USDA Natural Resources
Conservation Service

Ecological site R035XY302UT
Upland Dissected Slope (Twoneedle Pinyon-Utah Juniper)

Accessed: 05/18/2024

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.

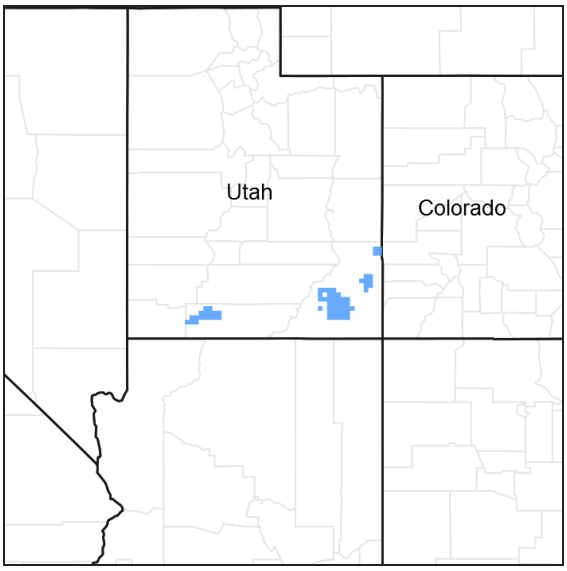

Figure 1. Mapped extent

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.

Classification relationships

Pinus edulis - Juniperus spp. / *Artemisia tridentata* (ssp. wyomingensis, ssp. vaseyana) Woodland (Western Ecology Working Group of NatureServe).

Pinus edulis - Juniperus osteosperma / *Shepherdia rotundifolia* Woodland (NatureServe 2015).

Ecological site concept

This site occurs in the upland zone of the Colorado and Green River Plateaus Region (MLRA 35) in southeastern Utah. It typically occurs on dissected hillslopes on structural benches, but has been mapped on fan remnants and stream terraces. Elevations range from 5200 to 8000 feet, and slopes range from 2 to 30%. Typical soils are very deep, calcareous, fine sandy loams that formed in alluvium and/or eolian deposits derived from sandstone. The soil moisture regime is typically aridic ustic and the soil temperature regime is mesic. The climax plant community is an open canopy of Utah juniper - twoneedle pinyon over a very sparse shrub cover dominated by Wyoming big sagebrush (*Artemisia tridentata* subsp. wyomingensis) and roundleaf buffaloberry (*Shepherdia rotundifolia*). Shrub cover is higher following disturbance that removes forest canopy, and may be higher in areas of the landscape with active erosion. Slopes are dissected by well-defined concentrated flow patterns and channels and soil erosion is evident.. Biological crust cover is characterized as high. The natural disturbance regime includes infrequent stand-clearing fire, light grazing by native wildlife, and fluctuating climate with significant dry and wet periods. Prehistoric Anasazi use, including land-clearing and agriculture, may have impacted this site. The current interpretive state is impacted by livestock grazing, invasive annual grasses (that may increase fire severity and frequency), and off-road

vehicle use.

Associated sites

R035XY306UT	**Upland Loam (Basin Big Sagebrush)** This site occurs on adjacent level to gently sloping landforms. Wyoming big sagebrush is strongly dominant, and perennial grasses are an important component of the reference plant community.
R035XY315UT	**Upland Shallow Loam (Pinyon-Utah Juniper) AWC <3** This site occurs on shallow soils with high rock fragments among areas with a high proportion of rock outcrop. Utah juniper and twoneedle pinyon dominate.
R035XY321UT	**Upland Stony Loam (Pinyon-Utah Juniper)** This site occurs on slopes with deep sandy loam soils. Utah juniper and twoneedle pinyon dominate, and a diverse shrub, forb and grass community may be present.

Similar sites

R035XY311UT	**Upland Shallow Dissected Slope (Pinyon-Utah juniper)** This site occurs on shallow soils and Wyoming big sagebrush is not an important species.

Table 1. Dominant plant species

Tree	(1) *Juniperus osteosperma* (2) *Pinus edulis*
Shrub	(1) *Artemisia tridentata subsp. wyomingensis* (2) *Shepherdia rotundifolia*
Herbaceous	Not specified

Physiographic features

This site typically occurs on dissected hillslopes on structural benches, but has been mapped on fan remnants and stream terraces. Elevations range from 5200 to 8000 feet. Slopes range from 2-30%. Runoff ranges from low to very high.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Structural bench
Flooding frequency	None
Ponding frequency	None
Elevation	1,585–2,438 m
Slope	2–30%

Climatic features

The climate is characterized by hot summers and cool winters. Large fluctuations in daily temperature are common. Precipitation is bimodal, with summer monsoons from July through October and winter rains from January through March. Precipitation is variable from month to month and from year to year and typically ranges between 11 and 17 inches. Snow typically falls every winter, but snowpacks are generally light and not persistent.

