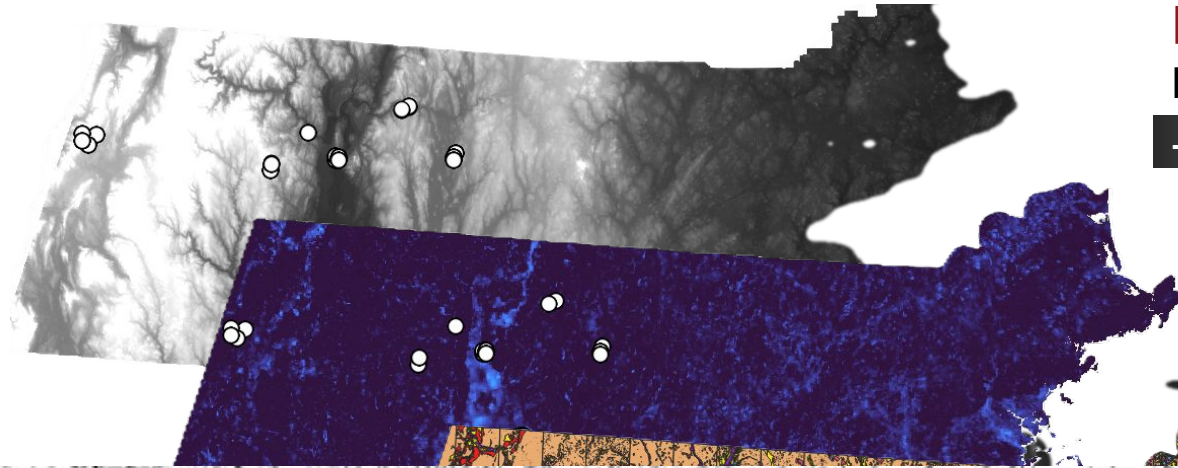


Land cover

Sentinel-2 land cover explorer - Esri

- | | |
|------------|--------------------|
| Trees | Bare ground |
| Water | Flooded vegetation |
| Built area | Rangeland |
| Crops | |

Geologic/geomorphic factors



Landscape (slope)

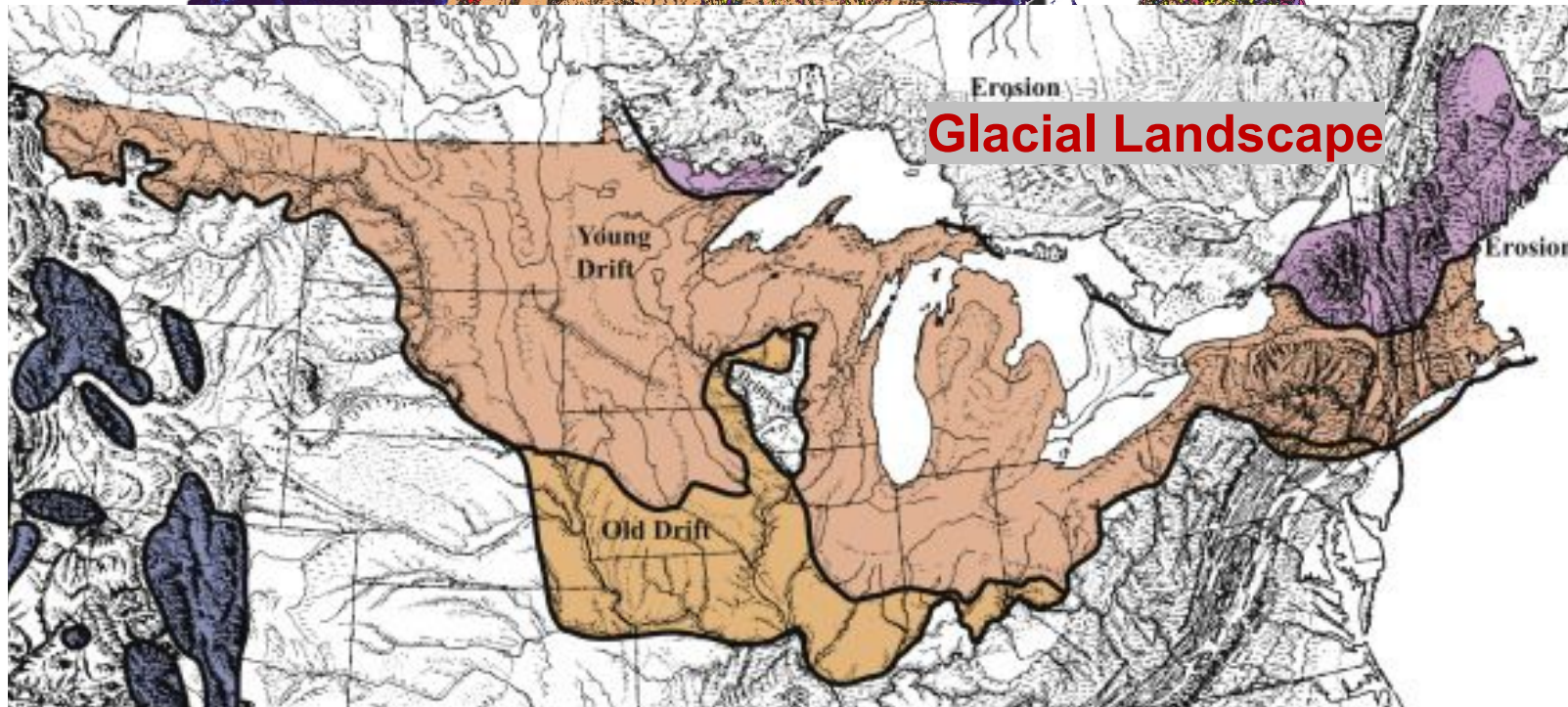
LiDAR terrain data (elevation)

