Welcome to the Pedoderm and Pattern Class workshop

1. Provide participants with a clear understanding of Pedoderm and Pattern Classes (PPCs), how to record, and how to interpret them.

2. Train participants to assign each of the 3 PPCs (Pedoderm Class, Resource Retention Class and Soil Redistribution Class) to the same piece of ground in a consistent and repeatable fashion.

3. Test the repeatability of PPC assignments based on the information provided to you and improve that information.

What are Pedoderm and Pattern Classes?

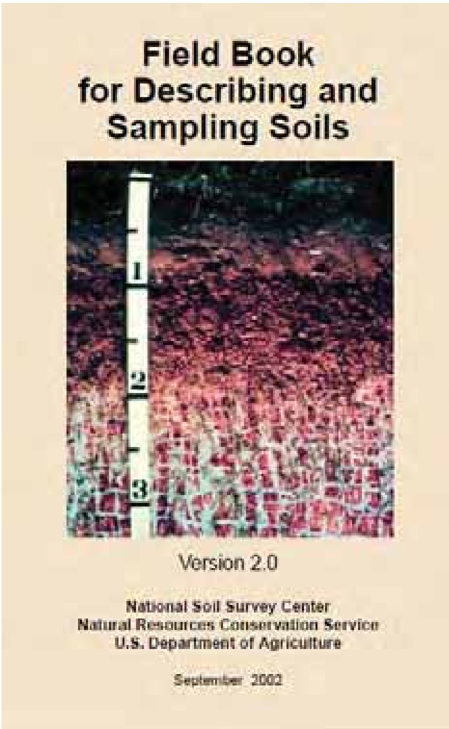
Three indicators that relate to critical soil surface processes affecting soil functions and ecological communities

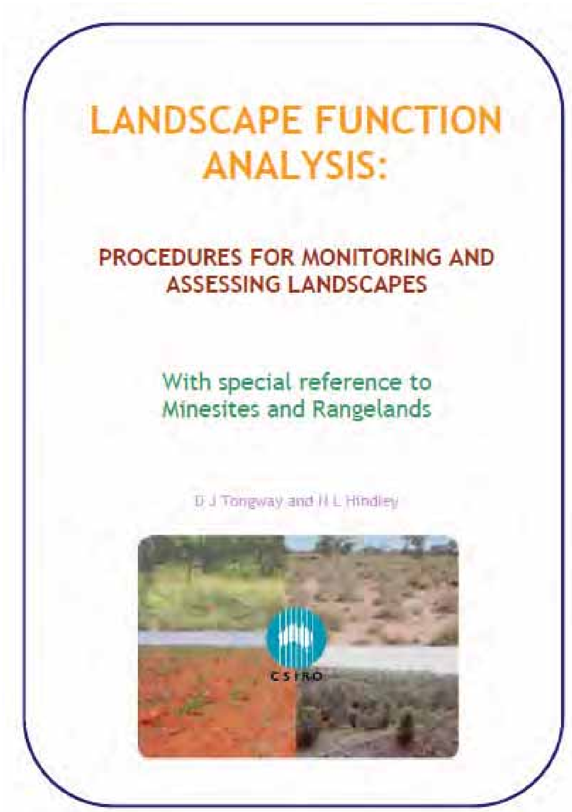
1. Description of the pedoderm (air-soil interface, top inch or so of soil) which influences infiltration, seed establishment, erodibility, nutrient inputs, and more…

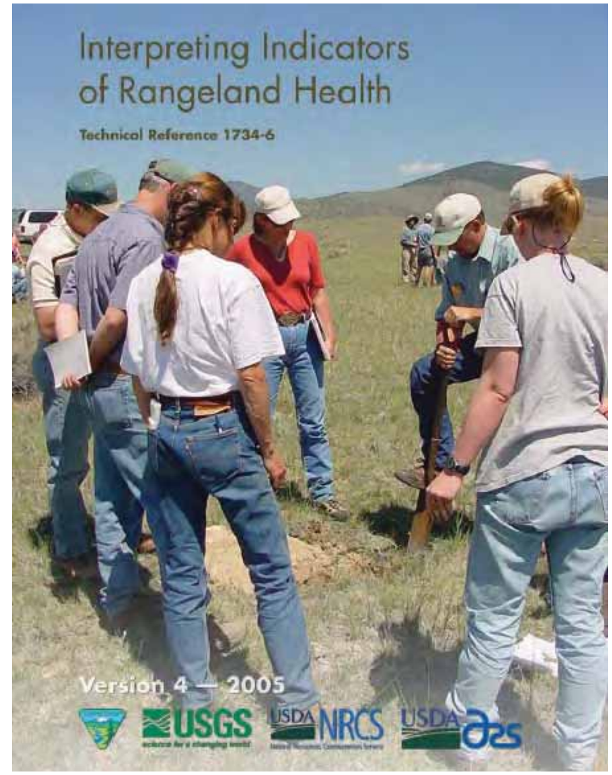
2. Spatial arrangement of plants that affects resource retention (whether water and nutrients are available to be used by plants or lost to another location or out of the ecosystem)

3. Estimate of the magnitude and extent of soil redistribution (erosion *and* deposition processes that affect plant establishment and survival)

Why do we need ANOTHER set of soil indicators????



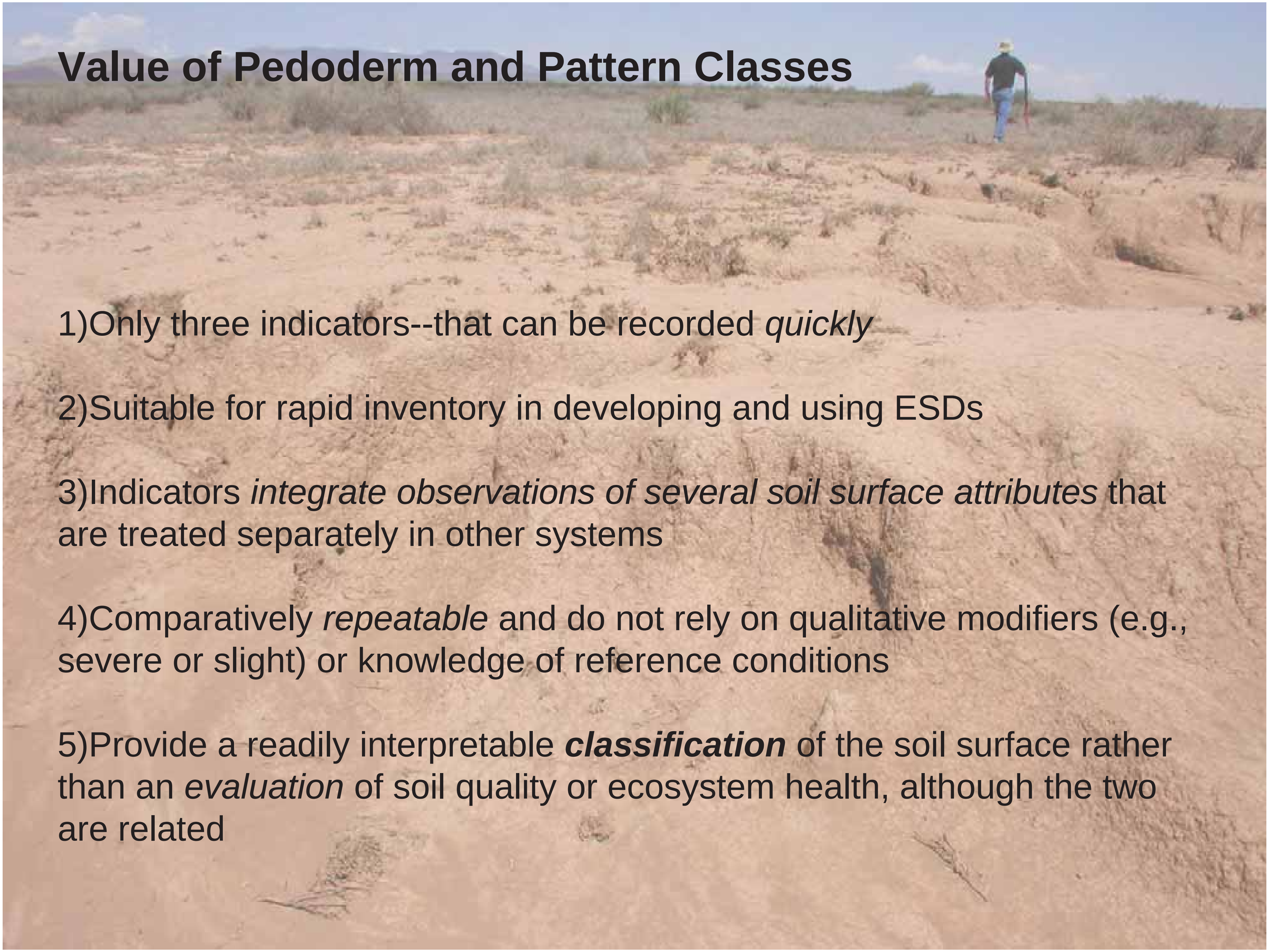




Several assessment approaches already feature soil surface indicators

PPCs are related to and inspired by these approaches

But, PPCs approach the inventory of soil surface properties in a unique and useful way



Value of Pedoderm and Pattern Classes

1)Only three indicators--that can be recorded *quickly*

2)Suitable for rapid inventory in developing and using ESDs

3)Indicators *integrate observations of several soil surface attributes* that are treated separately in other systems

4)Comparatively *repeatable* and do not rely on qualitative modifiers (e.g., severe or slight) or knowledge of reference conditions

5)Provide a readily interpretable ***classification*** of the soil surface rather than an *evaluation* of soil quality or ecosystem health, although the two are related

How do we classify this site for management?

How do we classify this site for management?

Is this all you need to know?

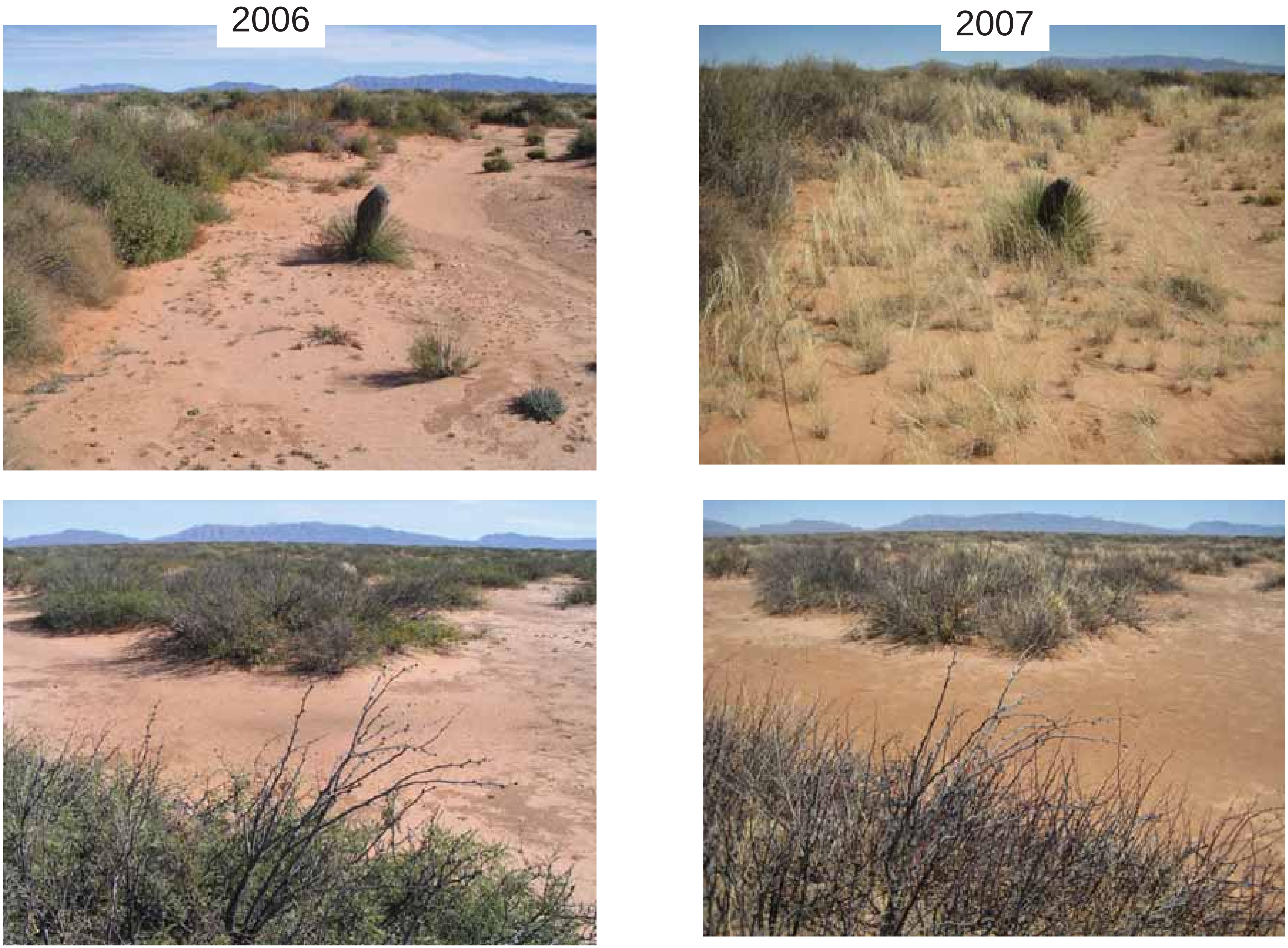
Answer (Nature Serve/US National Vegetation Classification)
= Prosopis glandulosa / Atriplex canescens Shrubland

Answer (Ecological Site Information System)
= Mesquite shrubland state of the Sandy 8-10” p.z. ecological site

Variations within the mesquite shrubland state

Cemented horizon in the interdunes

Single grain soil and weak physical crusts in interdunes



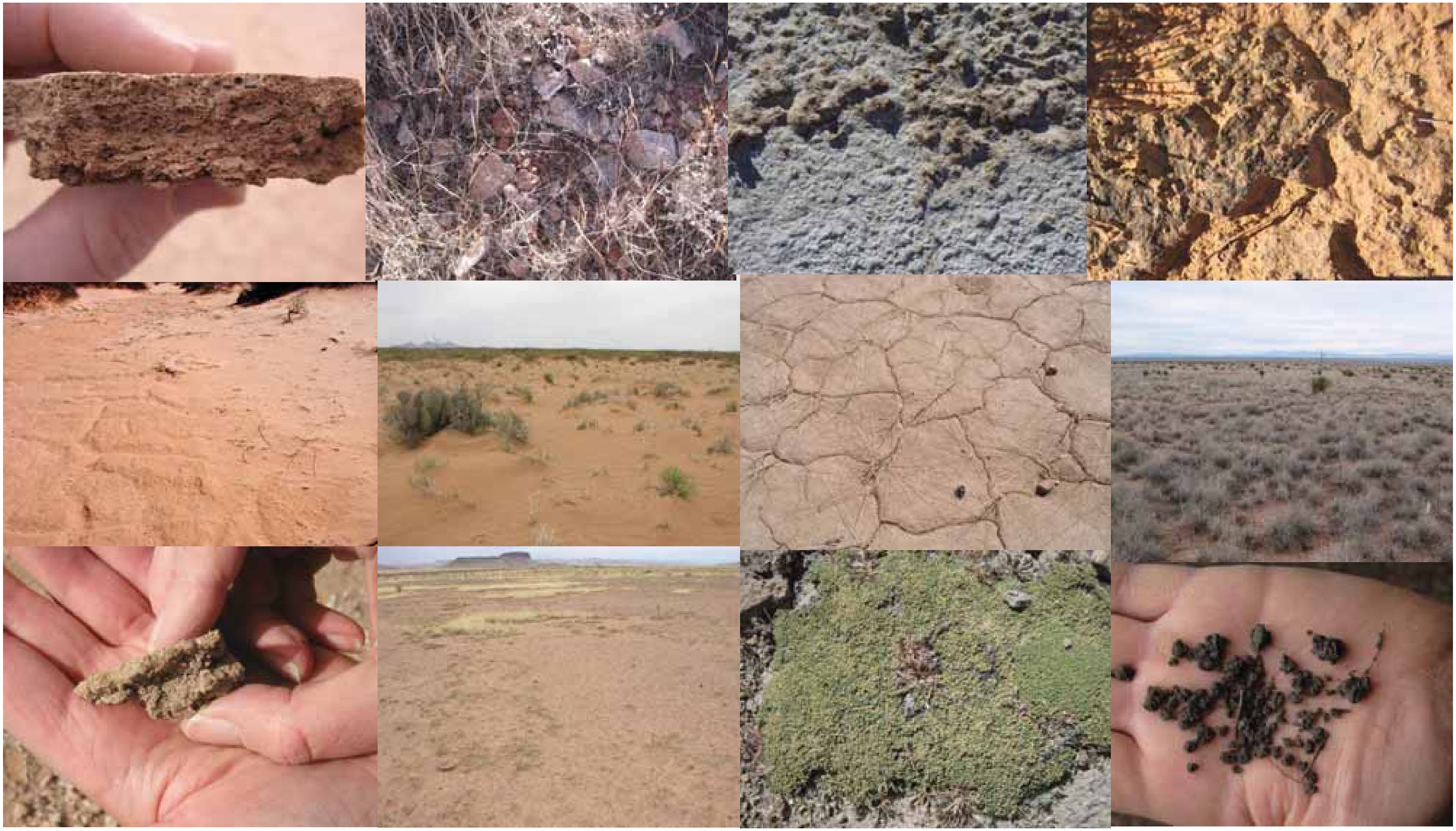
Soil surface properties have predictive value that is not captured in either vegetation or soil profile classifications

Another way of seeing these two sites

Mesquite shrubland state
Sandy 8-10” p.z. ecological site
Pedoderm class WP, with So
Resource Retention Class 5
Soil Redistribution Class 4b

Mesquite shrubland state
Sandy 8-10” p.z. ecological site
Pedoderm class CEM, with So
Resource Retention Class 5
Soil Redistribution Class 4b

PPCs are a new language for the soil surface



Using Pedoderm and Pattern Classes

At site visits, record: plant community attributes, soil profile, and PPCs

PPCs may add 5-10 minutes to your inventory

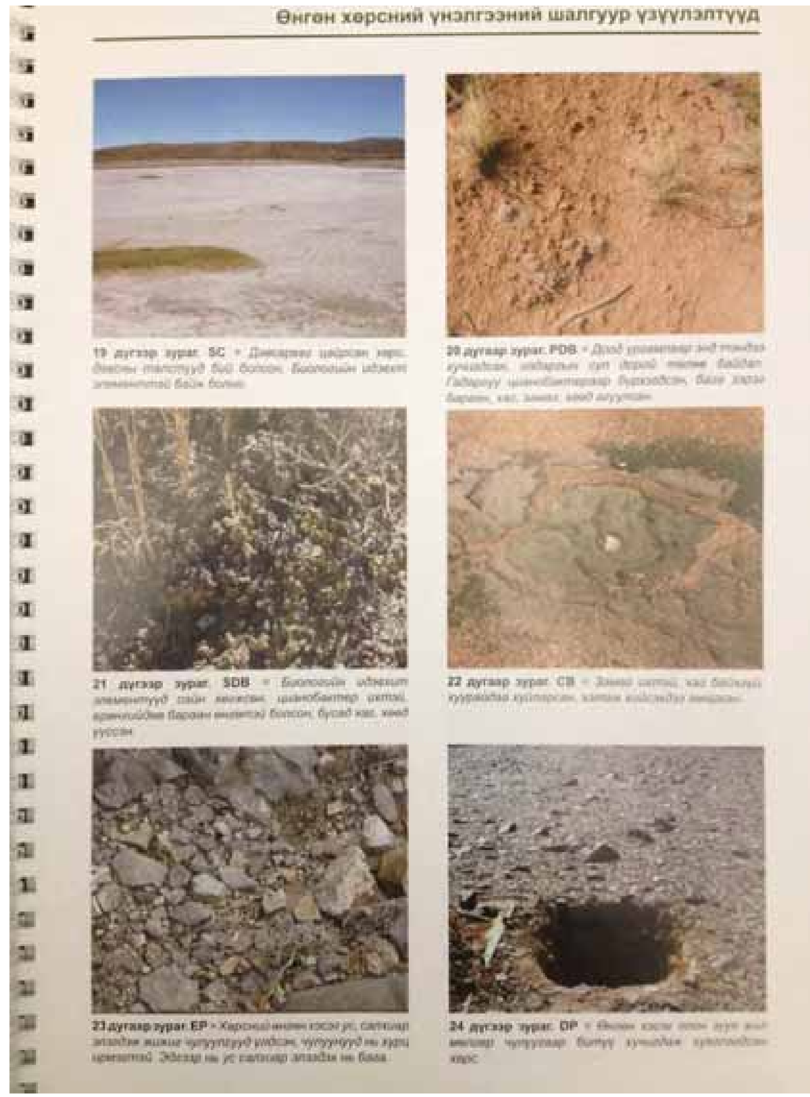
Soil Profile ⇨ site potential

Vegetation ⇨ plant community state or phase

Pedoderm Class and Resource Retention Class ⇨ how the soil surface influences plant community productivity and soil erosion

Soil Redistribution Class ⇨ describes active & recent erosion/deposition that affects soil surface and plant community

Where can PPCs be used?



