# Ecological site R028AY137UT
# Desert Sandy Loam (Shadscale)

Accessed: 07/18/2024

## 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.

## MLRA notes

Major Land Resource Area (MLRA): 028A–Ancient Lake Bonneville

This site occurs in MLRA 28A, LRU A, the northern part of MLRA 28A. This LRU has a mesic soil temperature regime and a typic aridic soil moisture regime. Typically most precipitation occurs in the winter with some precipitation in the summer with convective thundstorms. Mean annual precipitation is between 4 to 8 inches. The south desert ecological zone typically has no big sagebrush (Artemisia tridentate spp.), but typically is dominated by shadscale (*Atriplex confertifolia*), winterfat (*Krascheninnikovia lanata*), saltbushes (Atriplex spp), Indian ricegrass (*Achnatherum hymenoides*), and bottlebrush squirreltail (*Elymus elymoides*). Unlike the northern LRUs, there is typically galleta (*Pleuraphis jamesii*) grass present in the community.

## Classification relationships

MLRA 28A, LRU E, southern desert ecological zone

## Ecological site concept

This site is typically dominated by shadscale in reference condition. It occurs on gently sloping alluvial fans, fan terraces or lake terraces with loamy fine sand textures.

## Associated sites

| | |
|---|---|
| R028AY122UT | **Desert Gravelly Sandy Loam (Indian Ricegrass)** |
| R028AY134UT | **Desert Sand (Four-Wing Saltbush)** |
| R028AY140UT | **Desert Silt Flat (Winterfat)** |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | (1) *Atriplex confertifolia* |
| Herbaceous | Not specified |

## Physiographic features

This site occurs on alluvial fans, fan terraces, lake terraces and fan remnants. It occurs on slopes between 0 and 8 percent at elevations between 4300 to 5800 feet. There is no ponding or flooding on this site.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Alluvial fan<br>(2) Fan remnant<br>(3) Lake terrace |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 1,311–1,768 m |
| Slope | 0–8% |

## Climatic features

The climate is cold and snowy in the winter and warm and dry in the summer. The average annual precipitation is 5 to 8 inches. Approximately 70 percent comes as rain from March through October. On the average, June through September are the driest months and March through May are the wettest months.

Mean Annual Air Temperature: 45-50
Mean Annual Soil Temperature: 50-53

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 101 days |
| Freeze-free period (average) | 141 days |
| Precipitation total (average) | 178 mm |

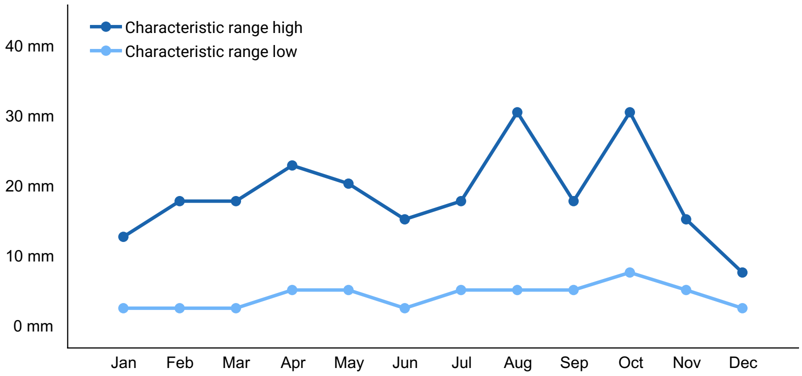


**Figure 1. Monthly precipitation range**

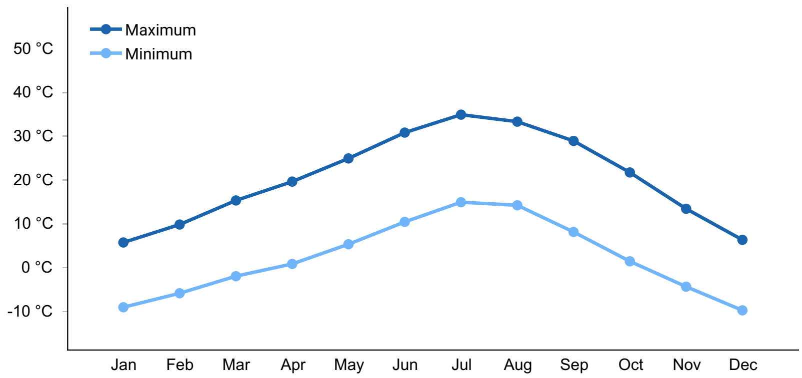


**Figure 2. Monthly average minimum and maximum temperature**

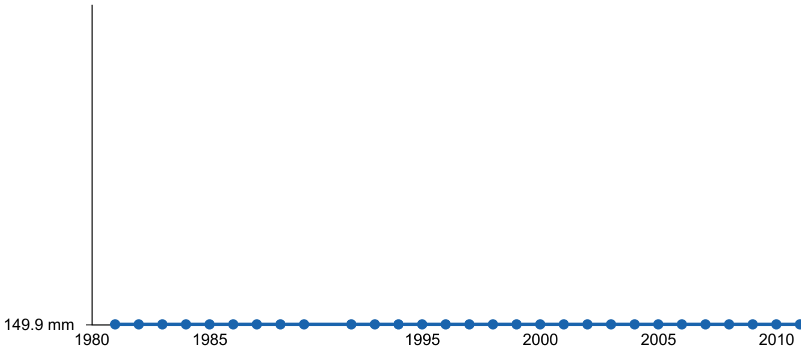


**Figure 3. Annual precipitation pattern**

## Climate stations used

- (1) WAH WAH RCH [USC00429152], Milford, UT

## Influencing water features

## Soil features

The characteristic soils in this site are over 60 inches deep and well drained.

