USDA Natural Resources Conservation Service

Ecological site R038XC318AZ
Limestone Hills 20-24" p.z.

Last updated: 9/05/2019
Accessed: 05/10/2025

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 038X–Mogollon Transition South

AZ 38.3 – Upper Mogollon Transition

Elevations range from 5,100 to 7,000 feet and precipitation averages 20 to 27 inches per year. Vegetation includes Gambel oak, Arizona white oak, Emory oak, pinyon, alligator juniper, one- seed juniper, Arizona cypress, ponderosa pine, shrubby buckwheat, sacahuista, skunkbush sumac, Wright silktassle, blue grama, sideoats grama, muttongrass, western wheatgrass, and bottlebrush squirreltail. The soil temperature regime is mesic and the soil moisture regime is typic ustic. This MLRA occurs within the Transition Zone Physiographic Province and is characterized by canyons and structural troughs or valleys. Igneous, metamorphic, and sedimentary rock classes occur on rough mountainous terrain in association with less extensive sediment filled valleys exhibiting little integrated drainage.

Ecological site concept

The Limestone Hills ecological site occurs on south and west facing aspects of narrow summits and back slopes with parent material of slope alluvium and/or residuum weathered from limestone.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

Popcorn soils occur south and west facing aspects of narrow summits and back slopes with parent material of slope alluvium and/or residuum weathered from limestone.

Table 2. Representative physiographic features

Landforms	(1) Hill
Elevation	5,100–7,000 ft
Slope	10–50%
Aspect	W, S

Climatic features

Precipitation in this common resource area averages approximately 20 to 24 inches annually. Precipitation is lower and temperatures are cooler in the eastern part of the MLRA. The winter-summer rainfall ratio ranges from about 60/40% in the western part of the area to 45/55% in the eastern part. Summer rains fall July through September; and are from high-intensity convective thunderstorms. This moisture originates primarily from the Gulf of Mexico, but can come from the remnants of Pacific hurricanes in September. Winter moisture is frontal, originates in the north Pacific, and falls as rain or snow in widespread storms of low intensity and long duration. Snowfall ranges from 10 to 18 inches per year and can occur from November through April. May and June are the driest months of the year. Humidity is generally low all year.

Average annual air temperatures range from 50 to 57 degrees F (mesic temperature regime). Daytime temps in the summer are commonly in the mid 80's in the eastern portion of the MLRA and the low to mid 90's in the western portion. Freezing temperatures are common from October through April. The actual precipitation, available moisture and temperature varies, depending on, region, elevation, rain shadow effect and aspect.

Table 3. Representative climatic features

Frost-free period (average)	167 days
Freeze-free period (average)	188 days
Precipitation total (average)	24 in

Influencing water features

Soil features

Popcorn soils occur south and west facing aspects of narrow summits and back slopes with parent material of slope alluvium and/or residuum weathered from limestone.

Soils mapped on this site include: from SSA-675 San Carlos IR Area - MU Popcorn-58.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–limestone
Surface texture	(1) Very gravelly clay loam
Family particle size	(1) Loamy
Soil depth	4–20 in

Surface fragment cover <=3"	10–35%
Surface fragment cover >3"	0–5%
Calcium carbonate equivalent (0-40in)	30–45%
Soil reaction (1:1 water) (0-40in)	7.4–8.8
Subsurface fragment volume <=3" (Depth not specified)	15–45%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

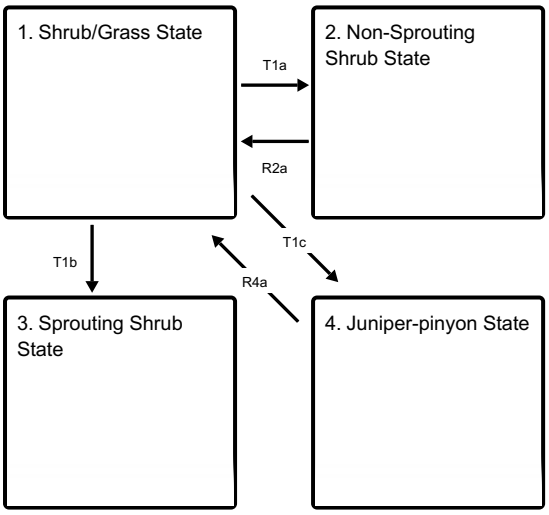
The plant communities found on an ecological site are naturally variable. Composition and production will vary with yearly conditions, location, aspect, and the natural variability of the soils. The Reference Plant Community represents the natural potential plant community found on relict or relatively undisturbed sites. Other plant communities described here represent plant communities that are known to occur when the site is disturbed by factors such as grazing, fire, absence of fire or drought.

