

Understanding Soil Health in California's Annual Rangelands

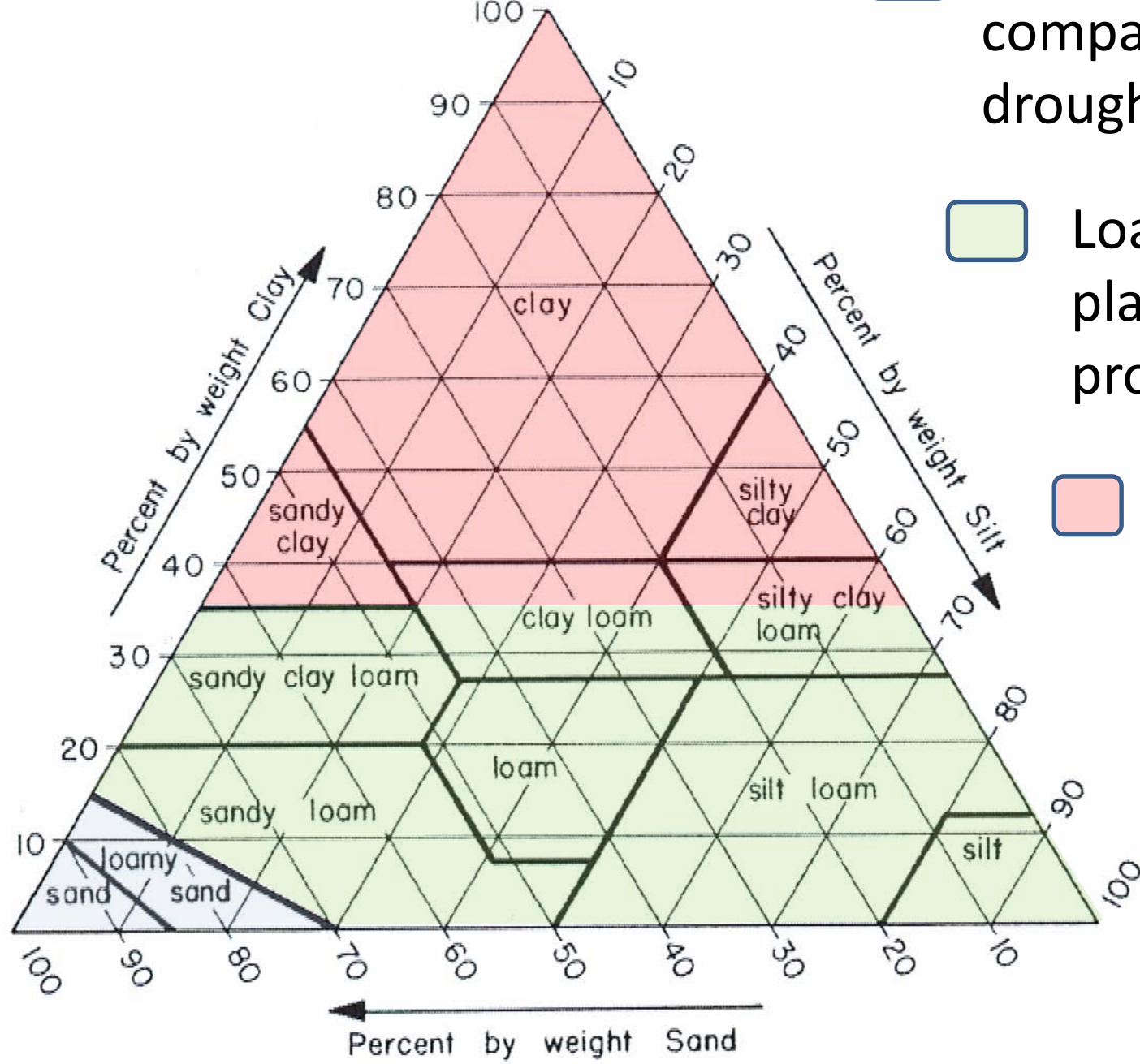



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Rangeland Soil Health/Performance Indicators


Soil Health Indicators	Cause if degraded	Implication
-Texture	Nature	Everything
-Bulk density	Compaction	Degraded root zone
-Structure & aggregate stability	Low SOM	Poor surface condition
-Soil Organic C	Erosion	Poor fertility & tilth
-Infiltration	Many	High runoff & erosion
-Plant available water	Erosion & compaction	Reduced productivity
-Vegetative cover	Over grazing & climate	Erosion & reduced fertility

Textural Triangle



 Coarse-resilient to compaction but droughty

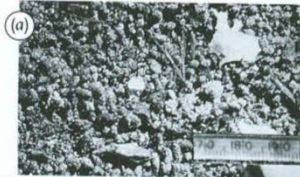
 Loamy- ideal for plant growth, but prone to erosion

 Fine- fertile, but prone to compaction when wet

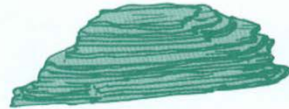
Soil Structure

Shape:

Granular



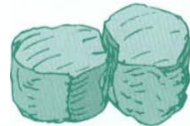
Platy



Angular
Blocky



Subangular
Blocky



Columnar



Prismatic



Soil structure is the aggregation of soil particles into identifiable shapes (aggregates).

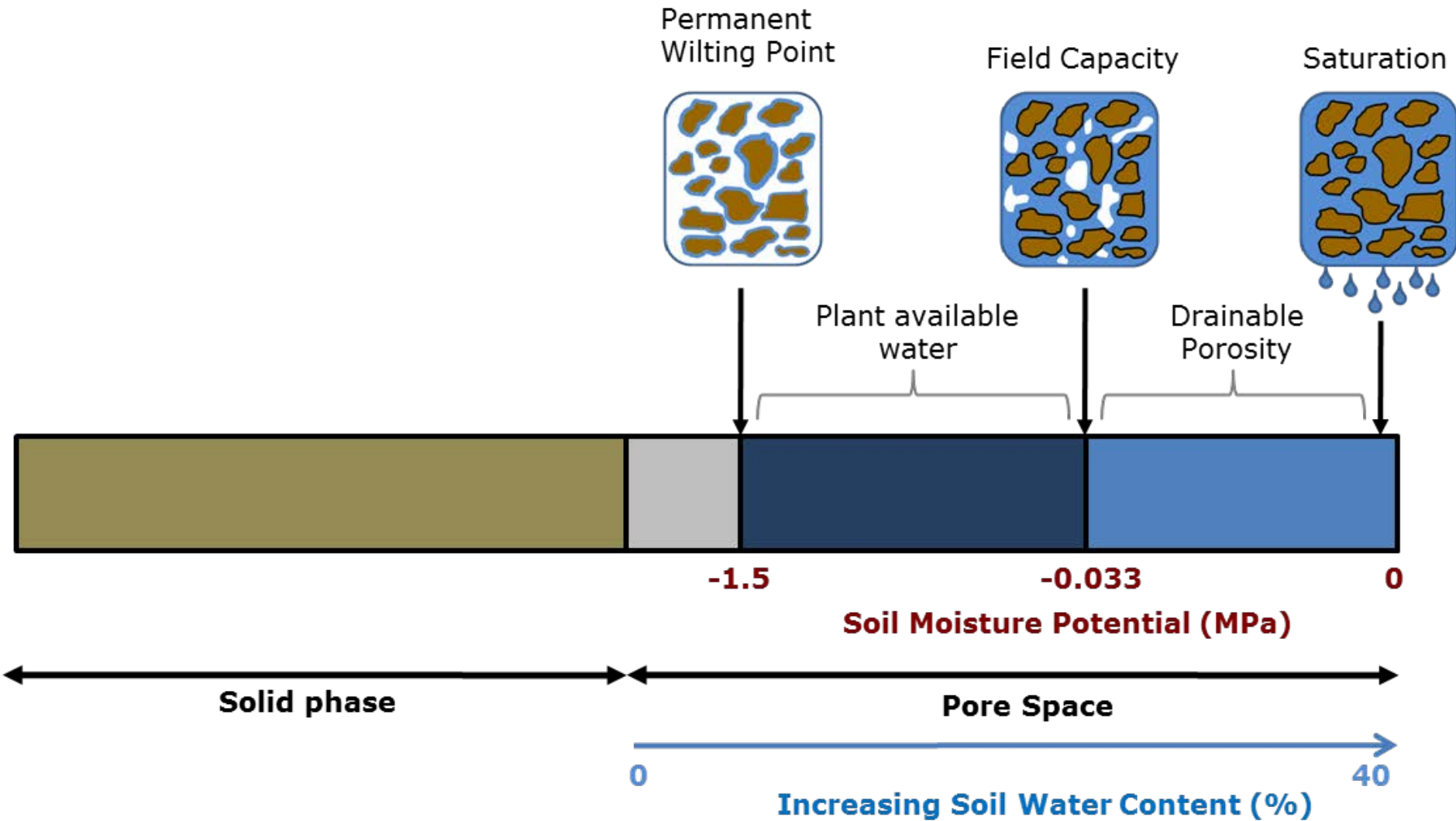
Grade-degree of aggregation
Shape of aggregates
Size of aggregates

