Understanding Soil Health in California's Annual Rangelands

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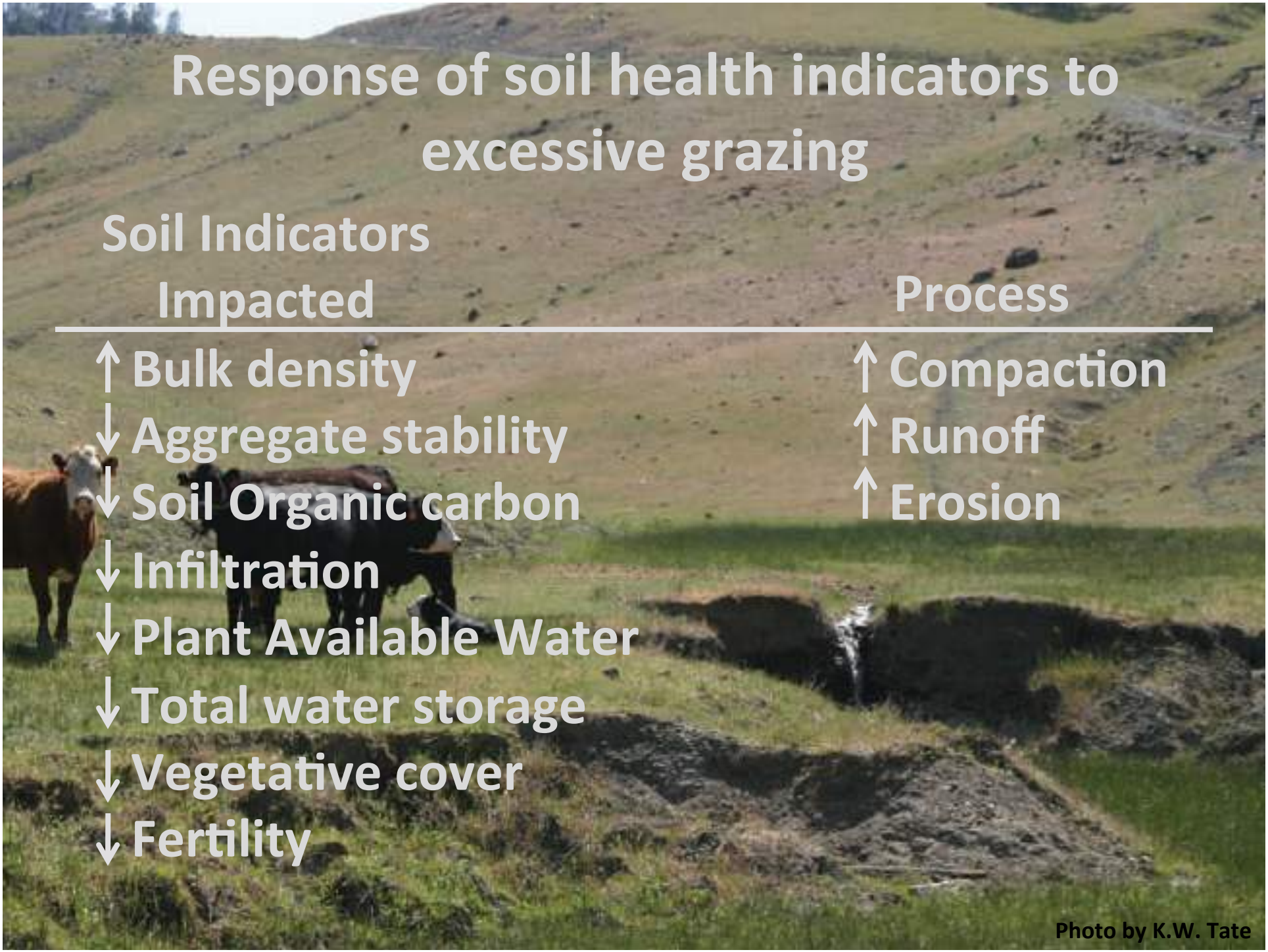
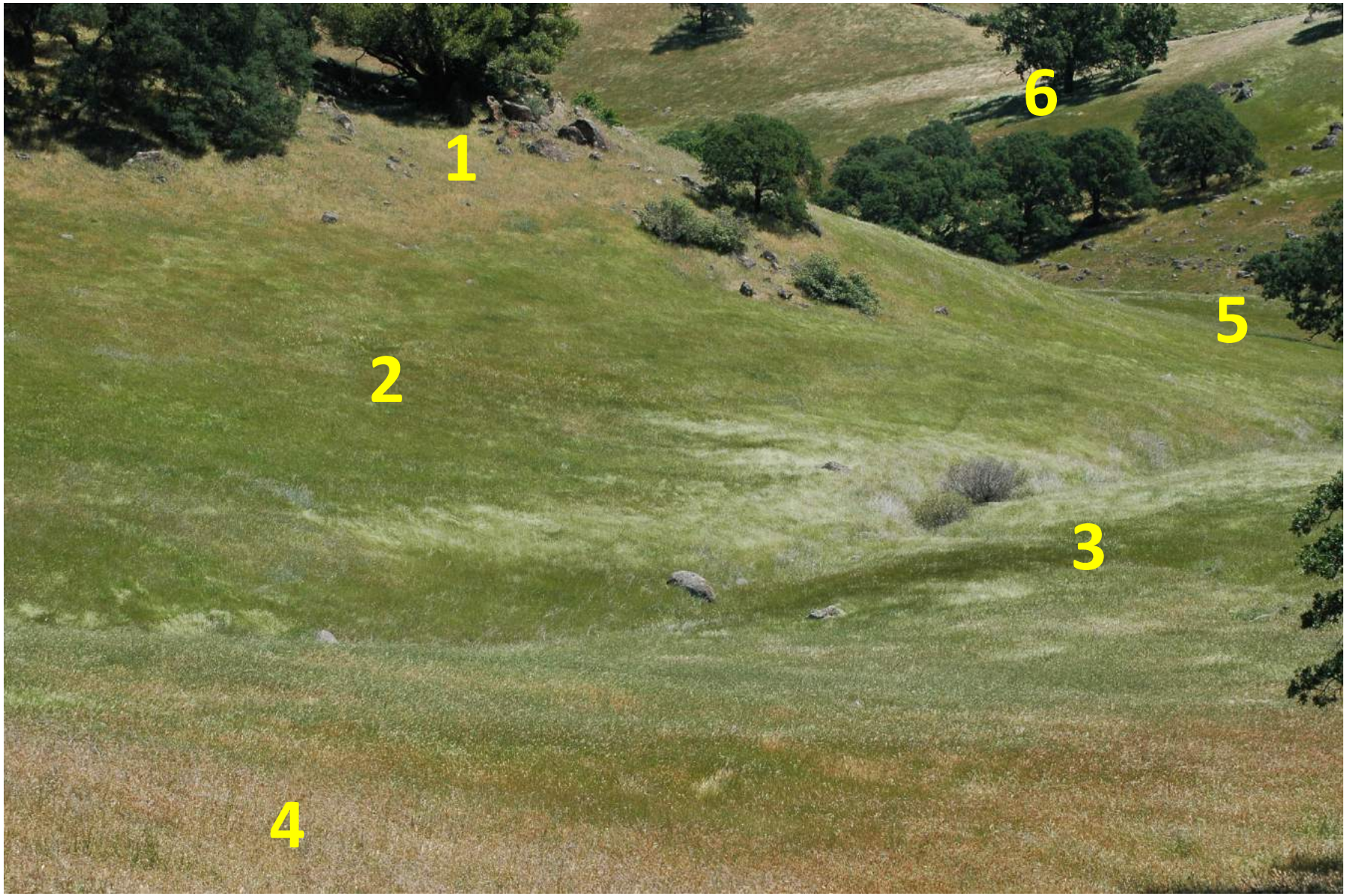
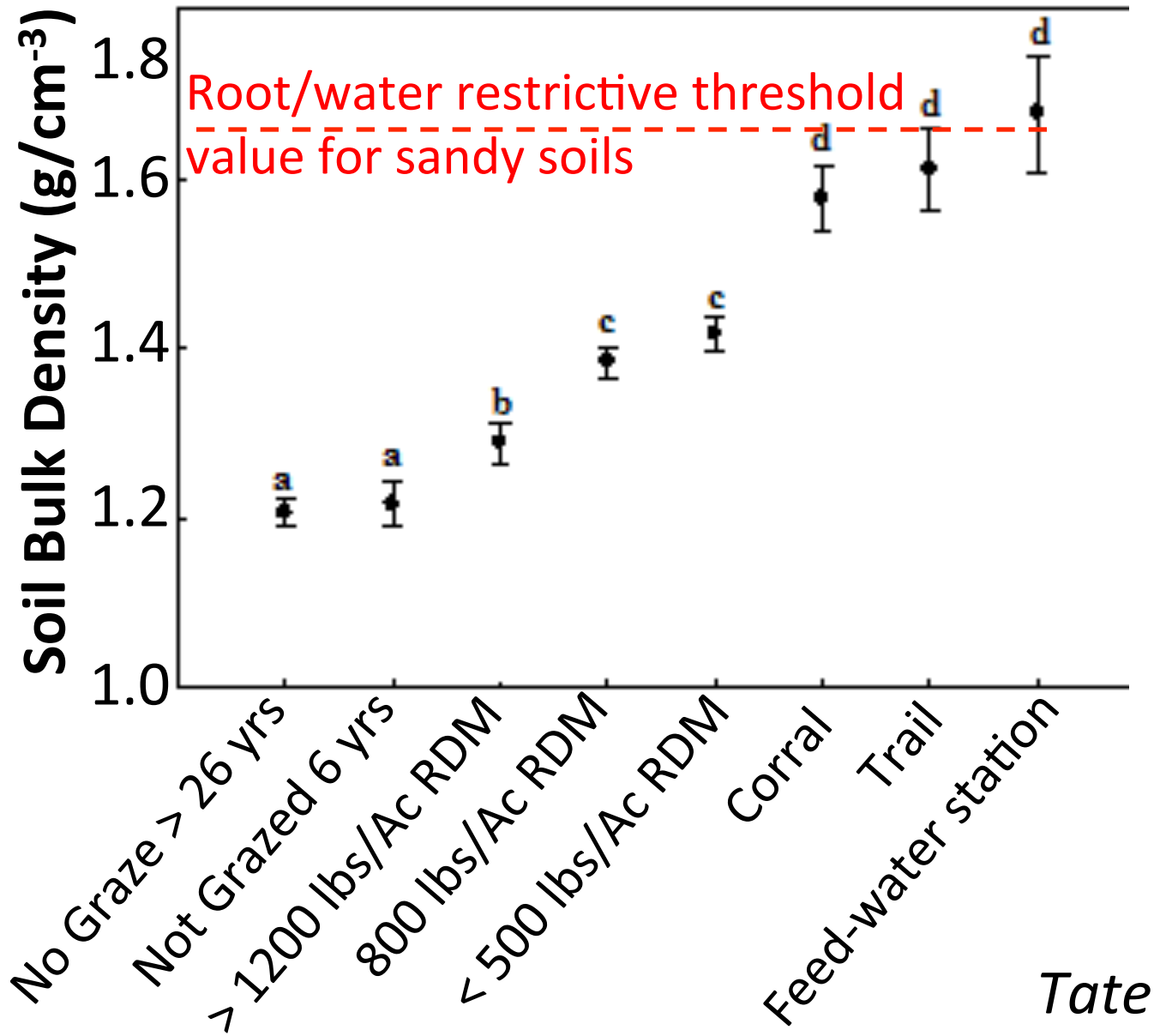