Production data provided in this site description is standardized to air-dry weight at the end of the summer growing season. The plant communities described in this site description are based on near normal rainfall years.

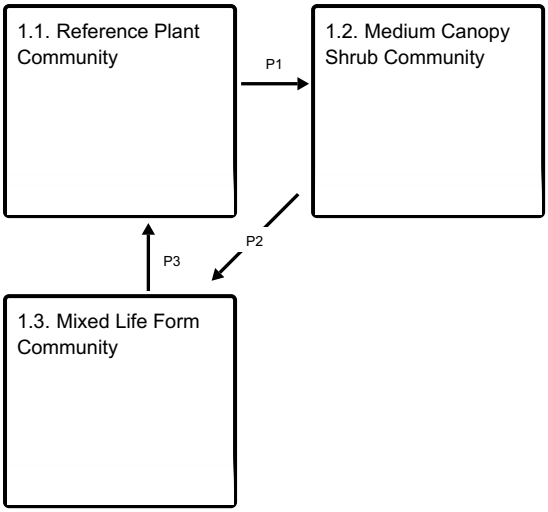
NRCS uses a Similarity Index to compare existing plant communities to the plant communities described here. Similarity Index is determined by comparing the production and composition of a plant community to the production and composition of a plant community described in this site description. To determine Similarity Index, compare the production (air-dry weight) of each species to that shown in the plant community description. For each species, count no more than the maximum amount shown for the species, and for each group, count no more than the maximum shown for the group. Divide the resulting total by the total normal year production shown in the plant community description. If rainfall has been significantly above or below normal, use the total production shown for above or below normal years. If field data is not collected at the end of the summer growing season, then the field data must be corrected to the end of the year production before comparing it to the site description. The growth curve can be used as a guide for estimating production at the end of the summer growing season.

State and transition model

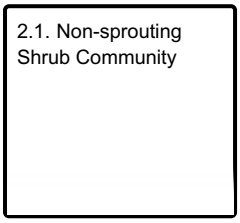
Ecosystem states



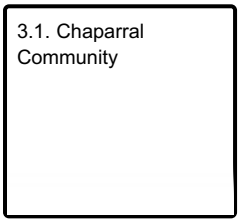
State 1 submodel, plant communities



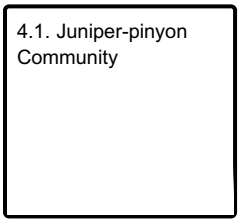
State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Shrub/Grass State

The Shrub/Grass State is the Reference Plant Community. Shrub canopy is 35-45% on all aspects.

Community 1.1
Reference Plant Community

The Shrub/Grass State is the Reference Plant Community. It is a diverse mixture of perennial grasses, suffrutescent forbs, shrubs, succulents, and scattered trees. A flora of native annual forbs and grasses, of both the winter and summer seasons, exist in the plant community. Periodic, naturally occurring, wildfires were important in maintaining the Reference Plant Community. North slopes have a mixture of grass and evergreen chaparral shrubs like turbinella oak, mountain mahogany, and redberry buckthorn. Southern exposures will have a higher percentage of desert shrubs and succulents in the plant community. Shrub canopy is 35-45% on all aspects.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	200	400	600
Shrub/Vine	300	430	470
Tree	40	60	100
Forb	30	70	90
Total	**570**	**960**	**1260**

Table 6. Ground cover

Tree foliar cover	0-1%
Shrub/vine/liana foliar cover	2-4%
Grass/grasslike foliar cover	3-6%
Forb foliar cover	0-1%
Non-vascular plants	0%
Biological crusts	0-2%
Litter	30-50%
Surface fragments >0.25" and <=3"	15-30%
Surface fragments >3"	20-25%
Bedrock	0%
Water	0%
Bare ground	3-7%

Figure 5. Plant community growth curve (percent production by month). AZ3812, 38.2 16-20" p.z. all sites. Growth begins in the spring and continues into the summer and fall..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	5	5	15	10	10	15	20	10	5	5	0

Community 1.2
Medium Canopy Shrub Community

Shrubs increase in canopy and density to approximately 45-60% canopy in the absence of fire. Herbaceous species are present in sufficient quantity and are evenly distributed to promote fire intensities sufficient to reduce abundance of shrub species.

Community 1.3
Mixed Life Form Community

Juniper or pinyon germinate and are present at densities of 5 to 10 per acre and are still small in size. One-seed or redberry juniper are the juniper species. Tree canopy is approximately 5-10%. Herbaceous production is approximately 700 lbs/ac and fires are effective at killing fire sensitive juniper and pinyon.

