USDA Natural Resources Conservation Service

# Ecological site F018XI201CA
# Moderately Deep Thermic Foothills

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 characterized by shallow to moderately deep soils occurring on all hillslope positions except toeslopes on hills formed on various types of parent material. Slopes typically range from 6 to 70%. Precipitation typically ranges from 27 to 34 inches per year, and elevation ranges from 350 feet to 2150 feet.

Soil depth and greater precipitation allow for greater canopy cover of trees (mean canopy cover 25%), and a more diverse array of shrubs than what is found in more droughty sites of the land resource unit (which are dominated by F018XI200CA). Representative soil components include Argonaut, Sobrante, and Loafercreek soils. These soils are moderately deep and all have argillic horizons, meaning that clay is translocated to lower horizons by percolating water. They have thermic soil temperature regimes and are classified as Mollic Haploxeralfs (Argonaut & Sobrante) or Ultic Haploxeralfs (Loafercreek).

Vegetation includes open oak woodland with scattered California foothill pines (Pinus sabiniana) and buckbrush (Ceanothus cuneatus). Blue oak (Quercus douglasii) tends to be dominant in the overstory component. Scattered interior live oak (Quercus wislizeni) also occur. Forbs and annual grasses generally comprise less than 50% of the annual production, and tree species make up 40% or more of annual production.

## Associated sites

| | |
|---|---|
| F018XI200CA | **Low Elevation Foothills**<br>This site commonly occurs nearby. |
| F018XI205CA | **Thermic Granitic Foothills**<br>This site commonly occurs nearby. |
| F018XI202CA | **Deep Thermic Steep Hillslopes**<br>This site commonly occurs nearby. |

## Similar sites

| | |
|---|---|
| F018XI200CA | **Low Elevation Foothills**<br>Site relationships being developed. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Quercus douglasii*<br>(2) *Pinus sabiniana* |
| Shrub | (1) *Ceanothus cuneatus* |
| Herbaceous | (1) *Avena* |

## Physiographic features

This site is characterized by moderately deep soils occurring on all hillslope positions except toeslopes on foothills formed on various types of parent material (although it occurs frequently along the metamorphic belt within this LRU). Slopes typically range from 6 to 70% and elevation ranges from 350 feet to 2150 feet .

**Table 2. Representative physiographic features**

| | |
|---|---|
| Hillslope profile | (1) Summit<br>(2) Shoulder<br>(3) Backslope<br>(4) Footslope |
| Landforms | (1) Foothills > Hill<br>(2) Foothills > Ridge |
| Runoff class | Medium |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 350–2,150 ft |
| Slope | 6–70% |
| Aspect | W, NW, SW |

**Table 3. Representative physiographic features (actual ranges)**

| | |
|---|---|
| Runoff class | Medium |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 30–3,500 ft |
| Slope | 1–90% |

## Climatic features

This ecological site is characterized by hot, dry summers and cool, wet winters, a typical Mediterranean climate. Mean annual precipitation ranges from 31 to 40 inches and usually falls from October to May. Mean annual temperature is 58 to 62 degrees F with 152 to 292 frost free days.

**Table 4. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 152-292 days |
| Freeze-free period (characteristic range) | 235-365 days |
| Precipitation total (characteristic range) | 31-40 in |
| Frost-free period (actual range) | 150-347 days |
| Freeze-free period (actual range) | 225-365 days |
| Precipitation total (actual range) | 25-47 in |
| Frost-free period (average) | 228 days |
| Freeze-free period (average) | 299 days |
| Precipitation total (average) | 35 in |

