Monitoring soil carbon and co-benefits on rangelands

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Central Coast Rangeland Coalition
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Conservation science
for a healthy planet.

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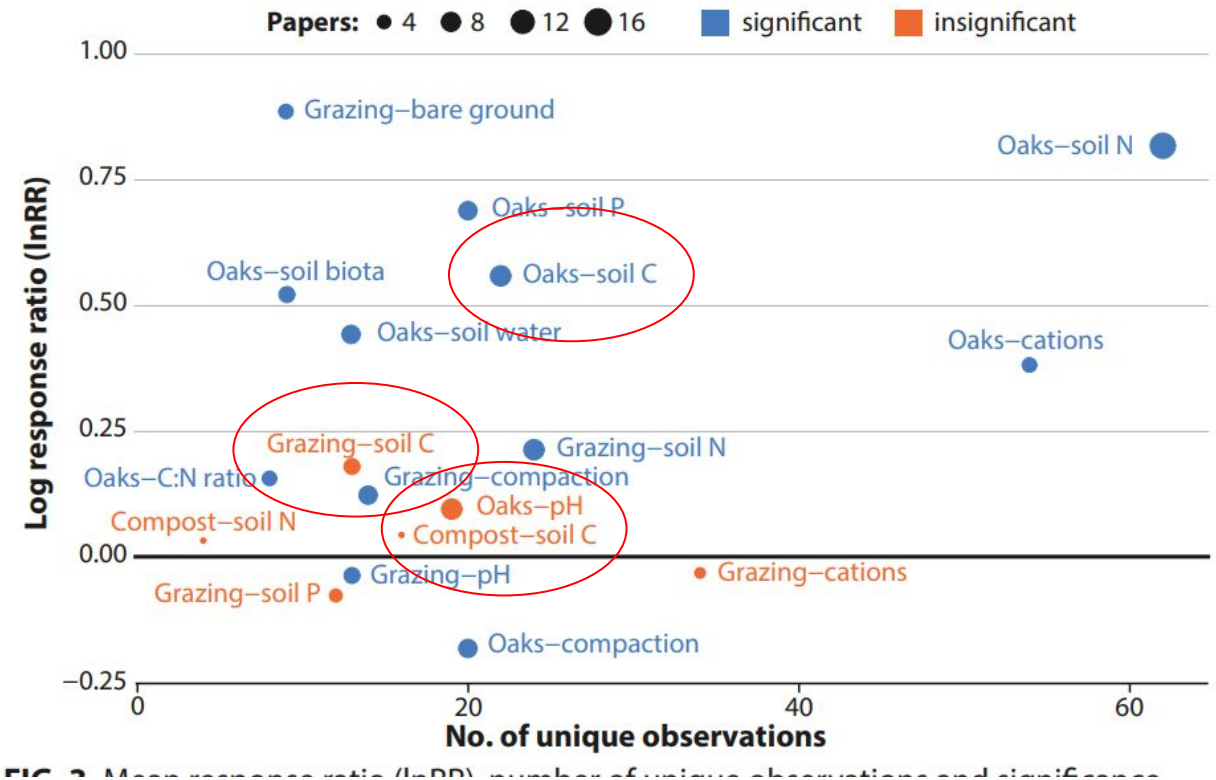
Major investments are underway to fund carbon stewardship, but considerable uncertainty surrounds carbon sequestration predictions

USDA to Invest $1 Billion in Climate Smart Commodities, Expanding Markets, Strengthening Rural America

Cargill launches U.S. carbon farming program for 2022 season

California Natural Resources Agency writes a BIG blank check to the "restoration" industry

New funds will expand Marin carbon farming



Carey et al. 2020 California Agriculture: Supporting evidence varies for rangeland management practices that seek to improve soil properties and forage production in California

