USDA Natural Resources
Conservation Service

Ecological site R047XB539UT
High Mountain Stony Loam (mixed conifer)

Last updated: 2/11/2025
Accessed: 05/10/2025

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): 047X–Wasatch and Uinta Mountains

MLRA 47 occurs in Utah (86 percent), Wyoming (8 percent), Colorado (4 percent), and Idaho (2 percent). It encompasses approximately 23,825 square miles (61,740 square kilometers). The northern half of this area is in the Middle Rocky Mountains Province of the Rocky Mountain System. The southern half is in the High Plateaus of the Utah Section of the Colorado Plateaus Province of the Intermontane Plateaus. Parts of the western edge of this MLRA are in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. The MLRA includes the Wasatch Mountains, which trend north and south, and the Uinta Mountains, which trend east and west. The steeply sloping, precipitous Wasatch Mountains have narrow crests and deep valleys. Active faulting and erosion are a dominant force in controlling the geomorphology of the area. The Uinta Mountains have a broad, gently arching, elongated shape. Structurally, they consist of a broadly folded anticline that has an erosion-resistant quartzite core. The Wasatch and Uinta Mountains have an elevation of 4,900 to about 13,500 feet (1,495 to 4,115 meters).

The mountains in this area are primarily fault blocks that have been tilted up. Alluvial fans at the base of the mountains are recharge zones for the basin fill aquifers. An ancient shoreline of historic Bonneville Lake is evident on the footslopes along the western edge of the area. Rocks exposed in the mountains are mostly Mesozoic and Paleozoic sediments, but Precambrian rocks are exposed in the Uinta Mountains. The Uinta Mountains are one of the few ranges in the United States that are oriented west to east. The southern Wasatch Mountains consist of Tertiary volcanic rocks occurring as extrusive lava and intrusive crystalline rocks.

The average precipitation is from 8 to 16 inches (203 to 406 mm) in the valleys and can range up to 73 inches (1854 mm) in the mountains. In the northern and western portions of the MLRA, peak precipitation occurs in the winter months. The southern and eastern portions have a greater incidence of high-intensity summer thunderstorms; hence, a significant amount of precipitation occurs during the summer months. The average annual temperature is 30 to 50 degrees F (-1 to 15 C). The freeze-free period averages 140 days and ranges from 60 to 220 days, generally decreasing in length with elevation.

The dominant soil orders in this MLRA are Aridisols, Entisols, Inceptisols, and Mollisols. The lower elevations are dominated by a frigid temperature regime, while the higher elevations experience cryic temperature regimes. Mesic temperature regimes come in on the lower elevations and south facing slopes in the southern portion of this MLRA. The soil moisture regime is typically xeric in the northern part of the MLRA, but grades to ustic in the extreme eastern and southern parts. The mineralogy is generally mixed and the soils are very shallow to very deep, generally well drained, and loamy or loamy-skeletal.

LRU notes

E47B is the Wasatch Mountains South MLRA. It occurs in the Loa, Panguitch, New Harmony area. Most of Zion, Bryce Canyon National Parks and Cedar Breaks National Monument are in this area. This area is composed of mountain ranges that run north and south.

Ecological site concept

The soils of this site formed mostly in colluvium and residuum derived from limestone and shale. Surface soils are very gravelly loam to gravelly loam in texture. Rock fragments may be present on the soil surface and throughout the profile, generally making up more than 35 percent of the soil volume. These soils are moderately deep but can be shallow, well-drained, and have moderate permeability. pH is slightly to moderately alkaline. Available water-holding capacity ranges from 2.0 to 4.0 inches of water in the upper 40 inches of soil. The soil moisture regime is mostly ustic and the soil temperature regime is cryic. Precipitation ranges from 22 to 35 inches annually.

Associated sites

R047XB508UT	**High Mountain Loam (aspen)** Sites can occur adjacent to each other.

Similar sites

R047XB519UT	**High Mountain Loam (mixed conifer)** Sites have similar floral characteristics, however this soil has less rock fragment in the soil profile.