- Designed for use within dryland ecosystems, including deserts, grasslands, shrublands, woodlands, and forests
- Might be used in croplands, especially where fallow periods are employed in dryland farming
- Might be used in more humid ecosystems where soil degradation is important
- Has been applied internationally

Federal government natural resource agencies and status of PPCs

•PPCs are actively used for developing ESDs by a few individuals

•PPCs are not yet officially sanctioned for use in developing ESDs or in other assessment/inventory efforts

•PPC tables *are* included in recent NASIS releases

•The Pedoderm table in NASIS has been modified from that presented here to create complementarities with existing NASIS tables pertaining to the soil surface

•PPCs will eventually be included in the Field Book for Describing and Sampling Soils

Overview: Pedoderm and Pattern Classes (PPCs)

Pedoderm Class (PC)

- describes the type of material that occurs at the air-soil interface (the pedoderm or 'skin of the soil').
- each class represents properties of the unvegetated surface that influence soil erosion, nutrient retention and addition, water infiltration and plant establishment

Resource Retention Class (RRC)

- describes the spatial patterning of persistent vascular plant patches and interpatches across a plot.
- the different patterns can influence how well a site can retain water and nutrient resources as well as prevent erosion.

Soil Redistribution Class (SRC)

- describes the extent and severity of erosion and/or deposition on a plot.
- soil redistribution (erosion and deposition) affects plants directly via disturbances and indirectly via the addition or loss of nutrients.
- soil redistribution also affects air quality, water quality, and other ecosystem functions.

Pedoderm Class (PC) Definition

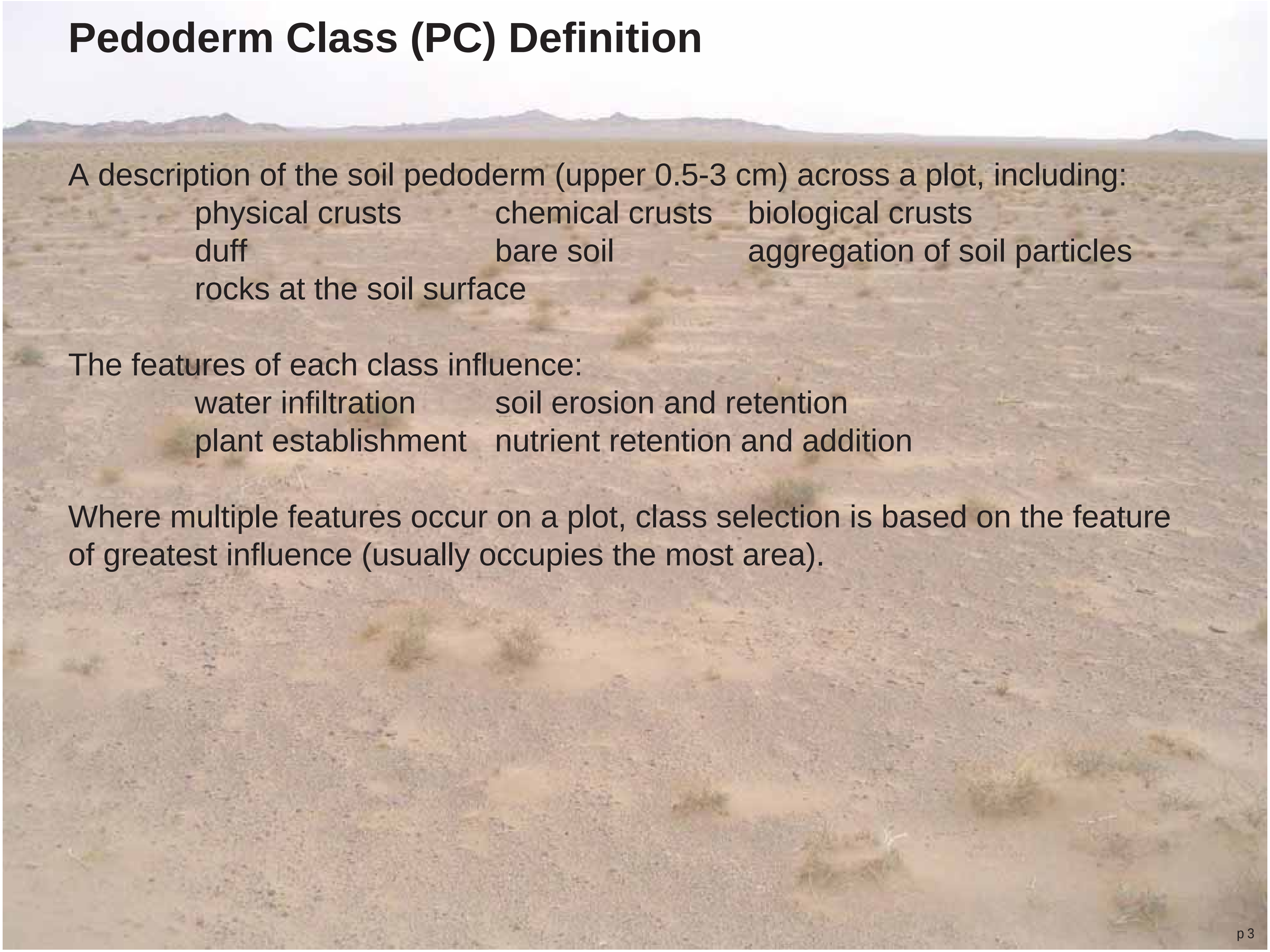
A description of the soil pedoderm (upper 0.5-3 cm) across a plot, including:

- physical crusts
- chemical crusts
- biological crusts
- duff
- bare soil
- aggregation of soil particles
- rocks at the soil surface

The features of each class influence:

- water infiltration
- soil erosion and retention
- plant establishment
- nutrient retention and addition

Where multiple features occur on a plot, class selection is based on the feature of greatest influence (usually occupies the most area).



Pedoderm Class (PC) Method

Walk around a 20 m x 20 m area (your plot). Observe the pedoderm.

Pull up several surface ‘crusts’ throughout the plot;
- Look for structural aggregates, cyanobacterial sheaths, physical or biological crusts, etc.

Consider only the pedoderm, and not the basal plant area.

Start at the top of the pedoderm class list and work your way down.
- Choose the first class encountered that describes the pedoderm.
- If more than one class is present, select the class that has the greatest influence on soil stability, water infiltration, and nutrient retention on the plot - usually has the greatest area on the plot.

When PC = WP, SC, PDB, CB, or SDB, record 1-2 dominant biological crust functional/structural groups under ‘Dom Biol Crust’ on the data form
CY (Cyanobacteria), LC (Lichen Crust), M (Moss), LV (Liverwort), A (Algae).

Pedoderm Class Modifier

If numerous patches of loose, structureless soil (often recent eolian deposits) discontinuously cover a pedoderm class, enter ‘So’ (Loose soil over a pedoderm class) in the corresponding Pedoderm Class Modifier cell.
- ‘So’ cannot be used as a modifier with ‘S’ (bare mineral soil).

Pedoderm Class (PC) Data Form

Pedoderm classes are arranged in order of the magnitude of their influence on ecosystem function, as well as to facilitate selection of the correct PC

Example: the ability to protect the soil from erosion and physical disturbance for a subset of pedoderm classes would rank as:

S (bare single grain soil) < WP (weak physical or biological crust) < SP (strong physical) < EP (erosion pavement) < DP (desert pavement)

← *low protection* *high protection* →

Pedoderm Class (v. 3.1)	select one	[1]Dom Biol Crust	[2]Pedoderm Class Modifier
S = Bare single grain soil; pedoderm is characterized by bare mineral soil and no other class.			
SA = Soil aggregates; well-formed or distinct structural aggregates at the soil surface and no other pedoderm class (well aggregated, but not platy, stable soils).			
RM = Rock mulch with stable soil; surface soil material is trapped and protected by closely spaced and partially embedded rock fragments (mostly cobbles and larger); can be associated with rock outcrops.			
WP = Weak physical or biological crust; none to few cyanobacterial sheaths dangling from ped, no darkening from cyanobacteria.			
SP = Strong physical crust; usually platy or massive, no substantial biological component.			
CEM = Cemented horizon exposed at surface.			
SC = Salt crust of fine to extremely coarse evaporite crystals or visible whitening on the soil surface; may include biological components.			
PDB = Poorly developed biological crust; discontinuous cover (broken or patchy) of one or more functional/structural group (lichen, algae, moss or dense cyanobacteria) forms a smooth or dimpled crust, typically with ≤1 cm of vertical relief (not rugose, rolling or pinnacled).[1]			
SDB = Strongly developed biological crust; typically two or more functional/structural groups (cyanobacteria, algae, moss, lichen) form a rugose, pinnacled or rolling crust.[1]			
CB = Cracking or curling, rubbery algal crust, with or without lichen.[1]			
EP = Erosion pavement; a lag of rock fragments remaining after erosion and removal of finer soil material, forming a dense uniform pavement dominated by gravel-sized rock fragments; individual fragments may be displaced during runoff events.			
DP = Desert pavement; a concentration of closely packed and varnished rock fragments at the soil surface, fully embedded in a vesicular crust (mostly gravel-sized rock fragments).			
D = Duff; non-decomposed to fully decomposed plant and organic matter located above the A horizon (a patchy or continuous O horizon).			

[1] List 1-2 dominant biological crust functional/structural groups from this list: CY (Cyanobacteria), LC (Lichen Crust), M (Moss), LV (Liverwort), A (Algae).

[2] Pedoderm Class Modifier: So = Loose soil over a pedoderm class.

Pedoderm Class (v. 3.1)	select one	[1]Dom Biol Crust	[2]Pedoderm Class Modifier
S = Bare single grain soil; pedoderm is characterized by bare mineral soil and no other class.			
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SP = Strong physical crust; usually platy or massive, no substantial biological component.			
CEM = Cemented horizon exposed at surface			

So

Figure 1. So - Loose soil over a pedoderm class. Arrows point to loose, structureless soil discontinuously covering the pedoderm. Note the difference in soil color between the loose soil (redder) and the soil it covers (grayer) in 1.a. In these examples, ‘So’ would be listed in the Pedoderm Class Modifier column to the far right of ‘weak physical or biological crust’ on the data form (the ‘weak physical or biological crust’ is the grayer soil in Fig. 1.a. and lighter/yellower soil in Fig. 1.b.).

Biological Soil Crust Terminology

Algae – nonvascular photosynthetic plant-like organisms, informally divided into groups by dominant pigment (green, brown, red)

Bacteria – microscopic, single celled organisms

Cyanobacteria – photosynthetic bacteria formerly called blue-green algae, their growth forms tend to be filamentous

Sheaths – external coating formed by some filamentous cyanobacteria

Fungi – nonphotosynthetic multicellular organisms that are either saprophytic or parasitic

Hyphae – single strands of a fungus (fungal filaments)

Lichens – consists of fungi living symbiotically with algae or cyanobacteria

Mosses – non-vascular plants of small stature; leaves attach in a whorl about the stem; divided into short vs. tall mosses

from Belnap 1997

Lichen morphology

Crustose – crust-like growth form; lichens can't be removed from the substrate without damaging the lichen or the substrate, may be continuous or patchy, appearing tile- or island-like and divided into small areas by cracks

Gelatinous – lichens have a single-celled structure of interwoven fungal threads with algae scattered between them and have a rubbery, jelly-like texture (when moistened); blackish

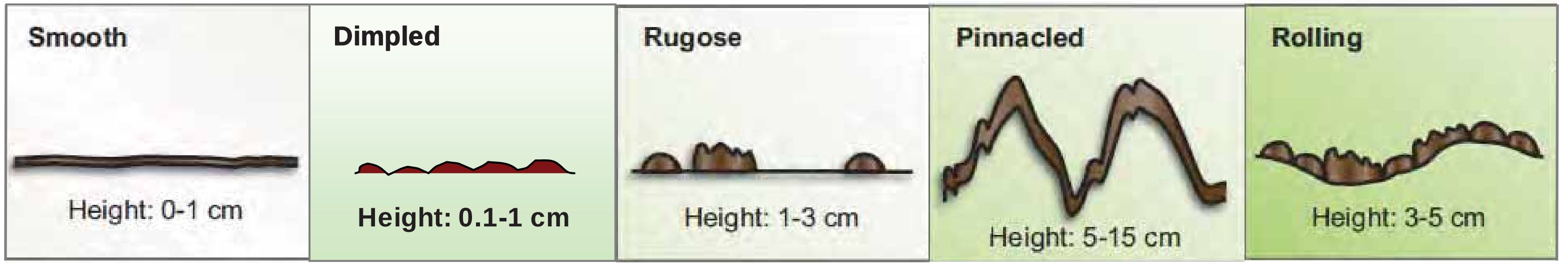
Squamulose – lichens have scale-like lobes that are usually small and over-lapping; rhizomes penetrate up to 5 mm into the soil; discrete flakes are round or ear-shaped with lobed margins, resemble cornflakes; grow in colonies (pads) on the ground

Foliose – lichens have lobes that are somewhat leaf-like and are relatively loosely attached to the soil

Fructicose – lichens are the most three-dimensional, usually form cylindrical branches that can grow upwards

Photos by J. VanZee
from Rosentreter et al. 2007
and Belnap et al. 2001

Biological Crust Morphology



WP PDB	PDB	SDB	SDB	SDB

Figure 2. Biological crust morphology adapted from Rosentreter et al. (2007). Smooth biological crusts typically occur in hot, hyper-arid deserts and in recently disturbed deserts. Smooth biological crusts have the least vertical relief with heights between 0 and 1 cm and are usually dominated by **cyanobacteria**. **Rugose** biological crusts occur in slightly less arid deserts. Rugose biological crusts have more vertical relief than smooth crusts, with heights between 1 and 3 cm and contain gaps of smooth crusts or mineral soil between them. **Pinnacled** biological crusts commonly occur in mid-latitude cool deserts. Pinnacled biological crusts have the greatest vertical relief with heights between 5 and 15 cm. **Rolling** biological crusts exist only where frost-heaving occurs in the winter. Rolling biological crusts have more vertical relief than smooth crusts, but less than pinnacled crusts, with heights between 3 and 5 cm; rolling crusts typically do not include gaps of mineral soil surface or smooth crusts.

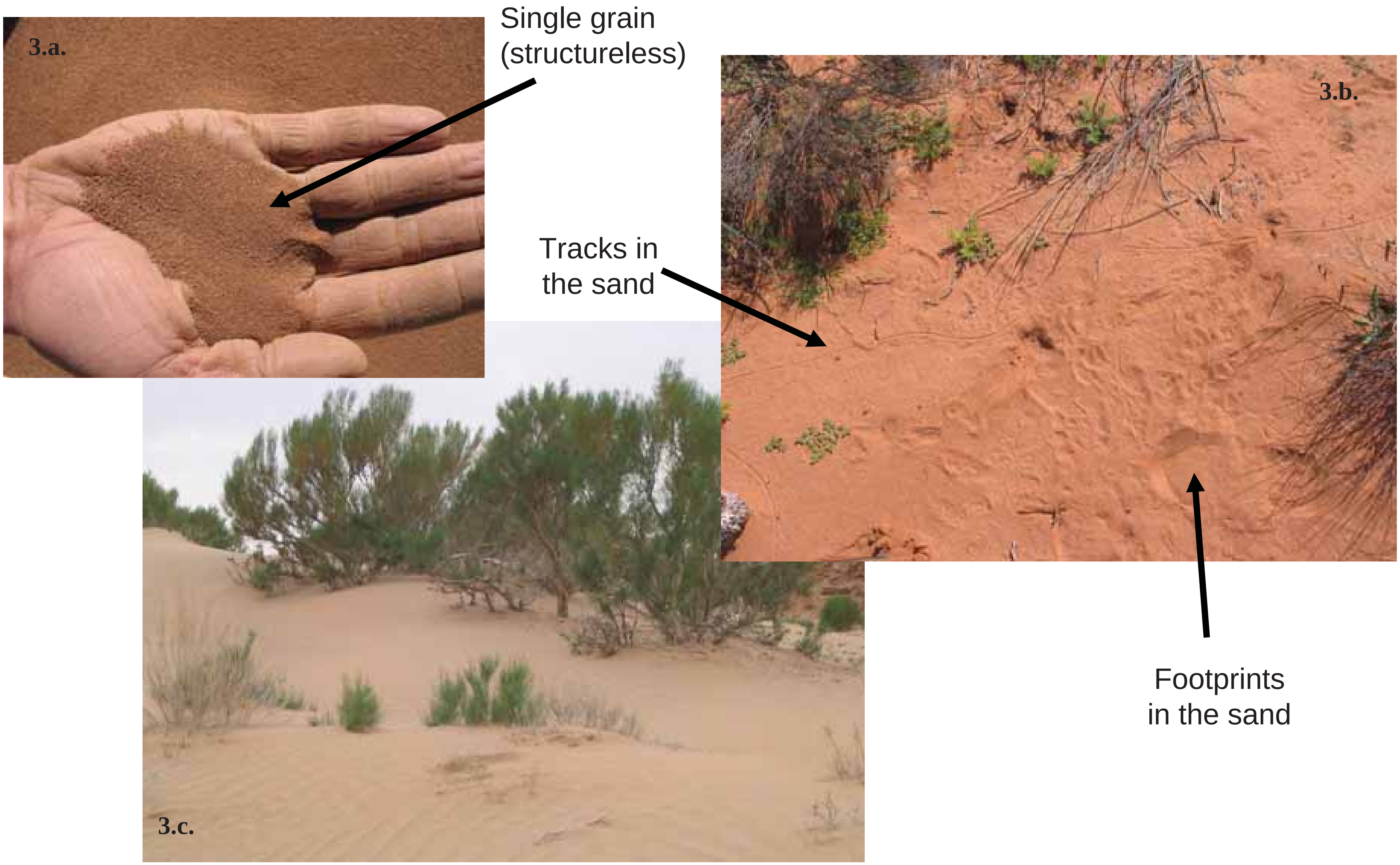


Figure 3. S –Bare single grain soil; pedoderm is characterized by bare mineral soil and no other class. This class is distinguished by a lack of structural aggregates (i.e., single grain). Soil peds do not occur at the surface. Individual particles of soil less than 5mm in diameter are visible in the hand (Fig. 3.a.). Physically disturbed soils tend to be in this class. This pedoderm is particularly susceptible to wind and water erosion. Animal tracks are frequently observed in a pedoderm class of S (left arrow of Fig 3.b.). The edges of human footprints look like tracks in sand and there are no structural aggregates broken up by footprints (bottom right arrow in Fig. 3.b.).