Table 3. Representative climatic features

Frost-free period (average)	161 days
Freeze-free period (average)	184 days
Precipitation total (average)	330 mm

Climate stations used

- (1) NATURAL BRIDGES NM [USC00426053], Blanding, UT

Influencing water features

Soil features

The soils associated with this ecological site are very deep, and formed from alluvium and or eolian deposits derived from sandstone, or cobbly alluvium derived from intrusive igneous rock. Soils are well drained with slow to moderately rapid permeability. The soil moisture regime is aridic bordering on ustic or udic ustic and the soil temperature regime is mesic. The surface texture is a fine sandy loam or cobbly loam, and surface rock fragments are not typically present. Slopes are dissected by well-defined concentrated flow patterns and channels and soil erosion is evident; however, most of the soil area in the reference state has moderate wind and water erosion potential due to high cover of biological crust. Biological crust cover is characterized as high, with continuous thick lichen, moss, and cyanobacteria cover typical of undisturbed sites. Subsurface textures are fine sandy loam, sandy clay loam, clay, and cobbly clay loam. Subsurface rock fragments smaller than 3 mm in diameter range from 0 to 12% by volume, and larger fragments range from 0 to 18%. Modal soils are strongly calcareous with disseminated carbonates throughout the profile. The Yarts soils (modal) (Coarse-loamy, mixed, superactive, calcareous, mesic Ustic Torriorthents) and the Abajo soils (Fine, smectitic, mesic Udic Paleustolls) are correlated to this ecological site.

This ecological site has been correlated to the following mapunits and soil components:

UT639 - San Juan Area - MUAbGC - Abajo (100%)
UT639 - San Juan Area - MUAcGC - Abajo (100%)
UT638 - San Juan County - MU45 - Yarts (20%)
UT638 - San Juan County - MU68 - Yarts (90%)

Typical Soil Profile (Yarts):
A--0-3 inches; fine sandy loam; strongly calcareous with disseminated carbonates; moderately alkaline
C1--3-10 inches; fine sandy loam; strongly calcareous with disseminated carbonates; moderately alkaline
C2--10 to 60 inches; fine sandy loam; strongly calcareous with disseminated carbonates; moderately alkaline

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone (2) Alluvium–sandstone
Surface texture	(1) Fine sandy loam (2) Cobbly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderately rapid
Soil depth	152 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	9.91–15.75 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm

Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–12%
Subsurface fragment volume >3" (Depth not specified)	0–18%

Ecological dynamics

This site occurs in the upland zone of the Colorado and Green River Plateaus Region (MLRA 35) in southeastern Utah. The climax plant community is an open canopy of Utah juniper - twoneedle pinyon over a very sparse shrub cover dominated by Wyoming big sagebrush (*Artemisia tridentata* subsp. wyomingensis) and roundleaf buffaloberry (*Shepherdia rotundifolia*). Shrub cover is higher following disturbance that removes forest canopy, and may be higher in areas of the landscape with active erosion. Slopes are dissected by well-defined concentrated flow patterns and channels and soil erosion is evident; however, most of the soil area in the reference state has moderate wind and water erosion potential due to high cover of biological crust. Biological crust cover is characterized as high. A diverse range of forbs may occur on the site, but herbaceous cover is sparse in the absence of disturbance. The natural disturbance regime includes infrequent stand-clearing fire, light grazing by native wildlife, and fluctuating climate with significant dry and wet periods and accompanying drought-related pathogen attacks. Prehistoric Anasazi use, including land-clearing and agriculture, may have impacted this site. The current interpretive state is also impacted by livestock grazing, invasive annual grasses that may increase fire severity and frequency, land-clearing and logging, and off-road vehicle use.

Low severity understory fires are generally accepted to have never been a significant process in pinyon-juniper systems on the Colorado Plateau (e.g. Floyd et al. 2004, Romme et al. 2009, Shinneman and Baker 2009). All evidence points to natural regime of very long fire rotations (400-600 years) with high-intensity stand-initiating events. Following fire (or other vegetation clearing disturbance), recovery of the woodland structure is very slow (West 1979, Floyd et al. 2000, Floyd et al. 2004, Floyd et al. 2008, Romme et al. 2009, Shinneman and Baker 2009), with a succession of early dominance by herbaceous species, a long-period of shrub dominance, and tree dominance taking as long as 250 years (West 1979). Cheatgrass (*Bromus tectorum*) invasion in pinyon-juniper woodlands may increase fine fuel loads and increase fire frequency, thus significantly changing the natural dynamic (Floyd et al. 2008, Romme et al. 2009).

The composition and productivity of this site is also significantly influenced by climatic patterns, and interactions of climate with fuel buildup and pathogen outbreaks (e.g. Floyd et al. 2004, Romme et al. 2009). Dramatic climate fluctuations that include periods of catastrophic drought and unusually wet conditions have been the norm for the Colorado Plateau for at least the past several centuries. Decadal scale variation in precipitation due to the Pacific Decadal Oscillation (PDO) has characterized the climate of the Colorado Plateau over the last century, with a wet period from 1905-1941, a dry period between 1942-1977, a wet period from 1978-1998, and a dry period from 1999 to the present, with a particularly catastrophic drought in 2002 (Ehleringer et al. 2000, Hereford et al. 2002, Miller 2004, Schwinning et al. 2008). Twoneedle pinyon is especially susceptible to mortality from both direct effects of drought, and indirect effects, such as barkbeetle (Ips) attack (Romme et al. 2009). Severe drought with high temperatures caused widespread twoneedle pinyon mortality throughout the Colorado plateau, with trees of cone bearing age suffering the greatest losses (Romme et al. 2009). Megadrought in the late 1500’s is also thought to have caused severe pinyon mortality, and explain the general absence of twoneedle pinyon greater than 400 years old (Romme et al. 2009). Large recruitment pulses typically occurred during the first wet period after sustained drought, and caused a surge in twoneedle pinyon recruitment early in the 20th century (Romme et al. 2009, Shinneman and Baker 2009). Utah juniper is much more drought resilient; very old juniper are more prevalent, and Utah juniper recruitment pulses have been more or less continuous over time (Shinneman and Baker 2009). In this ecological site drought impacts severe enough to cause a shift to a new community phase have not been observed; however fluctuations in precipitation are certainly important in the community dynamics of this site. Drought has caused mortality of twoneedle pinyon in the area, and precipitation determines herbaceous fuel loads, recovery trajectories after disturbance, and annual productivity, which interacts with browse and livestock impacts.