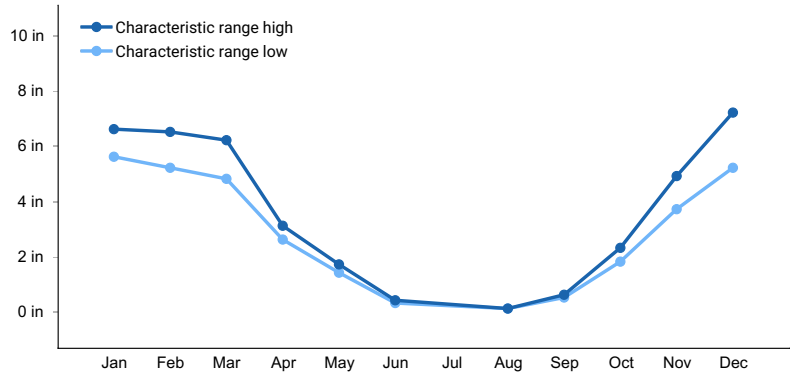



**Figure 1. Monthly precipitation range**

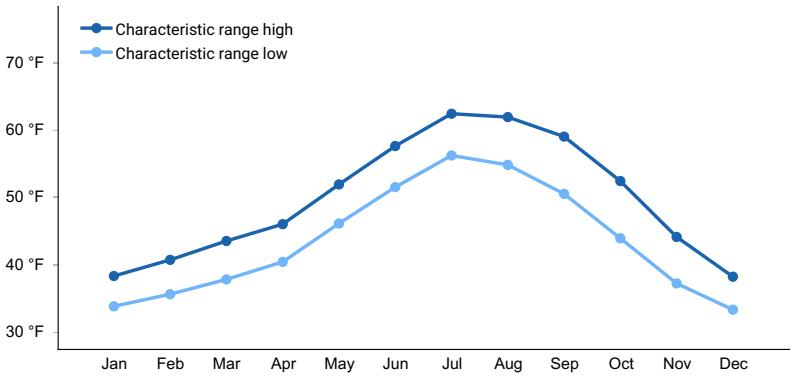



**Figure 2. Monthly minimum temperature range**

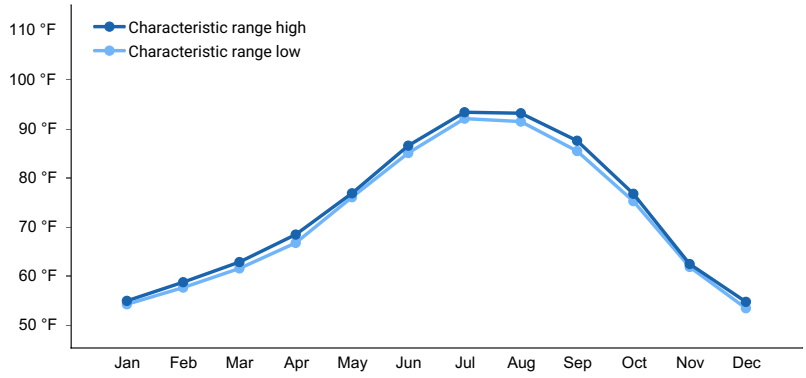



**Figure 3. Monthly maximum temperature range**

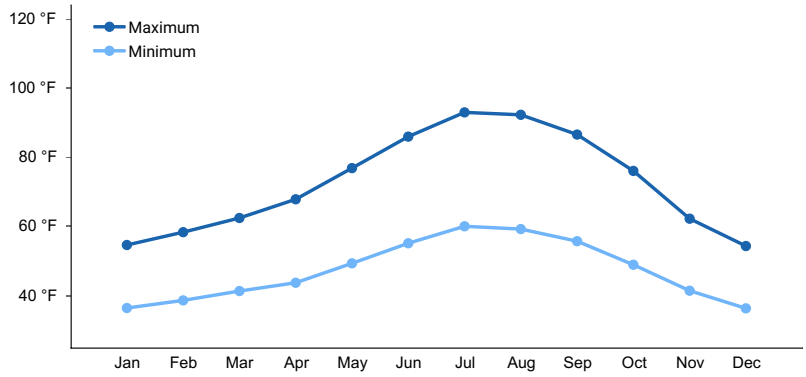



**Figure 4. Monthly average minimum and maximum temperature**

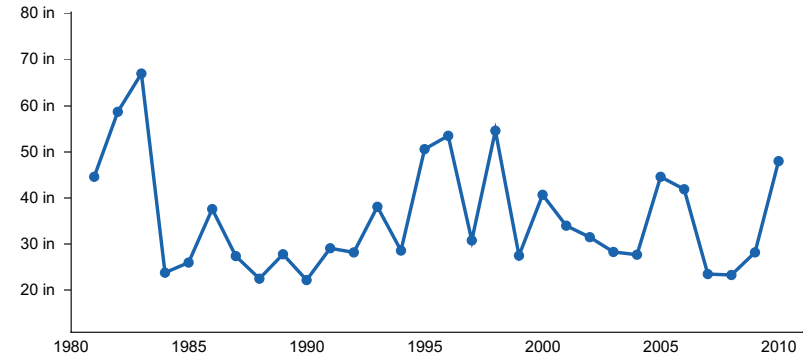



**Figure 5. Annual precipitation pattern**

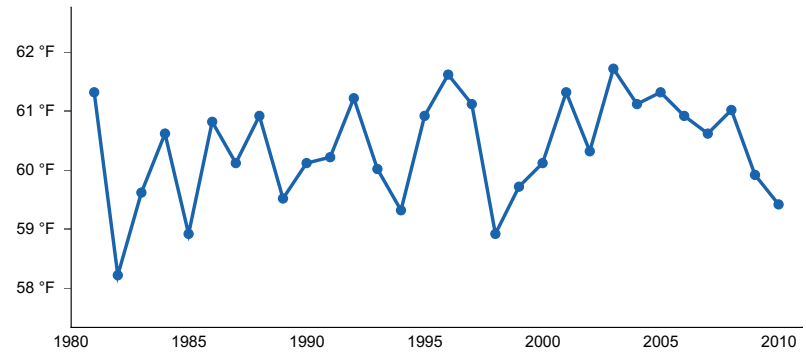



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) CAMP PARDEE [USC00041428], Valley Springs, CA
- (2) SONORA [USC00048353], Jamestown, CA
- (3) DOBBINS 1 S [USC00042456], Dobbins, CA

- (4) AUBURN [USC00040383], Auburn, CA
- (5) SUTTER HILL CDF [USC00048713], Jackson, 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 correlated to this ecological site are formed from colluvium and residuum from metavolcanic rocks, mainly greenschist. The soils are shallow to moderately deep, and have loam to fine-loamy particle size control sections (although some soils such as Argonaut are heavier in texture, and some, such as Gopheridge, have over 35 percent rock fragments in the subsoil). Depth to restrictive bedrock is between 16 and 40 inches. Gravels (< 3 inch diameter) cover between 0 to 5% of the soil surface, while larger fragments (= 3 inch diameter) cover between 0 to 4% of the surface. Within the profile, gravels range between 5 to 32%, and larger fragments range from 0 to 15% by volume. The soils are well drained and the permeability is moderate to moderately rapid. Available Water Capacity ranges from 2.2 to 5.4 inches. The soil pH in the top 10 inches is between 5.9 and 6.5 and in the sub-horizons it ranges from between 5.8 to 6.7.

Representative soil components include Argonaut, Sobrante, and Loafercreek soils. These soils have argillic horizons, meaning that clay is translocated from above, and increases in the subsoil. These soils have thermic soil temperature regimes and are classified as Mollic Haploxeralfs (Argonaut & Sobrante) or Ultic Haploxeralfs (Loafercreek and Gopheridge).