-75 m 1065 m

Depth to Bedrock

Massachusetts Geological Survey

0 m 531 m



Glacial Landscape

Parent materials

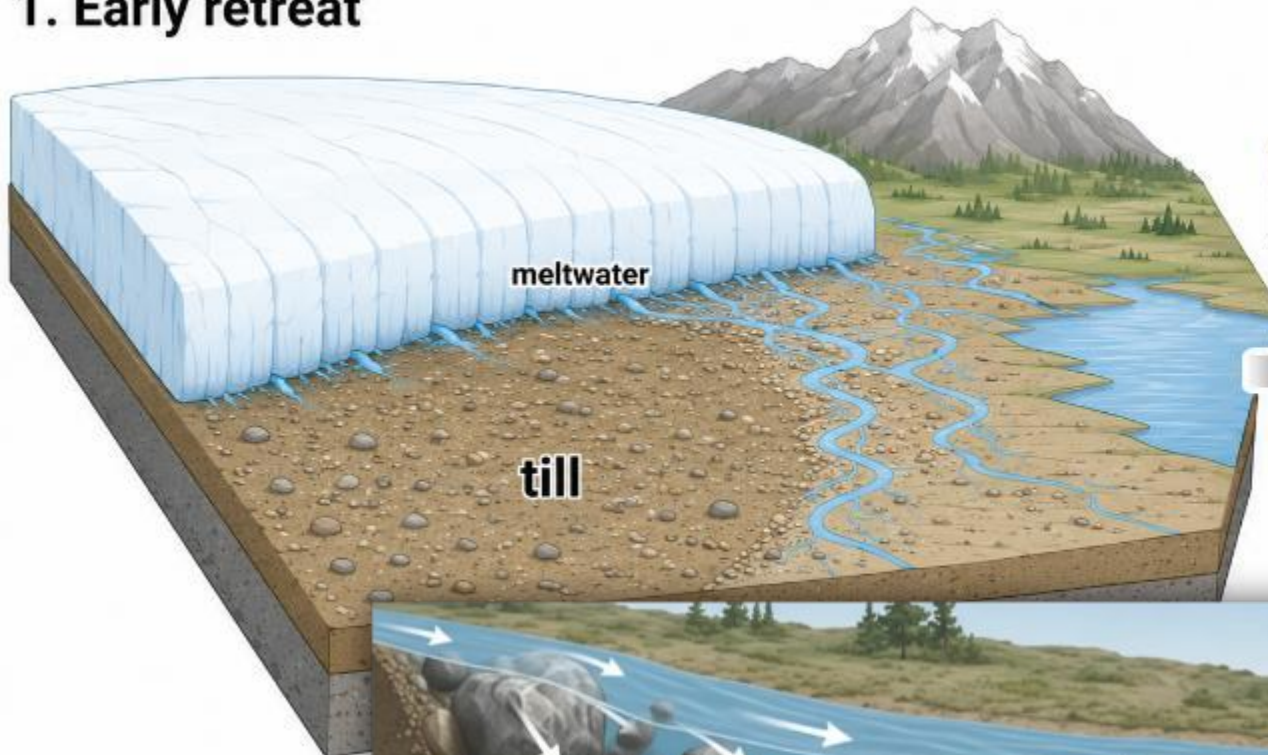
Massachusetts Geological Survey

- Thin till (48%)
- Coarse glacial stratified deposits (29%)
- Thick till (6%)
- Swamp deposit (5%)
- Flood-pain alluvium (3%)