Table 1. Dominant plant species

Tree	(1) *Abies lasiocarpa var. lasiocarpa* (2) *Picea engelmannii*
Shrub	(1) *Arctostaphylos uva-ursi* (2) *Juniperus communis*
Herbaceous	(1) *Achnatherum nelsonii* (2) *Arnica cordifolia*

Physiographic features

This ecological site typically occurs on mountain slopes and mesas. Slopes normally range from 25 to 60 percent but may occasionally be steeper. Slope steepness, aspect and elevation will influence the vegetative floristics of this site. Sites are typically located between 8,200 to 9,200 feet in elevation. Runoff is medium to very high.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Mesa
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	8,200–9,200 ft
Slope	25–60%
Aspect	Aspect is not a significant factor

Climatic features

The climate is characterized by cold, snowy winters and cool, moist summers. Approximately 50 percent of the moisture comes during the plant growth period from April 1 through September 30. On the average April, May, and June are the driest months and July, August, and September are the wettest months. Average annual precipitation is 22 to 35 inches.

Table 3. Representative climatic features

Frost-free period (characteristic range)	55-75 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	22-35 in

Influencing water features

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

Wetland description

N/A

Soil features

The soils of this site formed mostly in colluvium/residuum derived from limestone and shale. Surface soils are very gravelly loam to gravelly loam in texture. Rock fragments may be present on the soil surface and throughout the profile, generally making up more than 35 percent of the soil volume. These soils are moderately deep but can be shallow, well-drained, and have moderate permeability. pH is slightly to moderately alkaline. Available water-holding capacity ranges from 2.0 to 4.0 inches of water in the upper 40 inches of soil. The soil moisture regime is mostly ustic and the soil temperature regime is cryic. Precipitation ranges from 22 to 35 inches annually.

Table 4. Representative soil features

Parent material	(1) Colluvium–limestone and shale (2) Residuum–limestone and shale
Surface texture	(1) Gravelly loam (2) Very gravelly loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderate
Depth to restrictive layer	20–40 in
Soil depth	20–40 in
Surface fragment cover <=3"	18–39%
Surface fragment cover >3"	0–26%
Available water capacity (Depth not specified)	2–4 in
Calcium carbonate equivalent (Depth not specified)	0–15%
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	30–50%
Subsurface fragment volume >3" (Depth not specified)	0–48%

Ecological dynamics

It is impossible to determine in any quantitative detail the Historic Climax Plant Community (HCPC) for this ecological site because of the lack of direct historical documentation preceding all human influence. In some areas, the earliest reports of dominant plants include the cadastral survey conducted by the General Land Office, which began in the late 19th century for this area (Galatowitsch 1990). However, up to the 1870s the Shoshone Indians, prevalent in northern Utah and neighboring states, grazed horses and set fires to alter the vegetation for their needs (Parson 1996). In the 1860s, Europeans brought cattle and horses to the area, grazing large numbers of them on unfenced parcels year-long (Parson 1996). Itinerant and local sheep flocks followed, largely replacing cattle as the browse component increased.

Below is a State and Transition Model diagram to illustrate the “phases” (common plant communities), and “states” (aggregations of those plant communities) that can occur on the site. Differences between phases and states depend primarily upon observations of a range of disturbance histories in areas where this ESD is represented. These situations include grazing gradients to water sources, fence-line contrasts, patches with differing dates of fire, herbicide treatment, tillage, and kinds and times of timber harvest, etc. Reference State 1 illustrates the common plant communities that probably existed just prior to European settlement.

The major successional pathways within states, (“community pathways”) are indicated by arrows between phases. “Transitions” are indicated by arrows between states. The drivers of these changes are indicated in codes decipherable by referring to the legend at the bottom of the page and by reading the detailed narratives that follow the diagram. The transition between Reference State 1 and State 2 is considered irreversible because of the naturalization of exotic species of both flora and fauna, possible extinction of native species, and climate change. There may have also been accelerated soil erosion.

When available, monitoring data (of various types) were employed to validate more subjective inferences made in this diagram. See the complete files in the office of the State Range Conservationist for more details.