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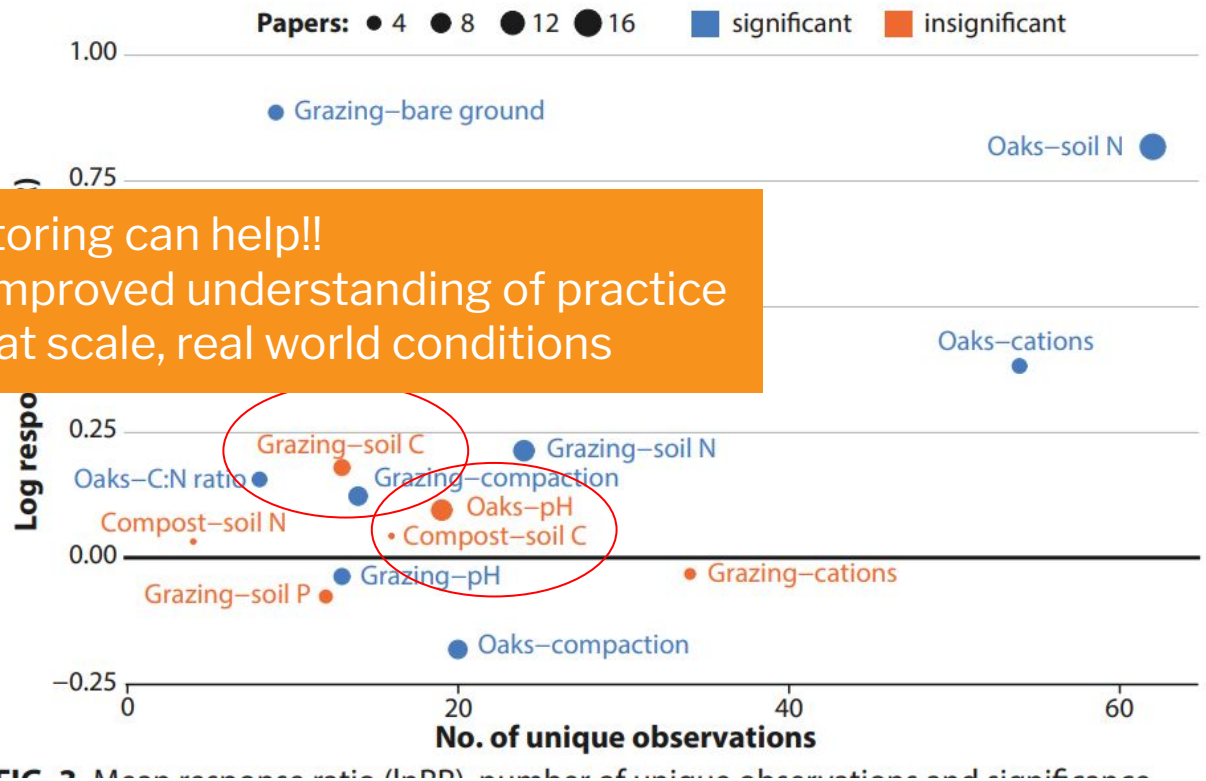
Monitoring can help!!
Adaptive management, improved understanding of practice impact on-site and at scale, real world conditions



Carey et al. 2020 California Agriculture: Supporting evidence varies for rangeland management practices that seek to improve soil properties and forage production in California

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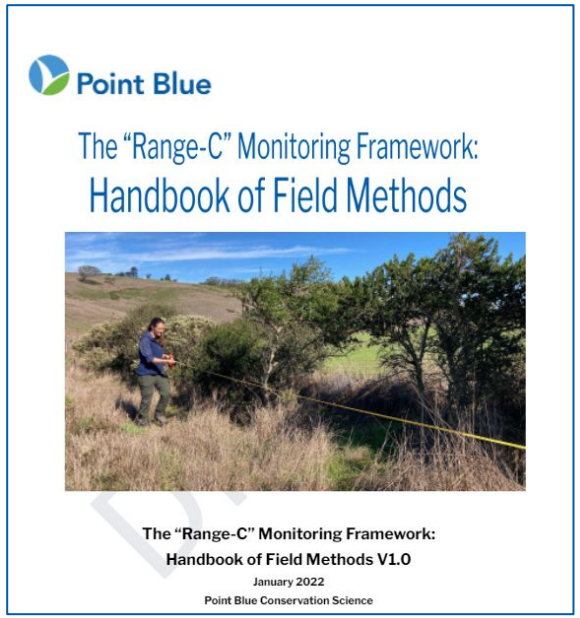
Range-C Monitoring Framework