**Table 5. Representative soil features**

| | |
|---|---|
| Parent material | (1) Colluvium–metavolcanics<br>(2) Residuum–metavolcanics<br>(3) Residuum–schist |
| Surface texture | (1) Loam<br>(2) Gravelly loam<br>(3) Silt loam |
| Family particle size | (1) Fine-loamy<br>(2) Clayey<br>(3) Loamy-skeletal |
| Drainage class | Well drained |
| Permeability class | Moderate to moderately rapid |
| Depth to restrictive layer | 16–40 in |
| Soil depth | 16–40 in |
| Surface fragment cover <=3" | 0–5% |
| Surface fragment cover >3" | 0–4% |
| Available water capacity (0-40in) | 2.2–5.4 in |
| Soil reaction (1:1 water) (0-10in) | 5.9–6.5 |
| Subsurface fragment volume <=3" (0-60in) | 5–32% |
| Subsurface fragment volume >3" (0-60in) | 0–15% |

**Table 6. Representative soil features (actual values)**

| | |
|---|---|
| Drainage class | Moderately well drained to well drained |
| Permeability class | Very slow to moderately rapid |
| Depth to restrictive layer | 4–60 in |
| Soil depth | 4–60 in |
| Surface fragment cover <=3" | 0–35% |
| Surface fragment cover >3" | 0–77% |
| Available water capacity (0-40in) | 0.8–7.8 in |
| Soil reaction (1:1 water) (0-10in) | 4.7–7.7 |
| Subsurface fragment volume <=3" (0-60in) | 0–59% |
| Subsurface fragment volume >3" (0-60in) | 0–44% |

## Ecological dynamics

This ecological site exists along the mid elevations of the Sierra Nevada Foothills and consists of blue oak-foothill pine woodlands dominated by annual grasses and forbs in the understory. Blue oak woodland is the most extended hardwood cover in California (Bolsinger, 1988) distributed primarily around the ranges surrounding the Sacramento and San Joaquin valleys. Historically, many native forbs and some perennial bunchgrasses (Bartolome, 1987) may have been found on this site, but there is a chasm of different opinions concerning which plant lifeform was prevailing at the time that the first Spanish settlers arrived. It is uncertain when exactly most of the introduced herbaceous plants arrived, but Bartolome (1987) estimates that by the mid 1800's, "most of the annual grasses, filarees, bromes and fescues" from the Mediterranean region had established. In 1850, one traveler in the vicinity of San Jose wrote, "we found ourselves between lofty hills, those to the right (east) being covered by wild oat" (Stewart, 2002). The introduced annuals quickly naturalized to a climate highly similar to their place of origin (i.e. mild, wet winters and dry summers; Bartolome, 1987). This ecological site has open canopy of blue oak and in some areas, the soil depth and presence of rocks may prohibit trees from growing.

Disturbance Dynamics:

Fire: Fire has likely been a shaping landscape force over the Sierra Nevada Foothills. Native indigenous groups among the entire length of the Sierra Nevada Foothills practiced setting fires millennia before European establishment. The diverse reasons for burning, included enhanced hunting, vegetation management (clearing underbrush), and to improve crop yields (Stewart, 2002). The openness of the oak savannah communities could be a consequence of repeated fires. Native Californians may have burnt in selected plots of the grassland/ oak communities to prepare sites for planting of tobacco. Some records indicate that the Maidu People of Northern California set fires annually to maintain open country (safety purposes) and to promote grasses and herbs over brush (Stewart, 2003).

Grazing: Livestock grazing has occurred for at least 200 years and has likely contributed to the spread of Mediterranean annual grasses such as the genera Bromus and Avena (Jackson, 1985). Grazing impacts can vary depending on the timing and duration, and livestock type (Keeley et. Al., 2003). A separate disturbance factor that often accompanies domestic livestock operations is mechanical clearing. Clearing is sometimes independent from livestock operations, as it is used to reduce fire danger or to generate firewood.

