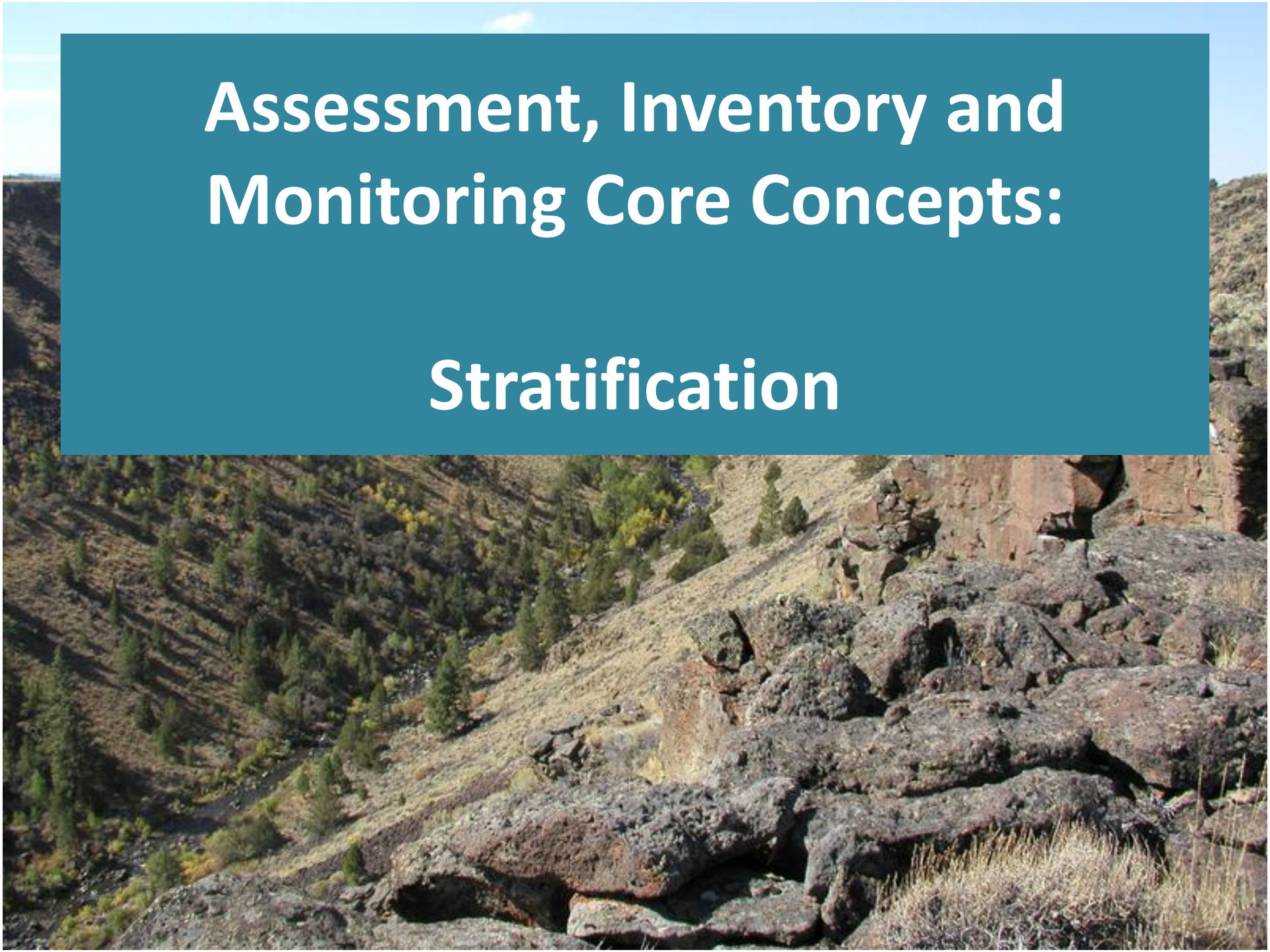
Assessment, Inventory and Monitoring Core Concepts:

Stratification



Objectives

Students will be able to:

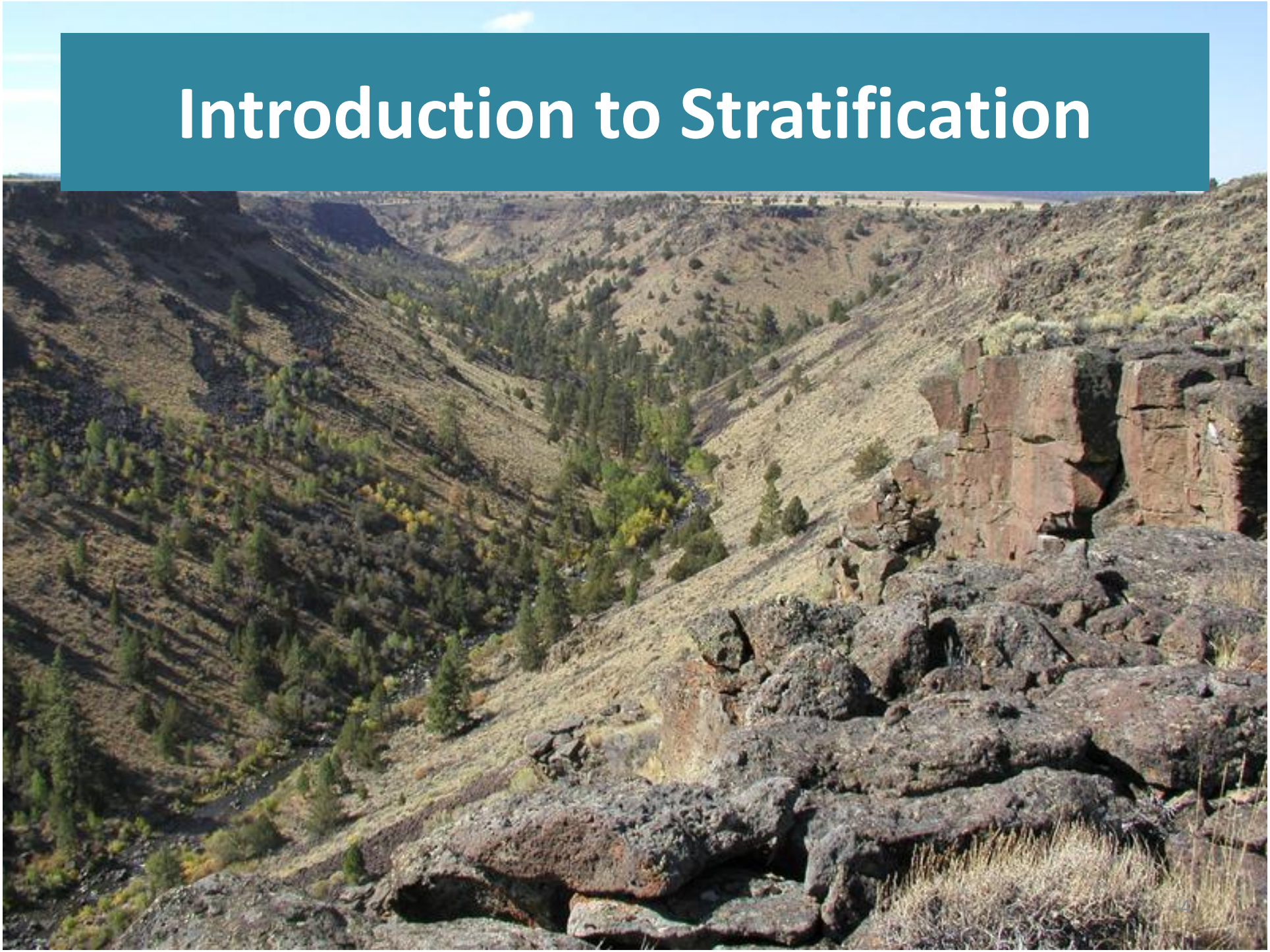
Explain what stratification is and its benefits for assessment, inventory and monitoring

Given soil and ecological site information for an area, stratify the landscape based on the its characteristics

Route

- Stratification
- Applying stratification using soils and ecological sites
- Resources for future learning