Historically the vegetation of the Colorado Plateau experienced only light grazing by native ungulates whose

populations were kept in check by native predators such as mountain lions and wolves (Mack and Thompson 1982, Cole et al. 1997, Schwinning et al. 2008). One of the most significant impacts of livestock grazing in this arid region has been damage to biological soil crust (BSC), including reductions in species diversity, cover, and alteration of species composition, with simplified communities of cyanobacteria replacing lichen and moss species that may take decades to recover (e.g Evans and Belnap 1999, Belnap and Eldridge 2003). The loss of BSC reduces soil stability, and soil moisture holding capacity, and consequently increases erosion potential (Evans and Belnap 1999, Belnap and Eldridge 2003, Harris et al. 2003, Neff et al. 2005). Some areas where this ecological site occurs were severely overgrazed in the early 1900's, and chaining of trees and shrubs to improve habitat for livestock also occurred in several areas (West 1979). The fine, very friable soils of this site are highly susceptible to erosion if vegetation and crust cover is removed, and active erosion channels are typical of this site today. Repeated phases of Anasazi land-use including land-clearing for agriculture, may have contributed to early arroyo cutting and increased erosion in this site (West 1979). Shrub cover is typically higher in areas with more active erosion, with productive roundleaf buffaloberry often found on channel banks.

Global climate change predictions for the Colorado Plateau include an increase in both average and extreme temperatures, which will increase the impacts of drought even if precipitation patterns remain relatively unchanged (Schwinning et al. 2008). The Colorado Plateau may be particularly sensitive to global climate change due to a transitional climatic position between strong monsoon dominated systems to the south and cool season precipitation dominance to the north (Ehleringer et al. 2000, Miller 2004). Evidence for global climate change so far shows an increase in minimum temperatures since the 1960s, a weak trend towards increasing winter precipitation and no change in the summer monsoon (Spence 2001). Climate change impacts could eventually eliminate twoneedle pinyon from this site.

The following State-and-Transition Model describes the most commonly occurring plant communities found on this ecological site. Separations between states and community phases are based on professional consensus. All tabular data listed for a specific community phase within this ecological site description represent a summary of one or more field data collection plots taken in modal communities within the community phase, except for community phase 1.1, which is inferred from community phase 2.1. Although such data are valuable in understanding the phase (kinds and amounts of ground and surface materials, canopy characteristics, community phase overstory and understory species, production and composition, and growth), they do not represent the absolute range of characteristics or an exhaustive listing of all species that may occur in that phase over the geographic range of the ecological site.