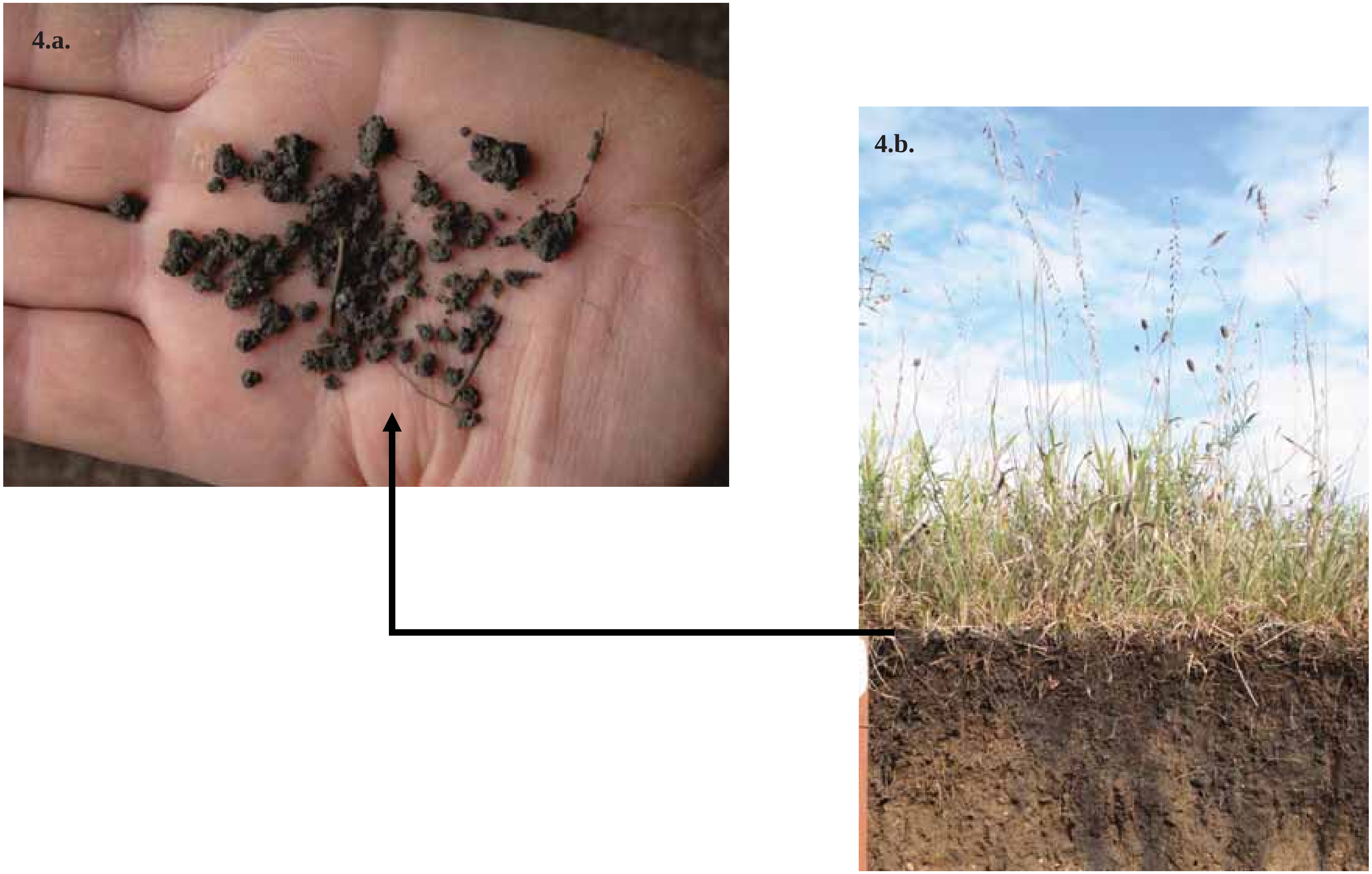


Figure 4. SA - Soil aggregates; well-formed or distinct structural aggregates at the soil surface and no other pedoderm class (well aggregated, but not platy, stable soils; Fig. 4.a.). The surface soil structure (peds) can be angular or subangular blocky, granular, columnar or cloddy. SAs are typically found in grassland communities (Fig. 4.b.) and are darkened by organic matter. It is often necessary to dig a small soil pit in order to view the structure. Soils with structural aggregates have high resistance to wind and water erosion and good infiltration, but the stability of peds can vary. Photos provided by Bruce Kunze, Area Resource Soil Scientist, NRCS.

Figure P3. RM - Rock mulch with stable soil; surface soil material is trapped and protected by closely spaced and partially embedded rock fragments (mostly cobbles and larger; Fig 5.a.–c.); can be associated with rock outcrops. Soil tends to accumulate. Rock mulch pedoderms are often fertile/productive (Fig 5.d.-e.). Rock mulch pedoderms consist mostly of larger clasts that are not redistributed by water. Rock mulch pedoderms do not contain concentrations of gravel (gravel is <76 mm or 3 in in diameter).

Figure 6. WP - Weak physical or biological crust; none to few cyanobacterial sheaths dangling from ped, no darkening from cyanobacteria. The cyanobacterial sheaths often appear as barely visible strands dangling from a fragment of the crust, with small soil aggregates adhering to them (circled area in Fig. 6.a.). The soil surface has thin or medium platy structure, with a weak or moderate grade of expression (Fig. 6.b.). The soil surface may appear smooth or with shallow cracks (Fig. 6.c.-d.). Weak crusts bind the soil together and thus have slightly increased resistance to wind and water erosion compared with loose soil (S). However, WPs can be disrupted by raindrop impact, resulting in splash erosion. This can seal surface soil pores, which reduces infiltration relative to loose (S) and structural aggregate (SA) pedoderms.

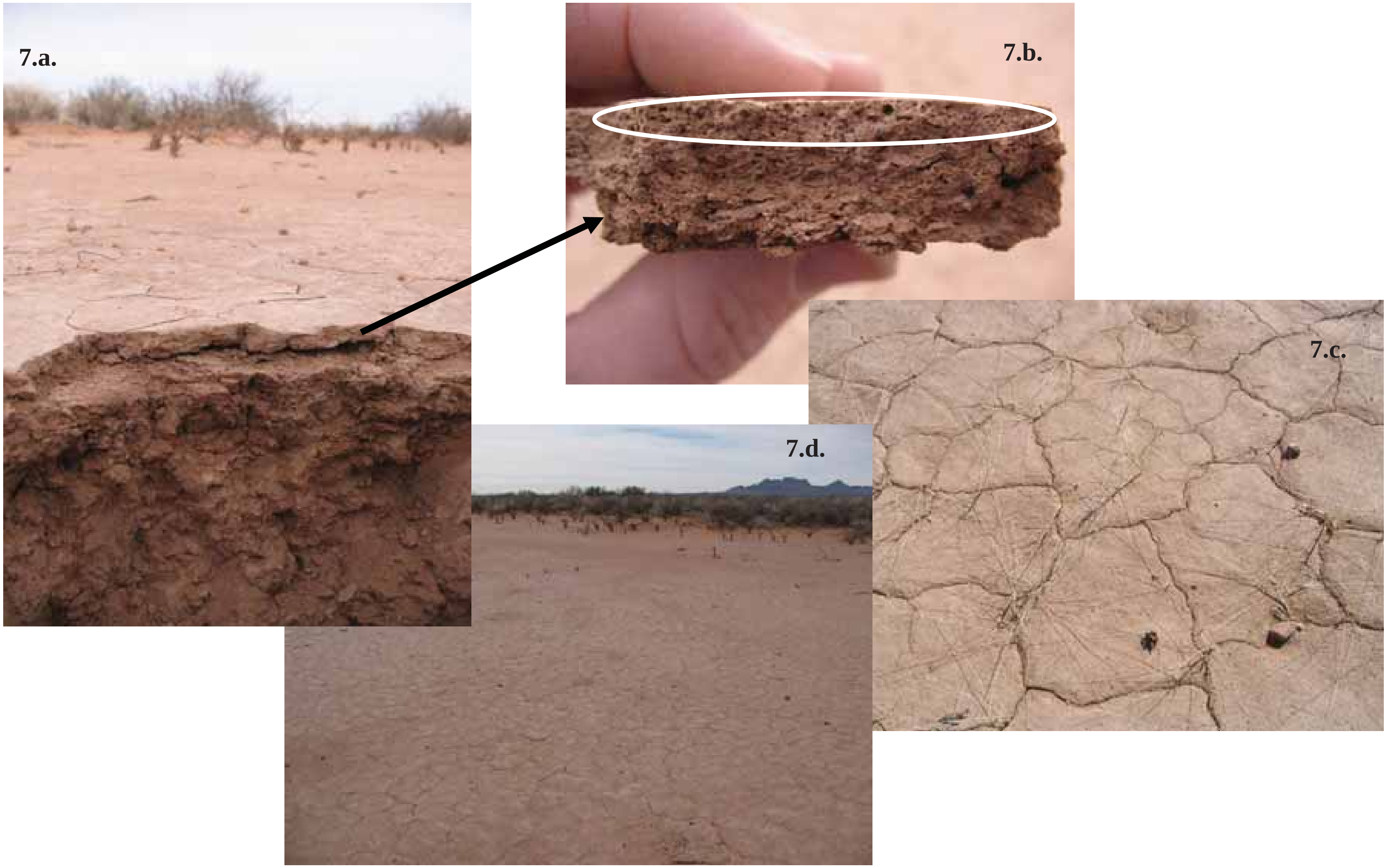


Figure 7. SP - Strong physical crust; usually platy or massive, no substantial biological component (Fig. 7.a.-d.). These crusts are medium to very thick platy, prismatic, columnar, or massive. Dry SPs are usually hard and difficult to penetrate when a finger is pressed against the crust. There are no substantial biological crust components, although in some cases, biological or weak physical crusts may form on top of thick strong physical crusts. Thus, care should be taken to ensure that the entire pedoderm is observed by digging and lifting out surface peds that may be over 2 cm thick (Fig. 7.a.-b.). Vesicular pores may be present. Strong physical crusts impart resistance to raindrop impact, reducing wind and water erosion relative to weak crusts (WP). Infiltration rates, however, are also low due to surface sealing and reduced pore space, and interrill erosion can occur.

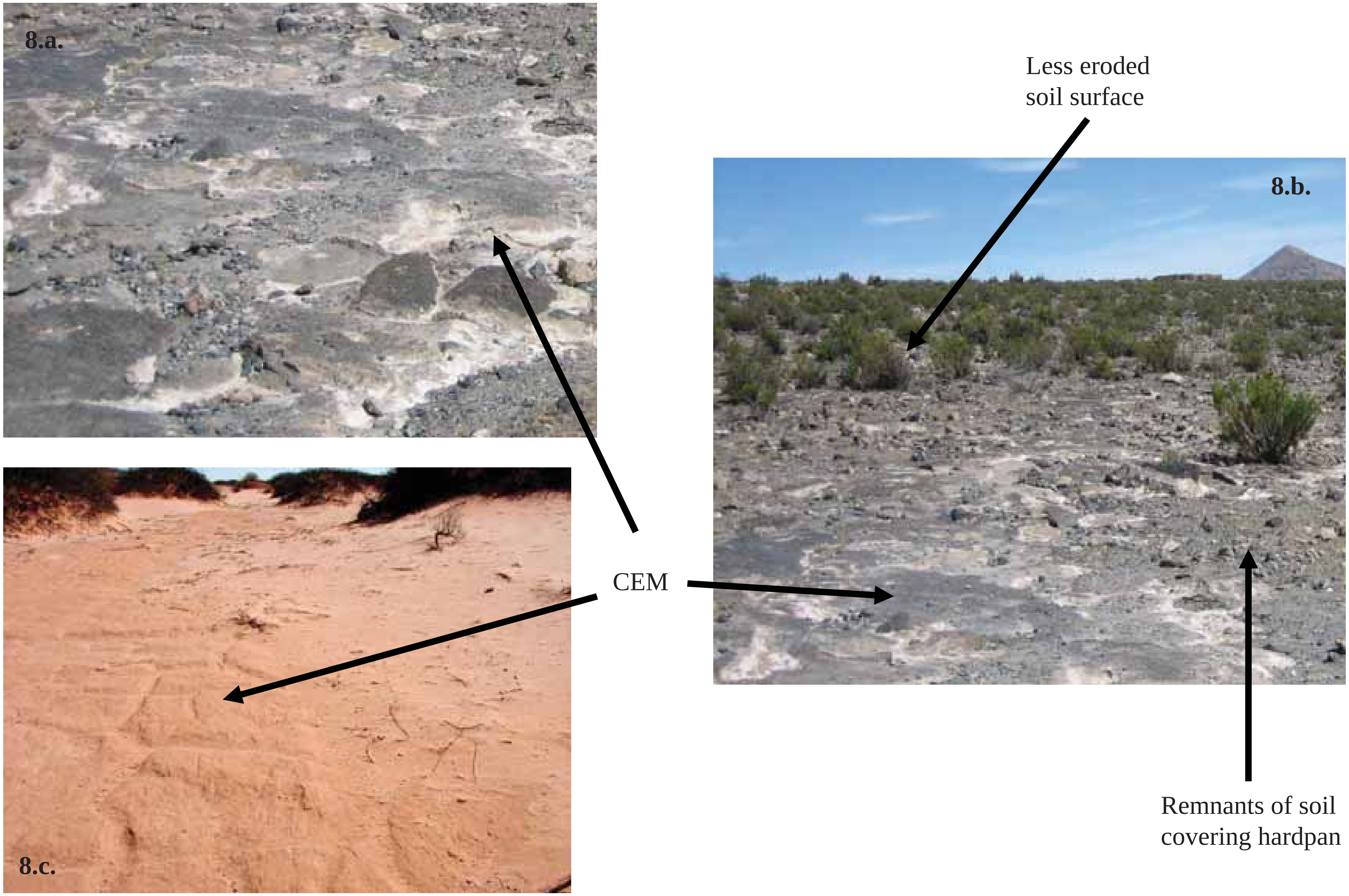


Figure 8. CEM - Cemented horizon exposed at surface. A cemented horizon forms through pedogenesis beneath the soil surface (i.e., it is a B horizon). Erosion exposes these cemented horizons at the soil surface (Fig. 8.a.-c.). Remnants of the soil that once covered the cemented horizon are typically scattered throughout the area of this pedoderm (Fig. 8.b.). A brittle crust of gypsum formed at the soil surface is included in CEM. Cemented horizons are resistant to wind and water erosion but restrict water infiltration and especially plant establishment. Bedrock (R or Cr) horizons exposed through erosion are included in CEM.

Figure 9. SC - Salt crust of fine to extremely coarse evaporite crystals (Fig. 9.a.-d.) or visible whitening (arrows on Fig. 9.e.-f.) on the soil surface; may include biological components. Salt crusts often form on top of weak (WP) or strong physical (SP) crusts. Infiltration rates vary depending on the type of salts and presence of underlying physical crusts. Where salt crusts appear as a result of salinization in plant communities that lack a tolerance for soil salinity, salts can interfere with seedling establishment. Photo 9.b. provided by Joe Chiaretti, NRCS.

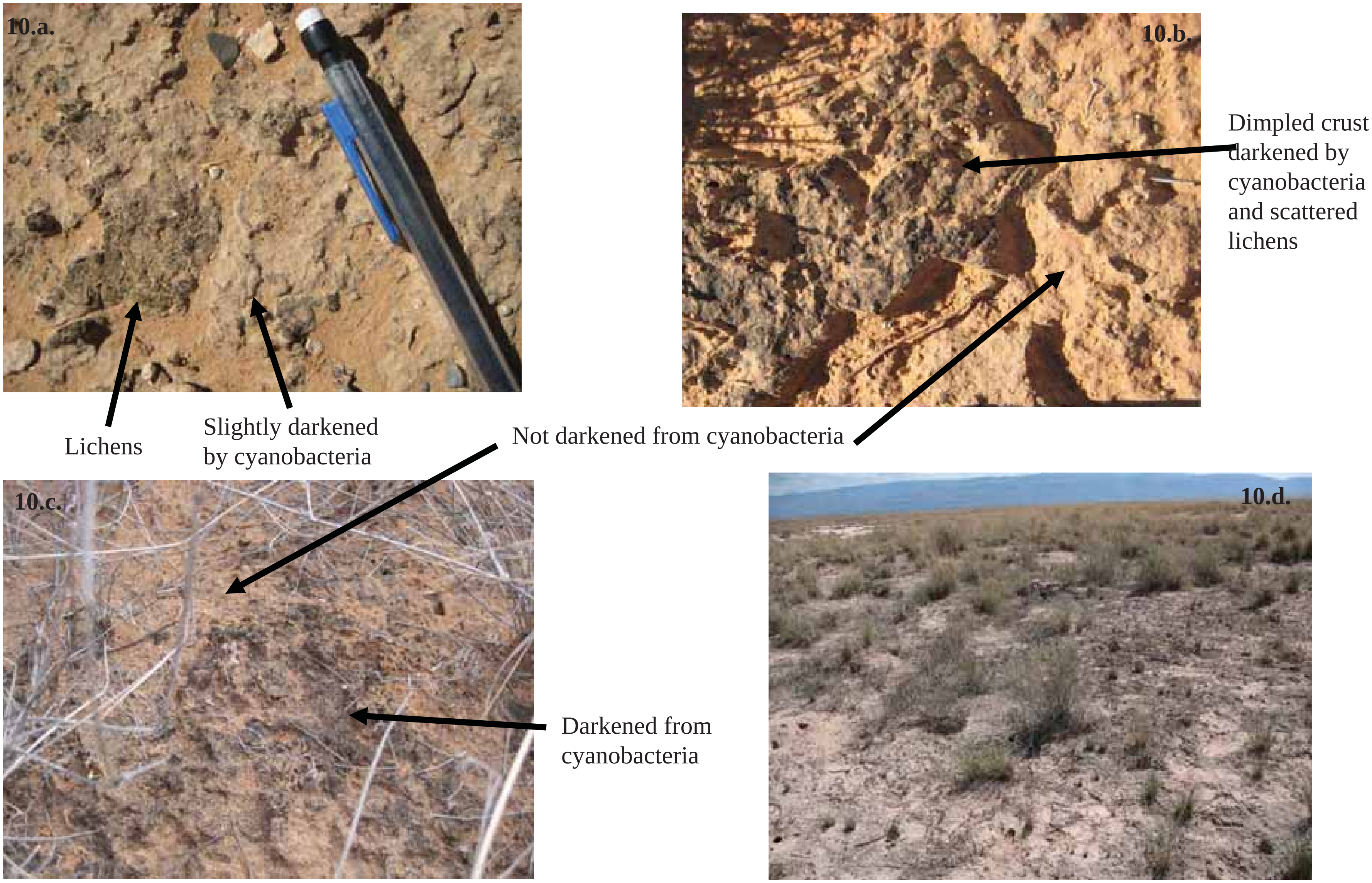


Figure 10. PDB - Poorly developed biological crust; discontinuous cover (broken or patchy) of one or more functional/structural group (lichen, algae, moss or dense cyanobacteria) forms a smooth or dimpled crust with ≤1 cm of vertical relief (not rugose, rolling or pinnacled; Fig. 10.a.). PDBs are recognized by either dense cyanobacterial sheaths (Fig. 10.a.-d.) compared to weak crusts (WP), or by their discontinuous cover of one or more functional/structural group forming a smooth or dimpled crust (in contrast to the continuous, darkened rugose, rolling or pinnacled crusts of strongly developed biological crust pedoderms). They resist raindrop impact and erosion better than weak crusts (WP), but are insufficiently rough or continuous to trap sediment or to slow runoff. PDB pedoderms often include areas with evidence of disruption of the biological crust that has lead to the formation of small, weak physical crust patches.