They formed in lake sediments derived mainly from mixed parent materials. The surface horizon is loam or sandy loam textures 14 inches thick. The volume of rock fragments in the soil profile is 15 to 35 percent.

This soil varies from slightly alkaline to moderately alkaline.

The water supplying capacity is 4 to 5 inches. Natural geologic erosion in potential is approximately 0.1 tons/acre/year.

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Alluvium–limestone and sandstone |
| Surface texture | (1) Loamy fine sand<br>(2) Gravelly sandy loam<br>(3) Fine sandy loam |
| Drainage class | Well drained |
| Permeability class | Moderate to moderately rapid |
| Soil depth | 152 cm |
| Surface fragment cover <=3" | 0–24% |
| Surface fragment cover >3" | 0% |
| Available water capacity (0-101.6cm) | 6.86–12.19 cm |
| Calcium carbonate equivalent (0-101.6cm) | 1–20% |
| Electrical conductivity (0-101.6cm) | 0–16 mmhos/cm |
| Sodium adsorption ratio (0-101.6cm) | 0–20 |
| Soil reaction (1:1 water) (0-101.6cm) | 7.9–9 |
| Subsurface fragment volume <=3" (Depth not specified) | 10–24% |

| | |
|---|---|
| Subsurface fragment volume >3" (Depth not specified) | 0–6% |

## Ecological dynamics

The plant communities and ecological dynamics associated with this site are presented in a State and Transition Model (STM) diagram and are described in more detail in the narratives that follow. These plant communities may not represent every possibility, but are probably the most prevalent and recurring plant communities. As more monitoring data are collected, some phases or states may be revised, removed, and/or new ones added. None of these plant communities should necessarily be thought of as “Desired Plant Communities.” The descriptions of plant communities in this document represent the current knowledge and experience at the time of this revision.

STMs are used to illustrate how a reference community (i.e. vegetation prior to Euro-American settlement but long after the arrival of Native Americans) and associated soil-vegetation relationships evolve when subjected to different environmental conditions and drivers of change (e.g. climate, land use, natural disturbances). The STM consists of the historic “Reference State” and potential “alternative states.” Each state may have one or more community “phases” to represent how system dynamics fluctuate within the “limits” of the state (Briske et al. 2008). The ecological resilience (i.e. stability) of a state can be maintained when negative feedbacks exist. Conversely, when system dynamics are disturbed enough through positive feedbacks, whether natural or human-caused, new conditions and processes may develop, resetting the trajectory of the site to an alternative stable state. Transitions between states occur when ecological “thresholds” are crossed. The ability to return to the prior state and reverse the transition would not occur without active restoration practices (i.e. “restoration pathways”). The drivers of change between phases and states are labeled in the diagram as codes (see legend beneath the diagram).

STMs provide a more mechanistic view of the ecological site, which land managers can use to distinguish current conditions from “desired” conditions, and to assess state vulnerability relative to ecological thresholds. Increased awareness of how soil-vegetation patterns and processes vary over space and time promotes greater opportunities to focus adaptive management and restoration efforts.

As ecological condition deteriorates due to overgrazing by cattle, the less desirable shrubs will increase, while on the other hand continued heavy grazing by sheep will result in an increase in desirable grasses unless grazing is severe; cheatgrass and halogeton are then likely to invade the site.

When the potential natural plant community is burned Indian ricegrass and needle and thread decrease while rabbitbrush and annuals increase.

Annuals grasses and annual forbs are most likely to invade this site.

This site is similar to R028AY124UT. This site is found in the southern desert zone while R028AY124UT is found in the northern desert zone.

