Diagnosing Soil Health in California's Annual Rangelands: Issues of Scale

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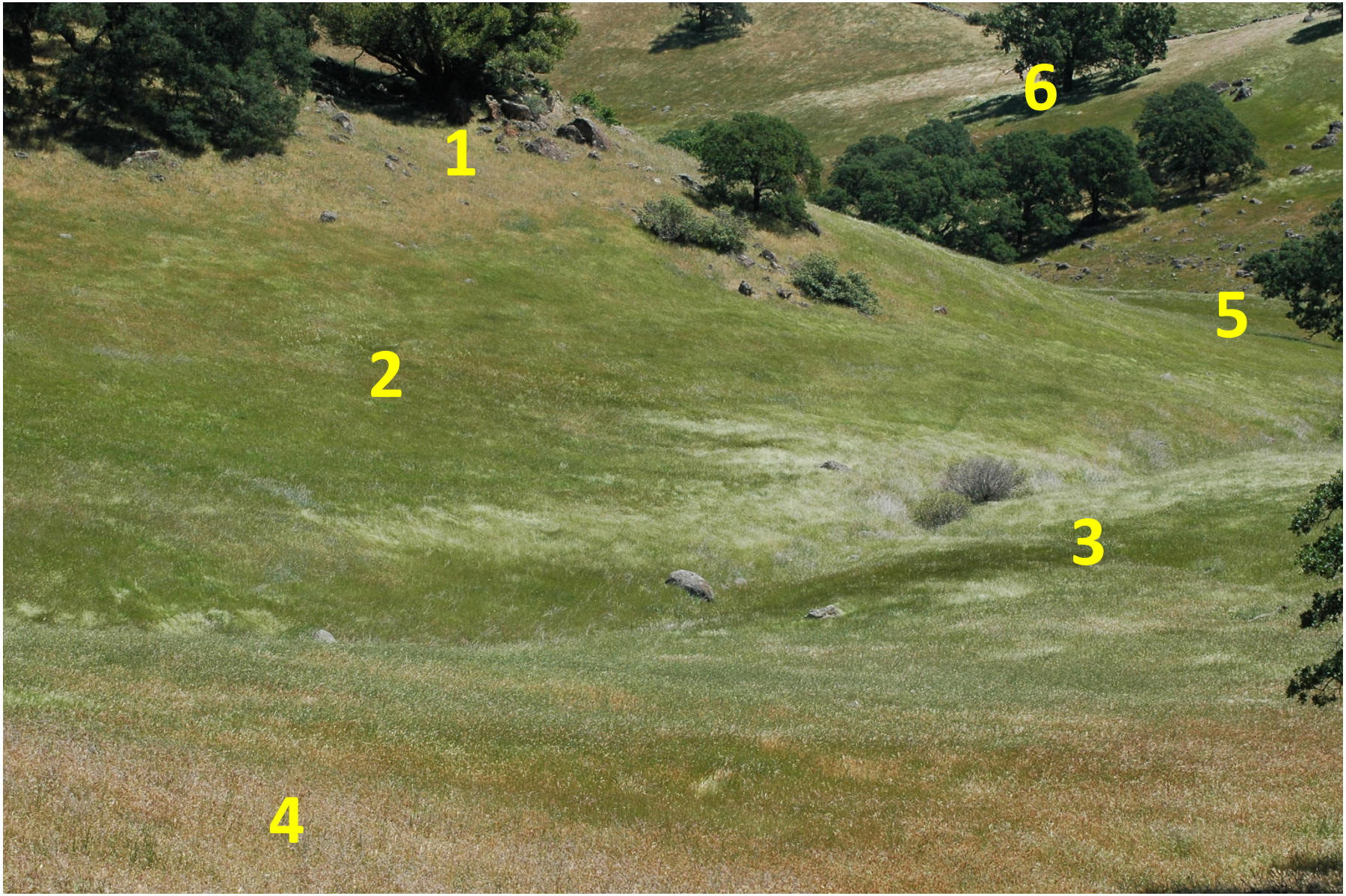
The challenge of diagnosing soil health