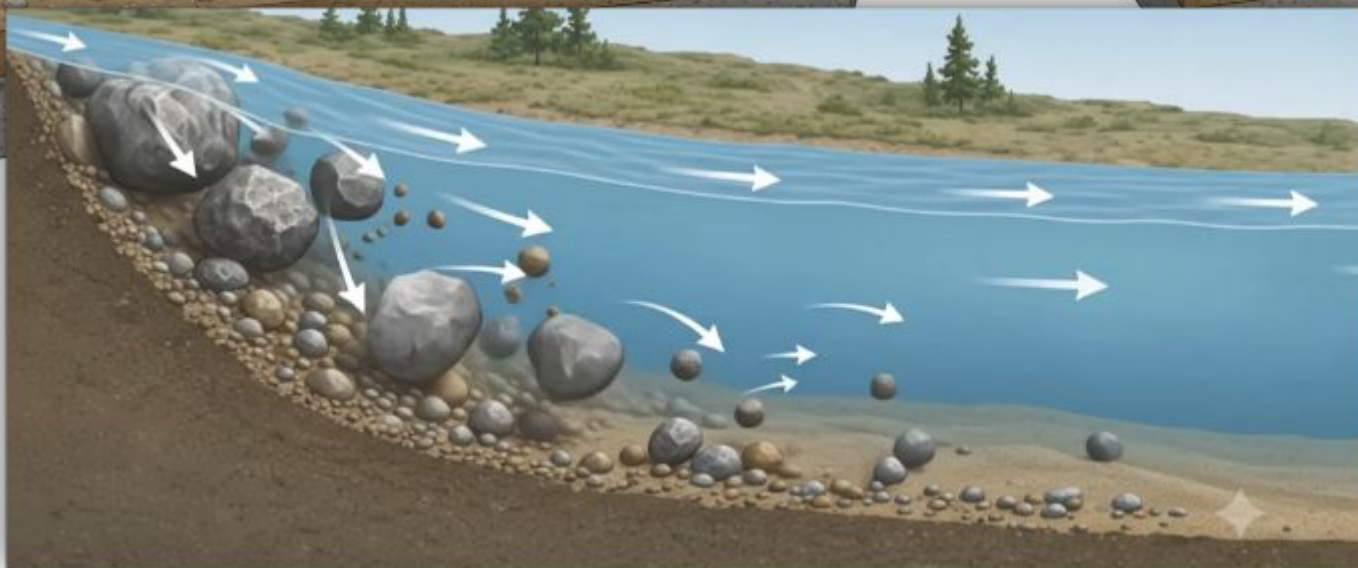
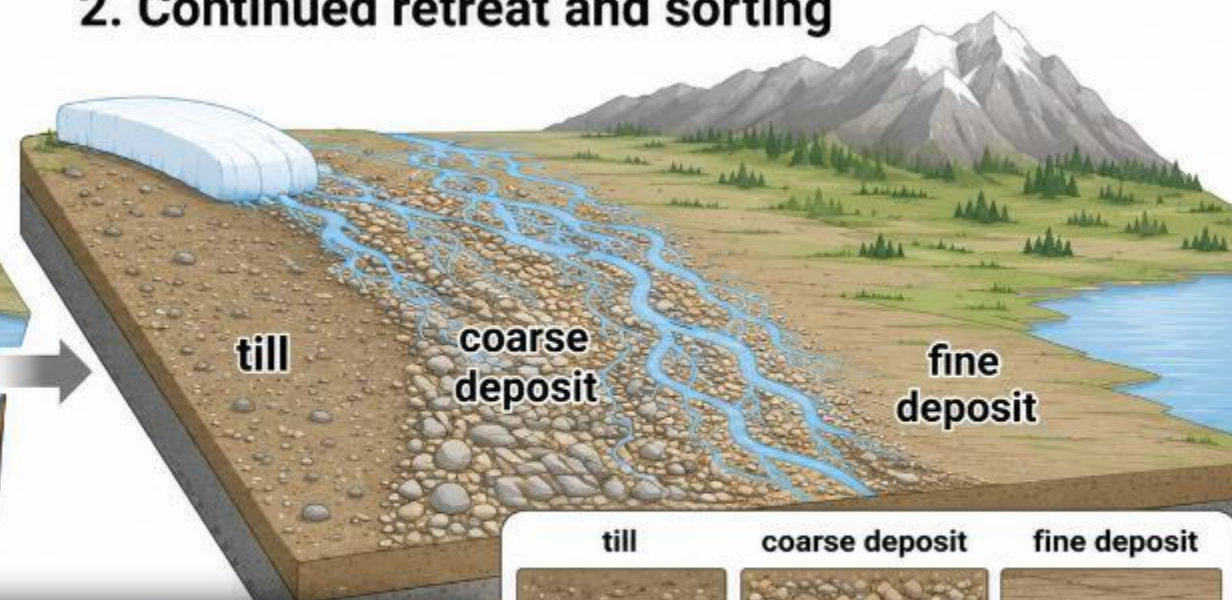
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Parent materials – Till and coarse deposit formation

1. Early retreat



2. Continued retreat and sorting



(Images and video generated by Gemini)

Vegetational factors

Site level:

- **Forest type**
- Tree density (number of trees / 0.2 acre)
- **Coarse wood debris (CWD) stock**
- etc.



Volume

← length & diameter of individual CWD (0.2 acre)

Decaying level classes (Sound; Partial; Decayed)

