Practical Guidelines, Integrated Metrics, and Statistical Methods for Quantifying Carbon Sequestration in Rangeland and Agricultural Soils

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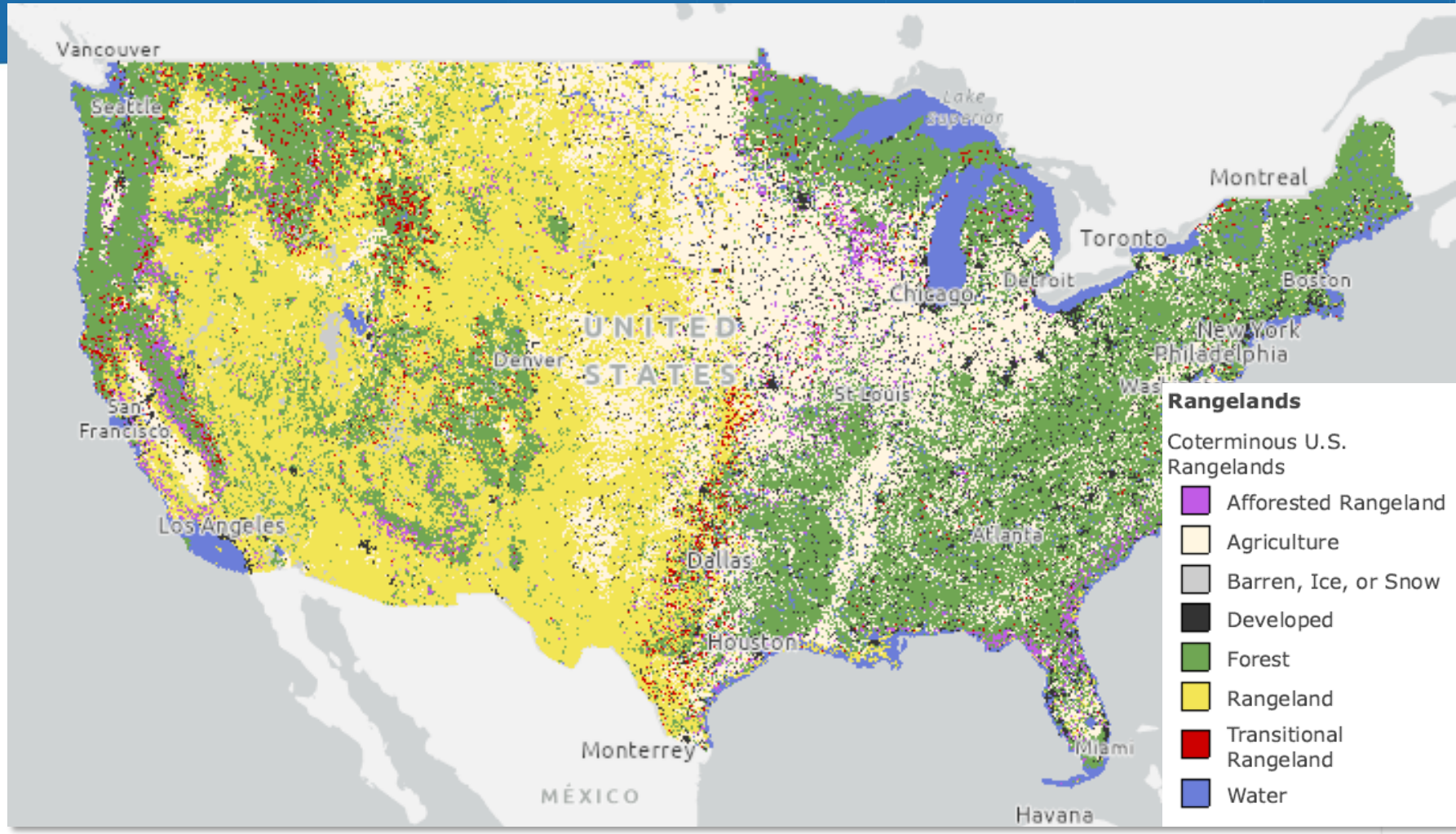
Carbon Sequestration Potential in U.S. Grasslands

- *"In total, US soils (including cropland, grazing and forest land, land conversion, and other land use) have the potential to* ***sequester an estimated 288 million MT C per year."***

  - Chambers et al. 2016) [emphasis added]



How does Nature-Based Carbon Capture Work?