Consistence- a measure of the ability of soil to resist deformation. *Which type is best?*

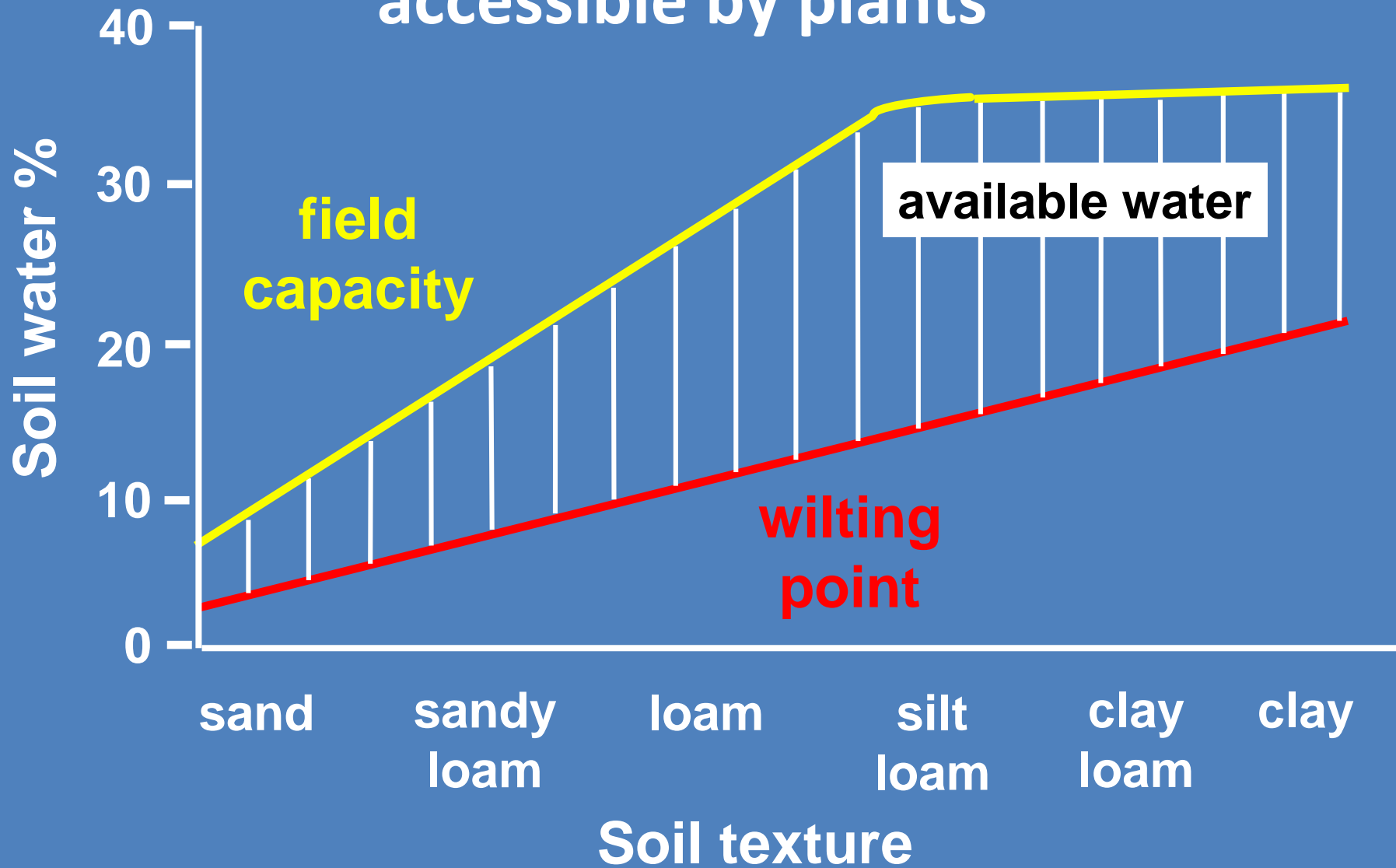
Moist Consistence

Loose	Soil is non-coherent
Very friable	Crushes easily under gentle pressure
Friable	Crushes easily under gentle to moderate pressure
firm	Crushes under moderate pressure but resistance is noticeable
Very firm	Crushes under strong pressure but difficult to crush between thumb and forefinger
Extremely firm	Cannot be crushed between thumb and forefingers.