→ Multiplying different wood densities by classes

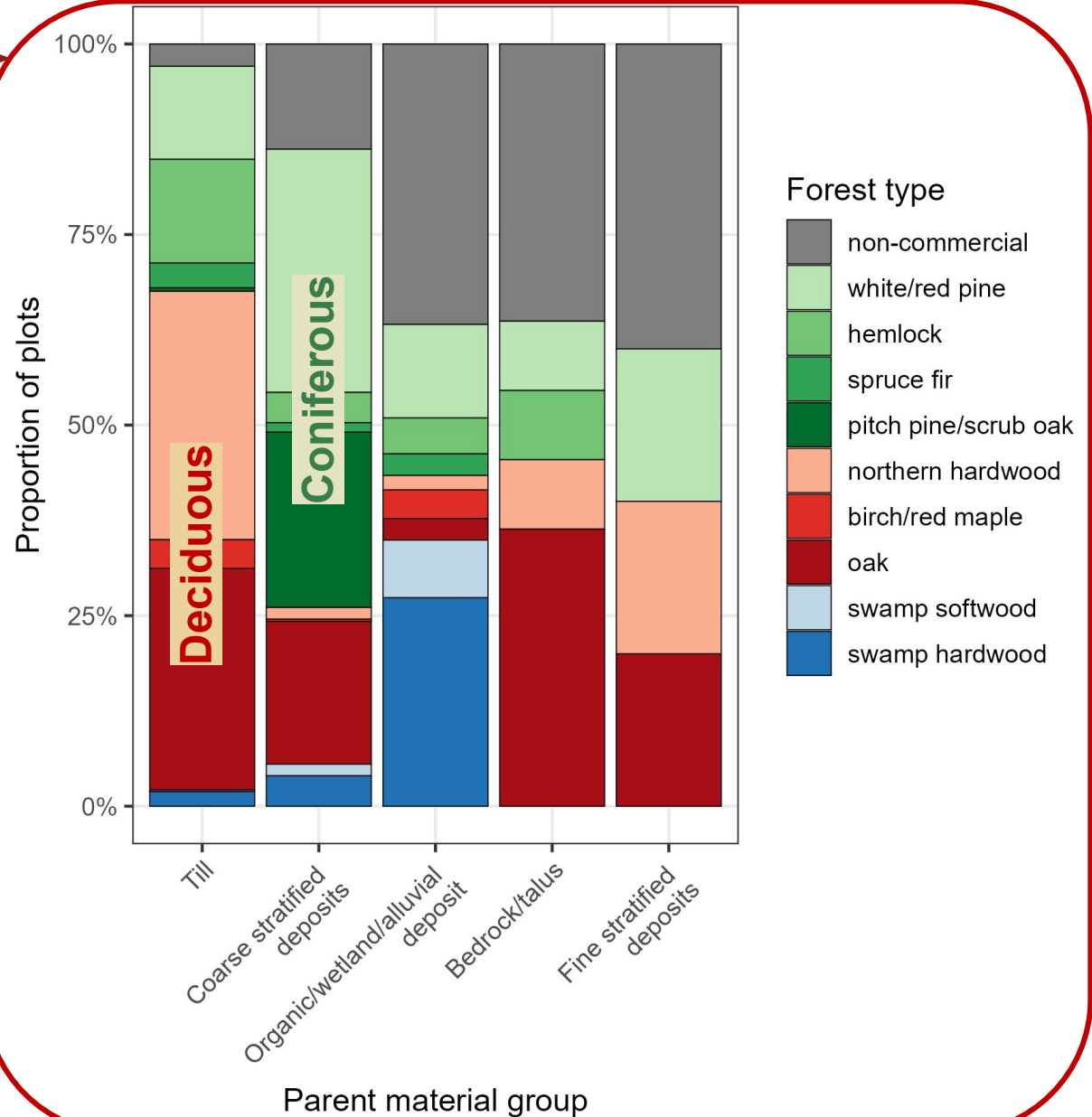
Sound
0.40

Partial
0.29

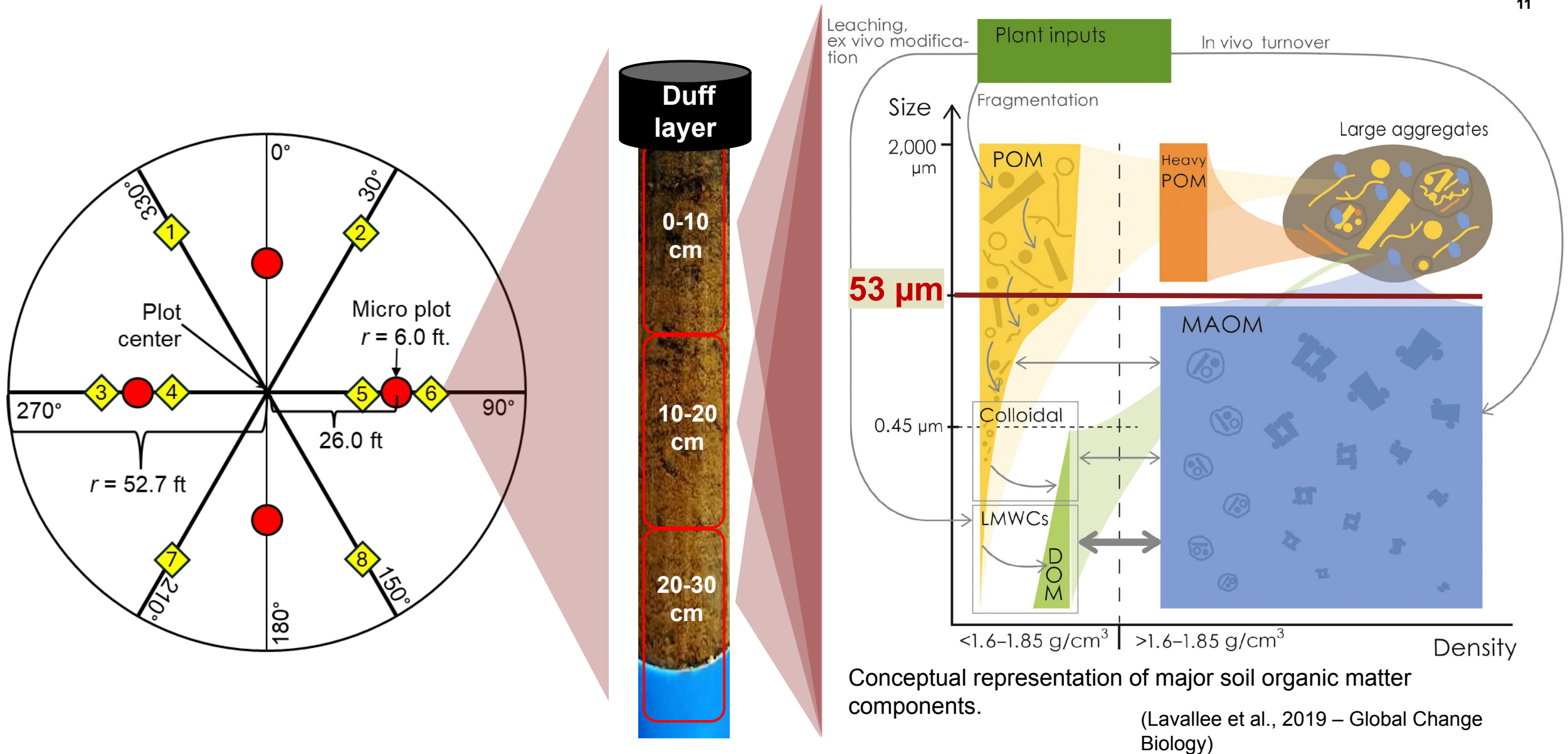
Decayed
0.17

(Harmon et al. 2008)