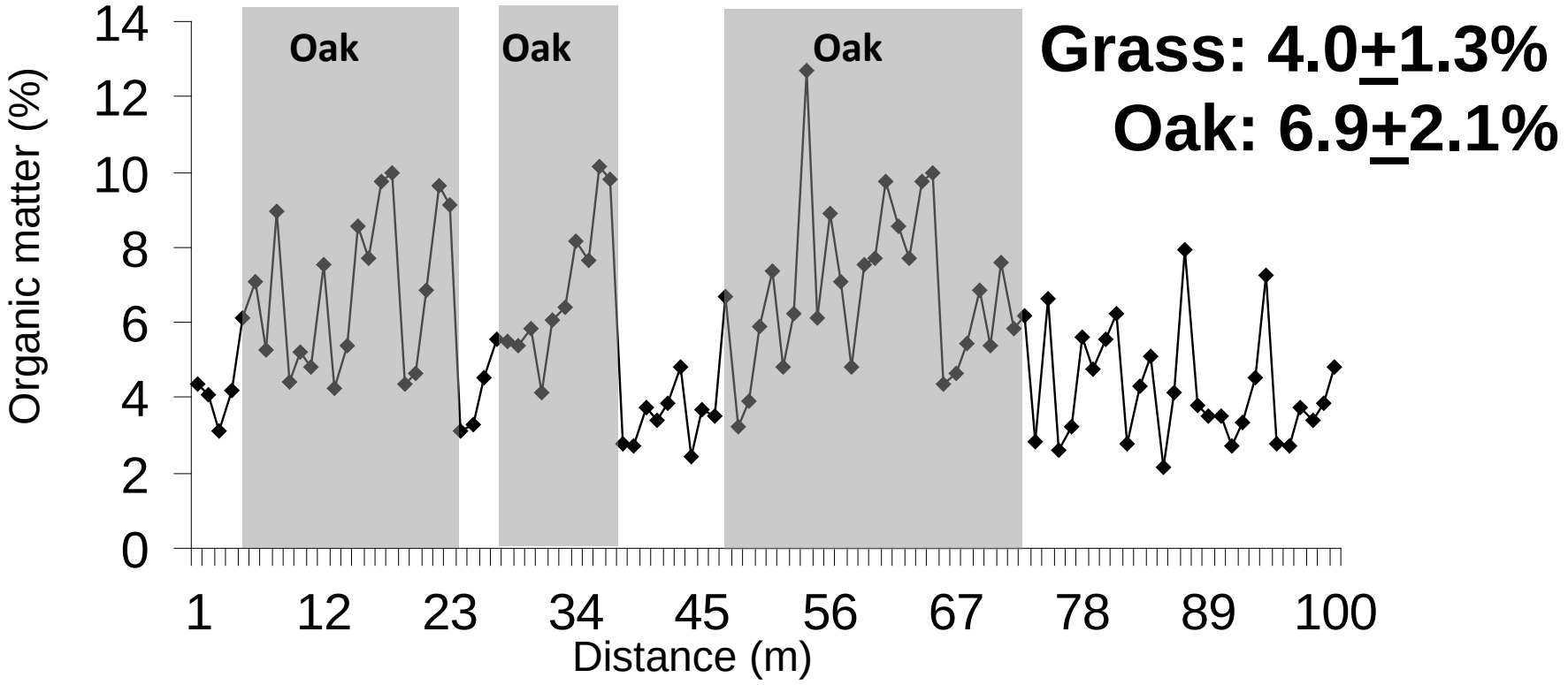
- How do we choose the right indicator?
- What are meaningful threshold values for indicators?
- Can place-based indictors overcome complexity of soil variability?

Assessing soil health in rangeland soil landscapes can be tricky



Is soil organic matter a good indicator here?

