Ecological site R028AY220UT
Semidesert Loam (Wyoming Big Sagebrush)

Accessed: 10/12/2024

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.

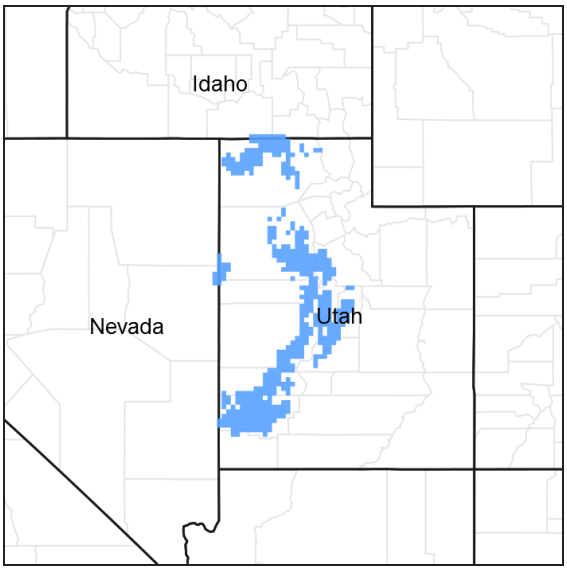


Figure 1. Mapped extent

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): 028A–Ancient Lake Bonneville

MLRA 28A occurs in Utah (82%), Nevada (16%), and Idaho (2%). It encompasses approximately 36,775 square miles (95,246 square kilometers). A large area west and southwest of Great Salt Lake is a salty playa. This area is the farthest eastern extent of the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level basins between widely separated mountain ranges trending north to south. The basins are bordered by long, gently sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. Most of the valleys are closed basins containing sinks or playa lakes. Elevation ranges from 3,950 to 6,560 feet (1,204 to 2000 meters) in the basins and from 6,560 to 11,150 feet (1996 to 3398 meters) in the mountains. Much of the MLRA has alluvial valley fill and playa lakebed deposits at the surface from pluvial Lake Bonneville, which dominated this MLRA 13,000 years ago. A level line of remnant lake terraces on some mountain slopes indicates the former extent of this glacial lake. The Great Salt Lake is what remains of the pluvial lake.

Mountains in the interior of this MLRA consist of tilted blocks of marine sediments from Cambrian to Mississippian age with scattered outcrops of Tertiary continental sediments and volcanic rocks. The average annual precipitation is 5 to 12 inches (13 to 30 cm) in the valleys and ranges up to 49 inches (124 cm) in the mountains. Most of the rainfall in the southern LRU occurs as high-intensity, convective thunderstorms during the growing season (April through September). The driest period is from midsummer to early autumn in the northern LRU. Precipitation in winter typically occurs as snow. The average annual temperature is 39 to 53 °F (4 to 12 °C). The freeze-free period averages 165 days and ranges from 110 to 215 days, decreasing in length with increasing elevation. The dominant

soil orders in this MLRA are Aridisols, Entisols, and Mollisols. Soils are dominantly in the mesic or frigid soil temperature regime, aridic or xeric soil moisture regime, and mixed mineralogy. They generally are well drained, loamy or loamy-skeletal, and very deep.

Land Resource Unit (LRU): Basin and Range North

Notes: The Basin and Range North LRU exhibits dry summer with stronger xeric patterns than the Basin and Range South LRU. Ranges in the north LRU are about 50 percent Paleozoic sedimentary/metasedimentary (limestone/quartzite dominant) and about 10 percent Tertiary volcanics. The basin floors are between 4,200 and 5,100 feet (1280 to 1554 meters) in elevation. Pinyon and juniper sites have a greater percentage of Utah juniper (Juniperus osteosperma) in the plant community than pinyon pine (Pinus edulis or monophylla). The Basin and Range North have few semidesert ecological sites with Utah juniper. Cool season grasses, such as bluebunch wheatgrass (Pseudoroegneria spicata), are dominant in the plant community, while warm season grasses are largely absent or a small component of the plant community.

Classification relationships

MRLA: 28A Great Salt Lake Area> LRU: Basin and Range North> Ecological Zone: Semidesert> Ecological Site: Semidesert Loam (Wyoming Big Sagebrush)

EPA Ecoregion: North American Deserts> Cold Deserts> Central Basin and Range> Shadscale- Dominated Saline Basins, Sagebrush Basins and Slopes, Woodland- and Shrub-Covered Low Mountains

Ecological site concept

This site is found on lake terraces, flood plains, alluvial flats, and fan remnants, generally on gentle slopes between 0 and 8 percent. Soils are typically moderately deep to deep and have a loamy surface texture, with few rocks on the surface or with the subsurface. Species composition is typically dominated by Wyoming big sagebrush (Artemisia tridentata subsp. wyomingensis). A wide mixture of other shrubs including Nevada ephedra (Ephedra nevadensis) and shadscale (Atriplex confiertifolia) are also commonly found. Bluebunch wheatgrass and Indian ricegrass (Achnatherum hymenoides) are the most prominent herbaceous species. Needle-and thread (Hesperostipa comata), and western wheatgrass (Pascopyrum smithii) are other common perennial grasses.

Associated sites

R028AY004UT	**Alkali Flat (Black Greasewood)** This site can be adjacent, but is dominated by basin wildrye and not sagebrush in reference condition.
R028AY230UT	**Semidesert Shallow Hardpan (Black Sagebrush)** This site occurs adjacent to this ecological site where the soils are shallow from either a duripan or petrocalcic layer.

Similar sites

R028AY215UT	**Semidesert Gravelly Loam (Wyoming Big Sagebrush) North** This site has more rock fragments within the soil profile.
R028AY220UT	**Semidesert Loam (Wyoming Big Sagebrush)** This is a similar site in the Basin and Range South LRU. Cool season bunchgrasses are dominant in this site with warm season grasses present.
R028AY015NV	**LOAMY 8-10 P.Z.** This site is a similar site that has been described in Nevada. This site is similar to the lower precipitation zone within the Semidesert ecological zone.
R028AY095NV	**LOAMY 10-12 P.Z.** This site is a similar site that has been described in Nevada.

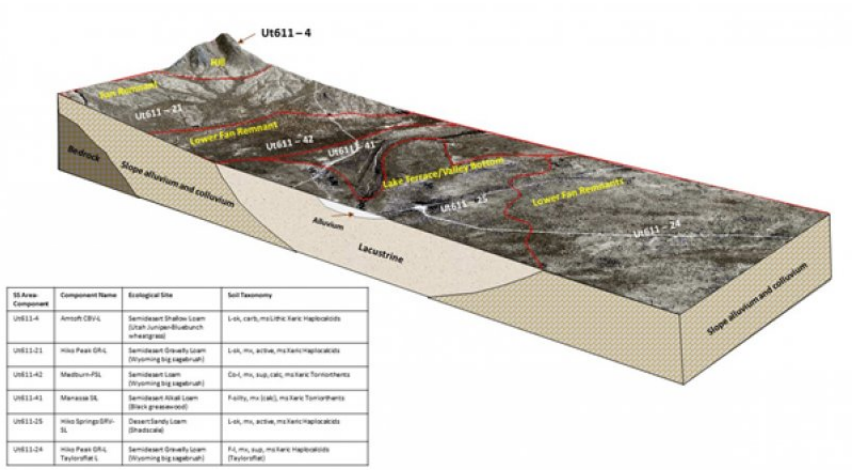
Table 1. Dominant plant species

Tree	Not specified

Shrub	(1) *Artemisia tridentata subsp. wyomingensis*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Pseudoroegneria spicata*

Physiographic features

This site is located on lake terraces, flood plains, alluvial flats, and fan remnants. Slopes range from 0 to 8 percent but may occasionally be steeper. Runoff potential ranges from low to medium. Sites are located between 4,300 to 6,500 feet in elevation.



