How rangeland soil characteristics affect our ability to change soil health properties.

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Outline of talk

- What is Soil Health and associated properties?
- What are Rangeland Soil Characteristics in California (and beyond)?
- What indicators for rangeland health have been accepted by agencies? Do they match up with California Rangelands?
- Final thoughts: Agronomic systems and Rangeland systems

What is Soil Health?

- "*the continued capacity of soil to function as a vital living system,*
- *within ecosystem and land-use boundaries,*
- *to sustain biological productivity, promote the quality of air and water environments,*
- *and maintain plant, animal, and human health*" (Pankhurst et al., 1997).
- Two elements in this definition of **soil health** distinguish it from the definition of **soil quality**:
- (i) the inclusion of a time component (e.g. "the continued capacity of" - reflecting the importance of the soil in being able to continue to function over time); and
- (ii) recognition of soil "as a vital living system" (emphasizing the importance of the soil biota to soil functioning).

- Source: FAO 2008. An international technical workshop Investing in sustainable crop intensification The case for improving soil health. Integrated Crop Management Vol.6-2008. FAO, Rome: 22-24 July 2008

Soil Health - "*the continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain plant, animal, and human health*"

What are the properties of Healthy Soils, therefore?

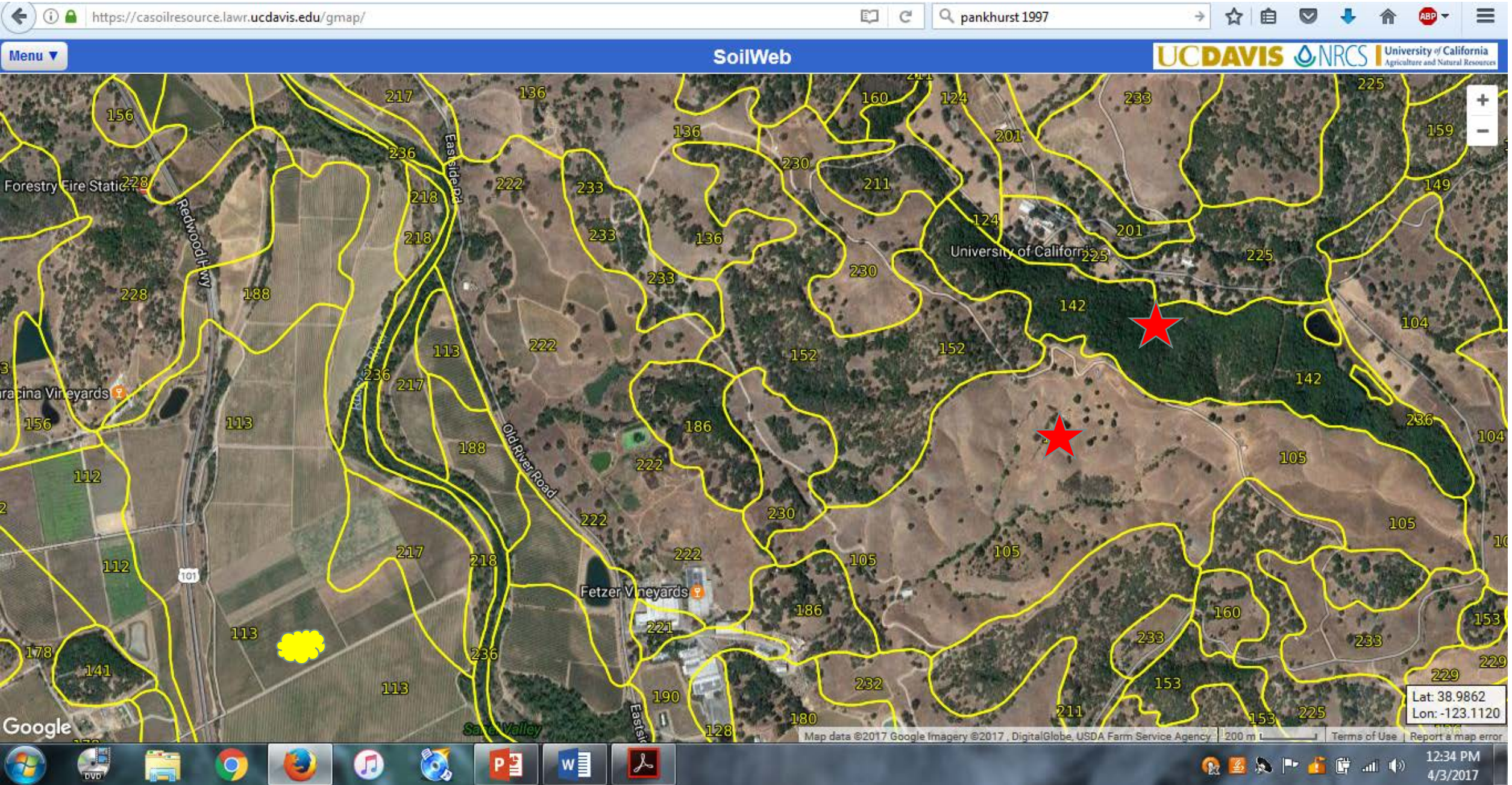
- Soil properties are usually categorized on the basis of physical, chemical, and biological properties. Such as: texture, pH, respiration
- ***Emergent properties***: Properties not obvious from the study of processes at finer levels of organization.
- Examples: decomposition rates, biodiversity, infiltration, system stability
- **Professor Horwath** addressed the critical component of Soil C cycling.