Pathway P1
Community 1.1 to 1.2

Shrub increase due to length of time between fire events

Pathway P2
Community 1.2 to 1.3

Fire

Pathway P3
Community 1.3 to 1.1

Time

State 2
Non-Sprouting Shrub State

Non sprouting shrubs have increased to 60-80% canopy.

Community 2.1
Non-sprouting Shrub Community

Non sprouting shrubs have increased to 60-80% canopy. Cooler aspects are dominated by sotol and minor amounts of turbinella oak. Warmer aspects are dominated by prickly pear, ocotillo, agave, cat claw acacia, and minor amounts of wait a bit. Herbaceous species are less than 100 lbs/ac and are not well distributed on the site.

State 3
Sprouting Shrub State

Sprouting shrubs have increased to 60-80% canopy.

Community 3.1
Chaparral Community

Turbinella oak has increased to 60-80% canopy in the absence of fire for extended periods of time. Herbaceous species are less than 100 lbs/ac and are not well distributed on the site. A restoration pathway is unlikely from this state given the ability of turbinella oak to withstand substantial fire intensities (Pase 1965) and this species prolific root sprouting ability.

State 4
Juniper-pinyon State

Juniper and/or pinyon have increased to 40-50% canopy in the absence of fire for very long periods of time.

Community 4.1
Juniper-pinyon Community

Juniper and/or pinyon have increased to 40-50% canopy in the absence of fire for very long periods of time. The dominant juniper is one seed or redberry juniper. Herbaceous species are vigorous and evenly distributed in the interspaces of trees in areas where turbinella oak has not increased in the interspaces. These herbaceous species contribute to recovery of the site without the need for substantial inputs in the form of range planting. Turbinella oak has increased to 20-30% canopy in some areas where pinyon has increased to 40-50% canopy. Herbaceous species are less than 100 lbs/ac and not well distributed on the site. It is unknown if this community can return to the reference plant community. This would only be likely with range planting applied after wildfire.

Transition T1a
State 1 to 2

Non-sprouting shrubs like sotol and prickly pear germinate and in the absence of fire for prolonged periods grow to maturity and eventually dominate the site.

Transition T1b
State 1 to 3

Sprouting shrubs, primarily turbinella oak that is the dominant shrub on other sites in this Land Resource Unit (16-20" precipitation zone), germinate and in the absence of fire for prolonged periods grow to maturity and eventually dominate the site.

Transition T1c
State 1 to 4

Trees germinate and in the absence of fire for prolonged periods grow to maturity. High densities of perennial grasses can still occupy the interspaces of trees with tree canopy as high as 45-55%. Trees are of sufficient size that most practitioners are unlikely to apply prescribed fire.

Restoration pathway R2a
State 2 to 1

It is unknown if this restoration is possible. Chemical brush management is likely the only alternative to reduce shrub species given the rocky nature of these soils. Range planting would be necessary to restore the herbaceous community if brush management is effective. Range planting would have greater success in this Land Resource Unit due to the higher rainfall this site receives.

Restoration pathway R4a
State 4 to 1

Extreme wildfire is likely the only restoration pathway. Trees have reached such a large size that very high temperatures and wind speeds are needed to allow fires to burn through canopies and top kill non sprouting juniper or pinyon. Very costly mechanical brush management where soils have lower amount of cobbles or boulders and gentler slopes is possible followed by burning of tree skeletons. Perennial grass canopy in the interspaces of trees is > 50% in some areas with existing plants likely providing an adequate seed source for restoration following brush management or fires. Range planting should likely only be considered where perennial grass canopy in the interspaces of trees is less than 25%; however this threshold needs additional investigation.

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Warm Season Grasses**			80–435	
	sideoats grama	BOCU	*Bouteloua curtipendula*	50–200	–
	blue threeawn	ARPUN	*Aristida purpurea var. nealleyi*	5–100	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	15–85	–
	black grama	BOER4	*Bouteloua eriopoda*	10–50	–
2	**Cool Season Grasses**			0–45	
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–10	–
	squirreltail	ELEL5	*Elymus elymoides*	0–10	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	0–10	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–10	–
	needle and thread	HECO26	*Hesperostipa comata*	0–5	–
3	**Miscellaneous grasses**			5–150	
	bullgrass	MUEM	*Muhlenbergia emersleyi*	0–35	–
	curly-mesquite	HIBE	*Hilaria belangeri*	5–15	–
	Arizona threeawn	ARAR6	*Aristida arizonica*	0–15	–
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	1–10	–