SS Area-Component	Component Name	Ecological Site	Soil Taxonomy
Ut611-4	Amsoft CBV-L	Semidesert Shallow Loam (Utah Juniper-Bluebunch wheatgrass)	L-ok, carb, mx Lithic Xeric Haplocalcids
Ut611-21	Hiko Peak DFrL	Semidesert Gravelly Loam (Wyoming big sagebrush)	L-ok, mx, active, mx Xeric Haplocalcids
Ut611-42	Madburn-FSL	Semidesert Loam (Wyoming big sagebrush)	Co-l, mx, sup, calc, mx Xeric Torriorthents
Ut611-41	Manassa SIL	Semidesert Alkali Loam (Black greasewood)	F-silty, mx (calc), mx Xeric Torriorthents
Ut611-25	Hiko Springs DFV-SL	Desert Sandy Loam (Shadscale)	L-ok, mx, active, mx Xeric Haplocalcids
Ut611-24	Hiko Peak DFrL Taylorsflat L	Semidesert Gravelly Loam (Wyoming big sagebrush)	F-l, mx, sup, mx Xeric Haplocalcids (Taylorsflat)

Figure 2. Block Diagram

Table 2. Representative physiographic features

Landforms	(1) Alluvial flat (2) Fan remnant (3) Lake terrace
Flooding frequency	None
Elevation	4,300–6,500 ft
Slope	0–8%
Aspect	Aspect is not a significant factor

Climatic features

The climate of this site is dry subhumid and semiarid. It is characterized by cold, snowy winters and warm, dry summers. The average annual precipitation ranges from 9 to 15 inches. March, April and May are typically the wettest months with June, July and August being the driest. The most reliable sources of moisture for plant growth are the snow that accumulates over the winter, and spring rains. Summer thunderstorms are intermittent and sporadic in nature, and thus are not reliable sources of moisture to support vegetative growth on this site. The mean annual air temperature is 45 to 50 degrees. Mean Annual Soil Temperature: 49-54

Table 3. Representative climatic features

Frost-free period (average)	124 days
Freeze-free period (average)	145 days
Precipitation total (average)	13 in

Climate stations used

- (1) VERNON [USC00429133], Vernon, UT
- (2) FAIRFIELD [USC00422696], Cedar Valley, UT
- (3) ELBERTA [USC00422418], Cedar Valley, UT
- (4) ROSETTE [USC00427408], Park Valley, UT

Influencing water features

There are no influencing water features on this ecological site.

Soil features

The soils of this site formed in alluvium and lacustrine sediments derived from sedimentary rocks. They are typically more than 60 inches deep, but a few soils may have a duripan or petrocalcic horizon from 20 to 40 inches of the soil surface. The surface horizon is 4 to 6 inches thick with loam textures and very little rock. The volume of rock fragments throughout the soil profile ranges from 0 to 16 percent.
These soils can be non-calcareous or moderately calcareous, and moderately or strongly alkaline. They are well-drained with slow to moderate permeability. Available water capacity for the upper 40 inches of soil is 3.1 to 7.4 inches. The soil temperature regime is mesic, and the soil moisture regime is aridic bordering on xeric.

Soil Survey Area: Soil Components:

Box Elder County - Western Part (UT601) Declo; Lembos; Taylorsflat.

Box Elder County - Eastern Part (UT602):
Palisade; Thiokol.

Fairfield-Nephi Area (UT608): Ashdown; Cheebe; Duggins; Firmage; Freedom; Genola; Musinia; Thiokol; Truesdale; Wales; Woodrow.

Tooele Area (UT611): Junkett; Medburn; Scalade; Taylorsflat.

Millard County (UT618): Ashdown; Bandag; Freedom; Genola; Jigsaw; Kessler; Kudlac; Linoyer; Musinia; Oakcity; Taylorsflat; Woodrow.

Sanpete Valley Area (UT627): Billings; Centerfield; Freedom; Linoyer; Lisade; Mayfield; Mellor; Quaker; Rapho; Ravola; Wales; Woodrow.

Delta Area (UT632): Kessler; Musinia; Woodrow.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone and sandstone (2) Lacustrine deposits–shale
Surface texture	(1) Loam (2) Silt loam (3) Fine sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderate
Soil depth	20–60 in
Surface fragment cover <=3"	0–2%
Surface fragment cover >3"	0–11%
Available water capacity (0-40in)	3.1–7.4 in

Calcium carbonate equivalent (0-40in)	0–30%
Electrical conductivity (0-40in)	0–4 mmhos/cm
Sodium adsorption ratio (0-40in)	0–10
Soil reaction (1:1 water) (0-40in)	7.9–9
Subsurface fragment volume <=3" (Depth not specified)	0–2%
Subsurface fragment volume >3" (Depth not specified)	0–14%

Ecological dynamics

This site is found in the Great Salt Lake Area of the Basin and Range Ecological Provence. It developed under the natural ecological conditions found there, including the normal influences of native wildlife herbivory, fire and climate.

This sites plant species composition is typically dominated by Wyoming big sagebrush. A wide mixture of other shrubs including Nevada ephedra and shadscale are also commonly found. Bluebunch wheatgrass and Indian ricegrass are the most prominent herbaceous species. Needle-and thread, western wheatgrass and James galleta are other common perennial grasses.

This ecological site has been grazed by domestic livestock since they were first introduced into the area in the mid 1800's. This introduction of livestock, mainly cattle and sheep, including the use of fencing to control those stock, and the development of reliable water sources, has in places altered the historic disturbance regimes associated with this ecological site. Improper livestock grazing that includes season long grazing and/or heavy stocking rates over long periods of time, will likely cause this site to depart from the reference plant community.

Periodic fire naturally occurred on this site with a burn period estimated at 80 to 90 years. Disturbances such as improper grazing, poorly designed brush treatments and OHV misuse can put this site at risk of entering a shorter burn cycle by allowing invasive annuals to enter the system. These annuals can produce flashy fuel loads which easily burn. Cheatgrass(*Bromus tectorum*), halogeton (*Halogeton glomeratus*), various mustard species, alyssum and Russian thistle (Salsola iberica) are most likely to invade this site. These and other invasive weed species are capable of establishing themselves on this site, however, even in the abscence of disturbance, but rarely increase to a point where they dominate the community.

As this sites ecological condition deteriorates, palatable perennial grasses and winterfat typically decrease while Wyoming big sagebrush, green rabbitbrush and less palatable grasses and forbs increase.

Management practices that maintain or improve rangeland vegetation include prescribed grazing and the proper location of water and fencing developments. Severe drought may adversely affect the production of the herbaceous perennial vegetation.

Suitability for rangeland seeding is good on this site. This practice can be used to improve forage quality and to control erosion. Treated pastures, including sagebrush spraying, brush beating and heavy disking are commonly found throughout this sites range. These treated areas are typically seeded to adapted forage plants including crested wheatgrass and intermediate wheatgrass.

Where vegetative communities have been impacted by changes in management or natural influences that moved them from one ecological state to another, a return to previous states is often not possible. The amount of energy needed to affect desired vegetative shifts on this site depends on both its present biotic and abiotic features and the desired results.

The following State and Transition diagram shows some of the most commonly occurring plant communities found

on this ecological site. These plant communities may not represent every possibility, but they are the most prevalent and repeatable. As more data are collected, some of these plant communities may be revised or removed, and new ones may be added. This model was developed using range data collected over the last 40 years in MLRA D28A in western Utah. Both ocular and measured data was collected and utilized.

This site is similar to the site Loam 8-10 P.Z. in Nevada. The site in Nevada has a state and transition model developed that is used below (Stringham et. al 2015).

