USDA Natural Resources Conservation Service

Ecological site F018XI206CA
Clayey Thermic Marble Hills

Last updated: 4/24/2024
Accessed: 05/11/2025

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): 018X–Sierra Nevada Foothills

Major Land Resource Area (MLRA) 18, Sierra Nevada Foothills is located entirely in California and runs north to south adjacent to and down-slope of the west side of the Sierra Nevada Mountains (MLRA 22A). MLRA 18 includes rolling to steep dissected hills and low mountains, with several very steep river valleys. Climate is distinctively Mediterranean (xeric soil moisture regime) with hot, dry summers, and relatively cool, wet winters. Most of the precipitation comes as rain; average annual precipitation ranges from 15 to 55 inches in most of the area (precipitation generally increases with elevation and from south to north). Soil temperature regime is thermic; mean annual air temperature generally ranges between 52 and 64 degrees F. Geology is rather complex in this region; there were several volcanic flow and ashfall events, as well as tectonic uplift, during the past 25 million years that contributed to the current landscape.

LRU notes

This LRU (designated XI) is located on moderate to steep hills in the Sierra Nevada Foothills east of Sacramento, Stockton, and Modesto, CA. Various geologies occur in this region: metavolcanics, granodiorite, slate, marble, argillite, schist and quartzite, as well as ultramafic bands to a limited and localized extent. It includes mesa formations from volcanic flows, where vernal pool habitats occur. Soil temperature regime is thermic and soil moisture regime is xeric. Elevation ranges between 300 and 3400 feet above sea level. Precipitation ranges from 14 to 42 inches annually. Most precipitation falls between the months of November and March in the form of rain. Dominant vegetation includes annual grasslands, blue oak (Quercus douglasii), interior live oak (Quercus wislizeni), chamise (Adenostoma fasciculatum), buckbrush (Ceanothus cuneatus), and foothill pine (Pinus sabiniana).

Classification relationships

CLASSIFICATION RELATIONSHIPS
This site is located within M261F, the Sierra Nevada Foothills Section, (McNab et al., 2007) of the National Hierarchical Framework of Ecological Units (Cleland et al., 1997), M261Fb, the Lower Foothills Metamorphic Belt Subsection.

Level III and Level IV ecoregions systems (Omernik, 1987, and EPA, 2011) are: Level III, Central California Foothills and Coastal Mountains and Level IV, Ecoregion 6b, Northern Sierran Foothills, Ecoregion 6c, Comanche Terraces.

Ecological site concept

This site is found on clayey soils on strongly sloping to moderately steep hills. It occurs on all hill slope positions except for toeslopes in marble-derived parent material. Slopes range from 3 to 30%. Mean annual precipitation typically ranges from 26 to 33 inches.

The overriding factor in this site is the accumulation of clay minerals in both the surface (representative value ~ 26%) and soil subsurface (20 inches; representative value ~ 36%). The presence of 2:1 clay minerals may stunt plant growth, and may overcome the influence of relatively high precipitation in this site. The main soil components associated with this ecological site are Aquariusmine and Beybek components. Aquariusmine soils are deep and occur on backslope positions. They are fine-loamy, mixed, active, thermic Ultic Haploxeralfs. The soil properties of Beybek are more telling of a clayey site. They are classified as clayey-skeletal, mixed, superactive, thermic Leptic Haploxererts.

This vegetation consists of often stunted blue oak (Quercus douglasii) and interior live oak (Quercus wislizeni) and scattered shrubs such as manzanita (Arctostaphylos spp.) and poison oak (Toxicodendron diversilobum). This site also has abundant annual grasses and forbs in the understory.

Associated sites

F018XI202CA	**Deep Thermic Steep Hillslopes** This site commonly occurs nearby.

Similar sites

F018XI205CA	**Thermic Granitic Foothills** Site relationships being developed.
F018XI207CA	**Deep Volcanic Plateaus and Hills** Site relationships being developed.