Response of soil health indicators to excessive grazing
Soil Indicators Impacted
Process
↑ Bulk density
↓ Aggregate stability
↓ Soil Organic carbon
↓ Infiltration
↓ Plant Available Water
↓ Total water storage
↓ Vegetative cover
↓ Fertility
↑ Compaction
↑ Runoff
↑ Erosion
Photo by K.W. Tate

Soil variability in rangelands



Effects of grazing on soil compaction

What is the functional difference?



Tate et al., 2004

Threshold root/water restrictive bulk density values by textural class

Textural Class	Root-restricting Bulk density (g/cm^3)
Sand & loamy sand	1.80
Sandy Loam	1.75
Loam & and clay loam	1.70
Clay loam	1.65
Sandy clay	1.60
Silt loam	1.55
Silty clay loam	1.45
Clay	1.40

NRCS Soil Quality Institute

Back-up the indicators with observation

Rangeland soil with good soil structure D_b= 1.4 g cm^{-3}

Compacted rangeland soil D_b= 1.65 g cm^{-3}

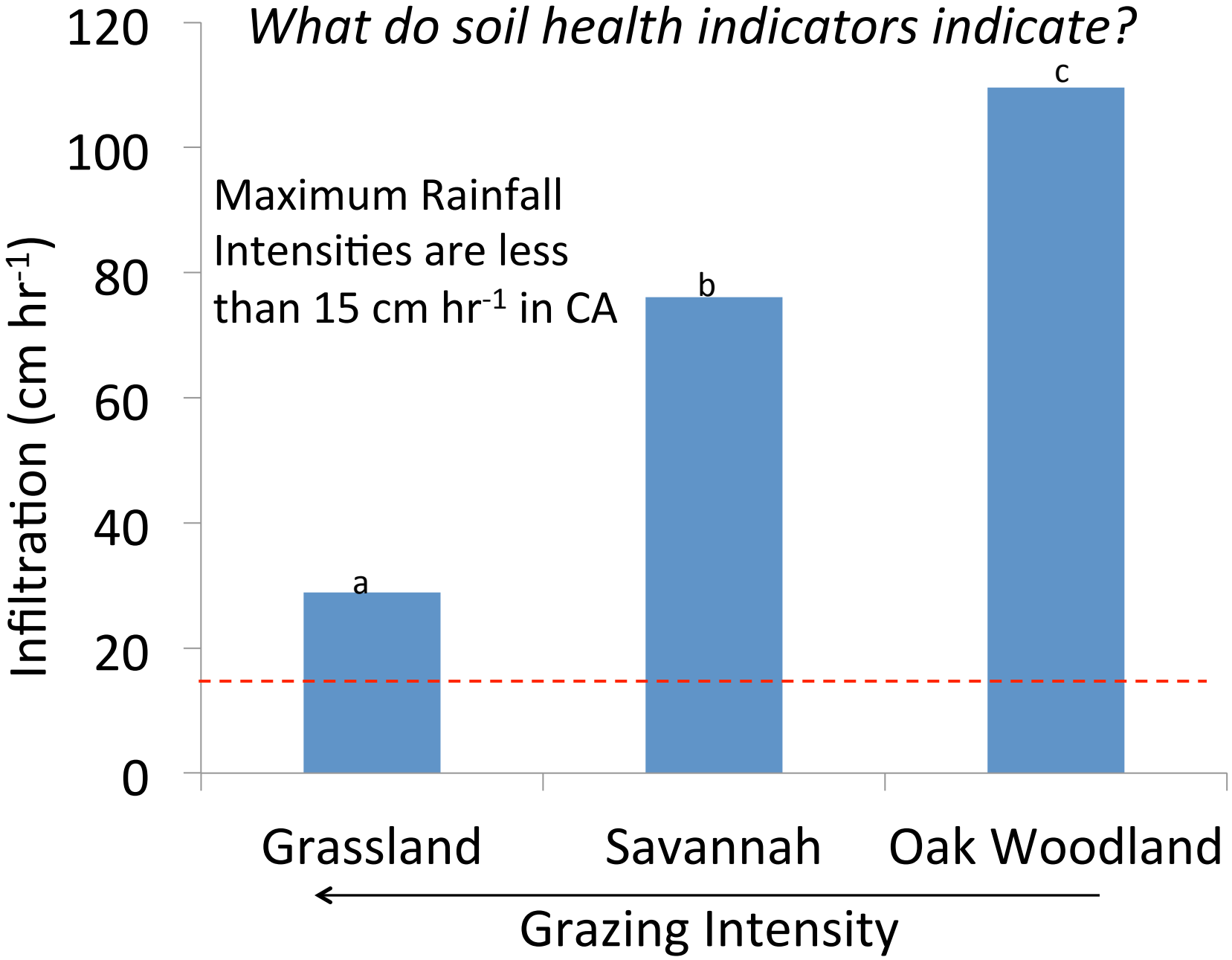
Link indicators with secondary observations that reflect a condition: diminished structure, abrupt boundary

Back-up the indicators

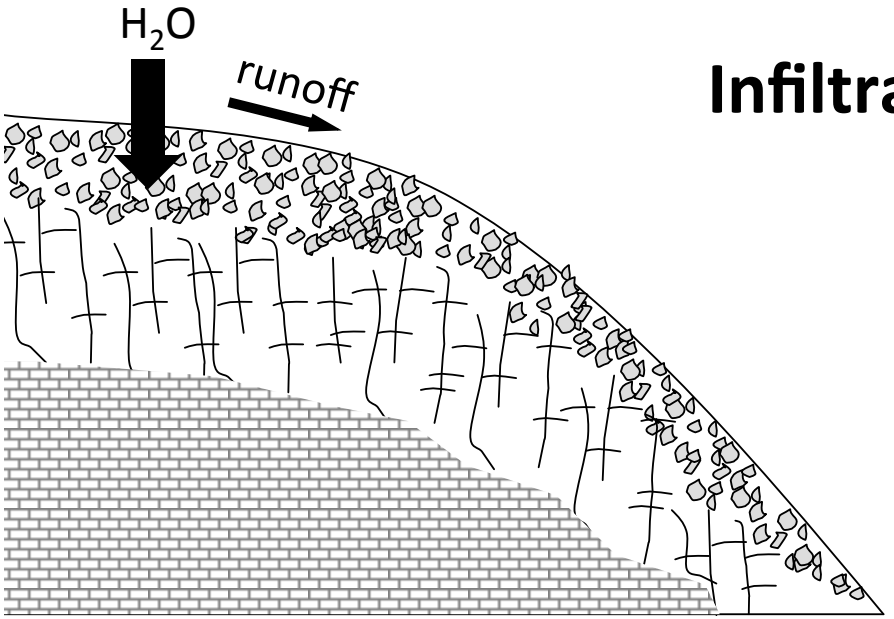
Redoximorphic features <u>only</u> within the compacted layer

Impacts of grazing and oak cover on infiltration

What do soil health indicators indicate?



Soil properties influencing Hortonian overland flow



Infiltration capacity exceeds rainfall intensity

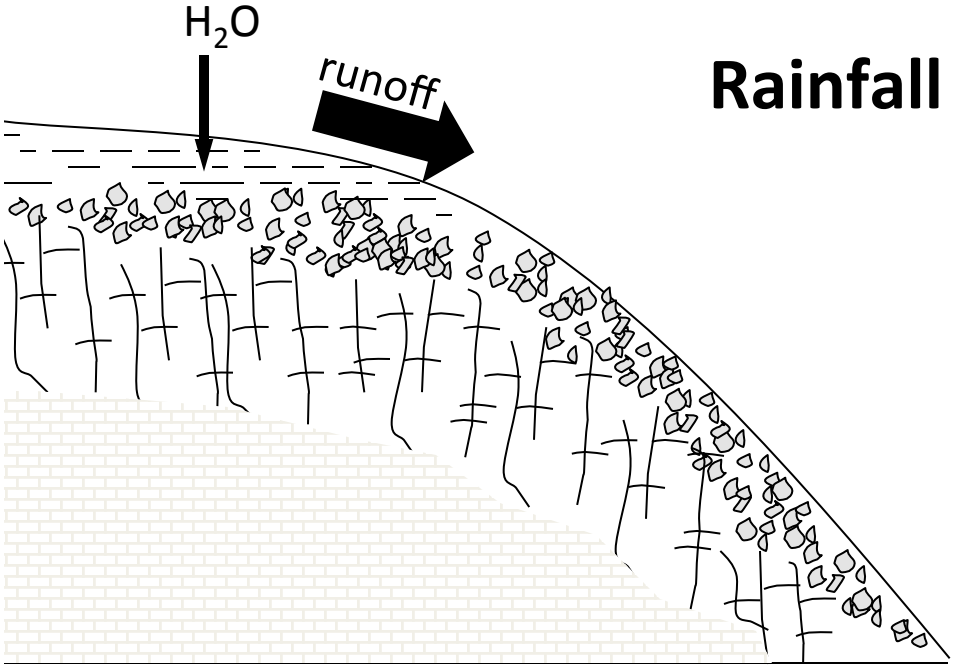
Low runoff:

Good structure

Coarse textures

High porosity

High organic matter



Rainfall intensity exceeds infiltration capacity

High runoff:

Poor structure

Compaction

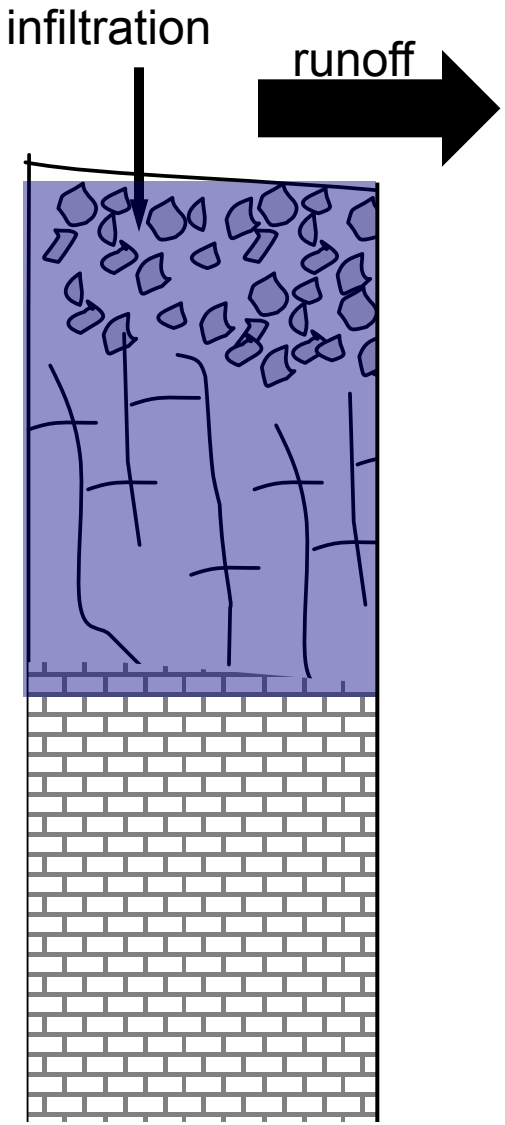
Fine textures

Low porosity

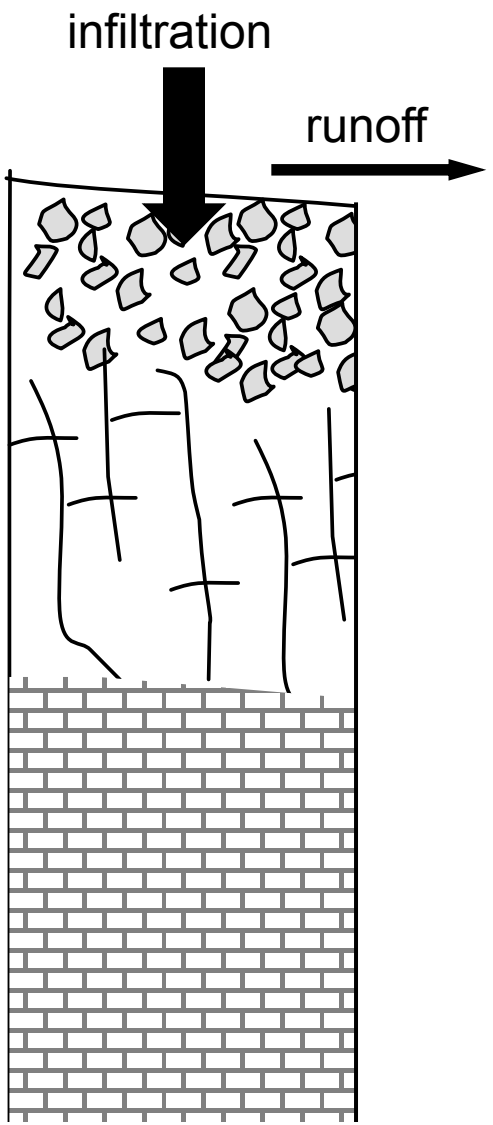
Low organic matter

Saturated overland flow is also a common form of runoff