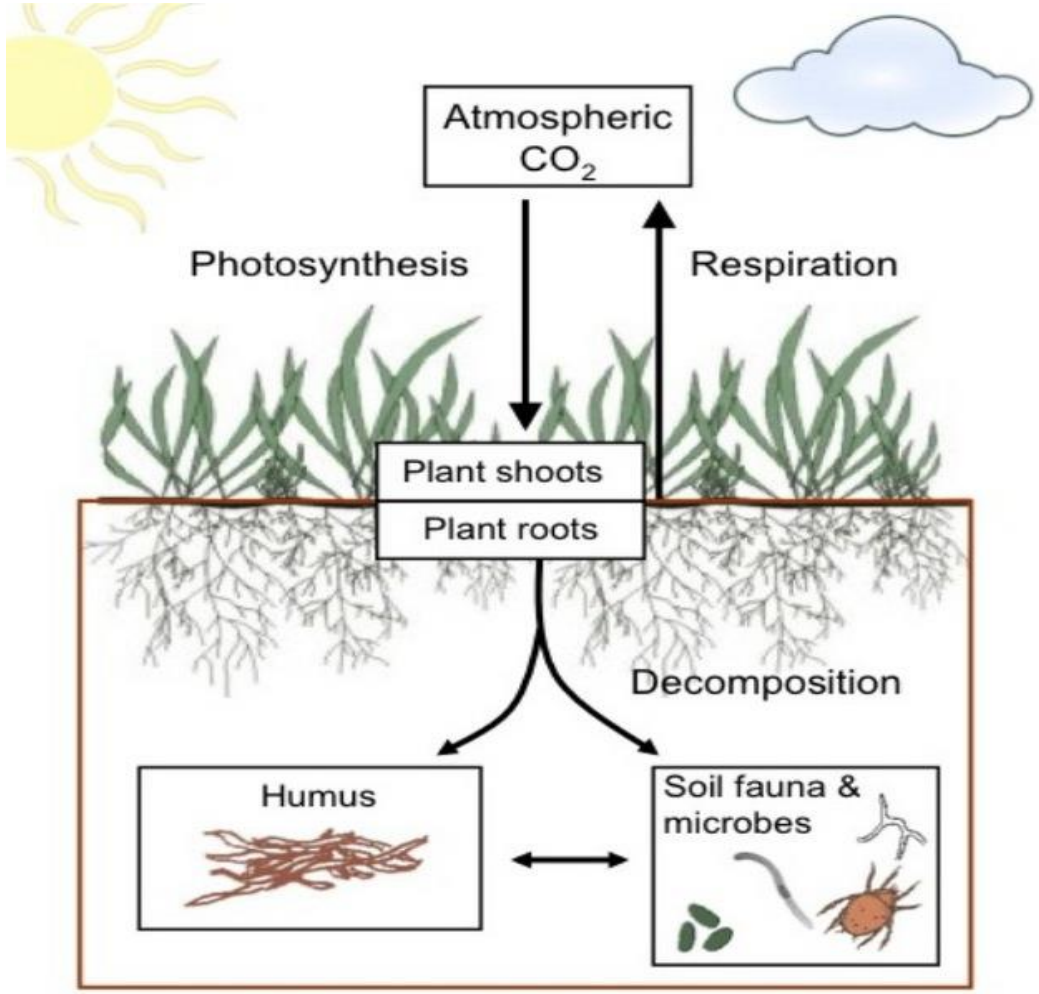


Image from Ontl, T. A. & Schulte, L. A. (2012) Soil Carbon Storage. *Nature Education Knowledge* 3(10):35

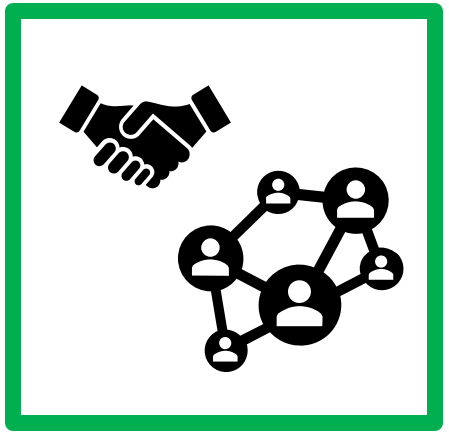
Change in Land Management

- Minimize disturbance
- Maximum Biodiversity
- Keep it Covered
- Regenerative Agriculture
- Include Animals
  - Rotational Grazing

Carbon Credit Marketplace

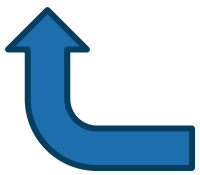
Landowner
Seller

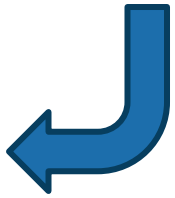
Assembler



Certifier

Buyers





Verifier

Cash Now

Data Later

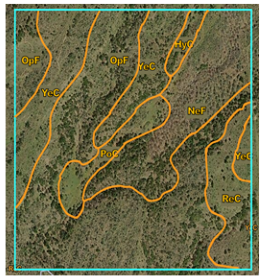
Trust

BCarbon Protocol

GSI ENVIRONMENTAL

Testing-Centric Monitoring, Recording, and Verification Protocol

Step 1
Definition of Project Area and Sub-Areas



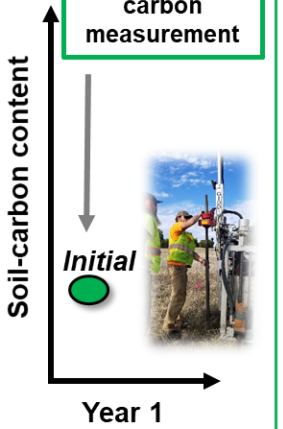
Property Boundary

OpF Soil Type

Year 1

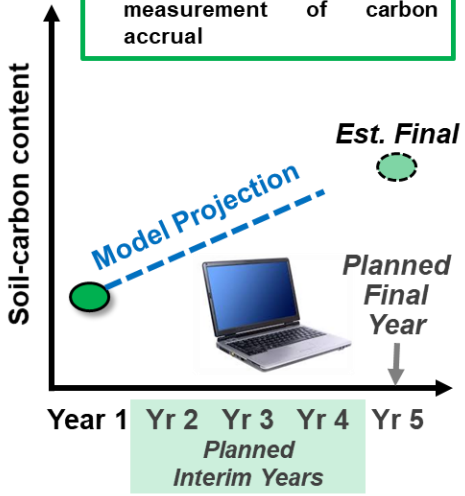
Step 2
Initial Below-Ground Carbon Measurement