## State and transition model

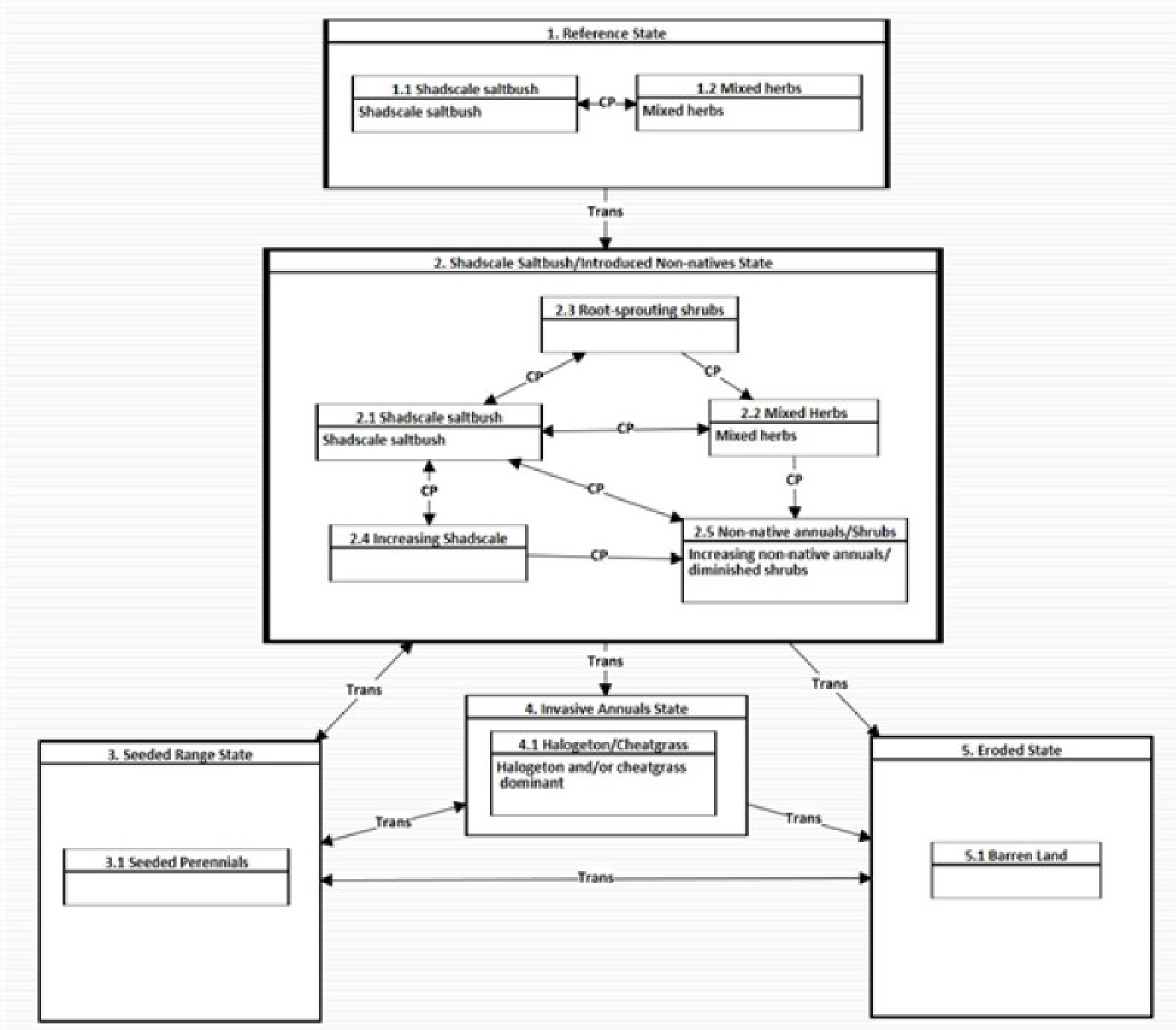


**Figure 5. R028AE137UT STM**

## State 1
## Reference State

The Reference State includes the plant communities best adapted to the unique combinations and factors associated with this ecological site prior to Euro-American settlement. Thus, the plant communities of the Reference State are believed to be non-existent or rare. The Desert Loam ecological site is driven primarily by climatic changes ranging from multi-year drought to years when precipitation levels are high. In response, the vegetation vacillates between a community co-dominated by shadscale saltbush (*Atriplex confertifolia*) and Indian ricegrass (*Achnatherum hymenoides*) to one dominated by a mix of perennial grasses and forbs. Historically, fire was not part of this system (West 1983, Brooks and Chambers 2011). The environmental conditions are hot and dry (i.e. 8-10" precipitation zone). Infiltration rates can be slow and potential water loss through evaporation relatively high compared to other coarser-textured soils (i.e. “inverse texture principle,” Noy-Meir 1973). However, due to a small representation of fine rock fragments (0-15%) contained within and on the soil surface, and higher production of perennial grasses, the Desert Loam (Shadscale) site is less susceptible to erosion than the associated Desert Flat (Shadscale) site.

## Community 1.1
## Shadscale Saltbush

Shadscale and Indian ricegrass represent the dominant aspect of this plant community. The composition by air dry weight is approximately 45 percent perennial grasses, 15 percent forbs, and 40 percent shrubs. Winterfat (*Krascheninnikovia lanata*), and bud sagebrush (*Picrothamnus desertorum*) are common, with fourwing saltbush (A. canenscens), black sagebrush (*Artemisia nova*), and horsebrush (Tetradymia spp.) occurring as sub-dominants. Other herbaceous species include squirreltail (*Elymus elymoides*), James' galleta (*Pleuraphis jamesii*), globemallow (Sphaeralcea spp.), Torrey's milkvetch (*Astragalus calycosus*) and cushion buckwheat (*Eriogonum ovalifolium*). Microphytic crusts commonly occur in the interspaces between shrubs, providing stabilization and nitrogen fixation to the soil (West 1990). The dominant aspect of the plant community is Indian ricegrass. The composition by air-dry weight is approximately 50 percent perennial grasses, 5 percent forbs, and 45 percent shrubs.

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

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Grass/Grasslike | 84 | 267 | 392 |
| Shrub/Vine | 76 | 240 | 353 |
| Forb | 9 | 27 | 39 |
| **Total** | **169** | **534** | **784** |

**Table 6. Ground cover**

| | |
|---|---|
| Tree foliar cover | 0% |
| Shrub/vine/liana foliar cover | 10-20% |
| Grass/grasslike foliar cover | 10-20% |
| Forb foliar cover | 2-5% |
| Non-vascular plants | 0% |
| Biological crusts | 0% |
| Litter | 0% |
| Surface fragments >0.25" and <=3" | 0% |
| Surface fragments >3" | 0% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 0% |

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

| Height Above Ground (M) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.15 | – | – | – | – |
| >0.15 <= 0.3 | – | – | – | – |
| >0.3 <= 0.6 | – | 15-25% | 15-25% | 0-10% |
| >0.6 <= 1.4 | – | – | – | – |
| >1.4 <= 4 | – | – | – | – |
| >4 <= 12 | – | – | – | – |
| >12 <= 24 | – | – | – | – |
| >24 <= 37 | – | – | – | – |
| >37 | – | – | – | – |