State and transition model

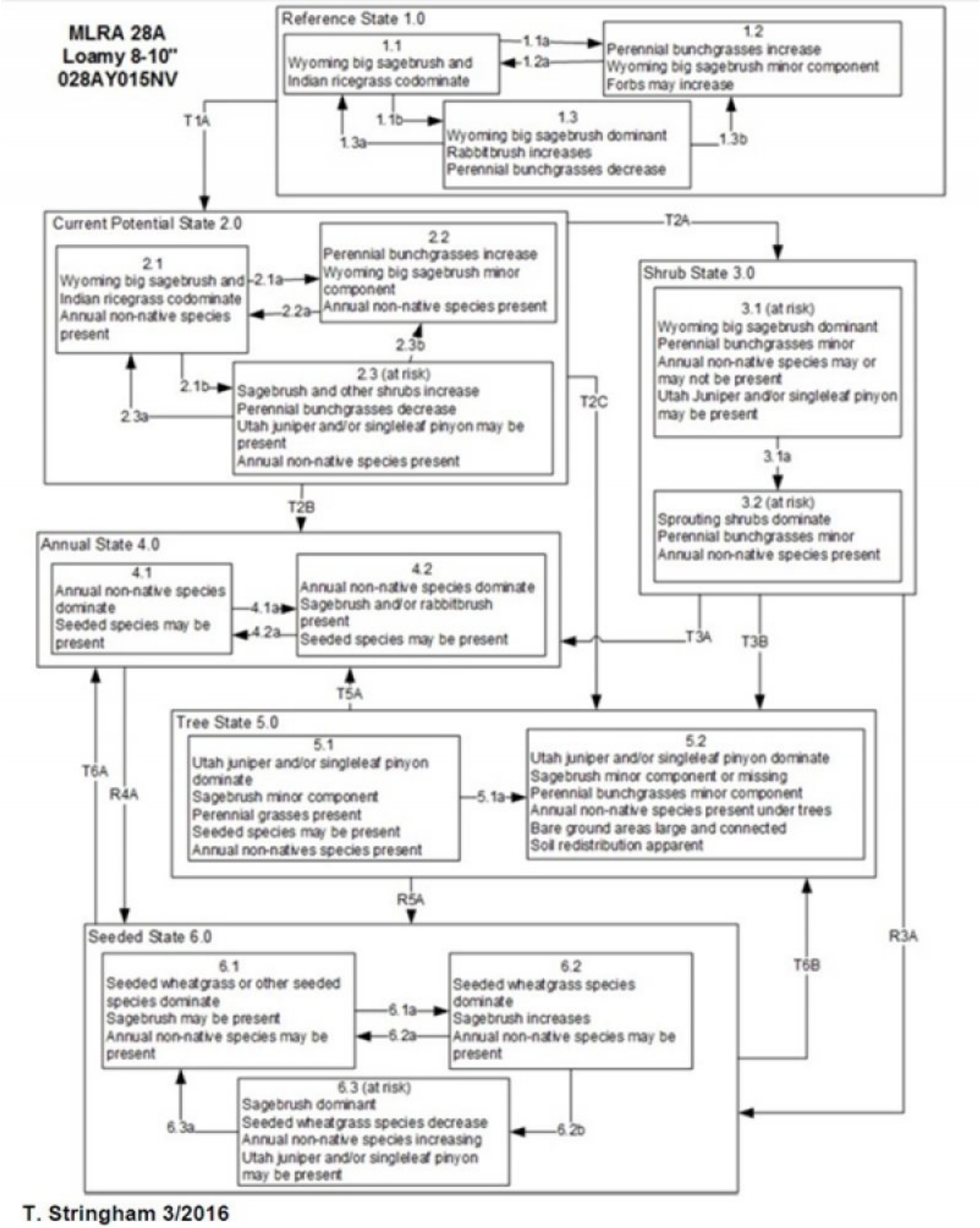


Figure 7. STM R028AA220UT

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community, dominated by grasses and forbs.
1.1b: Time and lack of disturbance such as fire or drought. Excessive herbivory may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.
1.3b: High severity fire significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of non-native species such as bulbous bluegrass, cheatgrass and thistles.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs; non-native annual species present.
2.1b: Time and lack of disturbance such as fire or drought. Inappropriate grazing management may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
2.3a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
2.3b: High severity fire significantly reduces sagebrush cover leading to early mid-seral community.

Transition T2A: Time and lack of disturbance and/or inappropriate grazing management (3.1).
Transition T2B: High severity fire and/or soil disturbance (4.1). Inappropriate grazing that favors shrubs in the presence of non-native annual species (4.2).
Transition T2C: Time and lack of disturbance allows for an increase in tree cover; inappropriate grazing management and/or chronic drought can reduce fine fuels and lead to increased tree establishment and dominance (5.1).

Shrub state 3.0 Community Phase Pathways
3.1a: Fire.

Transition T3A: Catastrophic fire and/or soil disturbance (4.1). Inappropriate grazing management in the presence of non-native annual species (4.2).
Transition T3B: Time and a lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management (5.1).

Restoration R3A: Brush management with minimal soil disturbance, coupled with seeding of desired species. Probability of success is minimal (6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of fire, unlikely to occur.
4.2a: Fire.

Restoration R4A: Seeding of desired species; may be coupled with herbicide; probability of success very low (6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for tree maturation

Restoration R5A: Tree removal and seeding of desired species.

Transition T5A: Catastrophic fire, inappropriate tree removal practices (5.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance may be coupled with inappropriate grazing management.
6.2a: Low severity fire.
6.2b: Inappropriate grazing management reduces bunchgrasses and increases density of sagebrush; usually a slow transition.
6.3a: Fire or brush treatment with minimal soil disturbance.

Transition T6A: Catastrophic fire and/or inappropriate grazing management.
Transition T6B: Time and a lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management (5.1).

Figure 8. Legend

State 1
Reference State

The Reference State is a representative of the natural range of variability under pristine conditions. The reference state has 3 general community phases; a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. This reference state has a well-developed shrub layer with Wyoming big sagebrush dominating. Nevada ephedra, winterfat and shadscale are other common shrub species. Bluebunch wheatgrass and Indian ricegrass are the most dominant herbaceous species with needle-and-thread, and western wheatgrass occurring. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack. The reference state is self-sustaining and resistant to change due to a natural resilience to its natural disturbances. The

primary natural disturbance mechanisms are livestock grazing and wildlife population densities which can affect the shrub layer composition, weather fluctuations, and fire period. Definitions: Reference State: Natural plant communities as influenced by shrub canopy density, long term weather fluctuations, and periodic fire. Indicators: These communities are dominated by Wyoming big sagebrush and bluebunch wheatgrass. The density of the shrub canopy determines the amount and composition of the other native species present in the community. Feedbacks: Natural fluctuations in weather patterns that allow for a self-sustaining shrub and native grass community. Prolonged drought, an increase in fire frequency, or other disturbances may allow for the establishment of invasive species. At-risk Community Phase: All communities are at risk when native plants are stressed and conditions are created that may allow invasive plants to establish. Trigger: The establishment of invasive plant species.

Community 1.1
Wyoming Big Sage/Bluebunch Wheatgrass Community Phase.