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

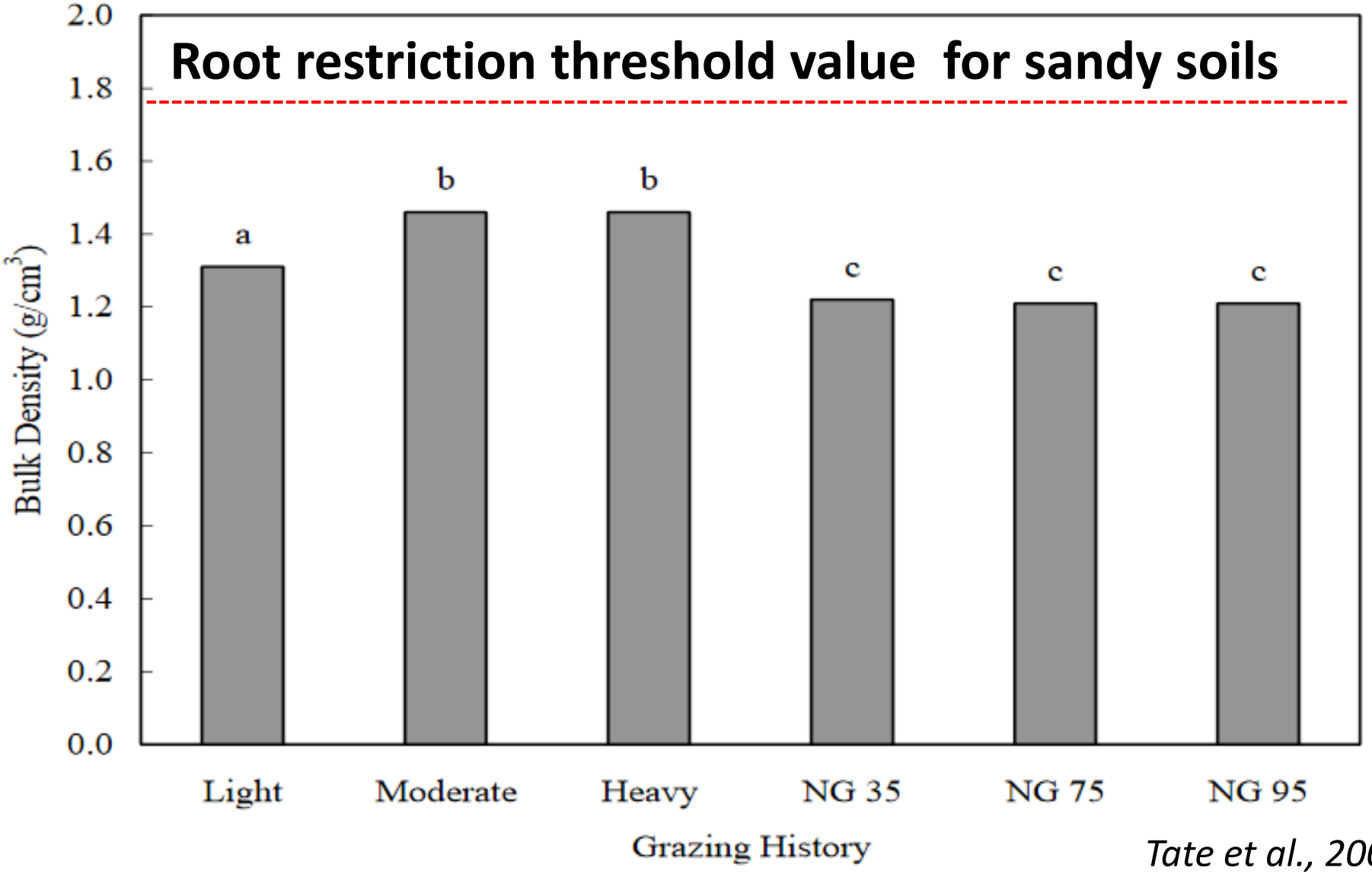


Shaded regions indicate soils under oak canopy, un-shaded = open grassland

Dahlgren et al., 2013

What do soil health indicators indicate?

Effect of grazing on bulk density



Tate et al., 2004

Back-up the indicators

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

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

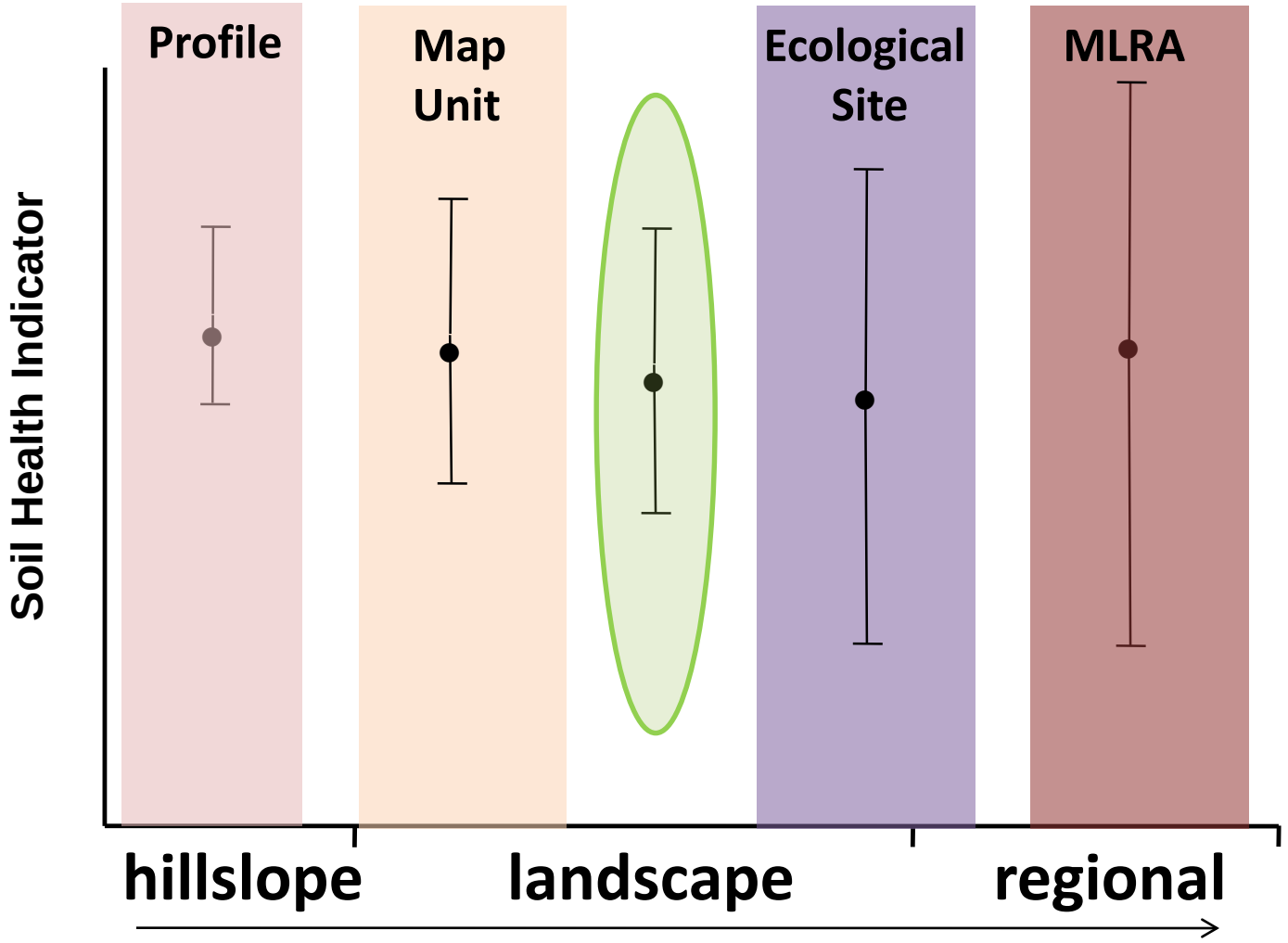
Link indicators with secondary observations that reflect a condition: diminished structure, abrupt boundary