Initial Below-ground carbon measurement

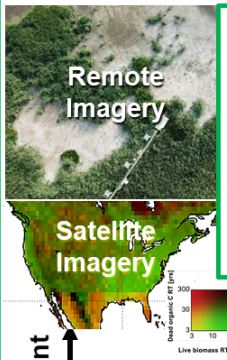


Step 3
Conservative Forecasting of Below-Ground Carbon Accumulation Rates

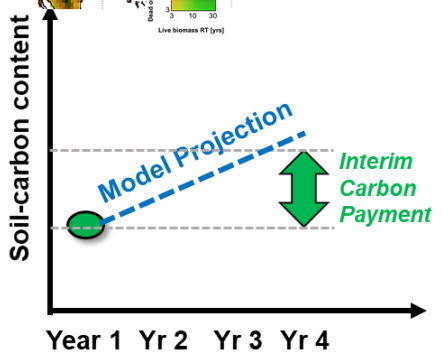
- Carbon estimate based on peer-reviewed models/literature
- Determination of Appropriate time (e.g. Year 5) for final measurement of carbon accrual



Step 4
Project Monitoring and Recordkeeping

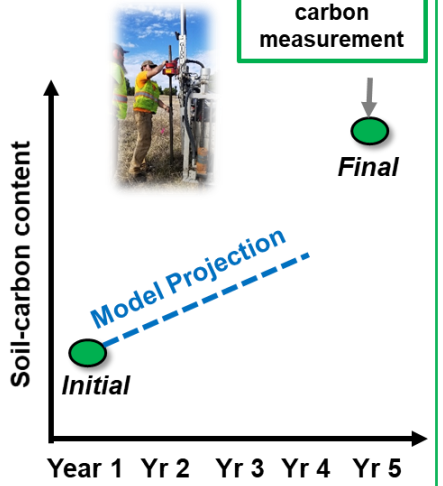


- Indirect measures monitoring
- Certifying implementation of land management practices
- Interim payments based on model projection

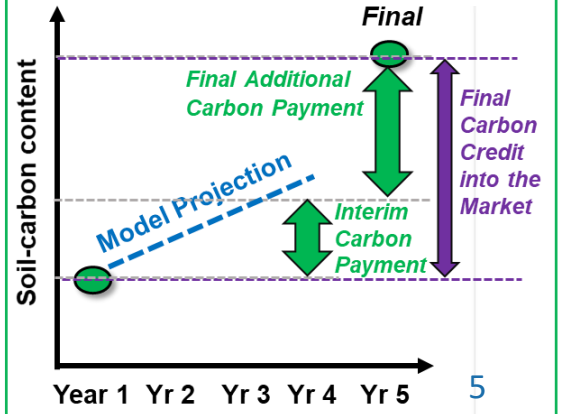


Step 5
Measurement and Quantification of Below-Ground Carbon Accrual at Project Completion