Introduction to Stratification



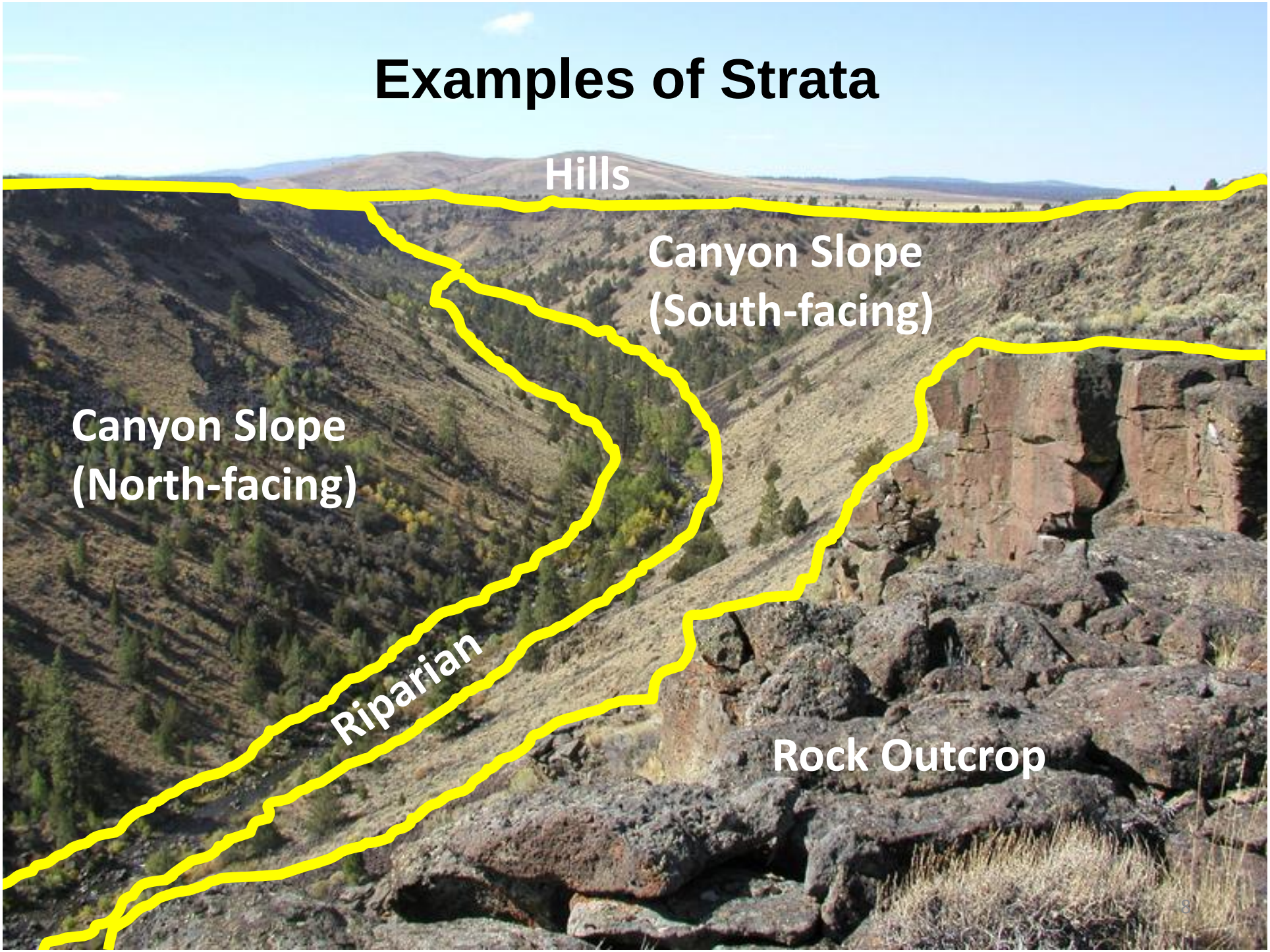
Rangeland landscapes are diverse

Dividing up the landscape into similar types helps resource managers understand diversity

Strata

- **Strata** are areas located in a particular part of the landscape (e.g., flood basin or hill summit) within which soil type, vegetation, management and current status are **relatively similar**
- All areas classified by the same stratum are expected to **respond similarly** to changes in management and to catastrophic disturbances, such as a combination of drought and fire

Examples of Strata



Stratification

- Stratification is dividing a population or study area (e.g., rangeland landscape) up into sub-groups or subunits called strata
- Typically done *prior* to sampling
- Sampling effort (e.g., number of sample locations per area) can be varied among strata according to your objectives

Benefits of Stratification

- Targeted monitoring
  - Enables data collection focused on management questions
- Supports data interpretation
  - Helps land managers set realistic monitoring objectives
  - Indicator interpretation may differ by stratum
- Improves efficiency
  - Separates & reduces variability



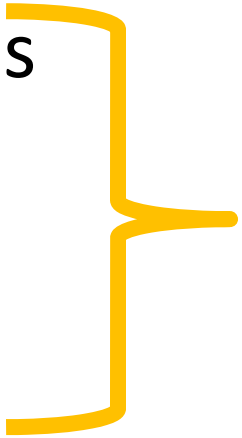
Why Stratify?

- Reduce the number of plots that need to be monitored
- Ensure that small areas get monitored
- Focus monitoring on priority areas
- Aid in interpretation of results
- Report on units that are meaningful to management
- Compare current conditions to ecological potential/reference

How to stratify?

Stratify by **relatively stable** factors related to variability of indicator values within a study area, such as:

- Differences in soil types
  or ecological sites
- Topography
- Climate
- Management
- And other factors

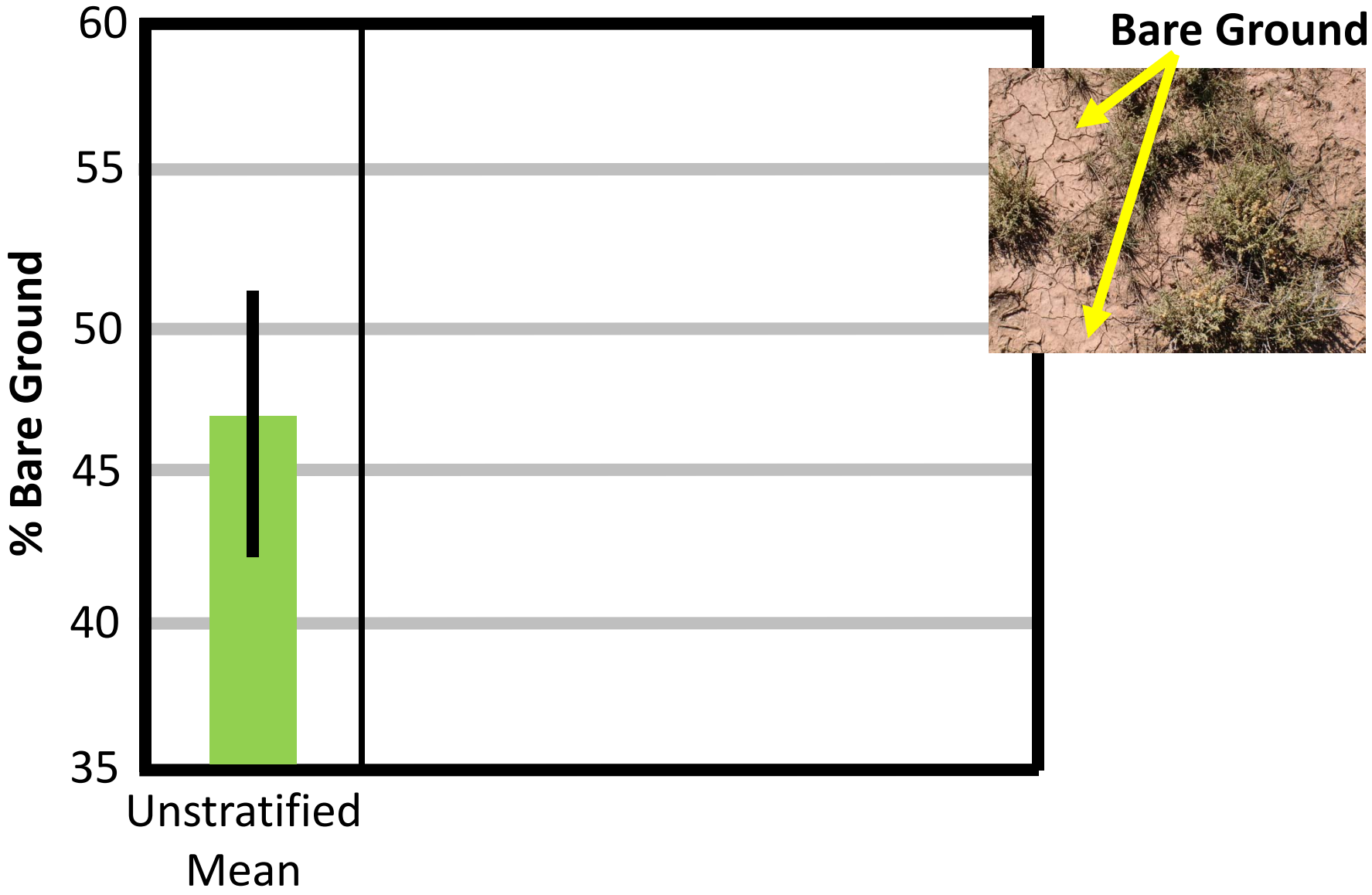


Land Potential

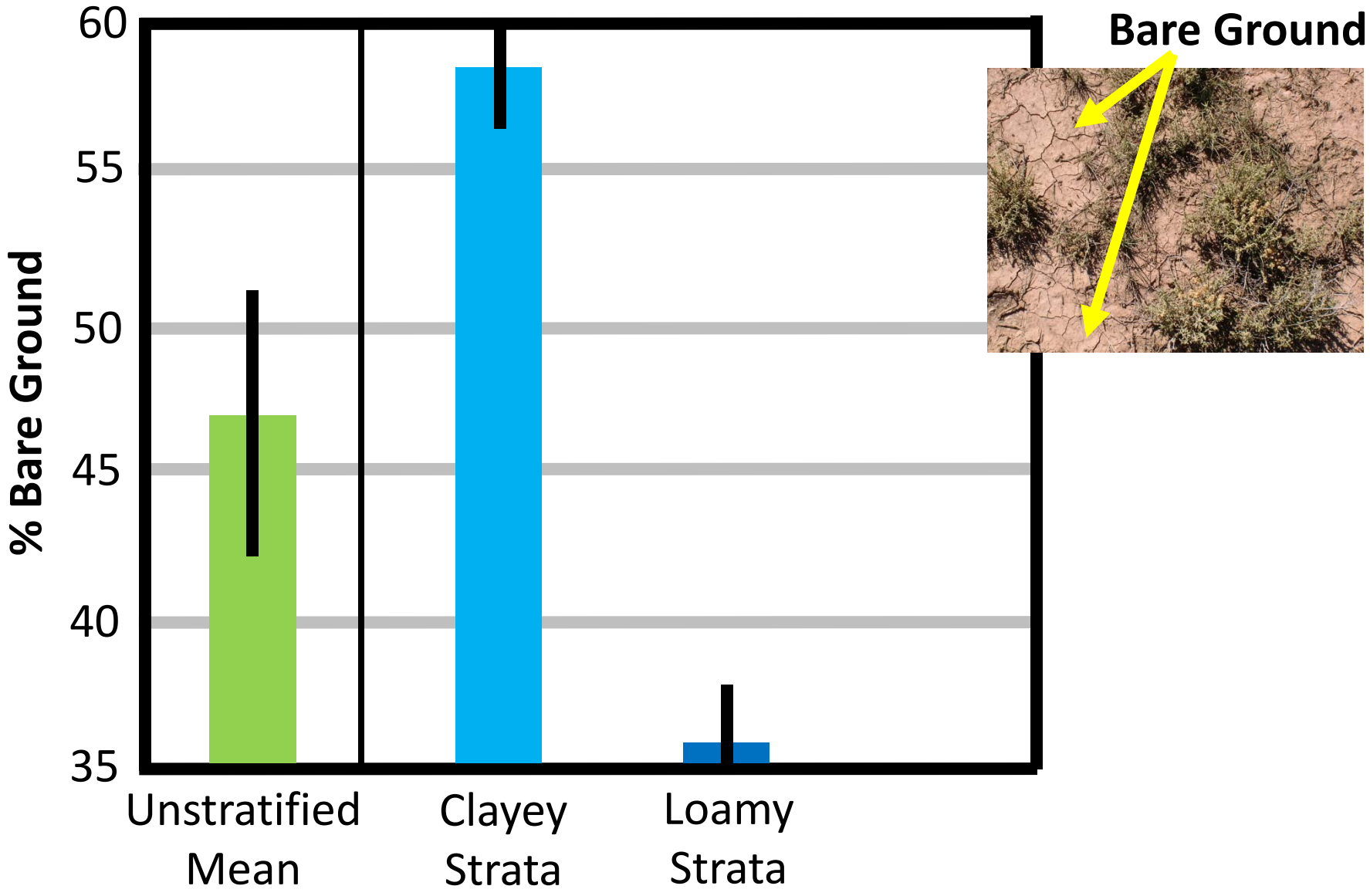
Example:

What factors might you stratify by in this landscape?