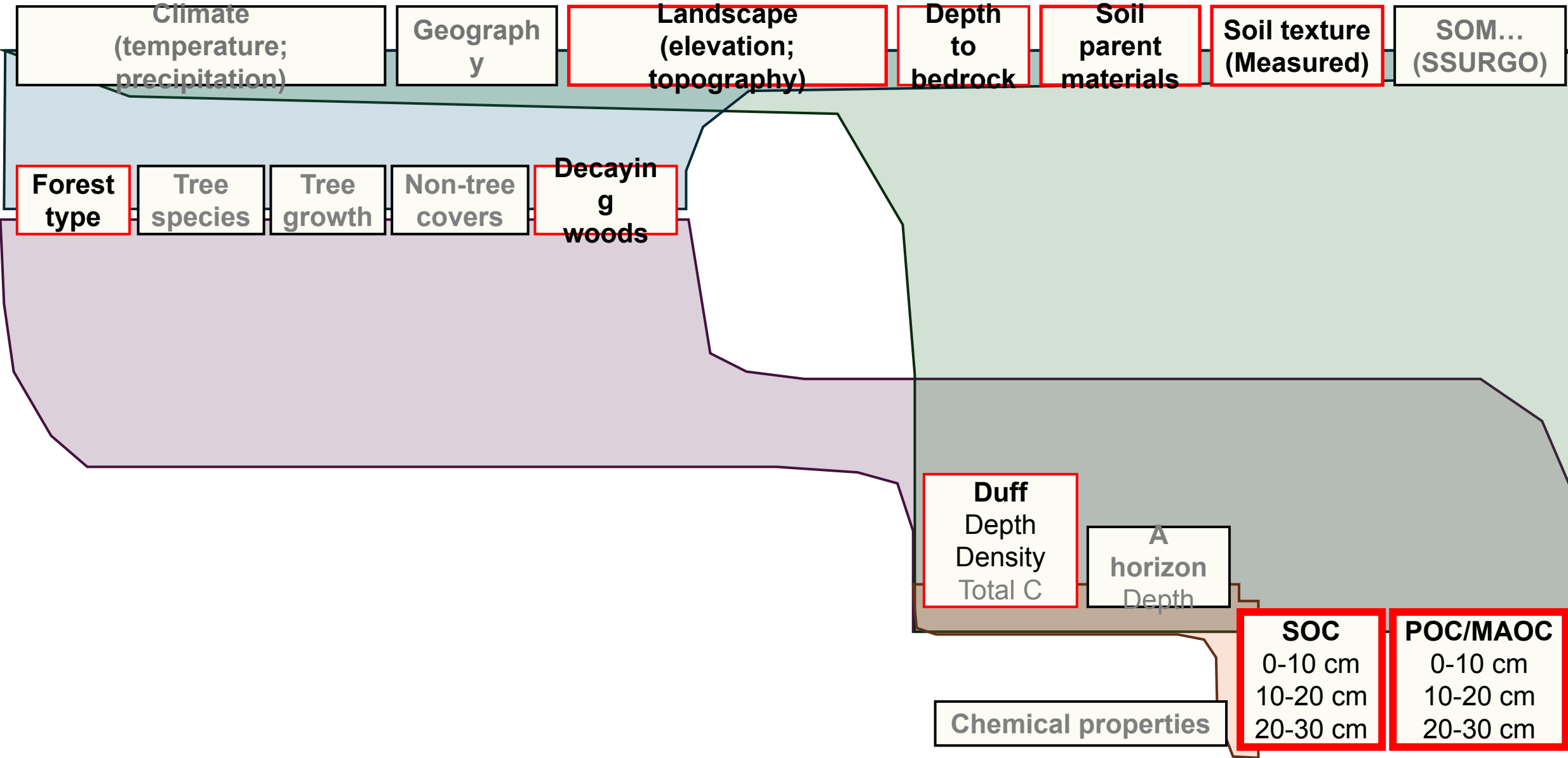
$$\text{CWD stock (Mg ha}^{-1}\text{)} = \Sigma (\text{Volume} \times \text{Density})$$