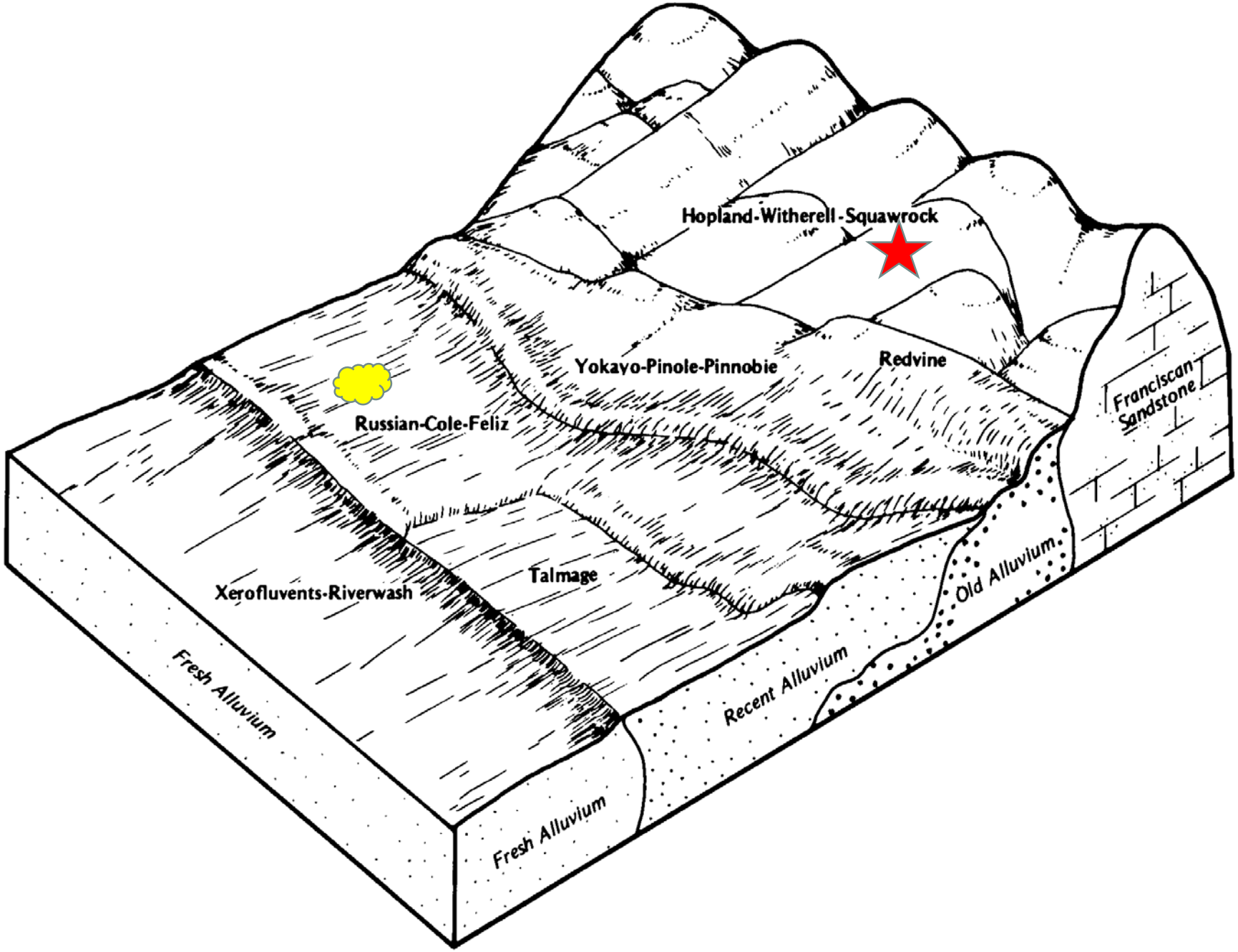
What are rangeland characteristics in California (and beyond)?