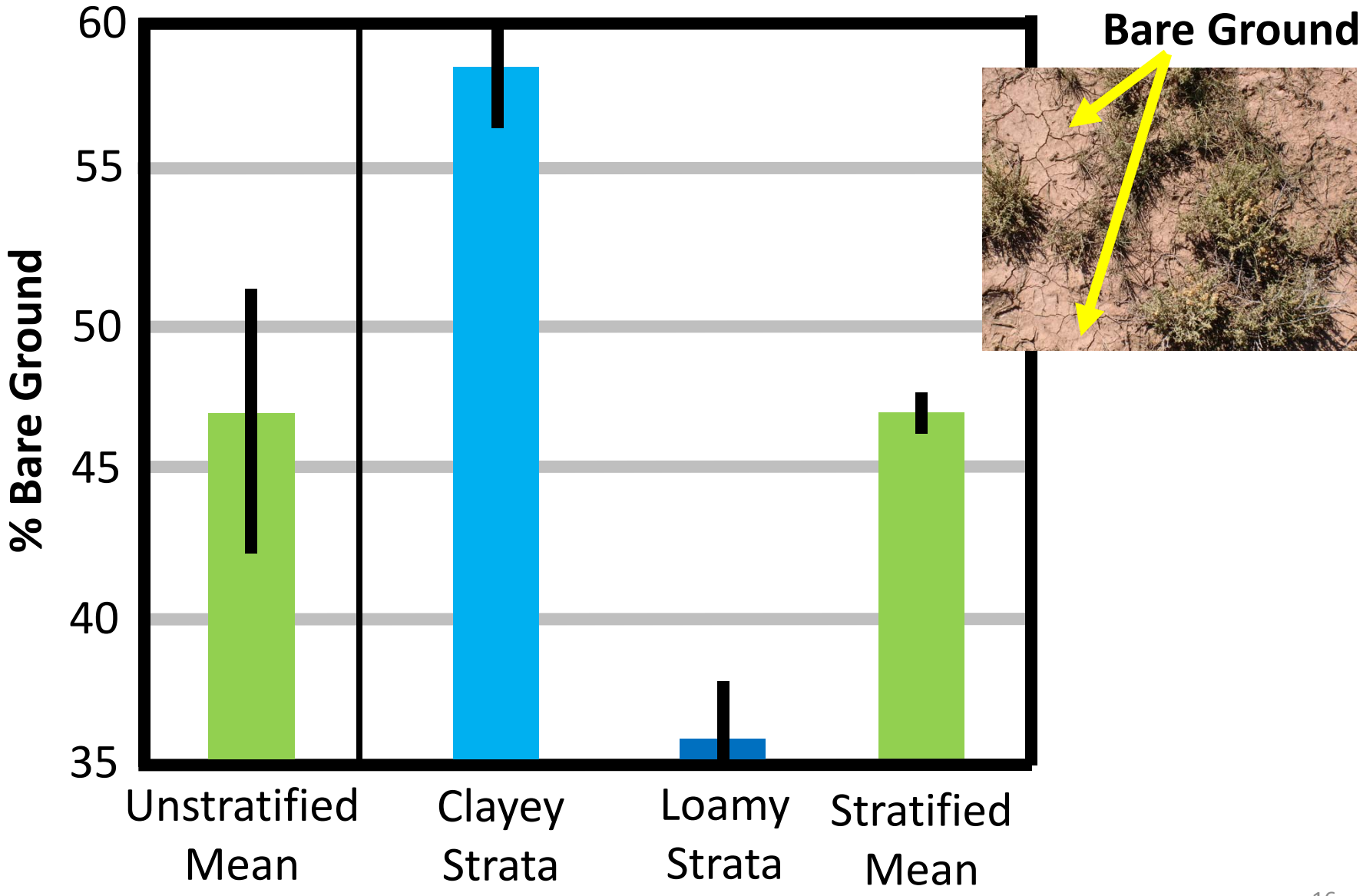
Effective Strata Example



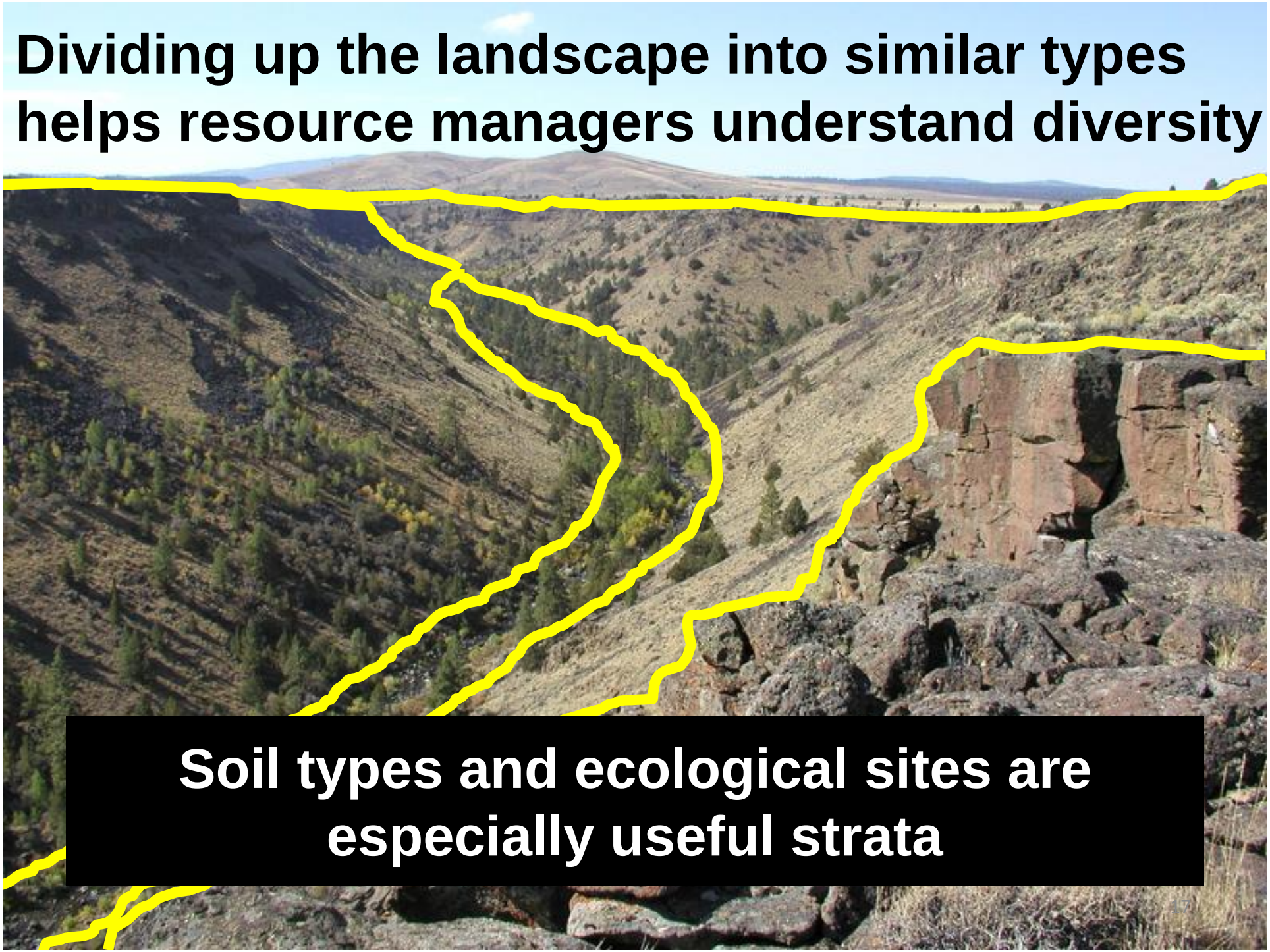
Effective Strata Example



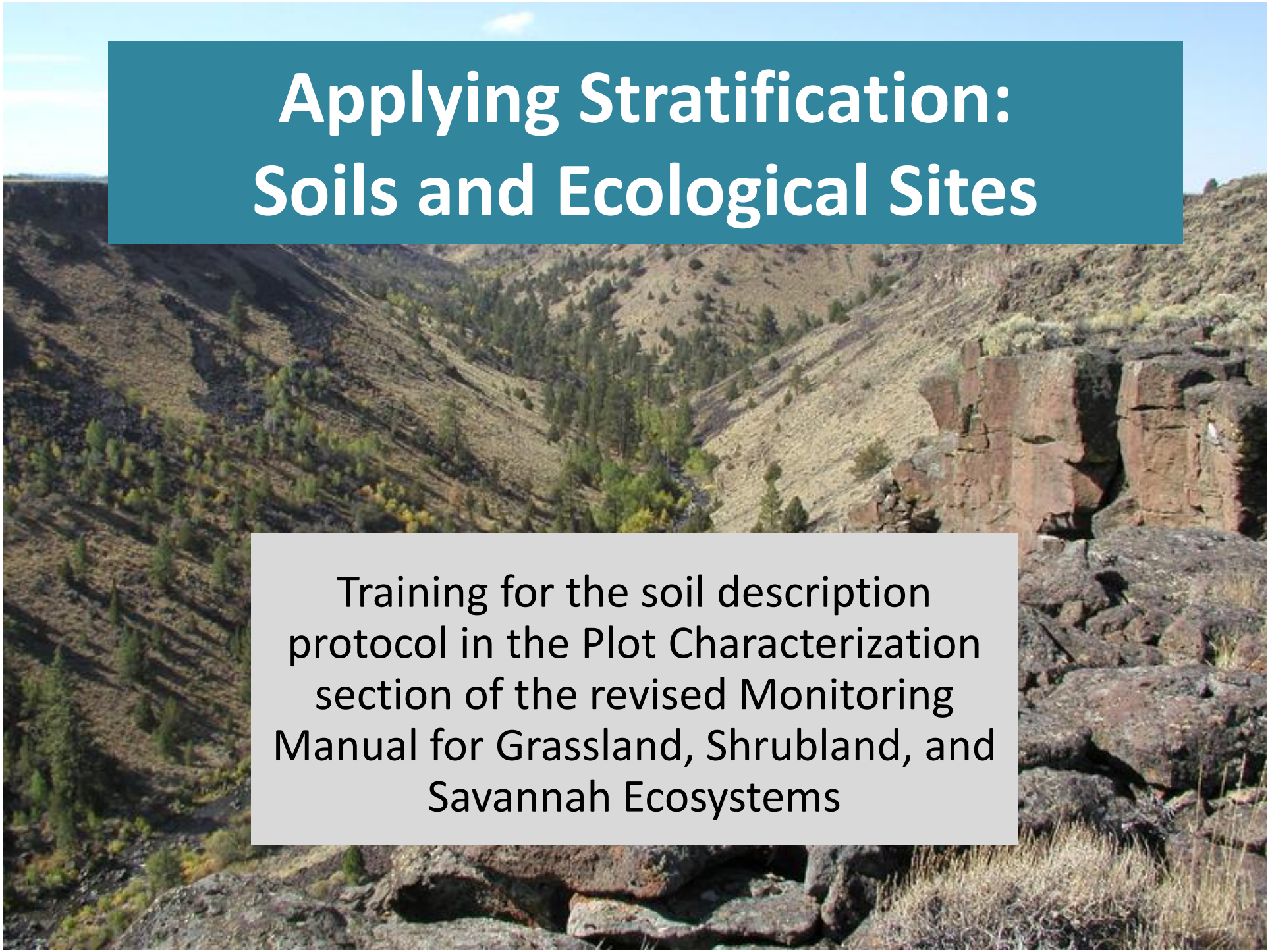
Effective Strata Example



Dividing up the landscape into similar types helps resource managers understand diversity



Soil types and ecological sites are especially useful strata



Applying Stratification: Soils and Ecological Sites

Training for the soil description protocol in the Plot Characterization section of the revised Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems

Applying Stratification

Stratify

Confirm the Strata in the Field for each Location

Analyze Data, Taking Strata into Account

Enjoy the benefits of stratification!