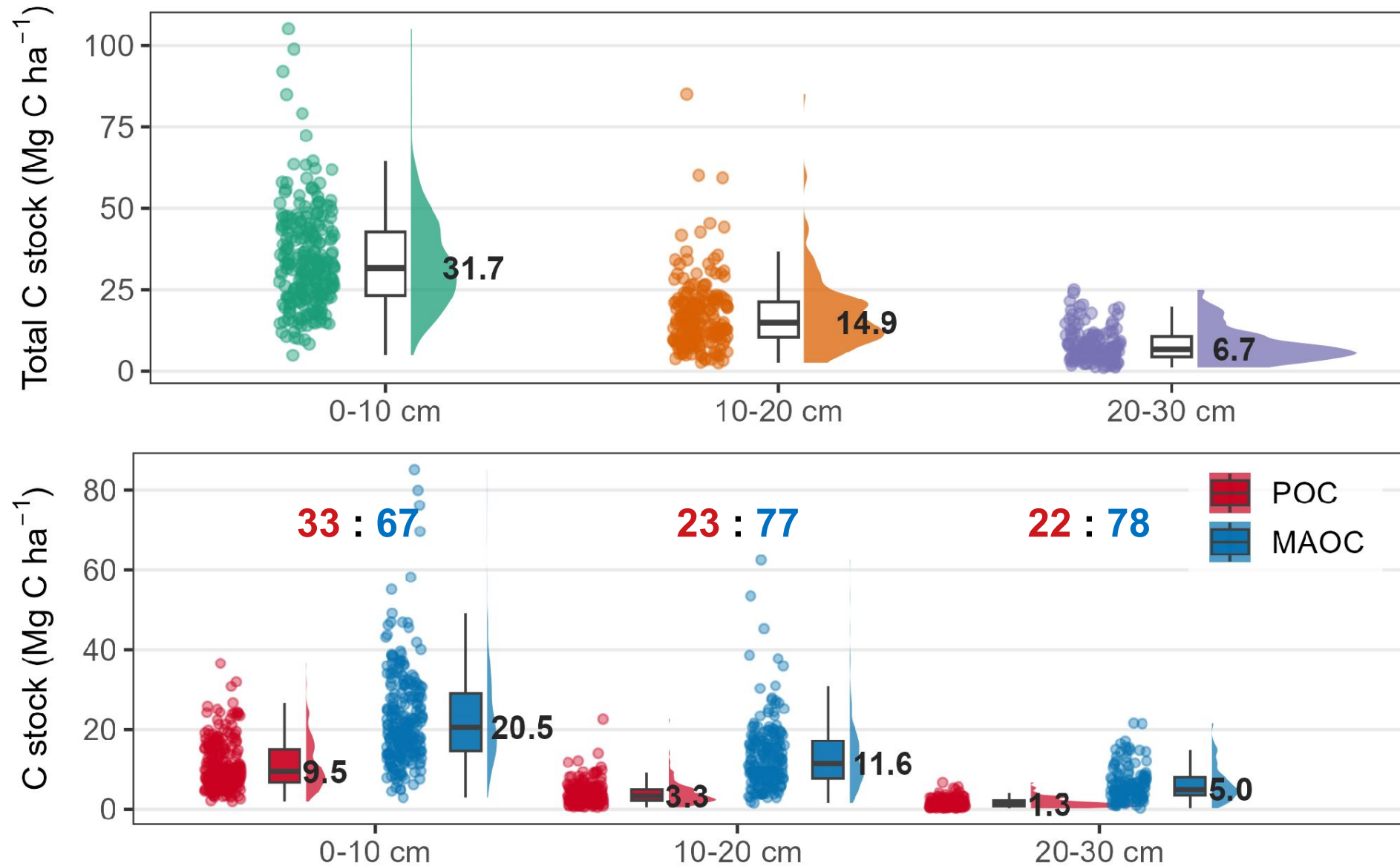
Field data collection & POM/MAOM fractionation