Final Below-ground carbon measurement

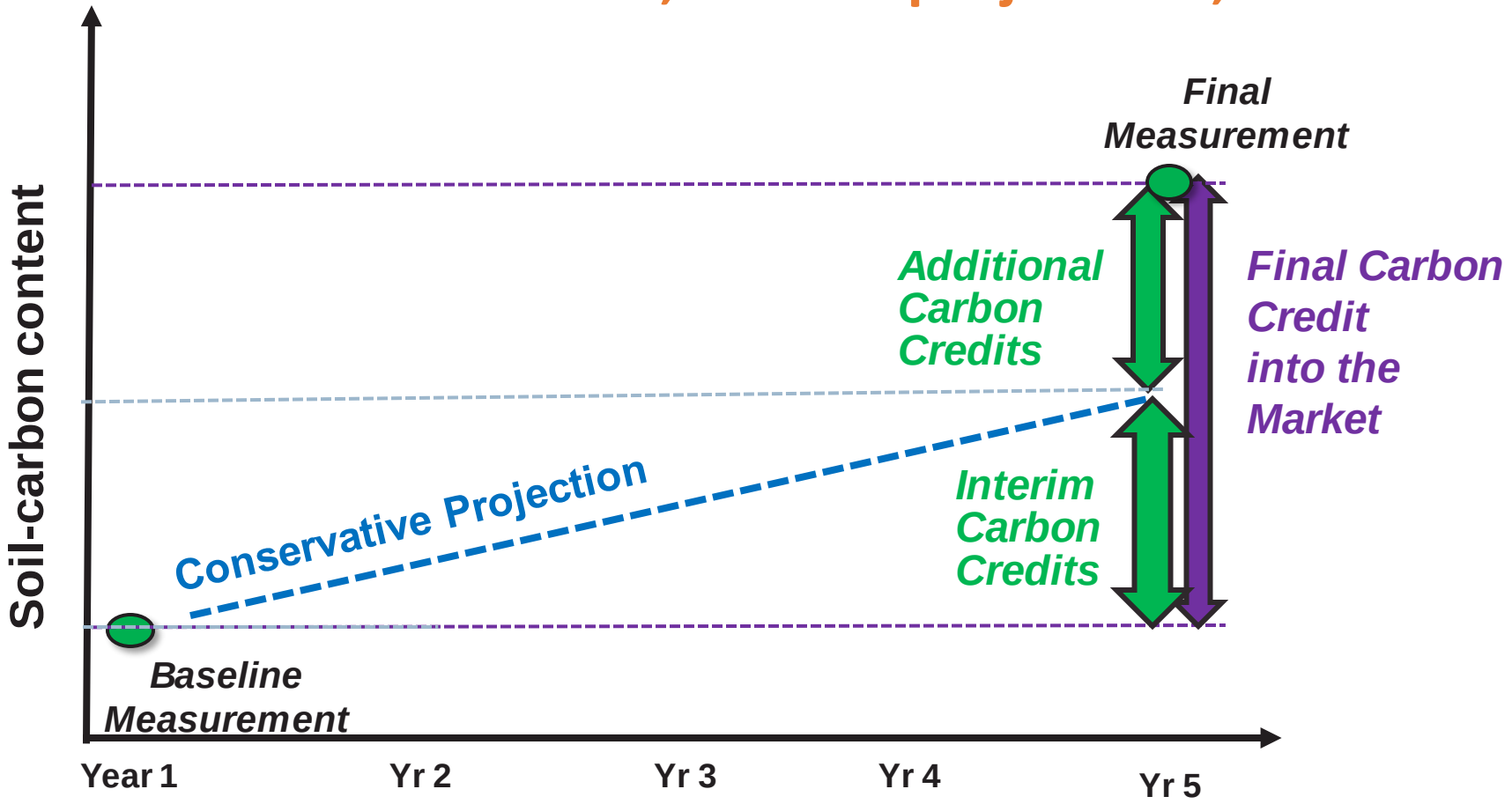


Step 6
Below-Ground Carbon Accounting and Documentation



BCarbon Crediting

Initial measurements, interim projections, final measurements

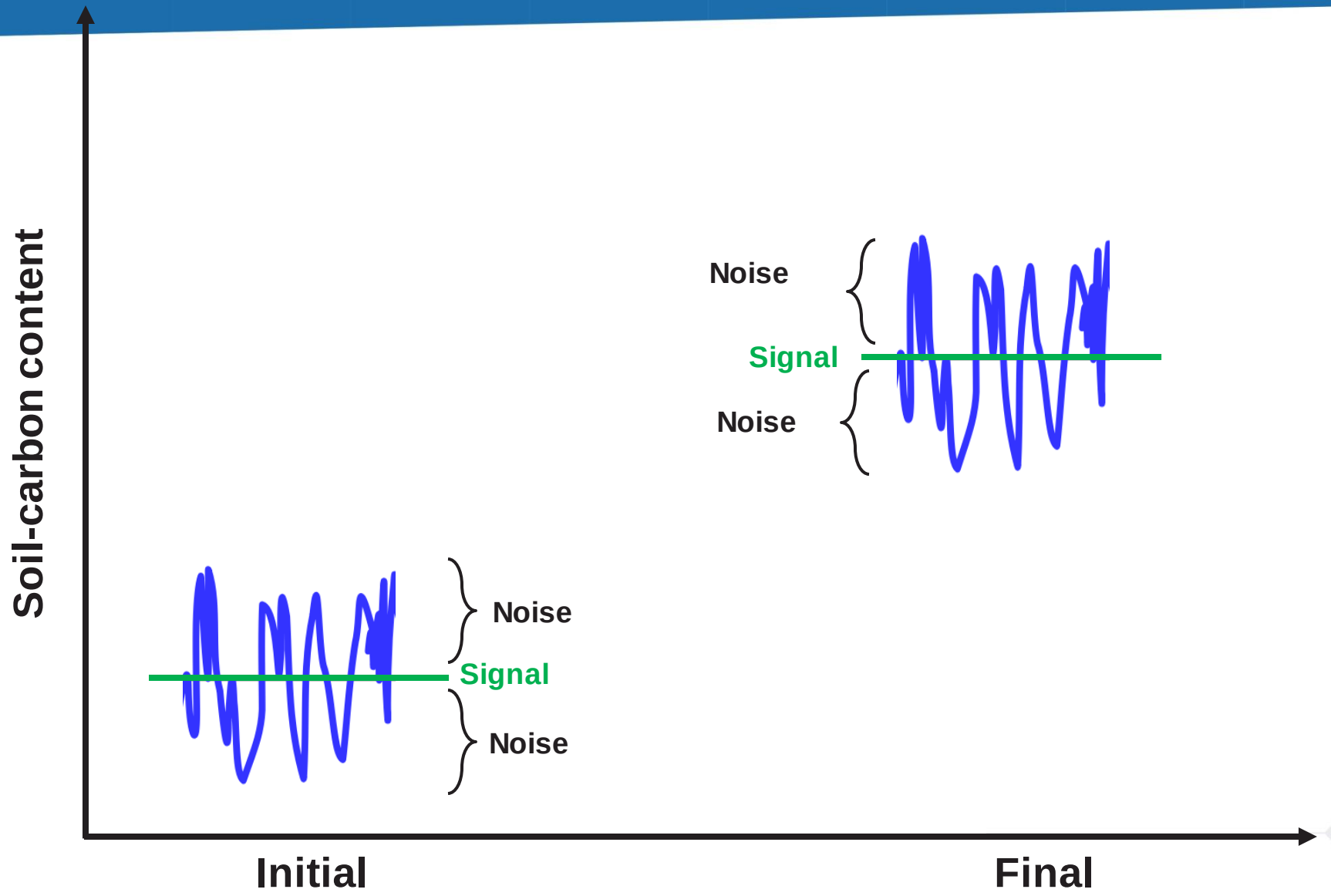


Key Points

- Allows for Optional Interim Crediting
- Credits based on Initial and Final Measurements