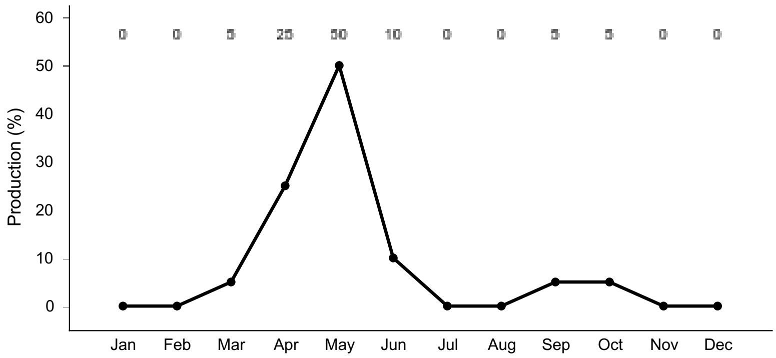


**Figure 7. Plant community growth curve (percent production by month). UT1161, PNC. Excellent Condition.**

### Community 1.2
### Mixed Herbs

Grasses including Indian ricegrass, squirreltail, and James' galleta (*Pleuraphis jamesii*) and forbs such as globemallow (Sphaeralcea spp.), will be the first to decline after extended drought, but are better equipped to take advantage of any transient precipitation, and will dominate the site once a wet period returns. A mixed herb community characterized by Indian ricegrass, squirreltail, western wheatgrass (*Pascopyrum smithii*), and globemallow, will re-occupy the recently opened niches.

### Pathway 1.1a
### Community 1.1 to 1.2

Although shadscale is able to tolerate some drought through partial shedding of leaves, multiple years of drought will kill shadscale, winterfat, and bud sagebrush, particularly in more decadent stands (West 1979). Any shrubs remaining following an extreme droughty period are typically weakened and thus more susceptible to invasion by insects, such as round-headed root borers, scales, grasshoppers, and other pathogens (Haws et al. 1990). During drought, native forbs and grasses will also decrease, but once a wet period returns to a drought-denuded stand, herbs are the first plants to re-occupy recently opened niches.

### Pathway 1.1b
### Community 1.1 to 1.2

An extremely wet period such as an El Nino-Southern Oscillation event and subsequent anoxic soil conditions will kill shadscale, and any other secondary shrubs. Prolonged periods of high soil moisture are believed to increase the susceptibility of shadscale to parasites and disease, such as water mold, root rot, and vascular wilt fungi (Wallace and Nelson 1990).

### Pathway 1.2a
### Community 1.2 to 1.1

Time, without significant disturbance and a return to a favorable climate, will allow shadscale and bud sagebrush to re-establish.

### State 2
### Shadscale Satlbush/Introduced Non-native Herbs State

State 2 is a description of the ecological site following Euro-American settlement, and the subsequent introduction of several non-native plants and animals. Climate change may also cause State 1 to shift into State 2, regardless of the land management practice. The plant community is very similar to State 1 with the exception that several introduced species including cheatgrass (*Bromus tectorum*), Russian thistle (Salsola spp.), halogeton ( *Halogeton glomeratus*), tall tumblemustard ( *Sisymbrium altissimum*), redstem stork's bill ( *Erodium cicutarium*), and curveseed butterwort (*Ceratocephala testiculata*) are likely to be present. Once established, there is no practical method to effectively remove these plants from the site. Additionally, microphytic crusts are likely to be diminished or absent depending on disturbance history. Although shadscale-dominated sites are typically characterized by lower precipitation, in some years the amount and timing of precipitation fluctuates. When precipitation is higher than normal, these sparsely vegetated sites are less effective at utilizing the increased resource (i.e. available water), and therefore are considered more susceptible to invasive species (i.e. fluctuating resource hypothesis) (Davis et al. 2000, Brooks and Chambers 2011). In some areas, invasive grasses have increased enough to fill interspaces between shrubs allowing the site to carry fire, an extremely unusual event in historic salt desert shrublands (West 1994, Brooks and Chambers 2011). Shadscale is used for forage by all classes of livestock, as well as mule deer and pronghorn antelope. Historically, lower desert communities including the Desert Flats were used for grazing of sheep during winter months. Prior to the Taylor Grazing Act of 1934, many of these areas were overgrazed and depending on the intensity, type of livestock, and season of use, the community was set onto various trajectories (Kitchen and Hall 1996).

### Community 2.1
### Shadscale Saltbush

Shadscale saltbush is the dominant component of this community. Bud sagebrush, Indian ricegrass, and squirreltail may be sparsely represented in the understory. Non-native species are present but do not dominate. Microphytic crusts are scarce.

### Community 2.2
### Mixed herbs

In this community Indian ricegrass is likely to be dominant. Squirreltail and a mix of annual forbs may also be present.

### Community 2.3
### Root-sprouting shrubs

Root-sprouting shrubs such as rubber rabbitbrush, yellow rabbitbrush, and green molly, will characterize this community. Indian ricegrass along with invasive annuals are likely to be present in the understory. Microphytic crusts may persist following low intensity fires provided there is enough precipitation and the burned area is protected from subsequent disturbance (Johansen et al 1984).

### Community 2.4
### Increasing Shadscale

Following a period of intensive fall grazing, shadscale will dominate the plant community with only a minor component of mixed herbs present in the understory.

### Community 2.5
### Increasing non-native annuals/Diminished shrubs

Some shrubs may be present, but invasive annuals (e.g. cheatgrass, Russian thistle, halogeton) are increasing and could potentially dominate the site without management attention. Other annuals such as tall tumblemustard, redstem stork's bill, and curveseed butterwort are also common. Native grasses and forbs are minimal or absent. Sites may have compacted soils and/or experienced soil loss. These degraded conditions put the community at greater risk for crossing an ecological threshold.

