Monitoring Manual

for Grassland, Shrubland and Savanna Ecosystems

Volume I: Quick Start

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Cover illustration:
Collecting Line-point intercept data
in a south-central New Mexico desert grassland.

Soil stability test

The Soil stability test provides information about the degree of soil structural development and erosion resistance. It also reflects soil biotic integrity, because the "glue" (organic matter) that binds soil particles together must constantly be renewed by plant roots and soil organisms. This test measures the soil's stability when exposed to rapid wetting. It is affected by soil texture, so it is important to limit comparisons to similar soils that have similar amounts of sand, silt and clay (see Volume II, Appendix E for a simple field procedure to determine soil texture).

Materials:

- **Complete soil stability kits (see Appendix A in Vol. II for construction and suppliers)**
- **Deionized water (or any noncarbonated bottled water, except mineral water) 1 L (32 oz)**
- **Clipboard, Soil Stability Test Data Form (page 27) and pencil(s)**
- **Stopwatch**

Standard methods (rule set)

This is easier than it sounds! With a little practice, it takes about 10-15 minutes to sample and 10 minutes to test 18 samples.

1. Randomly select 18 sampling points and decide whether you will collect surface samples only (1 box), or surface and subsurface samples (2 boxes).

Rules

1.1 Use 18 randomly selected points along the transects used for line-point and gap intercept measurements.

1.2 Record sampling locations (points) under "Pos" on the data form.

1.3 Always sample at least 5 cm (2 in) from any vegetation measurement line.

1.4 Include subsurface samples if you are interested in soil erodibility after disturbance.

2. Determine the dominant cover class over the random point and enter this into the "Veg" column on the data form.

Rules

2.1 The area to be classified is effectively as large as the sample area (6-8 mm (1/4 in) in diameter).

2.2 Record the dominant cover class in the "Veg" column (optional):

NC = no perennial grass, shrub or tree canopy cover
G = perennial grass canopy and grass/shrub canopy mixture
F = perennial forb
Sh = shrub canopy
T = tree canopy

3. Collect a surface sample.

Rules

3.1 Excavate a small trench (10-15 mm (1/2 in) deep) in front of the area to be sampled (Fig. 13).

3.2 Lift out a soil fragment and trim it (if necessary) to the correct size.

3.3 The soil fragment should be 2-3 mm (<1/8 in) thick and 6-8 mm (1/4 in) in diameter (Figs. 14 and 15). This is the diameter of a wood pencil eraser. Try to fit sample in this dot (6-8 mm dia.).

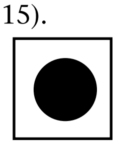


Figure 13. Excavate small trench.

Figure 14. Collect surface sample.

Figure 15. Ensure correct sample size.

3.4 Collect samples at the exact point. Move the sample point only if it has been disturbed during previous measurements or the soil surface is protected by a rock or embedded litter. Move the point a standard distance (1 m) and note this change on the data form.
3.5 Minimize shattering by: a) slicing the soil around the sample before lifting; b) lifting out a larger sample than required, and trimming it to size in the palm of your hand; or c) misting the sample area before collection (see 3.6).
3.6 If the soil sample is too weakly structured to sample (falls through the sieve), mist it lightly with deionized water (use an atomizer or equivalent) and then take a sample. Perfume and plastic hair spray bottles work well for this. If the sample still will not hold together, record a "1" on the data form.
3.7 If the soil surface is covered by a lichen or cyanobacterial crust, include the crust in the sample. If the sample is covered by moss, collect the sample from under the moss.
3.8 Gently place the sample in a dry sieve (Fig. 16); place sieve in the appropriate cell of a dry box.

4. Collect a subsurface sample (optional, see Step 1).
Rules
4.1 Sample directly below the surface sample.
4.2 Use the flat, square (handle) end of the scoop to gently excavate the previous trench (in front of the surface sample) to a depth of 3-4 cm (1 1/2 in).
4.3 Directly below the surface sample, remove soil so that a "shelf" is created with the top step 2-2.5 cm (3/4-1 in) below the soil surface (Fig. 17).
4.4 Use the scoop to lift out a subsurface sample from below (Fig. 18).
4.5 The soil fragment should be 2-3 mm (<1/8 in) thick and 6-8 mm (1/4 in) in diameter.
4.6 See steps 3.5-3.6. If you encounter a rock, record "R" and move to the next sample.
4.7 Place the sample in a dry sieve; place sieve in the dry box. Leave box lid open (Fig. 19).

Riparian note: No changes are needed for this method in riparian systems.

Figure 16. Place sample in sieve.