- *Reduced variability*
- *Comparison of results to reference conditions or potential*
- *More information with less effort*

How do soils help us understand landscape conditions and changes?

Soils affect the potential of the land

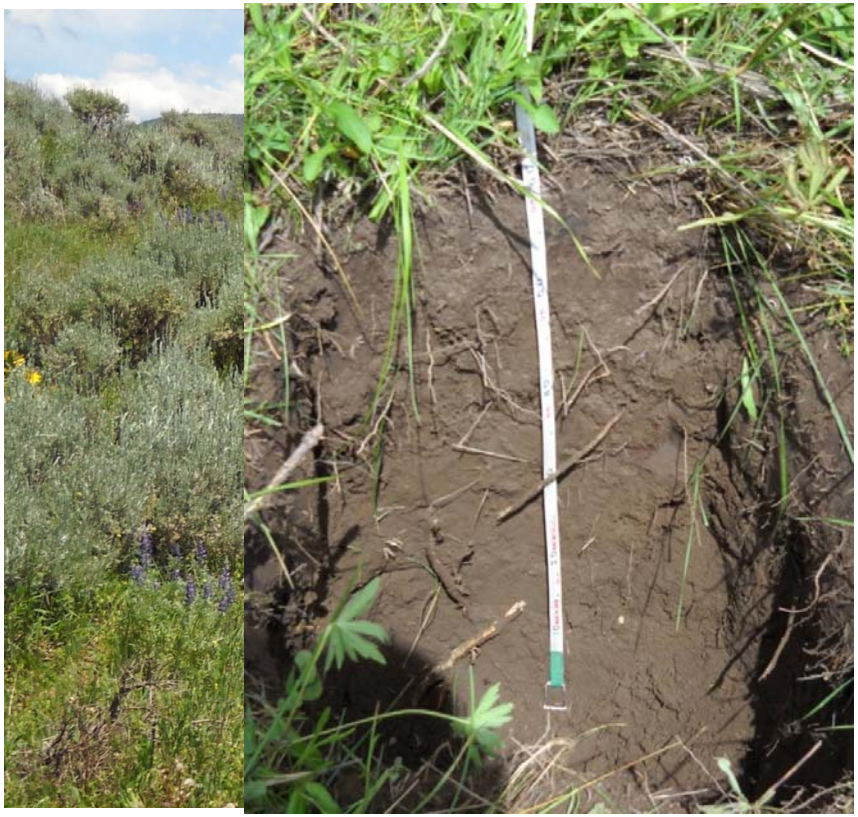
Mountain Big Sagebrush

Alkali Sagebrush

Kachergis et al. 2012 Rangeland Ecology and Management

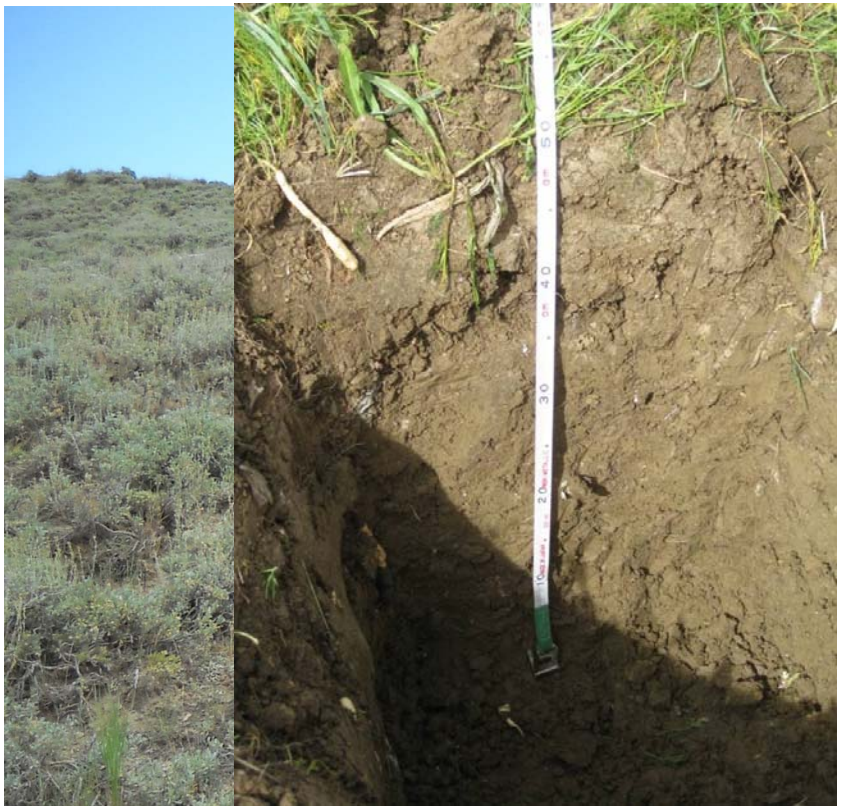
How do soils help us understand landscape conditions and changes?

Soils affect the potential of the land



Mountain Big Sagebrush

Loam or Clay Loam Soil



Alkali Sagebrush

Clay Soil

Kachergis et al. 2012 Rangeland Ecology and Management

How do soils help us understand landscape conditions and changes?