Back-up the indicators

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

Place based soil health assessments

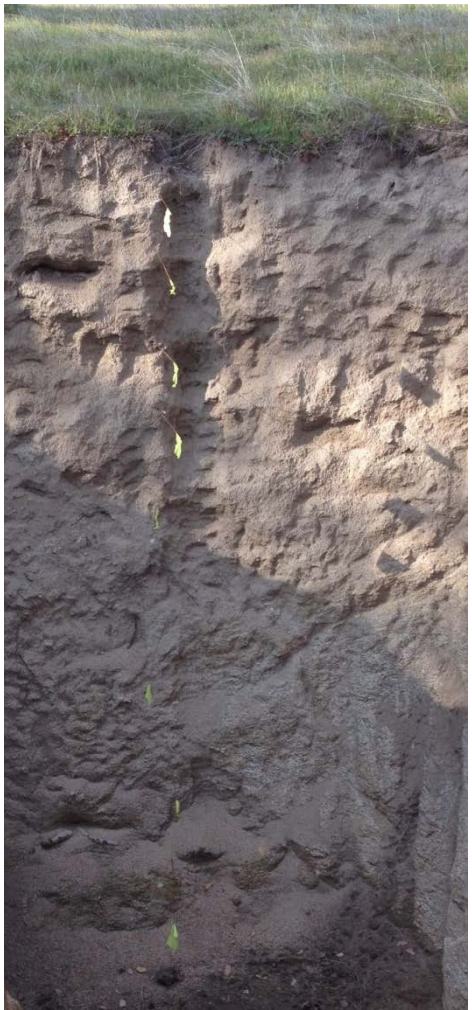
What is the optimum scale for soil health inventory?



Southern Sierra Foothills

Place-based indicators for drought tolerance: plant available water, soil organic matter

West → 100 km → East



Northern Coast Range

Place-based indicators for erosion: infiltration, aggregate stability, bare soil, bulk density