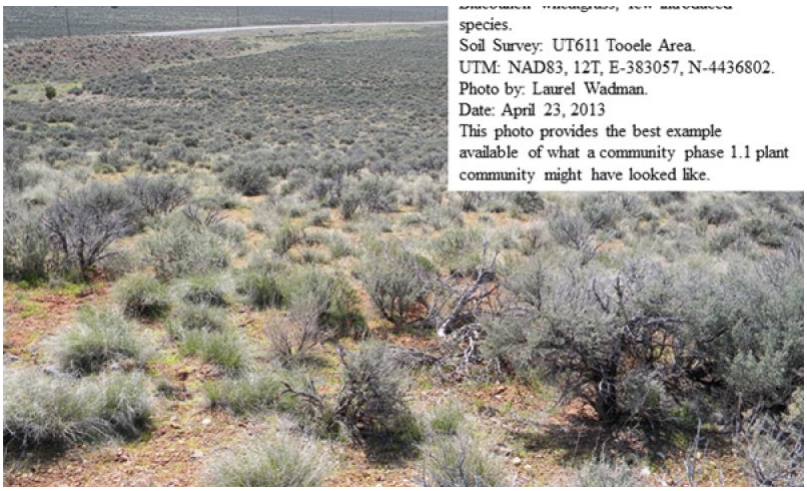


Figure 9. Community Phase 1.1

This reference community phase is dominated by Wyoming big sagebrush. Other significant shrubs include Nevada ephedra, winterfat and shadscale. Bluebunch wheatgrass and Indian ricegrass co-dominate the herbaceous layer. Other commonly occurring grasses include needle-and-thread and James galleta. This site is mature and may be nearing the end of its natural fire cycle. The sites vegetative composition by air-dry weight is approximately 45 percent perennial grasses, 10 percent forbs, and 45 percent shrubs. The following tables provide an example of the typical vegetative floristics of a community phase 1.1 plant community.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	230	325	420
Shrub/Vine	230	315	400
Forb	40	60	80
Total	**500**	**700**	**900**

Table 6. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-40%
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 (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	–	–	–
>1 <= 2	–	–	35-45%	0-10%
>2 <= 4.5	–	15-25%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Figure 11. Plant community growth curve (percent production by month). UT2141, PNC. Excellent Condition.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	40	30	5	5	0	0	0	0

Community 1.2
Bluebunch Wheatgrass, Herebaceous Grass Community Phase.

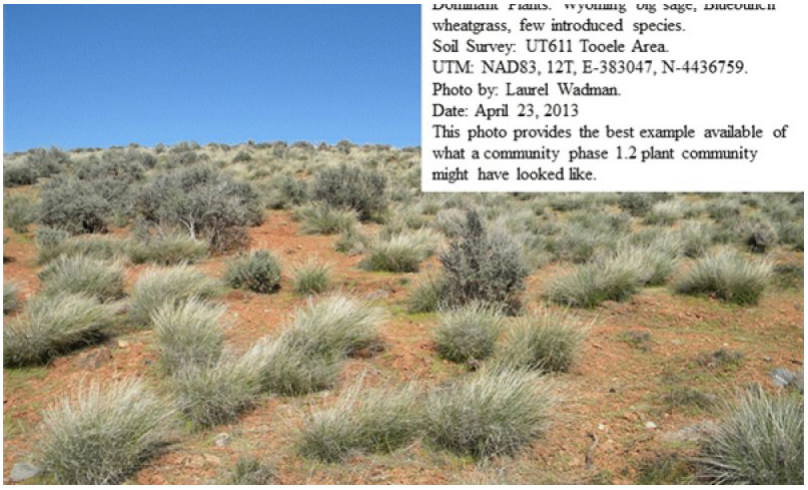


Figure 12. Community Phase 1.2

This reference community is dominated by bluebunch wheatgrass and Indian ricegrass. Significant shrubs are present and typically include Wyoming big sagebrush, Nevada ephedra, winterfat and green rabbitbrush. Other commonly occurring grasses include western wheatgrass and needle-and-thread. This site is early in its natural fire cycle and a slow transition from herbaceous species to woody species is occurring. The sites vegetative composition by air-dry weight is approximately 65 percent perennial grasses, 15 percent forbs, and 20 percent shrubs. The following tables provide an example of the typical vegetative floristics of a community phase 1.2 plant community.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	230	325	420
Shrub/Vine	230	315	400
Forb	40	60	80
Total	**500**	**700**	**900**

Table 9. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-40%
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 10. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	–	–	–
>1 <= 2	–	–	35-45%	0-10%
>2 <= 4.5	–	15-25%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

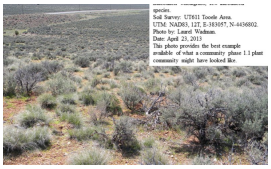
Figure 14. Plant community growth curve (percent production by month). UT2141, PNC. Excellent Condition.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	40	30	5	5	0	0	0	0

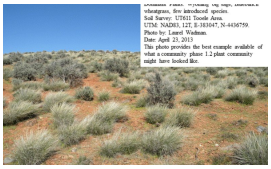
Community 1.3
Wyoming big sagebrush/rabbitbrush/perennial bunchgrasses

Wyoming sagebrush increases in the absence of disturbance or with grazing management that favors shrubs. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from grazing management.

Pathway 1.1a
Community 1.1 to 1.2



Wyoming Big Sage/Bluebunch Wheatgrass Community Phase.



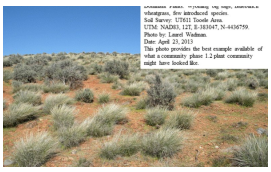
Bluebunch Wheatgrass, Herebaceous Grass Community Phase.

This community pathway occurs when weather patterns are within normal ranges and some level of fire reduces the Wyoming big sagebrush canopy, significantly opening the site. This more open canopy allows understory vegetation to increase in production, and under some circumstances, flourish on the site. Proper livestock grazing during these periods can facilitate this process.

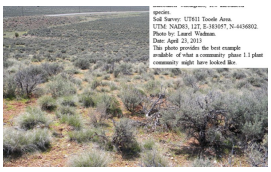
Pathway 1.1b
Community 1.1 to 1.3

Chronic drought, time and/or inappropriate grazing management favor an increase in Wyoming sagebrush over deep-rooted perennial bunchgrasses. Combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. Sandberg bluegrass may increase in density depending on the grazing management.

Pathway 1.2a
Community 1.2 to 1.1



Bluebunch Wheatgrass, Herebaceous Grass Community Phase.



Wyoming Big Sage/Bluebunch Wheatgrass Community Phase.

This community pathway occurs when long-term drought and/or extended periods without fire allows canopies, mainly Wyoming big sagebrush to significantly increase. This closing canopy event causes understory vegetation to be reduced and eventually nearly eliminated from the site. Drought alone can also reduce native perennial grass production and eventually eliminate some species from the system. Improper livestock grazing during these periods can facilitate this process.

Pathway 1.3a
Community 1.3 to 1.1

A change in grazing management that decreases shrubs would allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall grazing by sheep will reduce sagebrush and increase the herbaceous understory. A moderate Aroga moth infestation may also reduce sagebrush overstory and allow perennial bunchgrasses to increase.

Pathway 1.3b
Community 1.3 to 1.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 2
Current Potential State

The Current Potential State is similar to the Reference State except that non-native species are now present. This state describes the plant communities that may or have become established on this ecological site under various successional sequences and disturbance conditions. This state typically has a well developed shrub layer with Wyoming big sagebrush often dominating. Nevada ephedra and shadscale are other common shrub species. Bluebunch wheatgrass and Indian ricegrass are the dominant herbaceous species with needle-and-thread, James galleta and other perennial grasses and forbs commonly found in abundance also. These other native grasses, forbs, and shrubs may produce significant composition in the plant community. Cheatgrass, halogeton, alyssum, various mustard species and other non-native species are present on the site and under certain circumstances, may visually dominate the sites aspect. The primary disturbance mechanisms are the shrub layer density; the amount of invasive species present; weather fluctuations; and fire. The current potential state is still self-sustaining but may be losing its resistance to change due to the impact of disturbances with less resilience following those disturbances. Definitions: Current Potential State: Plant communities influenced by shrub canopy density, long term weather fluctuations, and periodic fire. Invasive species are present in various amounts. Indicators: A community dominated by Wyoming big sagebrush and bluebunch wheatgrass. The density of the shrub canopy determines the amount and composition of the other native and introduced grasses and forbs that may be present. Feedbacks: Natural fluctuations in weather patterns that allow for a self sustaining shrub and native grass community. Prolonged drought, more frequent fires, and/or other disturbances that may allow for the increase of invasive species. At-risk Community Phase: All communities are at risk when native plants are stressed and nutrients become available for invasive plants to increase. Trigger: A reduction of perennial grass and forb species combined with an increase of invasive plant species.

