USDA Natural Resources Conservation Service

Ecological site R022BI216CA
Active Hydrothermal Areas (Complex)

Accessed: 05/07/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 022B–Southern Cascade Mountains

Site Concept –
Slopes: 10 to 80, but generally 15 to 65.
Landform: Actively eroding mountain slopes and debris flows within the hydrothermally altered area of Brokeoff Volcano.
Soils: Shallow to very deep, well to somewhat poorly drained soils that formed in wet debris flow or colluvium and residuum.
Temperature Regime: Frigid.
MAAT: 38 and 42 degrees F (3.3 and 5.5 degrees C).
MAP: 63 to 119 inches (1,600 mm to 3,023 mm).
Soil texture: Clay loam and gravelly sandy loam.
Surface fragments: 2 to 30 percent gravel and 8 to 13 percent cobbles and stones.
Vegetation: During periods of stability patches of California red fir (*Abies magnifica*), mountain hemlock (*Tsuga mertensiana*) and western white pine (*Pinus monticola*) establish. There is fair cover of grasses and forbs such as western needlegrass (Achnatherum occidentale), squirreltail (Elymus elymoides), mountain monardella (Monardella odoratissima), lupine (Lupinus sp.) and hairy brackenfern (Pteridium aquilinum var. pubescens).

This site is a actively eroding mountain slope- debris flow complex. The actively eroding mountain slopes are shallow, steep, and dry, while the debris flow deposits are generally deep and in valley bottoms where there is more water availability. The erosion process is active enough that this complex is best described together than as separate sites, even though the actively eroding mountain slope and debris deposits have different site potentials they are only intermittently stable.

Associated sites

F022BI113CA	**Frigid Very Deep Loamy Slopes** This red fir site is associated with the Diamondpeak soils adjacent to this site.
R022BI203CA	**Moderately Deep Fragmental Slopes** This is a woolly mule-ears dominated rangeland found in the hydrothermally altered area.
R022BI209CA	**Loamy Seeps** This is a wet meadow site found in nearby drainages.

Table 1. Dominant plant species

Tree	(1) *Abies magnifica* (2) *Tsuga mertensiana*
Shrub	Not specified
Herbaceous	(1) *Carex* (2) *Pteridium aquilinum var. pubescens*

Physiographic features

This ecological site is found in the hydrothermally altered area of Brokeoff Volcano on actively eroding mountain slopes and debris flows. This site is found between 5,680 and 8,570 feet in elevation. Slopes range from 10 to 80 percent, but are generally between 15 and 65 percent.

The wetter positions in this site may have a water table at the surface from March to May, which drops below 60 inches by August.

Table 2. Representative physiographic features

Landforms	(1) Debris flow (2) Mountain slope
Flooding frequency	None
Ponding frequency	None
Elevation	1,731–2,612 m
Slope	10–80%
Water table depth	0 cm
Aspect	E, S, W

Climatic features

This ecological site receives most of its annual precipitation in the form of snow from November to April. The mean annual precipitation ranges from 63 to 119 inches (1,600 mm to 3,023 mm) and the mean annual temperature is between 38 and 42 degrees F (3.3 and 5.5 degrees C). The frost free (>32 degrees F) season is 60 to 85 days. The freeze free (>28 degrees F) season is 80 to 195 days.

There are no representative climate stations for this ecological site.

