

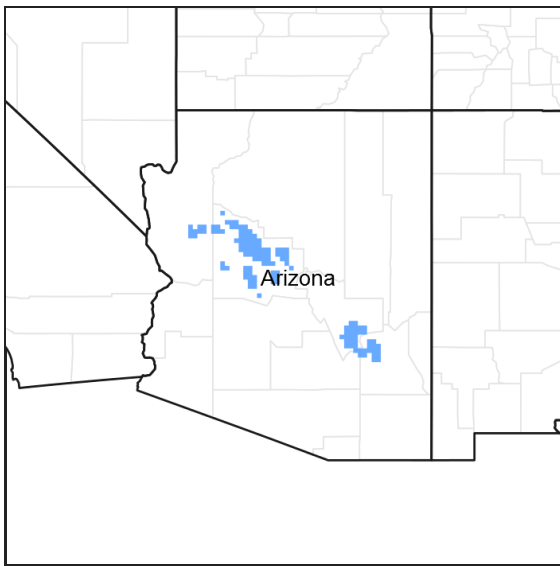
# Ecological site R038XA106AZ

## Limy Upland 12-16" p.z.

Accessed: 05/07/2024

### 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 38.1 – Lower Mogollon Transition

Elevations range from 3000 to 4500 feet and precipitation averages 12 to 16 inches per year. Vegetation includes canotia, one-seed juniper, mesquite, catclaw acacia, jojoba, turbinella oak, ratany, shrubby buckwheat, algerita, skunkbush, tobosa, vine mesquite, bottlebrush squirreltail, grama species, curly mesquite, desert needlegrass and New Mexico feathergrass. The soil temperature regime is thermic and the soil moisture regime is ustic aridic. This unit 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.

### Associated sites

|             |                                    |
|-------------|------------------------------------|
| R038XA105AZ | <b>Limestone Hills 12-16" p.z.</b> |
| R038XA108AZ | <b>Clayey Slopes 12-16" p.z.</b>   |
| R038XA126AZ | <b>Limy Slopes 12-16" p.z.</b>     |

## Similar sites

|             |                          |
|-------------|--------------------------|
| R040XA111AZ | Limy Upland 10"-13" p.z. |
| R041XC309AZ | Limy Upland 12-16" p.z.  |
| R041XB208AZ | Limy Upland 8-12" p.z.   |

Table 1. Dominant plant species

|            |  |
|------------|--|
| Tree       | Not specified  |
| Shrub      | (1) <i>larrea tridentata</i>   |
| Herbaceous | (1) <i>aristida purpurea</i> var. <i>nealleyi</i><br>(2) <i>muhlenbergia porteri</i> |

## Physiographic features

This site occurs at the lowest elevations of the interior chaparral zone in the Mogollon Transition area. It occurs in an upland position; on fan terraces, ridge-tops and mesa tops.

Table 2. Representative physiographic features

|                    |   |
|--------------------|---|
| Landforms          | (1) Fan piedmont<br>(2) Mesa<br>(3) Ridge |
| Flooding frequency | None                                      |
| Elevation          | 945–1,402 m                               |
| Slope              | 5–15%                                     |
| Aspect             | Aspect is not a significant factor        |

## Climatic features

Precipitation in this common resource area averages 12 to 16 inches annually. The winter-summer rainfall ratio ranges from about 60/40% in the northwest part of the area to 50/50% in the southeast part. Summer rains fall July through September; 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 a trace to 10 inches per year and can occur from November through March. Snow seldom persists for more than a day except on north aspects. May and June are the driest months of the year. Humidity is generally low all year. Average annual air temperatures range from 59 to 70 degrees F (thermic temperature regime). Daytime temperatures in the summer are commonly in the high 90's. Freezing temperatures are common from October through April, usually during the night or early morning hours. The actual precipitation, available moisture and temperature vary, depending on, region, elevation, rain shadow effect and aspect.

Table 3. Representative climatic features

|                               |          |
|-------------------------------|----------|
| Frost-free period (average)   | 230 days |
| Freeze-free period (average)  | 285 days |
| Precipitation total (average) | 406 mm   |

## Influencing water features

There are no water features associated with this site.

## Soil features

These soils are shallow (10 to 20 inches) and dark colored in the surface (3 to 6 inches). They are loamy textured, very calcareous and well drained. They have formed in alluvium and colluvium from limestone and related limy conglomerates. Soil surfaces are well covered by light colored gravels, cobbles and/or stones. The effective rooting depth is limited by hard, cemented lime-pans at 10 to 20 inches. The erosion hazard is slight due to gravel, cobble and rock covers. Soils mapped to date on this site include: SSA-627 Mohave County Southern Part MU's Bartmus-11, Tombstone-118, Caralampi-118; SSA-637 Yavapai County Western Part MU's Abra-AaB, AbB, AeB, AIC, AID, AmC, AnC, LpB, LrD, Wn, Pasture-LsC; SSA-639 Black Hills-Sedona area MU's Bilgray-431, 432, Tuzigoot-433, 633, Monterosa family-427, 439, Stronghold-438, 538, Tombstone-438, 538, Blancoverde-439; SSA-675 San Carlos Indian Reservation MU's Bigtoe-505 and Pedrogosa-595.