### Pathway 2.1a
### Community 2.1 to 2.2

With prolonged drought, shadscale's resistance to insects (e.g. round-headed root borers, scales, grasshoppers) and other pathogens will decrease, causing the shrub component to decline (Haws et al. 1990). Although the herbaceous component will be the first to go with drought, grasses and forbs are also the first to re-occupy the site when the rains return.

**Pathway 2.1b**
**Community 2.1 to 2.2**

An extremely wet period such as an El Nino-Southern Oscillation event and subsequent anoxic soil conditions can kill shadscale and other shrubs due to exposure to soil-borne parasites and diseases such as water mold, root rot, and vascular wilt fungi (Wallace and Nelson 1990).

**Pathway 2.1c**
**Community 2.1 to 2.3**

An increase of cheatgrass and other annual forbs can produce enough fine fuels to carry wildfires across these landscapes (West 1994, Brooks and Chambers 2011). Fire will temporarily remove shadscale and bud sagebrush. Other root-sprouting shrubs such as rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and green molly (*Bassia americana*) will increase with invasive annual species dominating the understory.

**Pathway 2.1d**
**Community 2.1 to 2.4**

Uncontrolled fall grazing while shadscale is dormant will favor shadscale, particularly if the grazing is done by sheep. Shadscale will increase to nearly pure stands. Some annual herbs may be present in the understory, but bud sagebrush will decrease (Harper et al. 1990, Kitchen and Hall 1996). In heavily trampled areas, microphytic crusts are reduced or absent. Topsoil is easily lost and infiltration is reduced.

**Pathway 2.1e**
**Community 2.1 to 2.5**

Uncontrolled spring or summer grazing is injurious to shadscale. Shadscale and bud sagebrush will diminish, while non-native annuals such as cheatgrass, halogeton, and Russian thistle will increase and potentially dominate the site (Harper et al. 1990, Kitchen and Hall 1996). Microphytic crusts are reduced or absent. Topsoil may be lost and infiltration reduced from the compaction of soils.

**Pathway 2.2a**
**Community 2.2 to 2.1**

Time, without significant disturbance and a return to a favorable climate, will allow shadscale and bud sagebrush to re-establish.

**Pathway 2.2b**
**Community 2.2 to 2.5**

Uncontrolled spring grazing will reduce perennial bunchgrasses allowing non-native annuals (e.g. cheatgrass, halogeton, and Russian thistle) to increase and potentially dominate the site (Harper et al. 1990, Kitchen and Hall 1996). Additionally, topsoil can be lost and infiltration reduced from the compaction of soils.

**Pathway 2.3a**
**Community 2.3 to 2.1**

Time, without significant disturbance and a return to a favorable climate, will allow shadscale and bud sagebrush to re-establish.

**Pathway 2.3b**
**Community 2.3 to 2.2**

An extremely wet period such as an El Nino-Southern Oscillation event and subsequent anoxic soil conditions will kill most shrubs due to exposure to soil-borne parasites and diseases such as water mold, root rot, and vascular wilt fungi (Wallace and Nelson 1990).

**Pathway 2.4a**
**Community 2.4 to 2.1**

If grazing practices are adjusted by matching stocking rates to current site productivity, shifting the season of use to later season (spring) grazing to reduce shadscale, and if the site has not experienced accelerated soil erosion, warm-season bunchgrasses such as Indian ricegrass and James' galleta (*Pleuraphis jamesii*) will increase.

**Pathway 2.4b**
**Community 2.4 to 2.5**

Provided the buildup of fine annual fuel is sufficient, disturbance by wildfire will kill shadscale. Post-fire, cheatgrass and other early spring annuals will increase outcompeting the perennial warm season grasses and push the community toward a more degraded phase (Community Phase 2.5), the most "at risk" for crossing an ecological threshold. Subsequent fires may become more frequent and intense, removing any remaining shrubs. It is possible however, if invasive annuals are kept under control and enough root-sprouting shrubs are present, the community may move toward a root-sprouting shrub phase (Community Phase 2.3) post-fire.

**Pathway 2.5a**
**Community 2.5 to 2.1**

If grazing practices are adjusted by matching stocking rate to current site productivity, shifting the season of use to early and/or mid-winter grazing when shadscale is dormant, and if the site has not experienced accelerated soil erosion, both shadscale and the warm-season bunchgrasses (e.g. Indian ricegrass and James' galleta) will increase. Protecting the site from unnecessary disturbance may limit further encroachment by annuals.

**State 3**
**Seeded Range State**

The Seeded Range State exists where managers decided to re-seed in order to address management concerns such as the need to increase forage production, control soil erosion, and/or suppress wildfire. Re-vegetation efforts often utilize non-native perennial herbs that mimic the structure and function of but are more competitive than native species (Brooks and Chambers 2011, Davies et al. 2010, DiTomaso and Smith 2012, Hirsch and Monaco 2011, Newhall et al. 2004). Therefore, these areas are often dominated with non-native perennial grasses (e.g. crested wheatgrass). Forage kochia is an introduced semi-shrub that is commonly used in revegetation and fire suppression (Monaco et al. 2003). In some cases, monocultures of the seeded species were created. However, more recent seedings have included a broader suite of species (and cultivars) to increase germination rate and assist succession and recovery of the native shadscale community (State 2). Depending on grazing levels, drought, and seed source availability, shadscale and a mix of other native species will re-establish over time. State 3 can be maintained when livestock grazing is compatible with current site productivity, but continued heavy livestock grazing will negatively impact resiliency. Non-native annuals such as cheatgrass and tall tumblemustard are common invaders in these areas.