Saturated soil



Unsaturated soil



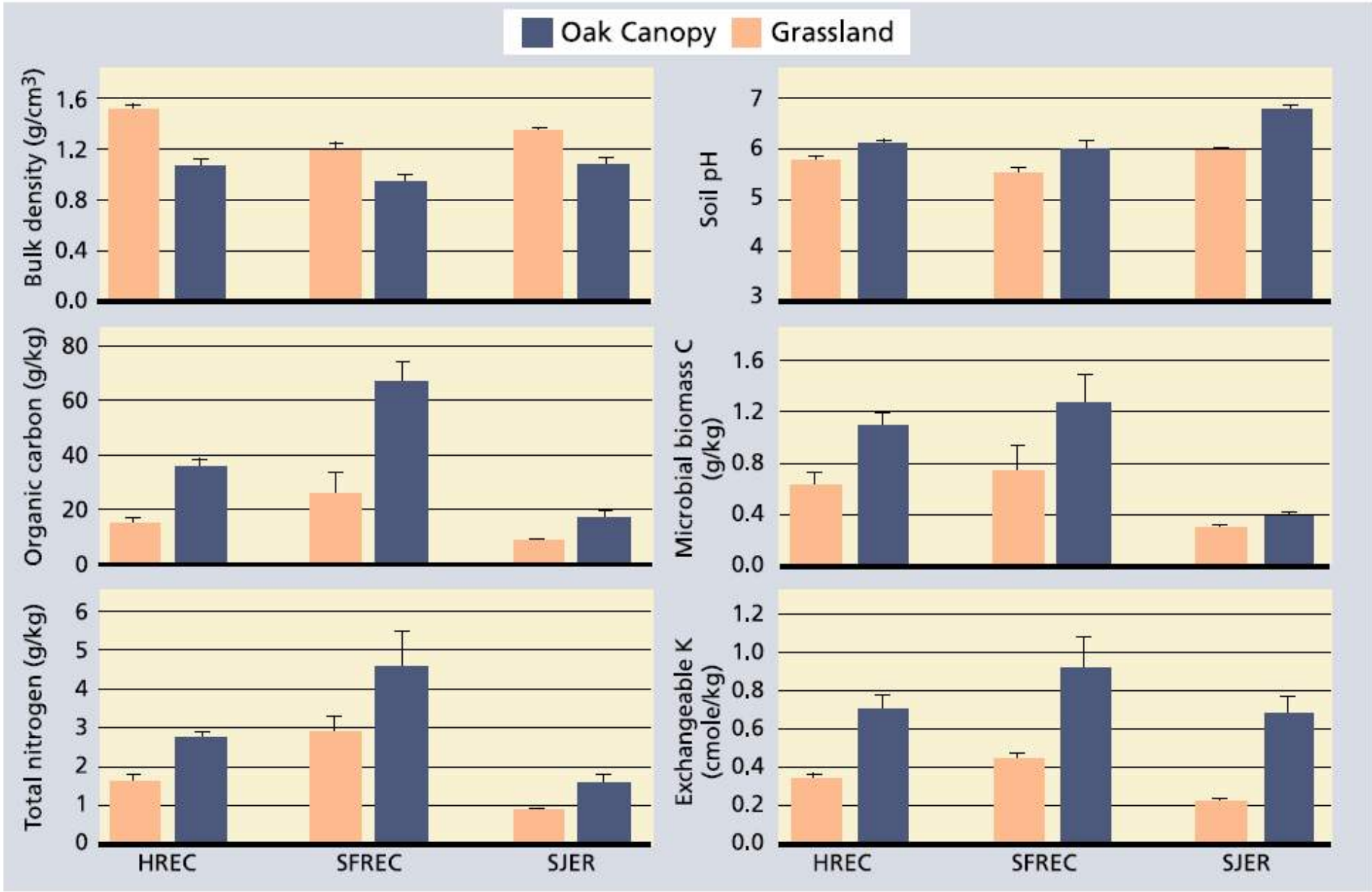


Fig. 1. Selected soil quality and fertility parameters (mean ± standard error; n = 5) for the 0-to-2-inch- (0-to-5 cm-) depth increment of soils beneath the oak canopy and adjacent

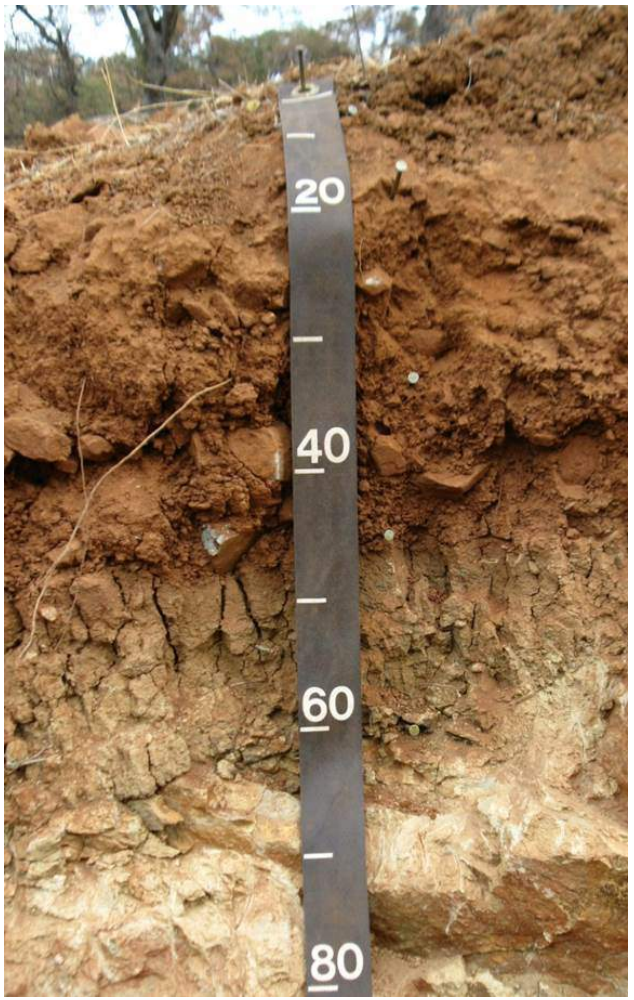
Southern Sierra Foothills

Infiltration (cm/hr)