Soils affect land response to management and disturbance

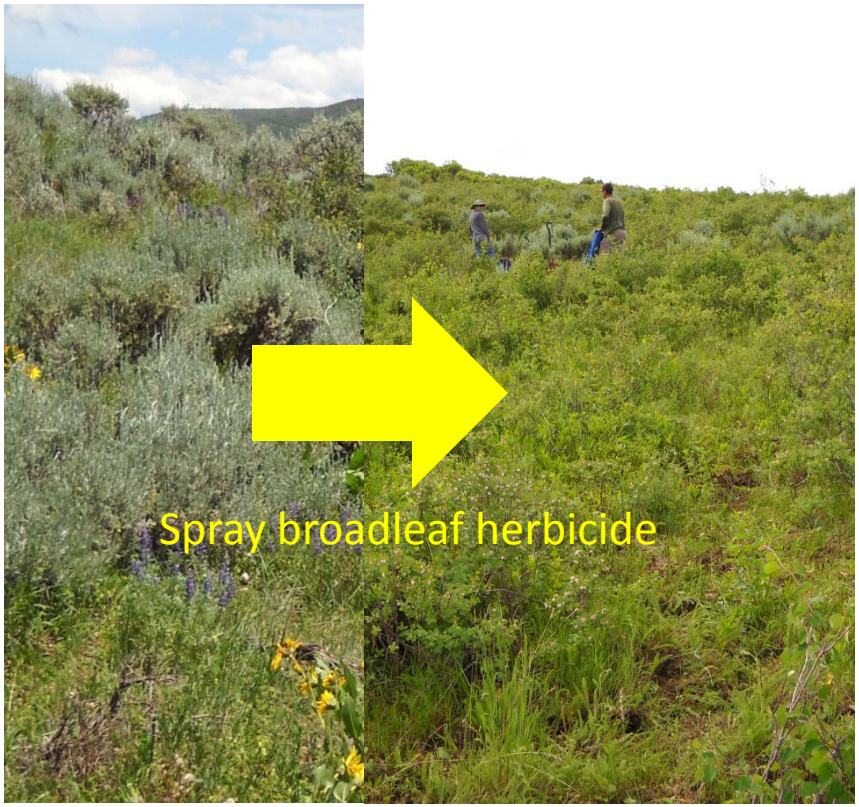
Mountain Big Sagebrush

Alkali Sagebrush

Kachergis et al. 2012 Rangeland Ecology and Management

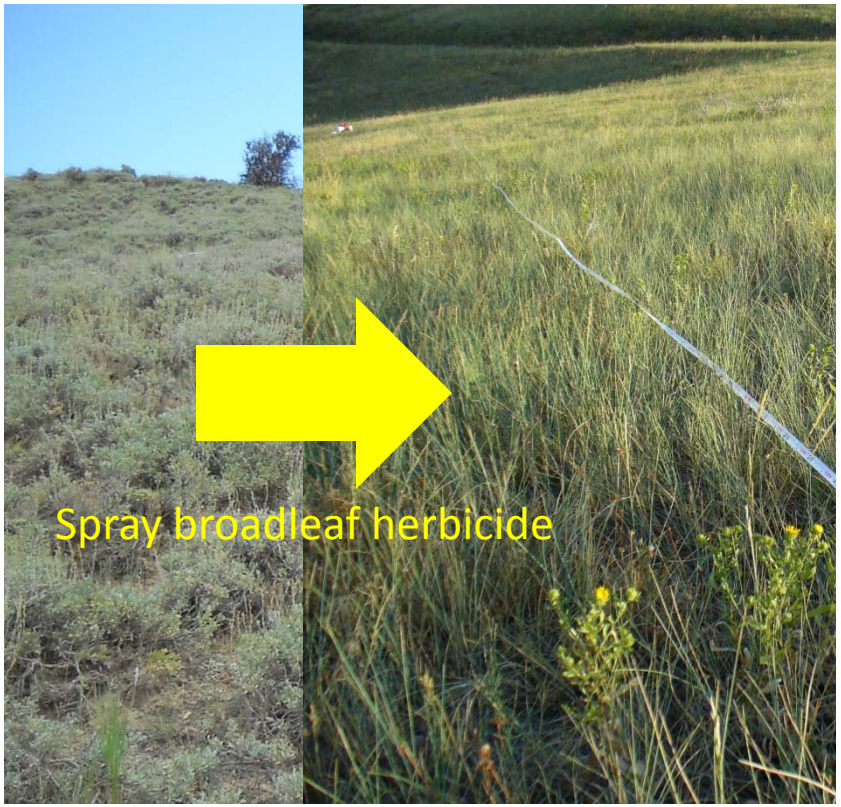
How do soils help us understand landscape conditions and changes?

Soils affect land response to management and disturbance



Mountain Big Sagebrush

Shrubland, esp. Resprouting

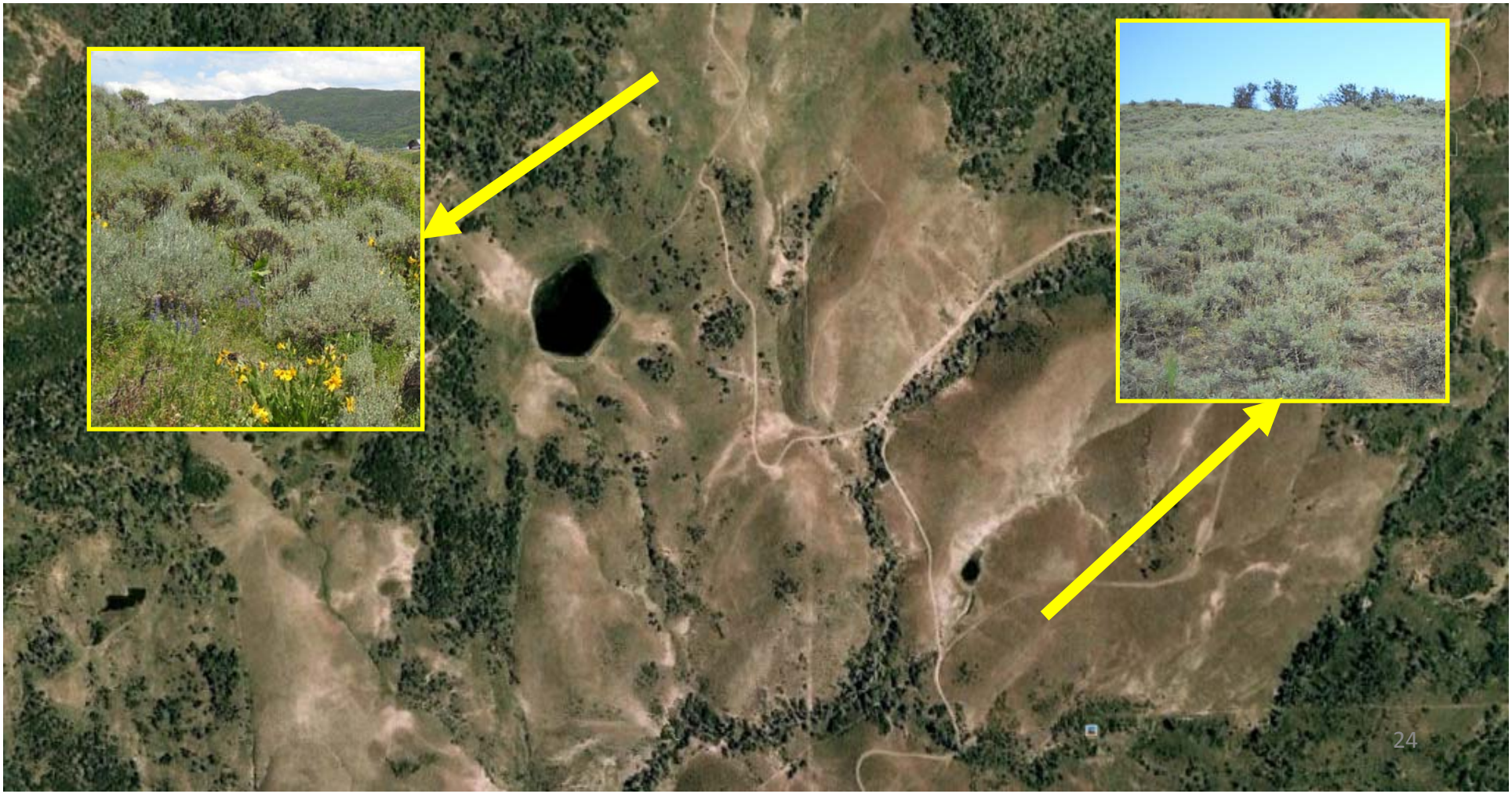


Alkali Sagebrush

Grassland

Kachergis et al. 2012 Rangeland Ecology and Management

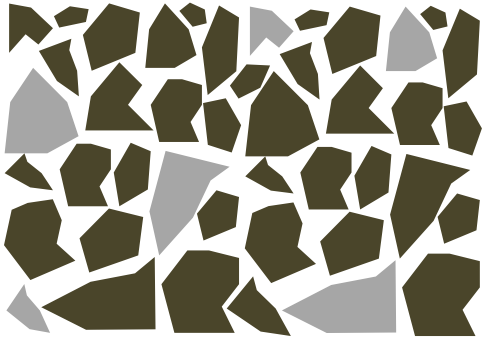
Soils provide important context for understanding landscape conditions and changes



Static soil properties that affect land potential and change through effects on processes

Texture

Depth



Rock Fragments

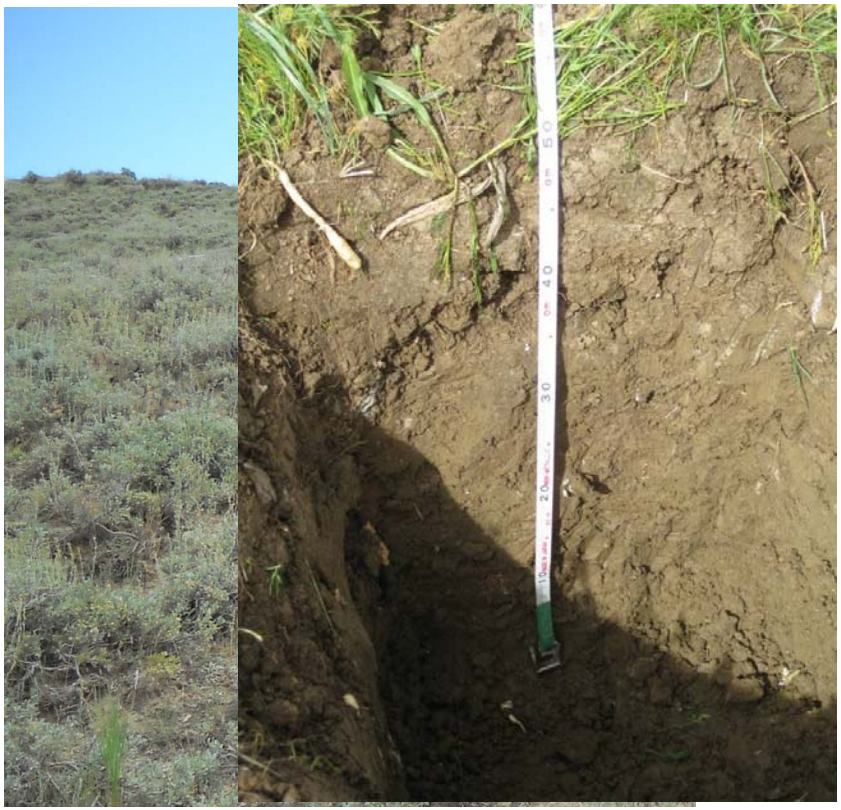
Example: Soil Water

Soil does not become saturated with water – Mountain big sagebrush flourishes

Mountain Big Sagebrush

Loam or Clay Loam Soil

Soil becomes saturated with water for several weeks yearly – Alkali sagebrush can tolerate it, but not mountain big sagebrush