Community 2.1
Wyoming Big Sage/Bluebunch Wheatgrass/Invasive Weed Community Phase.

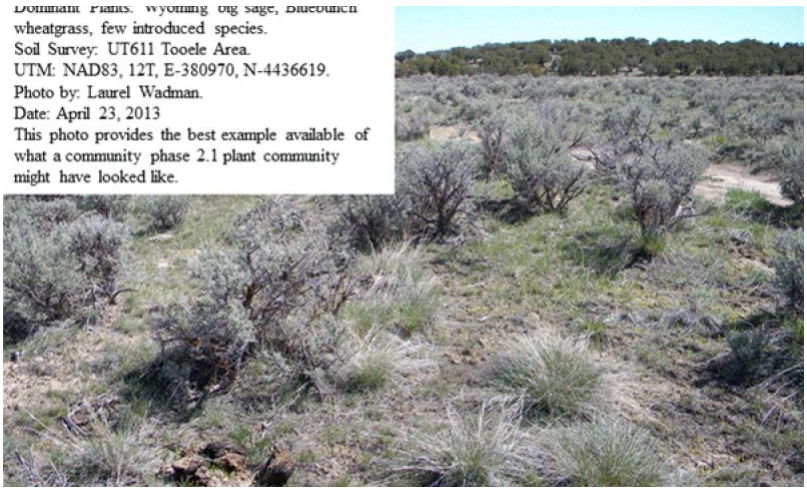


Figure 15. Community Phase 2.1

This current potential community phase is dominated by Wyoming big sagebrush. Other significant shrubs include Nevada ephedra, winterfat and shadscale. Bluebunch wheatgrass and Indian ricegrass co-dominate the herbaceous layer with needle-and-thread subdominant. Non-native species are now present in the all plant communities and are expected to remain a permanent part of these communities. This site is mature and may be nearing the end of its natural fire cycle. The sites vegetative composition by air-dry weight is approximately 45 percent perennial grasses, 10 percent forbs, and 45 percent shrubs. The following tables provide an example of the typical vegetative floristics of a community phase 2.1 plant community.

Table 11. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	230	325	420
Shrub/Vine	230	315	400
Forb	40	60	80
Total	**500**	**700**	**900**

Table 12. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-40%
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 13. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	–	–	–
>1 <= 2	–	–	35-45%	0-10%
>2 <= 4.5	–	15-25%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Figure 17. Plant community growth curve (percent production by month). UT2141, PNC. Excellent Condition.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	40	30	5	5	0	0	0	0

Community 2.2
Wyoming Big Sage/Invasive Weed Community Phase.

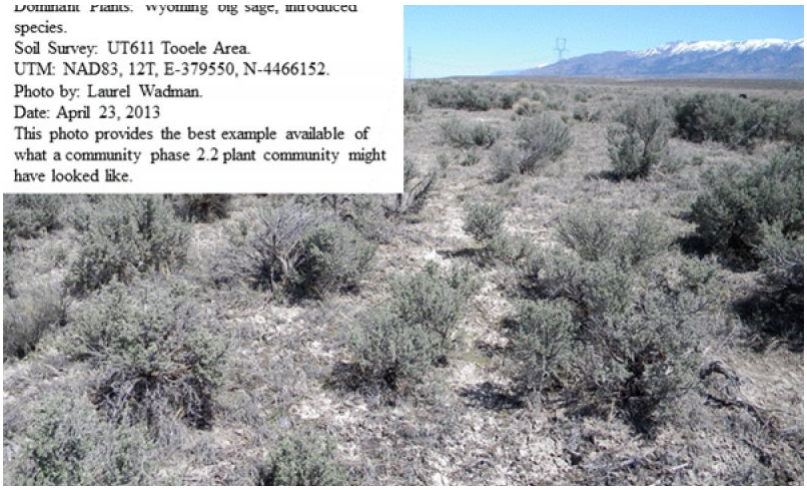


Figure 18. Community Phase 2.2

This current potential community phase is dominated by shrubs and invasive annual weeds. Wyoming big sagebrush, Nevada ephedra, horsebrush species and shadscale often dominate the shrub layer. Non-native species including cheatgrass, bulbous bluegrass, Russian thistle and various annual mustard species comprise most of the herbaceous understory. Bluebunch wheatgrass, Indian ricegrass and other native perennial grasses are much reduced or missing. This site may be nearing the end of its natural fire cycle. The sites vegetative composition by air-dry weight is approximately 50 percent perennial grasses, 10 percent forbs, and 50 percent shrubs. The following tables provide an example of the typical vegetative floristics of a community phase 2.2 plant community.

Table 14. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	230	325	420
Shrub/Vine	230	315	400
Forb	40	60	80
Total	**500**	**700**	**900**

Table 15. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-40%
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 16. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	–	–	–
>1 <= 2	–	–	35-45%	0-10%
>2 <= 4.5	–	15-25%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

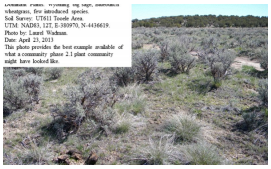
Figure 20. Plant community growth curve (percent production by month). UT2141, PNC. Excellent Condition.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	40	30	5	5	0	0	0	0

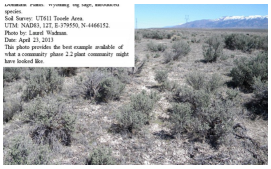
Community 2.3
Wyoming sagebrush/perennial bunch grasses & annual non-natives (at risk)

Wyoming big sagebrush increases and the perennial understory are reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from grazing management. Sandberg bluegrass will likely increase in the understory and may be the dominant grass on the site. Utah juniper may be present. Annual non-natives are present.

Pathway 2.1A
Community 2.1 to 2.2



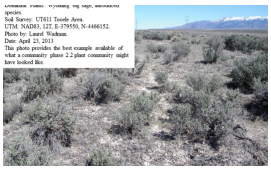
Wyoming Big Sage/Bluebunch Wheatgrass/Invasive Weed Community Phase.



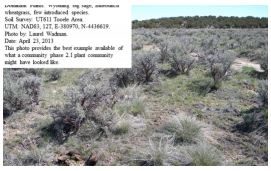
Wyoming Big Sage/Invasive Weed Community Phase.

This community pathway occurs when long-term drought and/or extended periods without fire allows canopies, mainly Wyoming big sagebrush to significantly increase. This closing canopy event causes understory vegetation to be reduced and eventually, nearly eliminated from the site. Drought alone can also reduce native perennial grass production and eventually eliminate some species from the system. Improper livestock grazing during these periods can facilitate this process.

Pathway 2.2a
Community 2.2 to 2.1



Wyoming Big Sage/Invasive Weed Community Phase.



Wyoming Big Sage/Bluebunch Wheatgrass/Invasive Weed Community Phase.

This community pathway occurs when weather patterns are within normal or above normal ranges and some level

of fire reduces the Wyoming big sagebrush canopy, significantly opening the site. This more open canopy allows understory vegetation to increase in production, and under some circumstances, flourish on the site. Proper livestock grazing during these periods can facilitate this process.

Pathway 2.3a
Community 2.3 to 2.2

Aroga moth infestation, release from growing season herbivory or drought or combinations of these allows for perennial bunchgrasses to increase.

State 3
Shrub State

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling, and soil organic matter are temporally and spatially redistributed. Restoration from this site is unlikely; brush treatments have been seen to fail and instead push the site to an annual state.

Community 3.1
Wyoming sagebrush/native herbaceous/non-native annuals

Wyoming big sagebrush dominates overstory and rabbitbrush may be a significant component. Perennial bunchgrasses are a minor component. Juniper may be present or increasing. Annual non-native species are present to increasing. Understory may be sparse, with bare ground increasing.