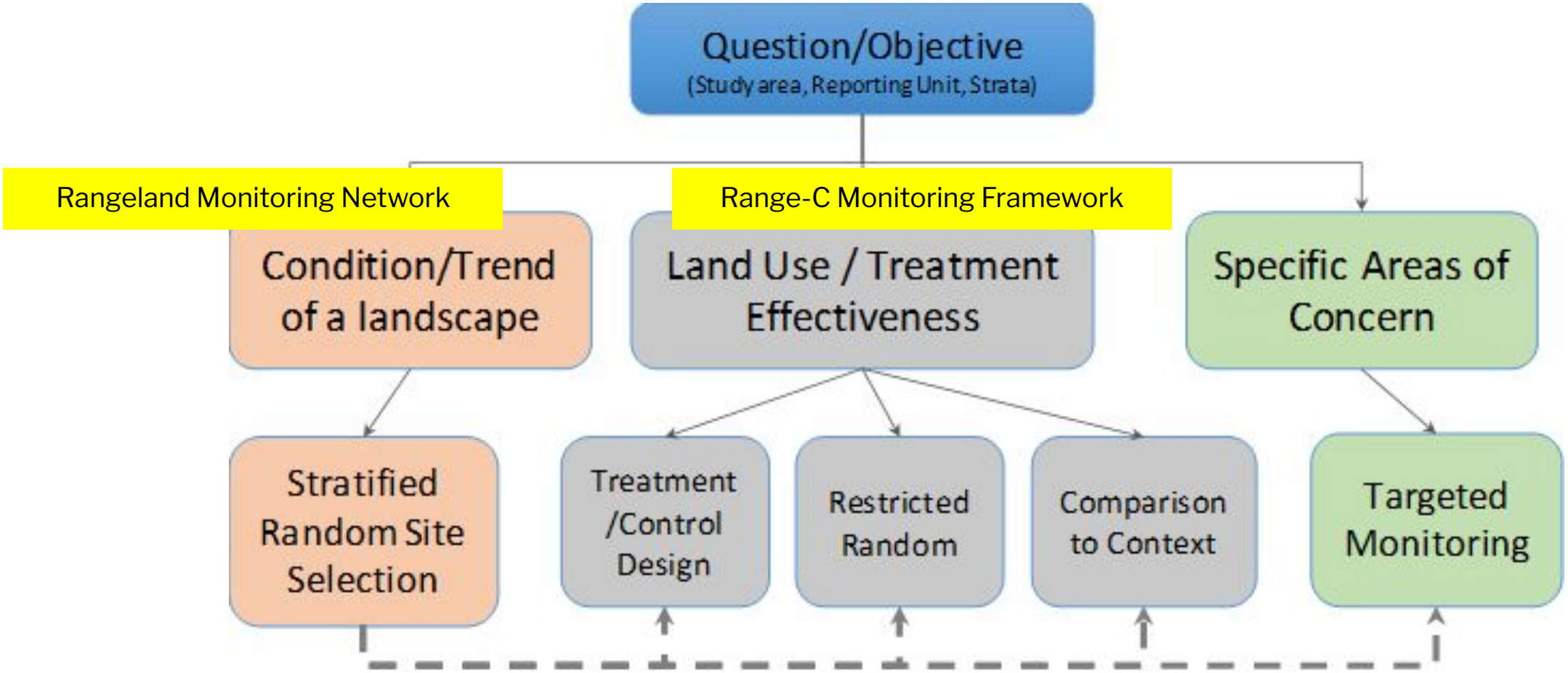
Technical Working Group
Colorado State: Keith Paustian
CDFA: Geetika Joshi, Amrith Gunasekara, Nina Bingham
UC Davis: Jessica Chiartas
UC Berkeley: Whendee Silver, Paige Stanley, Tyler Anthony
UC Merced: Rebecca Ryals
Carbon Cycle Institute: Jonathan Wachter
The Nature Conservancy: Clare Kazanski
Santa Lucia Conservancy: Rodrigo Sierra Corona
Humboldt State: Kerry Byrne
Mad Agriculture: Phil Taylor
Point Blue: Kristy Dybala, Maddison Easley, Michael Fitzgibbon, Erika Foster, Libby Porzig, saiah Thalmayer

Practitioner Working Group
NRCS: Kristan Norman
True Grass Farms: Guido Frossini
Paicines Ranch: Greg Richardson
TomKat Ranch: Mark Biaggi
Zero Foodprint: Leo Beckerman
North Coast Soil Hub: Emilie Winfield
Grounded Grassfed: Byron Palmer
San Mateo RCD: Doug Millar
Richards Grassfed: Carrie Richards

OpenTEAM Carbon Series Working Group
Regen Network: Sam Bennets, Gisel Booman, Sophia Leiker
OpenTEAM: Dorn Cox, Leah Puro
Hudson Carbon: Mike Howard
TerraCarbon: Dan Kane
Caney Fork Farms: Shaylan Kolodney
Soil Carbon Measurement Project: Paul Harris
USDA Agricultural Research Service: Jeff Herrick
Sustainable Food Lab: Patrick Lawrence
And more….