Foot slope —— **100 m** ——→ **Summit**

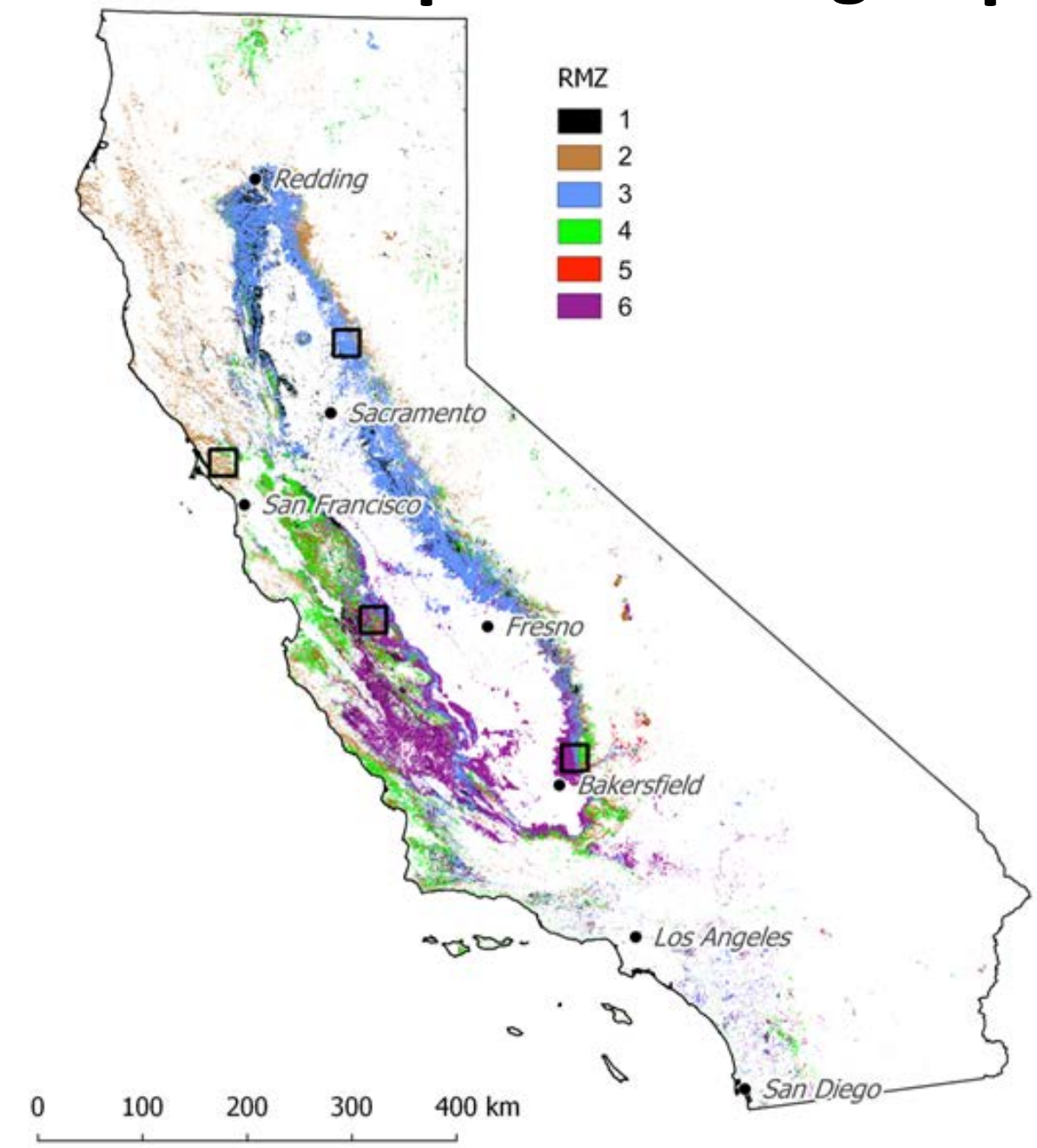
Northern Foothill Region

Place-based indicators for productive/resilient soils:

Nutrient limitations

backslope — 10 m → backslope

Landscape clustering experiment: RMZ



Inputs:

Plant available water

Soil organic matter

Soil depth

Solar radiation

MAT

MAP

Landscape position

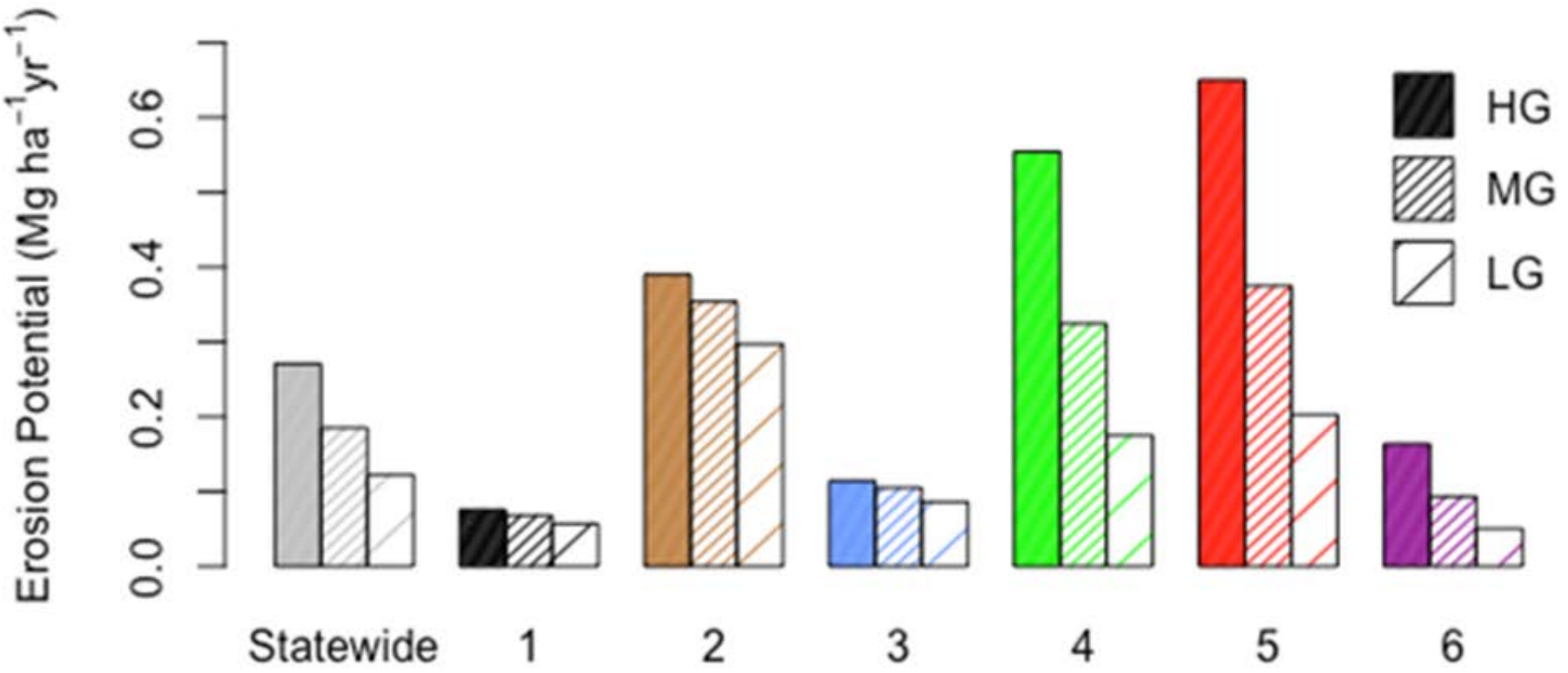
Slope

Flow accumulation

Climate variables

Modeled average erosion potential (RUSLE) by RMZ under three grazing scenarios (HG: heavily grazed, MG: moderately grazed, LG: lightly grazed).

RDM: HG < 500 lbs/ac; MG 700-900 lbs/AC; LG> 900 lbs/ac



Case Study: Landscape scale soil health

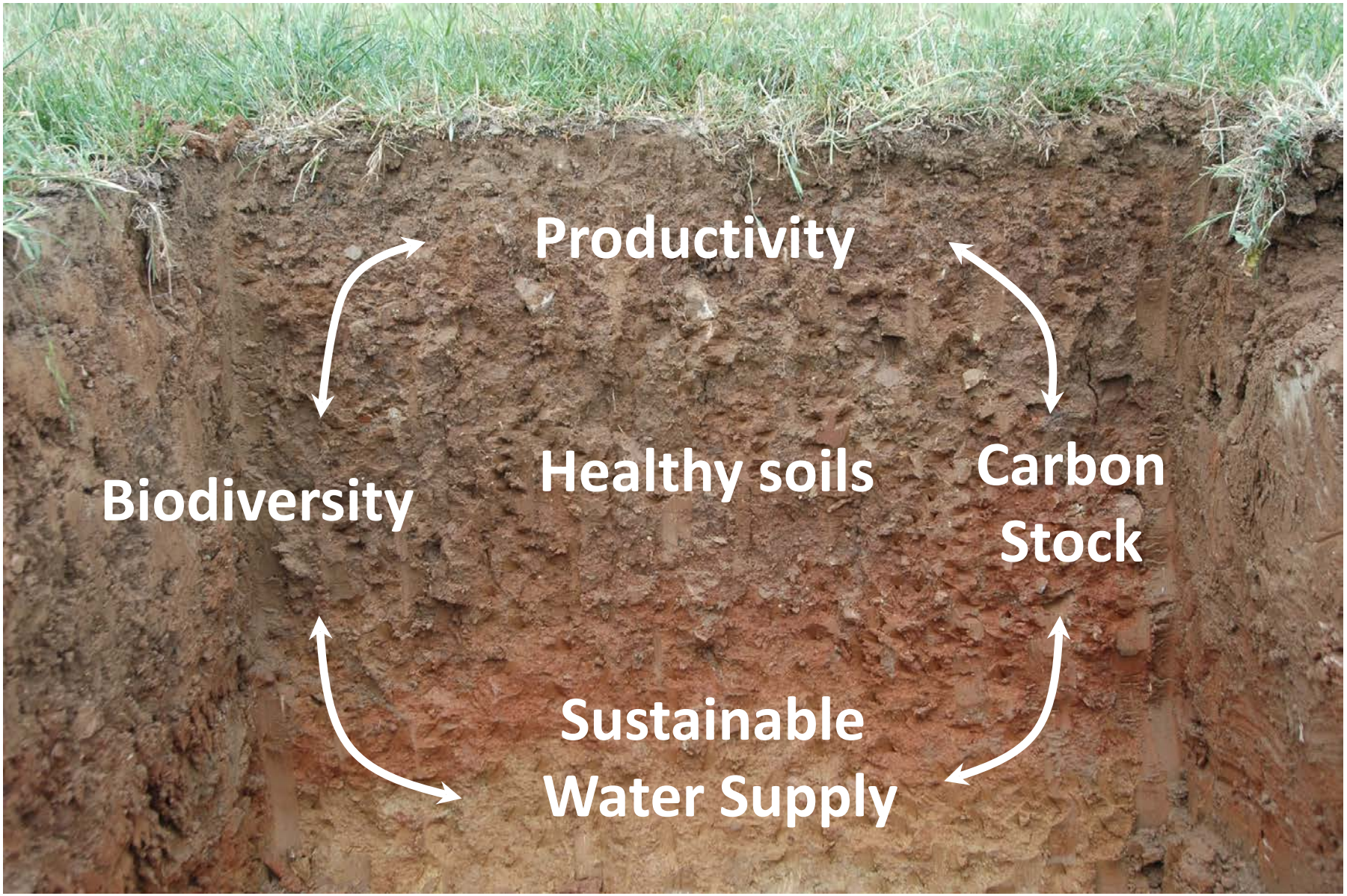
- Coastal shrub
- Oak woodland
- Annual grass
- Restored perennial grass