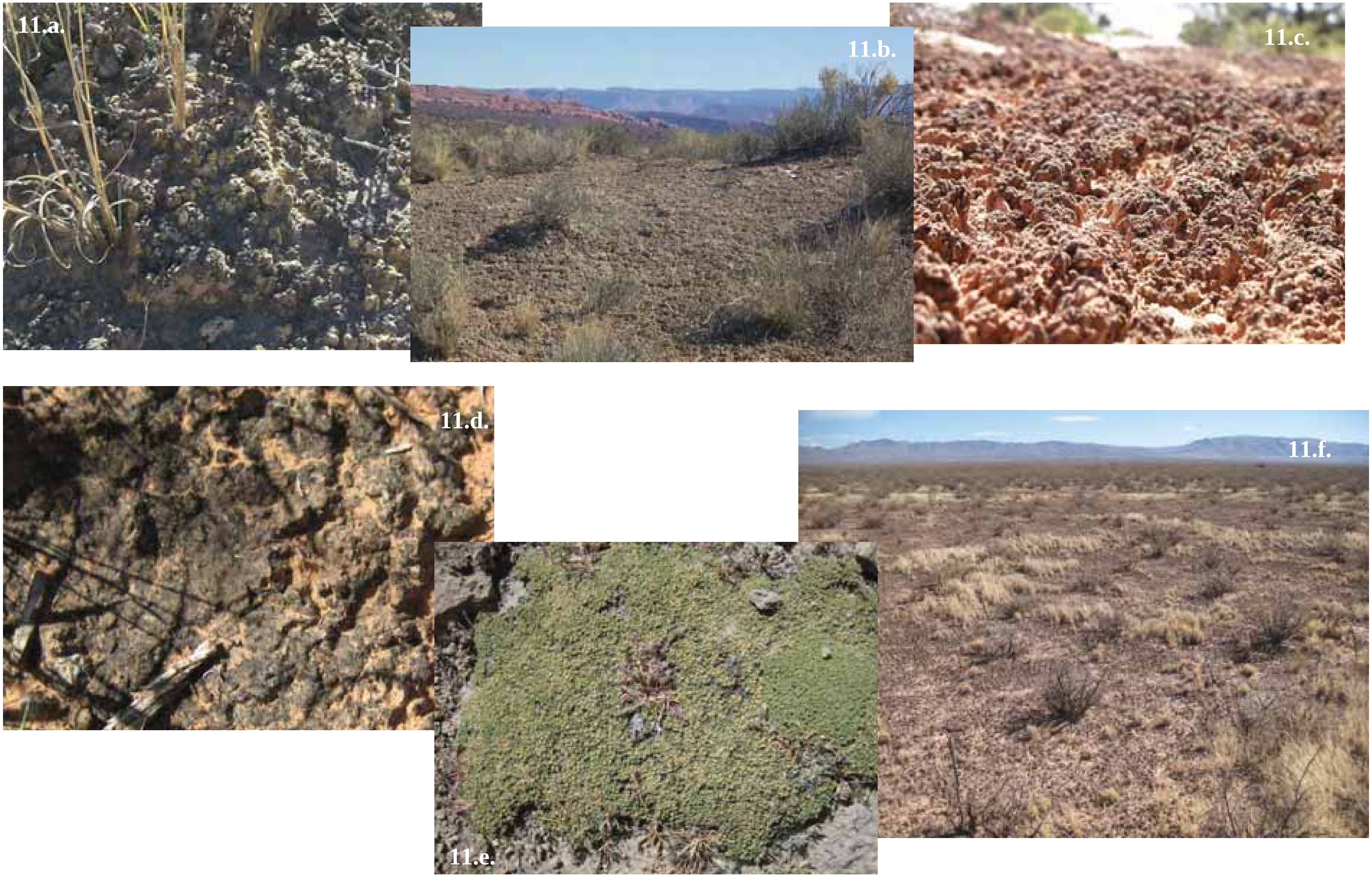


Figure 11. SDB - Strongly developed biological crust; typically two or more functional/structural groups (cyanobacteria, algae, moss, lichen) form a rugose, pinnacled or rolling crust (Fig. 11.a.-f.). Two or more functional groups are typically common in contrast to poorly developed biological crusts (PDB; Fig. 11.d.-f.). Compared to PDBs, strongly developed biological crusts are sufficiently rough and continuous to trap sediment, slow runoff and protect against erosion. Photo 11.c. provided by Tom Reedy, retired, NRCS.

The continuum from weak physical to strongly developed biological crusts

WP

-Smooth

-No darkening

-None to few cyanobacterial sheaths in crust, no other biological crust functional groups

PDB

-Smooth or Dimpled

-Variable darkness; biological crust may be disrupted by patches of WP

-Many cyanobacterial sheaths in crust, may see other functional groups in discrete patches;

or

-Interrupted crust composed of lichens, algae, moss, cyanobacteria or a combination of functional groups

SDB

-Pinnacled, Rugose, Rolling

-Continuous darkened crust

-Usually several functional groups present

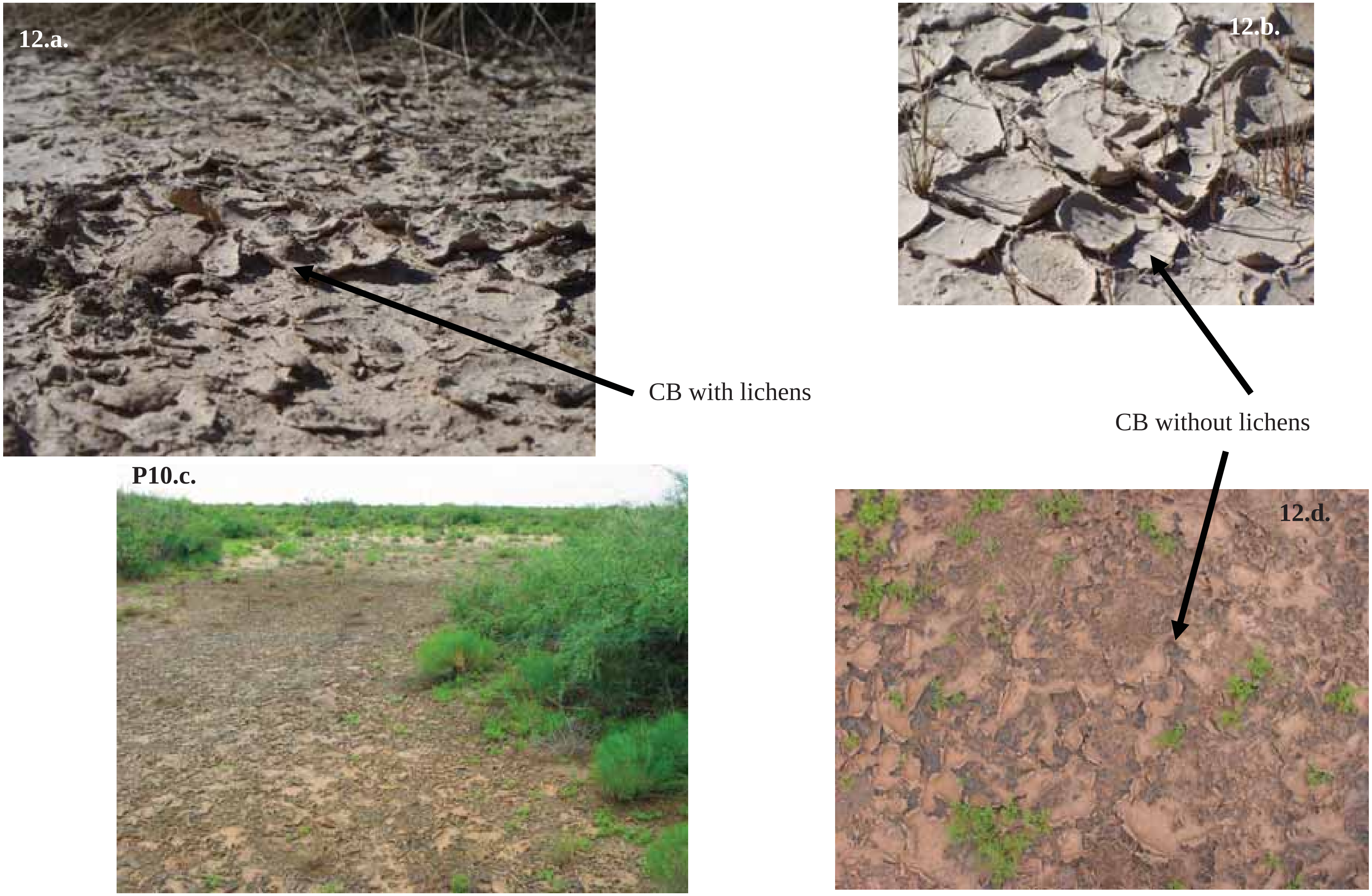


Figure 12. CB - Cracking or curling, rubbery algal crust, with or without lichen. These crusts are composed of thin, typically cracked surface peds that may curl upward at the edges (Fig. 12.a.-c.). When wet, the crust is rubbery to the touch and the underside of individual peds commonly appears green. CBs can have lichens associated with them (Fig. 12.a.-d.). These crusts stabilize the soil surface by binding soil particles together, however dry curled crusts can become detached and be carried away by wind or water. The ability of CBs to resist erosion depends on their moisture status, size, thickness and anchor strength. In general, dry CBs are less resistant to wind erosion than PDBs and SDBs. CBs stabilize the soil surface and trap sediments and resources better than WP and S pedoderms.

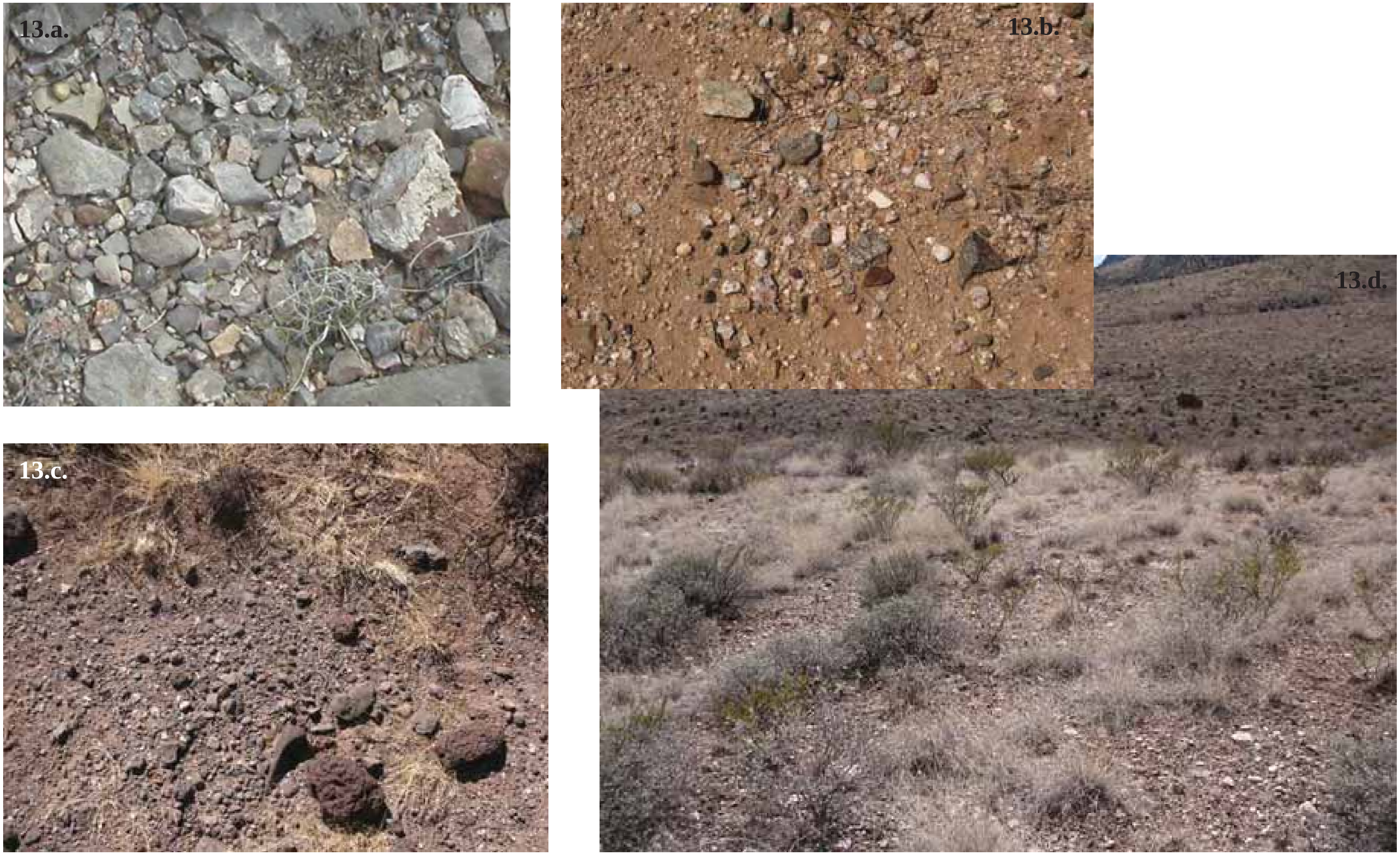


Figure 13. EP - Erosion pavement; a lag of rock fragments remaining after erosion and removal of finer soil material, forming a dense uniform pavement dominated by gravel-sized rock fragments; individual fragments may be displaced during runoff events. The density, cover and size of rock fragments can vary (Fig. 13.a.-c.), but gravel-sized rock fragments are the dominant soil surface feature in the plant interspaces (Fig. 13.d.). In contrast to desert pavements, rocks do not appear varnished or polished (Fig 13.a-c). Erosion pavements protect the soil surface from erosion by raindrop impact, overland water flow and wind. Unlike rock mulch and desert pavement pedoderms, rock fragments comprising EP pedoderms are not embedded in accumulating soil material. Erosion pavements include eroded rock mulch pedoderms with concentrations of surface gravel.

Figure 14. DP - Desert pavement; a concentration of closely packed and varnished rock fragments at the soil surface (Fig. 14.a. & b.), fully embedded in a vesicular crust (mostly gravel-sized rock fragments). The desert varnish imparts a darkened and shiny appearance to the exposed surface of the rocks (Fig. 14.a. & b.). In contrast to erosion pavements, gravel-sized rock fragments are fully embedded in the soil surface and are not displaced during runoff events (Fig. 14.a. & b.). The embedded rock fragments in the soil surface, along with the presence of well-developed vesicular layers, significantly reduces water infiltration relative to erosion pavements. Desert pavements do not indicate recent or active erosion. Photos provided by Joe Cook, AZGS Geologist.

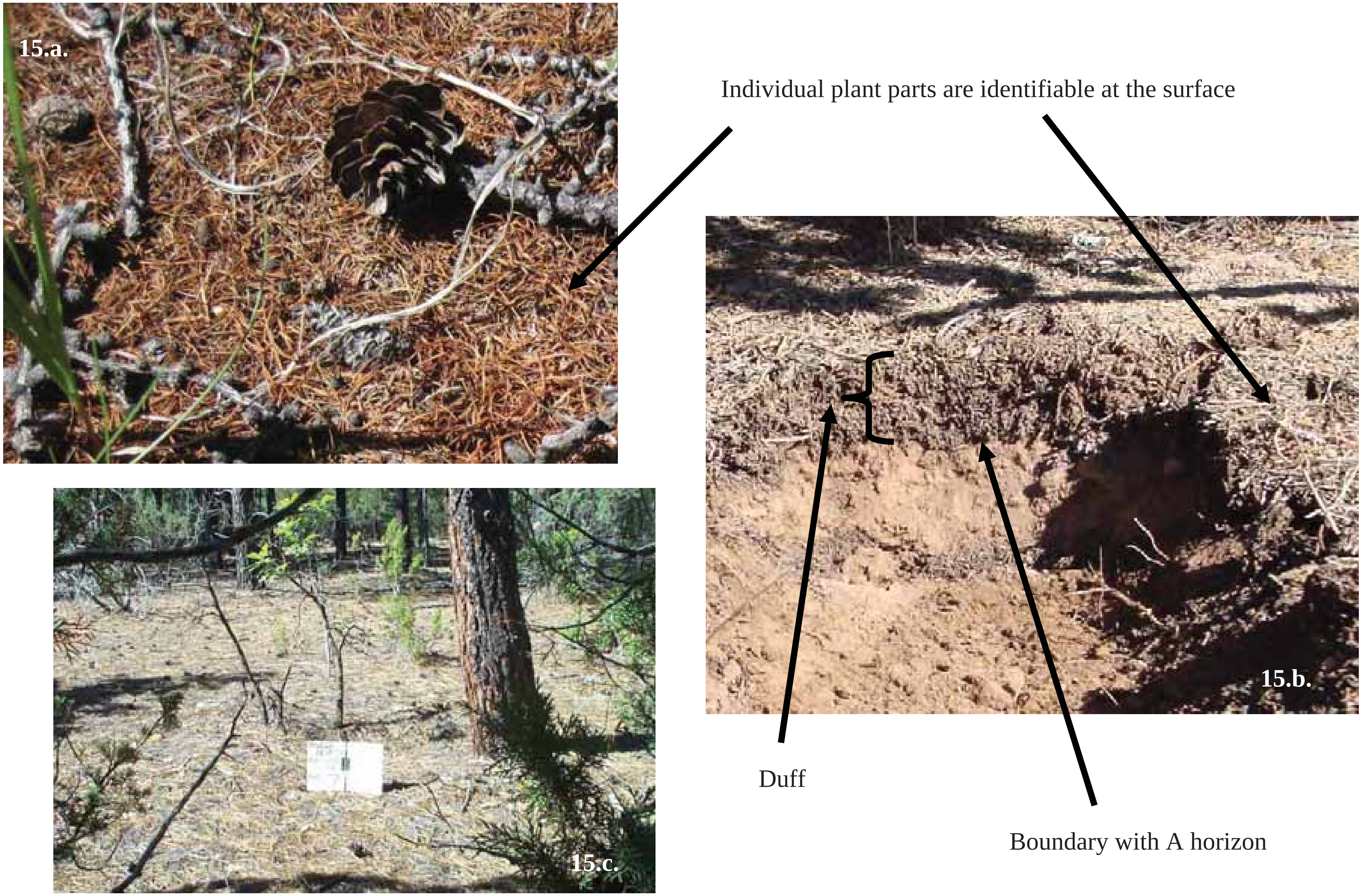


Figure 15. D - Duff; non-decomposed to fully decomposed plant and organic matter located above the A horizon (a patchy or continuous O horizon). Individual leaves and plant parts are recognizable in the upper part of the duff layer, but become less discernable with depth (Fig. 15.a. & b.). Individual plant parts are not readily distinguished at the boundary with the A horizon (Fig. 15.b.). Duff stabilizes the soil surface, protecting it from erosion by raindrop impact, overland water flow, and wind. The effect of duff on water infiltration depends upon its thickness, water content, and the water repellency of the duff and mineral soil. The presence of pores and wet areas in the duff and underlying mineral soil can promote preferential flow into and through the mineral soil.

Resource Retention Class (RRC) Definition

A description of the size and connectivity of persistent vascular plant patches and interpatch areas across a plot.

The features of each class reflect the ability of the persistent plant community to retain water, nutrients, soil, and other resources (litter, seeds). These resources have a greater potential to be retained at lower class values.

Unlike the gap intercept method that measures interpatches (gaps) in one dimension along a transect line (Herrick et al. 2009), the RRC considers interpatch size and shape in two dimensions and, therefore, patch connectivity.

Resource Retention Class (RRC)

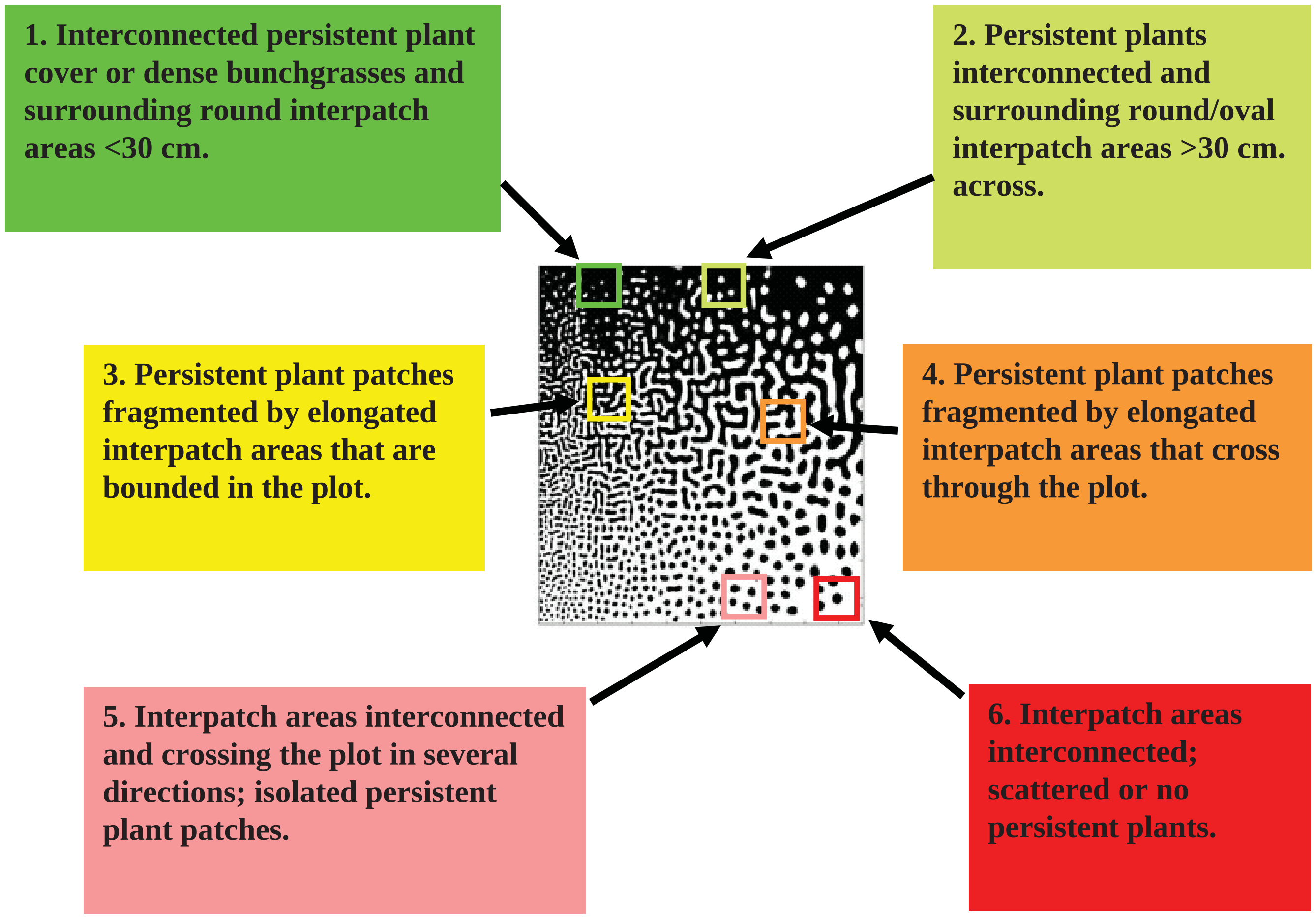


Figure 16. A schematic overview of resource retention classes (RRC) comparing the patterns described by each class. The image shows a continuum of patterns of vegetation fragmentation produced by a simulation model, where the dark areas represent **persistent plant patches** and the white areas are interpatch areas. The colored squares represent plots and the patch-interpatch patterns within each plot correspond to the associated RRC class. The figure was adapted from Reitkerk et al. (2004).