Table 1. Dominant plant species

Tree	(1) *Quercus douglasii* (2) *Quercus wislizeni*
Shrub	(1) *Arctostaphylos* (2) *Toxicodendron diversilobum*
Herbaceous	Not specified

Physiographic features

This site occurs in hills typically ranging from 3-30% (sometimes up to 60%) slopes. Elevation is generally around 2000 feet.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope (4) Footslope
Landforms	(1) Foothills > Hill
Runoff class	Medium
Flooding frequency	None
Ponding frequency	None
Elevation	1,900–2,100 ft
Slope	3–30%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Medium

Flooding frequency	None
Ponding frequency	None
Elevation	1,350–2,450 ft
Slope	1–60%

Climatic features

This ecological site is characterized by hot, dry summers and cool, wet winters, a typical Mediterranean climate. Mean annual precipitation ranges from 26 to 33 inches and usually falls from October to May. Mean annual temperature is 58 to 63 degrees F with 170 to 299 frost free days.

Table 4. Representative climatic features

Frost-free period (characteristic range)	170-299 days
Freeze-free period (characteristic range)	279-365 days
Precipitation total (characteristic range)	26-33 in
Frost-free period (actual range)	155-349 days
Freeze-free period (actual range)	236-365 days
Precipitation total (actual range)	24-34 in
Frost-free period (average)	239 days
Freeze-free period (average)	317 days
Precipitation total (average)	29 in