Table 3. Representative climatic features

Frost-free period (average)	85 days
Freeze-free period (average)	195 days

Precipitation total (average)	3,023 mm

Influencing water features

Soil features

This site is associated with the Aquic Dystroxerepts, Debris Flows and Typic Dystroxerepts soil components. Aquic Dystroxerepts, Debris Flows consist of very deep, somewhat poorly drained soils that formed in wet debris flow material from hydrothermally altered volcanic rocks. Aquic Dystroxerepts, Debris Flows have up to 2 inches of fresh organic material on the surface in more stable areas. The A horizon is about three inches thick with a clay loam texture. The subsurface horizons are medium to fine textured. Clay ranges from 30 to 34 percent. The buried soil is sometimes encountered at depths of 2 feet or more. Redoximorphic features are present at 9 inches. The Typic Dystroxerepts component consists of shallow to deep, well drained soils that formed in colluvium and residuum from hydrothermally altered volcanic rocks on actively eroding mountain slopes. The Typic Dystroxerepts have a 1 inch A horizon with a gravelly sandy loam texture, with gravelly or parargravelly loam and clay loam subsurface textures. Depth to a paralithic contact ranges from 10 to 60 inches. Permeability is moderately slow, but the paralithic bedrock is impermeable.

This ecological site is associated with the following major soil components within the Lassen Volcanic National Park Soil Survey Area (CA789):

Map Unit Component /Component percent %
119 Aquic Dystroxerepts, Debris Flows /11
119 Typic Dystroxerepts /10

Table 4. Representative soil features

Surface texture	(1) Gravelly sandy loam (2) Clay loam
Family particle size	(1) Loamy
Drainage class	Poorly drained to well drained
Permeability class	Moderately slow
Soil depth	25 cm
Surface fragment cover <=3"	2–30%
Surface fragment cover >3"	8–13%
Available water capacity (0-101.6cm)	6.86–11.43 cm
Soil reaction (1:1 water) (0-101.6cm)	3.5–5
Subsurface fragment volume <=3" (Depth not specified)	0–44%
Subsurface fragment volume >3" (Depth not specified)	0–25%

Ecological dynamics

This site is associated with debris flows caused by geothermal springs and the head cutting of the upper tributaries of Mill Creek. The wet and/or undercut slope material slumps and calves away, and collects in drainage bottoms. Portions of the deposits become stable for periods of time, until more material from above and/or stream channel down cutting remobilizes it from below.

This ecological site could be considered a process within the surrounding red fir forest site (F022BI113CA) if these slumps occur because factors related to soil stability in the Diamondpeak soil component. The Diamondpeak soils are mapped around these areas, and may have tendencies to calve away when adjacent to unstable areas. However, due to the long time scale of persistence and re-vegetation on these debris flows, the debris flows were created as an independent ecological site.

This ecological site is correlated to two soil components associated with the debris flows. The Aquic Dystroxerepts, Debris Flows component is the debris flow material found in the valley bottoms. This material is several feet deep, and the buried soil may be encountered beneath. The Typic Dystroxerepts component is the soil that remains on the actively eroding mountain slope. This soil, is similar to the Diamondpeak soil, but has lost the upper portion of the soil.

There is a combination of processes going on and variability in potential plant communities that establish on the slump faces and debris flow deposits. In deposits that remain stable for a time, California red fir (*Abies magnifica*), mountain hemlock (*Tsuga mertensiana*), and western white pine (*Pinus monticola*) grow fairly tall and develop into small patches of forest. In most areas, the debris flow is unstable and constantly readjusting with very little vegetation. In some areas logs in debris flows have held back material long enough for the forest to develop, but when the logs rot or erode away, the stable area may remobilize. Within the jumbled debris are small drainages and moist flats with sedges (Carex spp.) and thinleaf alder (*Alnus incana* ssp. tenuifolia). The Loamy Seeps ecological site (R022BI209CA) is similar to the wet areas within the debris deposits. Refer to this site (R022BI209CA) for more detailed information on plant species and ecological dynamics with in the wet deposits. The actively eroding mountain slope, where the debris material originated from is a harsh environment for conifer regeneration due low soil fertility, low water availability, and wind exposure. The trees remain stunted and grow openly for a long period after disturbance.