**Table 4. Representative soil features**

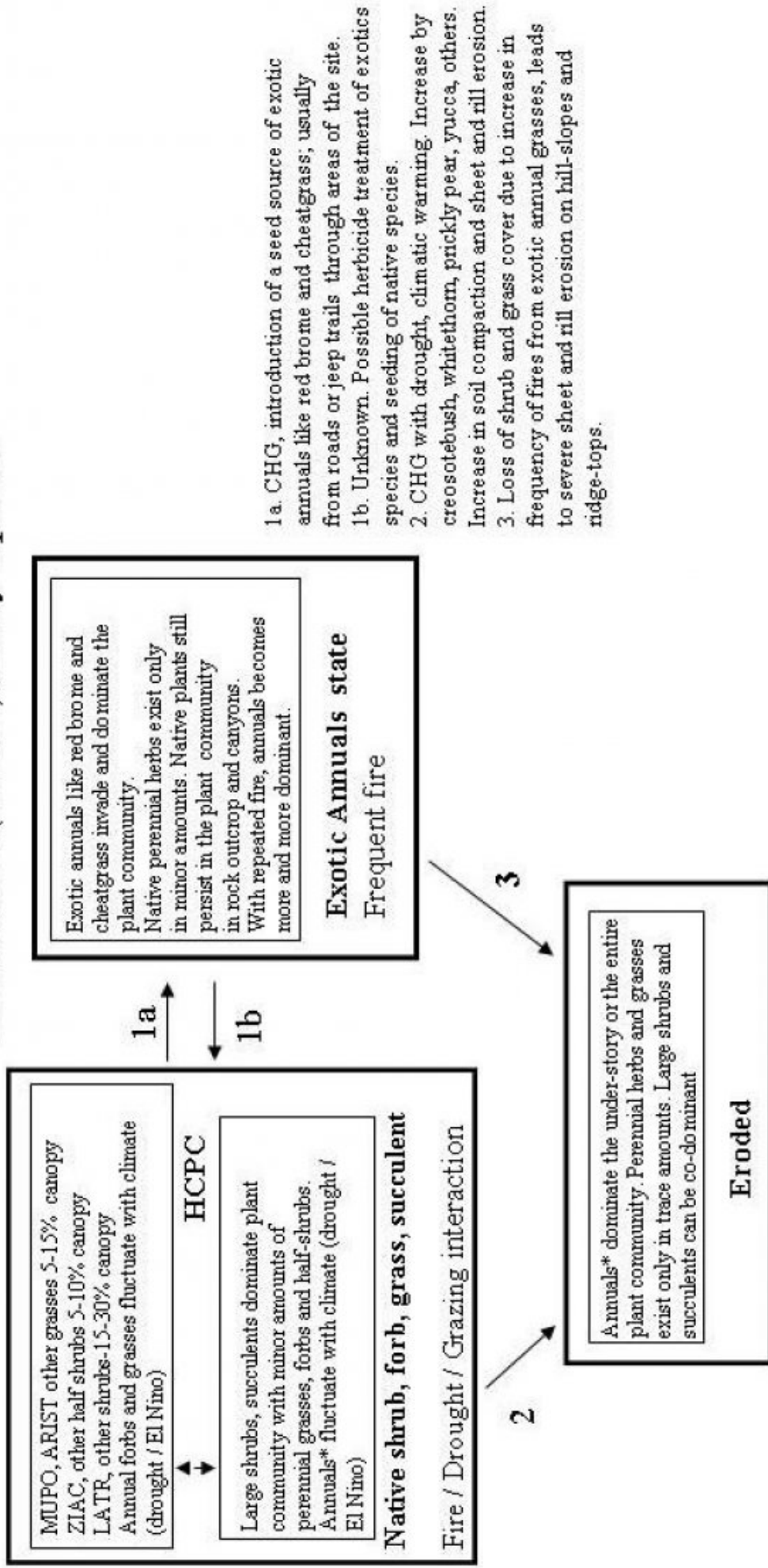
|  |   |
|--|---|
| Parent material  | (1) Alluvium–limestone<br>(2) Colluvium–conglomerate                              |
| Surface texture  | (1) Gravelly sandy loam<br>(2) Very gravelly sandy loam<br>(3) Very gravelly loam |
| Family particle size                                     | (1) Loamy   |
| Drainage class   | Well drained  |
| Permeability class                                       | Moderately rapid to moderate  |
| Soil depth   | 13–51 cm  |
| Surface fragment cover <=3"                              | 35–60%  |
| Surface fragment cover >3"                               | 1–10%   |
| Available water capacity<br>(0-101.6cm)                  | 1.02–3.56 cm  |
| Calcium carbonate equivalent<br>(0-101.6cm)              | 10–35%  |
| Electrical conductivity<br>(0-101.6cm)                   | 0–2 mmhos/cm  |
| Sodium adsorption ratio<br>(0-101.6cm)                   | 0–2   |
| Soil reaction (1:1 water)<br>(0-101.6cm)                 | 7.8–8.6   |
| Subsurface fragment volume <=3"<br>(Depth not specified) | 35–65%  |
| Subsurface fragment volume >3"<br>(Depth not specified)  | 0–10%   |

## Ecological dynamics

The historic native plant community is a mixture of desert shrubs, half shrubs, succulents, forbs and grasses. This includes a flora of native annual grasses and forbs of both the winter and summer seasons. Periodic wildfires which occurred at moderate intervals (15 to 30 years) in this region may not have burned areas of this site as frequently due to poor fine fuel continuity. The interactions of drought, fire and continuous livestock grazing can, over time, result in the loss of palatable grasses, half shrubs and suffrutescent forbs on this site. In some situations non-native annuals can dominate the site. These species can, over time, diminish the soil seed-bank of native annual species. Non-native annuals can act to increase the fire frequency of areas of the site near roads and urban areas, where the incidence of man-made fires is high.

## State and transition model

# MLRA 38-1(12-16''), Limy Upland



- 1a. CHG, introduction of a seed source of exotic annuals like red brome and cheatgrass; usually from roads or jeep trails through areas of the site.
- 1b. Unknown. Possible herbicide treatment of exotics species and seeding of native species.
2. CHG with drought, climatic warming. Increase by creosotebush, whitethorn, prickly pear, yucca, others. Increase in soil compaction and sheet and rill erosion.
3. Loss of shrub and grass cover due to increase in frequency of fires from exotic annual grasses, leads to severe sheet and rill erosion on hill-slopes and ridge-tops.

CHG - continuous heavy grazing  
 PG/NG - proper grazing, no grazing  
 LATR- creosotebush, ZIAC, desert zinnia  
 MUPO, bush mulberry, ARIST, threeawn

\*Native annuals dominant, may be patches of some non-natives

**State 1**  
**Native Shrub-Grass State**

**Community 1.1**  
**Historic Native Plant Community**

The historic native plant community is a mixture of desert shrubs, half-shrubs, perennial grasses, suffrutescent forbs and succulents. A rich flora of native annual forbs and grasses, of both the winter and summer seasons, exist in the plant community. Natural fires, which burned at moderate intervals in this region, may not have occurred as often on areas of this site due to poor continuity of fine fuels and sparse covers of shrubs.