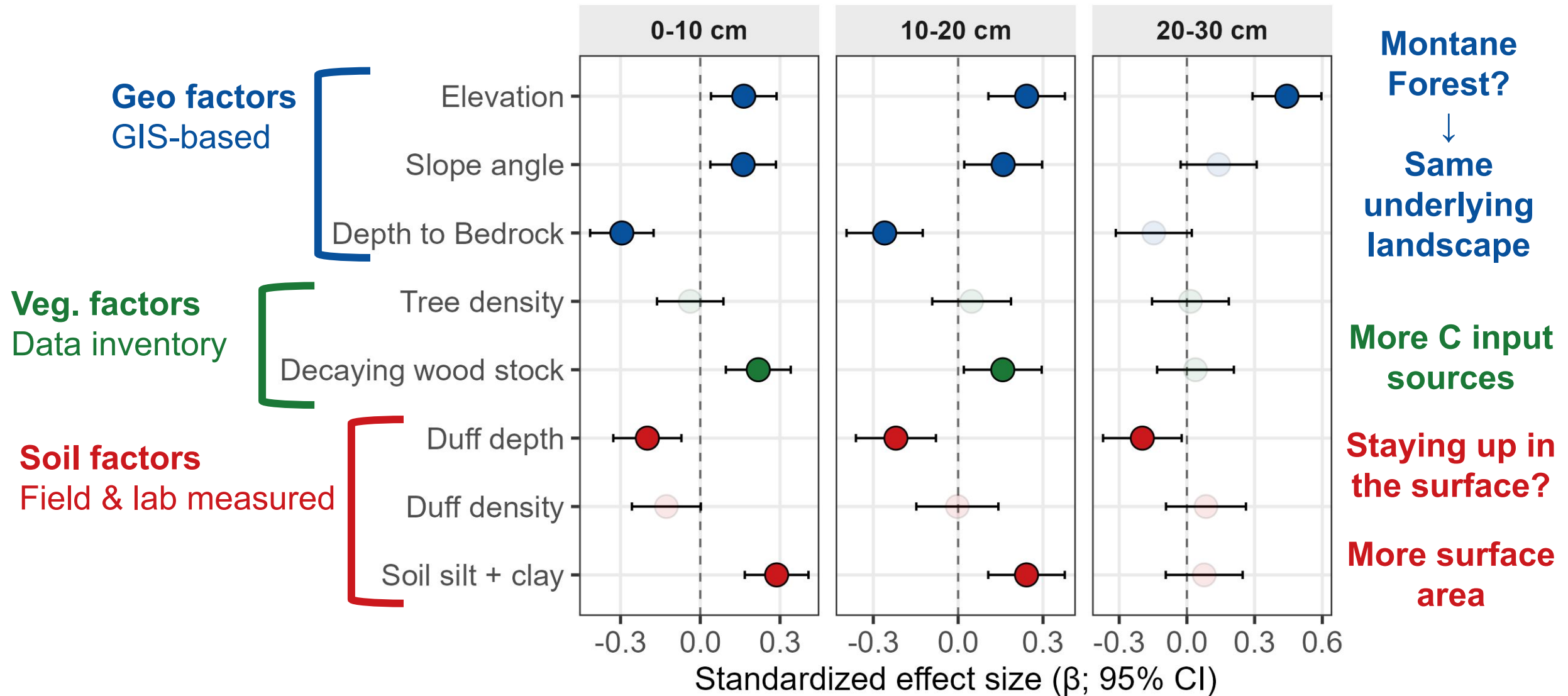
Potential factors in this study



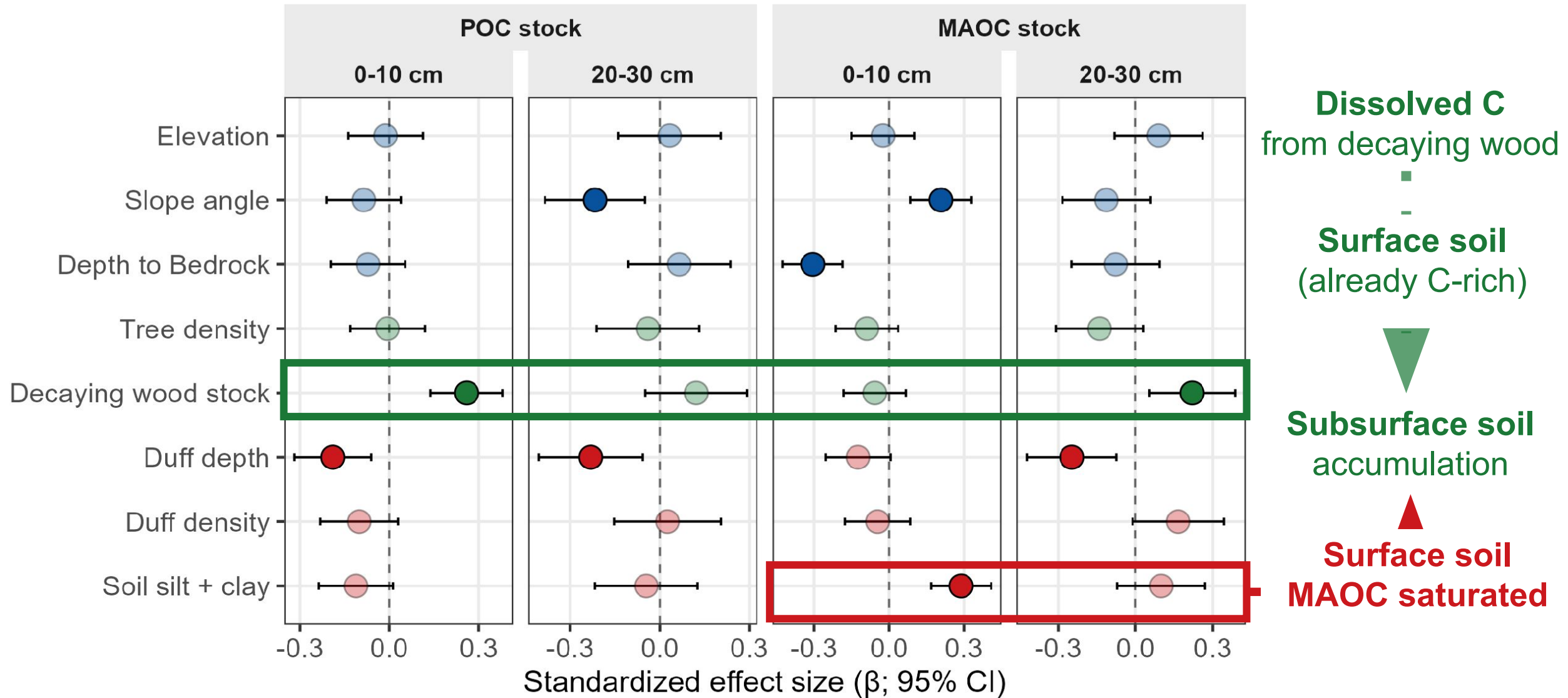
SOC & POC/MAOC stocks by soil depth



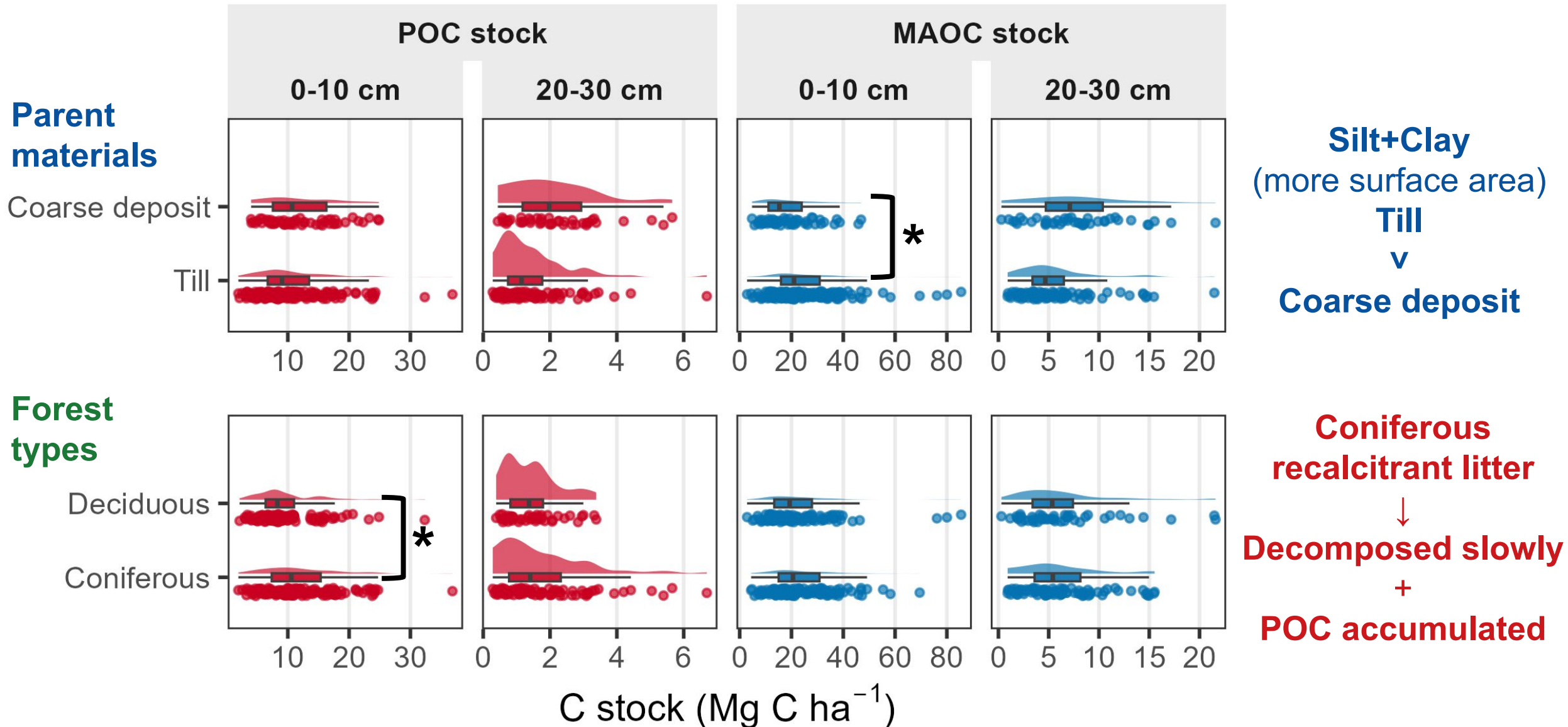
Numeric factors affecting SOC stocks



Numeric factors affecting POC/MAOC stocks



Non-numeric factors affecting POC/MAOC stocks



Main messages

- **Geographical + Geological**, **vegetation**, **soil property** factors
→ **SOC accumulation & MAOC stocks**

	SOC		MAOC	
Soil depth	0-10	20-30	0-10	20-30
Elevation	X	X	X	
Slope angle	X		X	
Depth to bedrock	X			
Parent material		Deposit	Till	Deposit
Tree density				
Tree type	Conifer			
Decaying woods	X			X
Duff depth	X	X		X