Lab data was not collected on the soil within the debris flow, but they may share some soil characteristics with the Diamondpeak soils. The Diamondpeak soils have been hydrothermally altered, and have high clay content, low pH, and potentially toxic levels of aluminum and manganese. In addition to the inherent properties of the soil, there may be ongoing chemical deposition from the active hydrothermal vents and bare areas, which can affect surface pH and mineralogy. Hydrogen sulfide (H_2S), carbon dioxide (CO_2), hydrogen gas (H_2), nitrogen (N), and helium (He) are some of the chemicals found in the thermal springs. They react with oxygen and other elements to form the variety of chemicals that can be found in the steam deposits.

The following State and Transition Model is a simplified example of the debris flow regeneration process. In actuality, this site is much more complex with multiple plant communities and pathways. More research is needed to fully describe this ecological site.

State and transition model

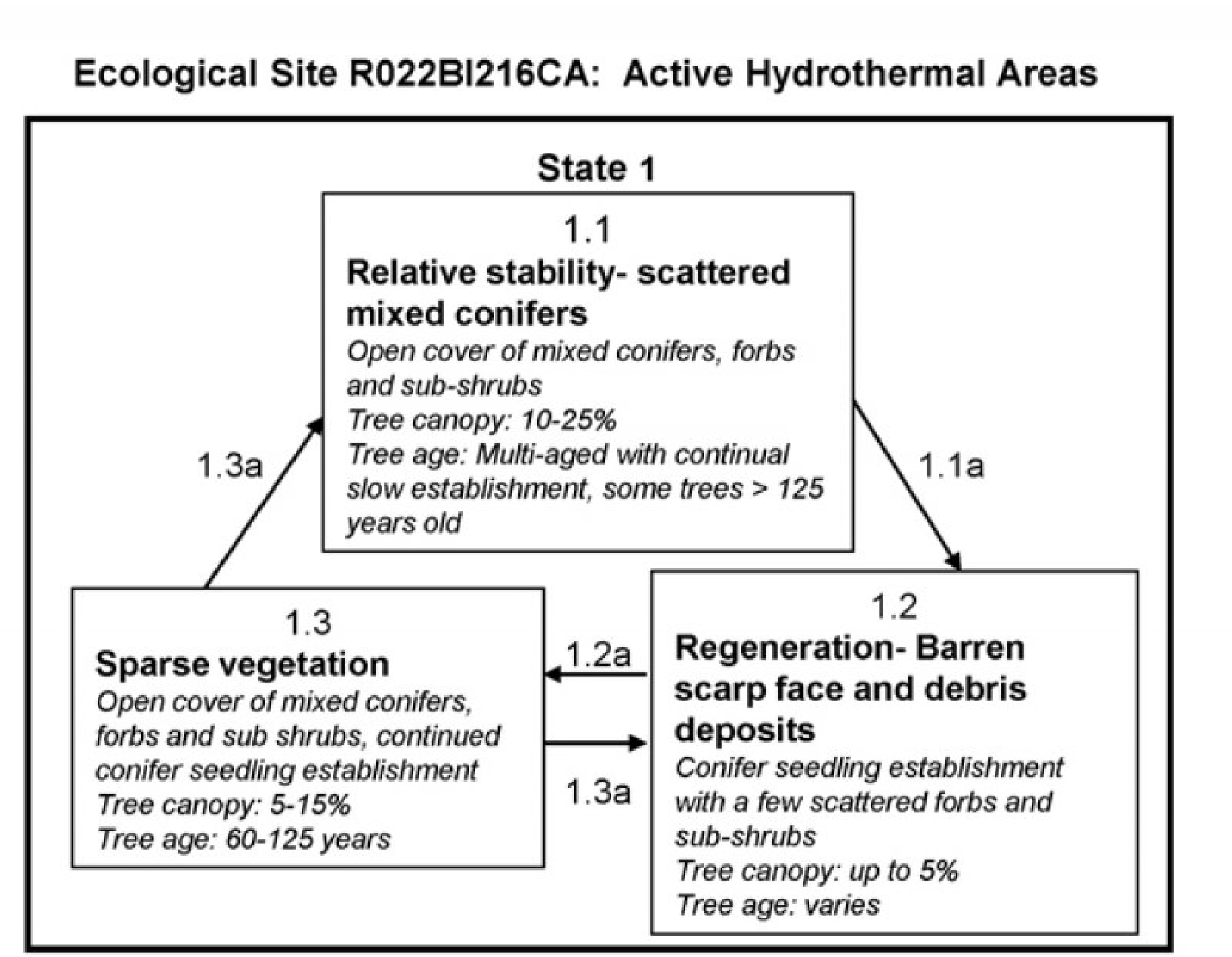

Figure 3. Active Hydrothermal Areas

State 1
Natural State

State 1 represents the natural conditions for this ecological site.

Community 1.1
Relative stability

Figure 4. Relative stability-scattered mixed conifers

This site has the potential to develop patches of open California red fir-mixed conifer forest. Within the patches canopy cover may be up to 35 percent, but across the slope canopy cover is low, 5 to 25 percent. The debris flow material and the scarp face develop at different paces. The debris flow deposits, when stable, can develop tree patches earlier than the scarp face. The scarp face has shallower soils on steep exposed slopes, lose water quickly to drainage and evaporation. Mountain hemlock is common at the upper elevations of the site, while California red-fir and western white pine are more common at the lower elevations of this site.

Forest overstory. Patches of California red fir and mountain hemlock may are .5 acres or so in size, with 70 to 80 feet tall trees. There are several younger strata of trees, since there is continual seedling establishment.

Overstory canopy cover ranges from 15 to 24 percent. California red fir and mountain hemlock dominate, with a small amount of western white pine.