State 1: Reference State
The Reference State is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans. The description of the Reference State was determined by NRCS Soil Survey Type Site Location information and familiarity with relict areas where they exist. At the time of European colonization, what would have been observed on these sites would have primarily depended on the time since the last wildfire occurred. If fire had not occurred for about 100 years, a stand of mixed conifers including subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*) would have been the dominant species occupying the site (1.1). The particular tree dominants would also sort out based on aspect exposure (Alexander 1985, 1988). The understory would have been relatively sparse under mature trees due to tree competition, overstory shading, and duff accumulation.

Wildfire or insect outbreaks on particular tree species (1.1a) would have replaced these stands with a rich diversity of herb-dominated vegetation (1.2). In the absence of any major disturbance (1.2a, 1.3a, 1.4a, 1.5a), the vegetation would have progressed into more of a shrub-herb co-dominance (1.3), followed by the increasing presence of aspen (*Populus tremuloides*) first as seedlings and saplings (1.4), and later as mature aspen with mixed conifer seedlings (1.5). Ultimately the conifers would have outcompeted aspen, returning the climax vegetation (1.1). Wildfire (1.1a, 1.5b) would have been the primary disturbance factor prior to colonization, although periodic outbreaks of insects destroying particular tree species could reset the successional clock. Early successional stages were shorter in duration.

Community Phase 1.1: mature subalpine fir/ white fir/ Douglas-fir/ sparse understory
This plant community (1.1) would have been characterized by a stand of mature mixed conifers including subalpine fir, Douglas-fir, and white fir, with a sparse understory of Geyer’s sedge (*Carex geyeri*), slender wheatgrass (*Elymus trachycaulus*), and heartleaf arnica (*Arnica cordifolia*).

Community Pathway 1.1a:
Wildfire would have removed the trees, allowing shade-intolerant herbs to flourish briefly.

Community Phase 1.2: herb-dominated
This plant community would have developed within the first 5 years following fire.
Geyer’s sedge, slender wheatgrass, and heartleaf arnica would have been the dominant species, along with many

other short-lived herbaceous shade-intolerant species.

Community Pathway 1.2a:
After about 5 years, shrubs would begin to establish in the site.

Community Phase 1.3: shrub-herb co-dominance
Between 5 and 60 years after fire, shrubs and herbs would co-dominate the site. The increasing shrub component would have included mountain snowberry (*Symphoricarpos oreophilus*), creeping barberry (*Mahonia repens*), mallow ninebark (*Physocarpus malvaceus*), and gooseberry currant (*Ribes montigenum*), among others.

Community Pathway 1.3a:
About 60 years after fire, aspen would have become established in the site.

Community Phase 1.4: immature aspen
This plant community would have been dominated by a stand of immature aspen, a seral species, while the conifer species would have begun to establish themselves under other nurse plants. A stand of immature aspen would have existed approximately 60 to 80 years following the last fire.

Community Pathway 1.4a:
Aspen would have continued to mature while the various conifers would have become well established in the understory.

Community Phase 1.5: mature aspen/ mixed conifer
A stand of mature aspen intermixed with mixed conifers and various understory shrubs would have been encountered approximately 80 to 100 years post fire.

Community Pathway 1.5a:
After about 100 years following the last fire, the conifers would become mature, shading out aspen and the shade-intolerant shrub and herb species in the understory.

Community Pathway 1.5b:
Wildfire would have removed the trees, allowing shade-intolerant herbs to flourish briefly.

Transition T1a: from State 1 to State 2 (Reference State to Secondary Forest/ Introduced State)
The simultaneous introduction of exotic species, both plants and animals, and possible extinctions of native flora and fauna, along with climate change, has caused State 1 to transition to State 2. Europeans further altered this vegetation largely through logging, livestock grazing, trapping of beaver, and changing the fire regime. Continued impacts could prevent the recovery toward potential conifer dominance (State 2, various phases). The reversal of these changes (i.e. a return pathway) back to State 1 is not impractical.