**Community 3.1**
**Seeded perennials**

Depending on the objectives of the seeding effort, this community may be characterized by a single species (e.g. crested wheatgrass, forgage kochia), or by a mix of seeded perennial species (native and/or non-native) including a variety of cool and/or warm season grasses (e.g. wheatgrasses, wildryes, Indian ricegrass, squirreltail, and sand dropseed (*Sporobolus cryptandrus*)). Provided the disturbances are minimal, livestock stocking rates match current site productivity, and seed sources exist, shadscale, rubber rabbitbrush, and other native species may begin to re-establish. Non-native annuals are likely to be present. If the climate is conducive, seeded ranges can be maintained when grazing practices are compatible with current site productivity.

**State 4**
**Invasive Annuals State**

The Invasive Annuals State is a degraded condition as a result of long-term heavy grazing and invasion by annuals. Halogeton and/or cheatgrass are typically dominant.

### Community 4.1
### Halogeton and/or cheatgrass dominant

Halogeton and/or cheatgrass are the primary species in this community. Russian thistle may also be present after fire, if topsoil has remained intact, but will likely diminish within 3 to 4 years post-fire without further disturbance (Young 1991). Conversely, if topsoil has been lost, Russian thistle can persist for nearly a decade (Allen 1989). Once established, exotic species can permanently alter soil properties and processes, even after the invasive species is removed or controlled (Allen et al. 2011, Kulmatiski et al. 2008). Soils invaded by cheatgrass typically have faster decomposition rates, with varying responses in total phosphorus (P) and nitrogen (N) availability and (N) cycling (Ehrenfeld 2003). Belnap et al. (2005) also noted shifts in and lower biomass of key taxa within the microbial community in cheatgrass dominated areas that can directly affect nutrient cycling and ultimately modify soil structure and plant growth. Halogeton, the succulent halophytic summer annual, will translocate and accumulate salts in plant tissues, which then leach back into near-surface soils from leaf litter and dead roots. Secondary effects from the increased soil salinity may limit infiltration rates and capillary rise of water, inhibit nitrifying microorganisms, and ultimately cause the soil crust to harden and depress plant growth (Eckert and Kinsinger 1960, Kitchen and Jorgensen 2001, Allen et al. 2011). Under such impoverished soil conditions, natural regeneration of native shrubs is unlikely and may impede the outcome of revegetation efforts (Harper et al. 1996, Grant and Paschke 2012). Due to the abundance of fine fuels cycling through this system annually, the site will become more prone to wildfire. Fire return intervals can shorten and perpetuate an invasive annuals state.

### State 5
### Eroded State

The Eroded State is a highly degraded condition as a result of extreme wildfire and very powerful, persistent winds removing most if not all vegetation. In some areas, multiple inches of soil may be lost, while deposition and dunning may occur in other areas.

### Community 5.1
### Barren lands

Extreme fire will remove most if not all vegetation. Microphytic crusts are very rare, but if present before the fire, may be found beneath surviving shrubs. High winds could cause further erosion or burial in some areas. Until some vegetation is in place to hold or catch less stable soil particles, persistently high winds can create positive feedbacks of continued soil erosion through the process of saltation. If coarser, less stable sediments from upwind are blown over finer-grained (e.g. lacustrine) deposits, the abrasion to the surface can trigger soil particles downwind to detach and add to the total horizontal sediment flux (Gillette et al. 1996, Miller et al. 2012).

### Transition T1A
### State 1 to 2

The introduction of exotic flora and fauna, possible extinctions of native flora or fauna, along with climate change, will cause State 1 to transition to State 2. Reversal of this change back to State 1 is impracticable. These soils are easily disturbed by trampling. Compacted areas are more susceptible to wind or water erosion. Perennial vegetation decreases while bare ground increases leading to further runoff and soil loss.

### Transition T2a
### State 2 to 3

Over the years, land managers have seeded rangelands for a variety of reasons. Historical tilling and removal of shadscale through chemical or mechanical means, followed by seeding of non-native perennial grasses such as crested wheatgrass (*Agropyron cristatum*) was done to increase forage production. In areas where annuals have invaded and fire is of concern, drilling and re-seeding with forage kochia (*Bassia prostrata*) to create fuel-breaks (i.e. “greenstripping”) has also been employed (Monaco et al. 2003).

## Transition T2b
## State 2 to 4

Heavy continuous season- (or year-) long grazing will worsen the fragile conditions of Community Phase 2.5 (Increasing non-native annuals/ Diminished shrubs) and create positive feedbacks to further degradation. Other Community Phases of State 2 (i.e. 2.1, 2.2, 2.3, and 2.4) could possibly sustain longer periods with heavy grazing, but this would eventually lead to Community Phase 2.5, and ultimately pass an ecological threshold into State 4. Annual species, particularly halogeton and cheatgrass, benefit from continued disturbance. Soils will become more compacted and susceptible to erosion.

## Transition T2c
## State 2 to 5

The unusual event of extreme wildfire and intense winds will move State 2 to a completely unvegetated and eroded state. If there is no plant cover and high winds continue, resident soils will be displaced and upwind soils may move in creating dune environments. Seed establishment is not possible under these conditions creating a positive feedback that is difficult to reverse.