Forest understory. The understory varies due to soil characteristics and water availability. Common understory species on drier, stable slump material are western needlegrass (Achnatherum occidentale), sedge (Carex spp.), squirreltail (Elymus elymoides), mountain monardella (Monardella odoratissima), lupine (Lupinus sp.) and hairy brackenfern (Pteridium aquilinum var. pubescens). On the slump faces there is low cover of pinemat manzanita (Arctostaphylos nevadensis). In wetter slump material hydrophytic vegetation is present including a mix of sedges, forbs and grasses.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	–	46	263
Grass/Grasslike	–	12	34
Tree	3	9	24
Shrub/Vine	–	9	22
Total	**3**	**76**	**343**

Table 6. Soil surface cover

Tree basal cover	0-3%
Shrub/vine/liana basal cover	0-1%
Grass/grasslike basal cover	0-2%
Forb basal cover	0-3%
Non-vascular plants	0%
Biological crusts	0%
Litter	50-90%

Surface fragments >0.25" and <=3"	2-30%
Surface fragments >3"	8-13%
Bedrock	3-8%
Water	0%
Bare ground	5-20%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	0-5%	–
>0.15 <= 0.3	–	0-2%	0-4%	–
>0.3 <= 0.6	–	–	0-1%	0-21%
>0.6 <= 1.4	1-11%	–	–	0-5%
>1.4 <= 4	0-10%	–	–	–
>4 <= 12	5-15%	–	–	–
>12 <= 24	2-8%	–	–	–
>24 <= 37	1-3%	–	–	–
>37	–	–	–	–

Community 1.2
Debris flow

This phase is characterized by barren scarp face and debris deposits created by a recent debris flow. Geothermal springs may arise in new locations which can trigger new debris flows. Active slumping and slope failures within existing landslide features also create barren conditions. The barren slopes and debris deposits slowly establish vegetation. This process may be similar to primary succession, but some organic matter and soil structure persists in these soils. Stable areas within the debris flow deposits may establish vegetation sooner than the upper slopes which lost the upper soil layers. The debris deposits are in the valley bottom where water and organic mater accumulates. The upper slopes are steep, droughty and exposed, loosing water rapidly. Organic matter rolls down the barren slopes or is deposited elsewhere by wind. The plants have higher survival rates after a period of physical and biological weathering of the debris material. Once plants pioneer into the debris material, they begin to accumulate organic matter and provide limited shade. The intact forests adjacent to the landslide provide seeds for colonization. Wind and animals disperse seed across the landslide. Data was not collected on this community. Forbs and grasses may establish along with mountain hemlock and California red fir seedlings. Mountain hemlock and California red fir seedlings have higher survival rates in partial shade, which is limited on this site at first, so trees may be slow to establish.

