USDA Natural Resources Conservation Service

Ecological site R048AY308UT
Upland Loam (Bonneville Big Sagebrush)

Last updated: 3/05/2024
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.

MLRA notes

Major Land Resource Area (MLRA): 048A–Southern Rocky Mountains

MLRA 48A makes up about 45,920 square miles (119,000 square kilometers) and is the southern part of the Rocky Mountains. The Southern Rocky Mountains lies east of the Colorado Plateau, south of the Wyoming Basin, west of the Great Plains, and north of the Rio Grande Rift. It is in western and central Colorado, southeastern Wyoming, eastern Utah, and northern New Mexico. The headwaters of major rivers such as the Colorado, Yampa, Arkansas, Rio Grande, North Platte and South Plate rivers are located here. This MLRA has numerous national forests, including the Medicine Bow National Forest in Wyoming; the Routt, Arapaho, Roosevelt, Pike, San Isabel, White River, Gunnison, Grand Mesa, Uncompahgre, Rio Grande, and San Juan National Forests in Colorado; the Carson National Forest and part of the Santa Fe National Forest in New Mexico. Rocky Mountain National Park also is in this MLRA.

MLRA 48A is the southern Rocky Mountains physiographic region. The Southern Rocky Mountains consist primarily of two belts of strongly sloping to precipitous mountain ranges trending north to south. Several basins, or parks, are between the belts. Some high mesas and plateaus are included. It is characterized by mountain ranges that were uplifted during the Laramide Orogeny and then had periods of glaciation. The ranges include the Sangre de Cristo Mountains, the Laramie Mountains, and the Front Range in the east and the San Juan Mountains and the Sawatch and Park Ranges in the west. The ranges are dissected by many narrow stream valleys having steep gradients. In some areas the upper mountain slopes and broad crests are covered by snowfields and glaciers. Elevation typically ranges from 6,500 to 14,400 feet (1,980 to 4,390 meters) in this area. The part of this MLRA in central Colorado includes the highest point in the Rockies, Mount Elbert, which reaches an elevation of 14,433 feet (4,400 meters). More than 50 peaks in the part of the MLRA in Colorado are at an elevation of more than 14,000 feet (4,270 meters). Many small glacial lakes are in the high mountains.

The mountains in this area were formed mainly by crustal uplifts during the late Cretaceous and early Tertiary periods. This large MLRA can be subdivided into at least 4 large general divisions. First is the Rockies on the east side of this area are called the “Front Range,” which is a fault block that has been tilted up on edge and uplifted and is largely igneous and metamorphic geology. It was tilted up on the east edge, so there is a steep front on the east and the west side is more gently sloping and in the south east there are rocks exposed in the mountains are mostly Precambrian igneous and metamorphic rocks. Second is the tertiary rocks, primarily basalt and andesitic lava flows, tuffs, breccias, and conglomerates, are throughout this area (San Juan Mountains Area). The third division is Northwest part of the MLRA is dominantly sedimentary rock from the cretaceous/tertiary and Permian/ Pennsylvanian periods. The fourth subset is the long and narrow Sangre de Cristos mountains uplifted in the Cenozoic are between the Rio Grande rift and the great plains. Many of the highest mountain ranges were reshaped by glaciation during the Pleistocene. Alluvial fans at the base of the mountains are recharge zones for local basin and valley fill aquifers. They also are important sources of sand and gravel.

The average annual precipitation ranges predominantly from 12 to 63 inches. Summer rainfall commonly occurs as high-intensity, convective thunderstorms. About half of the annual precipitation occurs as snow in winter; this proportion increases with elevation. In the mountains, deep snowpacks accumulate throughout the winter and

generally persist into spring or early summer, depending on elevation. Some permanent snowfields and small glaciers are on the highest mountain peaks. In the valleys at the lower elevations, snowfall is lighter and snowpacks can be intermittent. The average annual temperature is 26 to 54 degrees F (-3 to 12 degrees C). The freeze-free period averages 135 days and ranges from 45 to 230 days, decreasing in length with elevation. The climate of this area is strongly dependent upon elevation; precipitation is greater, and temperatures are cooler at the higher elevations. The plant communities vary with elevation, aspect and change in latitudes due to changing in precipitation kind and timing and temperature.