Comparison of ecosystem health indicators relative to annual grassland soils.

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

↑ Significantly Higher
↓ Significantly lower = No significant difference

Managing the ranch mosaic for multiple outcomes



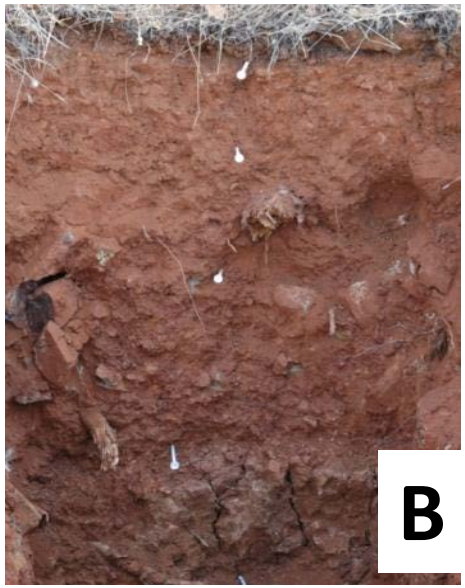
Is managing for multiple outcomes always compatible?

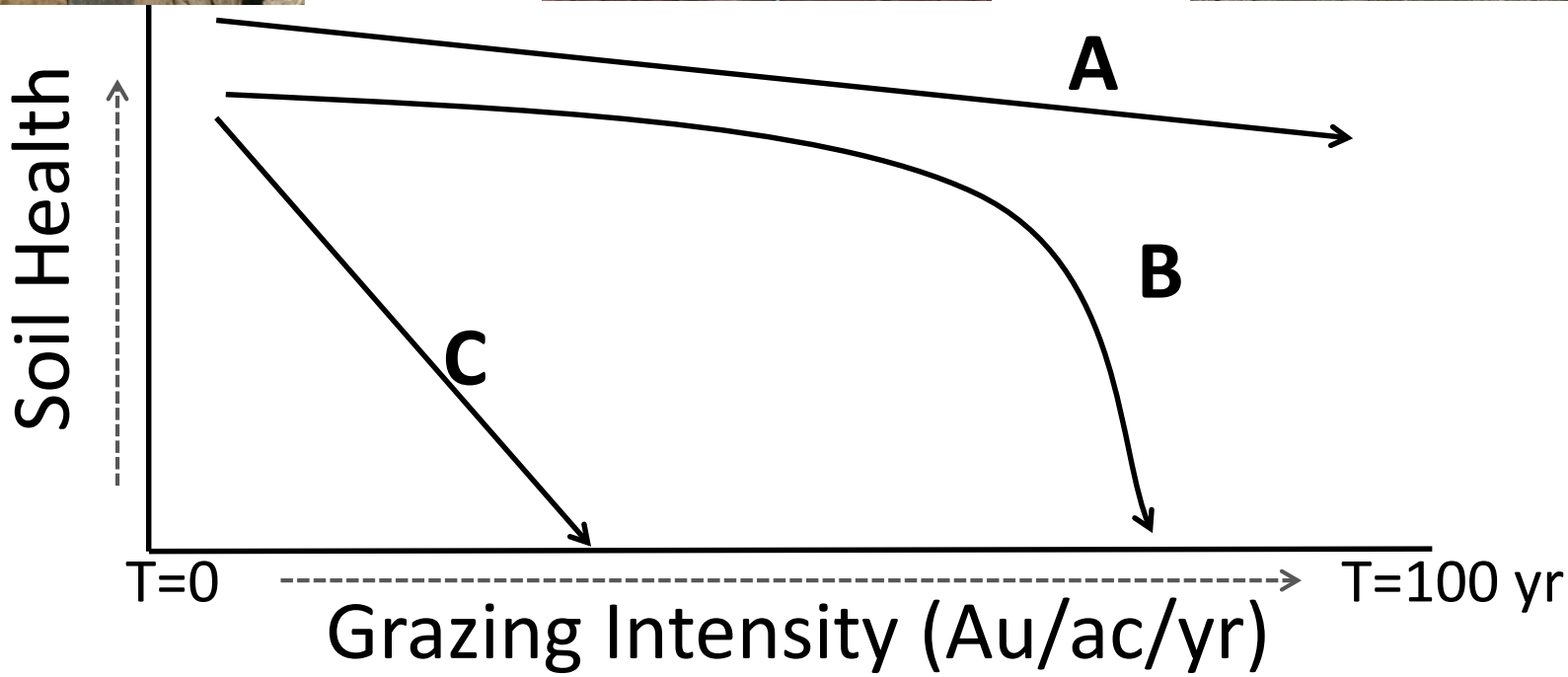
Do low quality soils: shallow, rocky or saline soils give rise to more landscape scale biodiversity?