Aggregate Stability

Northern Foothill Region

Plant Available Water →

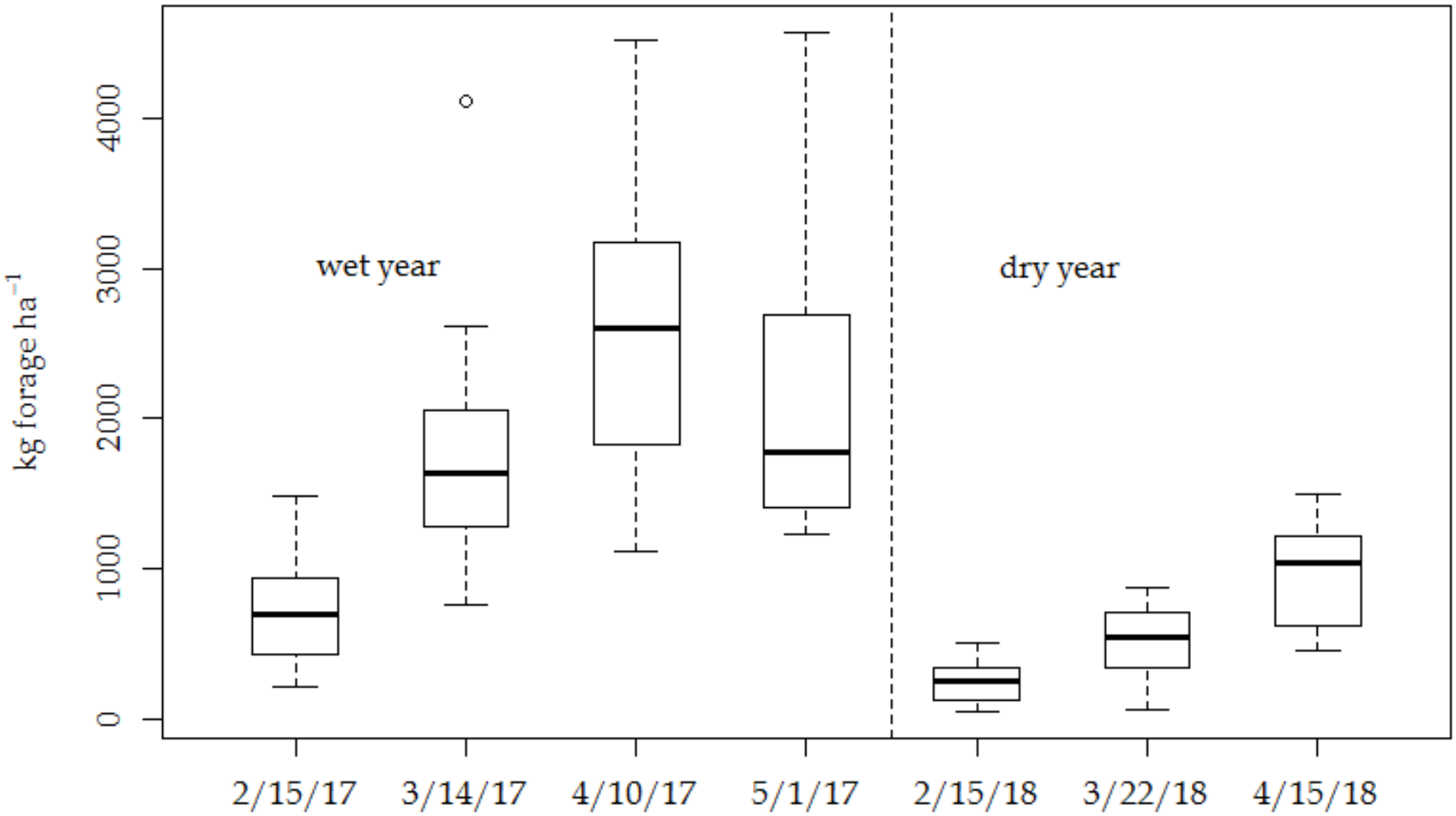


← Plant Available Phosphorus

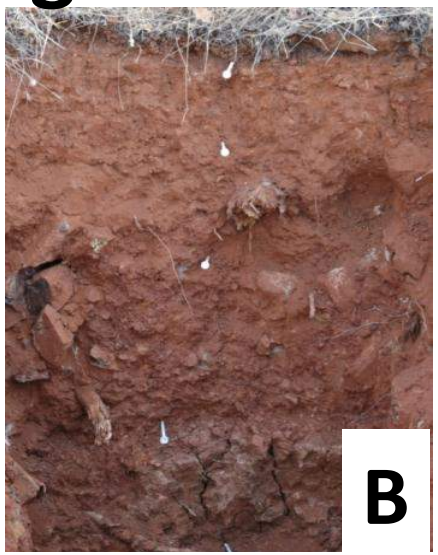
Northern Coast Range

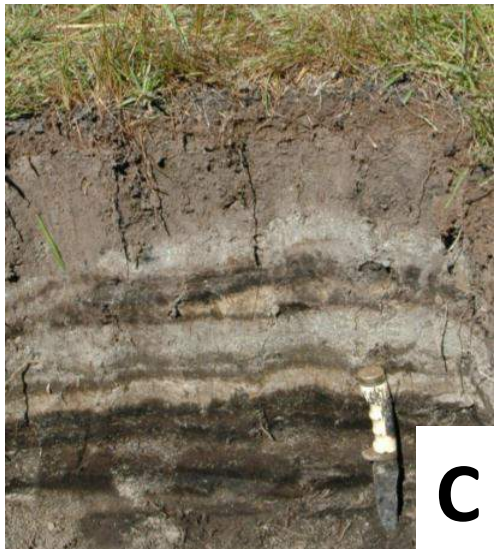
Foot slope ← Soil Organic Carbon (%) → Summit

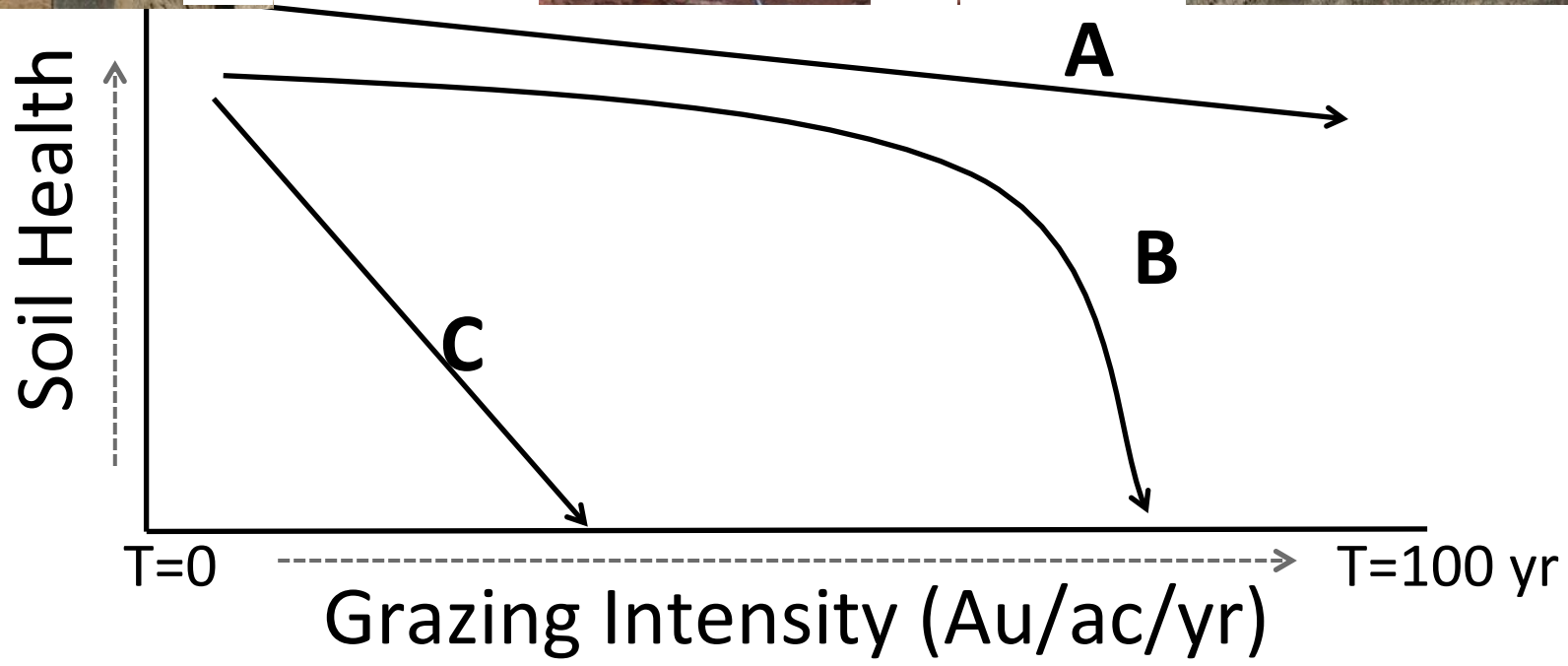
Forage productivity at a site in San Luis Obispo County, 2017 & 2018