The dominant soil orders in this MLRA are Mollisols, Alfisols, Inceptisols, and Entisols. The soils in the area dominantly have a frigid or cryic soil temperature regime and an ustic or udic soil moisture regime. Mineralogy is typically mixed, smectitic, or paramicaceous. In areas with granite, gneiss, and schist bedrock, Glossocryalfs (Seitz, Granile, and Leadville series) and Haplocryolls (Rogert series) formed in colluvium on mountain slopes. Dystrocryepts (Leighcan and Mummy series) formed on mountain slopes and summits at the higher elevations. In areas of andesite and rhyolite bedrock, Dystrocryepts (Endlich and Whitecross series) formed in colluvium on mountain slopes. In areas of sedimentary bedrock, Haplustolls (Towave series) formed on mountain slopes at low elevations and with low precipitation. Haplocryolls (Lamphier and Razorba series), Argicryolls (Cochetopa series), and Haplocryalfs (Needleton series) formed in colluvium on mountain slopes at high elevations.

Ecological site concept

The soils of this site formed mostly in slope alluvium derived from sedimentary rock over residuum weathered from sandstone and shale. Surface soils are fine gravelly silty clay loam to gravelly loam in texture. Rock fragments may be present on the soil surface and throughout the profile, but generally make up less than 35 percent of the soil volume. These soils are moderately deep to deep, well-drained, and have moderately slow to moderate permeability. pH is slightly to moderately alkaline. Available water-holding capacity ranges from 3 to 6 inches of water in the upper 60 inches of soil. The soil moisture regime is mostly aridic bordering on ustic and the soil temperature regime is frigid. Precipitation ranges from 12-16 inches annually.

Associated sites

F048AY330UT	**Upland Shallow Stony Loam (Two-Needle Pinyon /Douglas Fir)** Often occurs adjacent to this site.

Similar sites

R048AY306UT	**Upland Loam (Wyoming Big Sagebrush)** Similar plant community but this site has a higher aspect of Wyoming big sagebrush.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. ×bonnevillensis*
Herbaceous	(1) *Pseudoroegneria spicata*

Physiographic features

This site occurs at elevations between 6,400 and 8,800 feet. It is found on ridges and mountain slopes with slopes ranging from 5-40 percent. Flooding and ponding do not occur on this site.

Table 2. Representative physiographic features

Landforms	(1) Escarpment (2) Hill
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None

Elevation	1,951–2,682 m
Slope	5–40%
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 12 to 16 inches. July, August, and October are typically the wettest months with June 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 soil moisture regime is mostly ustic and the soil temperature regime is frigid.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-110 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	305-406 mm

Influencing water features

Due to its landscape position, this site is not influenced by streams or wetlands.

Soil features

The soils of this site formed mostly in slope alluvium derived from sedimentary rock over residuum weathered from sandstone and shale. Surface soils are fine gravelly silty clay loam to gravelly loam in texture. Rock fragments may be present on the soil surface and throughout the profile, but generally make up less than 35 percent of the soil volume. These soils are moderately deep to deep, well-drained, and have moderately slow to moderate permeability. pH is slightly to moderately alkaline. Available water-holding capacity ranges from 3 to 6 inches of water in the upper 60 inches of soil. The soil moisture regime is mostly aridic bordering on ustic and the soil temperature regime is frigid. Precipitation ranges from 12-16 inches annually.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–sedimentary rock (2) Residuum–sandstone and shale
Surface texture	(1) Gravelly silty clay loam (2) Gravelly loam
Family particle size	(1) Fine-loamy
Drainage class	Well drained
Permeability class	Moderately slow to moderate
Depth to restrictive layer	51–152 cm
Soil depth	51–152 cm
Surface fragment cover <=3"	2–25%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	7.62–15.24 cm
Calcium carbonate equivalent (Depth not specified)	0–12%

Electrical conductivity (Depth not specified)	0–3 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0–5
Soil reaction (1:1 water) (Depth not specified)	7.6–9
Subsurface fragment volume <=3" (Depth not specified)	3–32%
Subsurface fragment volume >3" (Depth not specified)	0–8%

Ecological dynamics

Ecological dynamics
As ecological condition deteriorates due to overgrazing, grasses and bitterbrush decrease, while mountain big sagebrush and rubber rabbitbrush increase.