Resource Retention Class (RRC) Terminology

Persistent vascular plant: a long-lived, vascular plant species that remains on the site for multiple years, or a short-lived species that consistently replaces itself in the same location year after year.

Persistent plant patch: a discrete group of multiple individuals of one or more persistent vascular plant species separated from other such patches by an interpatch area. Persistent plant patches do not include annuals and short-lived plants that may be absent on the site during wind or water erosion events, nor non-vascular plants that are considered part of the pedoderm. Persistent plant patches trap and retain water, nutrients and soil due to their persistent physical structures. There is often (but not always) evidence of sediment accumulation within a persistent plant patch.

As a general guideline, a persistent plant patch consists of multiple plants whose plant bases are within 20 cm of one another. A separate patch is recognized when the spacing between adjacent plants in a given direction is greater than 20 cm.

Resource Retention Class (RRC) Terminology cont.

Interpatch area: an area without perennial, long-lived vascular plants; effectively the soil pedoderm or the soil pedoderm with short-lived, non-persistent plants. Interpatch areas are generally recognized when plant spacing exceeds 20 cm. Areas covered by rock fragments, mineral soil, litter, duff, biological/physical crusts, and annual/non-persistent plants are considered interpatch areas because the RRC focuses on the role of persistent vascular plant cover and the arrangement of that cover in stabilizing the soil surface and capturing resources. Interpatch areas can be sources of water runoff and bare or disturbed soil pedoderms are often sources of sediment.

Resources: water, soil, litter, seeds, and nutrients considered in the context of ecosystem or landscape function.

Resource Retention Class (RRC) Terminology cont.

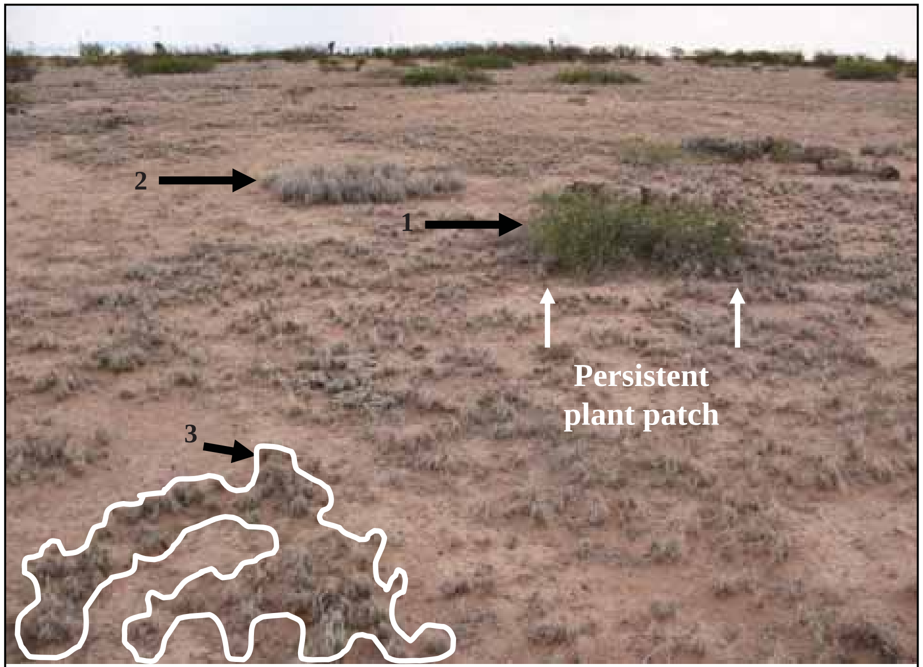


Figure 17. Three discrete patch types occur in this system.

Patch composition can be described on the data form (Table 2) as:

Spp code:		General:		Lifeform code:
(1) PRGL2,	or	shrub,	or	SH
(2) PLMU3,	or	perennial mid-grass,	or	mid PG
(3) SCBR2,	or	perennial short grass,	or	short PG

The white arrows show the width of the PRGL2 patch. The white lines indicate the SCBR2 patch.

Persistent plant patch

- plant parts that are at or near the soil surface
- not shrub canopies high above the soil surface (they trap few resources moving across the soil)
- plant bases and portions of the canopy at the soil surface.

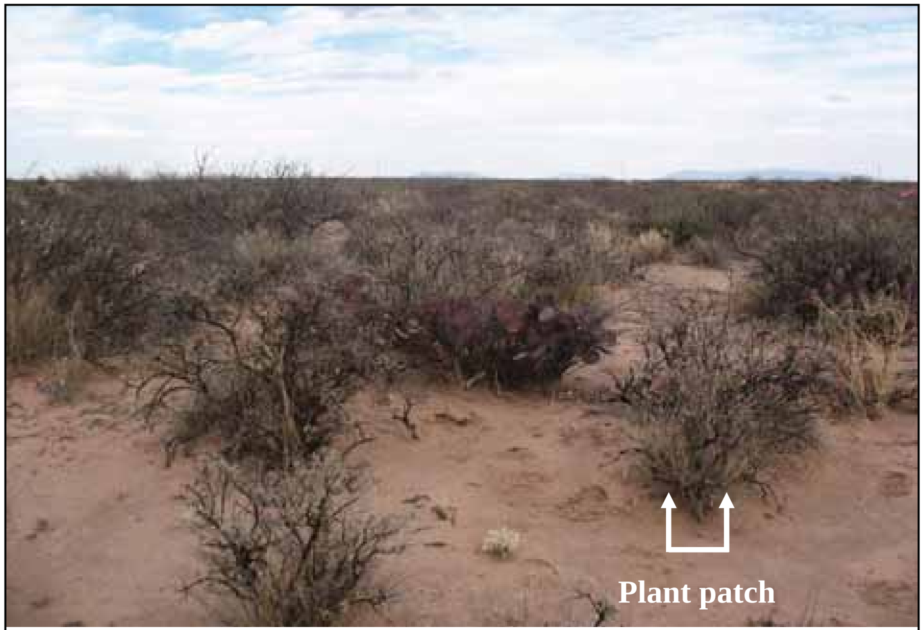


Figure 18. Plant patches here always include tarbush (*Flourensia cernua*; FLCE) accompanied by one or more additional species, almost always including a long-lived perennial mid-grass species. These plant patches can be described on the data form (Table 2) as FLCE mixed with perennial grasses and other species (SH w/ mid PG, etc). The width of a patch is shown with white arrows. Note that the patch width is smaller than the width of the canopy.

Resource Retention Class (RRC) Method

Walk around a 20 m x 20 m area (or other defined area representing a plot), typically centered on the soil pit. Observe the size and shape of interpatch areas (> 20 cm across) as well as the size and connectivity of persistent vascular plants.

Consider how the persistent plants are influencing lateral resource movement on the site.

Evaluate overland water flow paths from the uphill side of the plot to the downhill side of the plot. How far can water travel before encountering a persistent plant patch that would slow water flow and trap sediments (i.e., what is the length of the interpatch area)?

Begin at the prevailing windward side of the plot, assess the likely paths wind would travel as moving leeward. How far can wind travel in interpatch areas before encountering a persistent plant patch that would intercept wind-born sediment (i.e., what is the length of the interpatch area or fetch)?

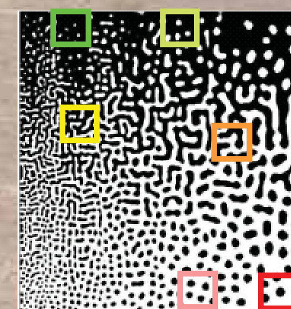
Now, keeping in mind their lengths, how wide are these interpatch areas?

Resource Retention Class (RRC) Method

After observing the size and shape of interpatch areas throughout the plot, consider the following questions when selecting a RRC:

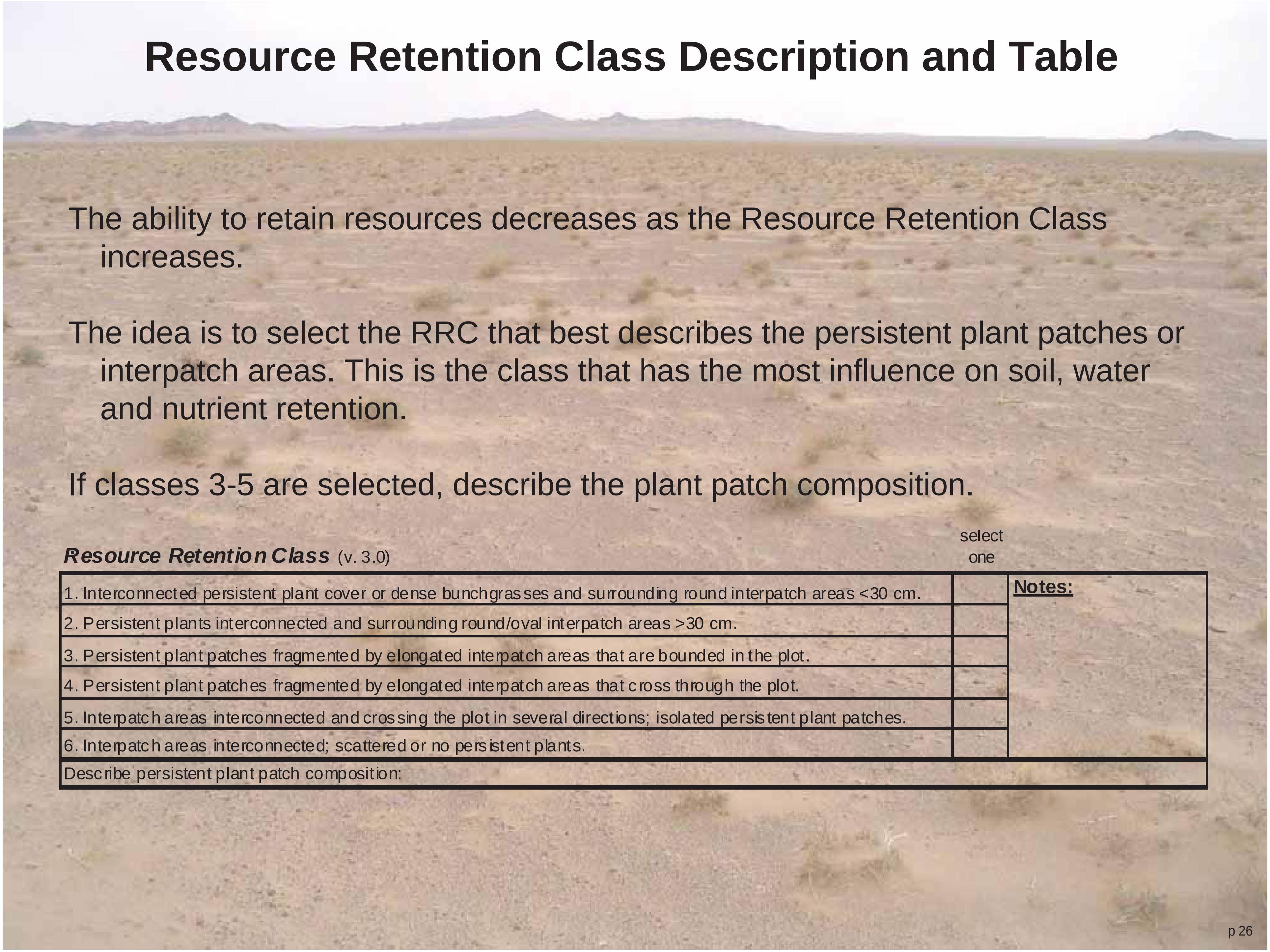
Are the interpatch areas small (<30 cm in diameter) and oval or round in shape?
Or are the interpatch areas distinctly longer than they are wide?
Do the interpatch areas create pathways for wind and/or water that
- are bounded within the plot?
- extend across the plot?

Are the interpatch areas roughly as long as they are wide and interconnected in several directions?



Is the plot characterized by a matrix of interconnected persistent plants with or without scattered interpatch areas (e.g., RRC 1 or 2)?
Or, is the site described better as a matrix of interconnected interpatch areas surrounding isolated, scattered or no persistent plant patches (e.g., RRC 5 or 6)?
If the plot falls somewhere in between the two previous conditions, consider classes 3 and 4.

Different areas of the plot may be best described by more than one class, but the goal is to assign the plot to a single class. In general, choose the class that is likely to have the greatest influence on the site or is of greatest concern.



Resource Retention Class Description and Table

The ability to retain resources decreases as the Resource Retention Class increases.

The idea is to select the RRC that best describes the persistent plant patches or interpatch areas. This is the class that has the most influence on soil, water and nutrient retention.

If classes 3-5 are selected, describe the plant patch composition.

Resource Retention Class (v. 3.0)

	select one	
1. Interconnected persistent plant cover or dense bunchgrasses and surrounding round interpatch areas <30 cm.		**Notes:**
2. Persistent plants interconnected and surrounding round/oval interpatch areas >30 cm.		
3. Persistent plant patches fragmented by elongated interpatch areas that are bounded in the plot.		
4. Persistent plant patches fragmented by elongated interpatch areas that cross through the plot.		
5. Interpatch areas interconnected and crossing the plot in several directions; isolated persistent plant patches.		
6. Interpatch areas interconnected; scattered or no persistent plants.		
Describe persistent plant patch composition:		

Resource Retention Class 1: Interconnected persistent plant cover or dense bunchgrasses and surrounding round interpatch areas <30 cm.

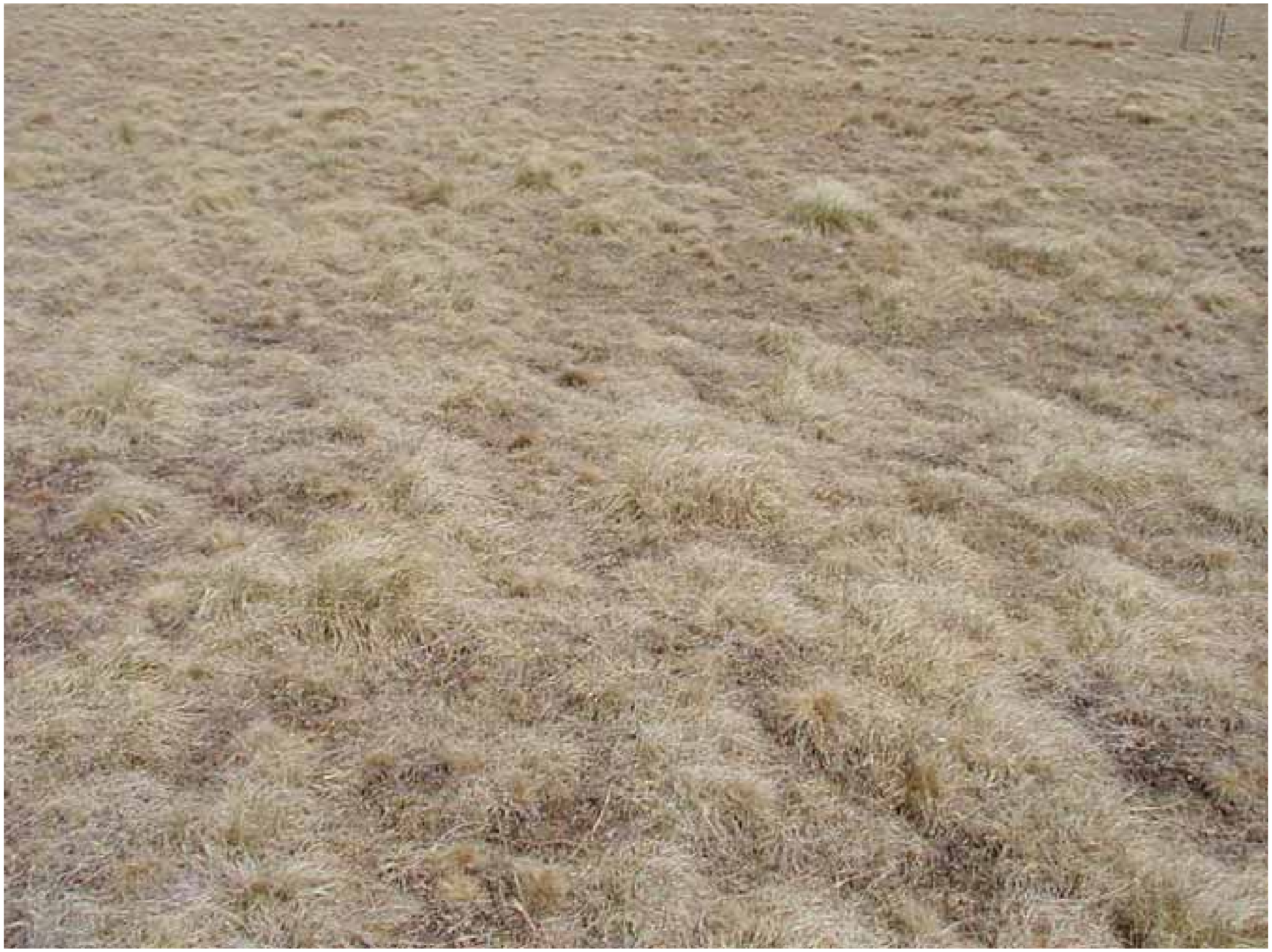


Figure 19. Resource Retention Class 1: Interconnected persistent plant cover or dense bunchgrasses and surrounding round interpatch areas <30 cm. Interpatch areas among the persistent plants are less than 30 cm in size throughout the plot. In order to select this class, interconnected persistent plants must be the prevalent feature on your plot (not interpatch areas nor ephemeral, short-lived grasses or forbs). The plant community is likely a grassland, altered grassland, shrub/tree-invaded grassland, or shrub/tree savanna community.

Resource Retention Class 2: Persistent plants interconnected and surrounding round/oval interpatch areas >30 cm.

Figure 20. Resource Retention Class 2: Persistent plants interconnected and surrounding round/oval interpatch areas >30 cm. Interpatch areas are larger than 30 cm throughout the plot, and persistent plants are connected throughout the plot. In order to select this class, persistent plants must characterize the plot (not interpatch areas nor ephemeral, short-lived grasses or forbs). The plot is likely in a grassland, altered grassland, shrub/tree-invaded grassland, shrub/tree savanna or altered savanna community.

Resource Retention Class 3: Persistent plant patches fragmented by elongated interpatch areas that are bounded in the plot.

Figure 21. Resource Retention Class 3: Persistent plant patches fragmented by elongated interpatch areas that are bounded in the plot. Persistent plant patches are separated by elongated interpatch areas, but those interpatch areas do not cross the entire width of the plot (are bounded within the plot). If this class is selected, the plot is likely in an altered grassland, a shrub/tree savanna or shrub/tree-invaded grassland community.

Resource Retention Class 4: Persistent plant patches fragmented by elongated interpatch areas that cross through the plot.

Figure 22. Resource Retention Class 4: Persistent plant patches fragmented by elongated interpatch areas that cross through the plot. Persistent plant patches are separated by elongated interpatch areas and those interpatch areas repeatedly cross the entire width of the plot or extend beyond the plot's dimensions (are not bounded within the plot). A plot in this class is likely in an altered grassland, a shrub/tree savanna or shrub/tree-invaded grassland community.

Resource Retention Class 5: Interpatch areas interconnected and crossing the plot in several directions; isolated persistent plant patches.

Figure 23. Resource Retention Class 5: Interpatch areas interconnected and crossing the plot in several directions; isolated persistent plant patches. Persistent plants are not the dominant feature on your plot and those that are present are found in scattered, isolated patches. Plots in this class are likely in a shrub/tree dominated or shrubland plant communities. The plot may also be in an area dominated by bare ground and/or ephemeral or short-lived species.