Community 3.2
Sprouting Shrubs/annual non-natives

Sprouting shrubs such as rabbitbrush or spiny hopsage may dominate aspect following fire for a number of years. Trace amounts of sagebrush may be present.

Pathway 3.1a
Community 3.1 to 3.2

Fire would decrease or eliminate the overstory of sagebrush. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the Sandberg bluegrass, forbs and sprouting shrubs.

State 4
Annual State

This state is characterized by a dominance of Utah juniper and/or singleleaf pinyon in the overstory. Wyoming big sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community 4.1
Annual non-native species

Annual non-native species such as cheatgrass, annual mustards and Russian thistle are common. With an unsuccessful range planting, non-native perennial grasses, such as crested wheatgrass may also be present.

Community 4.2

Native shrubs/annual non-native species

Figure 21. Community Phase 4.2, photo 1

Wyoming big sagebrush and/or spiny hopsage remain in the overstory with annual non-native species, likely cheatgrass, dominating the understory. Trace amounts of desirable bunchgrasses may be present.

Pathway 4.1a
Community 4.1 to 4.2

Time and lack of fire allows for shrubs to reestablish. Sprouting shrubs such as spiny hopsage and rabbitbrush will be the first to reappear after fire. Probability of sagebrush establishment is extremely low.

Pathway 4.2a
Community 4.2 to 4.1

Fire removes sagebrush and allows for annual non-native species to dominate the site.

State 5
Tree State

This state will only occur on the upper end of the precipitation zone, adjacent to the upland ecological zone. This state is characterized by a dominance of Utah juniper and/or singleleaf pinyon in the overstory. Wyoming big sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community 5.1
Utah juniper/native herbaceous/non-native herbaceous

Utah juniper and/or singleleaf pinyon trees dominate overstory, sagebrush is decadent and dying, deep rooted perennial bunchgrasses are decreasing. Recruitment of sagebrush cohorts is minimal. Annual non-natives may be present or increasing.

Community 5.2
Utah juniper/non-native herbaceous

Utah juniper dominates the site and tree leader growth is minimal; annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Bunchgrasses may or may not be present. Sandberg bluegrass or mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is evident.

Pathway 5.1a
Community 5.1 to 5.2

Absence of disturbance over time allows for tree cover and density to further increase and out-compete the herbaceous understory species for sunlight and water.

State 6
Seeded State

This state is characterized by the dominance of seeded introduced wheatgrass species. Forage kochia and other desired seeded species including Wyoming sagebrush and native and non-native forbs may be present.

Community 6.1
Non-native bunchgrasses/sagebrush/annual non-native species

Figure 22. Community Phase 6.1, photo 1

Seeded wheatgrass and/or other seeded species dominate the community. Non-native annual species are present. Trace amounts of Wyoming big sagebrush may be present, especially if seeded.

Community 6.2
Sagebrush/non-native bunchgrass/annual non-native species

Figure 23. Community Phase 6.2, photo 1

Wyoming big sagebrush increases and may become the dominant overstory. Seeded wheatgrass species dominate understory. Annual non-native species may be present in trace amounts.

Community 6.3
Sagebrush/annual non-natives/non-native bunchgrasses (at risk)

Sagebrush becomes the dominant plant. Perennial bunchgrasses in the understory are reduced due to increased competition. Annual non-native species may be increasing. Juniper and/or pinyon may be present.

Pathway 6.1a
Community 6.1 to 6.2

Non-native bunchgrasses/sagebrush/annual non-native species

Sagebrush/non-native bunchgrass/annual non-native species

Repeated growing season grazing opens site for shrub establishment.

Pathway 6.2b
Community 6.2 to 6.1

Sagebrush/non-native bunchgrass/annual non-native species

Non-native bunchgrasses/sagebrush/annual non-native species

Continued abusive grazing reduces bunchgrasses and increases density of sagebrush; usually a slow transition.

Pathway 6.2a
Community 6.2 to 6.3

Fire would reduce sagebrush and increase seeded deep-rooted perennial bunchgrasses.

Pathway 6.3a
Community 6.3 to 6.1

Fire would reduce sagebrush to trace amounts and allow for the perennial understory to increase.

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustard, poverty weed, and halogeton. Slow variables: Over time the annual non-native plants will increase within the community. Threshold: Any amount of introduced non-native species causes an immediate decrease in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

Transition T2a
State 2 to 3

Trigger: Inappropriate, long-term grazing of perennial bunchgrasses during growing season would favor shrubs and initiate transition to Community Phase 3.1. Fire would cause a transition to Community Phase 3.2. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes spatial and temporal nutrient cycling and nutrient redistribution, and reduces soil organic matter.

Transition T2b
State 2 to 4

Trigger: Fire or a failed seeding leads to plant community phase 4.1, inappropriate grazing management that favors

shrubs in the presence of non-native annual species leads to community phase 4.2. Slow variables: Increased production and cover of non-native annual species. Threshold: Cheatgrass or other non-native annuals dominate understory.

Transition T2c
State 2 to 5

Trigger: Time allows for trees to increase. Slow variables: Increased establishment and cover of Utah juniper. Threshold: Trees overtop Wyoming sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

Transition T3a
State 3 to 4

Trigger: Fire or abusive grazing can eliminate the Sandberg bluegrass understory and transition to community phase 4.1 or 4.2. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Transition T3b
State 3 to 5

Trigger: Lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management that reduces fine fuels. Slow variables: Increased establishment and cover of juniper trees. Threshold: Trees overtop Wyoming sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

Restoration pathway R3a
State 3 to 6

Brush management with minimal soil disturbance coupled with range seeding.

Transition A
State 4 to 4

Trigger: Catastrophic crown fire would reduce or eliminate trees to transition the site to 4.1. Tree removal when annual non-natives such as cheatgrass are present would also transition the site to state 4.0. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Restoration pathway R4a
State 4 to 6

Tree removal and seeding of herbaceous species, probability of success is low.

Conservation practices

Range Planting

Transition T5a
State 5 to 4

Trigger: Catastrophic crown fire would reduce or eliminate trees to transition the site to 4.1. Tree removal when annual non-natives such as cheatgrass are present would also transition the site to state 4.0. Slow variable:

Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Restoration pathway R5a
State 5 to 6

Tree removal and seeding of herbaceous species, probability of success is low.

Transition T6a
State 6 to 4

Trigger: Fire Slow variables: Increased production and cover of non-native annual species Threshold: Cheatgrass or other non-native annuals dominate understory

Transition T6b
State 6 to 5

Trigger: Lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management that reduces fine fuels. Slow variables: Increased establishment and cover of juniper trees Threshold: Trees overtop Wyoming sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

Additional community tables

Table 17. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Grasses**			225–325	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	150–225	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	120–180	–
4	**Secondary Grasses**			75–125	
	Grass, perennial	2GP	*Grass, perennial*	20–40	–
	purple threeawn	ARPU9	*Aristida purpurea*	20–40	–
	blue grama	BOGR2	*Bouteloua gracilis*	20–40	–
	squirreltail	ELEL5	*Elymus elymoides*	20–40	–
	needle and thread	HECO26	*Hesperostipa comata*	20–40	–
	basin wildrye	LECI4	*Leymus cinereus*	20–40	–
	western wheatgrass	PASM	*Pascopyrum smithii*	20–40	–
	James' galleta	PLJA	*Pleuraphis jamesii*	20–40	–
	muttongrass	POFE	*Poa fendleriana*	20–40	–
	Sandberg bluegrass	POSE	*Poa secunda*	20–40	–
Forb					
2	**Forbs**			75–100	
	Forb, annual	2FA	*Forb, annual*	10–20	–
	Forb, perennial	2FP	*Forb, perennial*	10–20	–
	tapertip onion	ALAC4	*Allium acuminatum*	10–20	–
	low pussytoes	ANDI2	*Antennaria dimorpha*	10–20	–
	Utah milkvetch	ASUT	*Astragalus utahensis*	10–20	–