State 2: Secondary Forest/ Introduced State
State 2 is similar to State 1 in form and function, with the exception of the presence of non-native plants and animals, possible extinctions of native species, a different climate, and a secondary stand of trees. State 2 is a description of the ecological site following Euro-American settlement. This state can be regarded as the current potential. With the least amount of disturbance or manipulation of the fire regime, a mature stand of subalpine fir, white fir, and Douglas fir with a sparse understory component is expected at this site (2.1).

As with the Reference State, time since last wildfire remains the key factor in determining what vegetation will be encountered on these sites. Wildfire, particularly crown fires, or complete harvesting of the forest (2.1b, 2.5b, 2.6a) will replace these stands with a rich diversity of herb-dominated vegetation. (2.2).

In the absence of any major disturbance (2.2a, 2.3a, 2.4a, 2.5a), the vegetation will progress into more of a shrub-herb co-dominance (2.3), followed by the increasing presence of aspen, first as seedlings and saplings (2.4), and later as mature aspen with immature conifers (2.5). Ultimately the conifers will outcompete aspen, returning to a semblance of climax vegetation (2.1). In some areas where wildfire has been prevented, the conifers may become over-mature (2.6) and consequently are more susceptible to infestation by insects and pathogens (2.1a). The resiliency of this State can be maintained by moderating human uses of the forest for timber and/or grazing.

Community Phase 2.1: Mature Douglas-fir/ Sparse understory
This plant community (2.1) is characterized by a stand of mature subalpine fir, white fir, and Douglas-fir. A sparse understory of Geyer's sedge, slender wheatgrass, and heartleaf arnica may be present.

Community Pathway 2.1a:
With fire exclusion, or well over 100 years since last fire, the conifer stand will ultimately deteriorate (become over-mature) and become increasingly susceptible to infestation by insects or other pathogens.

Community Pathway 2.1b:
A stand-replacing wildfire or intensive logging will set the vegetation back to an early seral herb-dominated phase. Logging opens up the forest canopy, allowing shade-intolerant understory herbs and shrubs to flourish for 20 to 30 years.

Community Pathway 2.1c:
The removal of only the mature Douglas-fir will leave only the less desirable true fir species in the overstory.

Community Phase 2.2: herb-dominated
This plant community will develop within the first 5 years following the last fire or complete tree removal. Geyer's sedge, slender wheatgrass, and heartleaf arnica will be the dominant understory species. A small component of introduced species may be present.

Community Pathway 2.2a:
The combination of heavy season long livestock grazing and fire exclusion will accelerate woody plant (shrub) establishment and diminish the herbaceous understory.

Community Phase 2.3: shrub-herb co-dominance
A plant community co-dominated by shrubs and herbs will develop approximately 5 to 60 years following fire or complete tree removal. A small component of introduced species may be present.

Community Pathway 2.3a:
The combination of heavy season long livestock grazing and fire exclusion will accelerate woody plant establishment and diminish the herbaceous understory.

Community Phase 2.4: immature aspen
Aspen will establish in the site 60 to 80 years after the last fire or complete tree removal.

Community Pathway 2.4a:
The combination of heavy season long livestock grazing and fire exclusion will accelerate woody plant establishment and diminish the understory.

Community Phase 2.5: mature aspen/ mixed conifer
A stand of mature aspen with an intermixed with subalpine fir, white fir, and Douglas-fir will develop approximately 80 to 100 years following fire or complete tree removal.

Community Pathway 2.5a:
The combination of heavy season long livestock grazing and fire exclusion will accelerate woody plant establishment and diminish the understory.

Community Pathway 2.5b:
A stand-replacing wildfire or intensive logging will set the vegetation back to an early seral herb-dominated phase. Logging opens up the forest canopy allowing grasses, herbs, and shrubs to flourish for 20 to 30 years.

Community Pathway 2.5c:
The removal of mature aspen will leave a stand of immature aspen, possibly with a few subalpine fir, white fir, and Douglas-fir in the understory.

Community Phase 2.6: over-mature, blighted mixed conifers/ understory absent

This plant community is the result of fire exclusion for well over 100 years. The Douglas-fir is over-mature and weakened, making it susceptible to infestation by insects or other pathogens.

Community Pathway 2.6a:
A stand-replacing wildfire will set the vegetation back to an early seral herb-dominated phase.