Resource Retention Class 6: Interpatch areas interconnected; scattered or no persistent plants.

Figure 24. Resource Retention Class 6: Interpatch areas interconnected; scattered or no persistent plants. There are no persistent plants on the plot, or only a few individual plants exist. A plot in this class is likely in a shrubland plant community, a bare area, or possibly in an altered grassland.

Resource and Soil Redistribution Processes and Indicators

Soil redistribution processes:

Erosion (by wind and water)

Deposition (by wind and water)

Water processes and indicators

Splash erosion – raindrop impact dislodges soil as it collides with the bare mineral soil surface, causing erosion of thin layers of soil (<5 mm)

Litter movement – rainfall rates exceed infiltration rates, water collects on soil surface, water begins to move down slope, water velocity and volume increases, small particles of litter become entrained in moving water

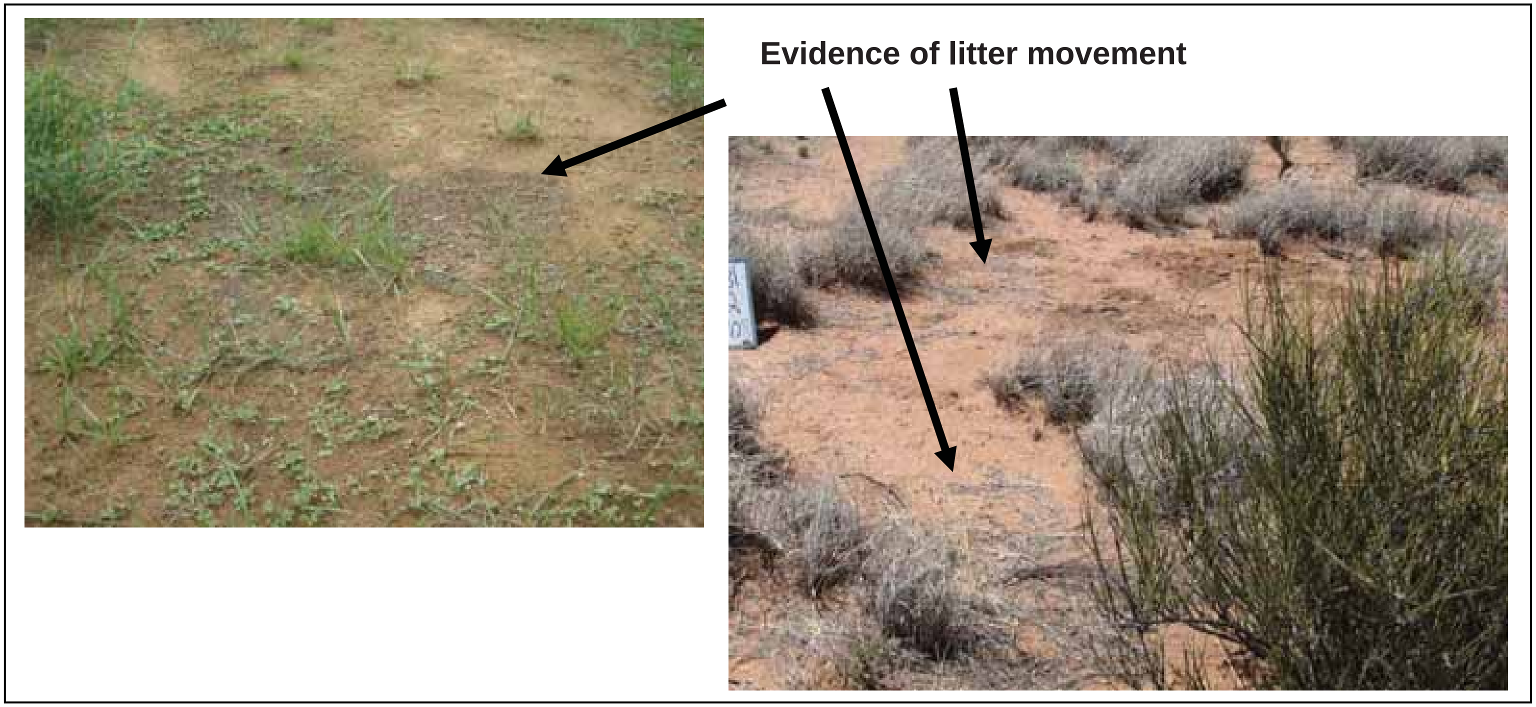
- easiest to see when litter moves from under plant canopies to interspaces

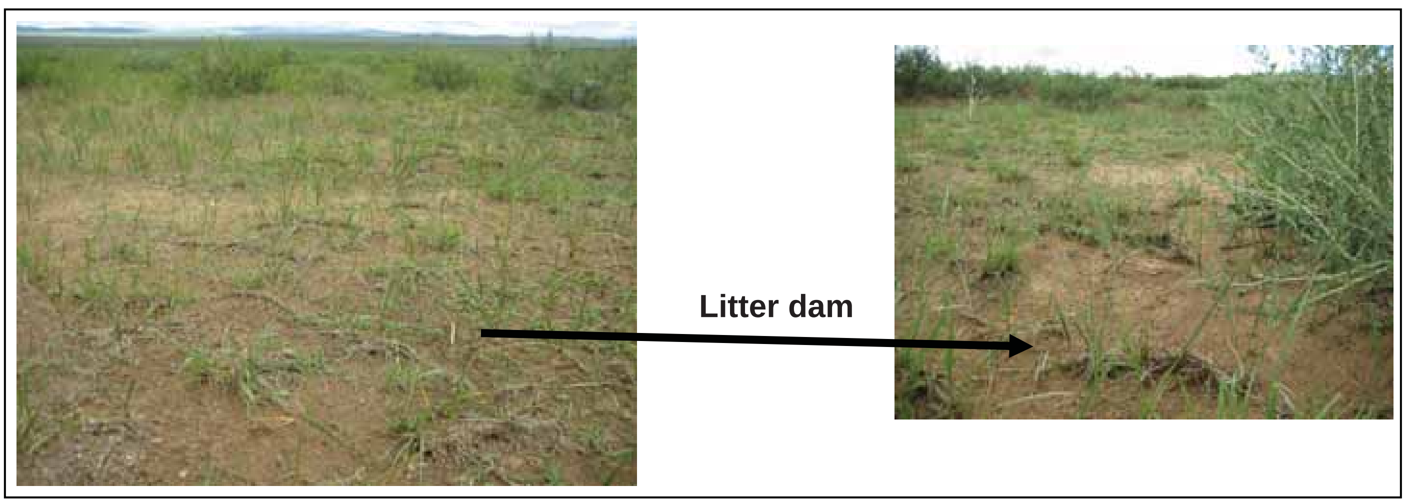
Litter dam - an increase in water momentum leads to more and larger pieces of litter being transported. When water encounters an obstacle, the rate of flow is reduced and litter is deposited, usually in the form of a litter dam.

*Litter movement and litter dams are evidence of soil redistribution only when soil is entrained in the litter!

Resource and Soil Redistribution Processes and Indicators

Litter movement and litter dams





Resource and Soil Redistribution Processes and Indicators

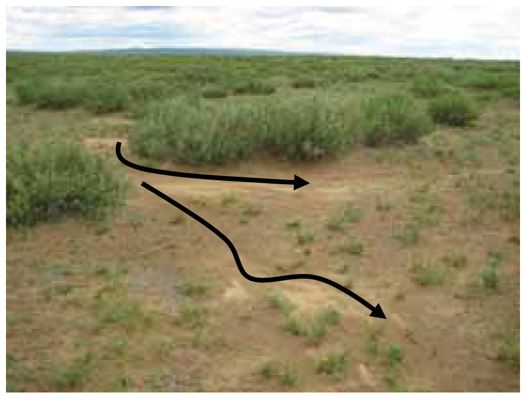
Water processes and indicators continued

<u>Concentrated flow</u> – as interpatch size increases and elongates, soil and water are transported down slope in slightly channeled areas

- Water flow patterns
- Sheet erosion
- Rill erosion
- Gully erosion

Resource and Soil Redistribution Processes and Indicators

Water flow patterns - the slightly channeled areas resulting from concentrated flow; depth of soil erosion varies from one millimeter to at most a few centimeters, and is deepest at the center



Sheet erosion – occurs when slightly channeled flows become interconnected, resulting in unchanneled surface water flow (sheet flow) and uniform removal of thin layers of soil

Resource and Soil Redistribution Processes and Indicators

Rill and gully erosion

Rills - as water flow becomes more concentrated and channelized, more soil is displaced and rills are formed that are several centimeters deep

Gullies - the most severe concentrated flow forms gullies, which are steep sided and usually ≥50 cm deep

Resource and Soil Redistribution Processes and Indicators

Wind processes and indicators

Litter movement - Wind also begins by entraining and transporting litter

Litter dams – increases in wind speed moves more and larger pieces of litter, litter falls out of the wind column and forms litter dams at obstacles to flow

Ability of the soil to resist wind erosion decreases as:

- Wind speeds increase
- Interpatch areas expand
- Plant stature decreases
- Soil aggregates become smaller/weaker (soil texture)

Saltation – a soil particle or aggregate is dislodged by wind, but is too heavy to be carried more than a few centimeters; as it falls back to the soil surface it causes the movement of additional soil particles

- the erosive forces of saltation increase with increasing wind speed
- within an interpatch area, erosion from saltation increases from the windward side, is greatest in the middle of an interpatch area, and decreases as it nears obstacles to flow (leeward side)

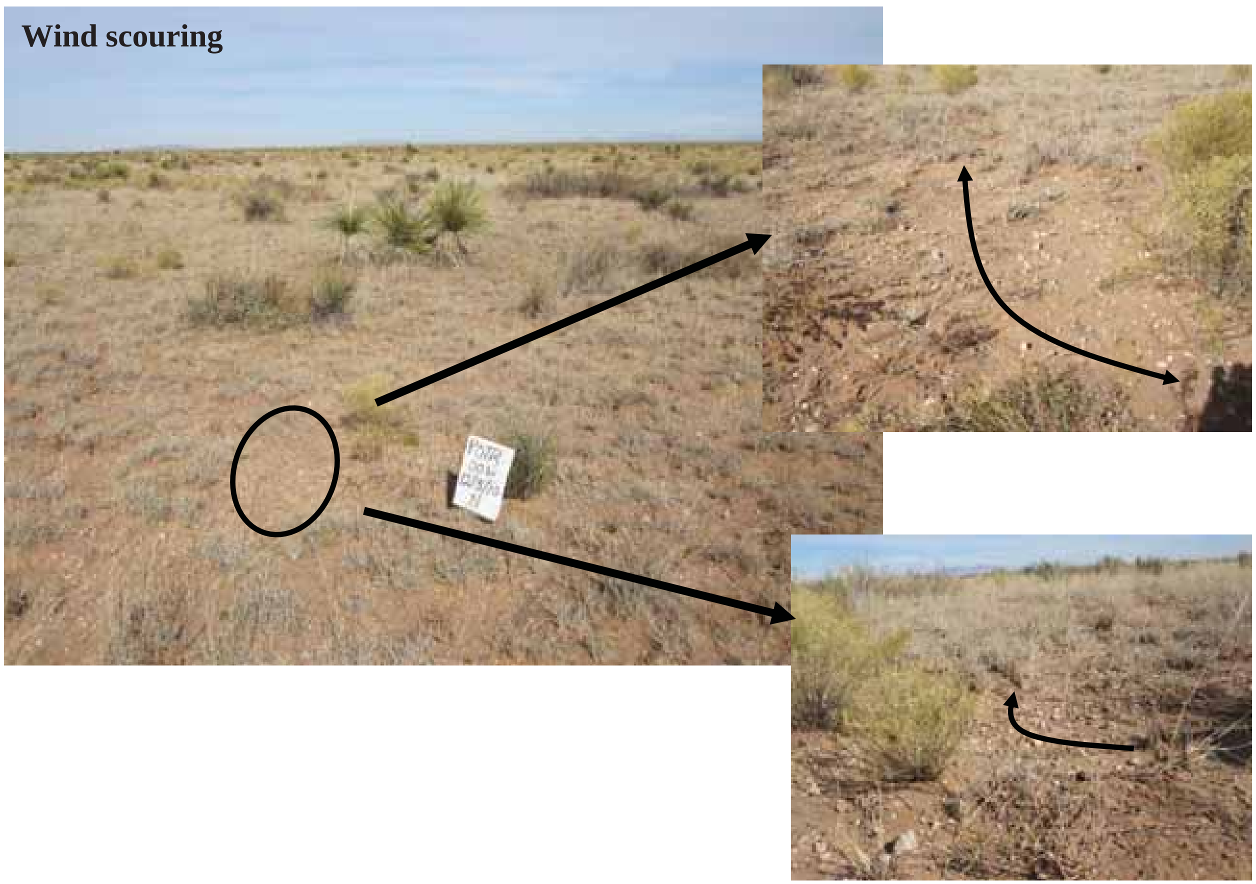
p 46-47

Resource and Soil Redistribution Processes and Indicators

Wind processes and indicators continued

Wind scouring – occurs as saltation becomes more severe; appears as a concave or platter-shaped bare area with as little as 1 mm of soil loss at the outer edges of the interpatch, up to several centimeters in the center.

- begins as patchy soil loss where interpatch areas are fairly small and not connected; can increase to large areas encompassing most or all of the plot



Resource and Soil Redistribution Processes and Indicators
Wind and Water

Pedestals – with continued erosion (wind or water), soil is removed from directly around the plant bases, forming plant pedestals

Compare the height of the plant bases to the non-mounded soil surface to determine the amount of soil lost.

Resource and Soil Redistribution Processes and Indicators

Exposed roots -continued wind and water erosion reveals exposed roots of the pedestalled plants

Exposed roots

Prominent pedestals with dead or decadent plants - usually seen in areas with ≥10 cm of soil loss; root exposure stresses plants causing decadence or mortality

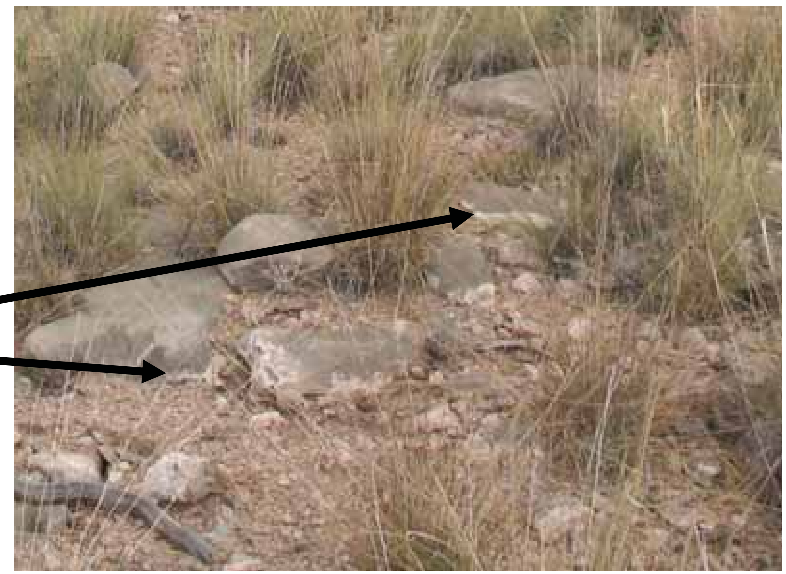
Resource and Soil Redistribution Processes and Indicators

Gravel lag - forms when wind and water remove small soil particles (<5 mm in diameter) and the remaining rock fragments are left behind to accumulate on the soil surface

Gravel lag

Resource and Soil Redistribution Processes and Indicators

Soil lines on rock fragments - rocks within the soil profile can become coated with clay, carbonates or stained with minerals; when soil material erodes away from the rocks, the coats and stains are exposed as soil lines on rock fragments roughly parallel to the soil surface



Soil lines / stains on rock fragments

Resource and Soil Redistribution Processes and Indicators

Scarplets - formed when highly erosive events or prolonged wind or water erosion removes 3-20 cm of soil within small areas

scarplet

Scarps - formed in the same manner as scarplets, but are more expansive and appear as escarpments or benches 20-50 cm in height

scarp

Resource and Soil Redistribution Processes and Indicators

Wind and Water

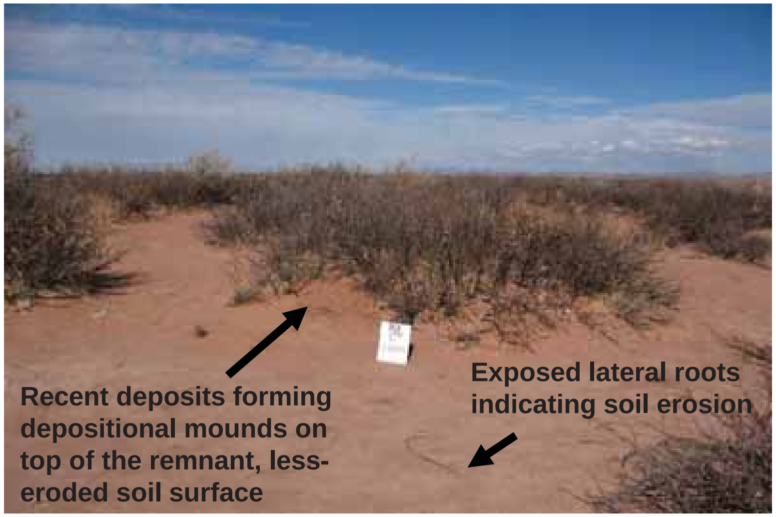
Exposed subsoil – severe erosion, including gully erosion, deep wind scouring and deep sheet erosion completely removes the soil surface (O and A horizons) and results in exposed subsoil (B, C and R horizons), typically featuring exposed roots

Resource and Soil Redistribution Processes and Indicators

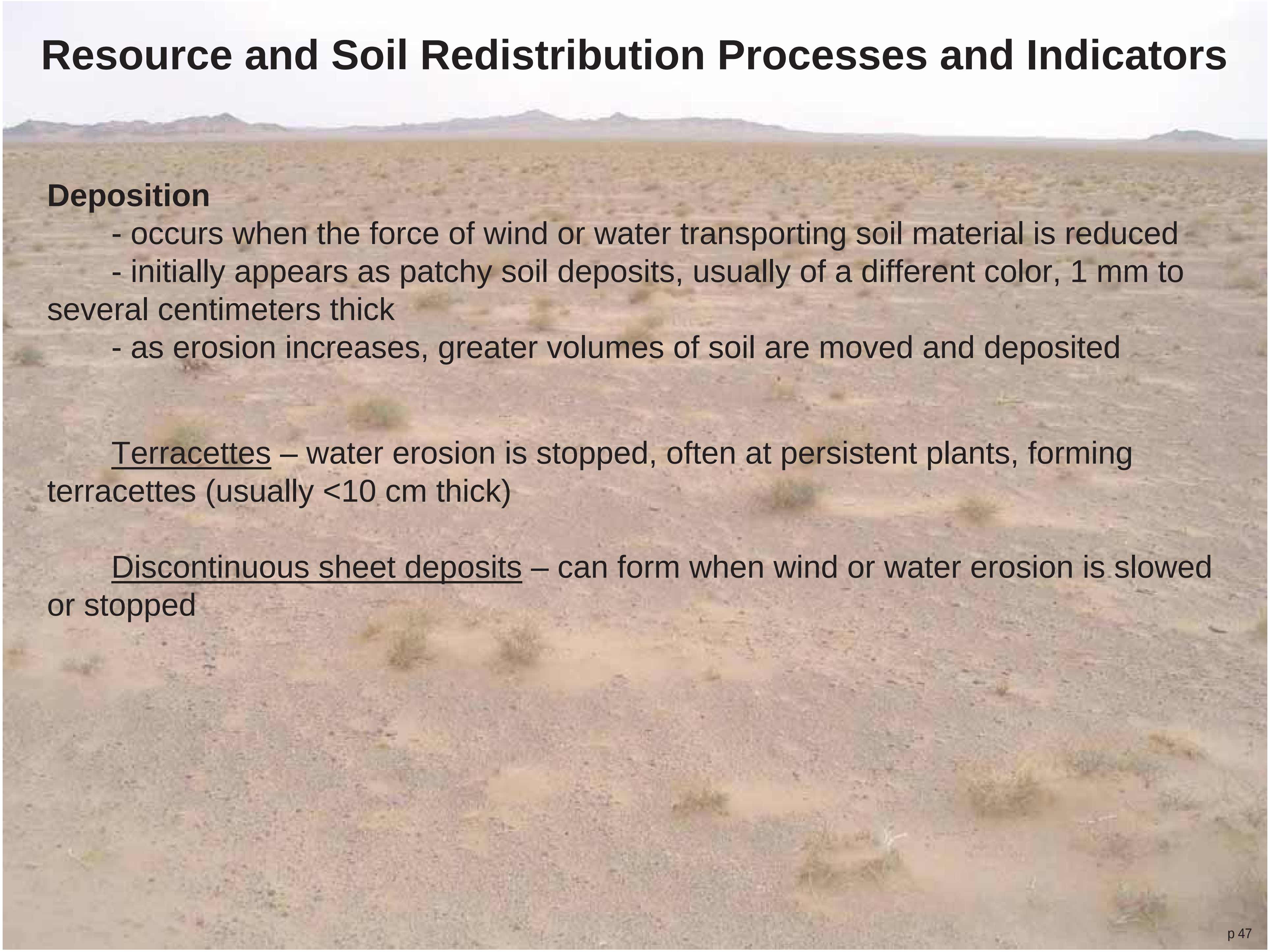
Soil mounds - patches of stable soil or soil mounds of the remnant, less-eroded soil surface remain only where persistent plants or other features stabilize the soil; the elevated position of these soil mounds above the surrounding interpatch soil surface is evidence of soil loss