State and transition model

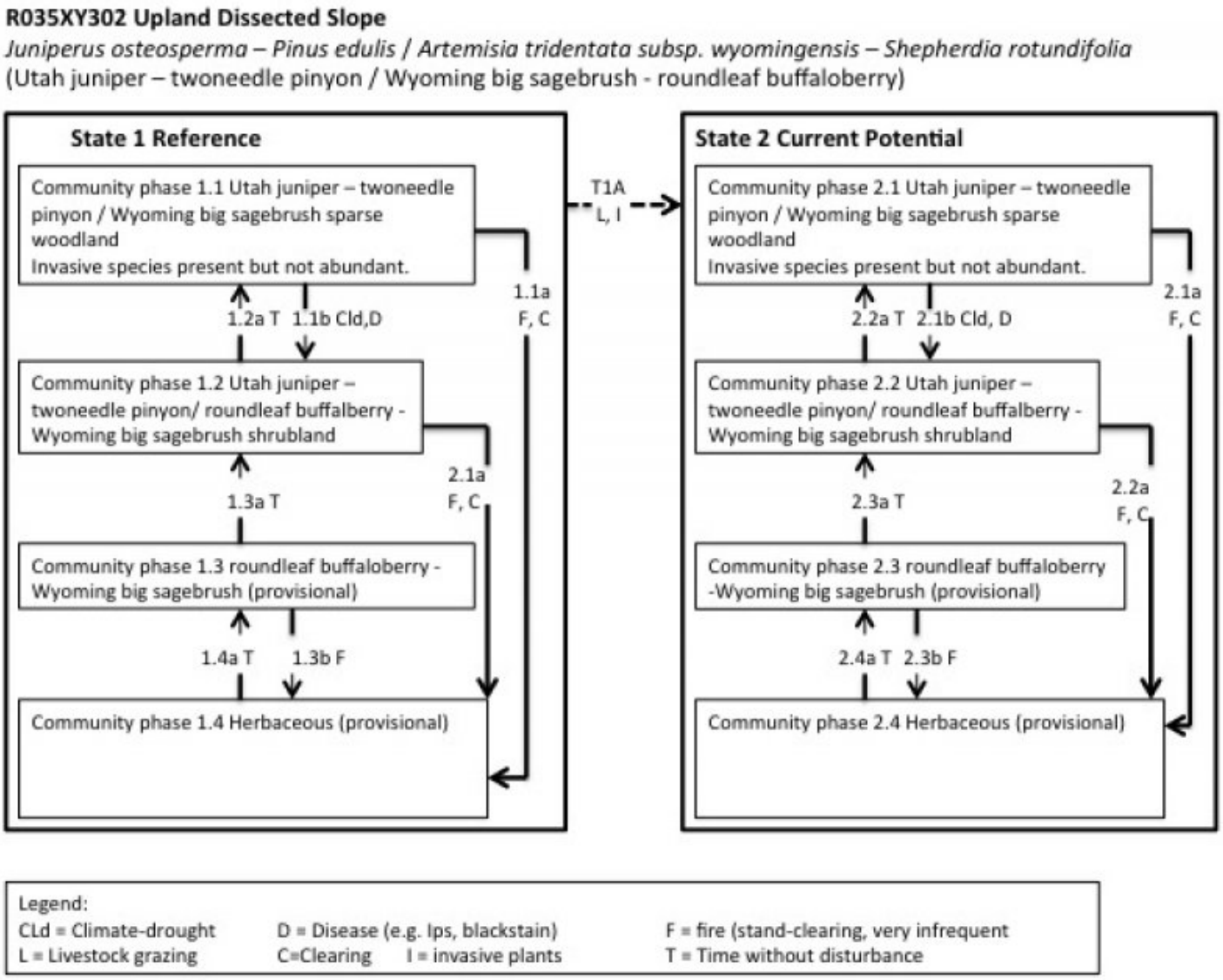

Figure 6. R035XY302UT

State 1
Reference

The reference state was determined by literature review, historical accounts, reports, and observations of trends in plant community dynamics. The reference state represents the plant communities and ecological dynamics of this ecological site under pre-settlement conditions and a natural disturbance regime (which likely included early land-clearing by the Anasazi). The plant communities of the reference state were similar to those of the current potential state (State 2), and were characterized by a sparse canopy of Utah juniper and twoneedle pinyon, with a very sparse understory (West 1979). Early land-use by the Anasazi could have contributed to episodes of arroyo cutting and soil erosion. Infrequent stand clearing fires would have created stands of shrublands and woodlands in different phases of succession. Cheatgrass was not present in the reference state. The primary disturbances included infrequent fire, fluctuations in precipitation, prehistoric land-use, and native ungulate browsing. Plant communities will naturally shift among the four phases with very infrequent fire and climatic fluctuations. Anasazi clearing could have caused shifts to community phase 1.4. Reference State: Plant communities influenced by fire, browse, climate fluctuations between wet and dry periods, and Anasazi land-use. Indicators: Dominance by Utah juniper and twoneedle pinyon with a sparse shrub layer of Wyoming big sagebrush and roundleaf buffaloberry, with stands of plant communities representing different phases of succession present over the landscape. Feedbacks: Very infrequent stand-clearing fire and light browse pressure allows for a self-sustaining woodland with herbaceous and shrub successional phases. At-risk Community Phase: Community phase 1.4 is particularly susceptible to invasion by cheatgrass due to a lack of competition and extensive bare soil; however all phases are susceptible to invasion, especially with heavy grazing, browse or other disturbances that remove vegetative cover and disturb soils. Trigger: Improper livestock grazing and introduction of invasive species.

Community 1.1
Utah juniper – twoneedle pinyon / Wyoming big sagebrush sparse woodland

Data for this community phase does not exist, but the community composition was likely similar to Community Phase 2.1, except with no cheatgrass, higher proportion of native grasses such as Indian ricegrass (*Achnatherum hymenoides*), possibly lower importance of Mormon tea (*Ephedra viridis*), higher overall vegetative cover, and higher BSC cover. Roundleaf buffaloberry may have been more abundant and Wyoming big sagebrush may have been less abundant. Species composition in the below table was inferred from community phase 2.1.

Community 1.2
Utah juniper – twoneedle pinyon/ roundleaf buffalberry -Wyoming big sagebrush shrubland

Data for this community phase does not exist, but the community composition was likely similar to Community Phase 2.2, except with no cheatgrass, higher proportion of native grasses such as Indian ricegrass, higher overall vegetative cover, and higher BSC cover. Roundleaf buffaloberry may have been more abundant and Wyoming big sagebrush may have been less abundant.

Community 1.3
Roundleaf buffaloberry -Wyoming big sagebrush (provisional)

Data for this community phase does not exist, but the community composition was likely similar to Community Phase 2.3, except with no cheatgrass, higher proportion of native grasses such as Indian ricegrass, higher overall vegetative cover, and higher BSC cover. Roundleaf buffaloberry may have been more abundant and Wyoming big sagebrush may have been less abundant.

Community 1.4
Herbaceous (provisional)

Data for this community phase does not exist, but the community composition was likely similar to Community Phase 2.4, except with no cheatgrass.

Pathway 1.1b
Community 1.1 to 1.2

This pathway may occur with localized disturbance that opens up the canopy, such as drought-induced insect mortality followed by a wet period that allows for shrub recruitment.