Disease and Pathogens: Some diseases of blue oak damage the heartwood of the trunk and large limbs (McDonald, 1990). Several fungi cause wood decay in the limbs and trunks of oaks (Hickman et al., 2011). Sulphur conk, (Laetiporus sulphureus), hedgehog fungus (Hydnum erinaceum) and the artist's fungus (Ganoderma applanatum) can cause significant damage to living oaks (i.e. heartwood rot.). Other diseases such as the shoestring fungus rot (Armillaria mellea) gradually weakens trees at the base until they fall. Diseases of California foothill pine include western gall rust (Periderium harknessii) and dwarf-mistletoe (*Arceuthobium occidentale* and *A.*

*campylopodum* forma campylopodum) (Howard, 1992).

Drought: Blue oak is one of the most drought resistant deciduous trees in California (Callaway, 1992; Abrams, 1990).

## State and transition model

Community pathways and Transitions

T1.a This transition occurs after decades of little to no disturbance agents (including management) which builds up fuels. A high severity, stand replacing fire then results in a system dominated by shrubs and other fire-adapted plants, leading to this chaparral dominated state.

T1.b This transition occurs after tree removal and repeated brush management.

1.1a This community pathway occurs when significant time passes without a natural disturbance.

1.1b Moderate intensity fire which kills some of the trees and shrubs. Alternatively, this community pathway occurs with light mechanical clearing or thinning. Some oaks remain on the site.

1.1c This uncommon community pathway occurs when favorable conditions such as abundant moisture and/or seeds (acorns) etc. cause oak regeneration. Low intensity fire or clearing can also result in a resprouting of oaks.

1.2a Normal growth and progression.

1.2b This community pathway occurs after a stand replacing fire, or mechanical treatment of some of the young trees/shrubs.

1.3a This community pathway occurs with time and regeneration of oaks, often following low to moderately intense fire and favorable conditions permitting saplings/seedlings to become established. This assumes that enough seedlings survive insect, rodent, or other types of herbivory to persist into adulthood.

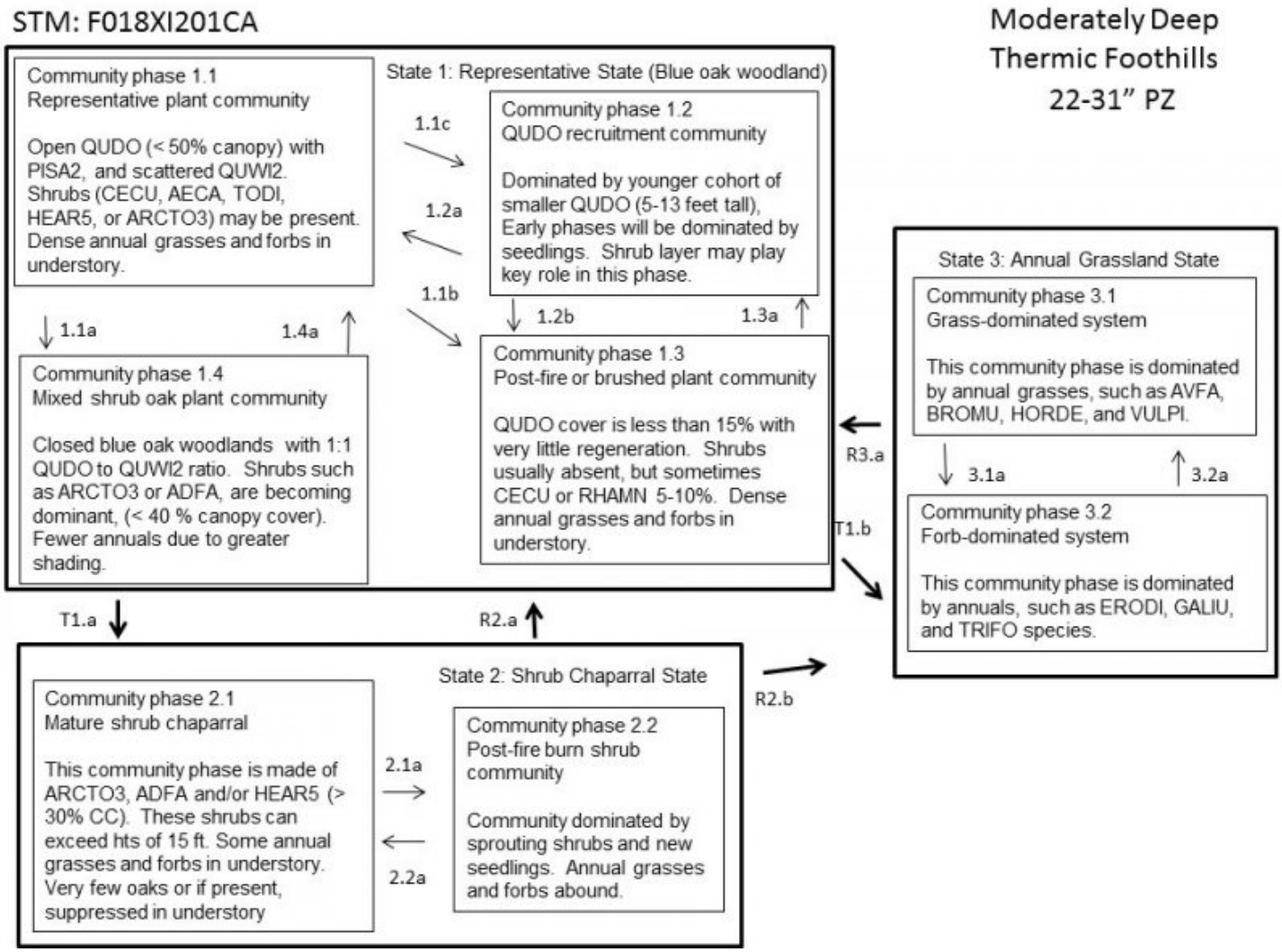
1.4a This community pathway occurs after mortality of older trees/shrubs create canopy gaps, leading to a slightly more open woodland.