There are many reasons to monitor soil carbon, with consequences for design



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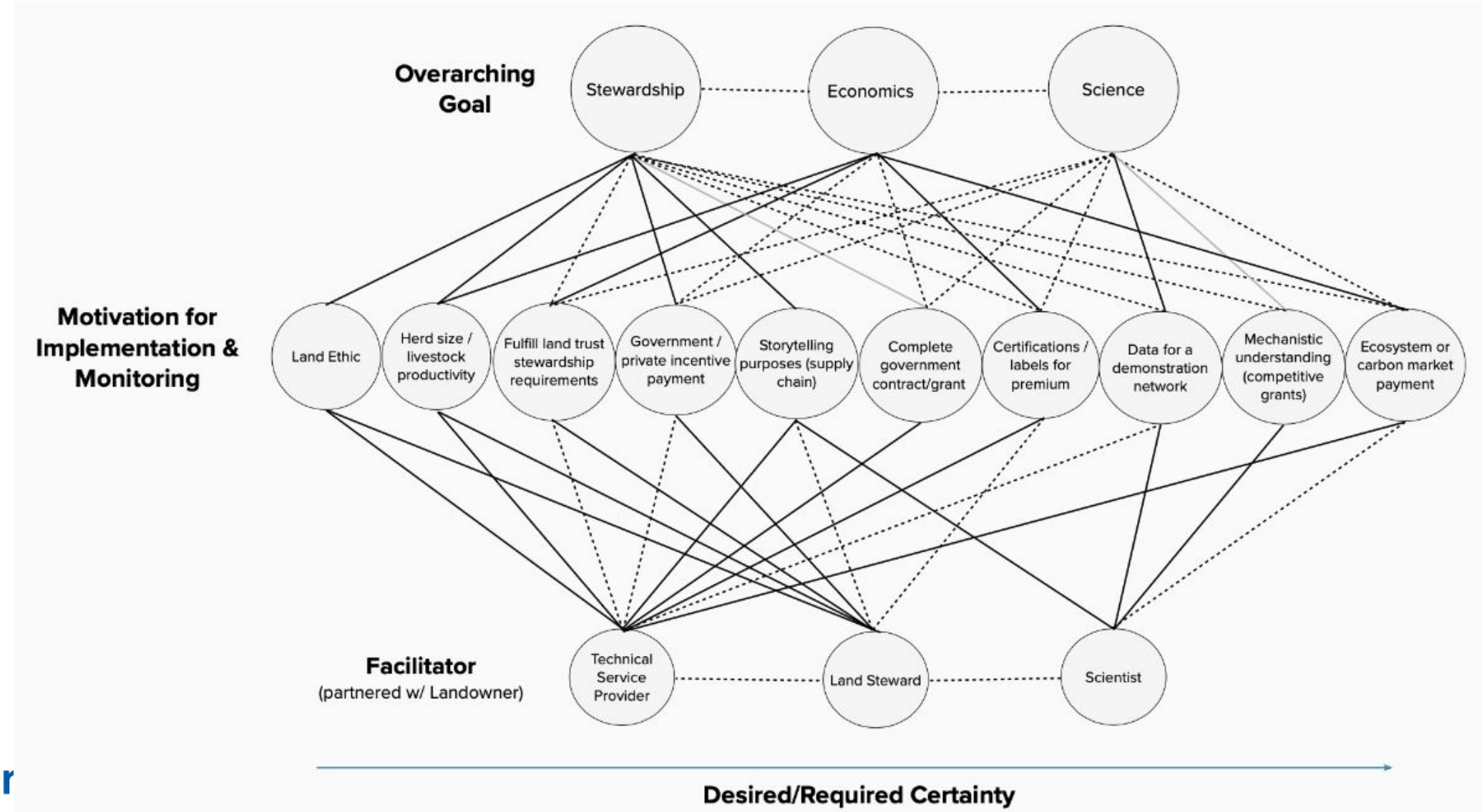
https://www.blm.gov/about/how-we-manage/assessment-inventory-and-monitoring-strategy

There are many reasons to monitor soil carbon, with consequences for design



What are some key considerations when designing a monitoring project?

- Where do I draw my monitoring boundaries?
- How do I pick where to take soil samples within that boundary?
- How many samples do I need to collect?
- How do I actually collect a sample?
- What do I do with a sample once it is collected?

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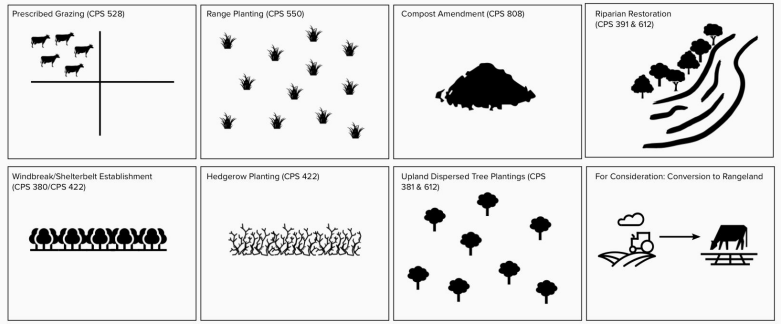

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How do I draw my monitoring boundaries?