	Utah milkvetch	ACUT	*Astragalus utahensis*	10–20	–
	northwestern Indian paintbrush	CAAN7	*Castilleja angustifolia*	10–20	–
	sego lily	CANU3	*Calochortus nuttallii*	10–20	–
	Douglas' dustymaiden	CHDO	*Chaenactis douglasii*	10–20	–
	maiden blue eyed Mary	COPA3	*Collinsia parviflora*	10–20	–
	bastard toadflax	COUM	*Comandra umbellata*	10–20	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	10–20	–
	roundspike cryptantha	CRHU2	*Cryptantha humilis*	10–20	–
	cushion buckwheat	EROV	*Eriogonum ovalifolium*	10–20	–
	shaggy fleabane	ERPU2	*Erigeron pumilus*	10–20	–
	pingue rubberweed	HYRI	*Hymenoxys richardsonii*	10–20	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	10–20	–
	pale evening primrose	OEPA	*Oenothera pallida*	10–20	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	10–20	–
	Tolmie's owl's-clover	ORTO	*Orthocarpus tolmiei*	10–20	–
	low beardtongue	PEHU	*Penstemon humilis*	10–20	–
	spiny phlox	PHHO	*Phlox hoodii*	10–20	–
	longleaf phlox	PHLO2	*Phlox longifolia*	10–20	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	10–20	–
	yellow salsify	TRDU	*Tragopogon dubius*	10–20	–
	salsify	TRPO	*Tragopogon porrifolius*	10–20	–
Shrub/Vine					
3	**Primary Shrubs**			175–275	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	135–210	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	20–40	–
	Nevada jointfir	EPNE	*Ephedra nevadensis*	20–40	–
5	**Secondary Shrubs**			25–75	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	20–40	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	20–40	–
	bud sagebrush	PIDE4	*Picrothamnus desertorum*	20–40	–
	spineless horsebrush	TECA2	*Tetradymia canescens*	10–20	–
	shortspine horsebrush	TESP2	*Tetradymia spinosa*	10–20	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	10–20	–
	slender buckwheat	ERMI4	*Eriogonum microthecum*	10–20	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	10–20	–
	spiny hopsage	GRSP	*Grayia spinosa*	10–20	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	10–20	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	10–20	–
	black sagebrush	ARNO4	*Artemisia nova*	10–20	–
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	10–20	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	10–20	–

Animal community

--Wildlife Interpretation--

This ecological site, in its reference state, produces significant amounts of nutritious forage that was utilized by native herbivores including Rocky Mountain elk, mule deer and pronghorn antelope who lived here along their associated predators. Although much of this site is presently different from the reference state, it is still very important as wildlife habitat. Other wildlife commonly observed using this site include mountain lions, rabbits, coyotes, badgers, and red fox's.

This site also provides habitat to raptors and other bird species including golden eagles, red-tailed hawks, ferruginous hawks, and several species of owls. Ringneck pheasant, sage grouse, chukars, and California quail are also commonly found.

--Grazing Interpretations--
This site provides good spring, fall, and winter grazing conditions for domestic livestock due to its accessibility and its supply of nutritious forage. The herbaceous plant community is primarily grasses, with the majority of canopy cover being attributed to bluebunch wheatgrass and Indian ricegrass. Improper livestock grazing can cause these species to decrease while annual forbs, Wyoming big sagebrush and rabbitbrush species to increase.

When this site is stressed, cheatgrass, alyssum, Russian thistle and halogeton are likely to invade.

Hydrological functions

The soils associated with this ecological site are generally in Hydrologic Soil Group B with hydrology curve numbers ranging from 61 to 74. On these sites runoff potential is moderately low and infiltration rates are moderate, depending on slope and ground cover/health (NRCS National Engineering Handbook). Hydrological groups are used in equations that estimate runoff from rainfall. These estimates are needed for solving hydrologic problems that arise in planning watershed-protection and flood-prevention projects and for designing structures for the use, control and disposal of water. In areas similar to the reference state where ground cover is adequate infiltration is increased and runoff potential is decreased. In areas where ground cover is less than 50%, infiltration is reduced and runoff potential is increased. Heavy use by domestic livestock affects hydrology in two ways. Trampling increases bulk density and breaks down soil aggregates. This results in decreased infiltration rates and increased runoff. Heavy grazing can also alter the hydrology by decreasing plant cover and increasing bare ground. Fire can also affect hydrology, but it affect is variable. Fire intensity, fuel type, soil, climate, and topography can each have different influences. Fires can increase areas of bare ground and hydrophobic layers that reduce infiltration and increase runoff.

Recreational uses

Recreation activities include aesthetic value and good opportunities for hiking, horseback riding, hunting, and off-road vehicle use. Due to the high erosion potential after a surface disturbance, care should be taken when planning recreational activities. Camp sites are usually limited due to lack of sheltering trees or rock outcrop.

Wood products

None

Other products

None.

Other information

--Poisonous and Toxic Plant Communities--
Toxic plants possibly associated with this site include woolly locoweed, broom snakeweed, and Russian thistle.

Woolly locoweed is toxic to all classes of livestock and wildlife. Locoweed is palatable and has similar nutrient value to alfalfa, which may cause animals to consume it even when other forage is available. Locoweed contains

swainsonine (indolizdine alkaloid) and is poisonous at all stages of growth. Poisoning will become evident after 2-3 weeks of continuous grazing and is associated with 4 major symptoms: 1) neurological damage, 2) emaciation, 3) reproductive failure and abortion, and 4) congestive heart failure linked with “high mountain disease”.

Broom snakeweed contains steroids, terpenoids, saponins, and flavones that can cause abortions or reproductive failure in sheep and cattle, however, cattle are most susceptible. These toxins are most abundant during active growth and leafing stage. Cattle and sheep generally will only graze broom snakeweed when other forage is unavailable, typically in winter when toxicity levels are at their lowest (Knight and Walter, 2001).

Russian thistle is an invasive toxic plant, causing nitrate and to a lesser extent oxalate poisoning, which affects all classes of livestock. The buildup of nitrates in these plants is highly dependent upon environmental factors such as after a rain storm, during a drought, during periods with cool/cloudy days, and when growing on soils high in nitrogen and low in sulfur and phosphorus. Nitrate collects in the stems and can persist throughout the growing season. Clinical signs of nitrate poisoning include drowsiness, weakness, muscular tremors, increased heart and respiratory rates, staggering gait, and death. Conversely, oxalate poisoning causes kidney failure; clinical signs include muscle tremors, tetany, weakness, and depression. Poisoning generally occurs when livestock consume and are not accustomed to grazing oxalate-containing plants. Animals with prior exposure to oxalates have increased numbers of oxalate-degrading rumen microflora, and thus, are able to degrade the toxin before clinical poisoning can occur.

--Invasive Plant Communities--
Generally, as ecological conditions deteriorate and perennial vegetation decreases due to disturbance (fire, drought, off road vehicle overuse, erosion, etc.) annual forbs and grasses may invade the site. Of particular concern in semi-arid environments are annual invaders including cheatgrass, Russian thistle, alyssum 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. Very few invaded site have been observed to date and so documentation is very limited.

--Fire Ecology--
The ability for an ecological site to carry fire depends primarily on its' present fuel load and plant moisture content. Sites with small fuel loads will burn more slowly and less intensely than sites with large fuel loads. Most research agrees that historic fire return intervals are at a minimum 100 years, indicating that fire may have not played an important role in short term community dynamics. Fires are more common when plants are stressed or dead due to drought. Fire tolerant shrubs will recover quickly following fire. Sagebrush will reestablish either by seeds dispersed from adjacent unburned patches or by unburned seeds found at the burn site. Continuous (every 20-40 years) burning of these ecological sites can result in herbaceous dominated communities, due to the relatively fast recovery of grasses and forbs when compared to shrubs. If invasive annual grasses are allowed to establish, fires may become more frequent, inhibiting the site’s ability to recover.