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

Are healthier soils less resilient to weed infestation?

Resilience: A function of time and location

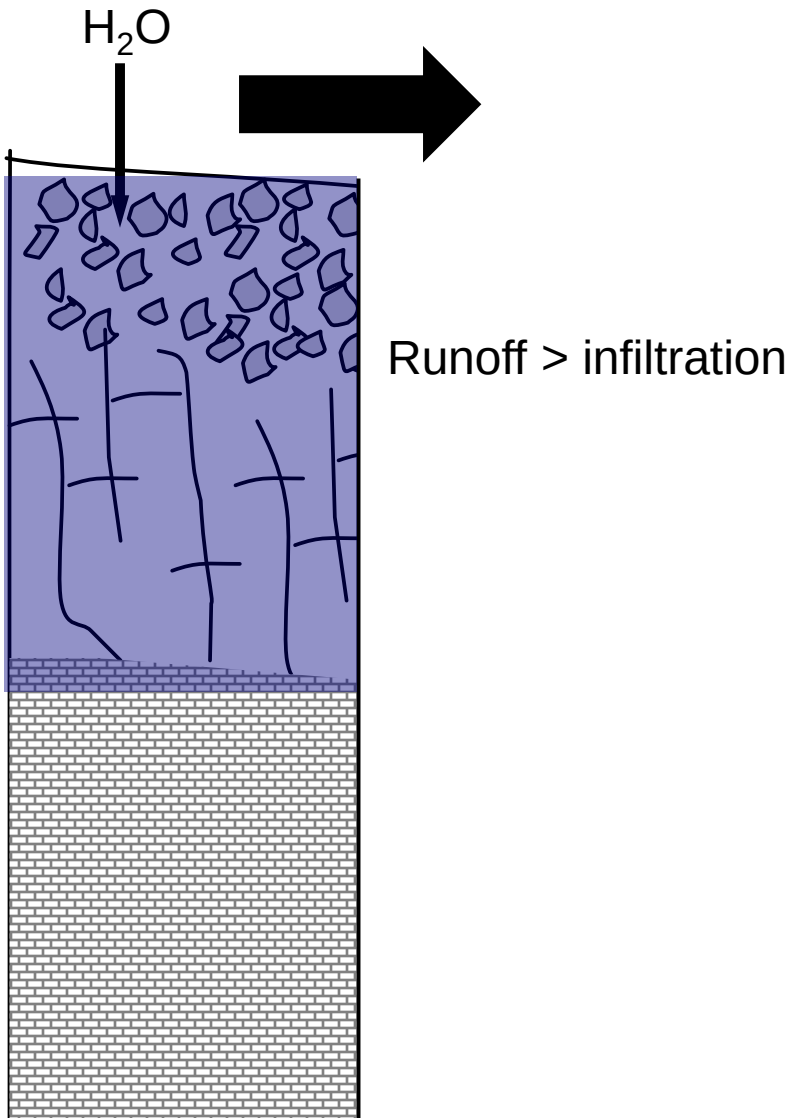




Thank You

Effects of soil moisture storage on runoff

Saturated soil



Unsaturated soil