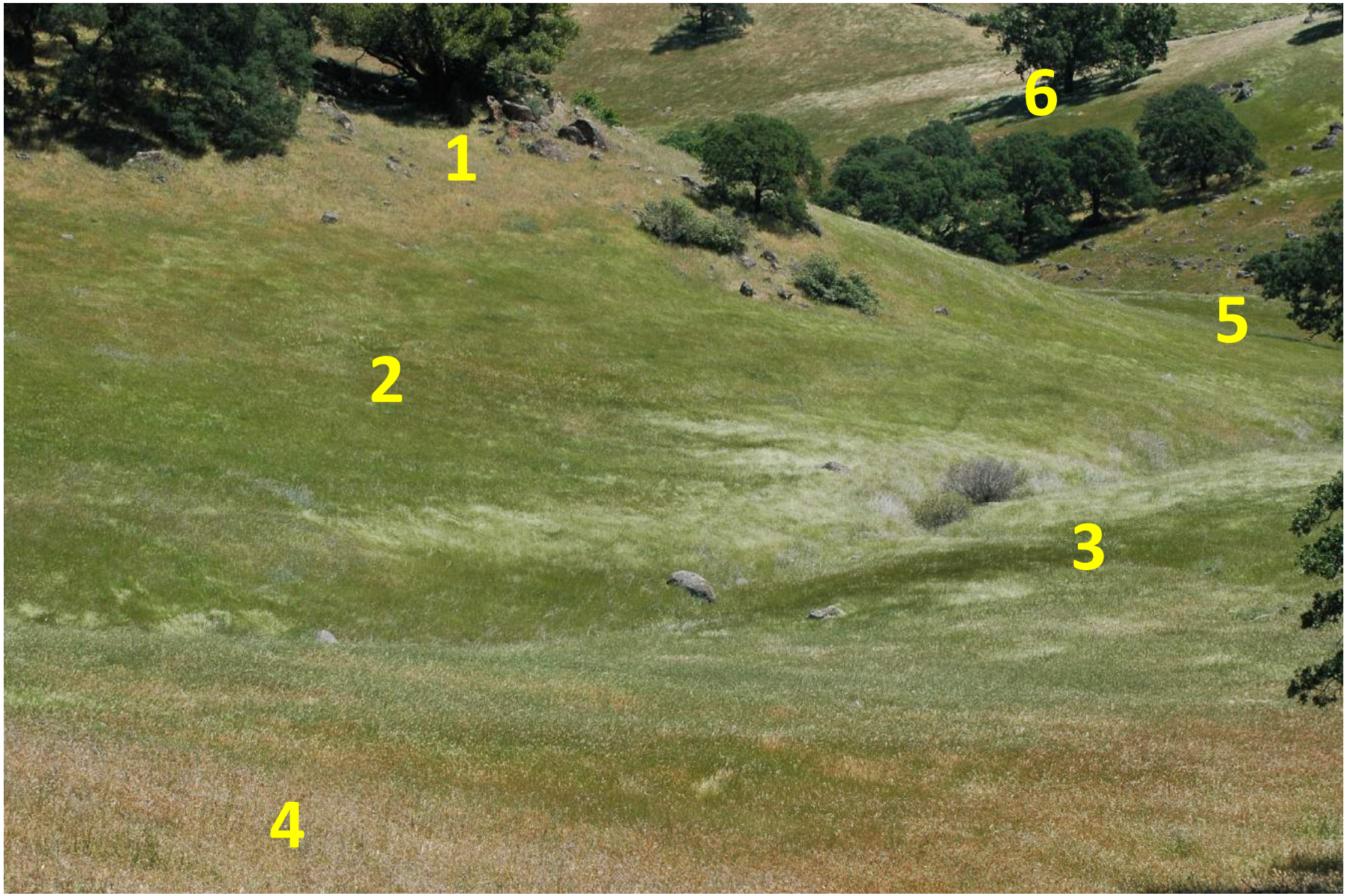
Can rangeland soil health indicators tell us anything about resilience?



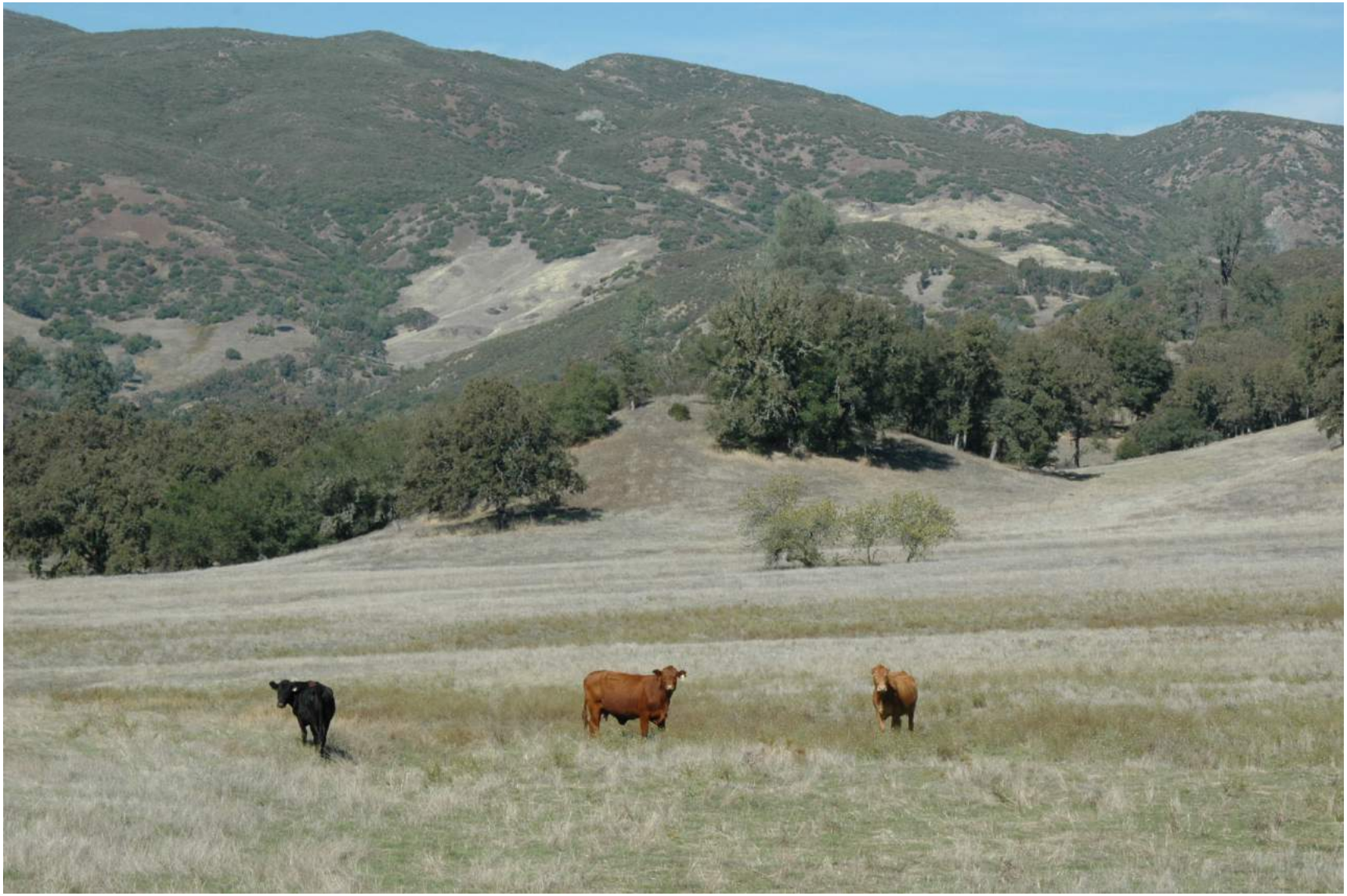




Soil variability in rangelands



Thank You



https://casoilresource.lawr.ucdavis.edu/

Is managing for healthy soils always compatible with other management goals?