Pathway 1.1a
Community 1.1 to 1.4

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 1.2a
Community 1.2 to 1.1

This pathway occurs with time without additional disturbance, as trees slowly regain dominance and shrubs die out. It could take 100-200 years (West 1979, Romme et al. 2009, Shinneman and Baker 2009).

Pathway 1.2b
Community 1.2 to 1.4

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 1.3a
Community 1.3 to 1.2

This pathway occurs with time and a lack of additional disturbance. Forty to 100 years may be required before canopy trees are a dominant aspect of the community.

Pathway 1.3b
Community 1.3 to 1.4

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 1.4a
Community 1.4 to 1.1

This pathway occurs with time without additional disturbance. It will take a minimum of 11 years, and could take much longer depending on precipitation amount and timing, and the availability of off-site seed for dispersal.

State 2
Current Potential

This state represents the current potential of this ecological site, and in addition to very infrequent fire and climate fluctuations, the dynamics include disturbance by livestock and invasive species, which may alter the fire regime. Land-clearing (chaining) for livestock improvement has also occurred. The interpretive state will shift among the four phases with very infrequent fire and climatic fluctuations. Cheatgrass invasion may result in a shortened fire rotation, maintaining a herbaceous community phase (e.g. D'Antonio and Vitousek 1992), but since this has not been observed in this ecological site, an altered grassland state is not included in the state and transition model. Livestock grazing impacts and vegetation removal may have accelerated erosion and channel cutting in some areas; however erosional processes have been a part of the dynamics of this site since prehistoric times (West 1979). Areas severely altered by erosion were not observed, so an eroded state is not included in the state and transition model. Managers should be aware of the possibility of an eroded state with severe soil disturbance and vegetation removal. Current Potential State: Plant communities influenced by very infrequent fire, climate fluctuations between wet and dry periods, livestock grazing, invasive species, and land-clearing. Off-road vehicle use and tree harvesting may also impact this state. Indicators: Dominance by Utah juniper and twoneedle pinyon with a sparse shrub layer of Wyoming big sagebrush and roundleaf buffaloberry, with stands of plant communities representing different phases of succession present over the landscape. Cheatgrass is often present. Feedbacks: Very infrequent stand-clearing fire and light browse and grazing pressure allow for a self-sustaining woodland with herbaceous and shrub successional phases. Cheatgrass is naturalized throughout the system. At-risk Community Phase: Community 2.4 is especially at risk of cheatgrass dominance, which may create a cycle of repeat burning that maintains a grassland state.

Community 2.1
Utah juniper – twoneedle pinyon / Wyoming big sagebrush sparse woodland

Figure 8. Community Phase 2.1

Figure 9. Community Phase 2.1

This community phase is characterized by 20-35% canopy cover of short-statured Utah juniper and twoneedle pinyon over 4-8% shrub canopy, with Wyoming big sagebrush the dominant shrub. Roundleaf buffalberry and Mormon tea are important shrubs; roundleaf buffaloberry has greatest abundance in actively eroding areas. Minor shrubs may include antelope bitterbrush (*Purshia tridentata*), plains pricklypear (*Opuntia polyacantha*), banana yucca (Yucca bacata), and broom snakeweed (*Gutierrezia sarothrae*). Recruitment of Utah juniper and twoneedle pinyon is evident with 2-15% cover of seedling and sapling juniper and 4-16% cover of seedling and sapling pine. Total canopy cover averages 35%. Grass cover is low, at 1% or less. Grass species include Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*) and cheatgrass. Forb cover is also low, ranging from 0-2%. Forb richness is higher than grass, and species recorded western tansymustard (*Descurainia pinnata* var. intermedia), woolly locoweed (*Astragalus mollissimus*), rabbit ear rockcress (*Arabis pendulina*), springparsley (Cympoterus spp), heartleaf twistflower (*Streptanthus cordatus*), Utah penstemon (*Penstemon utahensis*), wingnut cryptantha (*Cryptantha pterocarya*), and Ives' phacelia (*Phacelia ivesiana*), although many other species could be present at a given location and with a different precipitation pattern. The soil surface is dominated by BSC at 40-60% cover, with 6-15% litter, 3-7% woody debris, and 1-4% bare ground.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	897	1121	1849
Shrub/Vine	17	34	56
Forb	–	1	22
Grass/Grasslike	–	–	6
Total	**914**	**1156**	**1933**

Table 6. Ground cover

Tree foliar cover	20-35%
Shrub/vine/liana foliar cover	4-8%
Grass/grasslike foliar cover	0-1%
Forb foliar cover	0-2%
Non-vascular plants	0-1%
Biological crusts	40-60%
Litter	10-22%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%

Bare ground	1-4%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-1%	0-1%	0-1%	0-1%
>0.15 <= 0.3	0-1%	0-2%	0-1%	0-2%
>0.3 <= 0.6	0-1%	0-3%	0-1%	0-2%
>0.6 <= 1.4	0-1%	4-8%	–	0-1%
>1.4 <= 4	0-16%	–	–	–
>4 <= 12	20-35%	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Utah juniper – twoneedle pinyon/ roundleaf buffalberry -Wyoming big sagebrush shrubland