Plant Available Water Holding Capacity

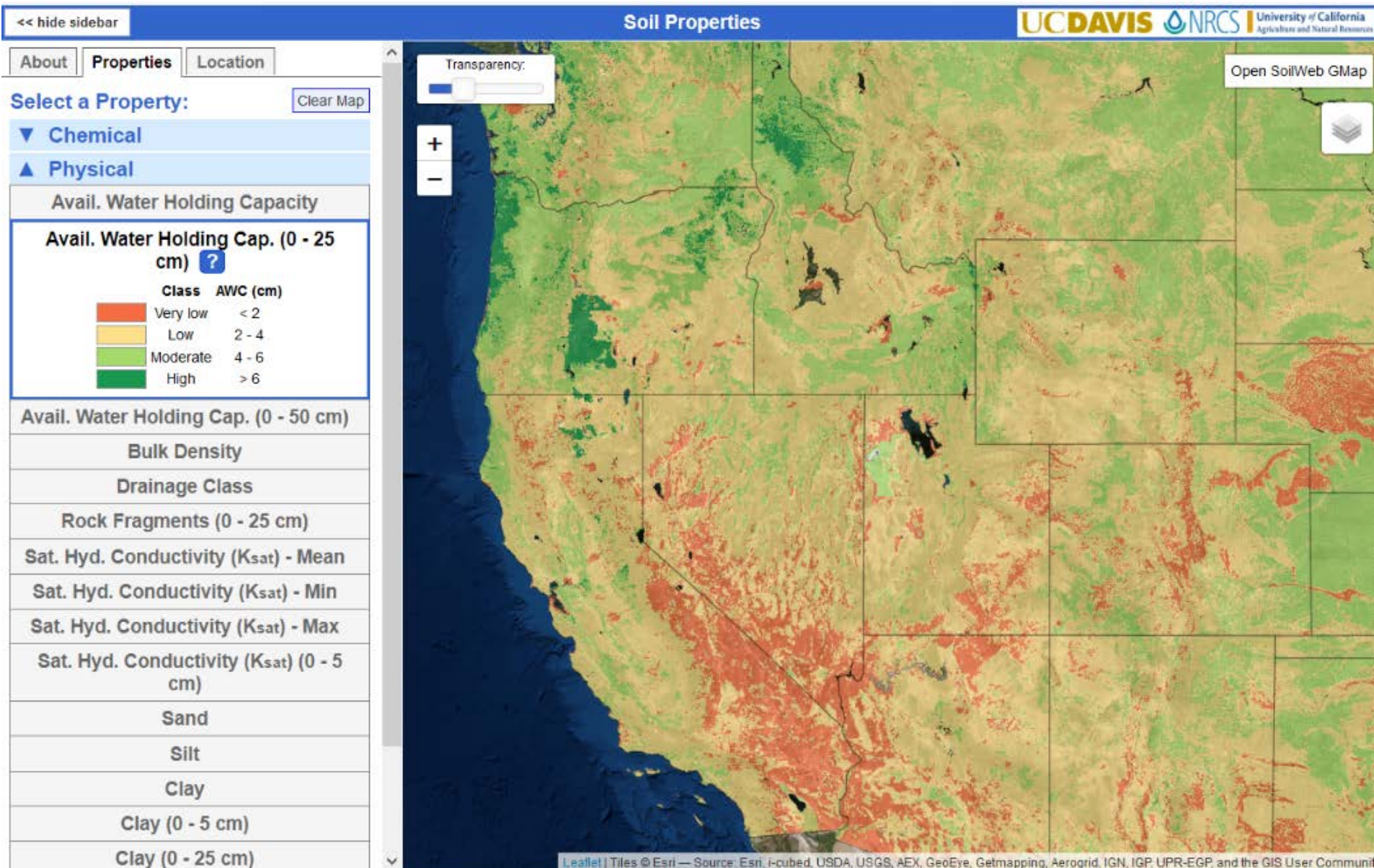


Plant available water is retained in the soil against the force of gravity yet readily accessible by plants



Plant available water holding capacity in top 25 cm of soil

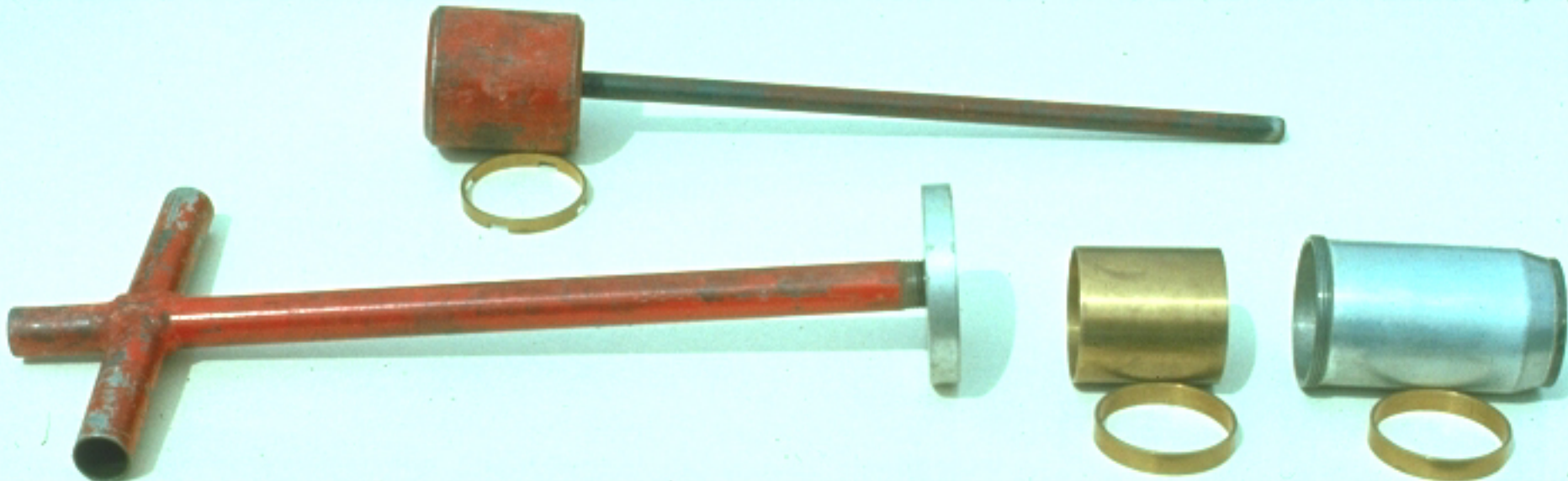
<https://casoilresource.lawr.ucdavis.edu/soil-properties/>



Bulk Density

$$\text{Bulk Density (g cm}^{-3}\text{)} = \frac{\text{weight of dry soil}}{\text{total volume of core}}$$

Used in mass to volume conversions. Lab analysis units are expressed as a mass. Management uses volumes and area. Also a measure of degree of compaction.



Interpreting bulk density values

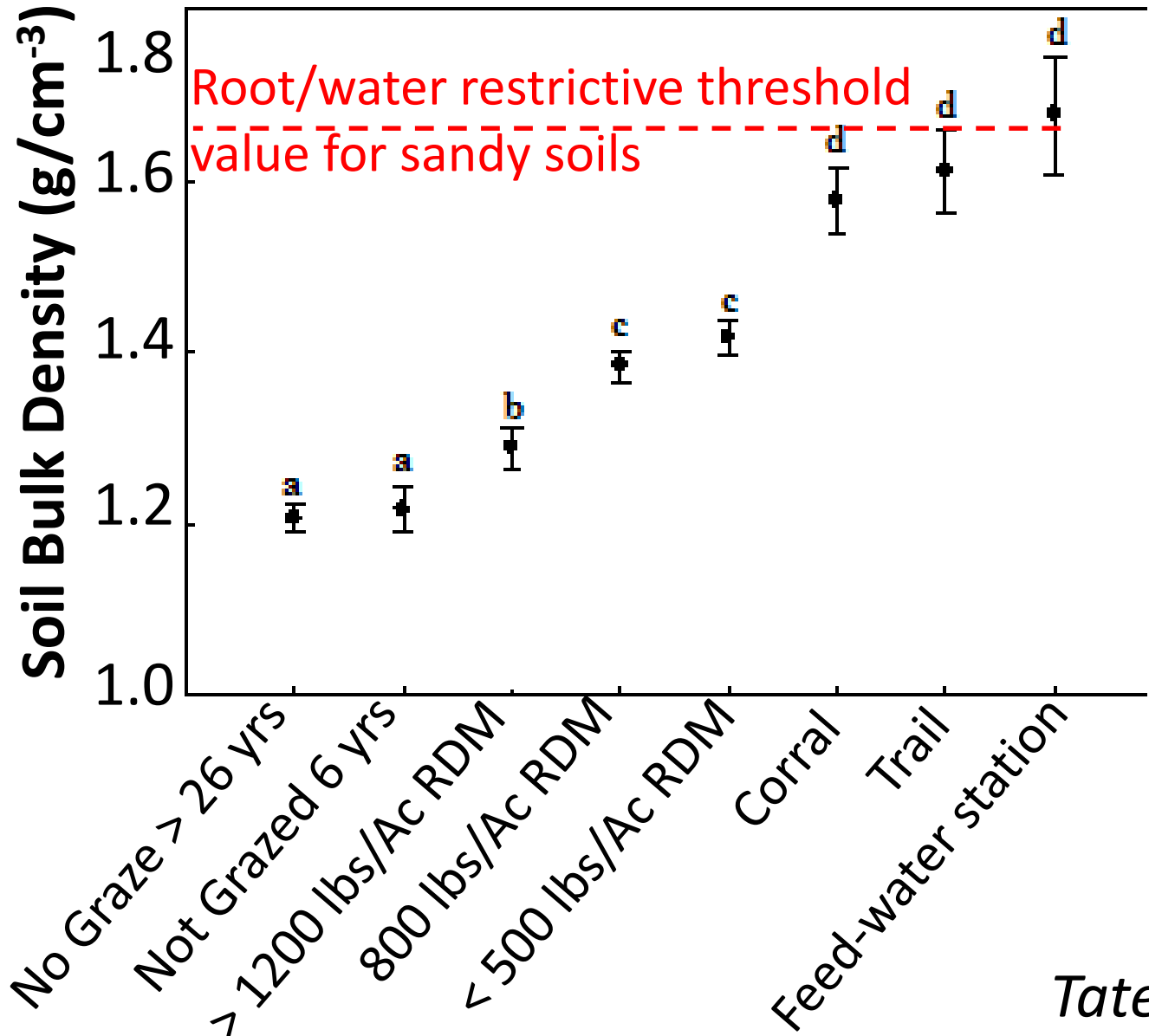
Table 1.—General relationship of soil bulk density to root growth based on soil texture*