Rangelands may be defined on the basis of soil and abiotic factors such as:

- Aridity
- Slope
- Rockiness
- Salinity
- Inherent fertility

Example: Hopland area range vs agricultural soils




Hopland-Witherell-Squawrock
Yokayo-Pinole-Pinnobie
Redvine
Franciscan Sandstone
Russian-Cole-Feliz
Talmage
Xerofluvents-Riverwash
Old Alluvium
Recent Alluvium
Fresh Alluvium
Fresh Alluvium

Map units

Chaparral 142: Hopland loam, 50 to 75 percent slopes
Fine-loamy, mixed, active, mesic Typic Haploxeralfs

Grasslands 105: Bearwallow-Hellman-Witherell complex, 30 to 50 percent slopes
Bearwallow: Fine-loamy, mixed, superactive, thermic Ultic Haploxeralfs
Hellman: Fine, mixed, superactive, thermic Mollic Palexeralfs
Witherill: Fragmental, mixed, thermic Typic Haploxerepts

Agricultural Land 113: Cole loam, drained, 0 to 2 percent slopes
Cole: Fine, mixed, superactive, thermic Pachic Argixerolls

So which factor(s) were most important?

Rangelands are often delimited on the basis of soil and abiotic factors such as:

- Aridity
- Slope
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Map units

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- Slope?
- Rockiness?
- Salinity?
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For characteristics important to Rangeland Soil Health, what can we change? Or not?

Which remain as limitations of unalterable “matrix” or abiotic conditions?

(Stuff you can’t change)

- Texture
- Aridity
- Slope
- Rockiness
- Salinity
- Inherent fertility

Further, rangelands are often marginal in terms of productivity,

so what level of effort is economically tenable?

What indicators for rangeland health have been accepted by agencies?
Do they match up with California Rangelands?

Indicators of Rangeland Health

Rangeland health indicator [1]	Related rangeland soil quality information sheets
1. Rills	Water Erosion
2. Waterflow patterns	Infiltration
3. Pedestals and/or terracettes	Water Erosion, Wind Erosion
4. Bare ground	Water Erosion, Wind Erosion
5. Gullies	Water Erosion
6. Wind-scoured areas	Wind Erosion
7. Litter movement	Water Erosion, Wind Erosion
8. Soil surface resistance to erosion	Physical and Biological Soil Crusts, Aggregate Stability
9. Soil surface loss or degradation	Water Erosion, Wind Erosion
10. Plant community composition and distribution relative to infiltration and runoff	Infiltration
11. Compaction layer	Compaction
12. Functional/structural groups	Soil Biota
13. Plant mortality/ decadence	
14. Litter amount	Organic Matter
15. Annual production	
16. Invasive plants	
17. Reproductive capability of perennial plants	