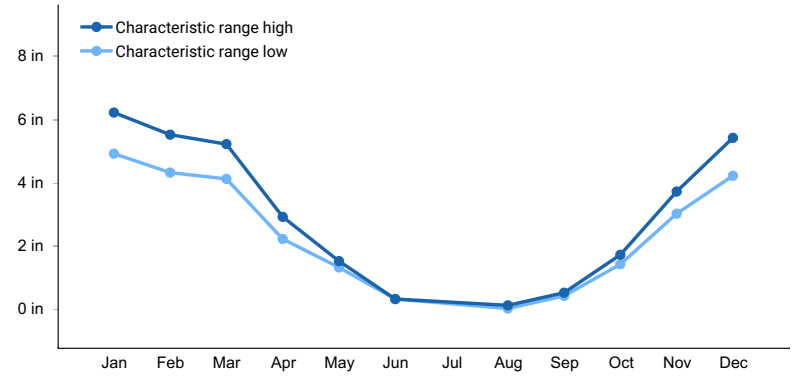

Figure 1. Monthly precipitation range

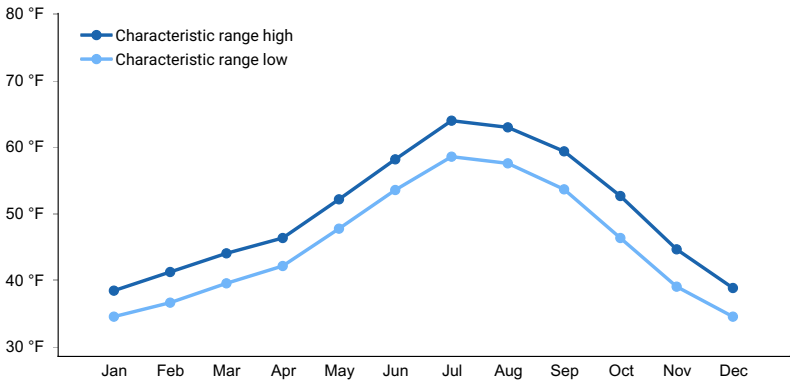

Figure 2. Monthly minimum temperature range

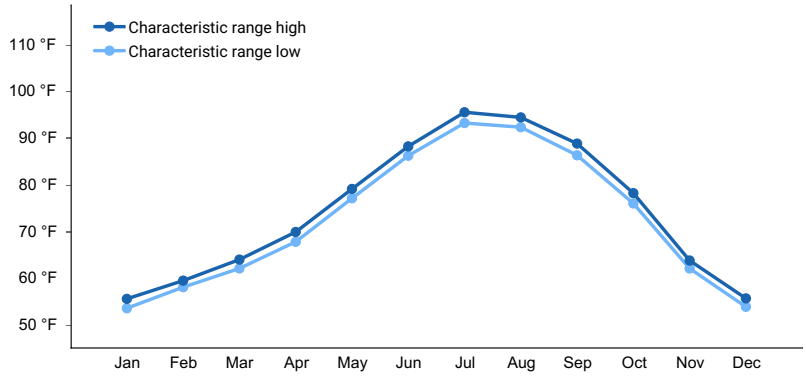

Figure 3. Monthly maximum temperature range

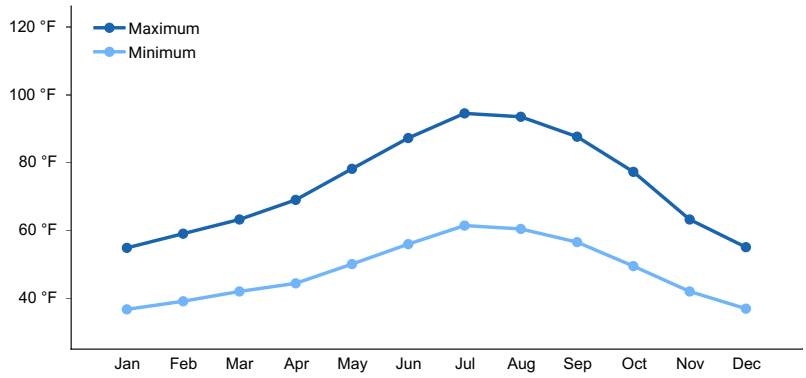

Figure 4. Monthly average minimum and maximum temperature

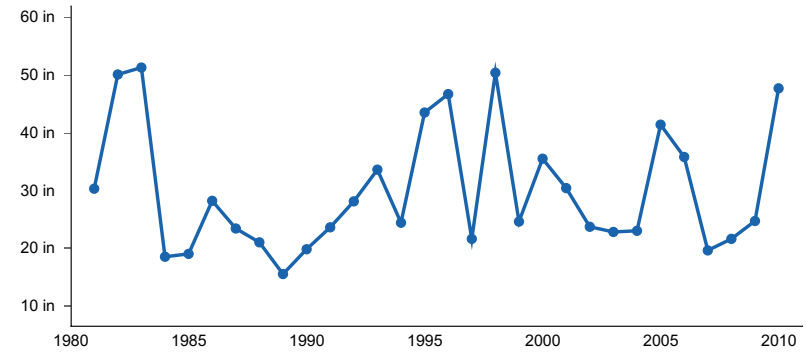

Figure 5. Annual precipitation pattern

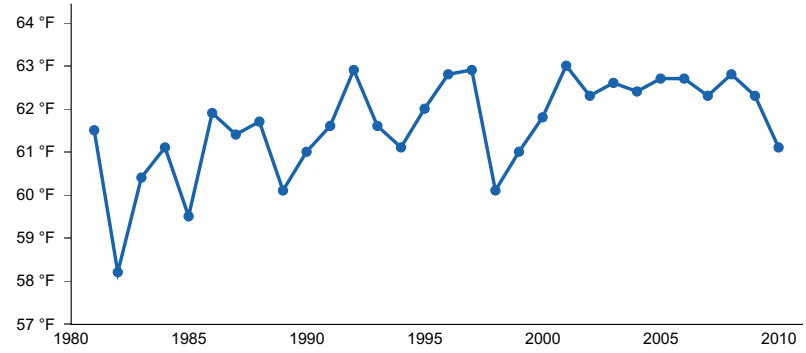

Figure 6. Annual average temperature pattern

Climate stations used

- (1) SONORA [USC00048353], Jamestown, CA
- (2) CAMP PARDEE [USC00041428], Valley Springs, CA
- (3) NEW MELONES DAM HQ [USC00046174], Angels Camp, CA

Influencing water features

Due to the topographic position, this site does not have water features or wetlands.

Wetland description

N/A

Soil features

The soils in this ecological site are formed from the colluvium of metasedimentary and/or marble rock over marble residuum. The typical depth range is from moderately deep to deep, the particle size control section ranges from fine-loamy to clayey-skeletal, and surface textures include loams, clay loams, and gravelly clay loams. The indurated marble bedrock is a restrictive layer found between 33 and 45 inches of depth. Up to 4% gravels (< 3 inch diameter), and 21% larger fragments (= 3 inch diameter) cover the soil surface. Below the surface, gravels range between 0 to 19% and larger fragments usually occupy between 0 to 13% space by volume, but in some Beybek pedons these larger fragments may reach as high as 25% by volume. The soils in this ecological site are well drained and the permeability class is moderately slow. Available Water Capacity (AWC) ranges from 3.9 to 6.9 inches. The soil reaction in the top 10 inches of the soil ranges from 6.2 to 7.3 and in the subsoil the range is from 6.2 to 7.5.

The most common soils correlated to this ecological site are Aquariusmine (Fine-loamy, mixed, superactive, thermic Vertic Haploxeralfs) and Beybek (Clayey-skeletal, mixed, superactive, thermic Leptic Haploxererts).