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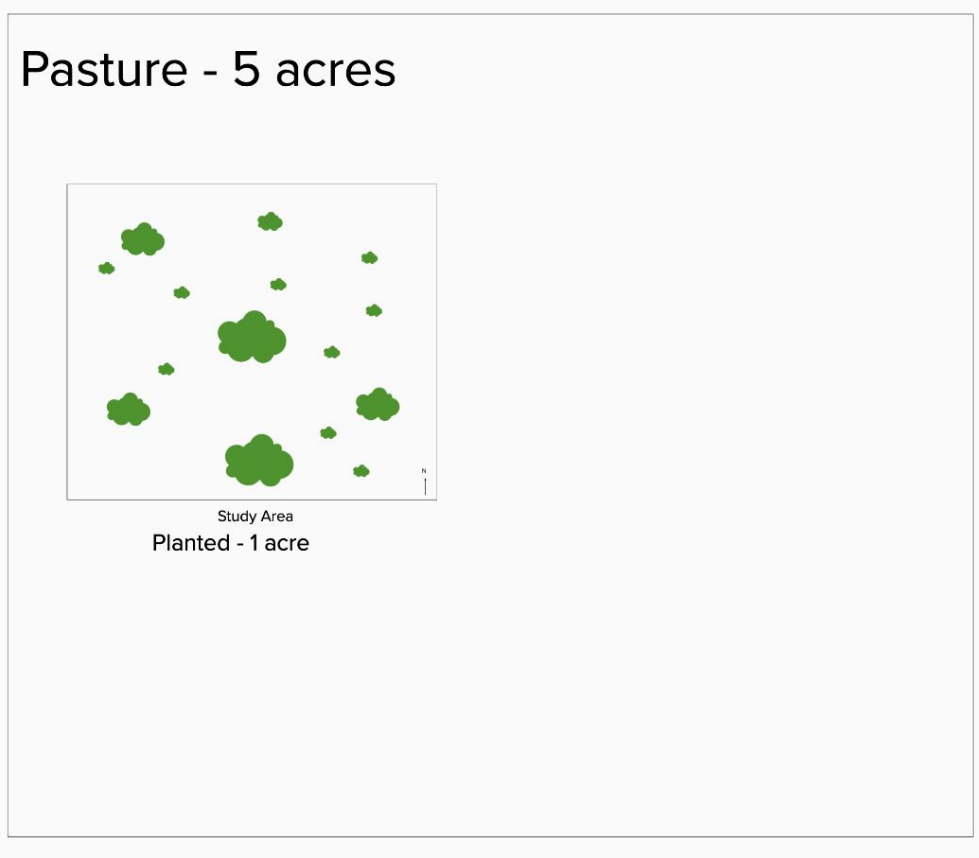
- The monitoring boundary should encompass, but not extend beyond, the entire area that received the management practice of interest



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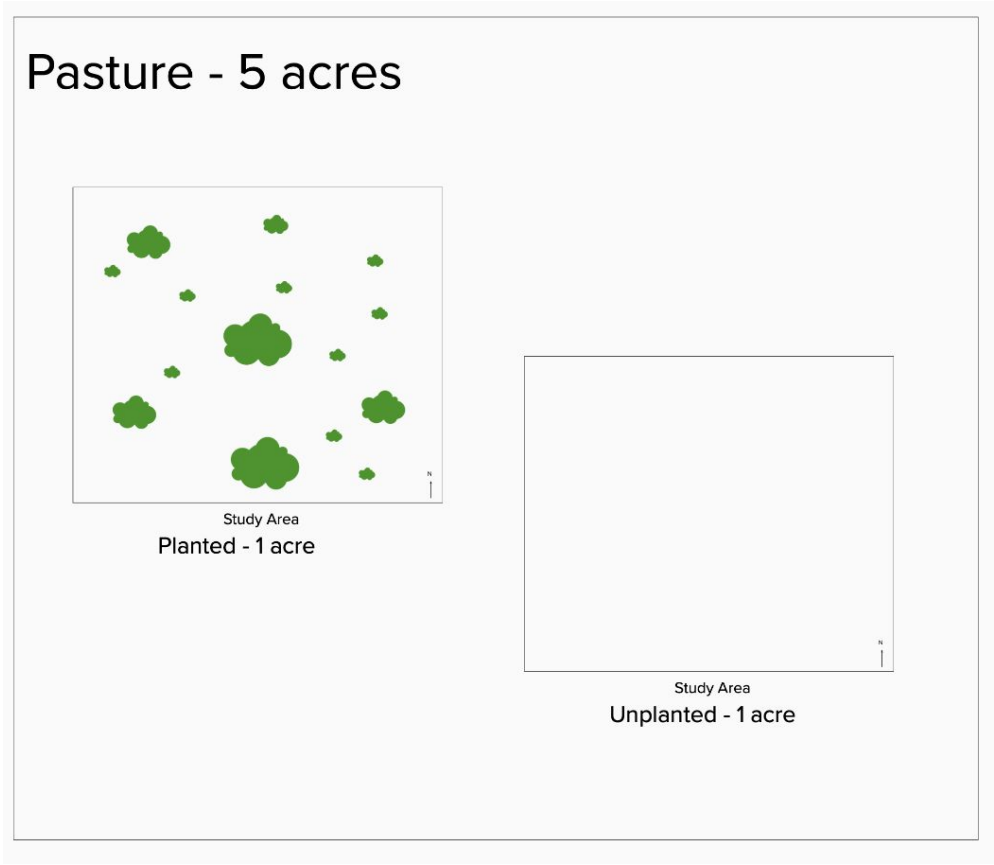
- The control site should be:
  - dominated by the same soil series, soil texture, topography, and vegetation community as the treated site
  - approximately the same acreage as the treated site (at least half the size)
  - as close to the treated site as possible (leaving a buffer) while maintaining the above