This community phase is characterized by lower tree cover (less than 20%) and greater shrub cover and production. Roundleaf buffaloberry is a dominant species in this phase and Wyoming big sagebrush is an important shrub. Minor shrubs may include Mormon tea, antelope bitterbrush, sulphur-flower buckwheat (*Eriogonum umbellatum*), cliffrose (*Purshia mexicana*), and snowberry (Symphoricarpos spp.). Grass cover is low, at 1% or less. Grasses and forbs are a minor component of this phase, and composition is similar to community phase 2.1. Data for this phase is from old range assessments, and ground cover data were not available.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	364	513	661
Tree	39	448	516
Forb	–	6	11
Grass/Grasslike	–	3	7
Total	**403**	**970**	**1195**

Community 2.3
Roundleaf buffaloberry -Wyoming big sagebrush (provisional)

Data were not collected for this community phase, and composition is based on literature review. This phase is characterized by shrub dominance, with scattered regenerating trees. Roundleaf buffaloberry and Wyoming big sagebrush are dominant, and secondary shrubs likely include Mormon tea, broom snakeweed, antelope bitterbrush, banana yucca, snowberry, and cliffrose. Herbaceous species are likely to be more abundant in this phase. Squirreltail is likely to be the dominant grass. Indian ricegrass may be abundant, but propagule supply in the area may be too low given the depletion of this species by grazing.

Community 2.4
Herbaceous (provisional)

Data were not collected for this community phase, and composition is based on literature review. This phase is characterized by herbaceous dominance, and may last for 11 or more years. Crown-sprouting shrubs such as banana yucca and Mormon tea, and grasses such as squirreltail and Indian ricegrass will regenerate in the first year after fire. Annual forbs are likely to become abundant soon after fire, and remain abundant in this phase if adequate

precipitation is available. Perennial forbs and grasses gradually become dominant, and shrubs and trees will begin to regenerate from seed.

Pathway 2.1b
Community 2.1 to 2.2

This pathway may occur with localized disturbance that opens up the canopy, such as drought-induced insect mortality followed by a wet period that allows for shrub recruitment.

Pathway 2.1a
Community 2.1 to 2.4

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs with time without additional disturbance, as trees slowly regain dominance and shrubs die out. It could take 100-200 years (West 1979; Romme et al. 2009, Shinneman and Baker 2009).

Pathway 2.2b
Community 2.2 to 2.4

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 2.3a
Community 2.3 to 2.2

This pathway occurs with time and a lack of additional disturbance. Forty to 100 years may be required before canopy trees are a dominant aspect of the community.

Pathway 2.3b
Community 2.3 to 2.2

This pathway occurs with fire (or other land-clearing disturbance).

Pathway 2.4a
Community 2.4 to 2.3

This pathway occurs with time without additional disturbance. It will take a minimum of 11 years, and could take much longer depending on precipitation amount and timing, and the availability of off-site seed for dispersal.

Transition T1A
State 1 to 2

Transition from reference state (State 1) to current potential state (State 2). This transition may occur with improper livestock grazing and introduction of invasive species.

Additional community tables

Table 9. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			897–1849	
	twoneedle pinyon	PIED	*Pinus edulis*	336–1009	2–23
	Utah juniper	JUOS	*Juniperus osteosperma*	504–897	7–30
Shrub/Vine					
2	**Shrubs**			56–112	
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	34–67	2–6
	mormon tea	EPVI	*Ephedra viridis*	1–22	1–2
	Shrub, other	2S	*Shrub, other*	0–22	0–2
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	0–1
	banana yucca	YUBA	*Yucca baccata*	0–6	0–1
	antelope bitterbrush	PUTR2	*Purshia tridentata*	0–6	0–1
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–2	0–1
Grass/Grasslike					
3	**Grasses**			17–62	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–56	1–5
	squirreltail	ELEL5	*Elymus elymoides*	0–6	0–1
	Grass, perennial	2GP	*Grass, perennial*	0–6	0–1
Forb					
4	**Forbs**			0–22	
	rabbit ear rockcress	ARPE	*Arabis pendulina*	0–2	0–1
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–2	0–1
	wingnut cryptantha	CRPT	*Cryptantha pterocarya*	0–2	0–1
	springparsley	CYMOP2	*Cymopterus*	0–2	0–1
	western tansymustard	DEPII	*Descurainia pinnata ssp. intermedia*	0–2	0–1
	Utah penstemon	PEUT	*Penstemon utahensis*	0–2	0–1
	Ives' phacelia	PHIV	*Phacelia ivesiana*	0–2	0–1
	heartleaf twistflower	STCO6	*Streptanthus cordatus*	0–2	0–1