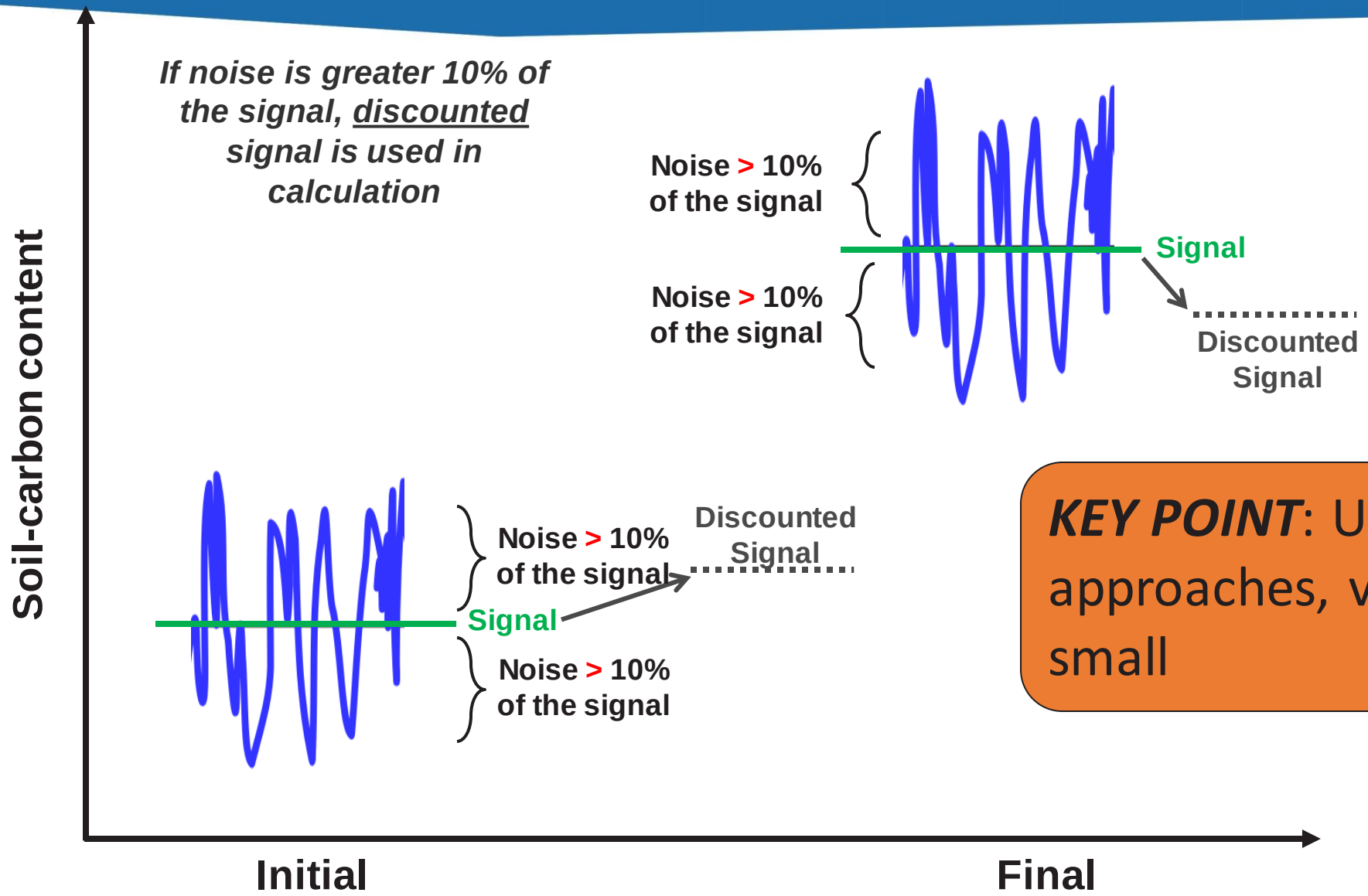
Signal and the Noise

But how do we demonstrate certainty with variable data?!?