**Table 5. Annual production by plant type**

| Plant Type      | Low<br>(Kg/Hectare) | Representative Value<br>(Kg/Hectare) | High<br>(Kg/Hectare) |
|-----------------|---------------------|--------------------------------------|----------------------|
| Shrub/Vine      | 224                 | 336                                  | 460                  |
| Grass/Grasslike | 45                  | 196                                  | 325                  |
| Forb            | 6                   | 28                                   | 168                  |
| Tree            | –                   | 1                                    | 11                   |
| <b>Total</b>    | <b>275</b>          | <b>561</b>                           | <b>964</b>           |

**Table 6. Soil surface cover**

|                                   |        |
|-----------------------------------|--------|
| Tree basal cover                  | 0%     |
| Shrub/vine/liana basal cover      | 2-3%   |
| Grass/grasslike basal cover       | 1-3%   |
| Forb basal cover                  | 0-1%   |
| Non-vascular plants               | 0%     |
| Biological crusts                 | 1-15%  |
| Litter                            | 10-30% |
| Surface fragments >0.25" and <=3" | 35-60% |
| Surface fragments >3"             | 1-10%  |
| Bedrock                           | 0%     |
| Water                             | 0%     |
| Bare ground                       | 10-50% |

**Table 7. Canopy structure (% cover)**

| Height Above Ground (M) | Tree | Shrub/Vine | Grass/<br>Grasslike | Forb  |
|-------------------------|------|------------|---------------------|-------|
| <0.15                   | –    | 0-3%       | 0-2%                | 1-10% |
| >0.15 <= 0.3            | –    | 1-5%       | 1-5%                | 1-5%  |
| >0.3 <= 0.6             | –    | 1-5%       | 5-10%               | 0-5%  |
| >0.6 <= 1.4             | –    | 10-25%     | 0-5%                | –     |
| >1.4 <= 4               | 0-1% | 0-5%       | –                   | –     |
| >4 <= 12                | 0-1% | –          | –                   | –     |
| >12 <= 24               | –    | –          | –                   | –     |
| >24 <= 37               | –    | –          | –                   | –     |
| >37                     | –    | –          | –                   | –     |

Figure 6. Plant community growth curve (percent production by month). AZ3811, 38.1 12-16" p.z. all sites. Growth begins in the spring, most growth occurs in the summer..

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0   | 0   | 1   | 7   | 15  | 20  | 22  | 20  | 10  | 5   | 0   | 0   |

## State 2 Exotic Annual Invaded State

### Community 2.1 Exotic Annual Invaded Plant Community

Non-native annual grasses like red brome and cheatgrass can invade and dominate areas of the site. These species can, over time, reduce the seed-bank of native annual grasses and forbs. Their presence can increase the fire frequency (of man made fires) especially where roads and urban areas are adjacent to areas of the site. Repeated fires tend to remove the native shrub, grass and forb canopy.

## State 3 Eroded State

### Community 3.1 Eroded Plant Community

Shrubs like creosotebush and whitethorn acacia and succulents like prickly pear and banana yucca can increase to dominate the site. Non-native annual forbs and grasses dominate the under-story. In "El Nino" years herbaceous fuels are sufficient for burning and repeat fires are especially common in areas close to residential zones and roads. Extreme rainfall events coupled with the fire, drought and grazing interaction, can lead to rilling of steep slopes. Compaction of soils can occur with heavy trailing from continuous livestock use. Loss of plant cover after repeated fire can lead to accelerated rill erosion under these circumstances.

## Additional community tables

Table 8. Community 1.1 plant community composition

| Group                  | Common Name                       | Symbol | Scientific Name                        | Annual Production<br>(Kg/Hectare) | Foliar Cover<br>(%) |
|------------------------|-----------------------------------|--------|--|-----------------------------------|---------------------|
| <b>Grass/Grasslike</b> |                                   |        |  |                                   |                     |
| 1                      | <b>Dominant perennial grasses</b> |        |  | 39–168                            |                     |
|                        | black grama                       | BOER4  | <i>Bouteloua eriopoda</i>              | 6–56                              | –                   |
|                        | bush muhly                        | MUPO2  | <i>Muhlenbergia porteri</i>            | 28–56                             | –                   |
|                        | blue threeawn                     | ARPUN  | <i>Aristida purpurea var. neallevi</i> | 1–45                              | –                   |

|   |                                |        |   |      |   |
|---|--------------------------------|--------|---|------|---|
|   | slim tridens                   | TRMU   | <i>Tridens muticus</i>                          | 1–22 | – |
|   | sideoats grama                 | BOCU   | <i>Bouteloua curtipendula</i>                   | 0–11 | – |
| 2 | <b>Cool season grasses</b>     |        |   | 0–34 |   |
|   | New Mexico feathergrass        | HENE5  | <i>Hesperostipa neomexicana</i>                 | 0–17 | – |
|   | needle and thread              | HECO26 | <i>Hesperostipa comata</i>                      | 0–6  | – |
|   | Indian ricegrass               | ACHY   | <i>Achnatherum hymenoides</i>                   | 0–6  | – |
|   | desert needlegrass             | ACSP12 | <i>Achnatherum speciosum</i>                    | 0–6  | – |
|   | squirreltail                   | ELEL5  | <i>Elymus elymoides</i>                         | 0–1  | – |
|   | prairie Junegrass              | KOMA   | <i>Koeleria macrantha</i>                       | 0–1  | – |
| 3 | <b>Misc. perennial grasses</b> |        |   | 6–67 |   |
|   | low woollygrass                | DAPU7  | <i>Dasyochloa pulchella</i>                     | 6–22 | – |
|   | red grama                      | BOTR2  | <i>Bouteloua trifida</i>                        | 0–17 | – |
|   | nineawn pappusgrass            | ENDE   | <i>Enneapogon desvauxii</i>                     | 1–11 | – |
|   | Parish's threeawn              | ARPUP5 | <i>Aristida purpurea</i> var. <i>parishii</i>   | 0–6  | – |
|   | spidergrass                    | ARTE3  | <i>Aristida ternipes</i>                        | 0–6  | – |
|   | purple threeawn                | ARPU9  | <i>Aristida purpurea</i>                        | 0–6  | – |
|   | Hall's panicgrass              | PAHA   | <i>Panicum hallii</i>                           | 0–6  | – |
|   | big galleta                    | PLRI3  | <i>Pleuraphis rigida</i>                        | 0–6  | – |
|   | plains bristlegrass            | SEVU2  | <i>Setaria vulpisetia</i>                       | 0–6  | – |
|   | sand dropseed                  | SPCR   | <i>Sporobolus cryptandrus</i>                   | 0–6  | – |
|   | slim tridens                   | TRMUE  | <i>Tridens muticus</i> var. <i>elongatus</i>    | 0–1  | – |
|   | tobosagrass                    | PLMU3  | <i>Pleuraphis mutica</i>                        | 0–1  | – |
|   | fall witchgrass                | DICO6  | <i>Digitaria cognata</i>                        | 0–1  | – |
|   | Fendler threeawn               | ARPUL  | <i>Aristida purpurea</i> var. <i>longiseta</i>  | 0–1  | – |
|   | spidergrass                    | ARTEG  | <i>Aristida ternipes</i> var. <i>gentilis</i>   | 0–1  | – |
|   | slender grama                  | BORE2  | <i>Bouteloua repens</i>                         | 0–1  | – |
|   | shortleaf woollygrass          | ERAV   | <i>Erioneuron avenaceum</i>                     | 0–1  | – |
|   | tanglehead                     | HECO10 | <i>Heteropogon contortus</i>                    | 0–1  | – |
|   | curly-mesquite                 | HIBE   | <i>Hilaria belangeri</i>                        | 0–1  | – |
| 4 | <b>Annual grasses</b>          |        |   | 1–56 |   |
|   | small fescue                   | VUMI   | <i>Vulpia microstachys</i>                      | 0–11 | – |
|   | Eastwood fescue                | VUMIC  | <i>Vulpia microstachys</i> var. <i>ciliata</i>  | 0–11 | – |
|   | sixweeks fescue                | VUOC   | <i>Vulpia octoflora</i>                         | 0–11 | – |
|   | Mexican panicgrass             | PAHI5  | <i>Panicum hirticaule</i>                       | 0–11 | – |
|   | sixweeks threeawn              | ARAD   | <i>Aristida adscensionis</i>                    | 1–11 | – |
|   | prairie threeawn               | AROL   | <i>Aristida oligantha</i>                       | 0–6  | – |
|   | witchgrass                     | PACA6  | <i>Panicum capillare</i>                        | 0–6  | – |
|   | mucronate sprangeltop          | LEPAB  | <i>Leptochloa panicea</i> ssp. <i>brachiata</i> | 0–6  | – |
|   | Arizona signalgrass            | URAR   | <i>Urochloa arizonica</i>                       | 0–6  | – |
|   | delicate muhly                 | MUFR   | <i>Muhlenbergia fragilis</i>                    | 0–2  | – |
|   | littleseed muhly               | MUMI   | <i>Muhlenbergia microsperma</i>                 | 0–2  | – |
|   | Rothrock's grama               | BORO2  | <i>Bouteloua rothrockii</i>                     | 0–2  | – |
|   | Arizona brome                  | BRAR4  | <i>Bromus arizonicus</i>                        | 0–2  | – |