Table 10. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			897–1849	
	twoneedle pinyon	PIED	*Pinus edulis*	336–1009	2–23
	Utah juniper	JUOS	*Juniperus osteosperma*	504–897	7–30
Shrub/Vine					
2	**Shrubs**			17–56	
	Shrub, other	2S	*Shrub, other*	0–22	0–5
	mormon tea	EPVI	*Ephedra viridis*	1–22	1–2
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	1–11	1–2
	banana yucca	YUBA	*Yucca baccata*	0–6	0–1
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	0–1
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–2	0–1
Grass/Grasslike					
3	**Native Grasses**			0–6	
	Grass, perennial	2GP	*Grass, perennial*	0–6	0–1
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–6	0–1
	squirreltail	ELEL5	*Elymus elymoides*	0–6	0–1
Forb					
4	**Native Forbs**			0–22	
	Forb, annual	2FA	*Forb, annual*	0–6	0–2
	Forb, perennial	2FP	*Forb, perennial*	0–6	0–2
	rabbit ear rockcress	ARPE	*Arabis pendulina*	0–2	0–1
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–2	0–1
	wingnut cryptantha	CRPT	*Cryptantha pterocarya*	0–2	0–1
	springparsley	CYMOP2	*Cymopterus*	0–2	0–1
	western tansymustard	DEPII	*Descurainia pinnata ssp. intermedia*	0–2	0–1
	Utah penstemon	PEUT	*Penstemon utahensis*	0–2	0–1
	Ives' phacelia	PHIV	*Phacelia ivesiana*	0–2	0–1
	heartleaf twistflower	STCO6	*Streptanthus cordatus*	0–2	0–1

Table 11. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Shrubs**			364–661	
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	226–639	5–20
	Mexican cliffrose	PUME	*Purshia mexicana*	0–28	0–2
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–3	0–1
	antelope bitterbrush	PUTR2	*Purshia tridentata*	0–1	1
	mormon tea	EPVI	*Ephedra viridis*	0–1	1
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–1	1
	snowberry	SYMPH	*Symphoricarpos*	0–1	1
Tree					
2	**Trees**			39–516	
	Utah juniper	JUOS	*Juniperus osteosperma*	16–476	5–15
	twoneedle pinyon	PIED	*Pinus edulis*	11–314	5–15
Grass/Grasslike					
3	**Native Grasses**			0–7	
	Grass, perennial	2GP	*Grass, perennial*	0–3	0–1
	squirreltail	ELEL5	*Elymus elymoides*	0–3	0–1
Forb					
4	**Shrubs**			0–11	
	Forb, annual	2FA	*Forb, annual*	0–3	0–1
	Forb, perennial	2FP	*Forb, perennial*	0–3	0–1
	beardtongue	PENST	*Penstemon*	0–2	0–1
	spiny phlox	PHHO	*Phlox hoodii*	0–1	0–1
	rubberweed	HYMEN7	*Hymenoxys*	0–1	0–1
	pepperweed	LEPID	*Lepidium*	0–1	0–1

Animal community

--Livestock and Wildlife Grazing--

This site provides poor/fair grazing conditions for livestock and wildlife during spring, summer, and fall when in good ecological condition due to the sparse understory of the mature woodland, and the general lack of natural perennial water sources. Care should be taken to maintain the native perennial grasses and shrubs when present due to the poor suitability for re-seeding or restoring this site, and the sensitivity of soils to erosion with loss of vegetative cover and BSC. This site may occur in mule deer, desert bighorn sheep, and elk habitat; however in many places the populations will be small and have little grazing impact on the site.

Roundleaf buffaloberry, mormontea, and Wyoming big sagebrush provide good browse for cattle, sheep, goats, mule deer, bighorn sheep and elk. Utah juniper and pinyon pine provide good cover for livestock and wildlife; goats and mule deer may utilize these trees. The presence of grasses, including Indian ricegrass and bottlebrush squirreltail provide good grazing habitat for all classes of livestock and wildlife. Forb composition and annual production depends primarily on precipitation amounts and thus is challenging to use in livestock grazing management decisions. However, forb composition should be monitored for species diversity, as well as poisonous or injurious plant communities which may be detrimental to livestock if grazed. Before making specific grazing management recommendations, an onsite evaluation must be made.

Hydrological functions

The soil is in hydrologic group b. The runoff curve numbers are 61 through 79 depending on the condition of the watershed.

Recreational uses

Recreation values are hiking, hunting, and camping.

Wood products

Fence posts and firewood. The site index is 60 to 80. Wood production is 8 to 10 cords per acre.

Other information

--Poisonous/Toxic Plant Communities--

Potentially toxic plants associated with this site include Wyoming big sagebrush, which contains sesquiterpene lactones and monoterpenes which have been suspected of being toxic to sheep. An experimental dosage of ¾ lbs of big sagebrush fed to sheep for three days was found to be lethal.

--Invasive Plant Communities--

Generally as ecological conditions deteriorate and perennial vegetation decreases due to disturbance (fire, overgrazing, drought, off road vehicle overuse, erosion, etc.) annual forbs and grasses will invade the site. Of particular concern in semi-arid environments are the non-native annual invaders including cheatgrass, Russian thistle, kochia, halogeton, and annual mustards. The presence of these species will depend on soil properties and moisture availability; however, these invaders are highly adaptive and can flourish in many locations. Once established, complete removal is difficult but suppression may be possible.

Inventory data references

High intensity sampling (Caudle et al. 2013) was used to describe this ecological site (Community Phase 2.1). Site characteristics such as aspect, slope, elevation and UTMS were recorded for each plot, along with complete species inventory by ocular percent cover. The line-point intercept method was used to measure foliar cover, groundcover, and vegetation structure. At 100 points along a 200 foot transect, ground cover and intercepted plant species were recorded by height. The first hit method (Herrick et al. 2009) was used to generate the foliar cover values entered in the community phase composition tables. Annual production was estimated using the double-weight sampling method outlined in the National Range and Pasture Handbook and in Sampling Vegetation Attributes (NRCS 2003 and Interagency Technical Reference 1999 pgs. 102 - 115). For herbaceous vegetation, ten 9.6 square foot circular sub-plots were evenly distributed along a 200 foot transect. For woody and larger herbaceous species, production was estimated in four 21x21 foot square plots along the same transect. Weight units were collected for each species encountered in the production plots. The number of weight units for each species is then estimated for all plots.