R2.a This restoration pathway occurs after active brush management, chemical treatment, followed up with tree planting.

R2.b This restoration pathway occurs when continual brush management has successfully removed all shrubs and their seed bank from the site for long enough that annual herbaceous species begin to take competitive advantage of the site resources, creating a threshold to a new state where annuals dominate all ecological functions on the site

2.1a This community pathway occurs following a high intensity wildfire.
2.2a This community pathway occurs over time with no management action.

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.




**State 1**
**Representative State (Blue oak woodland)**

**Community 1.1**
**Representative plant community**

Open QUDO (< 50% canopy) with PISA2, and scattered QUWI2. Shrubs (CECU, AECA, TODI, HEAR5, or ARCTO3) may be present. Dense annual grasses and forbs in understory.

**Community 1.2**
**QUDO recruitment community**

Dominated by younger cohort of smaller QUDO (5-13 feet tall), Early phases will be dominated by seedlings. Shrub layer may play key role in this phase.

### Community 1.3
### Post-fire or brushed plant community

QUDO cover is less than 15% with very little regeneration. Shrubs usually absent, but sometimes CECU or RHAMN 5-10%. Dense annual grasses and forbs in understory.

### Community 1.4
### Mixed shrub oak plant community

Closed blue oak woodlands with 1:1 QUDO to QUWI2 ratio. Shrubs such as ARCTO3 or ADFA, are becoming dominant, (< 40 % canopy cover). Fewer annuals due to greater shading.

### Pathway 1.1c
### Community 1.1 to 1.2

Representative plant community

QUDO recruitment community

1.1c This uncommon community pathway occurs when favorable conditions such as abundant moisture and/or seeds (acorns) etc. cause oak regeneration. Low intensity fire or clearing can also result in a resprouting of oaks.