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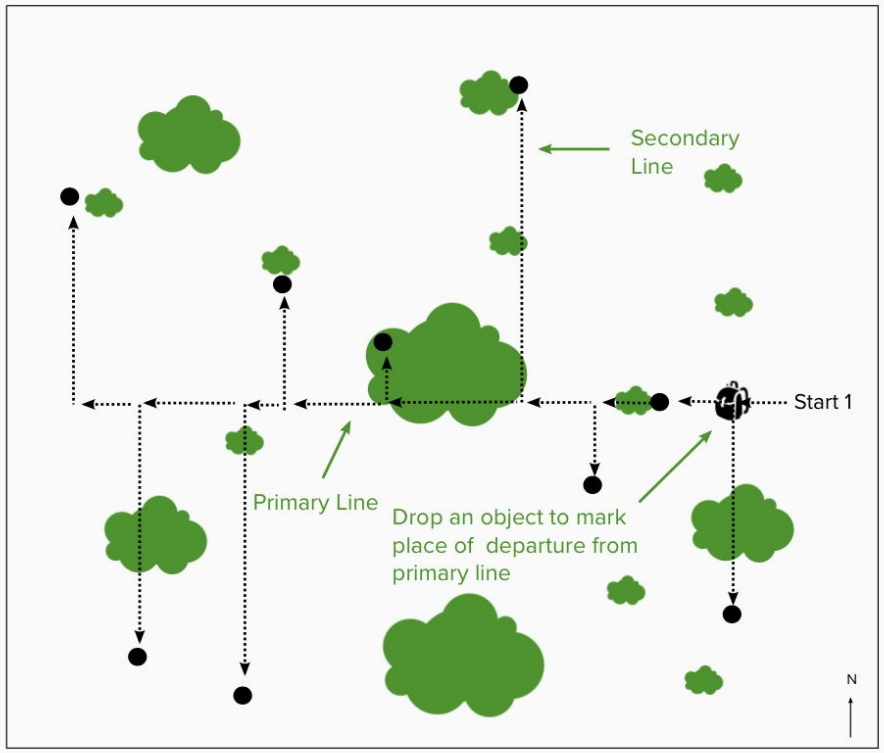
How do I pick where to take samples?

Goal: Track changes in soil carbon over time with the implementation of a management practice (e.g., compost addition, riparian restoration, shift in grazing management)

- Randomly selecting points is key
  - Helps ensure results are generalizable and representative of the entire study area.
- Lots of ways to do this!



Study Area

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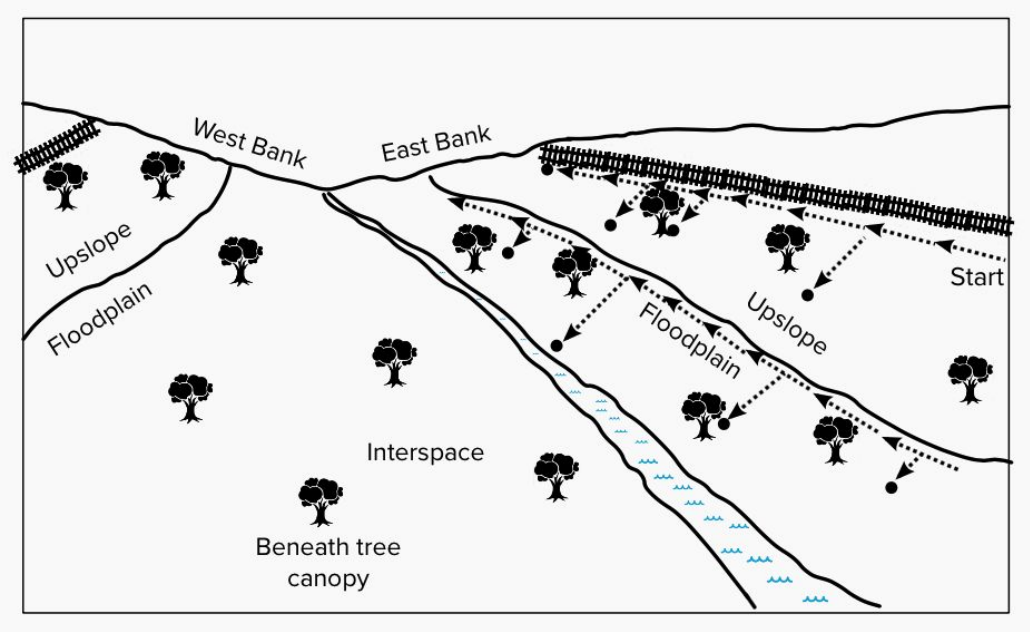
How do I pick where to take samples?

Goal: Track changes in soil carbon over time with the implementation of a management practice (e.g., compost addition, riparian restoration, shift in grazing management)

- Subdividing the study area into smaller homogenous units can help ensure representativeness and precision
- Consider doing this if the study area:
  - it is greater than one acre
  - it is hilly
  - it is adjacent to a waterbody (e.g., stream, river, pond)
  - it has greater than one soil type
  - it includes a management practice where shrubs or trees were planted and are relatively spread out



Repeat sampling = revisit same spots over time!

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How many samples do I need to collect?