Alkali Sagebrush

Clay Soil

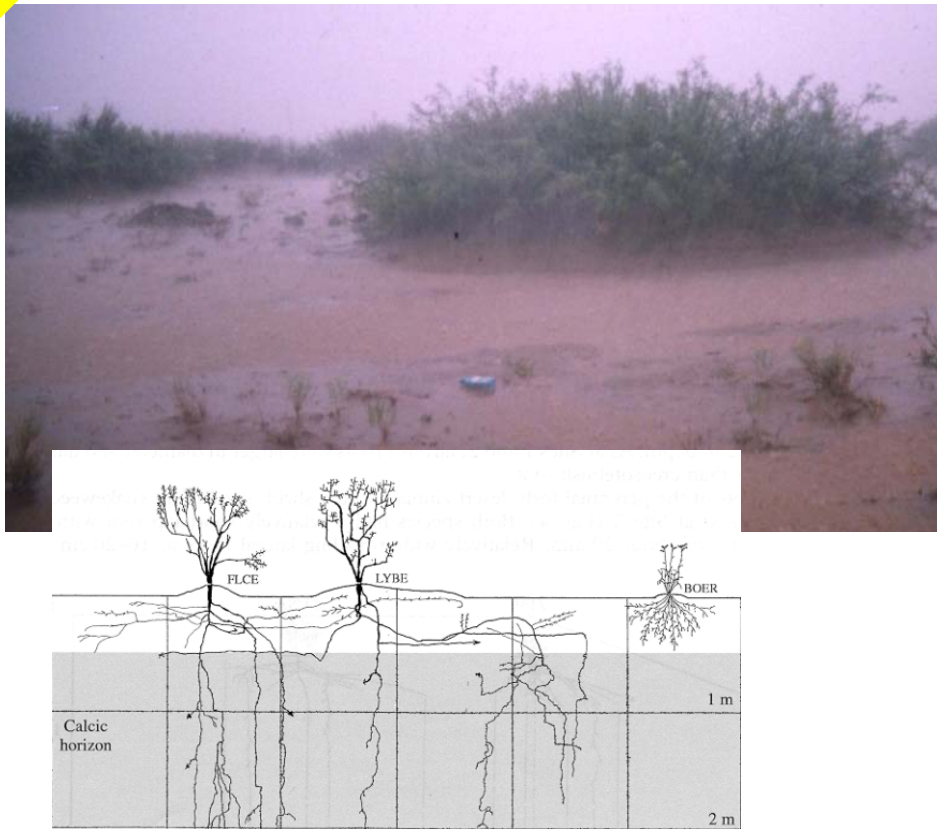
Soil properties affect processes

Easily measured *Hard to measure*

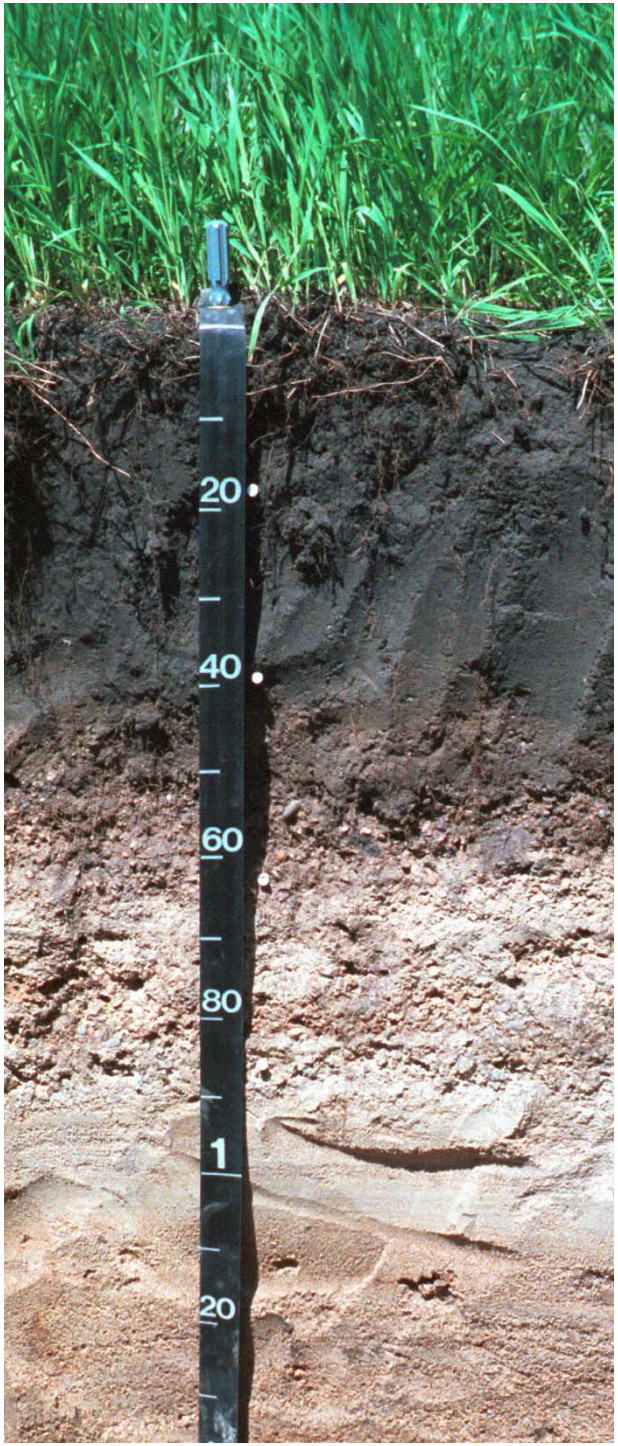
Properties

Soil Horizons
Rock Fragment Content
Texture
Clay content
Effervescence
Soil Color (optional)
Soil Structure (optional)

Processes



Gibbens and Lenz 2000, Journal of Arid Environments



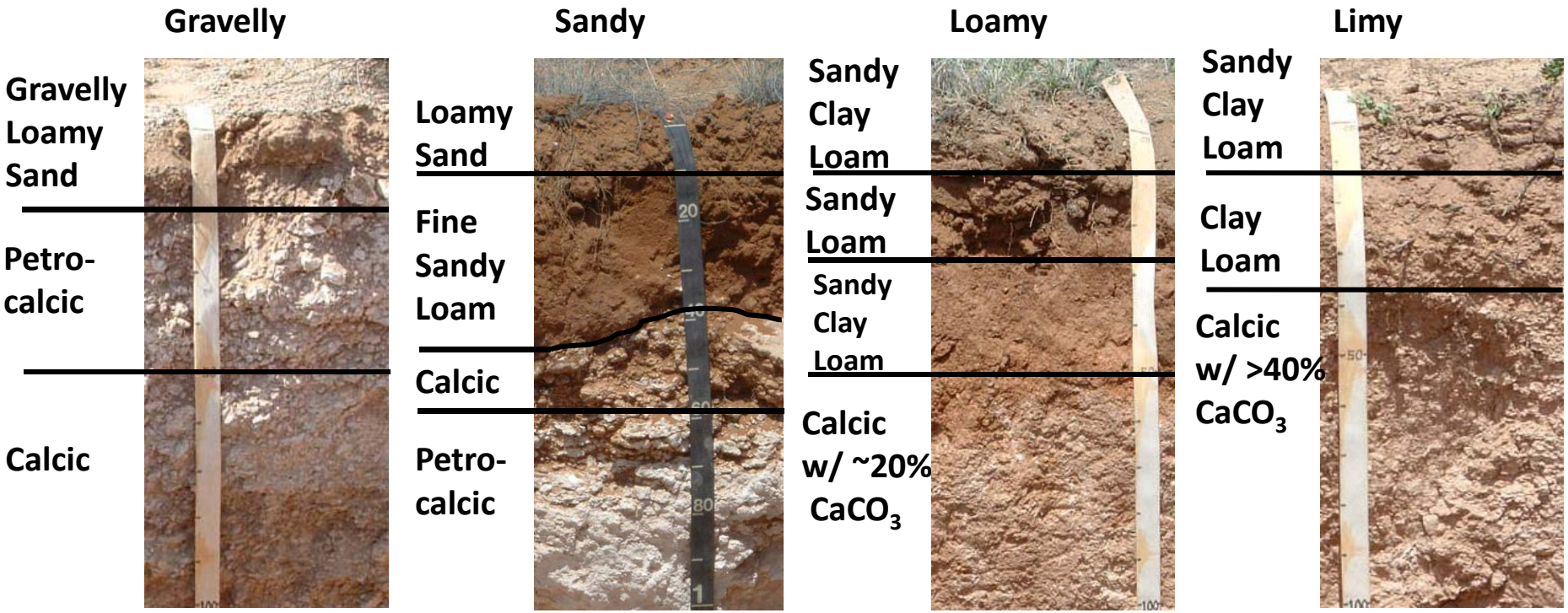
Soil Profile

Horizon: A layer of soil, generally parallel to the soil surface, whose properties differ from the layers above and beneath.

Any change in soil properties denotes a change in horizon.

How many different horizons do you see in this soil profile?

Comparison of Four Different Soil Profiles in New Mexico



Note the different properties of each horizon.