Transition T2a: from State 2 to State 3 (Secondary Forest/ Introduced State to Tertiary Forest/ Degraded State)
The Secondary Forest/ Introduced State will transition to the Tertiary Forest/ Degraded State following a second cycle of timber harvest or a stand replacing wildfire and further impacts from heavy continuous season-long grazing. Logging opens up the forest canopy allowing shade-intolerant species to flourish for 20 to 30 years. Secondary and tertiary disturbances can produce an array of vegetation from degraded temporary meadows to further simplified forests. The approach to this transition is indicated by a loss of species diversity, discontinuous litter and duff coverage, and evidence of accelerated soil erosion. This transition is triggered by excessive human utilization of the most economically desirable parts of the vegetation.

State 3: Tertiary Forest/ Degraded State
State 3 is characterized by tertiary forests in which both the understory vegetation and tree condition have been degraded. Fire suppression accelerates the development of woody plant dominance.

Community Phase 3.1: mature subalpine fir/ white fir/ Douglas-fir/ sparse understory
This plant community (3.1) is characterized by a mixed stand of mature subalpine fir, white fir, and Douglas-fir. A sparse understory of Geyer’s sedge, and slender wheatgrass, heartleaf arnica, and other shade-tolerant plants may be present.

Community Pathway 3.1a:
With fire exclusion, or well over 100 years since last fire, subalpine fir, white fir, and Douglas-fir will ultimately age, lose vigor, and become increasingly susceptible to infestation by insects or other pathogens.

Community Pathway 3.1b:
A stand-replacing wildfire or intensive logging will set the vegetation back to an early seral herb-dominated phase. Logging opens up the forest canopy, allowing shade-intolerant grasses, forbs, and shrubs to flourish for 20 to 30 years.

Community Pathway 3.1c:
The removal of only the mature Douglas-fir will leave only the less desirable true fir species in the overstory.

Community Phase 3.2: herb-dominated
This plant community will develop within the first 5 years following the last fire or complete tree removal. Dominant grasses are Geyer’s sedge and slender wheatgrass. A small component of introduced species may be present.

Community Pathway 3.2a:
After about 5 years, shrubs will begin to establish in the site.

Community Phase 3.3: shrub-herb co-dominance
A plant community co-dominated by shrubs and herbs will develop approximately 5 to 60 years after fire or complete tree removal. A small component of introduced species may be present.

Community Pathway 3.3a:
Aspen will become established at the site after 60 to 80 years following the last wildfire or complete tree removal.

Community Phase 3.4: immature aspen
Immature aspen dominate the stand 60 to 80 years following the last fire or complete tree removal.

Community Pathway 3.4a:
Aspen matures and immature conifers become well established in the understory 80 years after the last fire or complete tree removal.

Community Phase 3.5: mature aspen/ Douglas-fir

A stand of mature aspen intermixed with subalpine fir, white fir, and Douglas-fir will develop approximately 80 to 100 years following fire.

Community Pathway 3.5a:
After about 100 years following the last fire, subalpine fir, white fir, and Douglas-fir will become mature, shading out aspen and the shade-intolerant shrub and herb species in the understory.