Goal: Track changes in soil carbon over time with the implementation of a management practice (e.g., compost addition, riparian restoration, shift in grazing management)

- The answer is going to depend on:
  - the level of uncertainty one is willing to tolerate
  - the size of and amount of variability within the study area
  - how much change is expected to occur, or how much change someone wants to be able to detect.

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More certainty desired = more samples needed

Certainty Level	Significance (false positive)	Power (false negative)	Interpretation	Possible Contexts
High	0.95	0.90	A 5% chance that a difference is detected when in reality there's no difference; and a 10% chance that a real change won't be detected.	Storytelling purposes (supply chain); Government or private incentive programs; Scientific research
Medium	0.90	0.80	A 10% chance that a difference is detected when in reality there's no difference; and a 20% chance that a real change won't be detected.	Storytelling purposes (community education); Government or private incentive programs; Land trust stewardship requirements
Low	0.80	0.70	A 20% chance that a difference is detected when in reality there's no difference; and a 30% chance that a real change won't be detected.	Adaptive management for herd size/livestock productivity; land ethic

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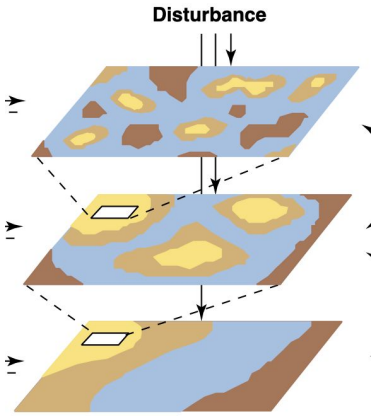
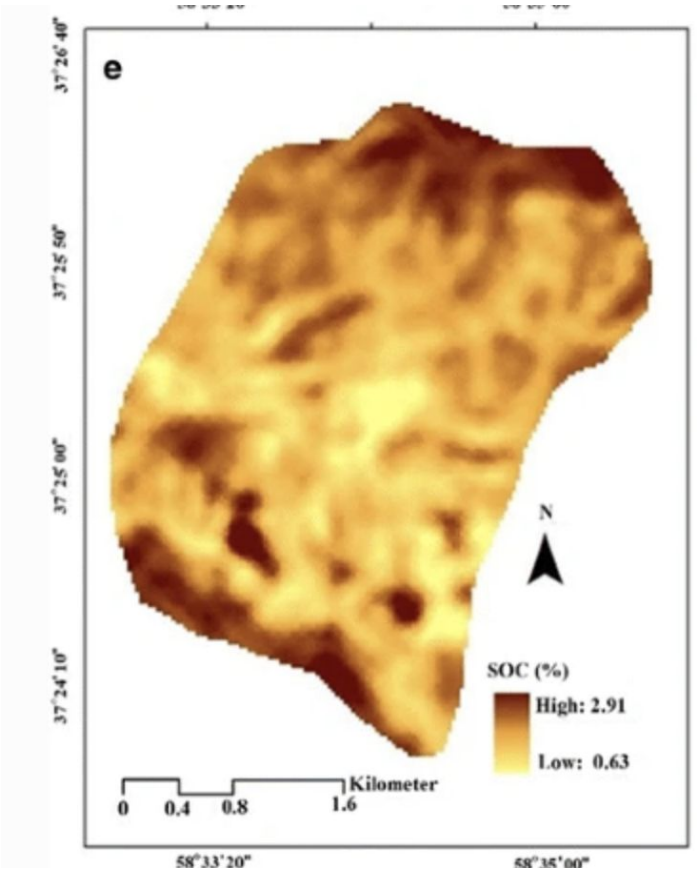
Greater variability = more samples needed





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Mahmoudabadi et al. 2017; Ettema and Wardle 2002

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Expected Variation in Carbon	Landscape Characteristics
High	-High slopes -Greater than 3 soil types -Diverse vegetation assemblages (e.g., open grassland plus oak woodland) -Adjacent to a waterbody -Large area (> 25 acres) -Was planted with trees or shrubs
Medium	-Moderate slopes -2-3 soil types -Similar vegetation assemblages, variables species (e.g., open grassland, different herbaceous species) -Not adjacent to a waterbody -Medium sized area (5-25 acres) -Was planted with trees or shrubs
Low	-Flat -1 soil type -Uniform vegetation (e.g., open grassland, generally same species across study area) -Not adjacent to a waterbody -Small area (<5 acre) -Was not planted with trees or shrubs

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Smaller effect size = more samples needed

3.0 Mg C ha-1 y-1 | 1.1 Mg C ha-1 y-1 | 0.41 Mg C ha-1 y-1 | 0.28 Mg C ha-1 y-1 | 0.18 Mg C ha-1 y-1 | 0.15 Mg C ha-1 y-1