|  |                     |       |   |     |   |
|--|---------------------|-------|---|-----|---|
|  | feather fingergrass | CHVI4 | <i>Chloris virgata</i>                                | 0-2 | - |
|  | canyon cupgrass     | ERLE7 | <i>Eriochloa lemmonii</i>                             | 0-1 | - |
|  | tufted lovegrass    | ERPE  | <i>Eragrostis pectinacea</i>                          | 0-1 | - |
|  | desert lovegrass    | ERPEM | <i>Eragrostis pectinacea</i> var.<br><i>miserrima</i> | 0-1 | - |
|  | little barley       | HOPU  | <i>Hordeum pusillum</i>                               | 0-1 | - |
|  | Mexican sprangletop | LEFUU | <i>Leptochloa fusca</i> ssp. <i>uninervia</i>         | 0-1 | - |
|  | needle grama        | BOAR  | <i>Bouteloua aristidoides</i>                         | 0-1 | - |
|  | sixweeks grama      | BOBA2 | <i>Bouteloua barbata</i>                              | 0-1 | - |
|  | Bigelow's bluegrass | POBI  | <i>Poa bigelovii</i>                                  | 0-1 | - |

### Forb

|   |                              |        |   |      |   |
|---|------------------------------|--------|---|------|---|
| 5 | <b>Perennial forbs</b>       |        |   | 2-28 |   |
|   | trailing windmills           | ALIN   | <i>Allionia incarnata</i>                   | 1-6  | - |
|   | weakleaf bur ragweed         | AMCO3  | <i>Ambrosia confertiflora</i>               | 1-6  | - |
|   | hairyseed bahia              | BAAB   | <i>Bahia absinthifolia</i>                  | 0-6  | - |
|   | leatherweed                  | CRPO5  | <i>Croton pottsii</i>                       | 0-6  | - |
|   | glandleaf milkwort           | POMA7  | <i>Polygala macradenia</i>                  | 0-6  | - |
|   | desert globemallow           | SPAM2  | <i>Sphaeralcea ambigua</i>                  | 1-6  | - |
|   | brownplume wirelettuce       | STPA4  | <i>Stephanomeria pauciflora</i>             | 1-6  | - |
|   | Coues' cassia                | SECO10 | <i>Senna covesii</i>                        | 0-2  | - |
|   | Fendler's bladderpod         | LEFE   | <i>Lesquerella fendleri</i>                 | 0-2  | - |
|   | Parry's false prairie-clover | MAPA7  | <i>Marina parryi</i>                        | 0-2  | - |
|   | lacy tansyaster              | MAPI   | <i>Machaeranthera pinnatifida</i>           | 0-2  | - |
|   | wishbone-bush                | MILAV  | <i>Mirabilis laevis</i> var. <i>villosa</i> | 0-2  | - |
|   | rue of the mountains         | THTE2  | <i>Thamnosma texana</i>                     | 0-2  | - |
|   | desert trumpet               | ERIN4  | <i>Eriogonum inflatum</i>                   | 0-2  | - |
|   | paleface                     | HIDE   | <i>Hibiscus denudatus</i>                   | 0-2  | - |
|   | slender janusia              | JAGR   | <i>Janusia gracilis</i>                     | 0-1  | - |
|   | ragged nettlespurge          | JAMA   | <i>Jatropha macrorrhiza</i>                 | 0-1  | - |
|   | longflower tube tongue       | JULO3  | <i>Justicia longii</i>                      | 0-1  | - |
|   | Mojave spurge                | EUSC6  | <i>Euphorbia schizoloba</i>                 | 0-1  | - |
|   | southwestern mock vervain    | GLGO   | <i>Glandularia gooddingii</i>               | 0-1  | - |
|   | desert rosemallow            | HICO   | <i>Hibiscus coulteri</i>                    | 0-1  | - |
|   | purplenerve springparsley    | CYMU2  | <i>Cymopterus multinervatus</i>             | 0-1  | - |
|   | Gregg's prairie clover       | DAGR2  | <i>Dalea greggii</i>                        | 0-1  | - |
|   | James' prairie clover        | DAJA   | <i>Dalea jamesii</i>                        | 0-1  | - |
|   | Cooley's bundleflower        | DECO2  | <i>Desmanthus cooleyi</i>                   | 0-1  | - |
|   | desert larkspur              | DEPA   | <i>Delphinium parishii</i>                  | 0-1  | - |
|   | tall mountain larkspur       | DESC   | <i>Delphinium scaposum</i>                  | 0-1  | - |
|   | bluedicks                    | DICA14 | <i>Dichelostemma capitatum</i>              | 0-1  | - |
|   | fleabane                     | ERIGE2 | <i>Erigeron</i>                             | 0-1  | - |
|   | desert marigold              | BAMU   | <i>Baileya multiradiata</i>                 | 0-1  | - |
|   | scarlet spiderling           | BOCO   | <i>Boerhavia coccinea</i>                   | 0-1  | - |
|   | climbing wartclub            | BOSC   | <i>Boerhavia scandens</i>                   | 0-1  | - |