Community Phase 2.2 data (3 plots) was obtained from NRCS range assessments from 1982.

Type locality

Location 1: San Juan County, UT	
UTM zone	N
UTM northing	4137956
UTM easting	596853

General legal description	The type location occurs on Cedar Mesa, Utah, on BLM land approximately 14 miles south of Highway 95 and approximately 2 miles east of Highway 261.

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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)	Robert Stager (BLM), F.E. Busby (USU), Dana Truman (NRCS), Paul Curtis (BLM), Shane A. Green (NRCS), Alice Miller (Pyramid Botanical Consultants)
Contact for lead author	shane.green@ut.usda.gov
Date	02/22/2016
Approved by	Shane A. Green
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Frequent. Occur throughout the site. Rills may extend down entire slope.

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2. **Presence of water flow patterns:** Common and occur throughout the area. Interspaces between well developed biological soil crusts appear to be water depression storage areas but can serve as water flow patterns across areas covered with biological soil crust during episodic precipitation events. Flow patterns will be more visible as slope increases.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals form at the base of plants that occur on the edge of rills. Larger rills and gullies may remove soil from the base of trees exposing roots that resemble pedestals.

Interspaces between well developed biological soil crusts resemble pedestals and may be up to 2 inches high. Terracettes are present. Debris dams of small to medium sized litter (up to 2 inches in diameter) may form in water flow patterns, rills, and gullies. These debris dams may accumulate smaller litter (leaves, grass and forb stems).

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 1 to 4 %. Most bare ground is associated with water flow patterns, and rills, and the soil surface is dominated by well developed biological soil crust (40 to 60%). Areas with well developed biological soil crusts should not be counted as bare ground. Poorly developed biological soil crusts that are interpreted as functioning as bare ground (therefore they would be susceptible to raindrop splash erosion) should be recorded as bare ground. Ground cover is based on first raindrop impact, and bare ground is the opposite of ground cover. Ground cover + bare ground = 100%.

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5. **Number of gullies and erosion associated with gullies:** None to few. On steeper slopes and areas adjacent to sites with concentrated water flow (such as exposed bedrock), gullies may increase. Length is short. Gullies may remove soil from the base of trees exposing roots.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None to very few. Trees and shrubs break the wind, and well developed biological soil crust covering the soil reduce the potential for wind erosion.

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7. **Amount of litter movement (describe size and distance expected to travel):** Most litter accumulates at base of plants. Woody stems from trees not moved unless present in water flow pattern, rill, or gully. On steeper slopes (> 20 %), woody stems may be washed from site. Large rills may remove accumulated litter from under trees.

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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 5 to 6 under the plant canopies, and a rating of 4 to 6 in the interspaces. The average should be a 5. Surface texture is loam. Biological soil crusts, vegetation cover, and litter reduce erosion.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is 2- 4 inches deep. Structure is weak medium blocky parting to weak fine granular. Color is brown (7.5YR5/3). The A horizon would be expected to be more strongly developed under plant canopies. It is important if you are sampling to observe the A horizon under plant canopies as well as the interspaces. Use the specific information for the soil you are assessing found in the published soil survey to supplement this description.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Spatial distribution of plants and/or well developed biological soil crusts intercept raindrops reduce splash erosion and provide areas of surface detention to store water allowing additional time for infiltration. Crowns of trees and accumulating litter at base of trees appear to create a micro-topography that may enhance development of water flow patterns below the drip line of the canopy.

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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. There may be layers of calcium carbonate accumulation or other

naturally occurring hard layers found in the soil subsurface. These should not be considered to be compaction layers.

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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: Shrubs > Trees (Juniper > Pinyon) > cool season perennial grasses

    Sub-dominant: Forbs

    Other: Functional/structural groups may appropriately contain non-native species if their ecological function is the same as the native species in the reference state (e.g. Intermediate wheatgrass and Russian wildrye etc.)

    Additional: Disturbance regime includes insects, drought, parasites, and very infrequent fire. Following a recent disturbance such as fire or drought that removes the woody vegetation, forbs and perennial grasses (herbaceous species) may dominate the community. If a disturbance has not occurred for an extended period of time, Pinyon, Juniper, and roundleaf buffalo berry may continue to increase crowding out the perennial herbaceous understory species. In either case, these conditions would reflect a functional community phase within the reference state. Dominants— Wyoming big sagebrush, buffaloberry, Utah Juniper, and Pinyon pine. Subdominants— squirreltail, Indian ricegrass, forbs. 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):** Several standing dead trees may be present on the site and approximately 20% of the trees and shrubs can show evidence of decadence. In drought tree mortality may increase with the first sign being a yellowish to reddish leaf color.

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

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 815 to 1725 lbs/ac

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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:** Cheatgrass and introduced annual forbs are likely to invade this site.

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17. **Perennial plant reproductive capability:** All perennial plants should have the ability to reproduce sexually or asexually in most years, except in drought years.