When the potential natural plant community is burned mountain big sagebrush decreases while arrowleaf balsamroot and rabbitbrush increase.

Utah juniper, pinyon pine, cheatgrass and Russian thistle are most likely to invade this site.
State 1
Reference State
This state includes the plant communities that were best adapted to the unique combination of factors associated with the ecological site. It was in a natural dynamic equilibrium with the historic biotic, abiotic, climatic factors on its ecological site in North America at the time of European immigration and settlement. This dominant aspect of the plant community is Bonneville big sagebrush and Bluebunch wheatgrass. The community is made up of 60 % Grass 25 % forbs and 15 % shrubs on a dry weight base.

Community 1.1
Bonneville big sagebrush Perenial cool season grasses Forbs Other native shrubs
The dominant aspect of this plant community is Bonneville big sagebrush and bluebunch wheatgrass. The composition by air-dry weight is approximately 60 percent perennial grasses, 25 percent forbs, and 15 percent shrubs.

Community 1.2
Bonneville Big sagebrush Other native shrubs Perennial cool season grasses = Forbs
Bonneville big sagebrush, other native shrubs, Perennial cool season grasses, and Forbs. This Community shows up when there is a period of time when the Bonneville big sagebrush increases to where it is suppressing the understory and other shrubs (notably) Mountain snowberry, Utah serviceberry and Antelope bitterbrush increase. This causes the grasses and forbs to be suppressed. The community will be represented by 40 % grasses, 25 % Forbs and 35 % shrubs. This community will have around 10 – 20 % bare ground.

Community 1.3
Perennial cool season grasses Forbs Fire tolerant shrubs
Perennial Cool Season Grasses, Forbs and Fire tolerant Shrubs: This community usually occurs when there is a hot erratically moving fire that heats the ground to the point where it damages the antelope bitterbrush, Snowberry and Utah serviceberry to the point where they cannot gain dominance in the community. The plant community is represented with 70 % grasses, 20 % Forbs and 10 % Shrubs. The initial plant list works well in this situation as well. This community will likely have around 15 to 20 % bare ground.

Pathway 1.1a
Community 1.1 to 1.2
Time without catastrophic event. This was probably dependent on a specific chain of climatic events.

Pathway 1.1b

Community 1.1 to 1.3
Fire: Normally mid-summer, insects, prolonged drought and pathogens that kill and/or reduces the dominant shrub overstory. Fire is the most effective of these disturbances.

Pathway 1.2a
Community 1.2 to 1.3
Fire: Normally mid-summer. A fire that is hot enough and fast moving enough to kill sagebrush and stimulate the perennial cool season grasses, insects, prolonged drought and pathogens that kill and/or reduces the dominant shrub overstory. Fire is the most effective of these disturbances.

Pathway 1.3a
Community 1.3 to 1.1
Time without catastrophic event. This was probably dependent on a specific chain of climatic events.

State 2
Current Potential State
This state includes the biotic communities that would become established on the ecological site if all successional sequences were completed without interferences by man under the present environmental conditions. Natural disturbances are inherent in its development. The CPS state will include acclimatized, naturalized or invasive nonnative species. There is no known way to effectively or efficiently remove these plants completely from the site once they have become established. The level of occurrence of these plants in the CPS can be controlled with carful management. Plant communities within the CPS state may be managed and used for various purposes by man without significant alteration in plant community composition or production. It includes all of the plant communities that exist in the RPC state with the inclusion of nonnative species. Additional plant communities with significant portions of invasive annuals may also be possible within this state.

Community 2.1
Bonneville sagebrush perennial cool season grass forb other native shrub non-native species
Bonneville big sagebrush, Perennial Cool Season Grasses, Forbs other Shrubs and non-native species: This is the Community that is described in the initial Plant List. This community is represented with 60 % Grasses; 25 % Forbs and 15 % Shrubs. The dominant shrub visually and in production is Bonneville big sagebrush. The dominant grass is Bluebunch wheatgrass and the dominant Forb is Arrowleaf balsamroot. This community is strong enough to have around 8 – 12 % bare ground.