|   |                            |        |  |       |   |
|---|----------------------------|--------|--|-------|---|
|   | wavyleaf Indian paintbrush | CAAPM  | <i>Castilleja applegatei ssp. martinii</i> | 0-1   | - |
|   | Arizona wrightwort         | CAAR7  | <i>Carlowrightia arizonica</i>             | 0-1   | - |
|   | desert mariposa lily       | CAKE   | <i>Calochortus kennedyi</i>                | 0-1   | - |
|   | sego lily                  | CANU3  | <i>Calochortus nuttallii</i>               | 0-1   | - |
|   | tuber anemone              | ANTU   | <i>Anemone tuberosa</i>                    | 0-1   | - |
|   | narrowleaf silverbush      | ARLA12 | <i>Argythamnia lanceolata</i>              | 0-1   | - |
|   | white sagebrush            | ARLUM2 | <i>Artemisia ludoviciana ssp. mexicana</i> | 0-1   | - |
|   | New Mexico silverbush      | ARNE2  | <i>Argythamnia neomexicana</i>             | 0-1   | - |
|   | perennial rockcress        | ARPE2  | <i>Arabis perennans</i>                    | 0-1   | - |
|   | dense ayenia               | AYMI   | <i>Ayenia microphylla</i>                  | 0-1   | - |
|   | largeflower onion          | ALMA4  | <i>Allium macropetalum</i>                 | 0-1   | - |
|   | dwarf desertpeony          | ACNA2  | <i>Acourtia nana</i>                       | 0-1   | - |
|   | brownfoot                  | ACWR5  | <i>Acourtia wrightii</i>                   | 0-1   | - |
|   | San Felipe dogweed         | ADPO   | <i>Adenophyllum porophylloides</i>         | 0-1   | - |
|   | branched noseburn          | TRRA5  | <i>Tragia ramosa</i>                       | 0-1   | - |
|   | Louisiana vetch            | VILUL2 | <i>Vicia ludoviciana ssp. ludoviciana</i>  | 0-1   | - |
|   | desert tobacco             | NIOB   | <i>Nicotiana obtusifolia</i>               | 0-1   | - |
|   | toadflax penstemon         | PELI2  | <i>Penstemon linarioides</i>               | 0-1   | - |
|   | Parry's beardtongue        | PEPA24 | <i>Penstemon parryi</i>                    | 0-1   | - |
|   | desert penstemon           | PEPS   | <i>Penstemon pseudospectabilis</i>         | 0-1   | - |
|   | orange fameflower          | PHAU13 | <i>Phemeranthus aurantiacus</i>            | 0-1   | - |
|   | slender poreleaf           | POGR5  | <i>Porophyllum gracile</i>                 | 0-1   | - |
|   | plains blackfoot           | MELE2  | <i>Melampodium leucanthum</i>              | 0-1   | - |
|   | Lemmon's ragwort           | SELE8  | <i>Senecio lemmonii</i>                    | 0-1   | - |
|   | New Mexico fanpetals       | SINE   | <i>Sida neomexicana</i>                    | 0-1   | - |
|   | silverleaf nightshade      | SOEL   | <i>Solanum elaeagnifolium</i>              | 0-1   | - |
|   | turpentinebroom            | THMO   | <i>Thamnosma montana</i>                   | 0-1   | - |
|   | canaigre dock              | RUHY   | <i>Rumex hymenosepalus</i>                 | 0-1   | - |
|   | twinleaf senna             | SEBA3  | <i>Senna bauhinioides</i>                  | 0-1   | - |
| 6 | <b>Annual forbs</b>        |        |  | 2-140 |   |
|   | lyreleaf jewelflower       | STCA5  | <i>Streptanthus carinatus</i>              | 0-17  | - |
|   | flatcrown buckwheat        | ERDE6  | <i>Eriogonum deflexum</i>                  | 0-17  | - |
|   | cryptantha                 | CRYPT  | <i>Cryptantha</i>                          | 0-11  | - |
|   | thelypody                  | THELY  | <i>Thelypodium</i>                         | 0-11  | - |
|   | phacelia                   | PHACE  | <i>Phacelia</i>                            | 0-11  | - |
|   | bristly fiddleneck         | AMTE3  | <i>Amsinckia tessellata</i>                | 0-11  | - |
|   | exserted Indian paintbrush | CAEXE  | <i>Castilleja exserta ssp. exserta</i>     | 0-11  | - |
|   | pitseed goosefoot          | CHBE4  | <i>Chenopodium berlandieri</i>             | 0-6   | - |
|   | Coulter's spiderling       | BOCO2  | <i>Boerhavia coulteri</i>                  | 0-6   | - |
|   | fivewing spiderling        | BOIN   | <i>Boerhavia intermedia</i>                | 0-6   | - |
|   | chia                       | SACO6  | <i>Salvia columbariae</i>                  | 0-6   | - |
|   | desert Indianwheat         | PLOV   | <i>Plantago ovata</i>                      | 0-6   | - |
|   | woolly plantain            | PLPA2  | <i>Plantago patagonica</i>                 | 0-6   | - |