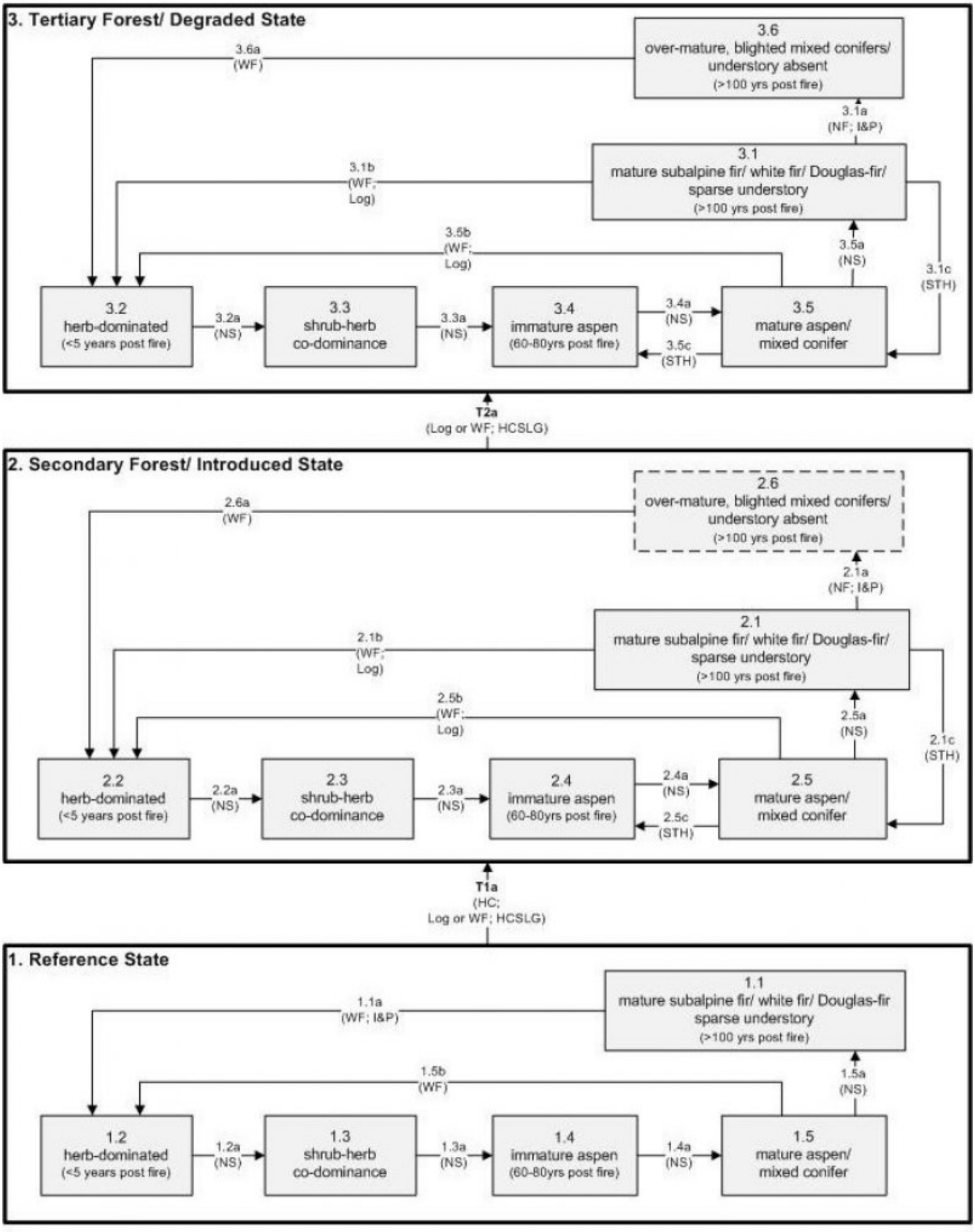
Community Pathway 3.5b:
A stand-replacing wildfire or intensive logging will set the vegetation back to an early seral herb-dominated phase. Logging opens up the forest canopy allowing grasses, herbs, and shrubs to dominate for 20 to 30 years.

Community Pathway 3.5c:
The removal of mature aspen will leave a stand of immature aspen, possibly with a few subalpine fir, white fir, and Douglas-fir in the understory.

Community Phase 3.6: over-mature, blighted mixed conifers/ understory sparse
This plant community is the result of fire exclusion well over 100 years. The conifers are over-mature and weakened, making them more susceptible to infestation by insects or other pathogens.

Community Pathway 3.6a:
A stand-replacing wildfire will set the vegetation back to an early seral herb-dominated phase.

State and transition model



HC	Historic Change	NF	No Fire
HCSLG	Heavy Continuous Season Long Grazing	NS	Natural Succession
I&P	Insects & Other Pathogens	STH	Selective Timber Harvest
Log	Logging	WF	Wildfire

Inventory data references

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range trained personnel were also used.

Other references

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Contributors

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Approval

Sarah Quistberg, 2/11/2025

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	05/10/2025
Approved by	Sarah Quistberg
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:**