### Pathway 1.1b
### Community 1.1 to 1.3

Representative plant community

Post-fire or brushed plant community

1.1b Moderate intensity fire which kills some of the trees and shrubs. Alternatively, this community pathway occurs with light mechanical clearing or thinning. Some oaks remain on the site.

### Pathway 1.1a
### Community 1.1 to 1.4

Representative plant community

Mixed shrub oak plant community

1.1a This community pathway occurs when significant time passes without a natural disturbance.

### Pathway 1.2a
### Community 1.2 to 1.1

QUDO recruitment community

Representative plant community

1.2a Normal growth and progression.

### Pathway 1.2b
### Community 1.2 to 1.3

QUDO recruitment community

Post-fire or brushed plant community

1.2b This community pathway occurs after a stand replacing fire, or mechanical treatment of some of the young trees/shrubs.

### Pathway 1.3a
### Community 1.3 to 1.2

Post-fire or brushed plant community

QUDO recruitment community

1.3a This community pathway occurs with time and regeneration of oaks, often following low to moderately intense fire and favorable conditions permitting saplings/seedlings to become established. This assumes that enough seedlings survive insect, rodent, or other types of herbivory to persist into adulthood.

### Pathway 1.4a
### Community 1.4 to 1.1

Mixed shrub oak plant community

Representative plant community

1.4a This community pathway occurs after mortality of older trees/shrubs create canopy gaps, leading to a slightly more open woodland.

## State 2
## Shrub Chaparral State

### Community 2.1
### Mature shrub chaparral

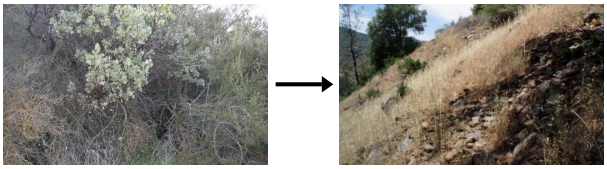
This community phase is made of ARCTO3, ADFA and/or HEAR5 (> 30% CC). These shrubs can exceed hts of 15

ft. Some annual grasses and forbs in understory. Very few oaks or if present, suppressed in understory

### Community 2.2
### Post-fire burn shrub community

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

### Pathway 2.1a
### Community 2.1 to 2.2



**Mature shrub chaparral**

**Post-fire burn shrub community**

2.1a This community pathway occurs following a high intensity wildfire.

### Pathway 2.2a
### Community 2.2 to 2.1

**Post-fire burn shrub community**

**Mature shrub chaparral**

2.2a This community pathway occurs over time with no management action.

## State 3
## Annual Grassland State

### Community 3.1
### Grass-dominated system

This community phase is dominated by annual grasses, such as AVFA, BROMU, HORDE, and VULPI.

### Community 3.2
### Forb-dominated system

This community phase is dominated by annuals, such as ERODI, GALIU, and TRIFO species.

### Pathway 3.1a
### Community 3.1 to 3.2

**Grass-dominated system** **Forb-dominated system**

3.1a 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**

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

### Transition T1.a
### State 1 to 2

T1.a This transition occurs after decades of little to no disturbance agents (including management) which builds up fuels. A high severity, stand replacing fire then results in a system dominated by shrubs and other fire-adapted plants, leading to this chaparral dominated state.

### Transition T1.b
### State 1 to 3

T1.b This transition occurs after tree removal and repeated brush management.

### Restoration pathway R2.a
### State 2 to 1

R2.a This restoration pathway occurs after active brush management, chemical treatment, followed up with tree planting.

### Transition R.2b
### State 2 to 3

This restoration pathway occurs when continual brush management has successfully removed all shrubs and their seed bank from the site for long enough that annual herbaceous species begin to take competitive advantage of the site resources, creating a threshold to a new state where annuals dominate all ecological functions on the site

### Restoration pathway R3.a
### State 3 to 1

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

## Additional community tables

## Inventory data references

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

## References

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## Other references

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## Contributors

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## 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):**

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:**