Table 5. Representative soil features

Parent material	(1) Residuum–marble (2) Colluvium–metasedimentary rock (3) Colluvium–marble
Surface texture	(1) Loam (2) Clay loam (3) Gravelly clay loam
Family particle size	(1) Fine-loamy (2) Clayey-skeletal
Drainage class	Well drained
Permeability class	Moderately slow
Depth to restrictive layer	33–45 in
Soil depth	33–45 in
Surface fragment cover <=3"	0–4%
Surface fragment cover >3"	0–21%
Available water capacity (0-40in)	3.9–6.9 in
Soil reaction (1:1 water) (0-10in)	6.2–7.3
Subsurface fragment volume <=3" (0-60in)	0–19%
Subsurface fragment volume >3" (0-60in)	0–13%

Table 6. Representative soil features (actual values)

Drainage class	Well drained
Permeability class	Moderately slow

Depth to restrictive layer	20–60 in
Soil depth	20–60 in
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–50%
Available water capacity (0-40in)	1.4–8.5 in
Soil reaction (1:1 water) (0-10in)	6–7.8
Subsurface fragment volume <=3" (0-60in)	0–45%
Subsurface fragment volume >3" (0-60in)	0–57%

Ecological dynamics

Community pathways and Transitions
T1.a Hydraulic mining, leading to significant loss of soil productivity. Although, this is a legacy effect and is not currently a common ecosystem driver. This type of mining was common in the Sierra Nevada Foothills during the mid to late nineteenth century, the effects of which are still seen today.

T1.b This transition occurs after mechanical clearing that results in loss of oak and acorn source. Annual dominated state may be further perpetuated by continual grazing of domestic livestock.

T1.c This transition occurs when undesirable plants become established in the understory. State 4 can exist underneath the canopy of oak, or in an annual grassland state.

1.1a Patchy, high intensity fire which kills some of the oaks, leaving islands of surviving trees. Incomplete mechanical clearing also may result in this plant community.

1.1b This community pathway occurs with mechanical clearing that removes only shrubs and dead material, leaving the oak communities intact.

1.2a Normal growth and progression.

1.3a Normal growth and progression.

1.3b Moderate to low intensity fire that resets the site to an early seral condition.

2.1a This community pathway occurs after a high intensity fire.

2.2a Normal growth and progression.

T3.a This transition occurs after undesirable invasive plants become established.

R3.a This restoration pathway occurs with tree planting, often requires shade screens and seedling protection from browsers to be successful.

3.1a This community pathway occurs as forbs become more dominant, often following low winter precipitation and reduced litter layers.

3.2a This community pathway occurs as grasses become more dominant, often in response to higher litter levels.

R4.a This restoration pathway occurs with integrated weed management and may require mowing, herbicides, and/or biological control.

4.1a This community pathway occurs as invasive forb species become dominant.

4.2a This community pathway occurs as invasive grass species become dominant.

State and transition model

Community pathways and Transitions
T1.a Hydraulic mining, leading to significant loss of soil productivity. Although, this is a legacy effect and is not currently a common ecosystem driver. This type of mining was common in the Sierra Nevada Foothills during the mid to late nineteenth century, the effects of which are still seen today.

T1.b This transition occurs after mechanical clearing that results in loss of oak and acorn source. Annual dominated state may be further perpetuated by continual grazing of domestic livestock.

T1.c This transition occurs when undesirable plants become established in the understory. State 4 can exist underneath the canopy of oak, or in an annual grassland state.

1.1a Patchy, high intensity fire which kills some of the oaks, leaving islands of surviving trees. Incomplete mechanical clearing also may result in this plant community.

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1.2a Normal growth and progression.

1.3a Normal growth and progression.

1.3b Moderate to low intensity fire that resets the site to an early seral condition.

2.1a This community pathway occurs after a high intensity fire.