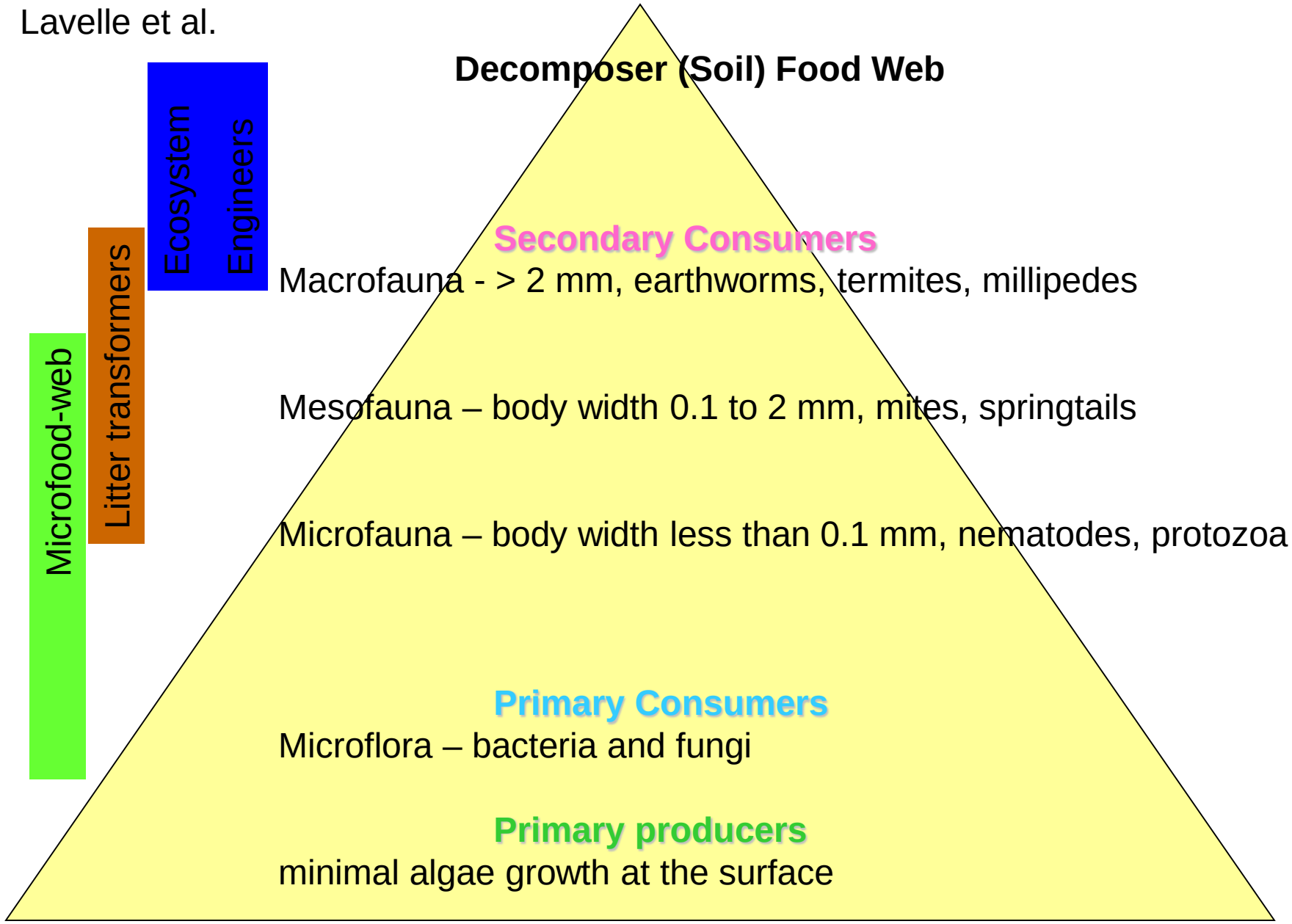
These indicators tell us about…

- Infiltration
- Water and Wind Erosion
- Aggregate Stability
- Compaction
- Above-Ground Vegetation