## Restoration pathway R3a
## State 3 to 2

If a period of time passes without fire (or other significant disturbance), grazing practices are compatible with productivity, and there is evidence of re-establishment of native shrubs and perennial grasses, it is possible that the Seeded Range State can be restored to the former Shadscale Saltbush/ Introduced Non-native Herbs State.

## Transition T3a
## State 3 to 4

If the Seeded Range State receives heavy continuous season- (or year-) long grazing, this will reduce the seeded and/or re-establishing perennial species (herbs and shrubs) and continue to disturb the soils, potentially creating a positive feedback where annual species, such as halogeton and cheatgrass, are the few species able to persist. Soils will be more compacted and susceptible to erosion.

## Transition T3b
## State 3 to 4

Depending on the intensity, frequency, and availability of exotic annuals, wildfire may reduce the seeded and/or re-establishing perennial species (herbs and shrubs), and push the community into one dominated by invasive annuals.

## Transition T3c
## State 3 to 5

The unusual event of extreme wildfire and intense winds will move the Seeded Range State to a completely unvegetated and eroded state. If vegetation cover is low and winds are high, resident soils may continue to erode and upwind soils may move to create dune environments. Seed establishment is not possible under these conditions thus creating a positive feedback that is difficult to reverse.

## Restoration pathway R4a
## State 4 to 3

Depending on the degree plant-soil feedbacks have changed (see: Community Phase 4.1), the potential to transition the Invasive Annuals State to a seeded range state may be practicable if the species selected for seeding are known to tolerate the “invader-cultured soil” (Grant and Paschke 2012, Newhall et al. 2004), provided a favorable climate and appropriate grazing practices are imposed. “Greenstripping” with forage kochia to facilitate the establishment of persistent vegetation and fire-breaks has been successfully employed as well (Monaco et al. 2003). Regardless of the land treatment, the landscape setting including the juxtaposition of particular landforms and soil properties should be considered carefully. Depending on the spatial extent and connectivity of the disturbance, land treatments can have variable impacts on aeolian sediment fluxes (i.e. wind erosion), particularly in areas with persistent high winds and fragile soils (Miller et al. 2012). For example, upwind soil and vegetation conditions are important factors when predicting and mitigating potential downwind erosion dynamics (Miller et al. 2012).

## Transition T4a
## State 4 to 5

The unusual event of extreme wildfire and intense winds will move the Invasive Annuals State to a completely unvegetated and eroded state. If there is no vegetation cover and winds are high, resident soils will continue to erode, or in some cases other soils can be blown in creating dune environments. Seed establishment is not possible under these conditions thus creating a positive feedback that is difficult to reverse.

## Restoration pathway R5a
## State 5 to 3

It may be possible to transition the Eroded State to a seeded range state, provided the seeded species are capable of surviving in these extremely harsh conditions (Newhall et al. 2004), the area receives enough precipitation, and careful consideration is made to the landscape setting (i.e. juxtaposition of certain landforms and soil properties) (Miller et al. 2012). The spatial extent and connectivity of land treatments, particularly in areas with high winds and fragile soils, can directly influence aeolian sediment flux through saltation. Upwind soil and vegetation conditions are important factors when predicting and mitigating potential downwind erosion dynamics (Miller et al. 2012). Arranging drill rows perpendicularly to prevailing winds, installing fences to catch sediments, and limiting grazing disturbances would be important mitigation measures to reduce erosion. Herbicides should be used with caution, as the cover of exotic annual plants can provide protection for perennial seedlings as they re-establish.

## Additional community tables

**Table 8. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Shrub/Vine** | | | | | |
| 0 | **Primary Shrubs** | | | 222–308 | |
| | shadscale saltbush | ATCO | *Atriplex confertifolia* | 93–123 | – |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 93–123 | – |
| | bud sagebrush | PIDE4 | *Picrothamnus desertorum* | 19–31 | – |
| | yellow rabbitbrush | CHVIS5 | *Chrysothamnus viscidiflorus ssp. viscidiflorus var. stenophyllus* | 19–31 | – |
| 3 | **Secondary Shrubs** | | | 19–31 | |
| | spiny hopsage | GRSP | *Grayia spinosa* | 7–19 | – |
| | granite prickly phlox | LIPU11 | *Linanthus pungens* | 7–19 | – |
| | littleleaf horsebrush | TEGL | *Tetradymia glabrata* | 7–19 | – |
| **Grass/Grasslike** | | | | | |
| 0 | **Primary Grasses** | | | 234–370 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 155–216 | – |
| | squirreltail | ELEL5 | *Elymus elymoides* | 31–62 | – |
| | James' galleta | PLJA | *Pleuraphis jamesii* | 31–62 | – |
| | needle and thread | HECO26 | *Hesperostipa comata* | 19–31 | – |
| 1 | **Secondary Grasses** | | | 7–19 | |
| **Forb** | | | | | |
| 2 | **Forbs** | | | 19–31 | |
| | cushion buckwheat | EROV | *Eriogonum ovalifolium* | 7–19 | – |
| | shaggy fleabane | ERPU2 | *Erigeron pumilus* | 7–19 | – |
| | tufted evening primrose | OECA10 | *Oenothera caespitosa* | 7–19 | – |
| | slimflower scurfpea | PSTE5 | *Psoralidium tenuiflorum* | 7–19 | – |
| | gooseberryleaf globemallow | SPGR2 | *Sphaeralcea grossulariifolia* | 7–19 | – |

## Animal community

This site is suited for sheep and cattle grazing during fall, winter, and spring.

Wildlife using this site include rabbit, coyote, fox, pronghorn antelope, and mule deer (seasonal).