Traditional Statistical Approaches

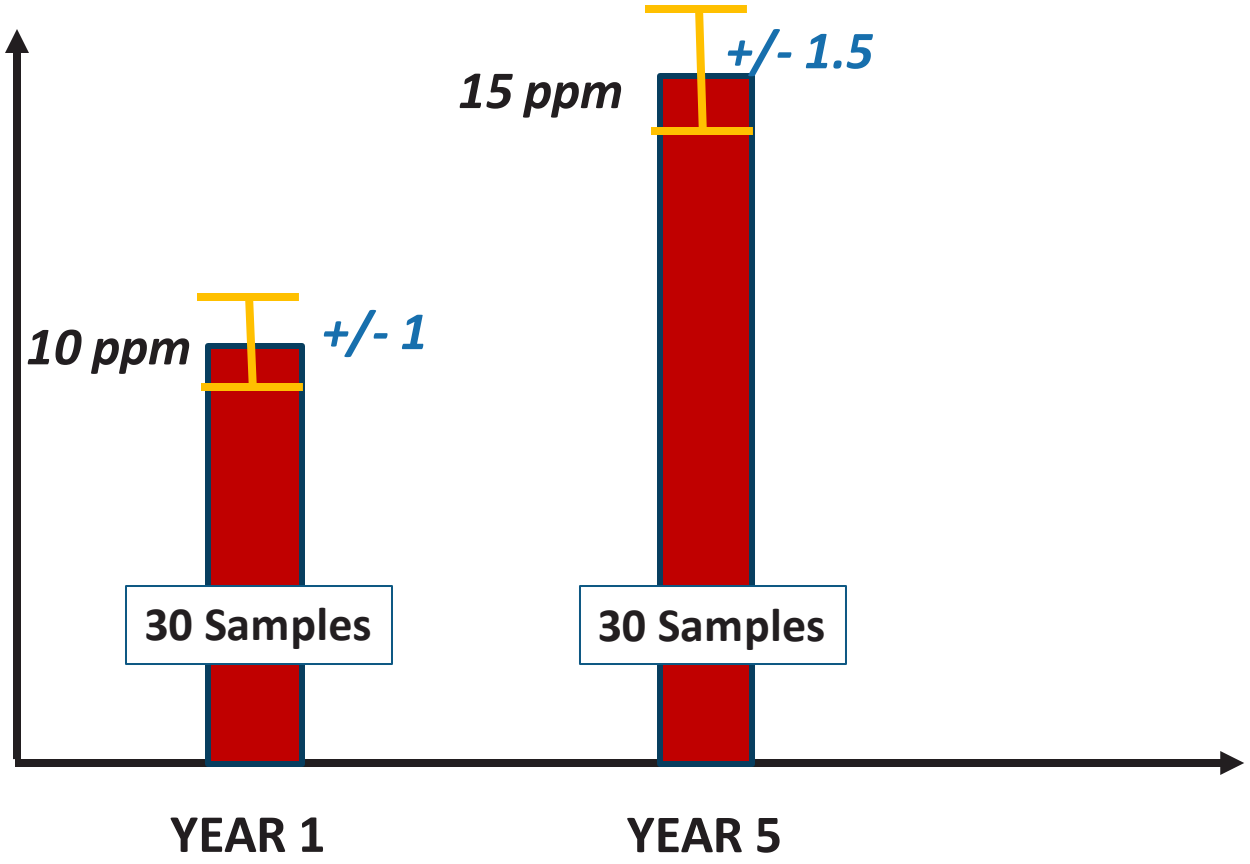
If noise is greater 10% of the signal, <u>discounted</u> signal is used in calculation



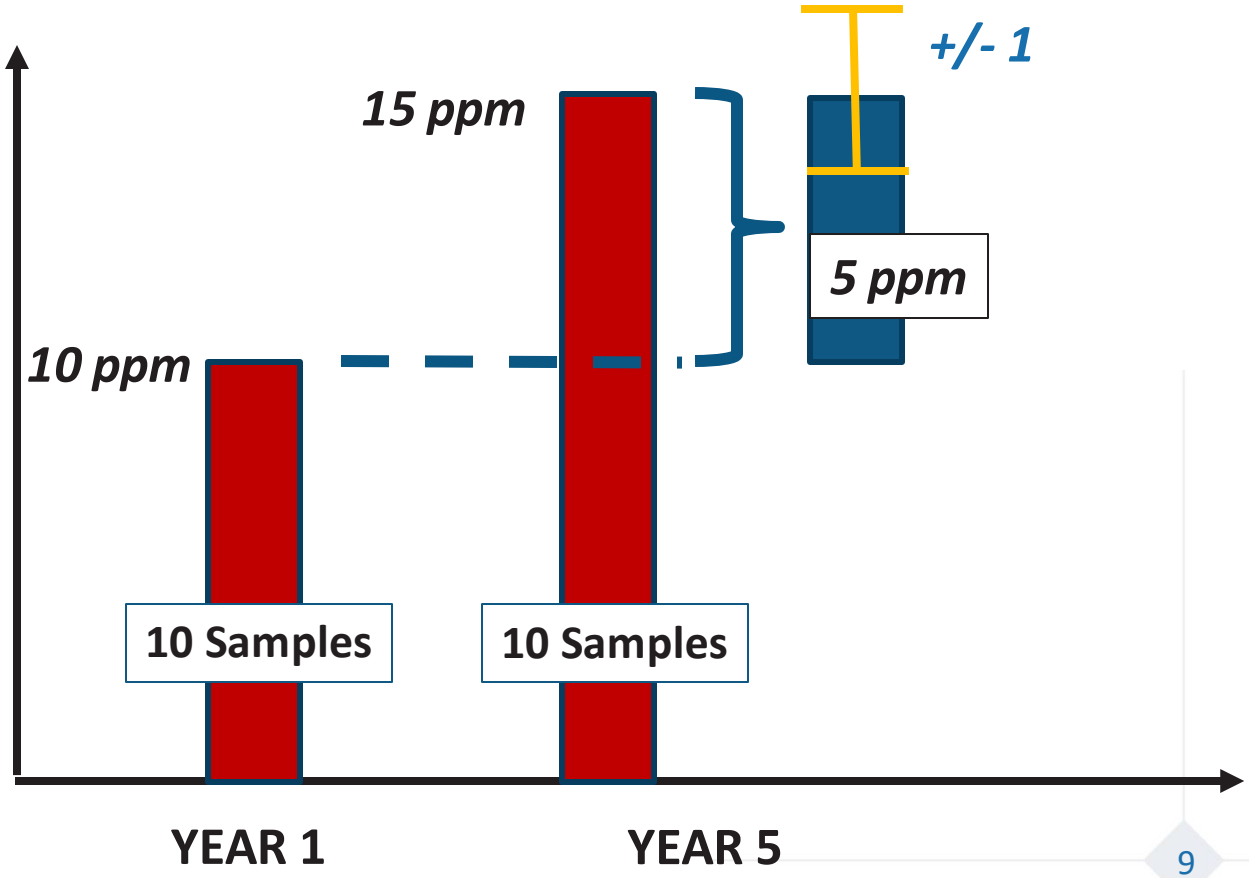
KEY POINT: Under traditional approaches, variability must be small