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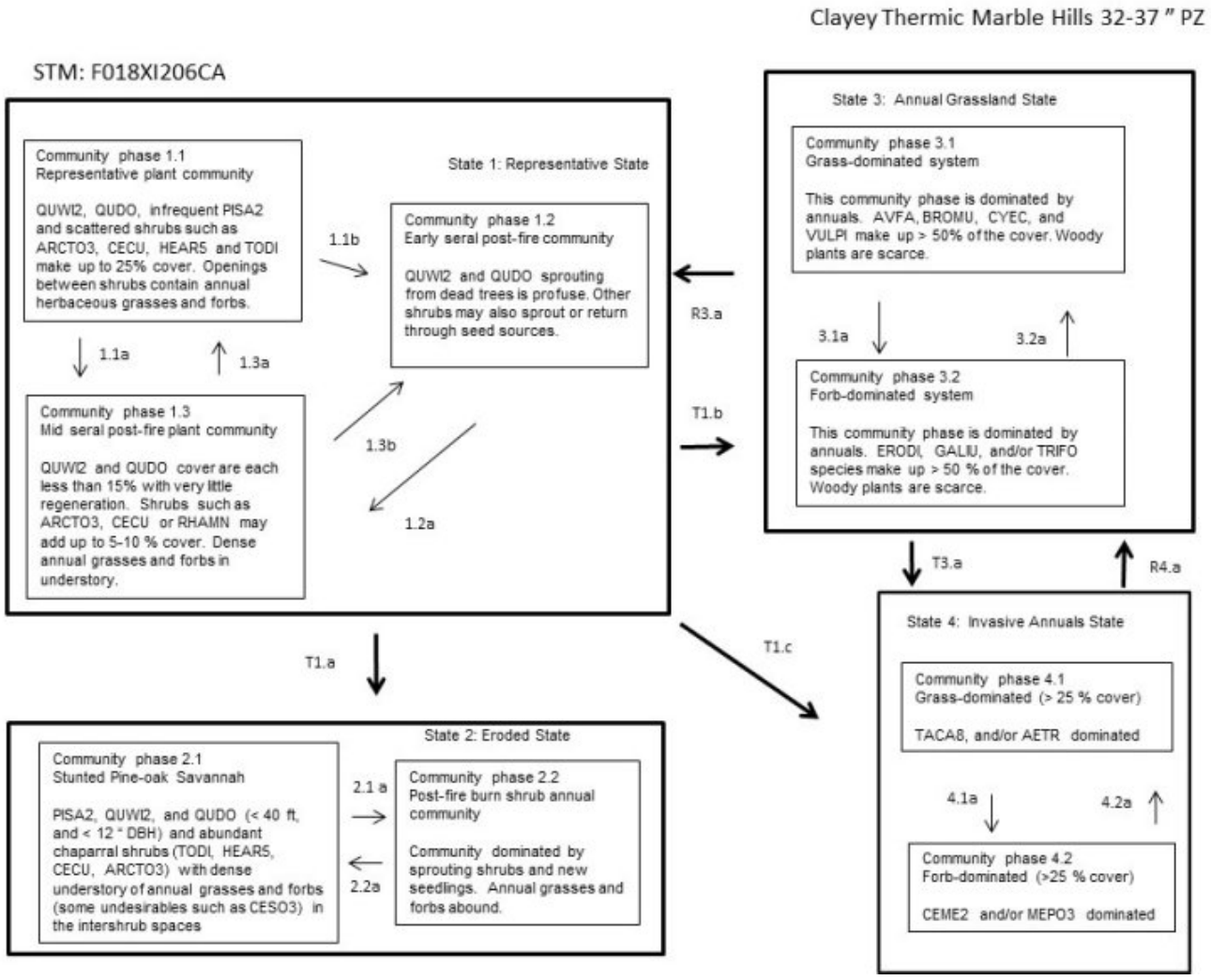


State 1
Representative State

Community 1.1
Representative plant community

QUWI2, QUDO, infrequent PISA2 and scattered shrubs such as ARCTO3, CECU, HEAR5 and TODI make up to 25% cover. Openings between shrubs contain annual herbaceous grasses and forbs.

Community 1.2
Early seral post-fire community

QUWI2 and QUDO sprouting from dead trees is profuse. Other shrubs may also sprout or return through seed sources.

Community 1.3
Mid seral post-fire plant community

QUWI2 and QUDO cover are each less than 15% with very little regeneration. Shrubs such as ARCTO3, CECU or RHAMN may add up to 5-10 % cover. Dense annual grasses and forbs in understory.

Pathway 1.1b
Community 1.1 to 1.2

Representative plant community

Early seral post-fire community

This community pathway occurs with mechanical clearing that removes only shrubs and dead material, leaving the oak communities intact.

Pathway 1.1a
Community 1.1 to 1.3

Representative plant community

Mid seral post-fire plant community

Patchy, high intensity fire which kills some of the oaks, leaving islands of surviving trees. Incomplete mechanical clearing also may result in this plant community.