|                             |        |   |     |   |
|-----------------------------|--------|---|-----|---|
| woolly tidestromia          | TILA2  | <i>Tidestromia lanuginosa</i>                           | 0-6 | - |
| western tansymustard        | DEPI   | <i>Descurainia pinnata</i>                              | 0-6 | - |
| California poppy            | ESCAM  | <i>Eschscholzia californica</i> ssp.<br><i>mexicana</i> | 0-6 | - |
| Gordon's bladderpod         | LEGO   | <i>Lesquerella gordonii</i>                             | 0-6 | - |
| shaggyfruit pepperweed      | LELA   | <i>Lepidium lasiocarpum</i>                             | 0-6 | - |
| foothill deervetch          | LOHU2  | <i>Lotus humistratus</i>                                | 0-6 | - |
| desertparsley               | LOMAT  | <i>Lomatium</i>   | 0-6 | - |
| coastal bird's-foot trefoil | LOSA   | <i>Lotus salsuginosus</i>                               | 0-6 | - |
| slender goldenweed          | MAGR10 | <i>Machaeranthera gracilis</i>                          | 0-6 | - |
| Coulter's lupine            | LUSP2  | <i>Lupinus sparsiflorus</i>                             | 0-6 | - |
| combseed                    | PECTO  | <i>Pectocarya</i>                                       | 0-6 | - |
| tanseyleaf tansyaster       | MATA2  | <i>Machaeranthera tanacetifolia</i>                     | 0-2 | - |
| Thurber's pepperweed        | LETH2  | <i>Lepidium thurberi</i>                                | 0-2 | - |
| sorrel buckwheat            | ERPO4  | <i>Eriogonum polycladon</i>                             | 0-2 | - |
| spurge                      | EUPHO  | <i>Euphorbia</i>  | 0-2 | - |
| crestrib morning-glory      | IPCO2  | <i>Ipomoea costellata</i>                               | 0-2 | - |
| wedgeleaf draba             | DRCU   | <i>Draba cuneifolia</i>                                 | 0-2 | - |
| hairy prairie clover        | DAMO   | <i>Dalea mollis</i>                                     | 0-2 | - |
| American wild carrot        | DAPU3  | <i>Daucus pusillus</i>                                  | 0-2 | - |
| purslane                    | PORTU  | <i>Portulaca</i>  | 0-2 | - |
| sleepy silene               | SIAN2  | <i>Silene antirrhina</i>                                | 0-2 | - |
| hyssopleaf sandmat          | CHHY3  | <i>Chamaesyce hyssopifolia</i>                          | 0-2 | - |
| New Mexico thistle          | CINE   | <i>Cirsium neomexicanum</i>                             | 0-2 | - |
| miner's lettuce             | CLPEP  | <i>Claytonia perfoliata</i> ssp. <i>perfoliata</i>      | 0-1 | - |
| scrambled eggs              | COAU2  | <i>Corydalis aurea</i>                                  | 0-1 | - |
| Esteve's pincushion         | CHST   | <i>Chaenactis stevioides</i>                            | 0-1 | - |
| brittle spineflower         | CHBR   | <i>Chorizanthe brevicornu</i>                           | 0-1 | - |
| yellow tackstem             | CAPA7  | <i>Calycoseris parryi</i>                               | 0-1 | - |
| white tackstem              | CAWR   | <i>Calycoseris wrightii</i>                             | 0-1 | - |
| hoary bowlesia              | BOIN3  | <i>Bowlesia incana</i>                                  | 0-1 | - |
| milkvetch                   | ASTRA  | <i>Astragalus</i>                                       | 0-1 | - |
| annual agoseris             | AGHE2  | <i>Agoseris heterophylla</i>                            | 0-1 | - |
| carelessweed                | AMPA   | <i>Amaranthus palmeri</i>                               | 0-1 | - |
| desert unicorn-plant        | PRAL4  | <i>Proboscidea althaeifolia</i>                         | 0-1 | - |
| doubleclaw                  | PRPA2  | <i>Proboscidea parviflora</i>                           | 0-1 | - |
| New Mexico plumeseed        | RANE   | <i>Rafinesquia neomexicana</i>                          | 0-1 | - |
| sawtooth sage               | SASU7  | <i>Salvia subincisa</i>                                 | 0-1 | - |
| spreading fanpetals         | SIAB   | <i>Sida abutifolia</i>                                  | 0-1 | - |
| Arizona popcornflower       | PLAR   | <i>Plagiobothrys arizonicus</i>                         | 0-1 | - |
| creamcups                   | PLCA5  | <i>Platystemon californicus</i>                         | 0-1 | - |
| woollyhead neststraw        | STMI2  | <i>Stylocline micropoides</i>                           | 0-1 | - |
| sand fringe pod             | THCU   | <i>Thysanocarpus curvipes</i>                           | 0-1 | - |
| sacred thorn-apple          | DAWR2  | <i>Datura wrightii</i>                                  | 0-1 | - |

|  |                            |        |   |     |   |
|--|----------------------------|--------|---|-----|---|
|  | miniature woollystar       | ERDI2  | <i>Eriastrum diffusum</i>               | 0-1 | - |
|  | spreading fleabane         | ERDI4  | <i>Erigeron divergens</i>               | 0-1 | - |
|  | redstar                    | IPCO3  | <i>Ipomoea coccinea</i>                 | 0-1 | - |
|  | ivyleaf morning-glory      | IPHE   | <i>Ipomoea hederacea</i>                | 0-1 | - |
|  | Arizona poppy              | KAGR   | <i>Kallstroemia grandiflora</i>         | 0-1 | - |
|  | California goldfields      | LACA7  | <i>Lasthenia californica</i>            | 0-1 | - |
|  | star gilia                 | GIST   | <i>Gilia stellata</i>                   | 0-1 | - |
|  | longleaf false goldeneye   | HELOA2 | <i>Heliomeris longifolia var. annua</i> | 0-1 | - |
|  | Texas stork's bill         | ERTE13 | <i>Erodium texanum</i>                  | 0-1 | - |
|  | Arizona lupine             | LUAR4  | <i>Lupinus arizonicus</i>               | 0-1 | - |
|  | miniature lupine           | LUBI   | <i>Lupinus bicolor</i>                  | 0-1 | - |
|  | whitestem blazingstar      | MEAL6  | <i>Mentzelia albicaulis</i>             | 0-1 | - |
|  | green carpetweed           | MOVE   | <i>Mollugo verticillata</i>             | 0-1 | - |
|  | desert evening primrose    | OEPR   | <i>Oenothera primiveris</i>             | 0-1 | - |
|  | Florida pellitory          | PAFL3  | <i>Parietaria floridana</i>             | 0-1 | - |
|  | manybristle chinchweed     | PEPA2  | <i>Pectis papposa</i>                   | 0-1 | - |
|  | Fendler's desertydandelion | MAFE   | <i>Malacothrix fendleri</i>             | 0-1 | - |