Soil mounds formed from erosion

Soil mounds formed from a combination of erosion & deposition



Resource and Soil Redistribution Processes and Indicators



Deposition

- occurs when the force of wind or water transporting soil material is reduced
- initially appears as patchy soil deposits, usually of a different color, 1 mm to several centimeters thick
- as erosion increases, greater volumes of soil are moved and deposited

Terracettes – water erosion is stopped, often at persistent plants, forming terracettes (usually <10 cm thick)

Discontinuous sheet deposits – can form when wind or water erosion is slowed or stopped

Resource and Soil Redistribution Processes and Indicators

Deposition

Thin soil deposits

Thin, discontinuous sheet deposits -

Resource and Soil Redistribution Processes and Indicators

Deposition continued

Depositional mounds – are soil mounds formed via sediment deposition
- depositional mounds increase in size due to prolonged deposition, typically from offsite sources

Partial burial of plants or stones – because persistent plants and large rock fragments are obstacles to wind and water flow, deposition begins by partially burying these obstacles (<10 cm thick)

Continuous sheet deposits – occur in low-lying, level positions as the severity of offsite erosion and sediment sources increase

Burial of plants and stones – occurs with prolonged deposition (>10 cm thick) from offsite sources; favoring persistent plants that tolerate thick deposition

Coppices –form at persistent plants via thick deposition, forming a hummocky surface appearing as numerous dunes (typically much greater than 10 cm tall)

Resource and Soil Redistribution Processes and Indicators

Plant burial, depositional mounds

Partial plant burial, small depositional mounds

Plant burial, depositional mounds

Plant burial, large depositional mounds

Coppicing

Soil Redistribution Class (SRC) Definition

A description of the extent and severity of soil redistribution processes (erosion and deposition by wind and water) across a plot. Redistribution processes are indicated by multiple features that include, but are not limited to, pedestals, water flow patterns, depositional mounds and carbonate coats or clay color stains on rock fragments. The features of each class influence the ability of the soil to support plant communities and other functions. The extent and severity of soil redistribution and its effects on plants are greater at higher class values (Fig. 25).

Soil Redistribution Class Description and Table

Soil Redistribution Class (v. 3.1)	select one
0. **No evidence of erosion or deposition**.	
1. **Very slight soil redistribution**. *No noticeable thinning of the soil surface and soil movement occurs within a matrix of vegetated/stable soil.* Evidence includes narrow, elongate, sometimes tortuous, water flow patterns and litter movement with entrained soil, indicating loss or deposits of <1 cm of soil from wind or water.	
2. **Patchy, slight (typically 1-5 cm) soil loss and deposition**[3,4]. *The soil surface is thinned in discrete patches within a matrix of vegetated/stable soil. Sediment source may be on or off the plot.* Evidence includes pedestals, soil lines on rock fragments, terracettes, water flow patterns, litter dams with entrained soil, wind scouring and soil mounds.	
3a. **Extensive, moderate soil loss (1-10 cm)**[3,4]. *Noticeable thinning of the soil surface across the plot, with or without patches of stable soil or sediment accumulation. Patches of stable soil and sediment deposits are typically associated with persistent plants.* Evidence includes soil mounds, pedestals throughout the plot, soil lines on rock fragments, scarplets, gravel lag, water flow patterns and rills suggesting the loss of several centimeters of surface soil across most of the plot.	
3b. **Extensive, moderate soil deposition (1-10 cm)**[3,4]. *Sediment deposits (1-10 cm thick) common across the plot from a sediment source off the plot. Sediment accumulation can be associated with erosion or redistribution of sediments suggesting that soil is currently moving into and out of the plot.* Evidence includes depositional mounds throughout the plot, partial burial of plants or stones, terracettes and discontinuous sheet deposits. These features are sometimes associated with scattered pedestals, water flow patterns and rills indicating erosion or local redistribution of the sediment deposits.	
4a. **Extensive, severe erosion (>10 cm); little deposition**. *Plot is embedded in an extensive area of erosion.* Evidence includes scarplets, scarps, gravel lag, soil lines on rock fragments, prominent pedestals (often with decadent or dead plants), rills, gullies, exposed roots and exposed subsoil. A site with a SRC of 4a is an eroding site, usually caused by fluvial processes.	
4b. **Extensive, severe erosion (>10 cm) with patchy sediment deposition**[3,4]. *Plot is embedded in an extensive area of erosion and deposition.* Evidence includes scarplets, scarps, gravel lag, soil lines on rock fragments, prominent pedestals often with decadent or dead plants, rills, gullies, exposed roots, exposed subsoil, extensive wind scouring, soil mounds, terracettes and buried plants indicating substantial deposition. Usually associated with a mix of fluvial and eolian processes.	
4c. **Extensive, severe sediment deposition (>10 cm)**[3,4]. *Sedimentation continuous across plot. May be hard to detect without excavation. Sediments originate from off the plot.* Evidence includes depositional mounds or continuous sediment deposits, buried plants or stones, coppicing and hummocky surface. Rills may be present. Deposition can be caused by fluvial or eolian processes.	

Notes:	
	_______ cm = Average Thickness of Deposition
	_______ cm = Average Depth of Erosion

Severity increases ↓

Spatial extent increases ↓

[3] Depositional mounds are formed by the settling of sediment transported by wind and water movement; mounds can occur on or behind obstructions or where wind/water velocity is reduced.

[4] Confirm deposition within a soil pit. Recently deposited material is usually seen as a thinly or finely stratified soil surface with alternating thin layers of varying textures; lacks structure.

Soil Redistribution Class (SRC)

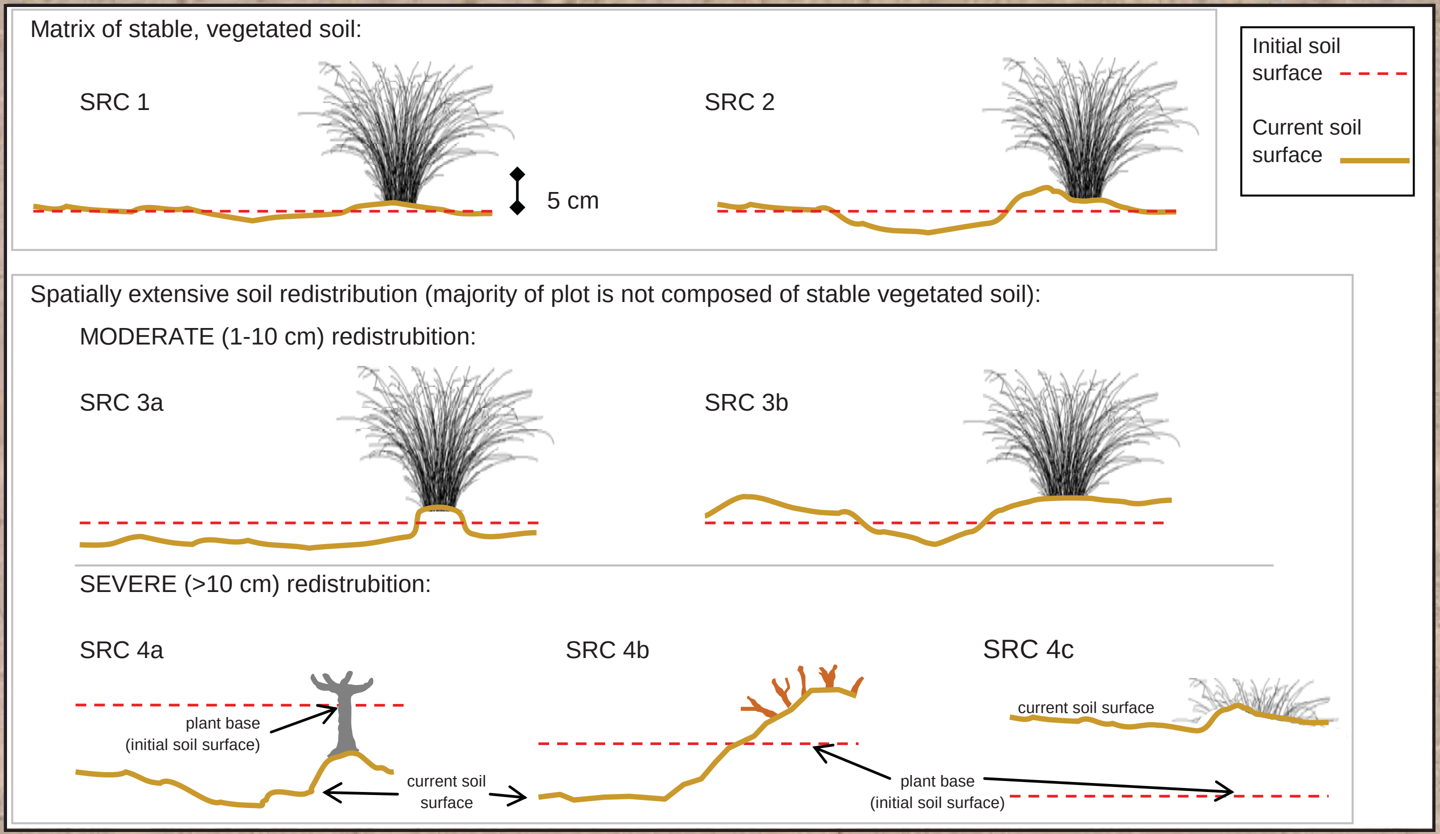


Figure 25. Depiction of increasing severity of soil redistribution with greater soil redistribution classes. Lateral extent of soil redistribution increases at higher class values.

Soil Redistribution Class (SRC)

The focus of SRC is on evidence of active and recent erosion and deposition processes.

SRC focuses on how soil redistribution influences the current plant communities and soil movement rates.

It is important to disentangle recent from historical redistribution processes, and consider only recent/active indicators when selecting a SRC.

At a given point in time, either erosion or deposition can be most apparent, or both can be equally apparent. Care must be taken to determine whether only one or both are affecting a site.

Soil Redistribution Class (SRC) Method

Walk around a 20 m x 20 m area (or other defined area representing a plot), and observe evidence of the erosional and depositional processes occurring on the site. Evidence of soil redistribution can include one or more indicators. See the “Soil Redistribution Classes Descriptions” for indicators commonly found in each SRC.

Step 1. Spatial extent of soil redistribution

The spatial extent of soil redistribution spans the following continuum

none	very slight	patchy	extensive
SRC 0	SRC 1	SRC 2	SRCs 3a-4c

The spatial extent of soil redistribution increases as the evidence of erosion or deposition becomes more common throughout a plot.

Answer the following questions:

Is soil loss or deposition extensive and occurring throughout most of the plot?

If **yes**, the plot is in class 3a, 3b, 4a, 4b or 4c. The plot contains widespread evidence of soil redistribution as evidenced by numerous, repeating indicators of erosion/deposition. Proceed to Step 2

Soil Redistribution Class (SRC) Method cont.

Step 1 cont:

Is soil loss or deposition extensive and occurring throughout most of the plot?

If the answer is **no** (soil loss or deposition is not extensive), the plot is in SRC 0, 1 or 2. Continue with the following questions to assign the class:

Is there evidence of erosion or deposition?

No – Select SRC ‘0’ on the data form

Is there very slight soil movement within a vegetated matrix?

Yes – Select SRC ‘1’ on the data form

Do indicators of soil redistribution occur in patches surrounded by a matrix of stable vegetated soil?

Yes – Select SRC ‘2’ on the data form

Step 2. Severity of soil redistribution

Severity is determined by the difference in elevation between the plant base and the soil surface. Is the depth of erosion and thickness of deposition more or less than 10 cm?

Determine whether the difference in elevation is due to erosion, deposition or both. It may be necessary to dig a small pit at the bases of plants.

Evidence of erosion: plant base is elevated above the soil surface (pedestalled)

Evidence of deposition: plant base lies below the soil surface, can see partial burial of plants and recent deposits.

p 31-32

Severity of Soil Redistribution

Step 2 cont:

Recent deposits: thinly stratified soil surface with alternating platy layers and layers lacking structure; structureless deposits that are a different color from the underlying soil surface

Evidence of both: Soil mounds formed through both erosion and deposition appear as soil with a different color or texture (frequently finely stratified) that sits on top of an eroded soil surface

The dominance or codominance of erosion and deposition is determined by their areal coverage relative to one another within the plot

Answer the following questions and review Fig. 25 to select the correct class.

Is the plot dominated by 1-10 cm of soil loss?

Yes – Select SRC '3a' on the data form

Is the plot dominated by sediment deposits 1-10 cm thick from a source off the plot?

Yes – Select SRC '3b' on the data form

Is the plot dominated by >10 cm of soil loss or an exposed subsoil throughout the majority of the plot AND soil deposition is not codominant?

Yes – Select SRC '4a' on the data form

Are patchy sediment deposits codominant with soil loss >10 cm thick, or an exposed subsoil, across the plot?

Yes – Select SRC '4b' on the data form

Is the plot dominated by continuous or >10 cm thick sediment deposits?

Yes – Select SRC '4c'

Step 3. Review class descriptions and select a class.

Refer to the definitions on the data form to verify class selection. If the description does not match initial class selection, re-evaluate the plot and select a different class. Record deposition and erosion.

Soil Redistribution Class (SRC) Method and Table

Select one SRC Class

- Key concept for each class is italicized
  - focus on these italicized concepts when selecting a class
- Evidence for each class follows the italicized concept
  - do not need to have all items listed to select a class
- Record average thickness of deposition for the entire plot if class 2, 3a, 3b, 4b or 4c is selected
- Record average depth of erosion if class 2, 3a, 4a or 4b is selected

Soil Redistribution Class (v. 3.1)	select one
0. **No evidence of erosion or deposition**.	
1. **Very slight soil redistribution**. *No noticeable thinning of the soil surface and soil movement occurs within a matrix of vegetated/stable soil.* Evidence includes narrow, elongate, sometimes tortuous, water flow patterns and litter movement with entrained soil, indicating loss or deposits of <1 cm of soil from wind or water.	
2. **Patchy, slight (typically 1-5 cm) soil loss and deposition**[3,4]. *The soil surface is thinned in discrete patches within a matrix of vegetated/stable soil. Sediment source may be on or off the plot.* Evidence includes pedestals, soil lines on rock fragments, terracettes, water flow patterns, litter dams with entrained soil, wind scouring and soil mounds.	
3a. **Extensive, moderate soil loss (1-10 cm)**[3,4]. *Noticeable thinning of the soil surface across the plot, with or without patches of stable soil or sediment accumulation. Patches of stable soil and sediment deposits are typically associated with persistent plants.* Evidence includes soil mounds, pedestals throughout the plot, soil lines on rock fragments, scarplets, gravel lag, water flow patterns and rills suggesting the loss of several centimeters of surface soil across most of the plot.	
3b. **Extensive, moderate soil deposition (1-10 cm)**[3,4]. *Sediment deposits (1-10 cm thick) common across the plot from a sediment source off the plot. Sediment accumulation can be associated with erosion or redistribution of sediments suggesting that soil is currently moving into and out of the plot.* Evidence includes depositional mounds throughout the plot, partial burial of plants or stones, terracettes and discontinuous sheet deposits. These features are sometimes associated with scattered pedestals, water flow patterns and rills indicating erosion or local redistribution of the sediment deposits.	
4a. **Extensive, severe erosion (>10 cm); little deposition**. *Plot is embedded in an extensive area of erosion.* Evidence includes scarplets, scarps, gravel lag, soil lines on rock fragments, prominent pedestals (often with decadent or dead plants), rills, gullies, exposed roots and exposed subsoil. A site with a SRC of 4a is an eroding site, usually caused by fluvial processes.	
4b. **Extensive, severe erosion (>10 cm) with patchy sediment deposition**[3,4]. *Plot is embedded in an extensive area of erosion and deposition.* Evidence includes scarplets, scarps, gravel lag, soil lines on rock fragments, prominent pedestals often with decadent or dead plants, rills, gullies, exposed roots, exposed subsoil, extensive wind scouring, soil mounds, terracettes and buried plants indicating substantial deposition. Usually associated with a mix of fluvial and eolian processes.	
4c. **Extensive, severe sediment deposition (>10 cm)**[3,4]. *Sedimentation continuous across plot. May be hard to detect without excavation. Sediments originate from off the plot.* Evidence includes depositional mounds or continuous sediment deposits, buried plants or stones, coppicing and hummocky surface. Rills may be present. Deposition can be caused by fluvial or eolian processes.	

Notes:	
	_______ cm = Average Thickness of Deposition _______ cm = Average Depth of Erosion

[3] Depositional mounds are formed by the settling of sediment transported by wind and water movement; mounds can occur on or behind obstructions or where wind/water velocity is reduced.

[4] Confirm deposition within a soil pit. Recently deposited material is usually seen as a thinly or finely stratified soil surface with alternating thin layers of varying textures; lacks structure.

Soil Redistribution Class 0: No evidence of erosion or deposition.

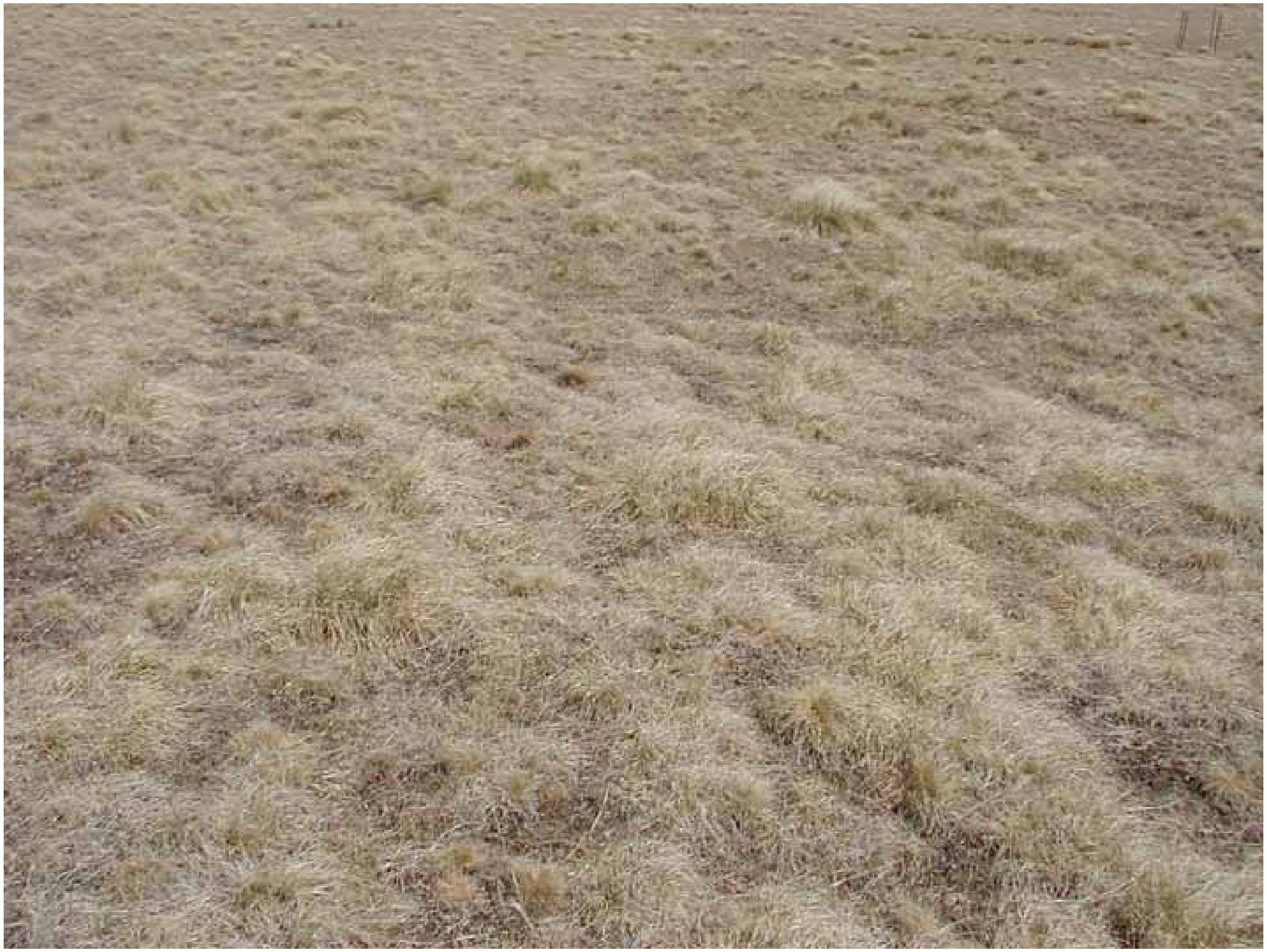


Figure 26. Soil Redistribution Class 0: No evidence of erosion or deposition. There is no evidence of active or recent erosion or deposition on the plot. The following are not present on the plot: water flow patterns, litter dams with entrained soil, pedestals, soil lines on rock fragments, wind scouring, rills, gullies, gravel lag, scarps, scarplets, exposed roots, terracettes, sediment deposits, depositional mounds, burial of plants or stones, sheet deposits, coppicing or hummocky surface. The soil surface (usually A or O horizon) is intact, stable, and has not been recently thinned or received any recent deposits.