Soil texture	Ideal bulk density for plant growth (grams/cm³)	Bulk density that affects root growth (grams/cm³)	Bulk density that restricts root growth (grams/cm³)
Sand, loamy sand	<1.60	1.69	>1.80
Sandy loam, loam	<1.40	1.63	>1.80
Sandy clay loam, clay loam	<1.40	1.60	>1.75
Silt, silt loam	<1.40	1.60	>1.75
Silt loam, silty clay loam	<1.40	1.55	>1.65
Sandy clay, silty clay, clay loam	<1.10	1.49	>1.58
Clay (>45 percent clay)	<1.10	1.39	>1.47

*Does not apply to red clayey soils and volcanic ash soils.

Effects of grazing on soil compaction

What is the functional difference?



Need to understand the trajectory of degradation. Not simply a relative change.



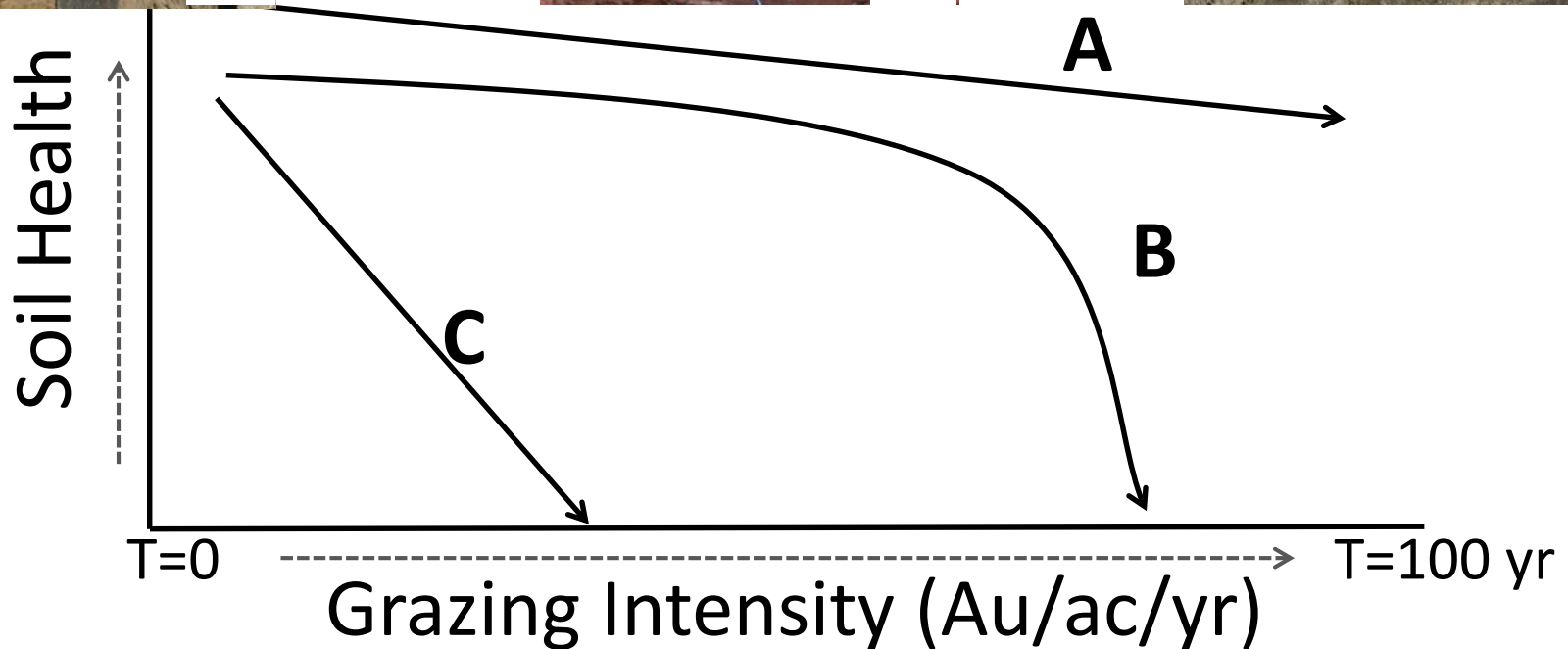
A



B



C



Back-up the indicators with observation

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



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



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

Back-up the indicators

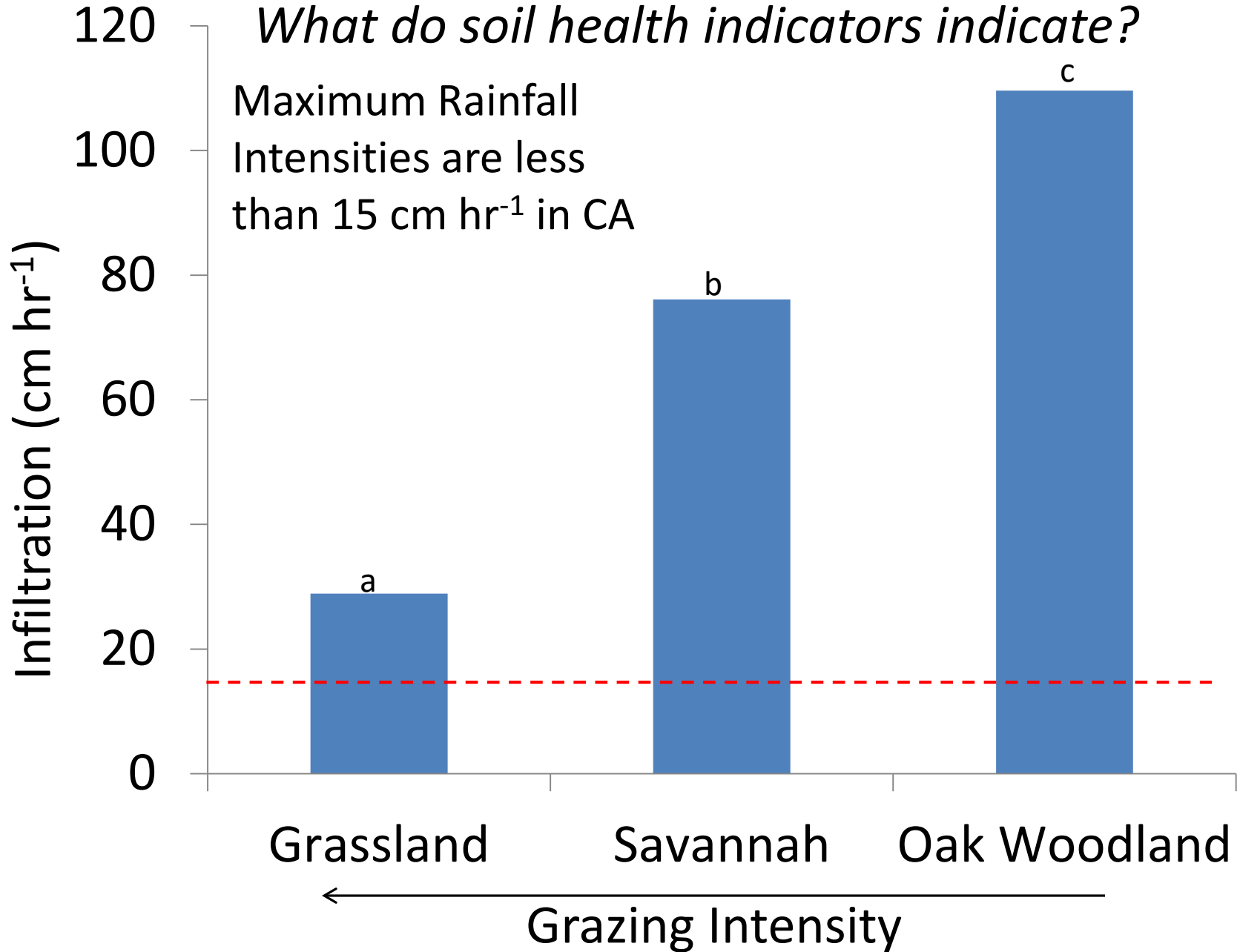


*Redoximorphic features only
within the compacted layer*

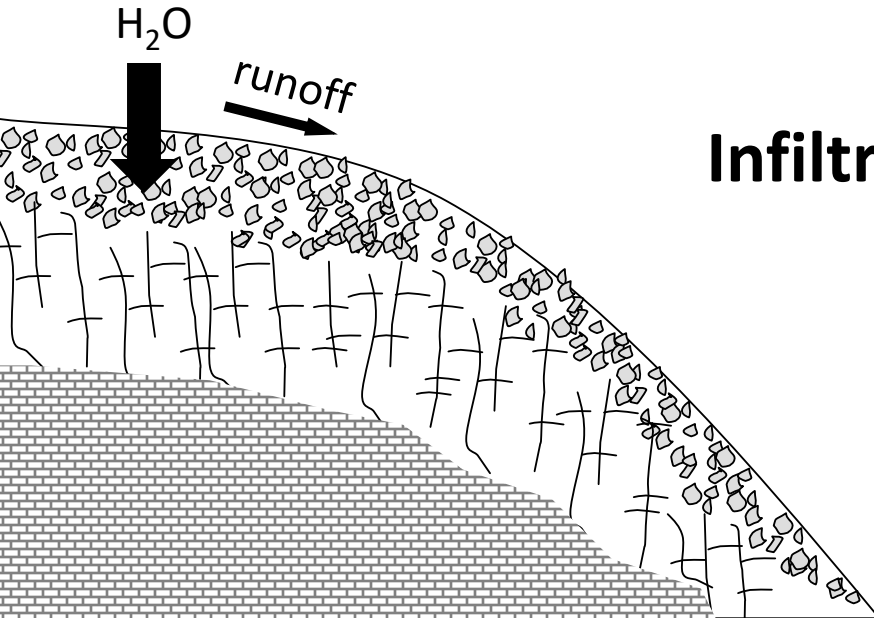


Impacts of grazing and oak cover on infiltration

What do soil health indicators indicate?



Runoff Mechanisms: Hortonian overland flow