Community 2.2
Bonneville sagebrush other native shrub perennial cool season grass = forb non-native species
Bonneville big sagebrush, other native shrubs, Perennial cool season grasses, Forbs and non-native species. This Community shows up when there is a period of time when the Bonneville big sagebrush increases to where it is suppressing the understory and other shrubs (notably) Mountain snowberry, Utah serviceberry and Antelope bitterbrush increase. This causes the grasses and forbs to be suppressed. The community will be represented by 40 % grasses, 25 % Forbs and 35 % shrubs. This community will have around 10 – 20 % bare ground.

Community 2.3
Perennial cool season grass forbs fire tolerant shrubs non-native species
Perennial Cool Season Grasses, Forbs, Fire tolerant Shrubs and non-native species: This community usually occurs when there is a hot erratically moving fire that heats the ground to the point where it damages the antelope bitterbrush, Snowberry and Utah serviceberry to the point where they cannot gain dominance in the community. The plant community is represented with 70 % grasses, 20 % Forbs and 10 % Shrubs. The initial plant list works well in this situation as well. This community will likely have around 15 to 20 % bare ground.

Pathway 2.1a
Community 2.1 to 2.2
Time without catastrophic event. This was probably dependent on a specific chain of climatic events.

Pathway 2.1b
Community 2.1 to 2.3
Fire: Normally mid-summer, insects, prolonged drought and pathogens that kill and/or reduces the dominant shrub overstory. Fire is the most effective of these disturbances.

Pathway 2.2a
Community 2.2 to 2.3
Fire: Normally mid-summer. A fire that is hot enough and fast moving enough to kill sagebrush and stimulate the perennial cool season grasses, insects, prolonged drought and pathogens that kill and/or reduces the dominant shrub overstory. Fire is the most effective of these disturbances.

Pathway 2.3a
Community 2.3 to 2.1
Time without catastrophic event. This was probably dependent on a specific chain of climatic events.

State 3
Utah Juniper / Invasive Annuals State
3 - Utah Juniper/Invasion State
This State has only two described Plant Communities but many variations of the represented ones are present. This is the State that this plant community will move to when there is a lack of fire (over exuberant fire control) and there is a source of Utah Juniper and/or Pinyon seed. Movement from community faze to community faze can and often is accelerated by overgrazing. The dominant aspect of the plant community is Utah juniper and Sandberg bluegrass if it moves from State (1) but the main grass will be Cheatgrass brome if it moves from state (2). With the coming of Cheatgrass brome this plant will always become the main grass on the site at this point in time. This state can persist for a long time until extreme conditions needed for a wildfire occur or some other management treatment is implemented.

Community 3.1
Utah juniper bonneville big sagebrush native perennials invasive annuals state
This community has a strong overstory of Utah Juniper and at times Pinyon but can still have an understory similar to community 2.1. This community will often have around 20 to 35 5 bare ground. Fire is the surest means to bring this community from this state to the Current Potential State. Chaining can also be used if done properly and with a lot of caution.

Community 3.2
Utah Juniper Invasive Annuals State
This community is present when 99 - 100% of the native plant community has been removed and only the Utah Juniper and/or Pinyon are left with only a sparse understory of invasive annuals are left on the site. This community will have around 35 to 50 % bare ground.

Pathway 3.1a
Community 3.1 to 3.2
Overgrazing with or without drought over a prolonged period of time.

Pathway 3.2a
Community 3.2 to 3.1
Fire, insects, prolonged drought and pathogens that kill and/or reduces the dominant shrub overstory. Fire is the most effective of these disturbances.

State 4
Yellow rabbitbrush / Invasive Annuals
This is the State that this Plant Community will move to when it is in an overgrazed and/or drought condition and not rested to allow recovery and/or burned (wild or controlled) without being seeded. The dominant aspect of the plant community is Cheatgrass brome, Yellow rabbitbrush, with a small amount of Bonneville big sagebrush.

Community 4.1
yellow rabbitbrush invasive annuals = native perennials
Yellow rabbitbrush, Invasive Annuals, native Perennials: This plant community consists of approximately 40 % Yellow rabbitbrush, 45 % Invasive Annuals and 10 % Native Perennials with 5 % Native Annuals. This community will have around 20 – 35 % bare ground.

Community 4.2

Invasive annuals
Invasive Annuals: This plant community consists of approximately 85 % invasive annuals (mostly Cheatgrass brome and Japanese (Field) brome), and 12 % Native perennials with 3 % Native annuals. The community will have around 20 – 40 % bare ground.