Soil Redistribution Class 1: Minor soil redistribution.

Figure 27. Soil Redistribution Class 1: Very slight soil redistribution. *No noticeable thinning of the soil surface and soil movement occurs within a matrix of vegetated/stable soil.* Evidence here shows narrow, elongate, sometimes tortuous water flow patterns indicating loss or deposits of less than 1 cm of soil from wind or water. Most of this plot (SRC = 1) consists of stable/vegetated soil. During strong flow events, thin sediments shift around within the plot. However, there is no net loss or gain within the plot, and the soil surface is intact.

Soil Redistribution Class 2: Patchy, slight (<5 cm) soil loss and deposition.

Figure 28. Soil Redistribution Class 2: Patchy, slight (typically 1-5 cm) soil loss and deposition. *The soil surface is thinned in discrete patches within a matrix of vegetated/stable soil. Sediment source may be on or off the plot.* Evidence on this plot includes pedestals, soil lines on rock fragments, water flow patterns, wind scouring and soil mounds. The majority of this plot is stable/vegetated. Unlike SRCs 0 and 1, this plot (SRC of 2) has patches where the soil surface is thinning, as well as patchy deposits. Deposits can be from soil or resources that originated on the plot, as well as from off-site sources.

Soil Redistribution Class 3a: Extensive, moderate soil loss (1-10 cm).

Figure 29. Soil Redistribution Class 3a: Extensive, moderate soil loss (1-10 cm). *Noticeable thinning of the soil surface across the plot, with or without patches of stable soil or sediment accumulation. Patches of stable soil and sediment deposits are typically associated with persistent plants.* Evidence depicted here includes soil mounds, pedestals throughout the plot, gravel lag and water flow patterns suggesting the loss of several centimeters of surface soil across most of both plots. Unlike SRCs 0, 1, or 2, the majority of the area on a plot with an SRC of 3a is not stable, but has active/recent soil redistribution throughout with patches of stable or vegetated soil (remnants of the intact, non-eroded soil surface with or without small deposits). The primary processes on a site with SRC 3a result in overall loss of soil and other resources. This site differs from those with SRCs of 4a-c in that soil loss is not deep and deposition is not thick. Plots with SRC 3a can have areas with discontinuous sheet deposits and few depositional mounds, but plants and stones are only partially buried and deposits are not thick or continuous.

Soil Redistribution Class 3b: Extensive, moderate soil deposition (1-10 cm).

Figure 30. Soil Redistribution Class 3b: Extensive, moderate soil deposition (1-10 cm). *Sediment deposits (1-10 cm thick) common across the plot from a sediment source off the plot. Sediment accumulation can be associated with erosion or redistribution of sediments suggesting that soil is currently moving into and out of the plot.* Evidence depicted here includes depositional mounds throughout the plot and partial burial of plants. Deposition must be confirmed with a small soil pit. This site (SRC 3b) is not dominated by stable soil. In contrast to SRC 3a, it has thin to moderate sediment deposits throughout most of the plot (aggrading landscape). This class differs from 4b-c in that soil deposition is not thick and is interrupted.

Soil Redistribution Class 4a: Extensive, severe erosion (>10 cm); little deposition.

Figure 31. Soil Redistribution Class 4a: Extensive, severe erosion (>10 cm); little deposition. *Plot is embedded in an extensive area of erosion.* Evidence on this plot includes scarplets, gravel lag, prominent pedestals with decadent or dead plants, rills, exposed roots and exposed subsoil. This is an eroding site, caused by fluvial processes. The soil surface has been removed throughout the majority of the plot (in contrast to SRC 0 to 3b). Small litter or soil dams (sediment from on the site) can be seen scattered throughout the plot at obstacles to flow, but soil deposition does not characterize the plot (compare to SRC 4b and 4c).

Soil Redistribution Class 4b: Extensive, severe erosion (>10 cm) with patchy sediment deposition.

Figure 32. Soil Redistribution Class 4b: Extensive, severe erosion (>10 cm) with patchy sediment deposition. *Plot is embedded in an extensive area of erosion and deposition.* Evidence on this plot includes prominent pedestals with decadent plants, exposed roots, exposed subsoil, extensive wind scouring, soil mounds and buried plants indicating substantial deposition. This is associated with a mix of fluvial and eolian processes. This site shares characteristics of both 4a and 4c; it is both actively eroding and receiving deposits. At least 10 cm of the soil surface has been lost throughout the majority of the plot (in contrast with SRCs 0-3b, 4c) and thick deposition is occurring (in contrast with 4a).

Soil Redistribution Class 4c: Extensive, severe sediment deposition (>10 cm).

Figure 33. Soil Redistribution Class 4c: Extensive, severe sediment deposition (>10 cm). *Sedimentation continuous across plot. May be hard to detect without excavation. Sediments originate from off the plot.* Evidence depicted here includes depositional mounds, continuous sediment deposits, buried plants or stones, coppicing and hummocky surface. A plot with a SRC of 4c is situated within an aggrading landscape. In contrast with classes 0-4a, it is receiving thick (>10 cm) and continuous sediment deposits, burying plants and stones.

Tips for Determining Pedoderm and Pattern Classes

The pedoderm, resource retention and soil redistribution classes are interrelated, HOWEVER

- **They MUST be determined separately!**
- **One class does NOT determine another!**
- **Assign each class FIRST, then interpret the PPCs**

  It is critically important that each class is assigned according to the PPC methods PRIOR to interpretation of PPCs, vegetation and soil data

Soil erosion and deposition are affected by

- **the pedoderm (PC)**
- **the plant and interpatch patterns (RRC)**
- **soil texture**
- **disturbance processes on and off site**

Pedoderm and Pattern Class Interpretation and Use

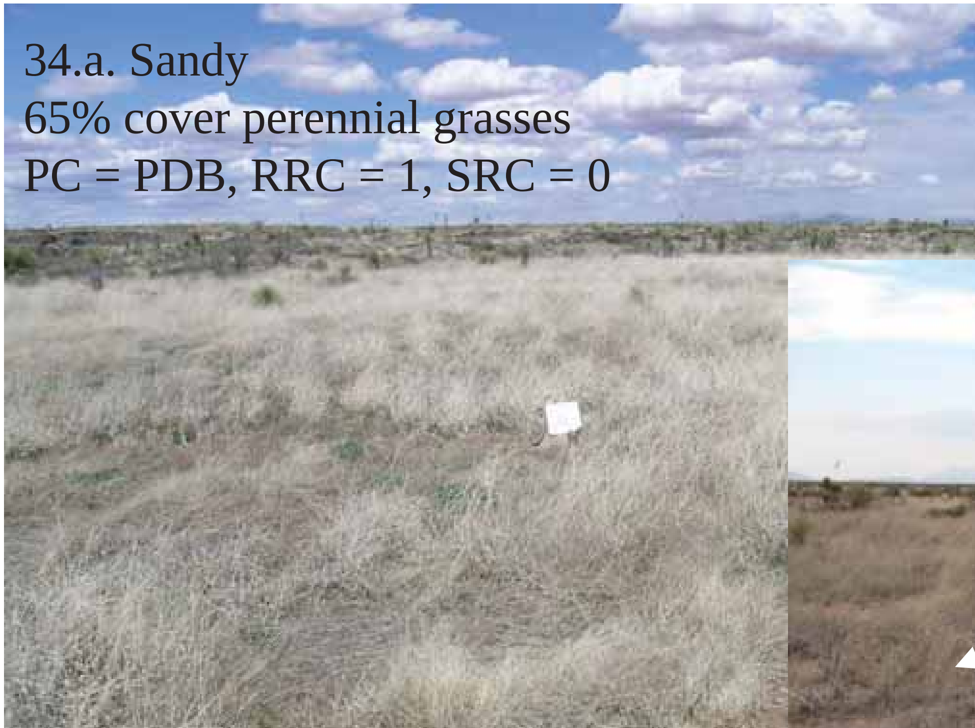
Collectively, the Pedoderm and Pattern Classes:

1. provide a record of current soil and plant community features that affect resources for plant growth, and ultimately, ecosystem function;

2. describe a site using observable features that reflect processes involved in the protection of the soil resource from erosion, the capture and retention of nutrients and water, and the erosion and deposition of soil;

3. together with information about the plant community and soil profile, PPCs provide a rapid assessment of ecosystem function.

Pedoderm and Pattern Classes: Interpretation and Use
Example 1



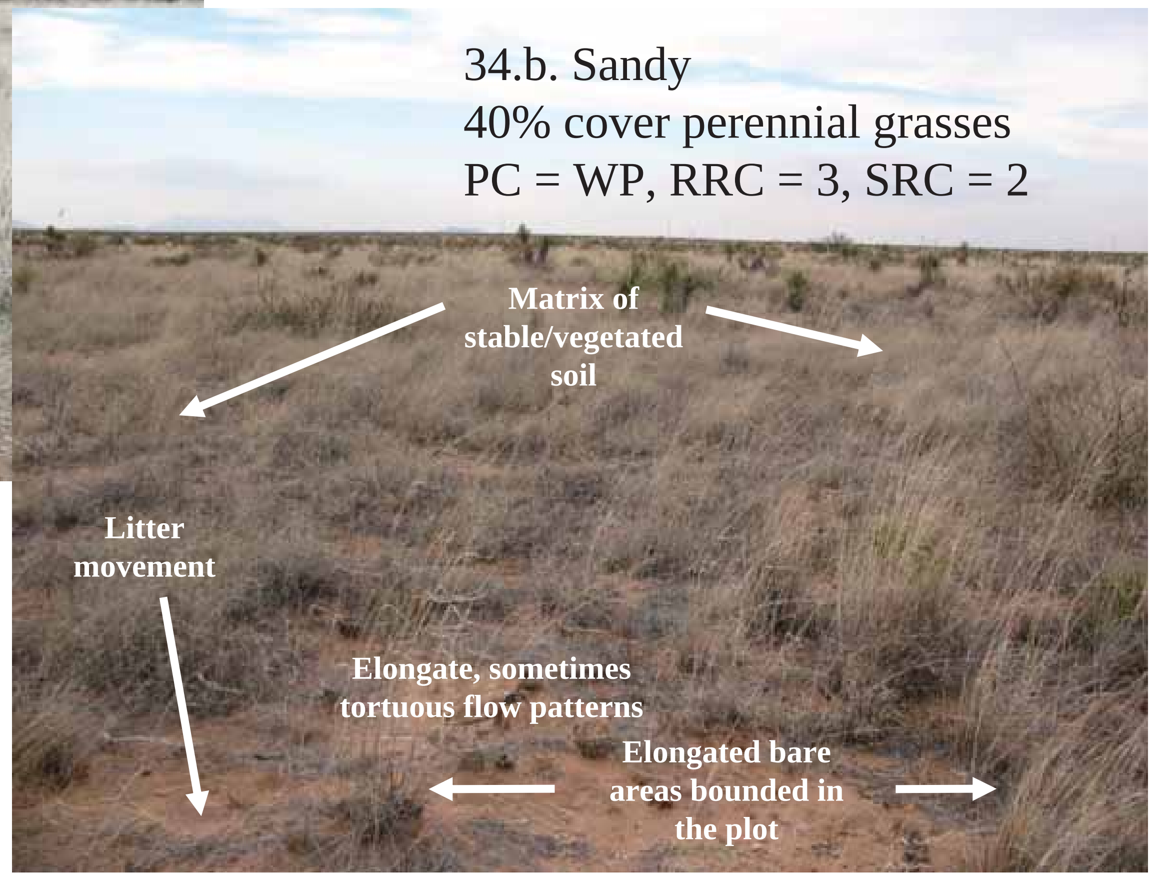
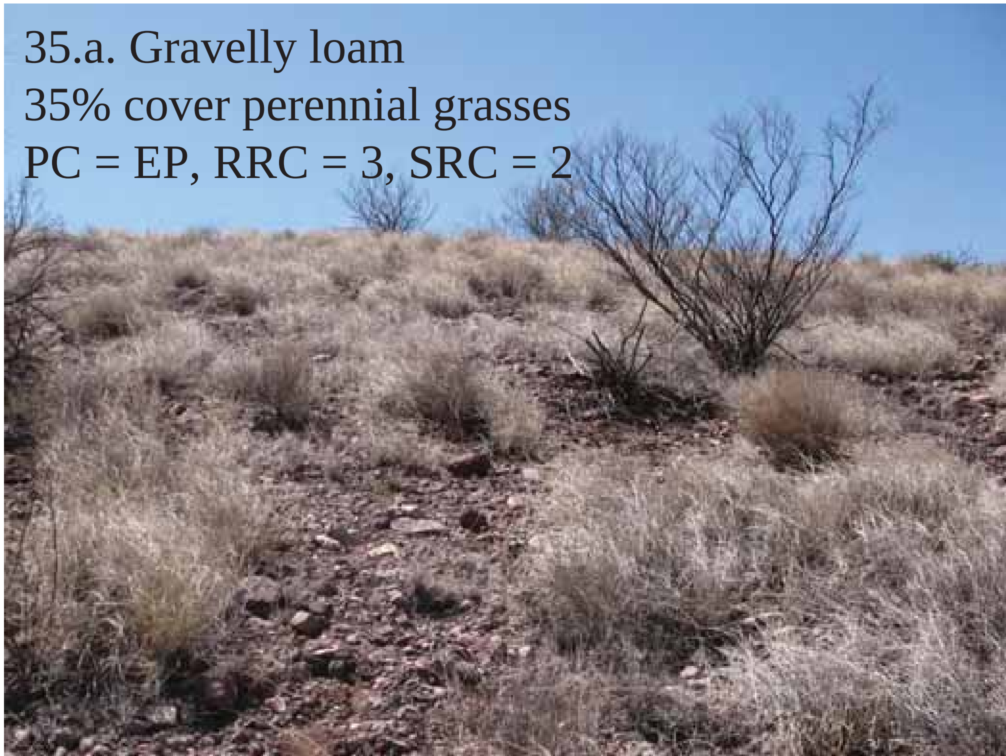


Figure 34. Both plots are in Sandy ecological sites and dominated by perennial grasses. The pedoderm (poorly developed biological crust), the small interpatches, and the stable soil (SRC = 0) of 34.a. convey that this plot has a better potential for plant establishment, growth and survival as well as retaining soil and site resources compared to that of 34.b. The weak physical or biological crust coupled with the larger interpatches of 34.b. suggests a reduced resistance to wind and water erosion and disturbance (physical or introduction of weedy/invasive species). The SRC of 2 in 34.b. demonstrates the reduced soil stability of the site. The site in 34.b. would be considered at greater risk of soil erosion and subsequent grass loss when compared to 34.a.

Pedoderm and Pattern Classes: Interpretation and Use
Example 2



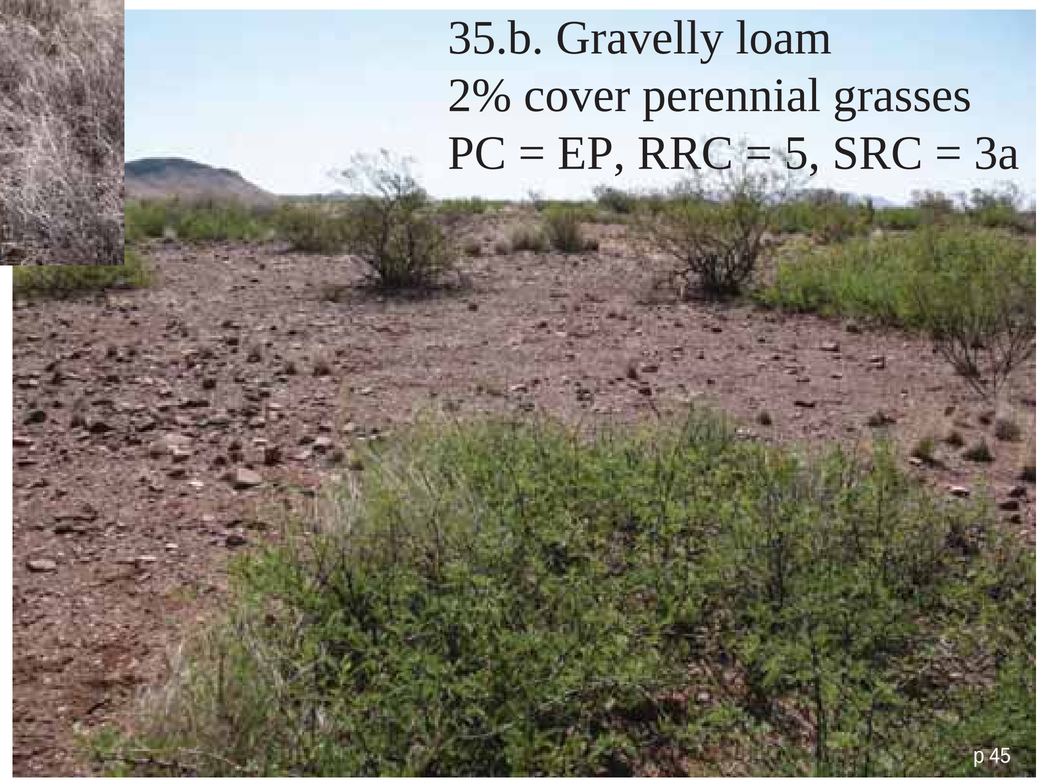


Figure 35. The plot pictured in Figure 35.a. is a Gravelly loam ecological site dominated by grasses with some honey mesquite (*Prosopis glandulosa*) and other woody species. The plot in 35.b. is the same ecological site, but is dominated by honey mesquite with perennial grasses occurring mainly in the shrubs. Both sites have an erosion pavement protecting the soil from erosion. However, 35.a. has a much greater potential to sustain soil resources and plant productivity due to its larger and more connected persistent plants and fewer indications of soil redistribution. The site pictured in 35.a. has a greater potential to respond favorably to management and manipulation than that in 35.b.

Pedoderm and Pattern Classes
Interpretation and Use

Suggested uses include:

1. **Incorporate information about soil surface processes in broad-scale inventory:** Records of PPCs can be linked to spatial data to incorporate information about soil surface processes across broad areas (e.g., a pasture or allotment). Such information can then be used for project planning, monitoring design, management and other analyses. Combining observations of PPCs with spatial data on soils and vegetation (e.g., soil survey, ecological site or state maps) further strengthens interpretative capabilities.

2. **Developing ecological site descriptions:**
   Records of PPCs alongside soil profile and vegetation data from multiple sites can facilitate the development of ecological site descriptions (ESDs).

3. **Differentiate ecological states and community phases:**
   PPCs can be used to help describe and distinguish the properties of ecological states or community phases.

4. **Predict responses to management, restoration and natural drivers:**
   Records of PPCs alongside descriptions of ecological sites and states can help understand the responses of a site to management actions, restoration, and natural drivers.

5. **Communication tools:**
   PPCs can also be used to communicate soil surface features related to ecosystem function in a relatively simple way to land users.