Infiltration capacity exceeds rainfall intensity

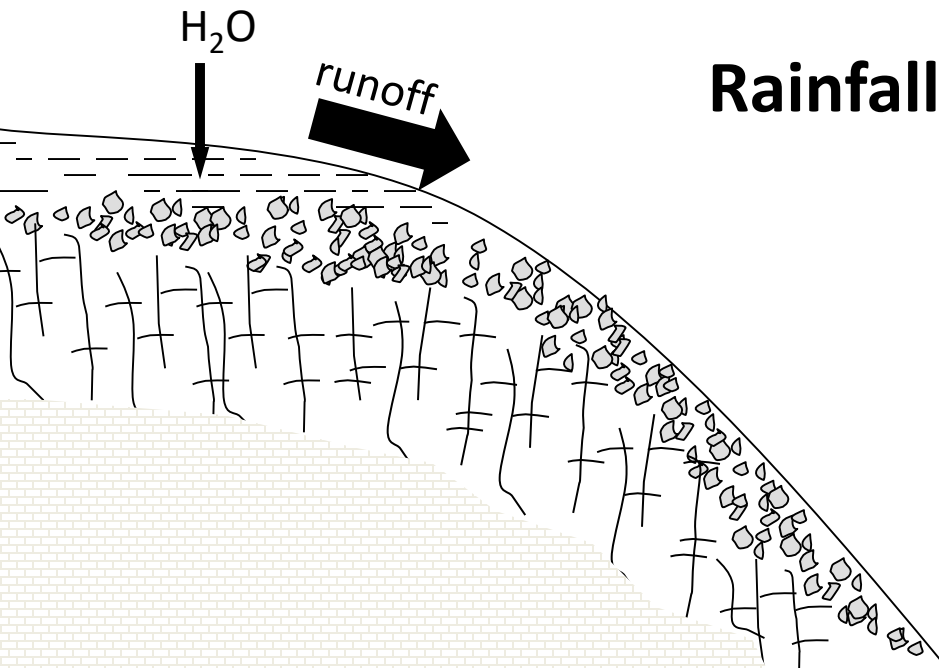
Low runoff:

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

Runoff Mechanisms: Saturated overland flow

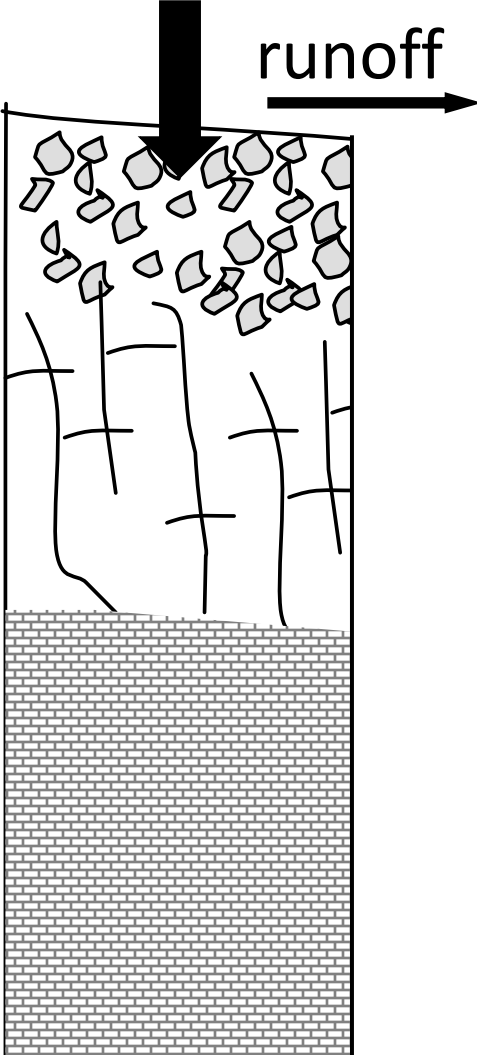
Saturated soil
infiltration

runoff



Unsaturated soil
infiltration

runoff



Soil Erosion

Warning signs:

Low cover, low RDM

Evidence of sediment transport: channels, gullies,
areas of sediment accumulation on soil surface

Degradation of soil structure, compaction

Solutions: maintain RDM recommendations; encourage
widespread utilization of ranch area, prescribed grazing



Soil Organic Matter (SOM)

Depends on climate, topography, and soil texture, drainage
Few if any range management tools available to increase
SOM

Semi-arid & arid climates limit SOM build up, must maintain
higher biomass inputs continuously to increase SOM



Soil variability in rangelands



<http://casoilresource.lawr.ucdavis.edu/soilweb-apps>

< Close

SoilWeb

Link to WSS

Soil Data Explorer | Series Extent Explorer | Description

Soil Profiles

Typical Profile >

Org. Matter | Clay

Sand | Ksat

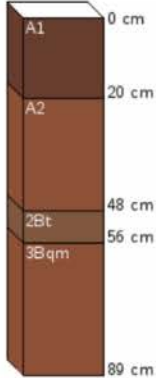
pH | Kf Factor

EC | SAR

CaCO₃ | Gypsum

CEC @ pH7

Linear Ext.