	green sprangletop	LEDU	*Leptochloa dubia*	1–10	–
	tanglehead	HECO10	*Heteropogon contortus*	0–10	–
	longtongue muhly	MULO	*Muhlenbergia longiligula*	0–10	–
	slim tridens	TRMU	*Tridens muticus*	0–10	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	0–10	–
	plains lovegrass	ERIN	*Eragrostis intermedia*	0–5	–
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	0–5	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–5	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–5	–
	Arizona brome	BRAR4	*Bromus arizonicus*	0–1	–
	ring muhly	MUTO2	*Muhlenbergia torreyi*	0–1	–
	Hall's panicgrass	PAHA	*Panicum hallii*	0–1	–
	common wolfstail	LYPH	*Lycurus phleoides*	0–1	–
4	**Annual grasses**			0–35	
	sixweeks threeawn	ARAD	*Aristida adscensionis*	0–10	–
	sixweeks fescue	VUOC	*Vulpia octoflora*	0–10	–
	mucronate sprangeltop	LEPAB	*Leptochloa panicea ssp. brachiata*	0–5	–
	witchgrass	PACA6	*Panicum capillare*	0–5	–
	Mexican panicgrass	PAHI5	*Panicum hirticaule*	0–5	–
	little barley	HOPU	*Hordeum pusillum*	0–2	–
	delicate muhly	MUFR	*Muhlenbergia fragilis*	0–1	–
Forb					
5	**Perennial Forbs**			10–125	
	variableleaf bushbean	MAGI2	*Macroptilium gibbosifolium*	0–40	–
	desert globemallow	SPAM2	*Sphaeralcea ambigua*	5–20	–
	brownfoot	ACWR5	*Acourtia wrightii*	0–15	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–10	–
	perennial rockcress	ARPE2	*Arabis perennans*	1–10	–
	cliffbrake	PELLA	*Pellaea*	1–10	–
	trailing windmills	ALIN	*Allionia incarnata*	1–5	–
	wishbone-bush	MILAV	*Mirabilis laevis var. villosa*	0–2	–
	Colorado four o'clock	MIMU	*Mirabilis multiflora*	0–1	–
	dwarf Indian mallow	ABPA3	*Abutilon parvulum*	0–1	–
	aster	ASTER	*Aster*	0–1	–
	mariposa lily	CALOC	*Calochortus*	0–1	–
	Indian paintbrush	CASTI2	*Castilleja*	0–1	–
	bastard toadflax	COUM	*Comandra umbellata*	0–1	–
	bluedicks	DICA14	*Dichelostemma capitatum*	0–1	–
	fleabane	ERIGE2	*Erigeron*	0–1	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–1	–
	wild dwarf morning-glory	EVAR	*Evolvulus arizonicus*	0–1	–
	silver dwarf morning-glory	EVSE	*Evolvulus sericeus*	0–1	–
	southwestern mock vervain	GLGO	*Glandularia gooddingii*	0–1	–
	tufted globe amaranth	GOCA	*Gomphrena caespitosa*	0–1	–