Pathway 4.1a
Community 4.1 to 4.2
Increased fire frequency (from 10 to 15 years to 3 to 5 years) and intensity without follow-up management. Overgrazing can move this change along faster. In state (5) the Yellow rabbitbrush/Invasive annuals State in box 5.5 the fire frequency will remain at the 3 to 5 year interval. This condition is somewhat self sustaining and the site will keep deteriorating until the site potential is lost. This will continue unless a large amount of energy is injected into the system to cause changes to take place.

Pathway 4.2a
Community 4.2 to 4.1
Time and management of grazing alone or along with other disturbances where human and/or naturalized introduction of native and/or introduced perennial plant species takes place.

State 5
Seeded Range State
This State exists when the site is cultivated and/or burned and planted to Introduced perennial plants and/or in some situations a mix of Native grasses and forbs with at times some Introduced plant species.

Community 5.1
Introduced perennial plants
The plant community here consists of Introduced and in some situations Native grasses, Forbs and sometimes native and/or introduced half-shrubs and/or shrubs. This State is often as productive as it is in the Current Potential State.

Community 5.2
Native shrubs = Introduced perennial plants
This Faze exists when weather conditions and often management create the kind of situation where the right kind of episodic weather situation allows Bonneville big sagebrush and other Native plants to reestablish in the site.

Pathway 5.1a
Community 5.1 to 5.2
Time without catastrophic event. This was probably dependent on a specific chain of climatic events. Also heavy prolonged cattle grazing can cause this to happen.

Pathway 5.2a
Community 5.2 to 5.1
Time and management of grazing alone or along with other disturbances where human intervention takes place to move the community back.

Transition T1a
State 1 to 2
Introduction of non-native species into the ecosystem.

Transition T2a
State 2 to 3
Prolonged drought, overgrazing, extreme lengthening of the fire interval frequency. This takes place when the sagebrush canopy gets so heavy that it destroys the perennial grass and forb understory and the fire frequency is increased from 20 to 40 years to 60 to 90 years and there is an introduction of Utah Juniper.

Transition T2b
State 2 to 4
Prolonged drought and/or prolonged overgrazing. Most often it is a combination of the two conditions that bring this condition into existence. Continued overgrazing and increase of the fire frequency over a very prolonged period of

time i.e. 3 to 5 year fire frequency interval.

Transition T3b
State 3 to 4
- Continued overgrazing and increase of fire frequency over a very prolonged period of time i.e. 3 to 5 year fire frequency interval.

Transition T3a
State 3 to 5
Human caused disturbance i.e. mechanical treatment and seeding; chemical treatment and seeding etc.