Soil Taxonomy

Land Classification

CA Storie Index: Grade 5 - Very Poor (14.5)

Land Capability Class (non-irrigated): 6-e ?

Land Capability Class (irrigated): 6-e ?

Ecological Site Description: n/a ?

Forage Suitability Group: n/a ?

Hydraulic and Erosion Ratings

Wind Erodibility Group: 6 ?

Wind Erodibility Index: 48 ?

T Erosion Factor: 2 ?

Runoff:

Drainage: Moderately well drained

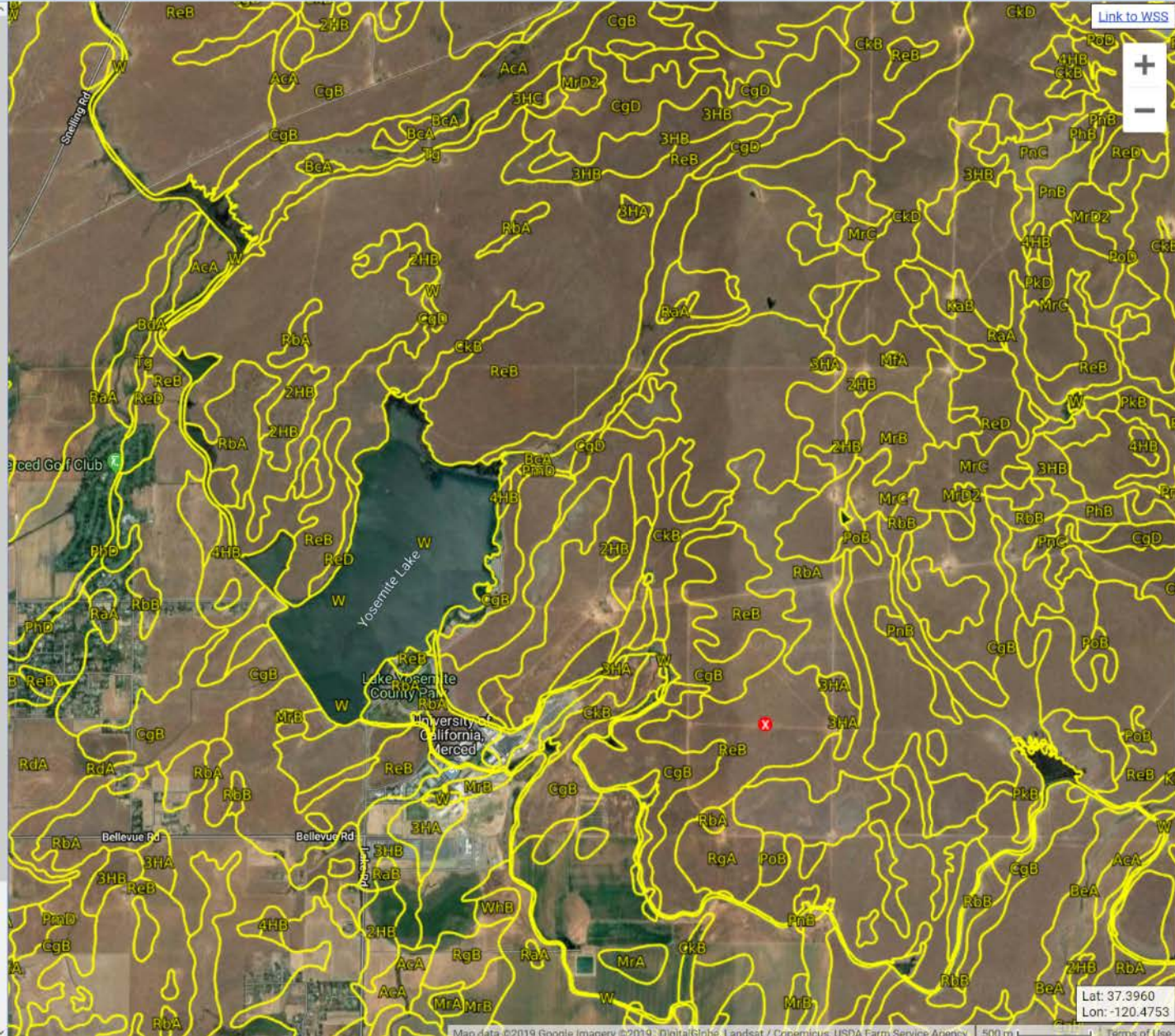
Hydic Rating: No ?

Hydrologic Group: Group D ?

Parent Material: loamy alluvium derived from igneous, metamorphic and sedimentary rock over clayey alluvium derived from igneous, metamorphic and sedimentary rock over cemented alluvium derived from igneous, metamorphic and sedimentary rock

Total Plant Available Water (cm): 5.81

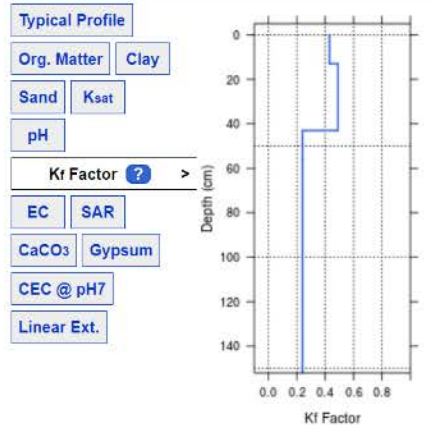
Forest Productivity



Lat: 37.3960
Lon: -120.4753

Redding
Soil Data Explorer | Series Extent Explorer | Description

Soil Profiles



Soil Taxonomy

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Forage Suitability Group: n/a ?

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Total Plant Available Water (cm): 5.81

Depth Range (cm)	Horizon Designation	Percent Clay	Percent Sand	Percent Organic Matter	pH by water Extraction	Sat. Hydraulic Conductivity (mm/hr)	EC (dS/m)	SAR (%)	Carbonates (% of < 2 mm)	Gypsum (% of < 20 mm)	CEC at pH 7 (cmol charge / kg soil)	K Factor	LEP	Oven-Dry D _b (g/cm ³)
0 - 13	Ap	14	38	3.52	5.5	32.4	0.3	0	0	0		.43	0.5	1.2
13 - 43	BA	17	36	0.93	5.8	32.4	0.3	0	0	0	9.1	.49	0.9	1.76
43 - 56	2Bt	50	25	0.4	6.5	0.774	0.3	0	0	0	26.1	.24	5.5	1.63
56 - 152	2Btqm	26	60.1	0.31	5.5	0.036	0.2	0	0	0		.24	1.4	1.63

All Horizon Data





Web Soil Survey

You are here: Web Soil Survey Home

Search

Enter Keyword
All NRCS Sites

Browse by Subject

- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Soil Series Extent Mapping Tool
- Geospatial Data Gateway

The simple yet powerful way to access and use soil data.