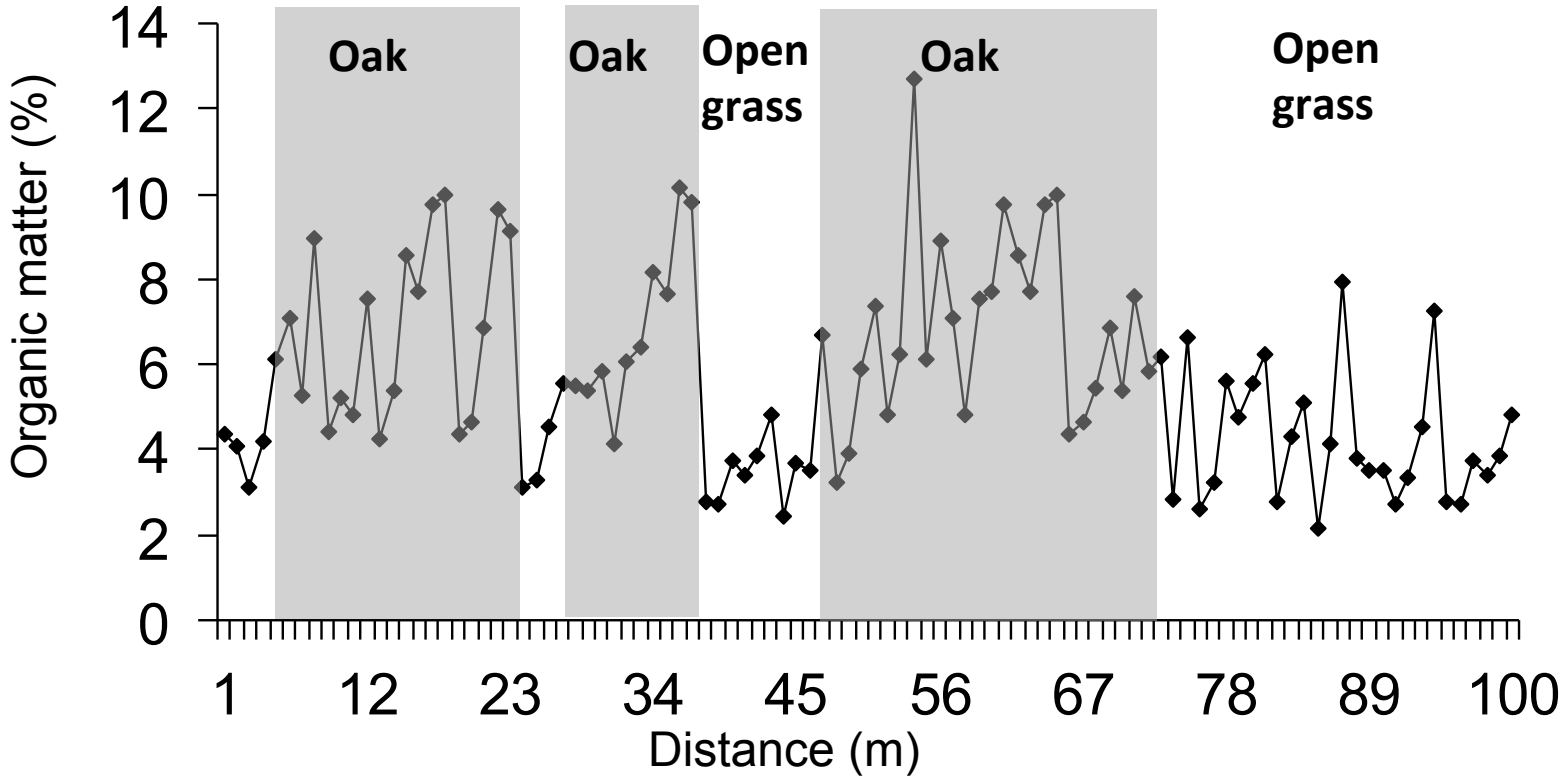
Do "unhealthy" soils give rise to more landscape scale biodiversity?

Do practices that promote soil organic matter correspond with long-term productivity increases?

Are healthier soils more or less resilient to weed infestation?

Soil organic carbon (top 5 cm) along a 100-m transect of an oak woodland/annual grassland.

Grass: 4.0±1.3% OM
Oak: 6.9±2.1% OM



Shaded regions = soils under oak canopy; un-shaded = open grassland

Case Study: Managing a ranch mosaic

- Coastal shrub
- Oak woodland
- Annual grass
- Restored perennial grass

Comparison of ecosystem health indicators relative to annual grassland soils.

Ecosystem Health Indicators	Oak	Coastal shrub	Perennial grass
Organic Carbon	↑	↑	=
Permeability	↑	↑	=
Aggregate stability	=	↑	=
Bulk density	=	↓	=
Microbial diversity	↑	↑	=
Bird Diversity	↑	↑	na
Bird Density	↑	↑	na

↑ Significantly Higher
↓ Significantly lower = No significant difference

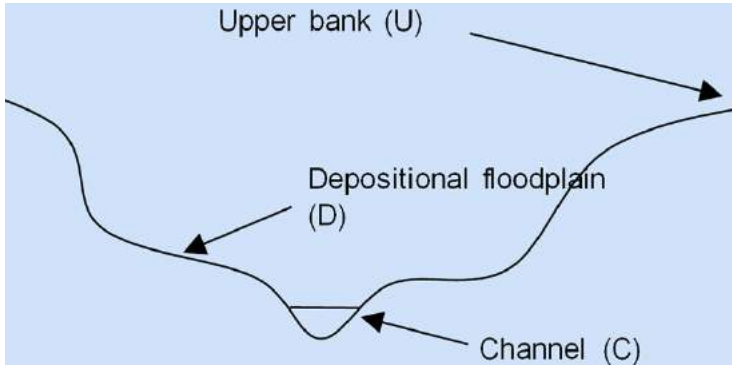
Study # 1. Can riparian restoration increase soil organic carbon sequestration in rangelands?

Time = 0 years → **Time = 45 years**

42 restoration projects

Practices include:

- **Tree planting**
- **Bio technical bank stabilization**
- **Grazing management (removal or reduced stocking rates)**



Landforms Sampled

Project team: D. Lewis UCCE, M. Lennox UCCE , V. Eviner UCD , J. Harper UCCE, K. Tate UCD

Effect of restoration on soil organic carbon stock (1-m) over time