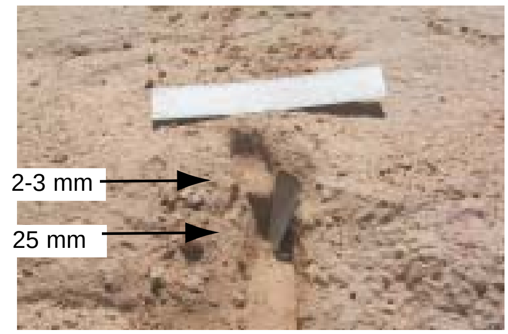


Figure 17. Excavate trench for subsurface sample.

Figure 18. Collect subsurface sample.

Figure 19. Complete soil stability kit with water and samples.

5. Make sure the surface and subsurface samples are dry.

Rules

5.1 Samples must be dry before testing. If samples are not dry after collecting, allow to air dry with the lid off.

5.2 Do not leave lid closed on samples for more than 1 minute on hot/sunny days. Excessive heat can artificially increase or decrease stability.

6. Fill the empty (no sieves) box with deionized or distilled water (Fig. 19).

Rules

6.1 Fill each compartment to the top.

6.2 The water should be approximately the same temperature as the soil.

7. Test the samples.

Rules

7.1 Lower the first sieve with the sample into the respective water-filled compartment—upper left corner of sample box to upper left corner of water box (Fig. 20).

7.2 From the time the sieve screen touches the water surface to the time it rests on the bottom of the box, 1 second should elapse.

7.3 Start the stopwatch when the first sample touches the water. Use Table 7 to assign samples to stability classes.

7.4 After five minutes, follow the sequence of immersions on the data form, adding one sample every 15 seconds. Beginners may want to immerse a sample every 30 seconds. This allows nine samples to be run in 10 minutes, so it takes 20 minutes to test one box of 18 samples.

Figure 20. Place first sample in water.

7.5 Observe the fragments from the time the sample hits the water to 5 min (300 sec) and record a stability class based on Table 7.

7.6 Raise the sieve completely out of the water and then lower it to the bottom without touching the bottom of the tray. Repeat this immersion a total of five times. Do this even if you have already rated the sample a 1, 2 or 3 (you are allowed to change your rating if after sieving, >10% of soil remains on sieve).

7.7 It should take 1 second for each sieve to clear the water's surface and 1 second to return to near the bottom of the box.

7.8 Hydrophobic samples (float in water after pushed under) are rated 6.

Bottlecap test (Semiquantitative alternative)

Place a soil fragment in a bottle cap filled with water. Watch it for 30 seconds. Gently swirl the water for 5 seconds. Assign one of three ratings:

M= Melts in first 30 seconds (without swirling)
D= Disintegrates when swirls (but does not melt)
S= Stable (even after swirling)

Table 7. Stability class ratings.

Stability class	Criteria for assignment to stability class
1	50% of structural integrity lost (melts) within 5 seconds of immersion in water, **OR** soil too unstable to sample (falls through sieve).
2	50% of structural integrity lost (melts) 5-30 seconds after immersion.
3	50% of structural integrity lost (melts) 30-300 seconds after immersion, **OR** < 10% of soil remains on the sieve after five dipping cycles.
4	10–25% of soil remains on the sieve after five dipping cycles.
5	25–75% of soil remains on the sieve after five dipping cycles.
6	75–100 % of soil remains on the sieve after five dipping cycles.

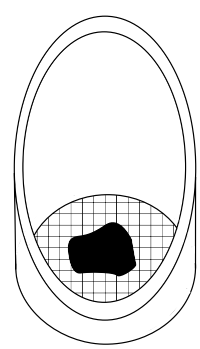


Figure 21. Sample in sieve, drawn to scale.

Sequence for stability class = 1.


Original sample


After 5 seconds


After 5 minutes


After 5 dips

Sequence for stability class = 4


Original sample


After 5 seconds

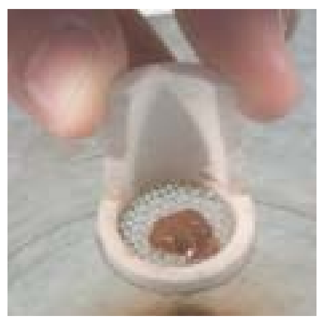

After 5 minutes


After 5 dips

Sequence for stability class = 5.


Original sample


After 5 seconds


After 5 minutes


After 5 dips

Sequence for stability class = 6.


Original sample


After 5 seconds


After 5 minutes


After 5 dips

Figure 22. The photos above illustrate the key steps of testing a soil sample for four different stability rankings. **Important note:** Some of the fragments shown in these samples may appear large. They are for illustration only. Be sure to follow the size guidelines (6-8 mm or 1/4 in) in Rule 3.3 and Fig. 21.