Welcome to Web Soil Survey (WSS)



Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources

Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near

I Want To...

- o **Start Web Soil Survey (WSS)**
- o **Know Web Soil Survey Requirements**
- o **Know Web Soil Survey operation hours**
- o **Find what areas of the U.S. have soil data**
- o **Find information by topic**
- o **Know how to hyperlink from other documents to Web Soil**

Range Productivity

Intro to Soils

Suitabilities and Limitations for Use

Soil Properties and Qualities

Ecological Site Assessment

Soil Reports

Search

Suitabilities and Limitations Ratings

Open All Close All

- Building Site Development
- Construction Materials
- Disaster Recovery Planning
- Land Classifications
- Land Management
- Military Operations
- Recreational Development
- Sanitary Facilities
- Soil Health

Vegetative Productivity

- American Wine Grape Varieties Site Desirability (Long)
- American Wine Grape Varieties Site Desirability (Medium)
- American Wine Grape Varieties Site Desirability (Short)
- American Wine Grape Varieties Site Desirability (Very Long)
- Crop Productivity Index
- Forest Productivity (Cubic Feet per Acre per Year)
- Forest Productivity (Tree Site Index)
- Iowa Corn Suitability Rating CSR2 (IA)
- Minnesota Crop Productivity Index
- Range Production (Favorable Year)

Range Production (Normal Year)

View Description View Rating

View Options

Map — Range Production (Normal Year)



Tables — Range Production (Normal Year) — Summary By Map Unit

Summary by Map Unit — Merced Area, California (CA648)				
Summary by Map Unit — Merced Area, California (CA648)				
Map unit symbol	Map unit name	Rating (pounds per acre per year)	Acres in AOI	Percent of AOI
3HA	Hopeton clay loam, 0 to 3 percent slopes		21.0	2.0%
CgB	Corning gravelly loam, 0 to 8 percent slopes		198.2	18.5%
CkB	Corning gravelly sandy loam, 0 to 8 percent slopes		0.8	0.1%
MrC	Montpellier coarse sandy loam, 8 to 15 percent slopes		0.9	0.1%
PkB	Pentz gravelly loam, 0 to 8 percent slopes		8.3	0.8%
PnB	Peters clay, 2 to 8 percent slopes		25.1	2.3%
PnC	Peters clay, 8 to 15 percent slopes		0.9	0.1%
PoB	Peters cobbly clay, 0 to 8 percent slopes		133.5	12.5%
RbA	Raynor cobbly clay, 0 to 3 percent slopes		153.3	14.3%
RbB	Raynor cobbly clay, 3 to 8 percent slopes		15.1	1.4%
ReB	Redding gravelly loam, 0 to 8 percent slopes, dry	1700	509.3	47.7%
RgA	Rocklin loam, 0 to 3 percent slopes		0.3	0.0%
W	Water		2.0	0.2%
Totals for Area of Interest			1,068.6	100.0%

Description — Range Production (Normal Year)

Total range production is the amount of vegetation that can be expected to grow annually in a well managed area that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation. In a normal year, growing conditions are about average. Yields are adjusted to a common percent of air-dry moisture content.

Thank You



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

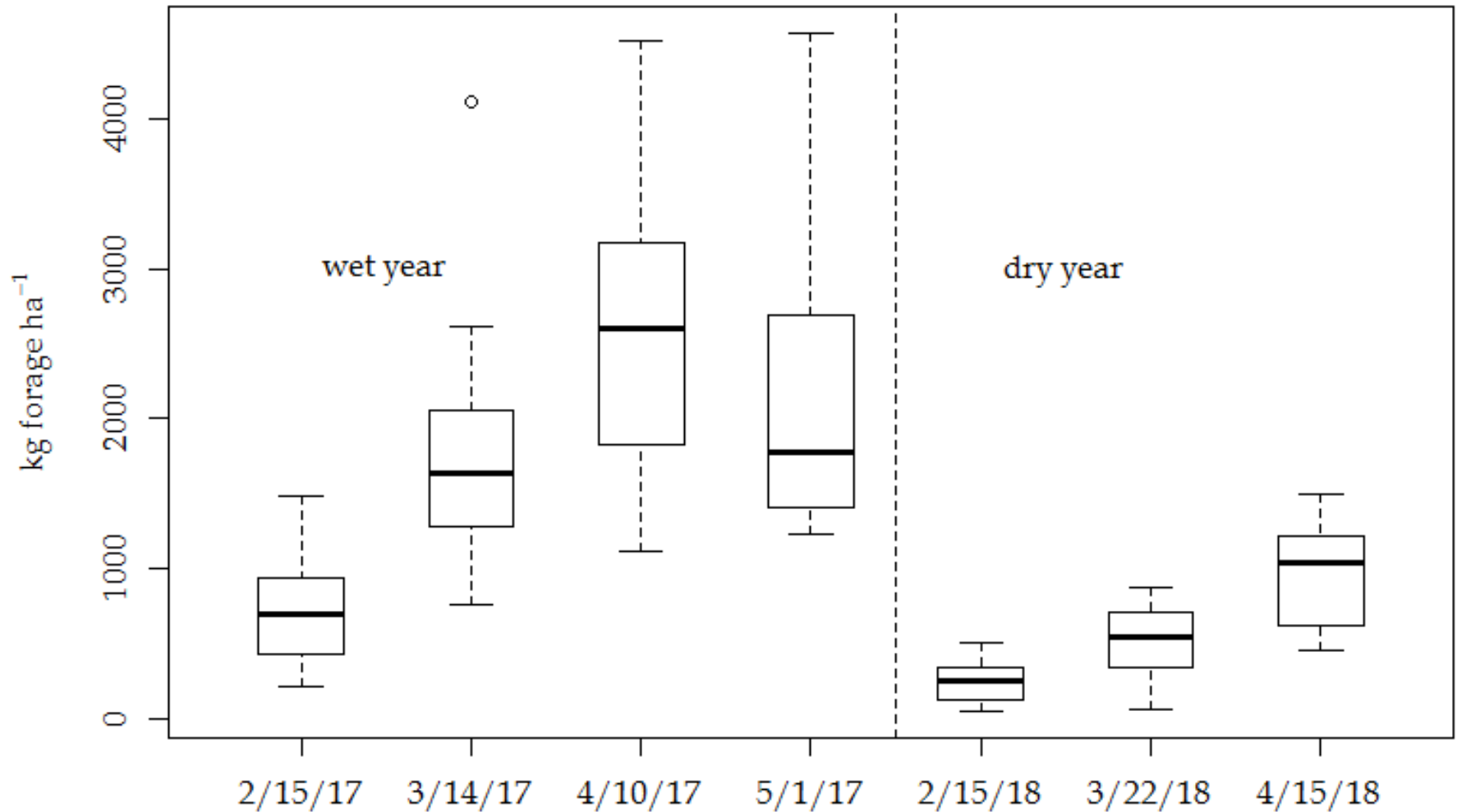
Is managing for healthy soils always compatible with other management goals?

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?