#### Shrub/Vine

|   |                                   |        |   |         |   |
|---|-----------------------------------|--------|---|---------|---|
| 7 | <b>Dominant large shrubs</b>      |        |   | 224-336 |   |
|   | creosote bush                     | LATR2  | <i>Larrea tridentata</i>                    | 224-336 | - |
|   | whitethorn acacia                 | ACCO2  | <i>Acacia constricta</i>                    | 0-56    | - |
|   | whitethorn acacia                 | ACCOP9 | <i>Acacia constricta var. paucispina</i>    | 0-11    | - |
| 8 | <b>Miscellaneous large shrubs</b> |        |   | 0-17    |   |
|   | ocotillo                          | FOSP2  | <i>Fouquieria splendens</i>                 | 0-2     | - |
|   | crown of thorns                   | KOSP   | <i>Koeberlinia spinosa</i>                  | 0-2     | - |
|   | Wright's beebrush                 | ALWR   | <i>Aloysia wrightii</i>                     | 0-2     | - |
|   | fourwing saltbush                 | ATCA2  | <i>Atriplex canescens</i>                   | 0-1     | - |
|   | desert sweet                      | CHMI2  | <i>Chamaebatiaria millefolium</i>           | 0-1     | - |
|   | Warnock's snakewood               | COWA   | <i>Condalia warnockii</i>                   | 0-1     | - |
|   | water jacket                      | LYAN   | <i>Lycium andersonii</i>                    | 0-1     | - |
|   | Berlandier's wolfberry            | LYBE   | <i>Lycium berlandieri</i>                   | 0-1     | - |
|   | Arizona desert-thorn              | LYEX   | <i>Lycium exsertum</i>                      | 0-1     | - |
|   | red barberry                      | MAHA4  | <i>Mahonia haematocarpa</i>                 | 0-1     | - |
|   | catclaw mimosa                    | MIACB  | <i>Mimosa aculeaticarpa var. biuncifera</i> | 0-1     | - |
|   | littleleaf sumac                  | RHMI3  | <i>Rhus microphylla</i>                     | 0-1     | - |
|   | skunkbush sumac                   | RHTR   | <i>Rhus trilobata</i>                       | 0-1     | - |
|   | Wright's mock buckthorn           | SAWR   | <i>Sageretia wrightii</i>                   | 0-1     | - |
|   | jojoba                            | SICH   | <i>Simmondsia chinensis</i>                 | 0-1     | - |
|   | Arizona necklacepod               | SOAR3  | <i>Sophora arizonica</i>                    | 0-1     | - |
|   | lotebush                          | ZIOBC  | <i>Ziziphus obtusifolia var. canescens</i>  | 0-1     | - |
|   | longleaf jointfir                 | EPTR   | <i>Ephedra trifurca</i>                     | 0-1     | - |
|   | catclaw acacia                    | ACGR   | <i>Acacia greggii</i>                       | 0-1     | - |
| 9 | <b>Dominant half shrubs</b>       |        |   | 6-67    |   |

|    |                              |        |   |      |   |
|----|------------------------------|--------|---|------|---|
|    | mariola                      | PAIN2  | <i>Parthenium incanum</i>                     | 0–17 | – |
|    | desert zinnia                | ZIAC   | <i>Zinnia acerosa</i>                         | 1–17 | – |
|    | rough menodora               | MESC   | <i>Menodora scabra</i>                        | 1–11 | – |
|    | littleleaf ratany            | KRER   | <i>Krameria erecta</i>                        | 0–6  | – |
|    | winterfat                    | KRLA2  | <i>Krascheninnikovia lanata</i>               | 0–6  | – |
|    | woody crinklemat             | TICA3  | <i>Tiquilia canescens</i>                     | 0–6  | – |
|    | fairyduster                  | CAER   | <i>Calliandra eriophylla</i>                  | 0–6  | – |
|    | featherplume                 | DAFO   | <i>Dalea formosa</i>                          | 0–2  | – |
|    | Eastern Mojave buckwheat     | ERFA2  | <i>Eriogonum fasciculatum</i>                 | 0–1  | – |
|    | bastardsage                  | ERWR   | <i>Eriogonum wrightii</i>                     | 0–1  | – |
|    | Coulter's brickellbush       | BRCO   | <i>Brickellia coulteri</i>                    | 0–1  | – |
|    | longleaf phlox               | PHLO2  | <i>Phlox longifolia</i>                       | 0–1  | – |
|    | purple sage                  | SADOM  | <i>Salvia dorrii ssp. mearnsii</i>            | 0–1  | – |
| 10 | <b>Succulents</b>            |        |   | 6–28 |   |
|    | buck-horn cholla             | CYAC8  | <i>Cylindropuntia acanthocarpa</i>            | 1–11 | – |
|    | banana yucca                 | YUBA   | <i>Yucca baccata</i>                          | 1–11 | – |
|    | Christmas cactus             | CYLE8  | <i>Cylindropuntia leptocaulis</i>             | 0–6  | – |
|    | cactus apple                 | OPEN3  | <i>Opuntia engelmannii</i>                    | 0–6  | – |
|    | purple pricklypear           | OPMA8  | <i>Opuntia macrocentra</i>                    | 0–6  | – |
|    | saguaro                      | CAGI10 | <i>Carnegiea gigantea</i>                     | 0–6  | – |
|    | tulip pricklypear            | OPPH   | <i>Opuntia phaeacantha</i>                    | 0–2  | – |
|    | common sotol                 | DAWH2  | <i>Dasyilirion wheeleri</i>                   | 0–2  | – |
|    | pinkflower hedgehog cactus   | ECBO2  | <i>Echinocereus bonkeriae</i>                 | 0–1  | – |
|    | Arizona hedgehog cactus      | ECCOA  | <i>Echinocereus coccineus var. arizonicus</i> | 0–1  | – |
|    | Engelmann's hedgehog cactus  | ECEN   | <i>Echinocereus engelmannii</i>               | 0–1  | – |
|    | redspine fishhook cactus     | ECER2  | <i>Echinomastus erectocentrus</i>             | 0–1  | – |
|    | pinkflower hedgehog cactus   | ECFA   | <i>Echinocereus fasciculatus</i>              | 0–1  | – |
|    | spinystar                    | ESVI2  | <i>Escobaria vivipara</i>                     | 0–1  | – |
|    | candy barrelcactus           | FEWI   | <i>Ferocactus wislizeni</i>                   | 0–1  | – |
|    | devil's cholla               | GRKU   | <i>Grusonia kunzei</i>                        | 0–1  | – |
|    | Graham's nipple cactus       | MAGR9  | <i>Mammillaria grahamii</i>                   | 0–1  | – |
|    | sacahuista                   | NOMI   | <i>Nolina microcarpa</i>                      | 0–1  | – |
|    | walkingstick cactus          | CYSP8  | <i>Cylindropuntia spinosior</i>               | 0–1  | – |
|    | soaptree yucca               | YUEL   | <i>Yucca elata</i>                            | 0–1  | – |
|    | teddybear cholla             | CYBI9  | <i>Cylindropuntia bigelovii</i>               | 0–1  | – |
|    | jumping cholla               | CYFU10 | <i>Cylindropuntia fulgida</i>                 | 0–1  | – |
|    | goldenflower century plant   | AGCH2  | <i>Agave chrysantha</i>                       | 0–1  | – |
|    | Parry's agave                | AGPA4  | <i>Agave parryi</i>                           | 0–1  | – |
|    | Schott's century plant       | AGSC3  | <i>Agave schottii</i>                         | 0–1  | – |
| 11 | <b>Increaser half-shrubs</b> |        |   | 0–17 |   |
|    | broom snakeweed              | GUSA2  | <i>Gutierrezia sarothrae</i>                  | 0–11 | – |