They do not really address soil biological activity, active carbon, etc…

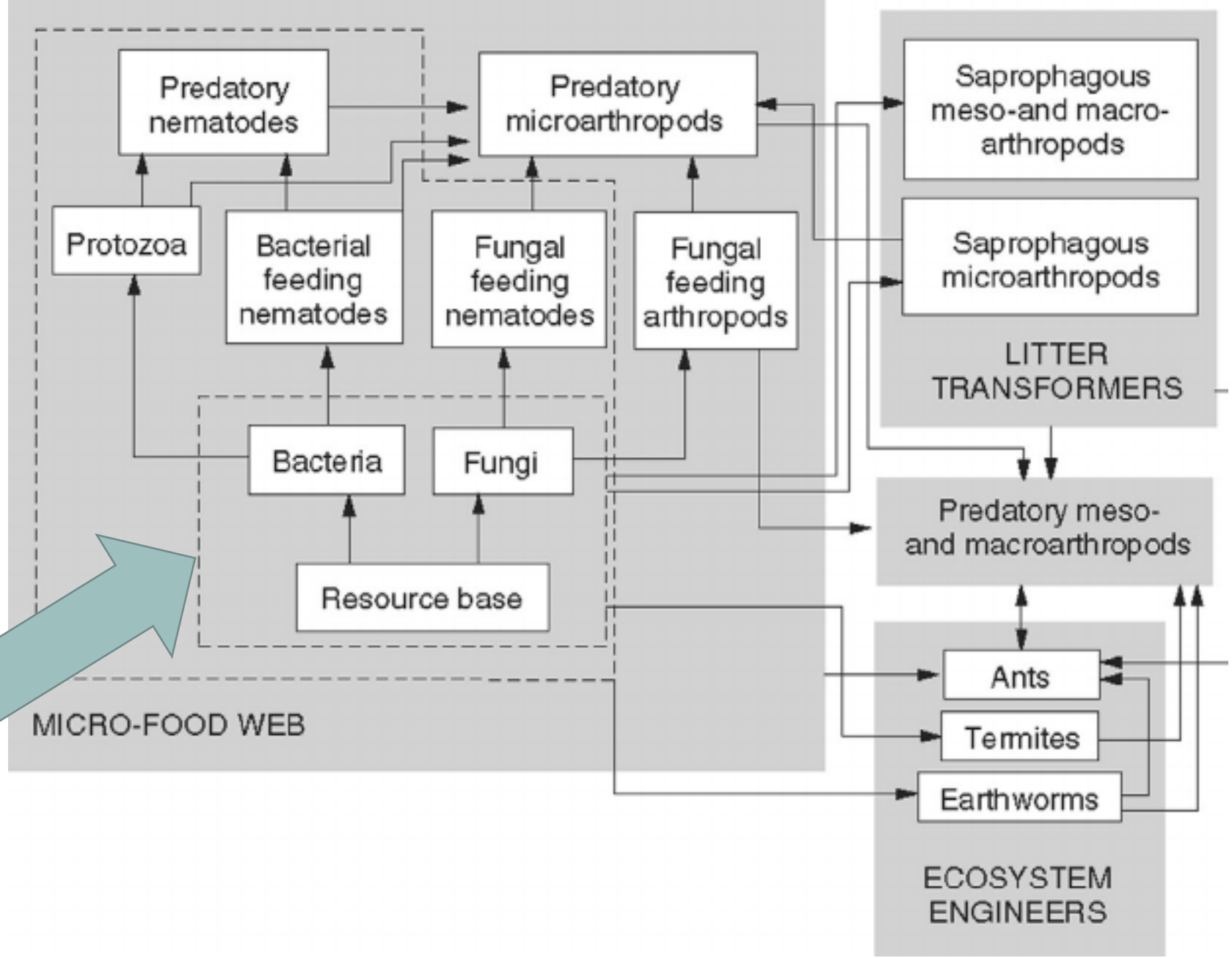
Characterizing the biological communities is complex!

Lavelle et al.



Only about 1-5% of soil micro-organisms can be cultured.