	[illegible]	[illegible]	[illegible]	[illegible]	
	Gordon's bladderpod	LEGO	*Lesquerella gordonii*	0–1	–
	Chihuahuan flax	LIVE2	*Linum vernale*	0–1	–
	brownplume wirelettuce	STPA4	*Stephanomeria pauciflora*	0–1	–
	jewels of Opar	TAPA2	*Talinum paniculatum*	0–1	–
6	**Annual Forbs**			0–50	
	spurge	EUPHO	*Euphorbia*	1–15	–
	longleaf false goldeneye	HELOA2	*Heliomeris longifolia var. annua*	0–10	–
	phacelia	PHACE	*Phacelia*	0–10	–
	bristly fiddleneck	AMTE3	*Amsinckia tessellata*	0–10	–
	desert Indianwheat	PLOV	*Plantago ovata*	0–5	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–5	–
	purslane	PORTU	*Portulaca*	0–1	–
	Thurber's pepperweed	LETH2	*Lepidium thurberi*	0–1	–
	Arizona lupine	LUAR4	*Lupinus arizonicus*	0–1	–
	pitseed goosefoot	CHBE4	*Chenopodium berlandieri*	0–1	–
	cryptantha	CRYPT	*Cryptantha*	0–1	–
	dodder	CUSCU	*Cuscuta*	0–1	–
	American wild carrot	DAPU3	*Daucus pusillus*	0–1	–
	flatcrown buckwheat	ERDE6	*Eriogonum deflexum*	0–1	–
	New Mexico copperleaf	ACNE	*Acalypha neomexicana*	0–1	–
Shrub/Vine					
7	**Evergreen shrubs**			10–145	
	Sonoran scrub oak	QUTU2	*Quercus turbinella*	10–95	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–15	–
	Palmer oak	QUPA10	*Quercus palmeri*	0–10	–
	redberry buckthorn	RHCR	*Rhamnus crocea*	0–8	–
	Mexican cliffrose	PUME	*Purshia mexicana*	0–5	–
	desert ceanothus	CEGR	*Ceanothus greggii*	0–5	–
	California buckthorn	FRCAU	*Frangula californica ssp. ursina*	0–2	–
	ashy silktassel	GAFL2	*Garrya flavescens*	0–2	–
	Wright's silktassel	GAWR3	*Garrya wrightii*	0–2	–
	red barberry	MAHA4	*Mahonia haematocarpa*	0–1	–
	Apache plume	FAPA	*Fallugia paradoxa*	0–1	–
8	**Large shrubs**			5–50	
	catclaw mimosa	MIACB	*Mimosa aculeaticarpa var. biuncifera*	5–25	–
	mariola	PAIN2	*Parthenium incanum*	0–10	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–6	–
	Wright's beebrush	ALWR	*Aloysia wrightii*	0–5	–
	stretchberry	FOPUP	*Forestiera pubescens var. pubescens*	0–2	–
	rockspirea	HODU	*Holodiscus dumosus*	0–1	–
	pale desert-thorn	LYPA	*Lycium pallidum*	0–1	–
	[illegible]	[illegible]	[illegible]	[illegible]	

	Coulter's brickellbush	BRCO	*Brickellia coulteri*	0–1	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–1	–
9	**Half shrubs**			55–190	
	fairyduster	CAER	*Calliandra eriophylla*	25–100	–
	featherplume	DAFO	*Dalea formosa*	30–40	–
	littleleaf ratany	KRER	*Krameria erecta*	0–25	–
	bastardsage	ERWR	*Eriogonum wrightii*	1–20	–
	rough menodora	MESC	*Menodora scabra*	0–5	–
	yerba de pasmo	BAPT	*Baccharis pteronioides*	0–2	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–1	–
10	**Succulents**			80–380	
	common sotol	DAWH2	*Dasylirion wheeleri*	50–120	–
	sacahuista	NOMI	*Nolina microcarpa*	0–120	–
	Schott's century plant	AGSC3	*Agave schottii*	10–60	–
	banana yucca	YUBA	*Yucca baccata*	20–50	–
	cactus apple	OPEN3	*Opuntia engelmannii*	1–10	–
	ocotillo	FOSP2	*Fouquieria splendens*	0–10	–
	tulip pricklypear	OPPH	*Opuntia phaeacantha*	0–5	–
	goldenflower century plant	AGCH2	*Agave chrysantha*	0–1	–
	Parry's agave	AGPA4	*Agave parryi*	0–1	–
	crucifixion thorn	CAHO3	*Canotia holacantha*	0–1	–
	Christmas cactus	CYLE8	*Cylindropuntia leptocaulis*	0–1	–
	walkingstick cactus	CYSP8	*Cylindropuntia spinosior*	0–1	–
	Whipple cholla	CYWH	*Cylindropuntia whipplei*	0–1	–
	Arizona hedgehog cactus	ECCOA	*Echinocereus coccineus var. arizonicus*	0–1	–
	Engelmann's hedgehog cactus	ECEN	*Echinocereus engelmannii*	0–1	–
	candy barrelcactus	FEWI	*Ferocactus wislizeni*	0–1	–
11	**Increaser half-shrubs**			5–20	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	5–20	–
	turpentine bush	ERLA12	*Ericameria laricifolia*	0–1	–
Tree					
12	**Trees**			10–120	
	redberry juniper	JUCO11	*Juniperus coahuilensis*	10–50	–
	oneseed juniper	JUMO	*Juniperus monosperma*	10–50	–
	singleleaf pinyon	PIMO	*Pinus monophylla*	0–50	–
	twoneedle pinyon	PIED	*Pinus edulis*	0–25	–
	alligator juniper	JUDE2	*Juniperus deppeana*	0–20	–

Type locality

Location 1: Gila County, AZ	
Township/Range/Section	T4N R20E S11

General legal description	Popcorn soil location 1,490 feet north and 890 feet west of the southeast corner of Section 11, Township 4N, Range 20E.

Contributors

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Approval

Scott Woodall, 9/05/2019

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

14. **Average percent litter cover (%) and depth (in):**

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

17. **Perennial plant reproductive capability:**