Type locality

Location 1: Box Elder County, UT	
Township/Range/Section	T11N R13W S34
General legal description	Maltlin Mountain Area, Box Elder County NW ¼ SE ¼, Section 34, Township 11N, Range 13W.
Location 2: Iron County, UT	
Township/Range/Section	T33S R10W S12
General legal description	Four Miles North of Parawan Gap NW ¼ SW ¼, Section 12, Township 33S, Range 10W. Iron County Utah, Clear Lake, Millard Co.

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Acknowledgments

Tamzen Stringham and Patti Novak-Echenique for providing the STM.

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.

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Contact for lead author	Shane Green, Shane.Green@ut.usda.gov
Date	02/08/2010
Approved by	Shane A. Green
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None to Rare. Very minor rill development may occur in sparsely vegetated areas. If rills are present, they should be widely spaced and not connected. Rill development may increase following large storm events, but should begin to heal during the following growing season. Frost heaving will accelerate recovery. Rill development may increase when run inflow enters site from adjacent sites that produce large amounts of runoff (i.e. steeper sites, slickrock, rock outcrop). Site is essentially level and rills do not normally form.

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2. **Presence of water flow patterns:** Some very minor evidence of water flow patterns may be found around perennial plant bases. They show little evidence of current erosion. They are expected to be short (3-6 feet), stable, sinuous and not connected. There may be very minor evidence of deposition. Evidence of water flow may increase somewhat with slope.

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3. **Number and height of erosional pedestals or terracettes:** Plants may have small pedestals (1”) where they are adjacent to water flow patterns, but without exposed roots. Terracettes should be few and stable. Terracettes should be small (3-6”) and show little sign of active erosion. Some plants may appear to have a pedestal but rather than be formed by erosion, the only place litter accumulates and soil collects is at plant bases forming the appearance of a pedestal.

   Well-developed biological crusts may appear pedestalled, but are actually a characteristic of the crust formation. Some plants may appear to have a pedestal but rather than be formed by erosion, the only place litter accumulates and soil collects is at plant bases forming the appearance of a pedestal.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 25-30% bare ground (soil with no protection from raindrop impact). Herbaceous communities are most likely to have lower values. As species composition by shrubs increases, bare ground is likely to increase. Poorly developed biological soil crust that is susceptible to raindrop splash erosion should be recorded as bare ground. Very few if any bare spaces of greater than 1 square foot.

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5. **Number of gullies and erosion associated with gullies:** No gullies present on site. A very few gullies may be present in landscape settings where they transport runoff from areas of greater water flow such as exposed bedrock. These gullies will be limited to slopes exceeding 10% and adjacent to sites where this runoff accumulation occurs. Any gullies present should show little sign of accelerated erosion and should be stabilized with perennial vegetation.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Very minor evidence of active wind-generated soil movement. Wind scoured (blowouts) and depositional areas are rarely present. If present they have muted features and are mostly stabilized with vegetation and/or biological crust. Gravel or desert pavement protects the site from wind scour.

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7. **Amount of litter movement (describe size and distance expected to travel):** Most litter resides in place with some redistribution caused by water and wind movement. Very minor litter removal may occur in flow patterns and rills with deposition occurring at points of obstruction. The majority of litter accumulates at the base of plants. Some leaves, stems, and small twigs may accumulate in soil depressions adjacent to plants. Woody stems are not likely to move.

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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 rating of 5 or 6 under plant canopies and a rating of 4 to 5 in the interspaces with an average rating of 5 using the soil stability kit test.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** This description is based on the modal soil (Lembos L., soil survey area: 601, West Box Elder). This site has 14 correlated soils, resulting in variation of each of these attributes. Unless working on a location with the modal soil, it is critical to supplement this description with the soil-specific information from the published soil survey.

   Soil surface horizon is typically 4 inches deep. Structure is typically weak thin platy. Color is typically pale brown (10YR 6/3), brown (10YR 4/3) moist. An ochric horizon extends to a depth of 9 inches. An ochric horizon typically extends to a depth of 2 to 10 inches. The ochric horizon is a surface horizon lacking fine stratification and which is either light colored, or thin, or has an low organic carbon content, or is massive and (very) hard when dry. 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.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Bunchgrasses and shrubs are equally important for increasing infiltration and reducing runoff. Litter plays a role in increasing infiltration and decreasing runoff. Plants provide microhabitat for seedlings, catch litter and soil, and slow raindrops and runoff. Vascular plants and/or well-developed biological soil crusts (where present) will break raindrop impact and splash erosion. Spatial distribution of vascular plants and interspaces between well-developed biological soil crusts (where present) provide detention storage and surface roughness that slows runoff allowing time for infiltration. Interspaces between plants and any well-developed biological soil crusts (where present) may serve as water flow patterns during episodic runoff events, with natural erosion expected in severe storms. When perennial grasses decrease, reducing ground cover and increasing bare ground, runoff is expected to increase and any associated infiltration reduced. Shrubs catch snow, slow wind evaporation, and provide microhabitat for seedling establishment.

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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. Naturally occurring soil horizons may be harder than the surface because of an accumulation of clay or calcium carbonate and should not be considered as compaction layers. A duripan (indurated layer of illuvial silica and lime) may be present at 20 to 40”.

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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: Non-sprouting Shrub (Wyoming big sagebrush) > Perennial Bunchgrasses (bluebunch wheatgrass, Indian ricegrass), >> Sprouting Shrubs (winterfat, green rabbitbrush).

Sub-dominant: Rhizomatous Grasses (western wheatgrass, James galleta) > Perennial Forbs (Scarlet globemallow).

Other: A wide variety of other perennial grasses and both perennial and annual forbs are expected to occur on this site.

Additional: In the northern portion of the MLRA cool-season perennial grasses (bluebunch wheatgrass, Indian ricegrass, needle-and-thread) dominate. In the southernmost portion of the MLRA warm-season perennial grasses (galleta, sand dropseed) dominate. The two groups share dominance in the middle portion of the MLRA.

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. crested wheatgrass and Russian wildrye may substitute for mid stature cool season perennial native bunchgrasses.). Biological soil crust is variable in its expression on this site and is measured as a component of ground cover. 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. Some mortality of bunchgrass and other shrubs may occur during very severe (long-term) droughts. There may be partial mortality of individual bunchgrasses and shrubs during less severe drought. Long-lived species dominate site. Open spaces from disturbance are quickly filled by new plants through seedlings and reproductive reproduction (tillering).

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14. **Average percent litter cover (%) and depth (in):** Litter cover includes litter under plants. Most litter will be fine litter. Depth should be 1-2 leaf thickness in the interspaces and up to 1/2” under canopies. Litter cover may increase to 20-30% following years with favorable growing conditions. Excess litter may accumulate in absence of disturbance. Vegetative production may be reduced if litter cover exceeds 40%.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Annual production in air-dry herbage should be approximately 700#/acre on an average year but could range from 500 - 900#/acre during periods of prolonged drought or above average precipitation. Even the most stable communities exhibit a range of production values. Production will vary between communities and across the MRLA. Refer to the community descriptions in the ESD. Production will differ across the MLRA due to the naturally occurring variability in weather, soils, and aspect. The biological processes on this site are complex; therefore, representative values are presented in a land management context.

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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, Russian thistle, alyssum, various mustard species and annual forbs. Utah juniper may invade this site if a seed source is available.

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17. **Perennial plant reproductive capability:** All perennial plants should have the ability to reproduce sexually or asexually, except in drought years. Density of plants indicates that plants reproduce at level sufficient to fill available resource. Within capability of site there are no restrictions on seed or vegetative reproductive capacity. Some seedling recruitment should be observed during years with average or above average precipitation.