Molecular genetics techniques and metagenomics will be key.



Agronomic and Rangeland Systems…

Tillage seems to be a common thread…

- It aerates soil and allows for decomposition of soil organic matter.
- Many discussions of improved soil health in agriculture center around decreased tillage, use of diverse cover crops, etc. to increase soil organic matter, infiltration, soil biodiversity….
- Coming from a different perspective, research on California grasslands suggests that restoring deep rooted perennial native grasses (and their companion microbial communities) is made more difficult when a specific site has a history of tillage/dry land farming. (Jackson et al. 2007. Soil Biology and Carbon Sequestration in Grasslands)
- The perennial grasses may get established – and this is a desirable outcome for deep carbon placement – but the microbial communities are fundamentally different.

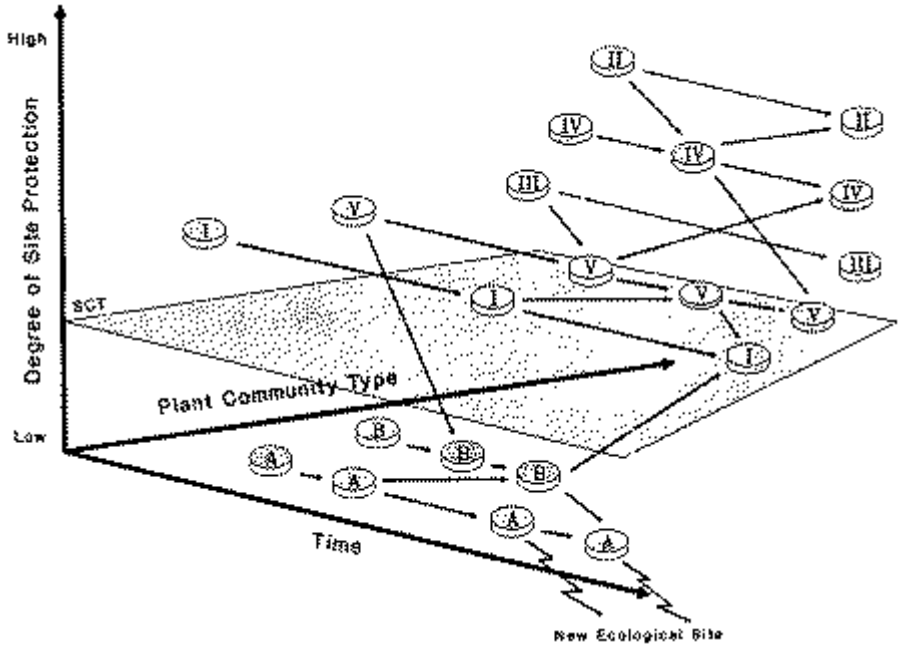
How do rangeland soil characteristics affect our ability to change soil health properties?

- Can we afford to use agronomic techniques to improve soil health? In some cases yes. In many cases they will not pencil out economically.

TOOLS AVAILABLE

- Managed and/or targeted grazing to control undesirable plants and encourage deep rooted plants and desired functional groups.
- Careful use of prescribed fire
- Selective use of herbicides
- With limited labor and favorable conditions, we may be able to create “patchiness” to slow water, create nurse plant situations, and accumulate soil organic matter.

Final thoughts…



1) If rangeland soil characteristics are altered irreversibly by devastating disturbances, it may not be reasonable to expect a return to an original state.

The transition back may be too costly.

2) Support landowners whose management shows increases in soil carbon storage compared to neighbors' soils across the fence.

We will also need to wait for the trickle down from molecular genetics/metagenomics research and development to properly assess soil biota.

Much of what we are asking requires much *longer term experiments and observations*. Support LTER at all costs!

The Abridged Serenity Prayer for Soil Health:

Grant me the serenity to accept the rangeland soil characteristics I cannot change;

Courage to change the things I can to achieve enhanced soil health;

And the wisdom to create indicators to know the difference between degraded soils and soils at their desired potential, or to

recognize that the soil has irreversibly changed!

QUESTIONS?