Community 1.3
Sparse vegetation

This community has sparse vegetative cover of small mountain hemlock and California red fir with scattered forbs and grasses. The stable areas on the debris deposits have fair cover of hairy brakenfern, mountain monardella, and lupines. The upper slopes have dispersed patches of pinemat manzanita.

Pathway 1.1a
Community 1.1 to 1.2

1.1a If this site experiences a slide or severe fire this community returns to the regeneration community (Community 1.2).

Pathway 1.2a

Community 1.2 to 1.3

1.2a This pathway is followed with time and growth in the absence of disturbance. During periods of stability vegetation continues to establish and increase in cover (Community 1.3).

Pathway 1.3a
Community 1.3 to 1.1

1.3a. With time and slope stability, canopy cover continues to increase and develops into Community 1.1.

Pathway 1.3b
Community 1.3 to 1.2

In the event of a landslide Community 1.2. develops.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			3–24	
	mountain hemlock	TSME	*Tsuga mertensiana*	3–17	1–5
	California red fir	ABMA	*Abies magnifica*	0–4	0–2
	western white pine	PIMO3	*Pinus monticola*	0–2	0–1
Shrub/Vine					
1	**Shrubs**			0–22	
	pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	0–22	0–2
Grass/Grasslike					
1	**Grass/ grasslike**			0–34	
	sedge	CAREX	*Carex*	0–17	0–5
	squirreltail	ELEL5	*Elymus elymoides*	0–7	0–2
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–7	0–2
	blue wildrye	ELGL	*Elymus glaucus*	0–3	0–1
Forb					
1	**Forbs**			0–263	
	hairy brackenfern	PTAQP2	*Pteridium aquilinum var. pubescens*	0–242	0–28
	lupine	LUPIN	*Lupinus*	0–15	0–1
	mountain monardella	MOOD	*Monardella odoratissima*	0–7	0–2

Animal community

Animals that use California red fir forests include martin, fisher, wolverine, black bear, squirrel, chickadee, pileated woodpecker, great gray owl, Williamson's sapsucker, mountain beaver, and pocket gopher.

Mountain hemlock forests provide cover and forage for wildlife species. Some birds eat the mountain hemlock seeds. In some areas the understory provides decent forage (Tesky, 1992).

Deer browse the new growth of conifers in the spring. Birds forage for insects in the foliage of mature conifers.

The California red fir cones are cut and cached by squirrels. Western white pine seeds are eaten by red squirrels and deer mice (Griffith, 1992).

Recreational uses

This area is unstable and not recommended for recreational uses.

Wood products

The wood from California red fir is straight-grained and light. California red fir is soft but stronger than the wood of other firs, and has a low specific gravity. The wood is used for fuel, coarse lumber, quality veneer, solid framing, plywood, printing paper, high-quality wrapping paper, and is preferred for pulping (Cope, 1993).

Western white pine wood is straight-grained, light, and highly valued. The wood is used to make window and door sashes, doors, paneling, dimension stock, matches, wood carvings and toothpicks (Griffin, 1992).

If harvested, mountain hemlock is usually sold with western hemlock. The wood is moderately strong and used as small lumber, pulp, interior finish, cabinetry, crates, flooring and ceilings (Tesky, 1992).

Inventory data references

The following NRCS data plots were used to describe this ecological site:

789343
789901- type location

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T30 N R4 E S15
UTM zone	N
UTM northing	4479662
UTM easting	624582
General legal description	The type location is about 0.7 miles north-northeast of the Sulphur Works parking lot, in Lassen Volcanic National Park.

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Contributors

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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	
Approved by	
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:**