Duff density				
Silt+Clay	X		X	

Keep moving forward

- ✓ Wetland C project
→ Expand coverage
- ✓ ^{13}C & ^{15}N → Soil erosion
- ✓ Causal relationship via path analysis



Acknowledgements



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PI and co-PIs



Brian Yellen



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Matthew Winnick

My small army of undergraduate students



Annabelle Nowicki



Ava Zimmermann



Ella Buchert



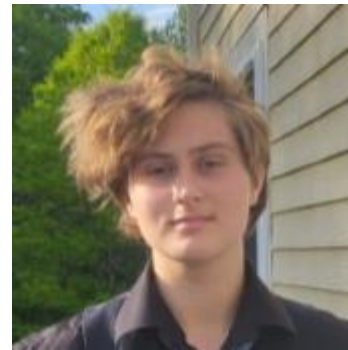
Finn Willis



Melissa Rymaszewski



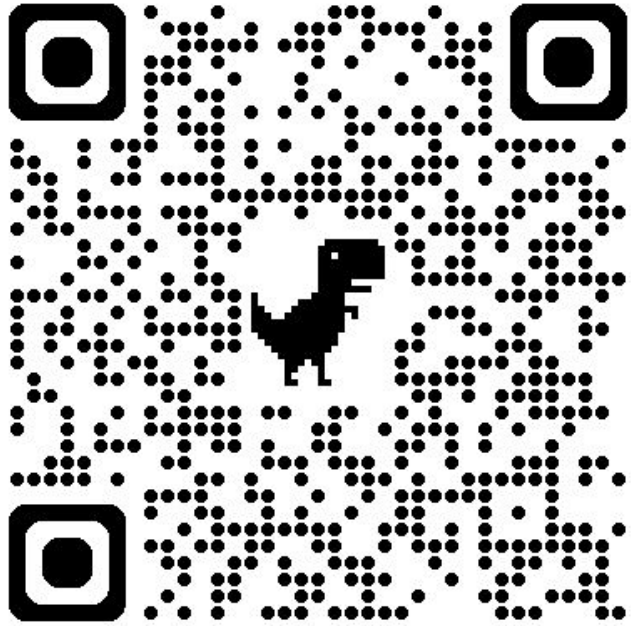
Nate Ainge



Silas Szklany



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Any questions?