This is a short list of the more common species found. Many other species are present as well and migratory birds are present at times.

## Hydrological functions

The soils are in hydrologic group B with runoff curves ranging from 61 to 79 depending on hydrologic condition.

## Recreational uses

Hiking and hunting.

## Wood products

None

## Other information

Threatened and endangered species include plants and animals.

## Type locality

| Location 1: Beaver County, UT | |
|---|---|
| General legal description | South and West of the Entrance to the Desert Range Experiment Station, West of Milford, Utah. |

## 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) | V. Keith Wadman (NRCS Ret.), Shane A. Green (NRCS) |
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| Date | 06/15/2004 |
| Approved by | Shane A. Green |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** Minor rill development may be evident in the reference community following significant storm or snow melt events. The presents of rills may be more apparent where run-on from adjacent upland sites or exposed bedrock concentrate flows. Any rill development will be somewhat short (< 6’) and widely spaced (6’ – 8’). Evidence of rills will decrease in the months following major weather events due to the affects of wind on this sites coarse textured surface soils.

2. **Presence of water flow patterns:** Slight evidence of water flow is apparent in the reference community; increased flow activity may be observed following significant weather events. There are no exposed roots around Indian ricegrass bunches and little evidence of soil or litter damming behind obstructions. Any flow patterns present are normally <15 feet long, follow natural contours, and are typically spaced 15 to 20 feet apart.

3. **Number and height of erosional pedestals or terracettes:** Pedestals or terracettes caused by accelerated water erosion are not typically evident in the reference community. 1 – 2 inches of depositional mounding in James galleta clumps, under Shadscale canopies and within cryptogamic crusts are normal and may not be erosion caused.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground ranges from 20% - 30% in the reference community. Ground cover (the inverse of bare ground) typically includes: coarse fragments – 15% to 35%; plant canopy – 20% to 25%; litter – 15% to 25%, and cryptogamic crusts – 2% to 5%.

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5. **Number of gullies and erosion associated with gullies:** Developed gully channels are a normal component of desert environments. Gullies associated with reference areas will typically have stable, partially vegetated sides and bottoms with no evidence of head-cutting. Some evidence of disturbance may be evident following significant weather events or when gullies convey runoff from higher elevation rocky or naturally eroding areas.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Some minor evidence of wind generated soil movement is present in reference communities. Wind generated blowouts, where present, are stabilized with vegetation and healing. Slight depositional mounding around Indian ricegrass bunches and James galleta clumps, and within cryptogamic crusts is a normal characteristic of this site. Slight coppice mounding under Shadscale canopies is also normal. Evidence of increased soil saltation may be present during severe wind storms.

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7. **Amount of litter movement (describe size and distance expected to travel):** Most litter resides in place within or under plant canopies. Some movement of the finest material (< 1/8”) may move (1’ – 2’) in the direction of prevailing winds or down slope if being transported by water. Little accumulation is observed behind obstructions. Larger woody litter (> ¼”) is found under or near shrubs.

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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):** This site should have a soil stability rating of 4 to 5. Surface textures are typically sandy loams containing 15% to 35% coarse fragments.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is 4 inches deep and structure is weak fine granular. The A-horizon color is 10YR 6/3. Soils have an Ochric epipedon that extends 14 inches into the soil profile. The A horizon is normally deeper and better developed under plant canopies.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The presence of healthy perennial bunchgrasses combined with vigorous stands of Shadscale and Winterfat in the reference community provides for the best infiltration and least runoff from storm events and snow melt. As perennial vegetation decreases and bare ground increases, runoff increases and soil loss is accelerated. Biological soil crusts (e.g. lichens, mosses, cyanobacteria) provide for added soil stability when present.

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

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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: Dominant: Non-sprouting shrubs (e.g. Shadscale and Bud sage) 20 – 25%, > cool season grasses (e.g. Indian ricegrass and Bottlebrush squirreltail) 25 – 45%.

Sub-dominant: Sub-dominant: Sprouting shrubs (e.g. Winterfat and Low rabbitbrush) 15 – 25%, > warm season grasses (e.g. Galleta) 5 – 10%, > Cool season grasses (e.g. Sandberg bluegrass and Needleandthread) 3 - 5%.

Other: Others: Shrubs (e.g. Spiny hopsage and Granite pricklygilia) 1-3%, perennial forbs (e.g. Gooseberryleaf globemallow and Cushion wild buckwheat) 3-5%, biological crusts (e.g. lichens, mosses, cyanobacteria) trace%.

Additional: Moss and lichen communities will normally be found under plant canopies while the cyanobacteria will be found throughout the site. Functional/structural groups may appropriately contain non-native species if their ecological function is the same as the native species in the reference state. Perennial and annual forbs can be expected to vary widely in their expression in the plant community based upon departures from average growing conditions.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** During years with average to above-average precipitation, there should be very little recent mortality or decadence apparent in either the shrubs or grasses. During severe (multi-year) drought or insect infestations up to 80% of the shadscale may die. There may be partial mortality of individual bunchgrasses and other shrubs during severe drought.

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14. **Average percent litter cover (%) and depth ( in):** Litter cover ranges from 15 to 25% with a spike when shrubs drop their leaves. Depth varies from ¾ to 1/2 inch with depth increasing near plant canopies.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 400 - 550 pounds on an average year.

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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, Russian thistle, Redstem storksbill, annual bromes and Halogeton are likely to increase in or invade this site.

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17. **Perennial plant reproductive capability:** All perennial plant species have the ability to reproduce in most years except drought years.

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