Soil Stability Test Data Form

Monitoring plot: ____________ **Observer:** ____________ **Date:** ____________

Recorder: ____________ **Page** ____ **of** ____

Veg = NC (no perennial canopy), **G** (grass or grass/shrub mix), **F** (forb), **Sh** (shrub), **T** (tree). **# = Stability value** (1-6)**.** Circle value if samples are hydrophobic.

Surface

Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip	
Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#
		0:00	5:00				0:15	5:15				0:30	5:30				0:45	5:45				1:00	6:00				1:15	6:15	
		1:30	6:30				1:45	6:45				2:00	7:00				2:15	7:15				2:30	7:30				2:45	7:45	
		3:00	8:00				3:15	8:15				3:30	8:30				3:45	8:45				4:00	9:00				4:15	9:15	

Notes: ____________

Subsurface

Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip		Line ___		In	Dip	
Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#	Pos	Veg	time	time	#
		0:00	5:00				0:15	5:15				0:30	5:30				0:45	5:45				1:00	6:00				1:15	6:15	
		1:30	6:30				1:45	6:45				2:00	7:00				2:15	7:15				2:30	7:30				2:45	7:45	
		3:00	8:00				3:15	8:15				3:30	8:30				3:45	8:45				4:00	9:00				4:15	9:15	

Notes: ____________

Avg. Stability = Sum of Stability Rankings (i.e., #) / Total No. Samples Taken

Line	All samples		Protected samples (Samples w/Veg = G, Sh, or T)		Unprotected samples (Samples w/ Veg = NC)	
	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
Plot Avg.						

Soil stability indicator calculations

1. Calculate the average stability for all samples.

Rules

1.1 Add together all stability values. Divide this sum by the total number of samples taken. Record this value as the average stability for "All samples" on your data form.

2. Calculate the stability for protected soil (Veg = G, F, Sh, or T).

Rules

2.1 Add together all values that were protected by canopy (Veg = G, F, Sh, or T). Divide this sum by the number of samples in this group. Record this value as the average stability for "Protected samples" on your data form.

3. Calculate the average stability for unprotected samples.

Rules

3.1 Add together all stability values that were classified as no canopy (Veg = NC). Divide this sum by the number of samples in this group. Record this value as the average stability for "Unprotected samples."

4. Averages should be calculated separately for surface and subsurface samples.

Table 8. Data form and calculations example for soil surface samples.

Surface

Line 1 Pos	Line 1 Veg	In time	Dip time	#	Pos	Veg	In time	Dip time	#	Line 2 Pos	Line 2 Veg	In time	Dip time	#	Pos	Veg	In time	Dip time	#
7	NC	0:00	5:00	3	28	NC	0:45	5:45	3	6	G	1:30	6:30	5	24	G	2:15	7:15	6
14	S	0:15	5:15	5	35	S	1:00	6:00	4	12	NC	1:45	6:45	1	30	S	2:30	7:30	3
21	G	0:30	5:30	6	42	G	1:15	6:15	5	18	S	2:00	7:00	4	36	NC	2:45	7:45	1

Avg. Stability = Sum of Stability Rankings (i.e., #) / Total No. Samples Taken

Line	All samples		Protected samples (Samples w/Veg = G, F, Sh, or T)		Unprotected samples (Samples w/o Veg = NC)	
	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
1	4.3		5.0		3.0	
2	3.3		4.5		1.0	
Plot Avg.	3.8		4.75		2.0	

Soil stability test basic interpretation

Increases in stability of both **surface** and **subsurface** samples reflect increased soil erosion resistance and resilience. Surface stability is correlated with current erosion resistance, while subsurface stability is correlated with resistance following soil disturbance. Sites with average values of 5.5 or above generally are very resistant to erosion, particularly if there is little bare ground and there are few large gaps. Maximum possible soil stability values may be less than 6 for very coarse sandy soils. High values usually reflect good hydrologic function. This is because stable soils are less likely to disperse and clog soil pores during rainstorms. High stability values also are strongly correlated with soil biotic integrity. Soil organisms make the "glue" that holds soil particles together. In most ecosystems, soil stability values decline first in areas without cover (Veg = NC). In more highly degraded systems, Veg = Canopy values also decline.

Use these indicators together with the indicators from the **Line-point intercept** and the **Gap intercept** to help determine whether observed erosion changes are due to loss of cover, changes in vegetation spatial distribution or reduced soil stability. For more information about how to interpret these indicators, please see Chapter 17 in Volume II.

Typical effect on each attribute of an increase in the indicator value			
Indicator	**Soil and site stability**	**Hydrologic function**	**Biotic integrity**
All samples	+	*	+
Veg = Canopy	+	*	+
Veg = NC	+	*	+

* Usually positive, but can be negative for hydrophobic (water-repellent) soils. Large increases in water repellency (after a very hot fire) can negatively affect soil and site stability by increasing the amount of runoff water available to erode soils downslope.