Comparison of Statistical Approaches

Traditional Approach



Difference in Means Approach



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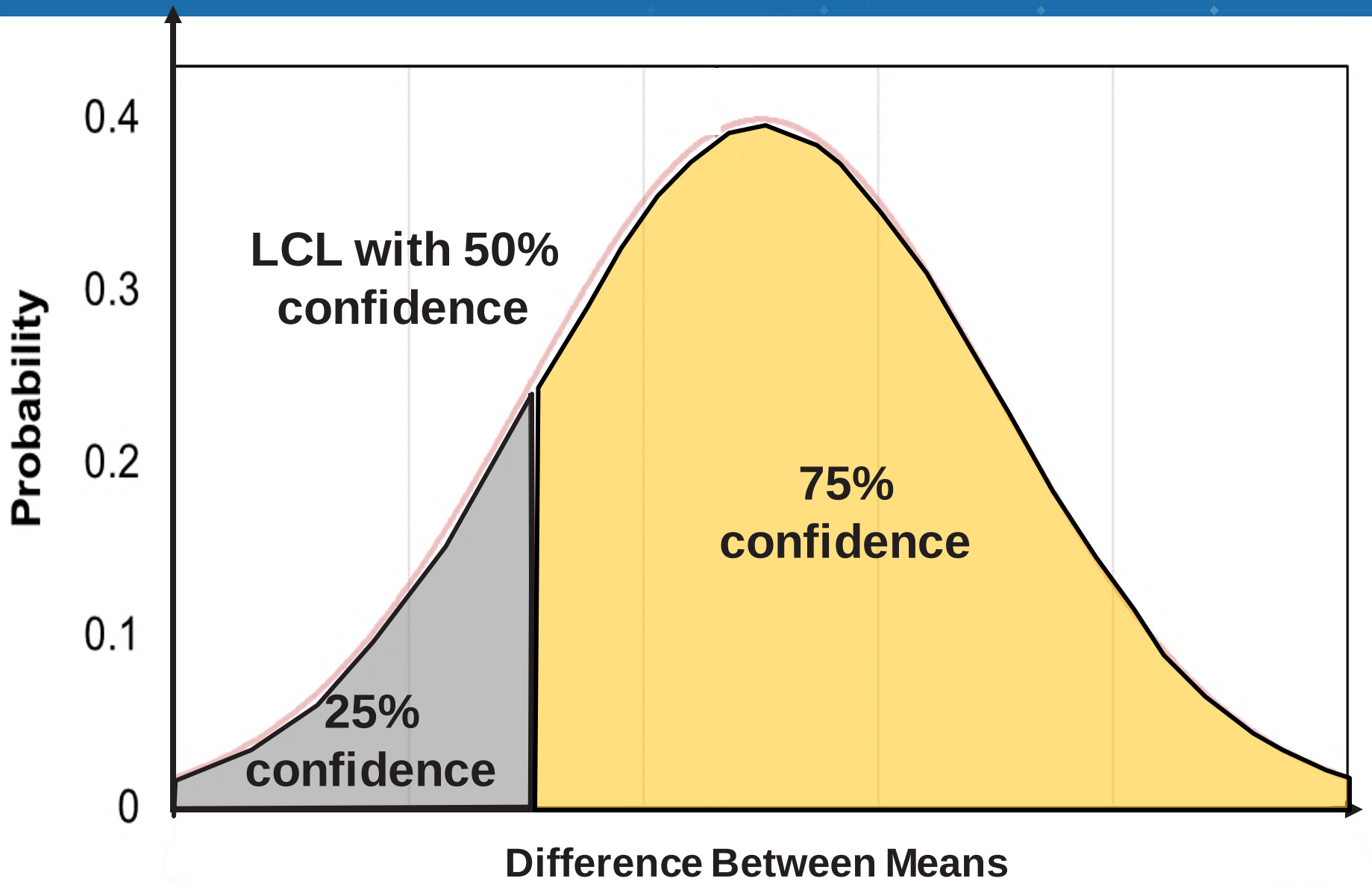


What does this "confidence" mean?