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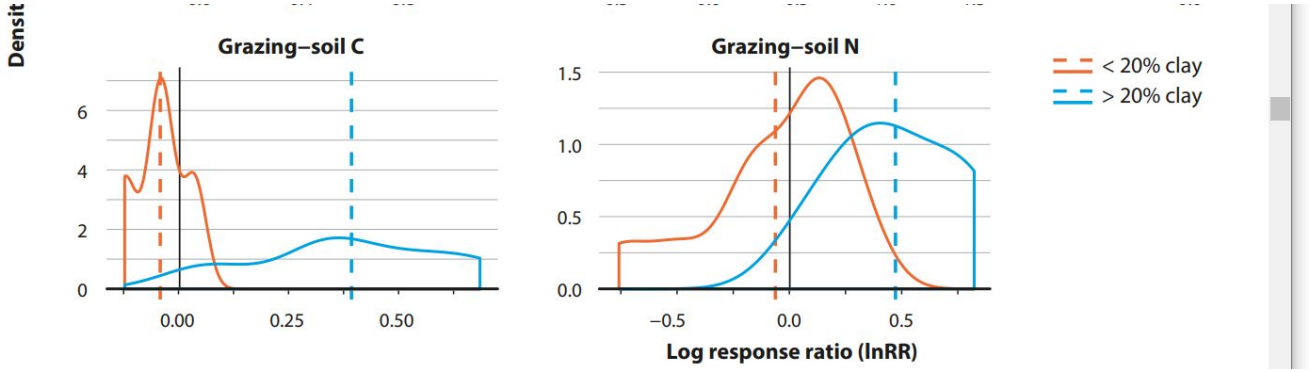

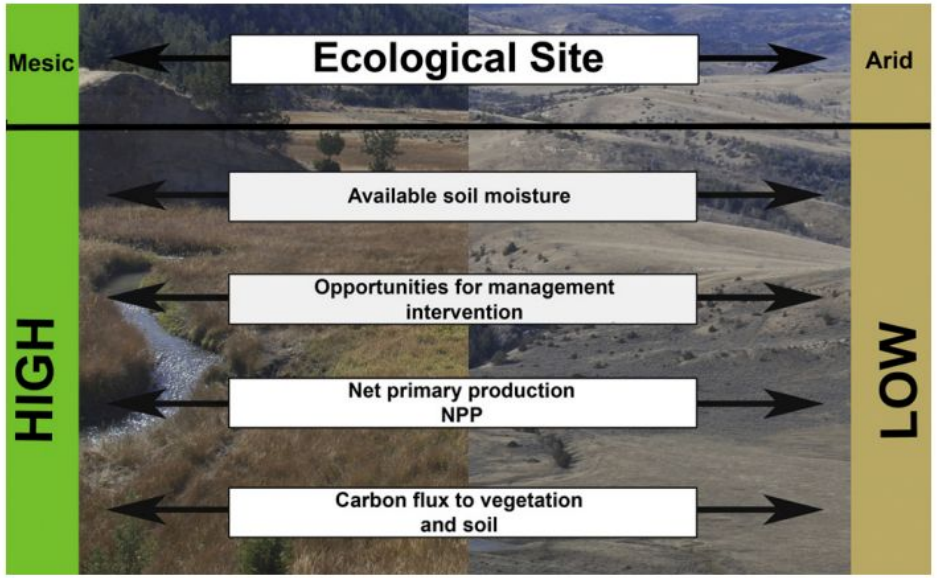

Fig. 1. Characteristics of ecological sites pertaining to carbon sequestration as influenced by aridity.

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Booker et al. 2013 Global Environmental Change; Carey et al. 2020 California Agriculture

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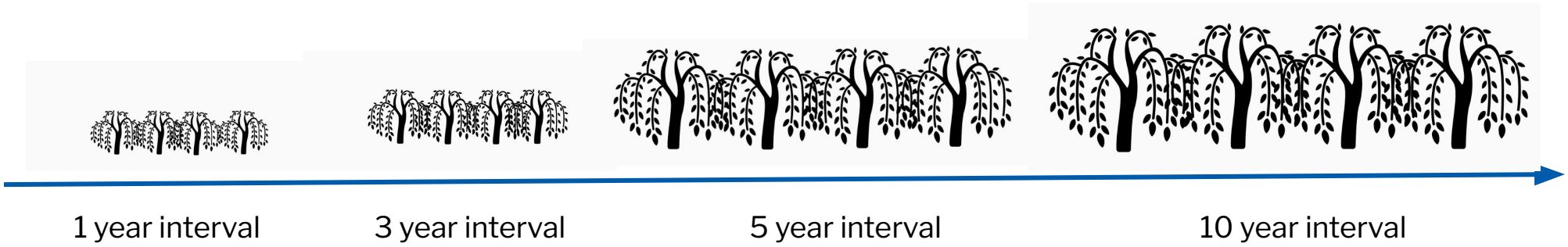

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Soil Organic Carbon			
Certainty	Low	Med	High
Low	3	7	22
Med	5	12	42
High	6	20	71

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How do I actually collect a sample? Then what do I do?

Goal: Track changes in soil carbon over time with the implementation of a management practice (e.g., compost addition, riparian restoration, shift in grazing management)

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Thank you! Questions?

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