|             |                        |        |   |      |   |
|-------------|------------------------|--------|---|------|---|
|             | whitestem paperflower  | PSCO2  | <i>Psilostrophe cooperi</i>               | 0–6  | – |
|             | burroweed              | ISTE2  | <i>Isocoma tenuisecta</i>                 | 0–1  | – |
|             | rayless goldenhead     | ACSP   | <i>Acamptopappus sphaerocephalus</i>      | 0–1  | – |
|             | threadleaf snakeweed   | GUMI   | <i>Gutierrezia microcephala</i>           | 0–1  | – |
| <b>Tree</b> |                        |        |   |      |   |
| 12          | <b>Trees</b>           |        |   | 0–11 |   |
|             | crucifixion thorn      | CAHO3  | <i>Canotia holacantha</i>                 | 0–6  | – |
|             | redberry juniper       | JUCO11 | <i>Juniperus coahuilensis</i>             | 0–1  | – |
|             | oneseed juniper        | JUMO   | <i>Juniperus monosperma</i>               | 0–1  | – |
|             | blue paloverde         | PAFL6  | <i>Parkinsonia florida</i>                | 0–1  | – |
|             | western honey mesquite | PRGLT  | <i>Prosopis glandulosa var. torreyana</i> | 0–1  | – |
|             | velvet mesquite        | PRVE   | <i>Prosopis velutina</i>                  | 0–1  | – |

## Animal community

This site is suitable for grazing year round, but is not easily traversed by livestock. Livestock grazing use is concentrated on south slopes and ridge-tops. The site is susceptible to erosion in overgrazed areas like bed-grounds, livestock trails and lower slopes adjacent to water.

The site has poor habitat diversity for most desert wildlife species. It is home mainly to rodents and rabbits and their predators. Water developments are very important to both livestock and wildlife on this site.

## Hydrological functions

This site has rough surfaces, due to a high cover of gravels and stones, which act to hold water on the site. When the soils are dry, it produces little runoff. It produces significant runoff only when heavy rain falls on snow or moist soils.

## Recreational uses

Hunting, camping, horseback riding, backpacking, rock hounding, fossil hunting, photography.

## Wood products

None

## Other products

There is some harvest of food plants like prickly pear tunas, jojoba nuts and mescal. There is limited harvest of medicinal plants like mormon tea and creosote bush.

## Contributors

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## 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)                    | Karlynn Huling             |
| Contact for lead author                     | NRCS Flagstaff Area Office |
| Date  | 05/18/2007                 |
| Approved by                                 | S. Cassady                 |
| Approval date                               |                            |
| Composition (Indicators 10 and 12) based on | Annual Production          |

## Indicators

1. **Number and extent of rills:** A few rills may form due to loamy textures, slow permeability, and medium to rapid runoff. Rills may be more common on shallow soils and steeper slopes; less common on deeper soils, gentler slopes, and soils with a lot of rock fragment armor on the surface and within the surface horizon.  

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2. **Presence of water flow patterns:** Water flow patterns may be common due to slow permeability and medium to rapid runoff. Water flow patterns will be more common on steeper slopes and shallow soils.  

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3. **Number and height of erosional pedestals or terracettes:** Some pedestals and terracettes may form, but they should be very short.  

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** One area had 30% bare ground. If a wet winter and spring produces a flush of annuals, there will be less bare ground. This site has an average available water capacity of 7 inches, so it has a low (shallow soils) to moderate (deep soils) potential to produce plant cover. Areas with a higher cover of rock fragments have less bare ground. Drought may cause an increase in bare ground.  

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5. **Number of gullies and erosion associated with gullies:** None  

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None  

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7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous and fine woody litter will be transported in water flow pathways. Coarse woody litter will remain under shrub and tree canopies.  

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values average 4 both under plant canopy and in the interspaces. Soil surface textures are mostly sandy loam, loam, and fine sandy loam. The surface horizon may have no rock fragments or it may be very gravelly. When well vegetated, the soils have a moderate to high resistance to water erosion and a moderate resistance to wind erosion.  

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

structure can be granular (weak to moderate, very fine to fine), platy (weak to moderate, medium to moderately thick), or subangular blocky (weak to moderate, fine). Surface thickness ranges from 1-5 inches. Color is variable depending upon parent material.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** This site is characterized by a relatively even distribution of mostly grasses with some shrubs and a few forbs. There may be up to 25% tree cover in higher elevations with very shallow to shallow soils. Canopy cover on one shallow area was 60% (40% grass, 2% forbs, 2% shrubs, and 20% trees). Basal cover was 13% (all grass). Both canopy and basal cover values decrease during a prolonged drought. This type of plant community is moderately effective at capturing and storing precipitation.
- 

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. Due to sandy loam, loam, and fine sandy loam surface textures, the soils may be easily compacted if there are no coarse fragments within the surface horizon. Some surface horizons, however, are naturally platy.
- 

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: none

Sub-dominant: warm season colonizing grasses = warm season bunchgrasses > deciduous or persistent shrubs > cool season bunchgrasses >

Other: minor: forbs > evergreen shrubs >

Trace: Agave family > cacti = trees > annual grasses

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** All plant functional groups are adapted to survival in all years except during the most severe droughts. Severe winter droughts affect shrubs and trees the most. Severe summer droughts affect grasses the most.
- 

14. **Average percent litter cover (%) and depth (in):** Mostly herbaceous litter with some woody litter. Litter amounts increase during the first few years of drought, then decrease in later years.
- 

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 450-575 pounds per acre (dry weight) during drought years; 575-800 pounds per acre during median years; 800-900 pounds per acre during wet years.
- 

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:** Broom snakeweed is native to the site, but has the potential to increase and dominate the area after heavy grazing. Juniper is native to the site, but can also increase after heavy grazing and fire exclusion. This site includes shallow soils, however, which can support a moderate amount of trees (up to 25% cover). Rubber rabbitbrush is a native plant that may invade and dominate the site after soil disturbance, overgrazing, or fire. Portulaca (purslane) and Amaranthus (pigweed) are native or exotic forbs that may invade and dominate the site after soil disturbance, overgrazing or fire.

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17. **Perennial plant reproductive capability:** All plants native to the site are adapted to the climate and are capable of producing seeds, stolons, and rhizomes in most years except during the most severe droughts.
-