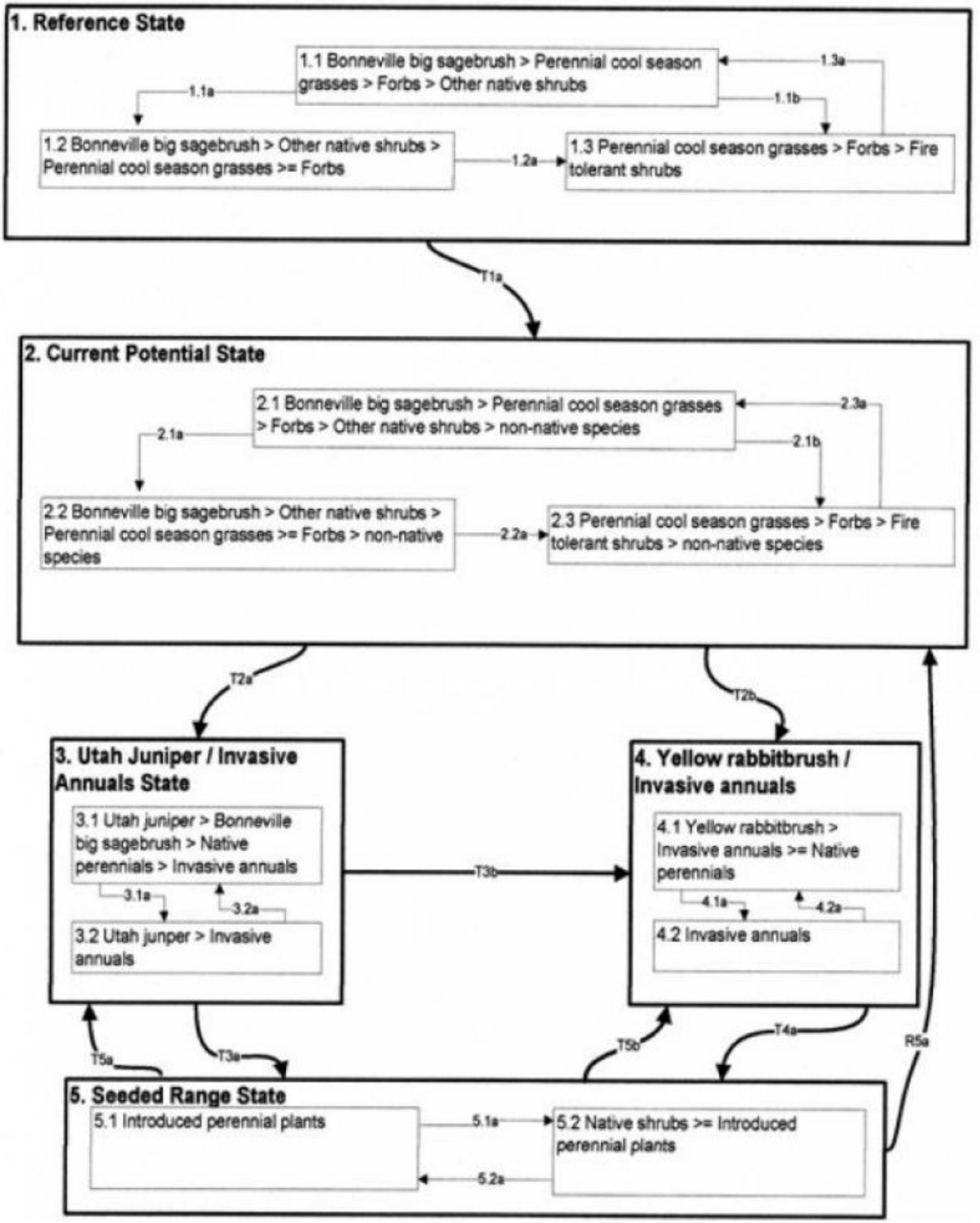
Transition T4a
State 4 to 5
Human caused disturbance i.e. mechanical treatment and seeding; chemical treatment and seeding etc.

Restoration pathway R5a
State 5 to 2
Time with proper management that favors the Native Plants as they move back onto the site.

Transition T5a
State 5 to 3
Prolonged drought, overgrazing, extreme lengthening of the fire interval frequency. This takes place when the sagebrush canopy gets so heavy that it destroys the perennial grass and forb understory and the fire frequency is increased from 20 to 40 years to 60 to 90 years and there is an introduction of Utah Juniper.

Transition T5b
State 5 to 4
Continued overgrazing and increase of fire frequency over a very prolonged period of time i.e. 8 to 12 year fire frequency interval.

State and transition model



Legend:

Pathway 1.1a – time without disturbance

Pathway 1.1b – fire

Pathway 1.1b – fire

Pathway 1.2a – fire

Pathway 1.3a – time without disturbance

Pathway 2.1a – time without disturbance

Pathway 2.1b – fire

Pathway 2.2a – fire

Pathway 2.3a – time without disturbance

Pathway 3.1a – overgrazing

Pathway 3.2a – fire

Pathway 4.1a – reoccurring fire

Pathway 4.2a – time and management

Pathway 5.1a – time without disturbance

Pathway 5.2a – time and management

Transition T1a – introduction of non-native species

Transition T2a – drought, overgrazing time without fire

Transition T2b – drought, overgrazing increased fire return interval

Transition T3a – brush management/seeding

Transition T3b – overgrazing, increased fire return interval

Transition T4a - brush management/seeding

Restoration pathway R5a – time and proper management

Transition T5a – drought, overgrazing, time without fire

Transition T5b - overgrazing, increased fire return interval

Inventory data references

Data to support ecological site gathered from historic surveys by USDA range professionals.

Other references

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Contributors

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Approval

Kirt Walstad, 3/05/2024

Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/18/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

decadence):

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

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

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

17. **Perennial plant reproductive capability:**