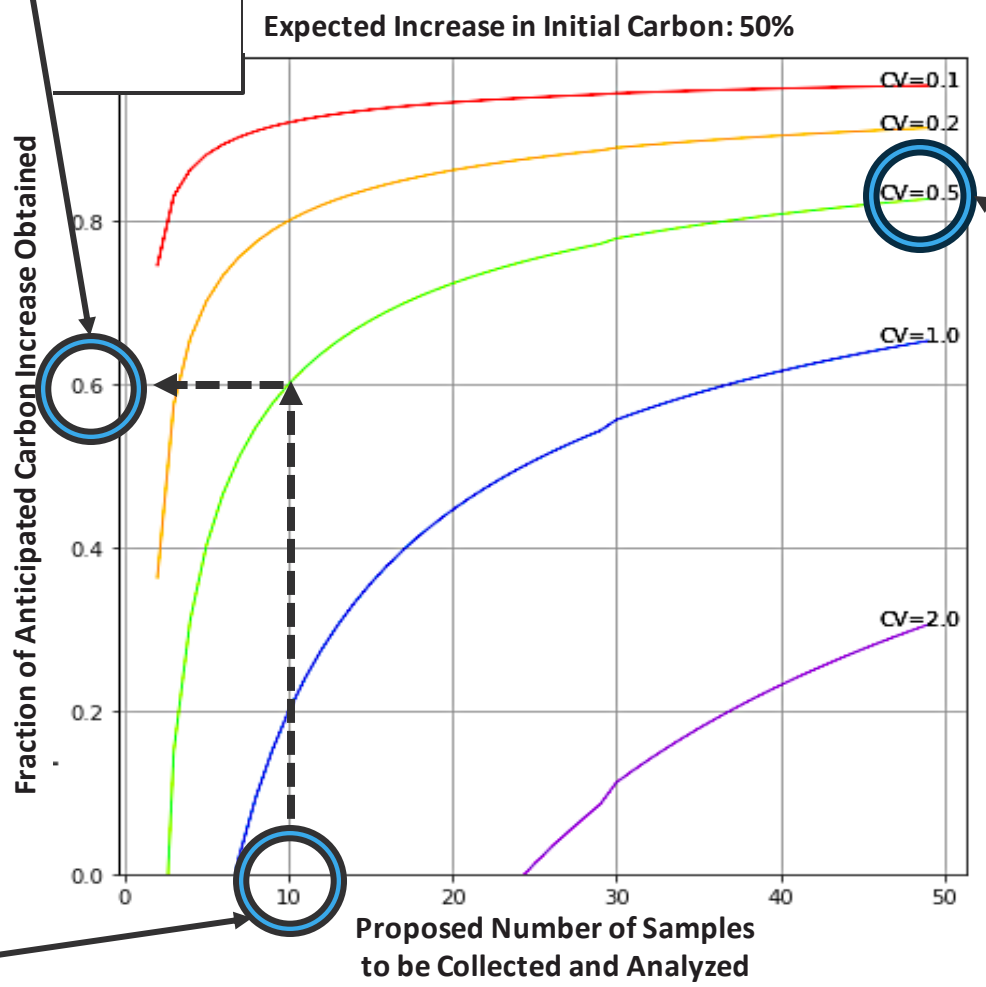
25% of the time < LCL, 75% of the time > LCL

25% of the time **the true change is < LCL, or we have** ***over-credited*** **the carbon change,**

75% of the time **true change is > LCL, or we have** ***under-credited*** **the carbon change.**

“Difference Between Means” Nomograph

Step 3: Determine corresponding credit



Step 1: Estimate variability (e.g., CV = 0.5)

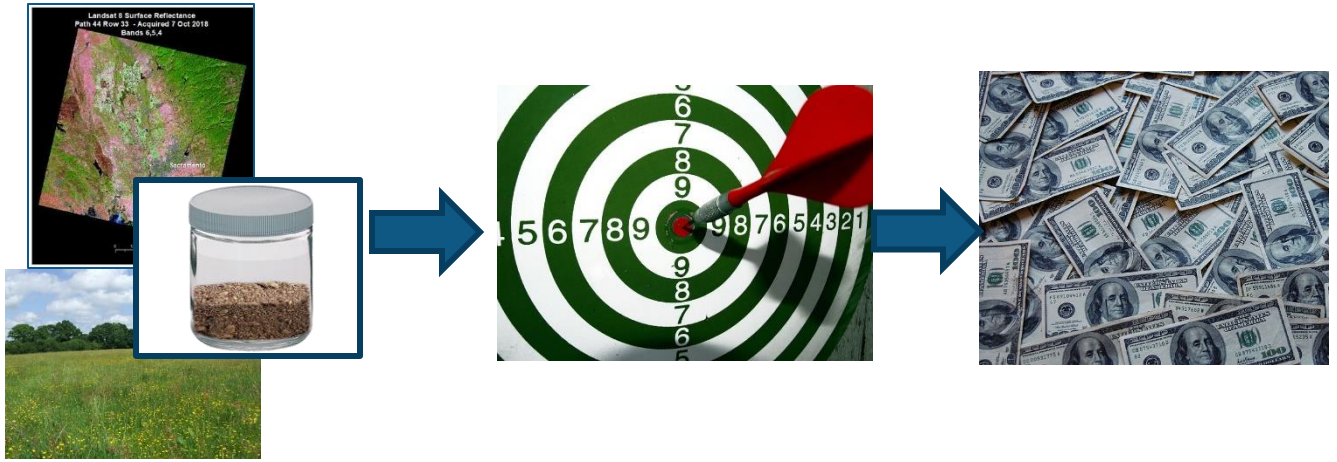
Step 2: Choose number of samples

Interim Crediting – Current State

1. ***Address one pilot application*** *initially to resolve procedures and process before addressing multiple sites*
2. ***Baseline Measurements*** *useful "reality check"*
3. ***Not all properties*** *may have sufficient supporting scientific information at this time*
4. ***Data provided must be sufficient to support 3rd party review and certification***
5. ***Quantification of uncertainty is essential!***

Future Research Needs

- Predictive Models
  - Indirect Indicators
  - Biogeochemical models
- Data fusion and advanced statistical methods
  - e.g., Bayesian framework
- Simplistic and uniform stratification approach -> spatially distributed estimate of SOC across landscape



KEY POINT: Any method must quantify uncertainty in order to support high-quality carbon credits for ultimate acceptance in the marketplace.

Graphics: Wikimedia.org; USGS

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