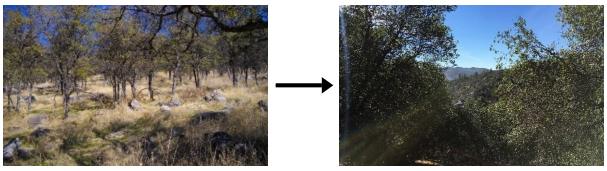
Pathway 1.2a
Community 1.2 to 1.3

Early seral post-fire community

Mid seral post-fire plant community

Normal growth and progression.

Pathway 1.3a
Community 1.3 to 1.1



Mid seral post-fire plant community

Representative plant community

Normal growth and progression.

Pathway 1.3b
Community 1.3 to 1.2

Mid seral post-fire plant community

Early seral post-fire community

Moderate to low intensity fire that resets the site to an early seral condition.

State 2
Eroded State

Community 2.1
Stunted Pine-oak Savannah

PISA2, QUWI2, and QUDO (< 40 ft, and < 12 “ DBH) and abundant chaparral shrubs (TODI, HEAR5, CECU, ARCTO3) with dense understory of annual grasses and forbs (some undesirables such as CESO3) in the intershrub spaces

Community 2.2
Post-fire burn shrub annual community

Community dominated by sprouting shrubs and new seedlings. Annual grasses and forbs abound.

Pathway 2.1a
Community 2.1 to 2.2

Stunted Pine-oak Savannah

Post-fire burn shrub annual community

This community pathway occurs after a high intensity fire.

Pathway 2.2a
Community 2.2 to 2.1

Post-fire burn shrub annual community

Stunted Pine-oak Savannah

Normal growth and progression.

State 3
Annual Grassland State

Community 3.1
Grass-dominated system

This community phase is dominated by annuals. AVFA, BROMU, CYEC, and VULPI make up > 50% of the cover. Woody plants are scarce.

Community 3.2
Forb-dominated system

This community phase is dominated by annuals. ERODI, GALIU, and/or TRIFO species make up > 50 % of the cover. Woody plants are scarce.

Pathway 3.1a
Community 3.1 to 3.2

Grass-dominated system | Forb-dominated system

This community pathway occurs as forbs become more dominant, often following low winter precipitation and reduced litter layers.

Pathway 3.2a
Community 3.2 to 3.1

Forb-dominated system | Grass-dominated system

This community pathway occurs as grasses become more dominant, often in response to higher litter levels.

State 4
Invasive Annuals State

Community 4.1
Grass-dominated (> 25 % cover)

TACA8, and/or AETR dominated

Community 4.2
Forb-dominated (>25 % cover)-no photo

CEME2 and/or MEPO3 dominated

Pathway 4.1a
Community 4.1 to 4.2

This community pathway occurs as invasive forb species become dominant.

Pathway 4.2a
Community 4.2 to 4.1

This community pathway occurs as invasive grass species become dominant.

Transition T1.a
State 1 to 2

Hydraulic mining, leading to significant loss of soil productivity. Although, this is a legacy effect and is not currently a common ecosystem driver. This type of mining was common in the Sierra Nevada Foothills during the mid to late nineteenth century, the effects of which are still seen today.

Transition T1.b
State 1 to 3

This transition occurs after mechanical clearing that results in loss of oak and acorn source. Annual dominated state may be further perpetuated by continual grazing of domestic livestock.

Transition T1.c
State 1 to 4

This transition occurs when undesirable plants become established in the understory. State 4 can exist underneath the canopy of oak, or in an annual grassland state.

Restoration pathway R3.a
State 3 to 1

This restoration pathway occurs with tree planting, often requires shade screens and seedling protection from browsers to be successful.

Transition T3.a
State 3 to 4

This transition occurs after undesirable invasive plants become established.

Restoration pathway R4.a
State 4 to 3

This restoration pathway occurs with integrated weed management and may require mowing, herbicides, and/or biological control.

Additional community tables

Inventory data references

Inventory data to be collected using future projects based on priorities.

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Contributors

K. Moseley
Dallas Glass
Andy Paolucci
Nathan Roe

Approval

Kendra Moseley, 4/24/2024

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	05/11/2025
Approved by	Kendra Moseley
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):**

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

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

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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):**

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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:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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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:**

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17. **Perennial plant reproductive capability:**