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



Southern Sierra Foothills

Infiltration (cm/hr)



Aggregate Stability



Northern Foothill Region

Plant Available Water



Plant Available Phosphorus



Northern Coast Range

Soil Organic Carbon (%)

Foot slope ←

Summit



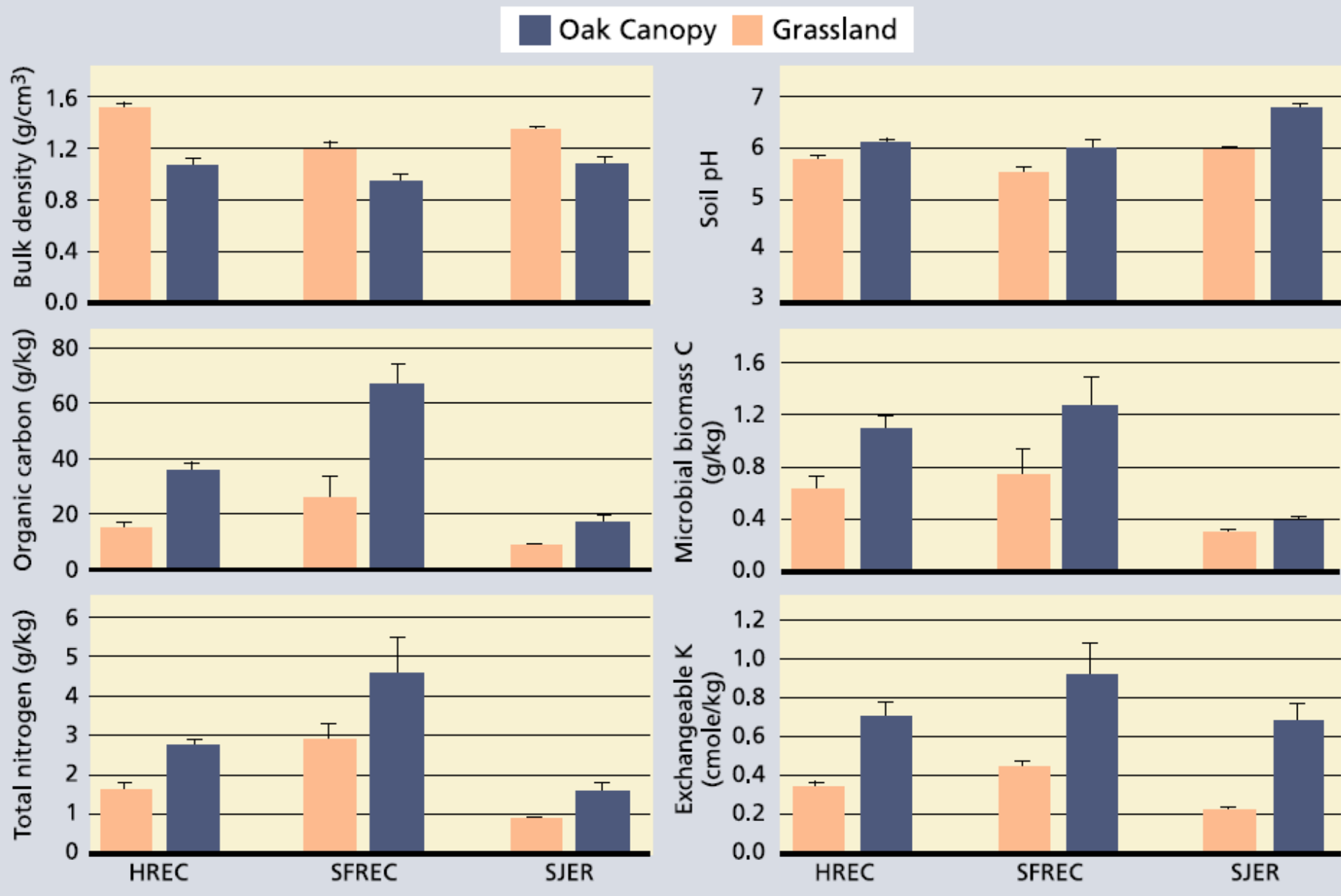
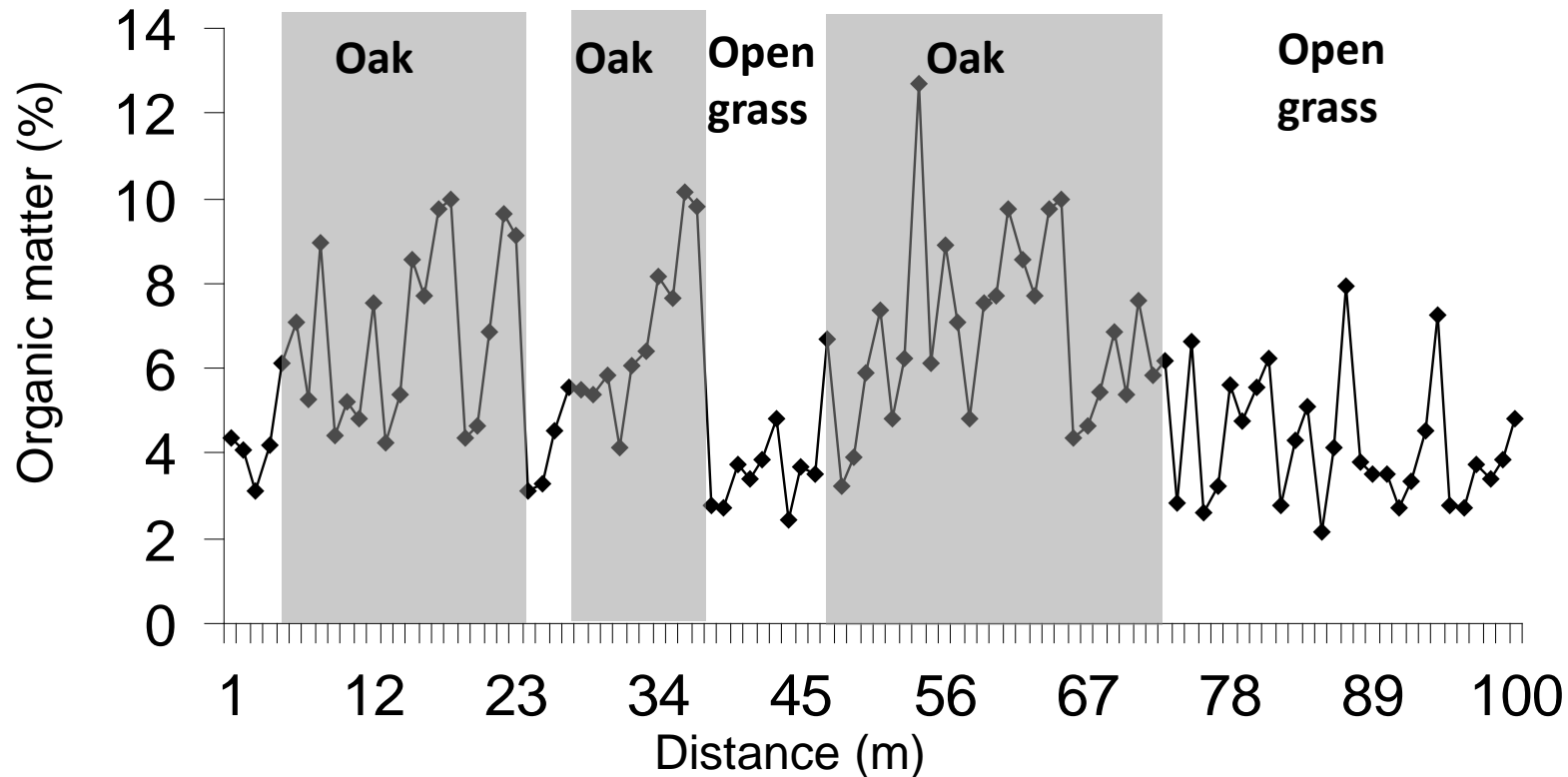


Fig. 1. Selected soil quality and fertility parameters (mean \pm standard error; $n = 5$) for the 0-to-2-inch- (0-to-5 cm-) depth increment of soils beneath the oak canopy and adjacent

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

Grass: $4.0 \pm 1.3\%$ OM
Oak: $6.9 \pm 2.1\%$ OM



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