Duniway et al. 2010 Rangelands

Soil Coarse Fragment Content

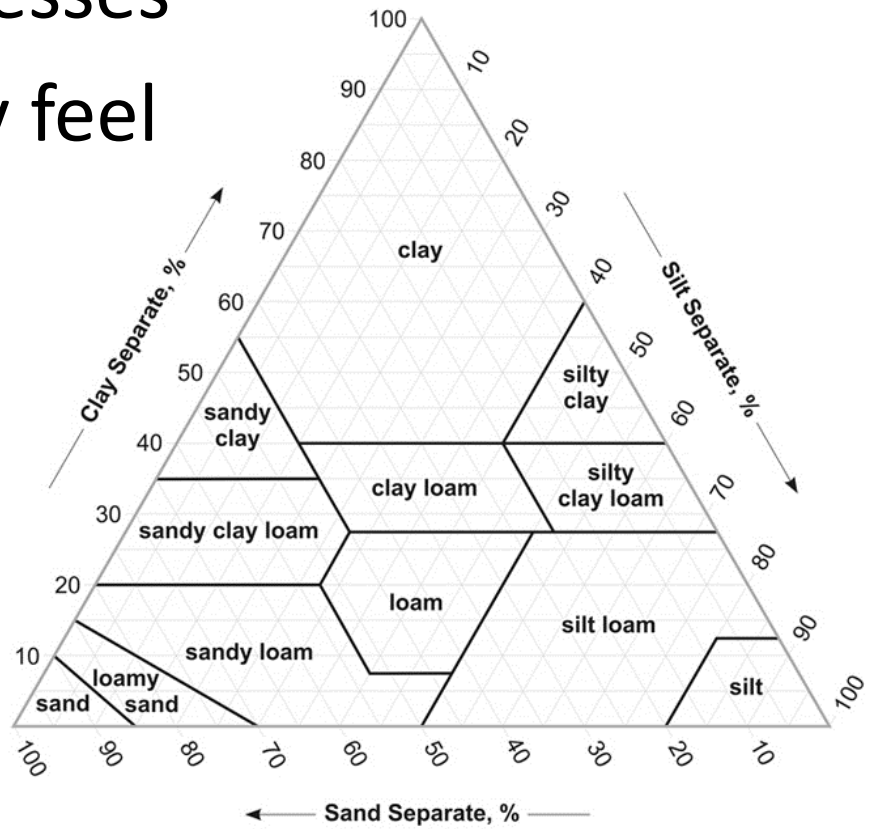
- Percent rocks (>2 mm) by volume
- Affects soil water availability through infiltration, storage and evaporation
- Measure by sieving and comparing soil volume with and without rocks

In arid regions, trees often grow better than grasses in soils with lots of coarse fragments in the top meter. Why?

Hint: Think roots.

Soil Texture

- Percent soil particles of different sizes (sand, silt, and clay)
- Affects all soil processes
- Estimate texture by feel



Percent Clay

- Smallest soil particle size (<2 micrometers)
- Amount of clay especially important for:
  - Infiltration and water availability
  - Soil stability and erodibility
  - Plant rooting
- Estimate percent clay by feel

Which side has more clay?

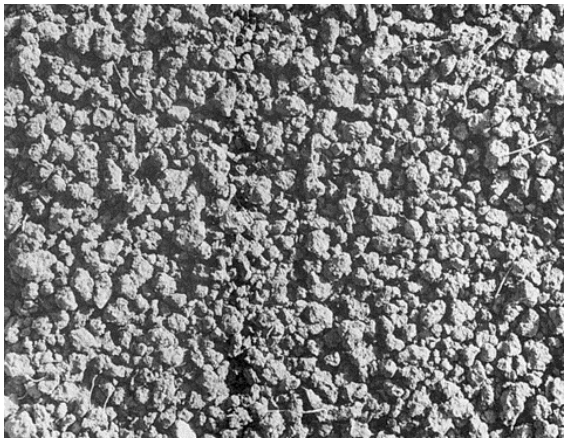
Effervescence

- Indicator of calcium carbonate content
- Tested by dropping weak hydrochloric acid on soil and looking at how many bubbles are produced

How might this cemented calcium carbonate horizon affect plant growth?

Soil Structure (optional)

- Description of the size, shape, and strength of soil peds or pieces
- Affects soil water availability through the depth that water can penetrate and residence time that water is available to plants



Which surface structure is better for seed germination -- granular (left) or platy (right)?

Soil Color (optional)

- Indicator of the amount of organic matter in the soil, which is important for water holding capacity and nutrient availability (darker→more organic matter)
- Match the soil with a color on the Munsell Color Chart

What happens to soil color with soil depth?
What about organic matter?

Some soil properties affect the potential of other soil properties

Example: Texture & Organic Matter

Loamy soil – Mountain Big Sagebrush

- Medium-textured soil with mix of sand, silt & clay
- Darker color, more organic matter

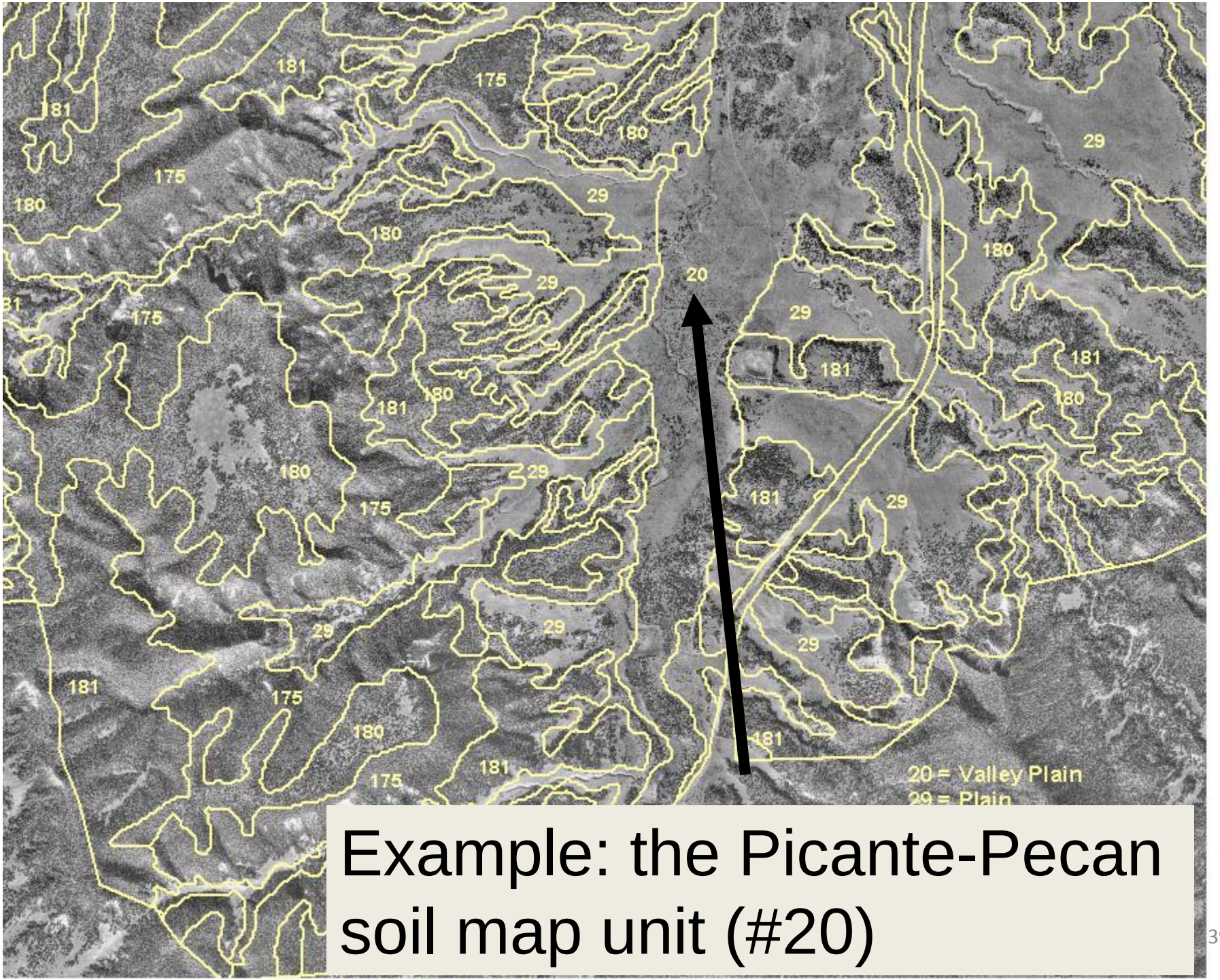
Clay Soil, Alkali Sagebrush

- Heavy clay-textured becomes saturated in spring
- Lighter color, less organic matter

Soil Maps and Ecological Sites

Soil Maps

- Created using soil pits, aerial photography, GIS, and an understanding of soil-landscape relationships
- Each **soil series** is named (e.g. Boyle) and has unique properties
- One or more **soil map unit components** occur within each soil map unit and consist of a soil series + slope and surface texture modifier
- **Soil map units** refer to a particular instance of one or more soil map unit components
- See resources at end of presentation



Example: the Picante-Pecan soil map unit (#20)

Picante-Pecan soil map unit (#20)

Soil Series	Soil map unit component
Picante	Picante loamy sand, 5-15% slopes
	Picante sandy loam, 5-15% slopes
	Picante sandy loam, >15% slopes
Pecan	Pecan loam, 0-5% slopes
	Pecan sandy loam, 0-5% slopes

Ecological Site

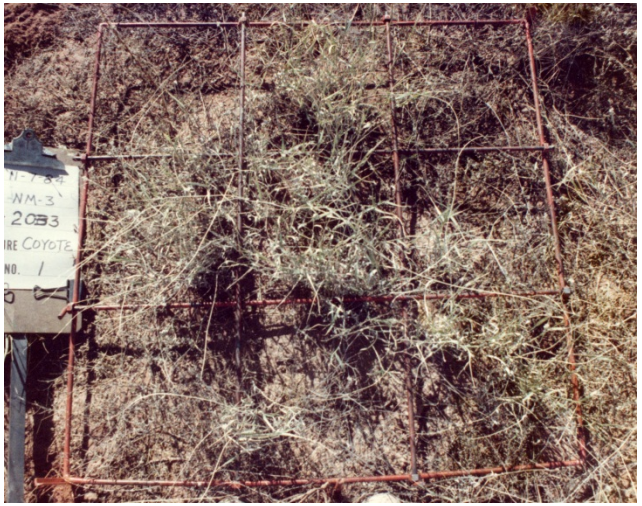
A kind of land, defined by its soils, topography and climate, that has the potential to:

1) produce similar kinds and amounts of vegetation

2) respond to disturbances and drivers similarly (e.g., grazing and rainfall)

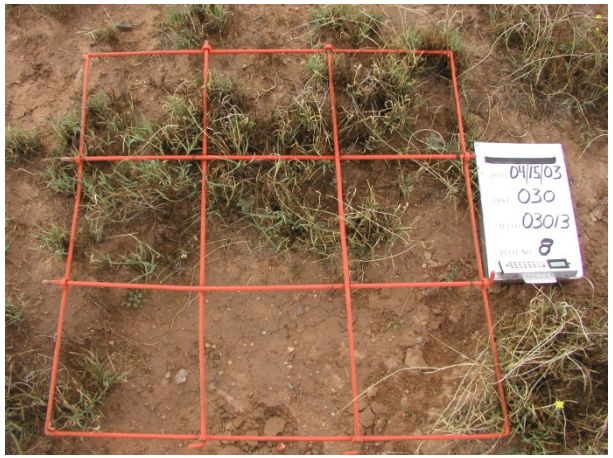
Ecological sites provide important context for understanding landscape change

1970s-80s



2003

Sandy soils (high erodibility)



Clayey soils (low erodibility)

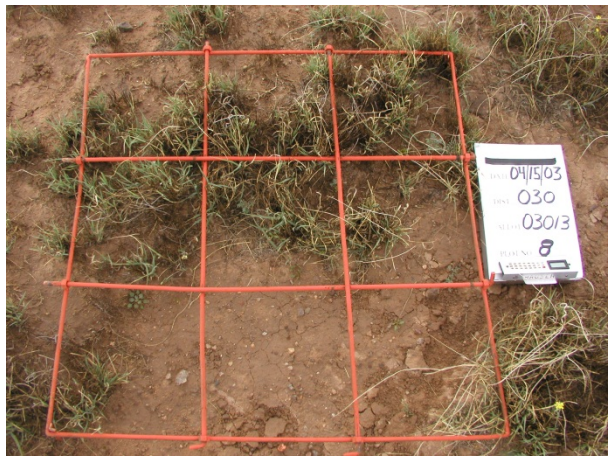
Bestelmeyer et al . 2006 Journal of Arid Environments

How are ecological sites differentiated?

Based on properties that are relatively insensitive to common management and disturbance scenarios:

- Static soil properties (e.g. % clay in subsoil)
- Landscape properties (e.g. run-in versus run-off)
- Climate (e.g. NRCS Major Land Resource Area)

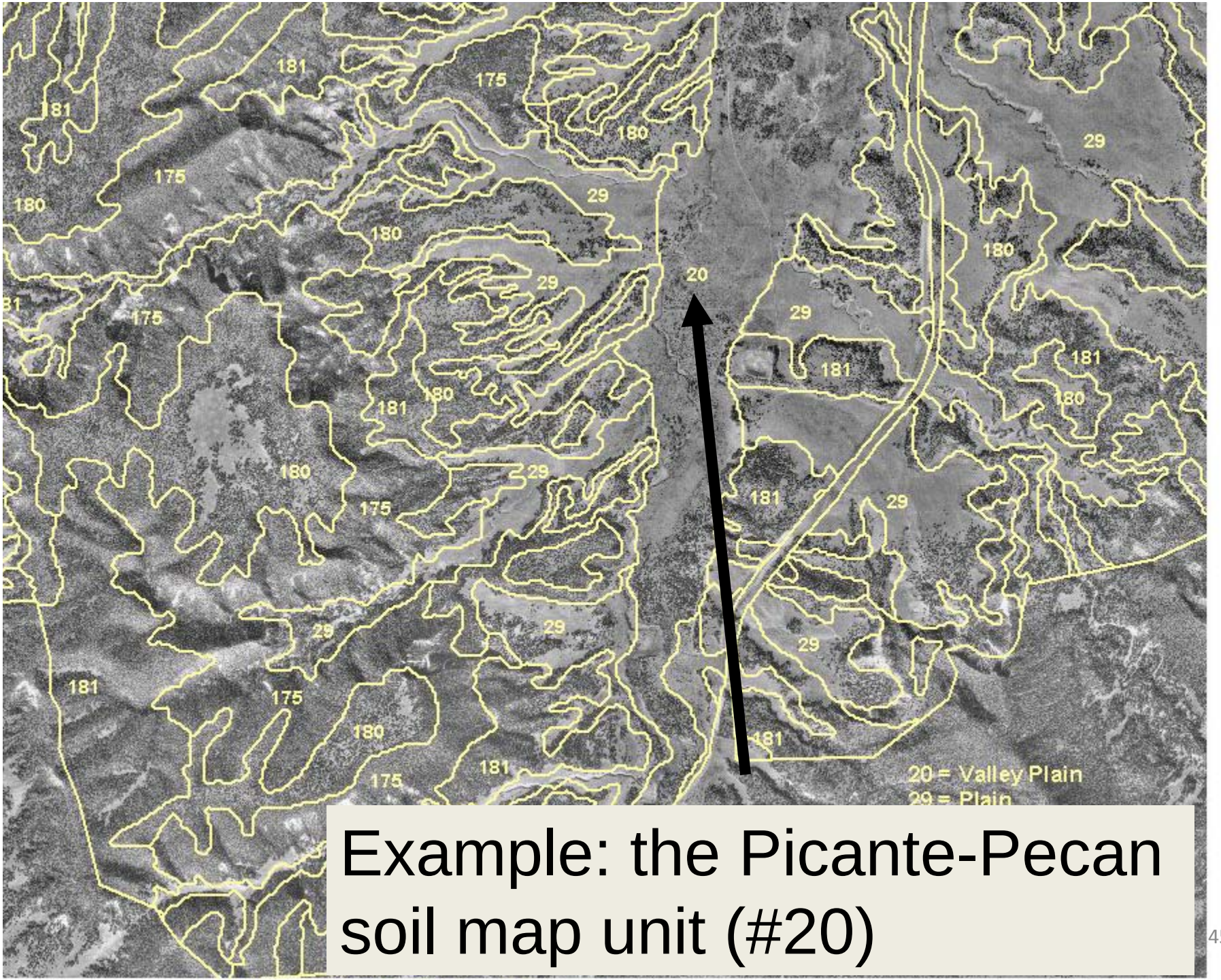
Sandy soils



Clayey soils

Ecological Site Map

- Based on soil maps
- One soil map unit component = one ecological site
- Each soil map unit can have multiple components
- Thus each map unit matches up with **one or more** ecological sites



Example: the Picante-Pecan soil map unit (#20)

N

(1) The Picante-Pecan soil map unit includes 3 ecological sites:

		Ecological Site		
Soil Series	**Soil map unit component**	**Sandy**	**Loamy**	**Hills**
Picante	Picante loamy sand, 5-15% slopes	X		
	Picante sandy loam, >15% slopes			X
Pecan	Pecan loam, 0-5% slopes		X	

(2) The loamy site includes many loamy soil series

		Ecological Site		
Soil Series	**Soil map unit component**	**Sandy**	**Loamy**	**Hills**
Picante	Picante loamy sand, 5-15% slopes	X		
	Picante sandy loam, 5-15% slopes		X	
	Picante sandy loam, >15% slopes			X
Pecan	Pecan loam, 0-5% slopes		X	
	Pecan sandy loam, 0-5% slopes		X	

(3) But the Picante soil series is associated with 3 different sites

		Ecological Site		
Soil Series	**Soil map unit component**	**Sandy**	**Loamy**	**Hills**
Picante	Picante loamy sand, 5-15% slopes	X		
	Picante sandy loam, 5-15% slopes		X	
	Picante sandy loam, >15% slopes			X
Pecan	Pecan loam, 0-5% slopes		X	
	Pecan sandy loam, 0-5% slopes		X	

Interpreting Soil and Ecological Site Maps

- One map unit component = one ecological site
- No map is accurate at small scales
- Best way to use them: Take the map and descriptions of all nearby ecological sites out in the field, and **DIG A SOIL PIT**

Identifying Ecological Sites

1. Gather Information	2. Go to the field	3. Compare physical characteristics
• Key to Ecological Sites • Topographical Map • Soil Map • Soil Map Unit Descriptions • Ecological Site Descriptions (ESD's)	• Go to a site. • Find out where you are on the maps. • According to the soil map units in the area, what ecological site(s) could you be on?	• Do you have the same topography as the ESD? • Are you at the same elevation as the ESD? • Are the soil properties (esp. texture) the same as described in the soil map unit component and associated ESD?

Applying Stratification

Stratify

Confirm the Strata in the Field for each Location

Analyze Data, Taking Strata into Account

Enjoy the benefits of stratification!

- *Reduced variability*
- *Comparison of results to reference conditions or potential*
- *More information with less effort*

Stratification helps resource managers understand diverse landscapes

Soil types and ecological sites are especially useful strata

Soil and ecological site resources

- Web Soil Survey
- SoilWeb App for iPhone and Android
- Soil Series Descriptions
- List of Published Soil Surveys
- Approved Ecological Site Descriptions
- LandPKS App for Site Characterization

For more soil background info:

Field Book for Describing and Sampling Soils – plus video on how to use it

Factors of Soil Formation – classic book by Hans Jenny available online

The Nature and Properties of Soils – book to purchase that provides a clearly written, general overview

Soils: Genesis and Geomorphology – textbook to purchase

Conclusion

Objective

You should now be able to:

Explain what stratification is and its benefits for assessment, inventory and monitoring

Given soil and ecological site information for an area, stratify the landscape based on the its characteristics

Summary

- Stratification
- Applying stratfication using soils and ecological sites
- Resources for future learning